REPORT OF THE TWENTY-SEVENTH MEETING OF THE COORDINATION GROUP FOR METEOROLOGICAL SATELLITES

CGMS XXVII

Beijing, People's Republic of China, 13-18 October 1999

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TWENTY-SEVENTH MEETING OF THE CGMS
FINAL REPORT OF THE PLENARY SESSION

A. INTRODUCTION

A.1 Welcome

CGMS-XXVII was convened by the China Meteorological Administration (CMA) at 10:00 a.m. on 13 October 1999 in Beijing. Prof. Dong Chaohua, Director General of the National Satellite Meteorological Center of CMA opened the twenty-seventh meeting of CGMS. Professor Yan Hong, the Deputy Administrator of the China Meteorological Administration on behalf of the Administrator of CMA, Mr. Wen Kegang, then welcomed the delegations from EUMETSAT, Japan, Russia, the United States and WMO, and expressed his great pleasure to host this meeting in Beijing. He stressed the important role of CGMS in satellite meteorological activities and in establishing and maintaining the space component of the Global Observing System. The discussions within CGMS and the exchange of information between all of the Members had a considerable influence on the development of meteorological satellite systems in China and applications of meteorological satellite data. Professor Yan Hong added that the work of CGMS would continue to influence meteorological satellite developments in China and emphasized CMA's continuing support to CGMS. He wished the twenty-seventh CGMS plenary meeting in Beijing a very successful session.

A.2 Election of Chairman

Prof. Xu Jianmin, Engineer General of NSMC, was unanimously nominated as Chairman of CGMS XXVII with Dr. Hinsman of WMO as Co-Chairman.

A.3 Adoption of Agenda and Work Plan of W/G Sessions

The Agenda (see annex 1) was adopted. It was agreed that Working Group III dealing with Satellite Tracked Winds would meet on Thursday morning, while Working Groups I and II, dealing with telecommunications and satellite products, respectively, would work in parallel on Thursday afternoon.

The Secretariat provided the list of working papers submitted to CGMS XXVII (see annex 2), as well as a provisional order of business which was used as a basis for the subsequent discussions.

A.4 Nomination of WG Chairmen, Rapporteurs and Drafting Committee

The following persons were nominated as Chairmen for the Working Groups:

- WG I (Telecommunications) - Mr. Robert Wolf
- WG II (Satellite Products) - Mr. Nobuo Sato
- WG III (Satellite Tracked Winds) - Dr. Paul Menzel

The Drafting Committee was appointed, comprising Mr. Gordon Bridge, Dr. Donald

Hinsman, Mr. Nobuo Sato, Dr. Elena Manaenkova, Mr. Marlin Perkins and Prof. Xu Jianping. All CGMS Members were invited to provide inputs to the final report through this drafting committee.

A.5 Review of Action Items from Previous Meetings

The Secretariat reviewed the outstanding actions from previous meetings, taking into account the input provided in EUM-WP-01, JPN-WP-01, RUS-WP-00, USA-WP-01 and WMO-WP-02:

(i) Permanent actions

1. *All CGMS Members to inform the Secretariat of any change in the status or plans of their satellites to allow updating of the CGMS Tables of Satellites.*

   This is done on a case by case basis.

2. *The Secretariat to review the tables of current and planned polar and geostationary satellites, and to distribute this updated information, via the WWW Operational Newsletter, via Electronic Bulletin Board, or other means as appropriate.*

   This information has been made on-line on the CGMS homepage. It also has been published in the Final Report of CGMS XXVI. A further update was submitted to CGMS XXVII for review.

3. *All satellite operators to circulate regular satellite operational reports.*

   This is routinely done.

4. *All satellite operators to provide NOAA/NESDIS with information on unexplained anomalies for study, and NOAA to provide solar event information to the satellite operators on request and a status report on the correlation study at each meeting.*

   Information on anomalies are presented under agenda item B.3 in USA-WP-04 and JPN-WP-03.

5. *All CGMS Members to regularly verify the consolidated list of IDCP assignments through the online service provided by the CGMS Secretariat.*

   This is routinely done.

6. *All satellite operators to regularly provide WMO with information on the number of meteorological satellite reception stations in their areas of responsibility.*

   This is routinely done.

7. *All CGMS Members to inform users to register user stations within their area of responsibility.*

This is routinely done.

8. *CGMS Members generating Satellite Tracked Winds to check that the following monthly statistics are sent and received on a quarterly basis via the CGMS server supported by WMO: number of co-locations, temporal and spatial co-location thresholds; and radiosonde inclusion/exclusion criteria.*

This is routinely done.

9. *CGMS Members also participating in the CEOS Cal/Val should ensure the complementarity of activities and report at CGMS and CEOS Cal/Val meetings as required.*

This is routinely done.

(ii) Outstanding actions from previous meetings

ACTION 25.05 *EUMETSAT to provide CGMS Members with direct FTP access, via Internet, to the IDCS database.*

Closed.

ACTION 25.07 *USA, with the assistance of the CGMS Secretariat, to develop a primary set of reporting statistics on IDCS performance to be provided as feedback to DCP Operators and the WMO on a quarterly basis by 31 August 1998.*

Closed.

ACTION 25.08 *CGMS Secretariat, with the assistance of WMO, to implement an IDCS end-to-end system test at the time of the regular WMO monitoring of the GTS in the period 1-15 October 1998, and report results to CGMS XXVII.*

Closed. Effectiveness of this type of test under review with WMO and CGMS satellite operators. This is reformulated in ACTION 27.01.

ACTION 25.09 *WMO to distribute the results of IDCS end-to-end system tests to the appropriate bodies with WMO (e.g. CMM and CBS).*

Closed. This is reformulated in ACTION 27.01.

ACTION 27.01 (1) EUMETSAT, Japan and USA to implement the monitoring of IDCS performance using the agreed set of reporting statistics and report to CGMS Secretariat.
(2) CGMS Secretariat to report on the effectiveness of this scheme at CGMS XXVIII.

(iii) Actions from CGMS XXVI

ACTION 26.01 *CGMS Members to review and provide comments to NOAA regarding NOAA's 300 bps and 1200 bps DCP design and certification procedures, by 31 August 1998.*

Closed. Design Specifications finalised in August 1999.

ACTION 26.02 *NOAA to present at CGMS XXVII, a proposed design and certification plan for 300 bps DCPs for acceptance as a "standard" by CGMS Members at CGMS XXVII.*

Closed. Certification Standards for 300 and 1200 bps DCPs were completed and released to manufacturers in August 1999. See Report of WG I.

ACTION 26.03 *All CGMS Members to inform the CGMS Secretariat by 15 September 1998 on any action planned to minimise the impact of the Leonid meteor storm expected in autumn 1998 for posting on the CGMS home page.*

Closed. Information posted on homepage from Japan, CMA, EUMETSAT and NOAA.

ACTION 26.04 *WMO and CGMS satellite operators to express to the USA their assessment of the difficulties anticipated for the global community resulting from the change of HRPT modulation scheme for NOAA-N and -N' and offer support to the USA in receiving a waiver by 30 July 1998.*

Closed. NOAA thanked the CGMS Members for their letters of support. As a result, NOAA will not change the modulation scheme for NOAA-N and N'.

ACTION 26.05 *CGMS satellite operators to inform WMO of the actions they propose to take in support of the WMO Strategy of Improved Satellite System Utilisation by April 1999.*

Closed. WMO-WP-05 reports on this.

ACTION 26.06 *WMO to continue the rolling review process to include additional applications of relevance to CGMS satellite operators and data impact studies and to present another iteration of the Statement of Guidance at CGMS XXVII.*

Closed. WMO-WP-07 reports on this.

ACTION 26.07 *WMO to inform GCOS that CGMS suggested that GOSSP develop its own Statement of Guidance for requirements within their purview for consideration at a future CGMS.*

Closed. Internal WMO (SSO/SAT) memo was sent on 22 July 1998.

ACTION 26.08 *CGMS Members to forward to EUMETSAT their final comments on the IDCS Users Guide by 31 August 1998.*

Closed. The document has been published.

ACTION 26.09 *Russian Federation, People's Republic of China to share their information and experience relevant to the interference on DCP channels in the GOMS and FY-2A areas of coverage.*

Closed. This has been done in an exchange of letters and emails. RUS-WP-04 reports on this.

ACTION 26.10 *USA to forward its final comments on LRIT Global Specification Issue 2.5, by 31 July 1998.*

Closed. No additional comments were received after CGMS XXVI. Specifications were published as discussed.

ACTION 26.11 *Russia, India to forward by 31 August 1998 their final comments on the proposed LRPT/AHRPT specifications.*

Closed. Response was received from Russia on 30.09.1998.

ACTION 26.12 *EUMETSAT to propose an outline of a Broadcast Format Guide to be developed with input from all CGMS Members, by 30 September 1998.*

Closed. An outline was distributed in February 1999. The format was approved by CGMS in March 1999.

ACTION 26.13 *CGMS Members to indicate points of contact and provide input to the Broadcast Format Guide by 1 January 1999.*

Closed.

ACTION 26.14 *WMO to inform the relevant CBS Working Group of the requirements of some members of CGMS requirement for a common code table to identify a particular instrument for satellite data and products.*

Closed. An Internal WMO (SSO/SAT) memo was sent on 22 July 1999.

ACTION 26.15 *WMO to initiate a study on the possibilities of meeting WMO requirements for digital satellite image data exchange, taking into account the future trends in communication technology.*

Closed. Two OPAG ISS Expert Team Meetings in October 1999 will propose strategy for redesign of MTN for consideration at next CBS.

ACTION 26.16 *EUMETSAT to invite ESA to report at CGMS XXVII on the status of the ENVISAT mission.*

Closed. ESA has provided a report in ESA-WP-01.

ACTION 26.17 *CGMS Members to nominate a point of contact to contribute to the development of the new Consolidated Report by 31 August 1998.*

Closed. CGMS XXVII will discuss the strategy presented in EUM-WP-14 for updating the Consolidated Report.

ACTION 26.18 *CGMS Members to forward to J. Morgan by 31 August 1998 their inputs to the second release of the CGMS Directory of Meteorological Satellite Applications.*

Closed. A second release has been distributed.

ACTION 26.19 *EUMETSAT to coordinate with UNOOSA participation of CGMS in UNISPACE III.*

Closed. A CGMS satellite meteorology workshop was held at UNISPACE III.

ACTION 26.20 *CGMS satellite operators to inform WMO of past and planned tests of year 2000 compliance for communication to WMO Members via the WWW Newsletter.*

Closed. WMO-WP-14 informs CGMS Members of the development of a WMO year 2000 Monitoring and Contingency Plan.

ACTION 26.21 *CGMS representative to make a presentation at CBS on behalf of CGMS on the Members' plans addressing year 2000 compliance of their operational satellite systems.*

Closed.

ACTION 26.22 *All CGMS satellite operators to express to EUMETSAT their position regarding CGMS views on CBS restructuring, by 30 September 1998.*

Closed.

ACTION 26.23 *EUMETSAT to forward to the President of WMO, by 15 November 1998 an agreed response by CGMS Satellite Operators to the CBS* *restructuring proposal, with respect to satellite activities and cooperation with CGMS.*

Closed.

ACTION 26.24 *WMO to inform the other CGMS Members on detailed procedures to be followed for placing CGMS working papers on the WMO Satellite Activities server (http://sat.wmo.ch).*

Closed.

ACTION 26.25 *CGMS to distribute the working papers for CGMS XXVII in an electronic form via the WMO Satellite Activities server (http://sat.wmo.ch).*

Closed. Working papers have been distributed via the WMO Satellite Activities server.

ACTION 26.26 *CGMS Members to provide inputs to WMO related to their planned use of passive sensors frequencies by 30 September 1998.*

Closed. "Handbook on frequencies for meteorological applications" sent to WMO. SFCG agreed plan for re-allocation of frequency band 70-270 GHz and sent this to ITU.

ACTION 26.27 *CGMS Members to indicate their use of the 2 GHz space operations band to their national frequency authorities to avoid potential future loss of parts of this important frequency band by 30 September 1998.*

Closed. Japan, USA, Russia, EUMETSAT and ESA communicated the use of the 2GHz space operations band to their national authorities.

ACTION 26.28 *WMO to communicate to its Members its recommendations concerning the protection of frequencies allotted to meteorological satellite operations prior to WRC99.*

Closed. Discussions prior to WRC 2000 in expert group planned in November 1999.

ACTION 26.29 *(i) All satellite operators to send to the CGMS Secretariat, by 31 January 1999, their planned use of frequencies in the bands 137-138 MHz and 1698-1710 MHz, together with full details of satellite orbits and other relevant supporting information.*

Closed. Response was received from NOAA via email on 1.02.99. Russia presented the information at CGMS-XXVII WG I.

(ii) The CGMS Secretariat to consolidate all of these inputs and provide the information to NOAA in order to perform computer simulations.

Closed. The requirement will be reviewed again next year if necessary.

ACTION 26.30 *NOAA to perform computer simulations leading to the preparation of a draft plan identifying potential areas of interference, for discussion at CGMS XXVII.*

Closed. See ACTION 26.29 (ii).

ACTION 26.31 *CGMS Members to do their utmost to determine sources of interference to geostationary meteorological satellite services and report to CGMS XXVII.*

Closed. Russia and EUMETSAT have sent a letter to ITU on 22.01.1999. NOAA/NESDIS has identified commercial vendors for identifying sources of interference. USA-WP-16 and EUM-WP-18 discuss this in WG I.

ACTION 26.32 *CGMS Members to analyse requirements for future use of the IDCS in the next 10-15 years and to consider the possible reconfiguration of the IDCS to narrower bandwidth channels and report to CGMS XXVII.*

Closed. EUM-WP-19, USA-WP-19, JPN-WP-06 present the requirements for future use of IDCS. See Report of WG I.

ACTION 26.33 *CGMS Members to report on the development and operation of higher-rate DCP at CGMS XXVII and to study the impact of such systems upon nominal IDCS operations.*

Closed. See USA-WP-19, JPN-WP-06 and EUM-WP-20. See also report of WG I.

ACTION 26.34 *USA to forward CGMS calibration papers to ISCCP and seek their comments*.

Closed. USA provided input in April 1999.

ACTION 26.35 *CGMS Members to present their operational calibration practices at CGMS XXVII.*

Closed. USA-WP-20, EUM-WP-22, CMA-WP-09, JPN-WP-17 present the operational calibration practices of respective CGMS Members.

ACTION 26.36 *EUMETSAT to invite ESA to present a paper at CGMS XXVII on calibration of active microwave sensors.*

Closed. ESA-WP-02 reports on calibration of active microwave sensors.

ACTION 26.37 *CGMS Members to report on algorithm adjustment, continued inter-comparisons (expanding to other spectral bands such as the split window and water vapour bands), and absolute calibration attempts at CGMS XXVII.*

Closed. USA-WP-21 and EUM-WP-23 report on this.

ACTION 26.38 *The CGMS rapporteur on ITWG to present a report at CGMS XXVII on ITSC X in particular addressing the issues raised at CGMS XXVI.*

Closed. Completed in January 1999. USA-WP-23 gives a report.

ACTION 26.39 *EUMETSAT to present a report on using satellite data over land at CGMS XXVII.*

Closed. Completed in January 1999. EUM-WP-24 reports on using satellite data over land.

ACTION 26.40 *CGMS Members to initiate an action such that satellite data and products records would be adjusted to contain the exact time and location of the observations and report at CGMS XXVII.*

Closed. See Report of WG II.

ACTION 26.41 *Members of the organising committee of IWW 4 to report on the outcome of the workshop at CGMS XXVII.*

Closed. See EUM-WP-26.

ACTION 26.42 *JMA to report at IWW4 in a working group meeting on a comparison of monthly wind statistics based on circular and elliptic collocation areas.*

Closed.

ACTION 26.43 *All satellite operators to consider to place their monthly performance statistics on their WWW homepages.*

Closed. Updates of performance statistics are regularly received.

ACTION 26.44 *EUMETSAT to implement and maintain on its homepage a section on "selection/rejection criteria at NWP centres for satellite tracked winds".*

Closed. The NWP center usage document has been put on-line on 7.12.1998.

ACTION 26.45 *The CGMS rapporteur at the Winds Workshop to raise at IWW4 the issue whether the current information on "selection/rejection criteria at NWP centres for satellite tracked winds" is complete and sufficient for a comparison of the different implementations of the utilisation of satellite tracked winds at NWP centres and report to CGMS XXVII.*

Closed. EUM-WP-28 reports on this.

ACTION 26.46 *The CGMS rapporteur at the Winds Workshop to raise at IWW4 the issue of utility and trade-offs of shorter time interval scans for the derivation of global wind fields and report to CGMS XXVII.*

Closed. A report is found in EUM-WP-29.

ACTION 26.47 *All satellite operators to investigate the current possibilities for scans at shorter time intervals (15 minutes) for the derivation of spatially denser and more accurate wind fields and report to CGMS XXVII.*

Closed . See USA-WP-24, EUM-WP-29.

ACTION 26.48 *The CGMS rapporteur at the Winds Workshop to raise at IWW4 the issue of encoding all satellite tracked winds with relevant auxiliary information in BUFR and report to CGMS XXVII.*

Closed. EUM-WP-30, USA-WP-25 address this topic.

ACTION 26.49 *All satellite operators to consider an encoding of their wind products in BUFR including the delivery of auxiliary information on the quality, etc. of winds and report to CGMS XXVII.*

Closed. Suggestion was made at IWW4. See USA-WP-25 and EUM-WP-30.

ACTION 26.50 *Japan and PRC to study the possibilities for back-up of product generation and inform CGMS XXVII of the progress in their discussions.*

Continuing. See report of WG II.

ACTION 26.51 *WMO to reconfirm the requirement for a Russian Federation geostationary satellite at 76° East over the Indian Ocean through correspondence with Roshydromet and the Russian Space Agency by 31 August 1998.*

<u>Closed.</u>

ACTION 26.52 *India to study possibilities for supporting the CGMS principles on regional contingency planning and transmit them to higher authorities and report at CGMS XXVII.*

Continuing.

ACTION 26.53 *India to actively promote the use of INSAT data throughout the Indian Ocean region and inform CGMS XXVII of such use.*

Continuing.

B. REPORT ON THE STATUS OF CURRENT SATELLITE SYSTEM

B.1 Polar-orbiting Meteorological Satellite Systems

China reported in PRC-WP-01 that FY-1C was launched on May 10, 1999. Compared to the previous satellites, FY-1A and -1B, the most notable change for FY-1C is the number of channels of its scanning radiometer which has been increased from 5 to 10. The High Resolution Picture Transmission of FY-1C is named CHRPT which can be acquired by other countries without any restriction. FY-1C is working well and the quality of its images is good. PRC-WP-01 also described the status, specification, orbit, instrument and transmission characteristics of the satellite.

Russia informed CGMS in RUS-WP-01 that two polar-orbiting satellites, of the Meteor-2 and 3 series, are currently operated beyond their lifetime and with reduced capabilities. Only TV image data from the MR-900 scanning instrument are available through direct broadcast in APT mode (137 MHz). To complement the existing Meteor meteorological satellite measurements, a similar imager (MR-900) was installed on board of RESURS-01 N4 (launched on 10 July 1998). Data is also transmitted in APT mode. Additional satellite information, useful for meteorological and hydrological applications, will be provided by the joint Russian–Ukrainian satellite OKEAN-O, which was launched on 17 July 1999. Its core payload includes, in particular, a side-looking radar and a MW radiometer.

NOAA reported on the status of the USA polar-orbiting meteorological satellite systems in USA-WP-02. The Polar Operational Environmental Satellite (POES) constellation includes two primary, two secondary and one stand-by spacecraft. The primary operational spacecraft, NOAA-14 and NOAA-15 are in sun-synchronous afternoon and morning orbits, respectively. Two secondary spacecraft, NOAA-11 and NOAA-12, provide additional payload operational data, while the stand-by spacecraft, NOAA-10, supports minimal SAR functions and is only contacted once a week. USA also reported on the current DMSP constellation that consists of two primary, two secondary and one back-up operational spacecraft. While the direct broadcast of the DMSP satellites is encrypted, the data are available in near-real-time from NOAA. The next DMSP spacecraft is scheduled for launch in December 1999.

B.2 Geostationary Meteorological Satellite Systems

EUMETSAT reported in EUM-WP-02 that Meteosat-7 is fully operational at 0°, Meteosat-6 is in stand-by mode at around 9° W, and Meteosat-5 is operated at 63° E in support of the Indian Ocean Experiment (INDOEX). The orbital inclination of Meteosat-5 is no longer controlled and by the end of December 1999 it will have reached 3.3°. Following an internal study to evaluate the effect of continuing to provide an operational service from a spacecraft with such a high inclination, it was agreed that the satellite would continue to provide the 63° East Operational Service until the end of 2001, when the inclination will have reached approximately 5°. On Meteosat-7 a lower than nominal battery capacity was observed after the spring 1998 battery conditioning and eclipse cycle. The impact is that Meteosat-7 has to be configured such that DCP messages are not received for the duration of the eclipse, and Meteosat-6 is used to support the mission in these periods. The battery performance continues to be monitored and is stable.

Table 1 : Current Polar-Orbiting Satellites Coordinated within CGMS

(as of 18 October 1999)

Orbit type **(equatorial crossing times)**	**Satellites in orbit** (+operation mode) P=Pre-operational Op=operational B=back-up L=limited availability	**Operator**	**Crossing Time** A=Northw D=Southw +Altitude	**Launch date**	**Status**
Sun-synchr. "Morning" (6:00 – 12:00) (18:00 – 24:00)	NOAA-15 (Op)	USA/NOAA	7:30 (D)	05/98	Functional
	NOAA-12 (L)	USA/NOAA	06:40 (D) 850 km	05/91	Functional (except sounding)
	NOAA-10 (L)	USA/NOAA	10:00 (D) 840 km	12/86	Search and Rescue only
	DMSP-F14 (Op)	USA/NOAA	20:42 (A) 852 km	04/97	Defense satellite. Data available to civilian users through NOAA.
	DMSP-F12 (B)	USA/NOAA	21:13 (A)	8/94	Defense Satellite. Data available to civilian users through NOAA.
	RESURS-01-4 (P)	Russia	09:30 (A) 835	7/98	Partly meteorological mission (APT broadcast of TV images)
Sun-synchr. "Afternoon" (12:00 –16:00) (00:00 – 04:00)	NOAA-14 (Op)	USA/NOAA	14:00 (A) 850 km	12/94	Functional, one OBP is unusable
	NOAA-11 (L)	USA/NOAA	14:00 (D)	09/88	Sounding only
Sun-synchr. "Early morning" (4:00 - 6:00) (16:00 – 18:00)	DMSP-F13 (Op)	USA/NOAA	17:40 (A) 850 km	03/97	Defense satellite. Data available to civilian users through NOAA.
	DMSP-F11 (B)	USA/NOAA	19:32 (A) 850 km	11/91	Defense Satellite. Data available to civilian users through NOAA.
Sun-synchr. "morning"	FY-1C	China	8:40 (A) 860 km	5/99	Functional
Non sun-Synchronous or unspecified orbits	METEOR 2-21 (Op)	Russia	950 km	08/93	Functional, except IR scanning instrument (APT only)
	METEOR 3-5 (Op)	Russia	1200 km	08/91	Functional, except IR scanning instrument (APT only)

The current generation of Meteosat satellites will continue until at least the end 2003, in order to allow time for many thousands of Meteosat users to transfer to Meteosat Second Generation (MSG) and to provide a “back-up” satellite throughout the transition period.

CMA informed the meeting that it receives Meteosat-5 HRI data using a reception system with two fixed antennas. CMA expressed its sincere thanks to EUMETSAT for providing Meteosat-5 data and supporting technical information in assisting CMA with image reception and processing.

In a working paper received by mail (IND-WP-01), India reported on the status of the Indian National Satellite (INSAT) System. INSAT satellites are three-axis stabilised operational multi-purpose spacecraft including a meteorological payload, as well as telecommunications and broadcast services. The operational INSAT system includes the 1st generation INSAT-1D (launched in 1990) positioned at 74°E, the second generation INSAT-2B satellite (launched in 1993) located at 93.5°E, INSAT-2E located at 83°E (launched in 1999) and INSAT-2A in stand-by mode at 74°E. Both operational satellites provide VHRR imagery on a 3-hourly basis (INSAT-2B provides only VIS data) with a possibility of rapid scans during special weather situations, as well as half-hourly sequences at main synoptic hours for the derivation of Cloud Motion Vectors (CMVs). The predicted end of life of INSAT-1D is early 2000, but some of its services may continue in an inclined orbit. INSAT-2E was launched on 3 April 1999 and is presently in a test mode. INSAT-2E has a new payload called the Charged Coupled Device (CCD) camera capable of taking 1 km resolution images during day time in 3 bands (visible, near IR and short-wave IR).

The INSAT system provides a Cyclone Warning Dissemination Service (CMDS) and a Meteorological Data Dissemination (MDD) service, which delivers 3-hourly WEFAX-type imagery and meteorological data operationally to some 90 domestic stations. INSAT also performs data collection and stations. Both MDD and CWDS are broadcast services operating at two separate frequencies using the S-band broadcast capability of INSAT. INSAT also performs data collection and re-transmission from more than 100 DCPs.

Japan reported on the status of GMS-5 and GMS-4 in JPN-WP-02. GMS-5 is stationed at 140° E. Lubricant build-up in the mirror scanning mechanism has been observed and JMA tries to reduce the impact by monitoring the scanning torque and changing the scanning range of the mirror. GMS-4 suffers from lower capability of solar cells and currently operates as a back-up satellite and is stationed at 120° E. After the missions are taken over by MTSAT, currently scheduled for launch in November 1999, GMS-5 will be moved to 120° E as a back-up satellite. MTSAT will become operational after six months of in-orbit tests.

CMA informed CGMS in PRC-WP-02 on the status, operation and anomalies of FY-2A since it was launched on 10 June 1997. The main defect of FY-2A is that the electrical current used by the motorised antenna de-spin subsystem is higher than the normal value and, as a consequence, the S-band antenna is operated in reduced mode. This causes interruption of satellite operations. Whilst FY-2A cannot be operated continuously, it does provide regular imagery.

In PRC-WP-12, CMA reported on the current status of the data processing system in the National Satellite Meteorological Center. The system has been updated to meet the requirements for FY-1C data processing and the capability of the network has been improved.

Table 2 : Current Geostationary Satellites Coordinated within CGMS

(as of 18 October 1999)

Sector	Satellites currently in orbit (+type) P: Pre-operational Op: Operational B: Back-up L: Limited availability	Operator	Loca-tion	Launch date	Status
EAST-PACIFIC (180°W-108°W)	GOES-10 (Op)	USA/NOAA	135°W	04/97	Inverted, solar array anomaly, DCP interrogator on back-up
WEST-ATLANTIC (108°W-36°W)	GOES-8 (Op) GOES-9 (L)	USA/NOAA USA/NOAA	75°W 105°W	04/ 94 05/98	Minor sounder anomalies, loss of redundancies on some sub-systems in stand-by, lubricant starvation condition of momentum wheels
EAST ATLANTIC (36°W-36°E)	METEOSAT-6 (B) METEOSAT-7 (Op)	EUMETSAT EUMETSAT	0°	11/ 93 02/97	minor gain anomaly on IR imager Functional
INDIAN OCEAN (36°E-108°E)	METEOSAT-5 (Op) GOMS-N1 (B) FY-2A (L) INSAT II-B (L) INSAT II-A (B) INSAT II-E (Op) INSAT I-D (Op)	EUMETSAT RUSSIA CHINA INDIA INDIA INDIA INDIA	63°E 76°E 105°E 93.5°E 74°E 83°E 74°E	03/91 11/94 06/97 07/93 04/99 06/90	INDOEX Experiment until 12/1999, function. but inclination Since 9/98 in stand-by Experimental Satellite Cloud imagery for domestic use but wind products available on WMO GTS
WEST-PACIFIC (108°E-180°E)	GMS-5 (Op) GMS-4 (B)	JAPAN JAPAN	140° E 120°E	03/ 95 09/89	Operational In stand-by

The status of NOAA geostationary satellites GOES-8, -9, -10 was described in USA-WP-03. GOES-8 at 75° W is operating nominally with some loss of redundancy on certain sub-systems. In the past year GOES-10 was transitioned out of an on-orbit storage mode and brought into primary status at 135° W as a replacement to GOES-9, which had suffered from a lubricant starvation condition of its momentum wheels and was subsequently transitioned to a passive, spin-stabilised storage mode at 105° W. GOES-9 can be called up to replace either GOES-8 or GOES-10 in the event of a spacecraft failure.

GOES-L is scheduled to be launched in December 1999. It will join GOES-9 in a spin-stabilised storage mode and will be used when needed to replace either GOES-8 or GOES-10 as primary operational spacecraft.

B.3 Anomalies from solar and other events

USA-WP-04 discussed the coming solar maximum predicted to occur around March 2000 and reported on its predicted intensity and the types of satellite anomalies to be expected over the next two to four years.

The USA mentioned that several new data sets have become available to space weather forecasters during recent years. Real-time data is being broadcast from NASA's Advanced Composition Explorer. This explorer together with a ground system network composed of international partners allows NOAA to give approximately one hour alerts of geomagnetic storms. Sometime after the solar maximum, solar x-ray imagers will be flying on NOAA's GOES satellites to provide continuous x-ray imagery of the sun. This will improve several classes of forecasts, especially the warnings of proton events. NOAA will also begin to continuously monitor the sun's EUV flux with a sensor on GOES-N to be continued on the other satellites in the GOES series. **The USA encouraged CGMS Members to make use of solar activity warnings to avoid damage to the operational satellites, as well as to report any observed solar events to NOAA.**

Japan reported in JPN-WP-03 on the intensified monitoring that had been carried out for GMS toward the Leonid Meteor Storms in November 1998, as well as its activities planned to monitor GMS and MTSAT during the Leonid Meteor Storms expected in November 1999.

C. REPORT ON FUTURE SATELLITE SYSTEMS

C.1 Future Polar-orbiting Meteorological Satellite Systems

EUM-WP-03 described the EUMETSAT Polar System (EPS), which is the European contribution to the Initial Joint Polar System (IJPS) established with NOAA, and the first European contribution to the follow-up Joint Polar System (JPS) expected to be formed with the US "Converged" NPOESS system. The IJPS and JPS will provide global meteorological and climate data from a series of European and American sun-synchronous polar-orbiting satellites, replacing the current NOAA K-L-M series.

The EPS system is dedicated to the acquisition, processing and dissemination of observational data from the morning orbit. It also provides capabilities for cross-support and data exchange with the NOAA POES system, which covers the afternoon orbit service. The EPS system comprises a space segment, based on three successive METOP satellites, and a ground segment. The application component of the ground segment that will generate a variety of products, is based on the combination of central facilities and a distributed network of satellite applications facilities developed and hosted by several EUMETSAT Member States.

The development and procurement of the three METOP satellites is under the responsibility of a joint ESA-EUMETSAT Single Space Segment Team. The METOP payload consists of a suite of 10 instruments, including a visible and IR imager (AVHRR-3), microwave sounders (MHS, AMSU-A and -B), IR (HIRS and IASI) and UV (GOME-2) sounders, a C-band dual swath scatterometer (ASCAT), a GNNS Receiver for atmospheric sounding (GRAS), data collection (ARGOS), S&R transponders and the Space Environment Monitor. The satellite is also equipped with a solid state recorder enabling it to dump all payload data at full resolution, including AVHRR-3 data. EUMETSAT is responsible for the delivery of the MHS, IASI, GRAS, ASCAT, GNN and ARGOS-DCS for METOP, whilst NOAA will provide the AMSU-A, HIRS-4, SEM, SER, ARGOS for POES, and AVHRR-3 instruments.

The EPS Overall Ground Segment is composed of the Core Ground Segment that performs the acquisition, control, pre-processing and dissemination functions, and additional facilities, including the U-MARF multi-mission archiving facility, the network of Satellite Applications Facilities (SAFs) and external support facilities, e.g. for external calibration/validation.

In ESA-WP-01, ESA informed CGMS that preparations are well advanced for ENVISAT, which will be launched by Ariane V, currently planned for November 2000. The same applies to ground segment preparation activities. ENVISAT is a multi-mission 8-ton polar orbiter, which will continue and enlarge the mission of the present ERS series. Of particular interest is the suite of innovative instruments dedicated to atmospheric chemistry research (e.g. GOMOS, SCHIAMACHY, MIPAS) as well as those to be used for climate and environment monitoring purposes. The ENVISAT mission is expected to last 5 years.

CGMS was informed in PRC-WP-03 that China plans to launch FY-1D in 2001. The function and specification of FY-1D are the same as FY-1C. In addition, the second generation of polar-orbiting meteorological satellite FY-3 is now in the concept design phase.

In RUS-WP-02 Russia reported on the development of the next series of Russian polar-orbiting meteorological satellites of the Meteor-3M series. Launches of the next satellites in this series are planned for June 2000 and August 2002.

The payload of the Meteor-3M-N1 satellite includes the scanning VIS and IR instrument (MR-2000M), the KLIMAT-2, an updated version of the MR-2000M instrument, to be used for cloud monitoring and SST measurement. To support imaging and sounding missions, the Meteor-3M-N1 satellite will carry a microwave (MW) scanning radiometer MIVZA, with 5 channels in the range 18-90 GHz. The sounding mission will be supported with a MW radiometer (MTVZA) with 20 channels in the range of 18.7-183.36 GHz. This instrument will provide data for atmospheric temperature and humidity soundings, as well as for oceanographic research such as microwave diagnostics of active ocean layer processes.

New sensors to support imaging and sounding missions are planned for Meteor-3M N2 (see Table 3). These are a multi-channel scanning radiometer MSR with four channels in visible and IR, similar to channels 1, 2, 4, 5 of AVHRR and a spatial resolution close to 1 km, as well as an advanced IR atmospheric sounder IRFS, based on a Fourier transform spectrometer, with a spectral range of 2–4.5 μm and 5.0–16 μm and a spectral resolution equal or higher than 0.5 cm^{-1}. The IRFS primary mission is to provide data on temperature and humidity profiles and to meet WMO requirements on vertical resolution and accuracy for soundings in the troposphere.

Both satellites of the Meteor-3M series will support a standard 1.7 GHz down-link for real-time direct broadcast of data. On Meteor-3M N2 the HRPT mode is planned.

Table 3 : Meteor-3M Satellites Payload Composition Summary

Instruments mission and name	**Meteor-3M N 1**	**Meteor-3M N 2**
Imaging mission Multispectral scanning systems	MR 2000M KLIMAT-2 MIVZA MSU-E	MSR** MZOAS**
Sounding mission Advanced multispectral sounders	MTVZA*	MTVZA IRFS*
Heliogeophysical mission SEM	KGI-4 MSGI-5	KGI-4 MSGI-5
Optional mission Trace gases monitoring	SAGE III (USA) SFM-2	TBD

Notes: * The pre operational mission
** The pre operational mission is performed in case of successful ground tests

USA-WP-05 provided a summary of U.S. plans for future polar-orbiting meteorological satellite systems. The new fifth generation Polar-Orbiting Environmental Satellites (POES) advanced TIROS-N (ATN) follow-on satellites are designated NOAA-K, -L, -M, -N and N'. NOAA-L is scheduled for launch in April 2000, NOAA-M in May 2001, NOAA-N in December 2003 and NOAA-N' in January 2008. NOAA-K, -L and –M will include upgraded environmental instruments, i.e. AVHRR/3, HIRS/3 and AMSU-A and –B. NOAA-N and N' will be updated to a later instrument baseline, i.e. include the HIRS/4, which will provide 10 km field of view versus 20 km on the previous model and the Microwave Humidity Sounder provided by EUMETSAT replacing the AMSU-B.

The first satellite of the National Polar-orbiting Operational Environmental Satellite System (NPOESS), the converged military and civil operational meteorological satellite system, is expected to be available for launch by 2008 to back-up the last launches of the current DMSP and POES satellites. The current operational concept for NPOESS consists of a constellation of three satellites. NPOESS will provide an early morning and an afternoon satellite with equatorial nodal crossing times of 0530 and 1330 local solar time, respectively. The Integrated Program Office (IPO), in charge of developing, managing, acquiring and operating NPOESS plans to continue co-operation with EUMETSAT for a Joint Polar System.

CGMS requested clarification of NOAA planning for use of the LRPT and AHRPT direct broadcast services on the NPOESS satellites. WMO recalled the need for compatible receiving stations that could receive both a.m. and p.m. satellite data. While recognising that satellite and instrument designs were not finalised, WMO requested confirmation of the USA policy for direct broadcast. WMO stated that in order to be compatible, such direct broadcast should use the 137-138 MHz and 1675-1710 MHz Meteorological Satellite Service allocations as defined by ITU and use the LRPT and AHRPT global specifications as agreed by CGMS Members.

USA stated that direct broadcast from NPOESS satellites remains an important requirement. However, the expected data rates associated with the enhanced NPOESS instruments raise serious difficulties for broadcasting in the current frequencies. The importance of compatible formats and receiving stations remains a priority. Other factors that relate to ensuring the utility of a direct broadcast service must also be considered. Study of this issue will intensify during the next year as more information on instrument and spacecraft design become available. By CGMS XXVIII, the USA stated that NPOESS planning should be sufficiently developed such that it could benefit from the input of other CGMS Members.

ACTION 27.02 **NOAA/NESDIS to provide information on the status of its plans for direct broadcast services on the NPOESS satellites at CGMS XXVIII.**

C.2 Future Geostationary Meteorological Satellite Systems

EUM-WP-04 reported on the current status of the MSG programme and included plans for the transition to the new satellite service. The development of the MSG satellites is proceeding according to schedule. All engineering models of the subsystems and the Spinning Enhanced Visible and Infrared Imager (SEVIRI) had been delivered. The GERB-1 instrument, after a complete calibration campaign, has also been delivered. Satellite integration and test activities will be completed in November 1999. The first MSG satellite is currently scheduled for launch in October 2000. MSG-2 and MSG-3 will be ready for launch at 18-month intervals, but MSG-3 will be stored for a few years before its launch. The procurement of the MSG Ground Segment is progressing to schedule and the development of the Unified Meteorological Archive and Retrieval Facility (U-MARF) began in December 1998. The U-MARF will be a facility common to both the MSG and EPS programmes and will include data from MTP spacecraft.

Table 4 : Future Polar-Orbiting Satellites Coordinated within CGMS

(as of 18 October 1999)

Orbit type **(equatorial crossing times)**	**Future Additional Satellites**	**Operator**	**Planned launch date**	**Other information**
Sun-synchr. **“Morning”** **(6:00 – 12:00)** **(18:00 – 24:00)**	METOP-1 METOP-2 METOP-3 METEOR 3M-1 METEOR 3M-2	EUMETSAT EUMETSAT EUMETSAT Russia Russia	06/2003 12/2007 06/2012 6/2000 8/2002	(827 km) (9:30) (827 km) (9:30) (827 km) (9:30) (9:15) (10:30) or (16:30)
Sun-synchr. **“Afternoon”** **(12:00 – 16:00)** **(00:00 – 04:00)**	NOAA-L NOAA-M NOAA-N NOAA-N’ NPOESS-1 NPOESS-3	USA/NOAA USA/NOAA USA/NOAA USA/NOAA USA/NOAA USA/NOAA	04/2000 05/2001 12/2003 01/2008 2009 2013	(13:30) (13:30) (13.30) (13.30) (13:30) (13.30)
Sun-synchr. **“Early morning”** **(4:00 - 6:00)** **(16:00 – 18:00)**	DMSP-S15 DMSP-S16 DMSP-S17 DMSP-S18 DMSP-S19 DMSP-S20 NPOESS-2 NPOESS-4	USA/NOAA USA/NOAA USA/NOAA USA/NOAA USA/NOAA USA/NOAA USA/NOAA USA/NOAA	12/1999 2001 2002 2003 2005 2007 2010 2016	
Sun-Synchronous	FY-1 D	China	2001	

The detailed design of MSG monitoring user stations (HRUS and LRUS) that will form part of the MSG ground segment is nearly complete and design documentation for these user stations has been made available to all interested manufacturers and users and can also be downloaded from the EUMETSAT Web Site.

The transition period of parallel operations of Meteosat-7 and MSG-1 allows for an overlap of some three years, from the commissioning of MSG-1 in early 2001 until the end of 2003.

EUM-WP-05 reported on the status of the Satellite Application Facilities (SAF) and presented a full list of SAF products (Table 6 presents an overview of the SAFs and appendix A-1 an updated list of the products)

The three SAFs supporting Nowcasting and Very Short Range Forecasting, Ocean & Sea Ice and Ozone Monitoring are currently working on the geophysical algorithms and the detailed design of product software. Fully validated products will only become available in the pre-operational phase of the SAFs (nominally the last 6 months of the initial 5-year SAF development period).

Two further SAFs, supporting Climate Monitoring and NWP were approved by the EUMETSAT Council in November 1998 and development activities have started. In addition, two further SAFs were approved by the EUMETSAT Council in April and June 1999, namely, support to GRAS Meteorology and support to Land Surface Analysis.

In JPN-WP-04, Japan reported on the plan of MTSAT-2. The procurement of MTSAT-2 has been approved and MTSAT-2 will be contracted within the financial year 1999. The basic functions of MTSAT-2 are the same as MTSAT-1 except for the half hourly regular observations of the northern hemisphere. MTSAT-2 will be launched in the summer of 2004 and its operation will be started in the spring of 2005.

China informed CGMS, in PRC-WP-04, that it will continue the FY-2 satellite program. FY-2B will be launched in 2000 and FY-2C, -D, -E will be the 3 succeeding satellites. The performance and specification of FY-2B is the same as for FY-2A. In FY-2C, -D, and -E, the number of spectral channels of the Visible and Infrared Spin Scan Radiometer (VISSR) will be increased from 3 to 5 and the S-FAX transmission will be cancelled.

In RUS-WP-03 Russia indicated that the GOMS-Electro-N2 spacecraft is currently being integrated. The spacecraft will be a 3-axis-stabilised platform carrying the VIS and IR imager BTVK (atmospheric window and 6.7µm water vapour absorption band) as a core payload, as well as a meteorological communication package (DCS and an ensemble of re-transmitters). Direct imagery broadcast will be available in WEFAX format. The satellite is scheduled to be launched on a PROTON vehicle in 2001 and placed into geostationary orbit at 76° E.

The USA (USA-WP-06) reported on the status of GOES-L, -M, -N, -O, -P and -Q. GOES-L is scheduled for launch on 7 December 1999. GOES-M is currently in production and will include a solar x-ray imager (SXI). GOES-M is scheduled to be available for launch in October 2001. The SXI will be available on two of the spacecraft (N-Q) in the series. It will continuously observe the sun and will provide images in up to eight x-ray energy bands. Other instrumentation is similar to that on GOES-10.

In USA-WP-07, the USA described a flight opportunity open to CGMS Members on future GOES-N, -O, -P, -Q. Candidate instruments for these spacecraft should be sized to fit the instrument footprint on the sun-side of the spacecraft. The first launch of the new series is scheduled for May, 2002.

ACTION 27.03 **CGMS Members to inform USA if they wish to propose experimental payloads for future GOES Satellites by 15 December 1999.**

Table 5 : Future Geostationary Satellites Coordinated within CGMS

(as of October 1999)

Sector	Future additional satellites	Operator	Planned launch	(Planned location) Other remarks
EAST-PACIFIC (180°W-108°W)	GOES-L GOES-M GOES-N GOES-O	USA/NOAA USA/NOAA USA/NOAA USA/NOAA	4/2000 2001 2002 2005	135° W and 75° W
WEST-ATLANTIC (108°W-36°W)	GOES-P GOES-Q	USA/NOAA USA/NOAA	2007 2010	
EAST – ATLANTIC (36°W-36°E)	MSG-1 MSG-2 MSG-3	EUMETSAT EUMETSAT EUMETSAT	10/2000 04/2002 2006	0° 0° 0°
INDIAN OCEAN (36°E-108°E)	GOMS-N2 INSAT III-A INSAT III-D FY-2B	RUSSIA INDIA INDIA CHINA	2001 2000 2003 2000	76° E 105° E
WEST-PACIFIC (108°E- 180°E)	MTSAT-1 MTSAT-2	JAPAN JAPAN	11/1999 2004	Multi-functional Transport Satellite 140°E

Table 6 : EUMETSAT Satellite Application Facilities

SAF on	Date of kick-off	Hosting Institute	Consortium members
Support to Nowcasting & VSRF	Feb. 1997	INM (Spain)	NMSs of France, Austria and Sweden;
Ocean & Sea Ice	April 1997	Météo France (France)	NMSs of The Netherlands, Denmark, Norway and Sweden; Institut Français de Recherche pour l'Exploitation de la Mer (France);
Ozone Monitoring	October 1997	FMI (Finland)	NMSs of The Netherlands, Belgium, Denmark, Greece, Germany and France; Deutsches Zentrum für Luft- und Raumfahrt (Germany), University of Thessaloniki (Greece);
Climate Monitoring	Dec. 1998	DWD (Germany)	NMSs of The Netherlands, Belgium, Finland and Sweden; Bundesamt für Seeschiffahrt und Hydrographie (Germany)
Numerical Weather Prediction	Feb. 1999	UKMO (UK)	NMSs of The Netherlands and France; ECMWF;
GRAS Meteorology	April 1999	DMI (Denmark)	NMS of United Kingdom; Institut d'Estudis Espacials de Catalunya (Spain);
Land Surface Analysis	Sep. 1999	IM (Portugal)	NMSs of Belgium, France and Sweden; Inst. Of Meteorology & Climate Research (Germany), University of Bonn (Germany), Federal Inst. Of Hydrology (Germany), University of the Aegean (Greece), Inst. of Agrometeorology & Environmental Analysis Applied in Agriculture (Italy), Applied Meteorology Foundation (Italy), Inst. For Applied Science & Technology (Portugal), University of Evora (Portugal), University of Valencia (Spain)

C.3 Reconfiguration of future combinations of LEO and GEO missions

Compliance of the post 2010 space-based component of the GOS with user requirements and a possible approach to update/upgrade future systems

EUM-WP-06 discussed the post 2010 configuration of the space-based component of the Global Observing System (GOS). The Working Paper addressed two interleaved issues:

- whether important gaps would exist in the post 2010 GOS and how could they be filled and
- how to better optimise the present configuration of the GOS including already planned and approved components in the 2000-2010 period.

CGMS was of the opinion that the Working Paper was most valuable in that it highlighted the need for a more strategic overview of the present space-based component of the GOS. CGMS recalled that the GOS had originally been designed in the 1960s composed of 2-3 polar–orbiting and 4-5 geostationary meteorological satellites provided by the CGMS satellite operators primarily in response to meteorological observational requirements. In fact, the original 1960s design was only realised during this decade. During this evolution, new and key observational requirements of WMO operational and research programmes and other established

Earth observation programmes had emerged that were beyond the capabilities of the current satellite observing systems.

CGMS was aware that the full suite of user requirements were not only from the meteorological community but also the hydrological, oceanographic, terrestrial and climate communities and agreed that any future development of the system should take full account of such user requirements.

CGMS recalled that WMO had recognised the emerging need of its programmes earlier in the decade and had expanded the definition of the satellites comprising the space-component of the GOS to include Earth observation satellites. WMO also recognised a meteorological satellite as a particular type of Earth observation satellite. Since the expansion, the space-based component of the GOS has continued to be constituted by only meteorological satellites in the 3-4 geostationary and 2-3 polar-orbiting configuration. In view of the discussion of potential gaps contained in the Working Paper, **CGMS was unanimously of the opinion that a review of the space-based component of the GOS was necessary.**

CGMS felt that to date the WMO process of Rolling Review of Requirements whereby periodic checks were carried out to measure the extent of how well requirements were or will be met by the GOS had been reasonably successful, taking into account the rapid development of technology.

CGMS also felt the time was most opportune to consider more comprehensively the future development of the space-based component of the GOS. The future design had to take account of operational requirements, e.g. operational continuity and multiplicity of observation, including orbit characteristics, equator crossing times, together with contingency planning at the level of both spacecraft and instrument. The new observing system had not only to take account of planned meteorological satellites but also research and other Earth observation satellite systems including a coherent and planned transition from research to operational status especially for new and emerging technologies. CGMS also realised that the space-based component of the GOS could well be comprised of several multi-purpose and multi-operator satellites as well as smaller single or limited purpose satellites. CGMS was of the opinion that a total redesign of the space-based component of the GOS was not envisioned but rather a progressive and planned evolution.

CGMS agreed that WMO was a key entity responsible for defining the user requirements of the meteorological, hydrological, oceanographic and climate communities. A role of CGMS was to help fill in the WMO defined system, albeit on a voluntary, best effort basis. Major emphasis has to be placed upon avoiding or, at least minimising gaps in the future satellite system. It was also clear that any evolution of the system has to be based upon a realistic support from the satellite operators and co-operation with research entities. Furthermore, care had to be taken to ensure that any review of the GOS was conducted with a vision of the future taking into account current system capabilities.

In summary, CGMS concluded that WMO should take the lead in reviewing and planning for the evolution of the space-component of the GOS. Furthermore, such

a review and evolution should be based upon a close collaboration between WMO and CGMS.

D. OPERATIONAL CONTINUITY AND RELIABILITY

No working papers were submitted for discussion under this Agenda item.

E. SATELLITE REQUIREMENTS OF WMO PROGRAMMES

In WMO-WP-05, CGMS was informed of developments in the new Strategy to Improve Satellite System Utilisation. It noted that CBS, at its Extraordinary Session in 1998, had endorsed the Strategy. CGMS was also informed of recent discussions at the CBS OPAG on IOS's Expert Team to Improve System Utilisation Meeting in Locarno, Switzerland, 2-4 June 1999. One important conclusion of that meeting was that many WMO Members in Regions II, III, IV and V had requested geostationary imagery every 30 minutes. Although such a frequency interval is not presently available, the request was stated as the highest priority for the application areas of Nowcasting and Aeronautical Meteorology. Regarding the retrieval of geophysical parameters from satellites, and noting the users' needs, which were requested at the highest priority but were not available in a satisfactory way, the Expert Meeting recommended that further development concentrate on at least the following areas:

(a) Quantitative precipitation estimates;
(b) Atmospheric instability.

The Expert Meeting also strongly urged the further development of the "virtual" laboratory concept and encouraged CGMS satellite operators to utilise homepages and Internet as a means for communication of satellite system status, data dissemination, distribution of training materials, and co-ordination of science activity. In the conclusion of WMO-WP-05, CGMS Members were informed of the potential for large and positive return on financial and personnel resource investments made by them that could lead to the early and full use of satellite systems.

In WMO-WP-07, CGMS noted the further development of the Statement of Guidance (SOG) on Feasibility of Meeting WMO Requirements. CGMS was also informed of recent discussions at the CBS Open Programme Area Group on Integrated Observing System's (OPAG IOS) Expert Team Meeting on Observational Data Requirements and Redesign of the Global Observing System held in Madison, Wisconsin, 23-25 June 1999. At that meeting, which started a second iteration to the Statement of Guidance, (1) *in situ* systems were added to satellite-based systems in the analysis of observing capabilities, and (2) the applications area of atmospheric chemistry was added to the five initial areas. CGMS was informed that the review of the SOG (previously prepared in 1998) found that no major changes were necessary related to three applications areas (global NWP, synoptic meteorology, and Nowcasting and VSRF), other than noting that the advent of AMSU had produced positive initial impact on global NWP. The Expert Team Meeting further discussed the incorporation of *in situ* observing systems into the Rolling Review of Requirements process. In order to test the proposed categorization of the *in situ* observing systems, a sample data set for land surface observations of air pressure and another data set for aircraft ascent and descent profiles of temperature, humidity and winds were developed. The data, while not fully validated, were felt to be of sufficient accuracy to be representative of the actual observing performances for the two systems. The continuing need in all application areas for operational continuity of a suite of instruments deployed from at least two polar-orbiting platforms and at least five geostationary platforms was also noted.

In WMO-WP-12, CGMS noted that the WMO/ESCAP Panel on Tropical Cyclones for the Bay of Bengal and the Arabian Sea at its twenty-sixth session had welcomed the decision by EUMETSAT to shift Meteosat-5 to cover the Indian Ocean Experiment (INDOEX) through 1999 and encouraged continuation of such coverage on a permanent basis. WMO expressed deep appreciation to EUMETSAT for its initiative in providing such valuable coverage over this data-sparse area.

F. COORDINATION OF INTERNATIONAL DATA COLLECTION & DISTRIBUTION

F.1 Status and Problems of IDCS

EUM-WP-07/08 reported on the status and use of the Meteosat International DCP channels (IDCS). CGMS Members were encouraged to make operational use of the EUMETSAT on-line database of IDCS allocations. EUMETSAT informed the Group that there appeared to be some interference affecting IDCS users within the Meteosat field of view. In addition, EUMETSAT reported that the Mission Data Reception System (MDRS) was now fully operational. This system allows certain DCP users to access their data via the Web. These users have first to register with EUMETSAT so that they can be provided with a user name and password. It was agreed that there would be further discussion of IDCS end-to-end monitoring tests and the need to increase the number of IDCS channels in Working Group I.

JMA reported on the status and the problems of the GMS IDCS in the JPN-WP-05. Interference to the IDCS channels has been increasing noticeably since last year. JMA tried to find the source of interference, but identification of the sources was extremely difficult.

Furthermore, there were considerable discrepancies between the numbers of DCP messages received and those disseminated to the GTS, because many reports do not contain observational data. Other operators reported similar discrepancies.

F.2 Ships, including ASAP

WMO-WP-13 discussed the Automated Shipboard Aerological Programe (ASAP). For the first time, the number of radio soundings taken in the frame of ASAP dramatically decreased in 1998, by approximately 20%. The decrease, however, had been associated with the inactivity of one ship and that normal numbers of radio soundings were now being experienced.

F.3 ASDAR

WMO-WP-09 discussed the ASDAR Programme. Twenty-two of the 23 units purchased by WMO Members of the Consortium for ASDAR Development (CAD) and the Operating Consortium of ASDAR Participants (OCAP) have been installed on commercial wide-bodied aircraft over the period 1991-1999. Of these, 18 were expected to be in operational service at the end of 1999. CGMS noted that the OCAP will wind up as a Consortium of WMO Members by the end of 1999. The ASDAR operational programme will continue, under the umbrella of the recently established Aircraft Meteorological Data Relay (AMDAR) Panel, as long as the individual owners are able to maintain the equipment in service. The AMDAR Panel will assume responsibility for international liaison aspects of ASDAR operations, including IDCS matters.

F.4 Dissemination of DCP messages (GTS or other means)

The USA reported, in USA-WP-09, on the status of disseminating DCS messages over the Internet. The service allows DCS users to either TELNET or FTP message data in real-time. Also, information pertaining to DCP platform operation can be received, together with bad messages and other information relevant to the operation of the DCS system. These services and other relevant information about the IDCS operations can be found on the GOES DCS homepage, http://DCS.NOAA.GOV. The new Internet service is provided in addition to the current GTS method of receiving DCP message data.

G. COORDINATION OF DATA DISSEMINATION

G.1 Dissemination of satellite images via satellite

EUM-WP-09 reported on the status of preparation of the CGMS Broadcast Format Guide, in response to Actions 26.12 and 26.13. The Guide will not only include formats commonly used by CGMS Members, but will also provide information on planned future broadcast formats. CGMS agreed on the proposed table of contents and layout of the Guide and encouraged its production both as hardcopy and as a Web version, available via the WMO/CGMS Web server. The Secretariat confirmed that it would now proceed with the preparation of the Guide.

EUM-WP-37 presented the current status of the LRIT/HRIT Global Specification and now included minor amendments to the document requested by Members. CGMS were pleased to approve this issue of the document (Issue 2.6) and to note that all relevant parameters had been agreed by all Members. The Secretariat added that the specifications would now be included in the CGMS Broadcast Format Guide.

In JPN-WP-08, JMA presented the schedule of MTSAT observation and image data dissemination. Regular observations will consist of hourly full disk observations and six-hourly sequential hemispheric observations for wind vector extraction, the interval of which is 15 minutes. Special observations of the northern hemisphere will be performed whenever there are typhoons in the Northwest Pacific or severe convective systems in the vicinity of Japan. Images of regular and special observations will be disseminated by High Resolution Image Data (HiRID) and by LRIT. Only regular observations will be disseminated by WEFAX. The WEFAX service will be continued for a period of three years after the start of MTSAT operations. The draft schedules (WEFAX and LRIT) will be provided to the WMO.

ACTION 27.04 Japan to place the draft MTSAT HiRID, LRIT and WEFAX schedule on the WMO server.

USA announced, in USA-WP-10, its plans for implementing LRIT, starting with GOES-N.

In WMO-WP-03, the current status of WMO activities for the LRIT/LRPT transition was discussed. CGMS recalled that WMO intended to inform its Members of the LRIT/LRPT improved capabilities in the form of a new WMO Satellite Activities Technical Document. A draft of the new Technical Document was expected to be reviewed by the CBS OPAG IOS Expert Team Meeting on Satellite System Utilisation to be held in Melbourne in October 1999 and that the final TD would be available before the first LRIT service on MTSAT became operational (during 2000).

CGMS also agreed that tables indicating the planned implementation dates for the new services would be most valuable and that such tables should be current and contain any necessary explanations. CGMS agreed to review the tables contained in WMO-WP-03 and provide any necessary updates before 31 December 1999.

ACTION 27.05 All CGMS satellite operators to review the Tables in Appendix A of WMO-WP-03 and provide any updates to WMO prior to 31 December 1999.

In USA-WP-11, WP-12 and WP–13, respectively, the USA provided information on ASAP activities using the GOES spacecraft, an annual assessment of DCP message data on the GTS and a new digital service for emergency managers. The latter new digital service is a continuous broadcast of warnings for the area within the GOES footprint.

G.2 Dissemination of satellite products via satellite, GTS or other means

In an oral presentation, EUMETSAT introduced its proposal for a MSG Internet Service. The key features of the proposed service are:

- availability in real-time of half-hourly images in three spectral channels (e.g. Visible: 0.6 micron, IR: 10.8 micron, and Water Vapour: 6.2 micron) in a graphical format using lossy compression (such as JPEG) so as to be suitable only for qualitative applications;
- image sizes reduced by sub-sampling and/or re-sizing so as to be not larger than the current WEFAX image size of 800 x 800 pixels, but possibly sized to be compatible with PC screen sizes;
- availability of a mixture of full Earth disc images and sectored images.

In addition, some of the functions currently available on most Meteosat WEFAX reception stations would be implemented for the service, e.g.:
- image animation loops;
- image colouring;
- addition of coastlines and grids.

As with the current Meteosat WEFAX service, the images would be identified by source, date and time and would carry the EUMETSAT Copyright as an integral part of the file format.

CGMS noted that this proposal would, in effect, be similar to, but no better than the current Meteosat WEFAX service. Therefore, the real benefits of the MSG system, when compared to Meteosat, would not be obvious for this user community (e.g. the availability of 15-minute images and many more channels).

EUMETSAT reminded the meeting that in some respects this service would be less attractive than the existing MTP WEFAX Service, as users would have to retrieve this image data from the EUMETSAT site, and this process could be subject to at least some delay and possible interruption due to marked variations in the performance of the Internet.

In JPN-WP-09, the meeting were informed that JMA, in cooperation with NOAA, had initiated an informal forum to promote satellite data exchange and utilisation in the Asia-Pacific Region. Following the success of the first meeting, which was held in Tokyo, in February 1999, the participants agreed to hold a second meeting, which will also be held in Tokyo, in January 2000.

JMA reported, in JPN-WP-10, that it had carried out several 15-minute interval special scans of the southern hemisphere by GMS-5 in April 1999, at the request of Australian Bureau of Meteorology (ABoM). ABoM had used this data to test a system to derive 15-minute interval cloud tracked winds.

H. OTHER ITEMS OF INTEREST

H.1 Applications of Meteorological Satellite Data for Environment Monitoring

PRC-WP-07 provided information on flood monitoring in China in the summer of 1998 by using NOAA/HRPT data. This particular flood incident was one of the most severe in the history of China.

H.2 Search and Rescue (S&R)

No working papers were presented for discussion under this Agenda item.

H.3 Meteorological Data Distribution via satellite

In JPN-WP-11, JMA presented its plan to disseminate meteorological data by LRIT (gridded values from JMA's global NWP and wave models, tropical cyclone advisories and observation data). The meteorological data, except for imagery, will be encrypted and decryption keys will be provided to National Meteorological Services on the basis of bilateral agreements.

CGMS was pleased to note that JMA was willing to provide software for LRIT, for the display of imagery and overlay gridded fields, to National Meteorological Services. The software has been developed based on JMA's Computer Aided Learning (CAL) system.

H.4 Training

EUM-WP-10 reported on satellite meteorology training activities carried out over the last year and provided an outline plan of activities for the coming years. Significant emphasis was now being placed on the preparation of Meteosat users for the transition to MSG (launch scheduled October 2000).

Also under consideration was the joint production of satellite meteorology training material with other CGMS Members, in preparation for the time when many of them will be operating polar-orbiting meteorological satellites, and there will be a truly global user community.

JMA reported in the JPN-WP-12 that the MSC-CAL, which is a specific training system for utilising satellite data for meteorologists or forecasters, had been developed since 1994 and was now fully introduced into nephanalysis training classes. MSC-CAL was well accepted by the trainees from developing countries. The application of the MSC-CAL has been expanding to the field of multi-functional satellite data browsers. They are contained in the CD-ROMs published by JMA aiming at promotion of satellite data utilisation. The MSC is developing an LRIT browser for MTSAT, which will be provided to National Meteorological Services.

In JPN-WP-13, JMA presented its plan for training in the use of LRIT/MTSAT data, which is targeted at National Meteorological Services in Southeast Asia. According to the plan, a survey of LRIT data utilisation will be carried out, and training seminars and workshops, hosted by JMA, will be conducted in the period 2000-2002.

USA-WP-13.1 reported on training activities carried out by NOAA/NESDIS in Costa Rica and Barbados using the Virtual Laboratory (VL) concept. The VL concept that is being demonstrated in the Costa Rica and Barbados RMTCs has focused on using personal computers (PCs), case study data sets, and the Internet to demonstrate the use of digital satellite imagery. This pilot program, with an objective of "training the trainers" in the interpretation and use of satellite imagery, was initiated in June of 1996. The program has been highly successful, resulting in training courses for WMO Members, research activities at the RMTCs, development of local case studies and regional applications, and other uses by the local science communities associated with the RMTCs. The "Virtual Laboratory" is in the midst of the third year of activity and a plan exists to extend the activity to make satellite imagery available to WMO Region III and IV countries supported by the RMTCs for demonstration, familiarisation and training: the proposed extensions are significant and activity will continue for several years. The ideas for extended activity were spurred on by the successful 2-week training event held in Barbados in October 1998 and by the devastation caused in Central American countries following the passage of Hurricane Mitch at the end of October 1998. During the training event digital satellite imagery was analysed on a system known as RAMSDIS (a menu driven McIDAS based PC). An Internet (non-digital) PC system known as RAMSDIS-Online was used in both the lectures and laboratory exercises. The participants from Regions III and IV were enthusiastic about the potential applications of the high resolution, multi-channel imagery and derived products and the easy usage of RAMSDIS and RAMSDIS-Online. This task, as currently envisioned, will proceed in two phases. In the first phase, the goal is to distribute satellite imagery through RAMSDIS-Online. In the second phase, the goal is to make digital satellite data available (in McIDAS format) to the participating countries, and to upgrade the software on their PCs to include full digital RAMSDIS capabilities.

In WMO-WP-06, CGMS was informed of activities related to education and training. CGMS was informed that the WMO Strategy for Education and Training in Satellite Matters has been especially successful with EUMETSAT cosponsoring the RMTCs in Nairobi and Niamey, while the USA was cosponsoring the RMTCs in Barbados and Costa Rica. It was also noted that the Japan Meteorological Agency (JMA), the Australian Bureau of Meteorology (BoM), and the Peoples' Republic of China had been active in satellite-related training activities. CGMS was informed that throughout all WMO Regions, more than 300 participants have benefited from WMO and satellite operator sponsored training events in satellite meteorology and hydrology (a 50% increase since the Twelfth Congress).

WMO-WP-06 opened discussions between WMO and satellite operators on the need to develop an overarching approach for education and training. Such an approach should take into account future needs in response to new and emerging satellite systems, data and products, as well as emerging concepts for education and training such as the "Virtual Laboratory (VL)". Discussions of the VL concept were begun at the CBS Open Programme Area Group on Integrated Observing Systems (OPAG IOS) Expert Team Meeting on Satellite Systems Utilisation and Products held in Locarno, Switzerland, 2-4 June 1999, where it was discussed as a concept that had the potential to provide the capability to leverage the science communities and emerging communications technologies to improve the utilisation of satellite data. CGMS was informed that the VL had great potential to improve the utilisation of satellite data while optimising the resources dedicated for education and training. In order to strive to achieve harmonisation/standardisation of training methodologies across WMO Regions, the next Expert Team Meeting to be held in Melbourne (October 1999) will address this issue as a matter of urgency and as its primary focus. WMO-WP-06 also noted the great success of the International TOVS Working Group (ITWG) and the CGMS Winds Workshops in focusing the science communities on a specific application area's issues and problems, and suggested that CGMS consider the development of science teams and workshops that would deal with the application areas of satellite meteorology in NWP, quantitative precipitation estimates and ocean and land surface properties. CGMS was informed that the OPAG IOS Expert Team

Meeting to be held in Melbourne, Australia, 25-29 October 1999 would be briefed on details of China's plans to implement the co-sponsorship of the RMTC in Nanjing.

H.5 Information

EUM-WP-11 provided a brief account of EUMETSAT Conferences that had taken place since the last meeting of the CGMS. Included were summaries of the Third African User Forum held in Rabat in September 1997, of which there is also a separate report in EUM-WP-12, EUMETSAT participation in UNISPACE III in July 1999 (see also EUM-WP-13), and the Satellite Data Users' Conference held in Copenhagen in September 1999. Also provided was a preliminary schedule of conferences to be held in the next two years. A list of EUMETSAT's current and new publications and a report on the development of its Web Site were also included in the document.

In EUM-WP-12, CGMS was informed that the Third EUMETSAT User Forum in Africa took place from 21 to 25 September 1998 in Rabat, Morocco. It was jointly organised by EUMETSAT, the Department of Meteorological Service of Morocco (DMN) and the World Meteorological Organization (WMO). Over 90 participants from 36 African countries and regional organisations, as well as other experts and ranking representatives of WMO attended the forum.

The Forum had four main objectives:

- to provide information on EUMETSAT systems and plans, in particular as regards access to and use of Meteosat products and services, and identify specific requirements of the regional user community in this respect;
- to provide an update on data and products expected from Meteosat Second Generation (MSG), as well as on MSG user station specifications, and to review and amplify the actions initiated at the Second Forum to prepare the transition to this future generation of systems;
- to exchange practical experience on regional applications of Meteosat data and services and on how to best meet end-users' needs in the region;
- to review the progress achieved in satellite meteorology training in Africa and discuss future plans for cooperation between EUMETSAT, WMO and the Regional Meteorological Training Centres (RMTC) in this area.

In EUM-WP-13, the Group were informed that CGMS participated in UNISPACE III, the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space, in Vienna from 19-30 July 1999 with a satellite meteorology workshop on 22 July 1999 held in the framework of the Technical Forum. The theme of the workshop was "the role of CGMS in promoting wider usage of satellite meteorological data".

An introductory statement given by EUMETSAT, as the CGMS Secretariat drew out the contribution of CGMS to the global objectives of UNISPACE III, namely:

- a better understanding of the Earth's System through the provision of long-term global meteorological and climatological observations.
- improvement of human condition through the improvement of reliable weather forecasts and long-term climate prediction.

- the development of further knowledge through the sharing of scientific knowledge (Cloud Motion Winds, …).
- the capacity building in the user community through the promotion of applications of meteorological satellites, information and training.
- the promotion of international cooperation through CGMS contingency strategy, bilateral cooperations.

These were followed by a presentation on "the use of US satellite data for national and international natural disaster mitigation" by Dr. James Baker, NOAA, and a presentation by the WMO on "the role of CGMS satellite meteorology from a global user perspective".

CGMS Members then gave presentations on the use of their satellite data by specific user communities in their regions. On behalf of EUMETSAT, Mr. E. Mukolwe, Director of Kenya Meteorological Department, reported on the use of Meteosat data in Africa, giving a perspective on the potential offered by MSG for the African continent. The workshop was chaired by the WMO. The conclusions and recommendations for this Workshop can be found in appendix A-2.

In EUM-WP-14 the Group recalled that, at CGMS XXVI, and in response to ACTION 25.25, a proposal had been presented for making enhancements to the CGMS homepage and updating the CGMS Consolidated Report. In addition, it had been proposed that there should be a new version of the CGMS Consolidated Report focussing on common CGMS achievements and agreed CGMS practices. The new Consolidated Report would avoid the duplication of information provided by each Member on its own activities or systems, and refer to home pages or publications issued by CGMS Members.

The meeting was informed that CGMS Members have nominated points of contact for this activity, who will contribute to the development of the new CGMS Consolidated Report. The working paper also proposed a work plan for the project with the objective of finalising the updated version of the Consolidated Report by June 2000.

CGMS agreed to the proposal prepared by the Secretariat and agreed on the work plan, adding that actions 2, 3 and 4 contained in the document should, if possible, be completed by 31 December 1999 in order to achieve the deadline for releasing the document on the CGMS homepage by June 2000.

ACTION 27.06 **The Secretariat and Drafting Committee for the CGMS Consolidated Report to complete the following by 31 December 1999:**

(i) CGMS Secretariat, in cooperation with WMO, to draft the "general" CGMS sections and send the drafts for comments and approval to the members of the drafting committee.

(ii) Members of the drafting committee to comment on and approve the text.

(iii) Each CGMS Member to update the sections referring to its organisation and to send these to the CGMS Secretariat. The representative of the drafting committee will be responsible for co-ordinating the inputs of its organisation.

CGMS suggested that the introductory section of the Consolidated Report should contain more information on satellite missions and services and an explanation of its interests in other matters such as frequency allocation.

EUM-WP-38 reported on the more recent evolution of the EUMETSAT External Information System. After already having become an operational infrastructure supporting nearly all domains in which EUMETSAT interacts with external communities (users, customers, industry, the general public), the EEIS Web site has continued to expand rapidly. In particular, the offering of on-line image browse services, distribution of DCP messages, as well as the on-line distribution service of Invitations to Tender, have significantly boosted the size and usage of the system. Encouraged by this development, EUMETSAT plans to continue exploiting the opportunities offered by the Internet for providing cost-effective, efficient services to its users, in particular, by focusing on operational access to and dissemination of satellite data and products.

In EUM-WP-15, EUMETSAT recalled that the first release of 64 applications pages were compiled into a first version of the CGMS Directory of Satellite Applications, which was published and distributed in May 1998. Based upon this initial experience, CGMS Members were then invited to submit further topics for inclusion in a second version of the Directory, to be published, both in a loose-leaf folder format and on CD-ROM. It was decided that a further batch of 64 topics would be included within this revised version of the document, which was subsequently distributed early in 1999.

CGMS were informed that since the Directory of Meteorological Satellite Applications is intended to be a "living" reference document, **CGMS Members are encouraged to submit further topics to the CGMS Secretariat at any time.** EUMETSAT will collect the topics and periodically collate batches of topic pages, with a view to publication in loose-leaf format, and with a corresponding revision of the CD-ROM, every two or three years.

In WMO-WP-01, WMO described the latest status of the database for satellite receiving equipment. The present database contains 8,766 unique receiving stations for APT, HRPT, WEFAX and High Resolution receivers. A copy of the database was provided to all CGMS Members. WMO indicated that queries to the database are also available on the WMO Satellite Activities Web pages. WMO thanked the satellite operators for their inputs, which will be used to justify frequency utilisation.

In WMO-WP-04, CGMS Members were informed of the various List-Servers used by CGMS focus groups, i.e. the Plenary, Cloud Track Winds and Frequency Matters. It also reviewed the latest CGMS Web pages and identified a need for CGMS Members to review and provide updates to WMO on a regular basis.

In WMO-WP-14, CGMS satellite operators were informed of the WMO Y2K Monitoring and Contingency Plan. It noted the need to monitor the performance of satellites and processing systems and report any problems to the designated WMO Y2K Situation Centres, as shown in Table 7.

Table 7: Designated WMO Y2K Situation Centres

Satellite Operator	**WMO Y2K Situation Centre**
China	Melbourne
EUMETSAT	Bracknell
India	Bracknell
JMA	Melbourne
NESDIS	Washington
Russian Federation	Moscow

H.6 ANY OTHER BUSINESS

EUM-WP-16 updated CGMS on its activities and plans to ensure the readiness of EUMETSAT operations systems for the Year 2000 transition. Significant detail had already been presented at CGMS XXVII.

USA explained in its working paper USA-WP-14 that USA has made significant progress over the last two years to prepare for the century date change and millenium leap year. The year 2000 activities followed the standard phased approach that includes assessment, renovation/replacement, testing and implementation. During the assessment phase a database was created of all the components that make up each mission critical and non-mission critical system. Each component was then checked to find Year 2000 date-related problems. All date-related problems that were found were either fixed or the component was replaced. During the validation phase a series of test plans for each system were developed. Each system was tested according to test plans using configuration management to ensure ongoing compliance. The implementation phase included the development of a Business Continuity and Contingency Plan (BCCP) for all mission critical systems. The BCCP documents contingencies to ensure continued readiness to manage any problem arising from Year 2000 issues.

USA presented a report in USA-WP-14.1 on international programs that depend on the IDCS. One such programme, AERONET, is a remote-sensing aerosol monitoring network initiated by NASA and developed to support and validate satellite aerosol retrievals from NASA, CNES and NASDA’s Earth satellite missions, to aid understanding of aerosol optical properties and develop a detailed ground based climatology of those properties. The program has expanded through national and international collaboration with NGOs, government institutions and universities. The combination of identical weather resistant automatic sun and sky scanning spectral radiometers, transmission of automatic measurements via the geostationary satellites GOES, GMS and Meteosat’s Data Collection System, advanced processing algorithms, Internet access to the data and strong institutional support have resulted in an internationally federated globally distributed network of quality assured aerosol optical properties.

CGMS agreed that the AERONET network will utilise IDCS channels I23 and I24. It was further noted that AERONET DCPs, operating in the field of view of the GMS satellite, and requiring data processing by JMA, would be required to encode their messages in standard WMO GTS format.

PARALLEL WORKING GROUP SESSIONS

REPORT FROM WORKING GROUP I: TELECOMMUNICATIONS

I/0 Introduction

Mr. Robert Wolf from EUMETSAT was elected as Chairman of Working Group I on Telecommunications. The Working Group comprised representatives of the satellite operators EUMETSAT, Japan, PRC, Russia and USA together with a representative of WMO.

I/1 Coordination of Frequency Allocations

Preparations for the World Radio Conference (WRC) 2000

Several documents related to preparations towards the WRC 2000 were presented, in particular documents: EUM-WP-17, RUS-WP-05, USA-WP-15 (including annexes 15.1 and 15.2), JPN-WP-15 and WMO-WP-11. The USA document also included the report of the working group on Earth Exploration and Meteorological Satellites of the Space Frequency Co-ordination Group from its 1998 meeting. The report of the 1999 meeting of this group was distributed during CGMS XXVII. During presentation of these documents the following information was discussed:

The World Radio Conference 2000 is scheduled from 8 May to 2 June 2000 and will take place in Istanbul (Turkey). The agenda for the Conference was agreed during WRC 1997. Preparatory work takes place in ITU working groups and task groups. Furthermore there are many activities in national and supranational organisations such as CEPT, CITEL, APT etc. A major milestone in WRC 2000 operations will be the Conference Preparatory Meeting, which will take place at the ITU in Geneva in November 1999. This Conference will complete the technical inputs to the WRC and will publish the CPM report, which is the main input document to the WRC.

The main WRC 2000 agenda points of relevance to Meteorological Services are:

- Agenda item 1.3: Earth Station Co-ordination Area (revision of Appendix S7)
- Agenda item 1.4: High Density Fixed Service (HDFS)
- Agenda item 1.6: IMT-2000 (International Mobile Telecommunications)
- Agenda item 1.9: Mobile Satellite Service (Resolutions 213 and 220)
- Agenda item 1.11: Non GSO/MSS below 1 GHz (Res 214 and Res 219)
- Agenda item 1.17: World-wide allocation for EESS & SRS at 18.6 – 18.8 GHz
- Agenda item 1.16: Harmonisation of Frequency Bands above 71 GHz

The status of topics related to these agenda points was reported as follows:

Earth Station Co-ordination Area:
EUMETSAT and NOAA studied the required co-ordination parameters for all frequency bands allocated to the Meteorological Satellite (MetSat) service and submitted input documents to the ITU-R with the objective to receive adequate protection for Earth stations operating in these bands. These input contributions were

discussed at the relevant ITU-R meetings (WP7C) and main elements were integrated into a text proposal for the Conference Preparatory Meeting (CPM) report. WRC 2000 is expected to discuss these Earth station co-ordination parameters which will hopefully be incorporated into the Radio Regulations as proposed. This will provide the basis for co-ordination, and thus adequate protection, of Earth stations.

High Density Fixed Service (HDFS):

The conditions for introduction of HDFS in various frequency bands are being studied and results will be forwarded to WRC 2000. The work is based on ITU resolutions 126 and 726. The introduction of HDFS could potentially create interference to EESS (passive) sensors in the bands 31.8 to 33.4 GHz and 51.4 to 52.6 GHz. There is also a potential problem in the planned use of the band 55.78 to 59 GHz although there is a much higher atmospheric absorption in this band, which could reduce interfering signal strength. The HDFS bands of concern are directly neighbouring the above EESS bands. The problems are related to out-of-band emissions, which are expected to exceed the acceptable interference levels to passive sensors.

Studies were produced by NOAA and Météo France and were submitted to ITU (WP7C). The studies demonstrated the potential of harmful interference, which could reduce the quality of measurements dramatically. It has to be expected that large quantities of links will be installed in the HDFS in the near future. It will be necessary to limit HDFS out-of-band emissions to an acceptable level. This is claimed to increase equipment cost and strong opposition of the HDFS community has therefore been raised. Several proposals to put restrictions on the use of HDFS were proposed. In particular there were proposals to limit the Power Flux Density of HDFS systems and to exclude the use of certain antenna types for this service. Controversial discussions are still ongoing between Fixed Service Users and the Earth Exploration Users including Meteorological Satellite operators.

IMT-2000 (International Mobile Telecommunications 2000):

The agenda for WRC 2000 covers the need for identification of additional frequency bands for the extended deployment of IMT-2000 systems, formerly referred to as Future Public Land Mobile Telecommunication System (FPLMTS). In Europe, this system is also called UMTS (Universal Mobile Telecommunication System). In the initial investigation phase of candidate bands for IMT-2000 expansion, the so-called Space Science bands (2025 – 2110 and 2200 – 2290 MHz) were identified as suitable bands. The lower band contains many MetSat up-links and the upper band the TTC links for MSG. After massive interventions from the space science and space operations community, these bands are at present not considered suitable for IMT-2000 expansion. Nevertheless, it has to be noted that the first generation of UMTS will be allocated in directly neighbouring bands below and in-between the above bands. Moreover, the band above 2290 MHz is also considered as a candidate band, which raises concerns that possible expansion discussions will be restarted at some stage.

Mobile Satellite Service Frequency Requirements:

The currently allocated frequency bands for Mobile Satellite Service applications are reaching saturation and new candidate bands are being investigated. This is stimulated by ITU Resolutions 213, 220 and 214, the latter one being limited to Non-Geostationary (NGSO) systems. In this context, there have been continuing discussions over several years on possible use of bands allocated to the Meteorological Satellite

Service (MetSat) and the Meteorological Aids Service (MetAids). In particular, parts of the bands 1675 to 1710 MHz and 400.15 to 406 MHz have been identified for potential MSS operations.

During WRC 97 it was possible to prevent a worldwide MSS up-link allocation in the band 1675 to 1683 MHz as proposed by several ITU administrations. The main reason for this was the unsuccessful allocation attempt of a suitable down-link companion band. Resolution 213 and 220 urgently invite the ITU-R to continue studies to satisfy MSS requirements above 1 GHz. Present discussions are again concentrating on the use of either the band 1675 – 1683 or 1683 – 1690 MHz for MSS up-links. Further studies are performed on the suitability of sharing additional up-links in the frequency band 1698 to 1710 MHz in a time-sharing mode with MetSat systems. CEPT has recently created a task group to evaluate possible scenarios.

EUMETSAT has produced several studies on sharing possibilities for the band 1675 to 1710 MHz. Basically all of the obtained conclusions were incorporated into an ITU-R recommendation. One particular study is still under consideration with respect to suitable text for the CPM report. It is related to the feasibility of time-sharing operations between MetSat and MSS in the sub-band 1698-1710 MHz. This study demonstrates that there is only limited potential for sharing and that, based on a number of considerations, the band 1698-1710 MHz is practically not suitable for sharing. A corresponding text is now proposed for inclusion into the CPM report.

Some MSS NGSO systems (so-called Little LEOs) require frequency bands below 1 GHz. Candidate bands for possible MSS allocations are 137.025 – 137.175 MHz, 137.825 – 138 MHz, and 405 –406 MHz. The first two bands are and will be used for direct readout services from meteorological polar-orbiting satellites (LRPT, APT). Sharing with MSS is not feasible in these bands. The band 405 – 406 MHz is used for MetAids operations. WMO has produced a study which indicates that the band will be needed for radiosonde operations for the medium-term future (12 years at least) and that sharing with MSS will not be possible in this band.

<u>World-wide primary allocation for EESS & SRS at 18.6 – 18.8 GHz:</u>
This issue was considered by WRC 97, but could not be resolved. So far it was not possible to find an acceptable compromise between the already primary Fixed and Fixed Satellite Service to support the requested upgrade of Earth Exploration Satellite Service (EESS) and Space Research Service (SRS) to primary status in ITU Regions 1 and 3. It has to be noted that in Region 2 (America) EESS and SRS have already a primary status in this band. Discussions in preparation to WRC 2000 are still not successful and compromise solutions are still being processed.

<u>Harmonisation of Frequency Bands above 71 GHz:</u>
During WRC 97 a re-allocation plan for the frequency band 50 –71 GHz was agreed. The new allocation table in this band satisfies the requirements of EESS, Fixed Service, and the Inter-Satellite Service. It was agreed that re-allocations for frequency bands above 71 GHz should be discussed at WRC 2000. Considerable work was done by the WMO rapporteur Dr. Rochard, the Space Frequency Co-ordination Group and within the framework of the CEPT Project Team PT 33 resulting in a proposed allocation table covering frequencies between 71 and 275 GHz. It was concluded that bands above 275 GHz should be considered at a later time. Following the progress in

WRC 2000 preparations in the various groups it can be expected that the table will now be internationally supported and that re-allocations will be successfully implemented at WRC 2000.

Members of Working Group I supported the above positions and discussed the preparation process for the WRC 2000. All members stressed the importance to support the protection of frequency allocations for meteorological applications. It was agreed that CGMS Member agencies shall promote meteorological topics by participation in the preparatory work towards the WRC on national, regional, and ITU level. The WG was also informed that the WMO Steering Group on Radio Frequency Co-ordination will meet in Geneva in the week prior to the CPM. Furthermore it was agreed to announce the names of those participants in the Conference Preparatory Meeting (November 1999 – Geneva) and the World Radio Conference 2000 (April 2000 – Istanbul) which will support meteorological issues. The names shall be announced using the WMO list server: cgmsfreq@www.wmo.ch.

ACTION 27.07 **CGMS Members to announce the names of participants of the Conference Preparatory Meeting and the World Radio Conference 2000, which will support meteorological issues. The announcement shall be done using the WMO list server: cgmsfreq@www.wmo.ch.**

Partition of the frequency band 1675 –1710 MHz

WMO-WP-11 reminded CGMS Members that a partition plan was agreed by CGMS Members for the use of the frequency band 1675 – 1710 MHz. It was agreed that three sub-bands will be used as follows:

- 1675 – 1690 MHz for main Earth stations
- 1690 – 1698 MHz for direct readout services of geostationary satellite
- 1698 –1710 MHz for direct readout services of polar-orbiting satellites

The corresponding CGMS partition plan had been included into ITU-R Recommendations and was used in various sharing studies. However, some CGMS Members are still operating direct readout services within the sub-band 1675 –1690 MHz. These services include GVAR (GOES) and S-VISSR(GMS) which both operate in the range 1683 to 1690 MHz. The WG confirmed the need for the frequency band partition and requested operators to inform on the dates when the partition plan for the band 1675 – 1710 MHz would be fully complied with.

ACTION 27.08 **Japan and USA to inform CGMS by 31 December 1999 on their plans and the dates to when the partition plan for the band 1675 – 1710 MHz would be fully complied.**

Use of the band 7750 –7850 MHz

During WRC 97 a new frequency band was allocated to the Meteorological Satellite Service on a primary basis. The band 7750 – 7850 MHz is restricted to the use by NGSO spacecraft. First uses were indicated by ESA/EUMETSAT on METOP and NOAA.

The WG concluded that it would be very important to carefully plan the use of the new band and to start the use of the band at band edges to allow the optimum amount of users in the band. The WG noted that SFCG has agreed on a similar resolution.

It was further noted that the use of the band for direct readout systems could result in co-ordination problems with existing systems of the Fixed Service which is co-primary in the band.

ACTION 27.09 **CGMS Members planning the use of the frequency band 7750 – 7850 MHz to start allocating the band from its edges.**

ITU charges for satellite network filings and administrative procedures

The WG I discussed the decision by the Minneapolis Plenipotentiary Conference of the ITU as well as its Council to implement a scheme for cost recovery for satellite network filings received by the Radiocommunication Bureau. The WG noted the potential financial impact for future filings of meteorological satellites. It agreed that due to the benefits to humankind provided by data from meteorological satellites that the filing of such systems should be exempted from cost recovery. Although preliminary ITU discussions indicated no probability for such an exemption, the WG agreed that national representatives to the ITU should be informed of the benefits provided by meteorological satellites and to be requested to support the exemption from the planned ITU charges for such systems.

ACTION 27.10 **CGMS Members to notify national ITU representatives of the benefits of meteorological satellites in seeking an exemption from cost recovery for satellite network filings of theses systems.**

International Frequency Co-ordination of MTSAT

Document JPN-WP-14 summarised the frequency band plan of the Multi-Functional Transport Satellite (MTSAT). The co-ordination activities with regard to the frequency plan have been performed by JMA since 1995. The Ministry of Posts and Telecommunications (MPT), the Telecommunication Administration of Japan, requested JMA to co-ordinate issues regarding the frequency interference with other meteorological satellite operators in accordance with ITU Radio Regulations before the commencement of MTSAT operation.

ACTION 27.11 **All satellite operators to inform their responsible Tele-communication Administration (with copy to JMA) before MTSAT will be operational, that they are convinced that there would be no unacceptable interference between MTSAT and their satellite systems in UHF, S-band and USB.**

I/3 International Data Collection System (IDCS)

Need for additional IDCS Channels

During discussion on new techniques planned to be introduced to the Data Collection Systems of various CGMS Members during CGMS XXVI the question was raised whether an expansion of the IDCS from presently 33 channels to a higher amount would be required.

The working group concluded that there is no immediate need for expansion but in the long-term the amount of international channels shall be increased. The discussion on potential means to increase the number of channels resulted in the proposal to introduce DCPs with bandwidth of 1.5 kHz for IDCS at a later time and thereby increase the amount of channels. This was preferred to the expansion of the frequency band allocated to IDCS as proposed in EUM-WP-19. CGMS will have to take up the proposal at a later time when the need for increase in IDCS channels becomes necessary.

High Rate DCPs (HRDCPs)

The USA presented USA-WP- 18 including the second draft of the “300/1200 bps DCP Certification Standard”. CGMS Members studied the possibility to use similar DCPs on their satellite systems.

In JPN-WP-06, Japan confirmed that the 300 bps HRDCPs could be operated using the GMS/MTSAT space segment and modifications to the ground segment. The 1200 bps HRDCPs could not be supported with the present ground segment. Further studies would be performed.
PRC has made an evaluation for the 300 bps HRDCPs and found these systems compatible with the FY-2 system. No evaluation has been performed for the 1200 bps equipment.

EUMETSAT has investigated the possibility to operate HRDCPs on MSG spacecraft in EUM-WP-20. A study has been performed by ESA but the final report has not been presented yet. The study has shown that there are problems in operating HRDCPs given by the jitters introduced by the antenna system of the MSG spin-stabilised system. It was concluded that operations of HRDCPs could be supported but not simultaneously with nominal DCS operations.

The WG concluded that the implementation of HRDCPs for IDCS is presently not feasible. Use of such equipment within the regional DCS would be possible for some operators.

Spread-spectrum operations on the IDCS

USA-WP-19.1 discussed the long-range plans of spread-spectrum use within the IDCS. The need for additional channels and interference on the system prompted the USA to investigate a new method to accommodate additional Data Collection Platforms and, at the same time reduce the impact of interference. The USA began investigating the use of spread-spectrum techniques as means to use the entire IDCS bandwidth to its full potential. It was decided, in order to use CDMA the signal must coexist with the present use of the UHF frequency. Transmissions of the CDMA signal was achieved to a great success on the IDCS channels. This revealed that using the IDCS frequency band could increase the number of platforms by an order of magnitude and eliminating interference in this application. CGMS Members are invited to consider use of spread spectrum techniques for their DCS in future.

Interference to the IDCS

As in previous CGMS meetings there were several documents reporting on interference to the IDCS presented by various satellite operators.

A detailed analysis of interference to the DCS on FY-2A was provided by PRC. The spectrum of the interference covers the full spectrum 401 – 403 MHz and has a repeat period of 198.5 ms. The pulse of the interfering signal is very narrow and no information content was detected in the modulation. The interfering signal is 10 dB higher than the signal of DCPs.

EUMETSAT reported on continuous interference to some of the DCS channels operated by METEOSAT. The interference has been monitored since the beginning of METEOSAT operations in 1977.

ROSHYDROMET reported on similar interference to the GOMS DCS.

The analysis of the various reports indicated that the interference has similar characteristics and it could be concluded that the same source of interference is affecting the various systems.

Following an analysis performed after CGMS XXVI EUMETSAT informed the Russian State Committee on Communication and Information on the interference, which appears to be created within the territory of the Russian Federation. EUMETSAT was asking for assistance in locating and removing the interference source. A copy of the letter was also addressed to the Radiocommunication Bureau of the ITU. So far there was no reply received from the Russian authorities.

The USA is regularly monitoring the performance of the GOES IDCS as reported in USA-WP-17 . This is performed by the "Channel Interference Monitoring System" (CIMS). The CIMS provides continuous, automatic testing and reporting for both GOES East and West. As a result of this monitoring the USA reported on interference to the GOES system, which reduces the capacity of the DCS substantially. By the characteristics of this interference and by the different regional areas it can be concluded that the interference sources are different to those described above. The USA in USA-WP-16 presented information on a method for locating transmitters that interfere with the IDCS operations. Interference on the IDCS channels has caused loss of time slots and, in some cases, loss of an entire channel. Past experiences in IDCS operations would allow the satellite operator to monitor the channels for interference. At CGMS XXVI, Members were asked to work on procedures to identify and locate sources of interference. The USA has identified an organisation capable of using the current constellation of GOES spacecraft to demonstrate procedures for locating and identifying illegal transmitters in the IDCS system. The new technology could also be implemented with other satellite systems and could give CGMS satellite operators the opportunity to effectively manage their frequency resources. The WG was very interested in this new technique and requested the USA to supply technical details on the system.

ACTION 27.12 **USA to provide detailed technical information on the new location system for interference to the IDCS to CGMS Members.**

REPORT FROM WORKING GROUP II: SATELLITE PRODUCTS

II/0 Introduction

Working Group II on Satellite Products was chaired by Mr. Nobuo Sato of JMA and Drs. Johannes Schmetz of EUMETSAT and Paul Menzel of NOAA/NESDIS assisted as secretaries.

II/1 Image Processing Techniques

The first paper JPN-WP-16 described the image processing method for HiRID (High Resolution Image Data) from MTSAT imager data. Details on image navigation, calibration and IFOV conversion into HiRID data on a fixed latitude/longitude grid were provided. WG II noted that this paper contains very relevant information on the forthcoming new geostationary satellite MTSAT and recommended it for inclusion in the final report.

II/2 Satellite Data Calibration

ESA-WP-02 informed CGMS about their experience in the calibration of active microwave sensors carried on board the ERS series of satellites. The three instrument suites (SAR, scatterometer, and altimeter) are calibrated using internal calibration pulses and using external ground based transponders as well as natural calibration sites. In the case of the altimeter, there was also an extensive campaign using in-situ measurements and tracking stations off the Adriatic Sea. This experience will be used for the calibration of the ENVISAT mission.

EUM-WP-22 summarised the operational practices at EUMETSAT for calibrating the IR and WV channels of Meteosat-7 at 0° longitude and Meteosat-5 at 63°, respectively, by vicarious techniques. JPN-WP-17 described the calibration of the IR window and WV channels by an onboard blackbody and calibration of the VIS channel through tables from pre-launch measurements. It also reported a problem with the spectral response function of the WV channel due to pre-launch measurements in a laboratory at ambient conditions; which included a significant amount of water vapour in the optical path. The resulting uncertainty in the WV observations is of the order of 1° K.

USA-WP-20 reported on the operational calibration practices of NOAA/NESDIS in the infrared and microwave channels. This paper contains a concise summary and many relevant references. USA-WP-20.1 added an overview of operational and proposed calibration procedures for the visible and near-infrared channels. Procedures applied to the polar-orbiting AVHRR are being extended to the geostationary GOES. The vicarious calibration from desert sites will be implemented soon; in the interim star observations are giving initial indications that the GOES-8/9 sensors are losing visible responsivity at the rates of 7.7 and 5 % per year at the low end of the dynamic range.

USA-WP-21 described an approach for calibrating all geostationary sensors with respect to a single polar-orbiting sensor. Radiances from two sensors near nadir view containing mostly clear sky are averaged to 100 km resolution. Differences in mean scene radiances are corrected for spectral response differences through a clear sky forward calculation. The corrected mean differences are attributed to calibration differences. Results, based on between 6 and 36 cases per satellite, suggest the infrared window sensors on GOES-8, GOES-10, Meteosat-5, Meteosat-7, and GMS-5 are within 0.5° C of each other (and within 0.4° C of the NOAA-14 HIRS and AVHRR). WG II noted the importance of continuing such inter-comparisons so that seasonal and diurnal effects as well as secular trends can be explored. WG II also noted the pending polar-orbiting high spectral resolution instruments will provide a greatly enhanced capability for pursuing these types of inter-comparisons.

EUM-WP-23 described two inter-calibration studies for the Meteosat water vapour channel. The first study compared Meteosat with the water vapour channel-12 from HIRS on NOAA-14. The second comparison was done for the 183+/-1 GHz channel of SSM/T2. Both studies suggest a warm bias of about 2 – 2.5° K for Meteosat. WG II noted various items of relevance to satellite calibration and recommended further work on three specific areas: (a) the advantage of using cloud free scenes for the inter-calibration of IR window radiances; (b) the influence of potentially different airmass at either side of the polar satellite track on comparisons using the iso-secant method; and (c) the utility of satellite µ-wave radiance observations for the inter-calibration with thermal IR radiances.

ACTION 27.13 **Satellite operators performing cross-calibration to study the importance of cloud clearing and near nadir viewing for inter-comparisons and to report at CGMS XXVIII.**

Recommendation: **The utility of microwave inter-comparisons need to be studied. Opportunities with the pending high spectral resolution instruments should be studied and pursued vigorously.**

EUM-WP-35 reported on the calibration of Meteosat-5 and –6 VIS channels with help of a radiative transfer model. Results should be useful for quantitative applications of Meteosat-5 during INDOEX and Meteosat-6 during MAP. The paper also pointed out that the spectral response functions (SRF) for Meteosat-5 and –6 originally provided by industry were incorrect and that the SRF of Meteosat-7 should be used instead. A general discussion on the correctness and credibility of satellite SRFs led to the following action:

ACTION 27.14 **All satellite operators to initiate investigations whether spectral response functions of current and previous satellites are potentially erroneous and quantify the error if possible.**

JPN-WP-18 presented the results of a preliminary study on inter-calibration of the visible channels between GMS-5 and NOAA-14. The JMA procedure was found to be effective in clear regions over ocean; JMA plans to apply the procedure on independent data and continue further inter-calibration activities for other regions (e.g. desert, cloud).

CMA-WP-08 reported on ongoing work for the inter-calibration of FY-2A IR window observations with collocated AVHRR radiances. The paper outlines a method that will be implemented in due course and will provide an accurate and tractable tool for cross-checking the operational calibration of FY-2A.

CMA-WP-09 described the well-instrumented test sites of CMA for the radiometric calibration of remote-sensing satellites. A desert test site has been prepared for calibrating solar sensors and a lake test site for infrared sensors. WG II commended CMA on the development of the test sites that provide an outstanding facility for future cal/val activities. In particular CMA was encouraged to utilise the site for the calibration of solar channels of current meteorological satellites of other CGMS Members (e.g. Meteosat–5).

II/3 Vertical Sounding and ITWG Matters

EUM-WP-21 gave an update on the AAPP development. It reported a successful delivery of version 1.3 to users. This version also includes correction software for the AMSU-B problems on NOAA-15. WG II noted the remarkable achievement of a distribution policy for global unlimited use by non-commercial users and the right for re-distribution; WG II thanked EUMETSAT and its partners for the effort in putting together this important software tool.

EUM-WP-24 reported on EUMETSAT activities to enhance the use of satellite data over land. A Meteosat Second Generation (MSG) Biosphere Working Group (MBWG) had been established jointly with the Joint Research Centre of the European Commission in order to analyse requirements and the potential of MSG to contribute to the observation of relevant geophysical quantities. A successful series of workshops of the MBWG was concluded with a report summarising requirements, potential and specific recommendations that should ensure the success of MSG land applications. A second item addressed in EUM-WP-24 was the improved use of infrared soundings over land. A report on this matter has been produced by a working group of the International IASI Sounder Science Working Group (ISSWG). Both reports are available from EUMETSAT upon request. WG II welcomed the proactive work and encouraged further rapid progress; the following action resulted:

ACTION 27.15 All satellite operators to report at CGMS XXVIII on activities concerning satellite radiance applications over land (e.g. thermodynamic soundings, surface albedo).

RUS-WP-07 reported on the adaptation of the AAPP to the PC environment. WG II noted that this effort was very important as many more users of ATOVS use PCs exclusively in their work.

USA-WP-22 reported that the GOES-8/10 sounders continue to produce operational soundings every hour over North America and nearby oceans. Atmospheric temperature and moisture profiles are generated using a simultaneous physical retrieval algorithm. During the past year GOES-10 moisture retrievals were added to GOES-8 moisture retrievals in the operational Eta model. The total column water vapour RMS difference with respect to radiosondes for 1998-99 has been reduced from 2.9 mm for the forecast first guess to 2.5 mm for the GOES retrievals, roughly an improvement of 15%; GOES improves the layer mean values by 0.1 to 0.3 mm in each layer. In addition to NWP applications the GOES sounder derived product images are becoming increasingly useful to the weather service forecasters for nowcasting and local forecasting.

Rapporteur Dr. Paul Menzel of International TOVS Working Group (ITWG) presented USA-WP-23 on the tenth meeting of ITWG, held in Boulder, Colorado from 27 January to 2 February 1999. About 120 scientists from 25 countries participated in presentations and working group deliberations. The recent launch of NOAA-15 with the new instrument suite provoked a number of intriguing presentations and lively discussions. The ITWG noted the CGMS guidance to study improved use of satellite radiances over land, mitigation of possible product differences due to different a.m. and p.m. sounder instruments, quantification of spectral response function specifications, and geostationary high spectral resolution measurements; their next meeting will include reports on these issues. Further, the ITWG recommended CGMS consider several recommendations with regard to coordinating of polar-orbiter crossing times, efficient access to their real-time data, hastening preparations for EOS MODIS and AIRS utilisations, exploring remote-sensing beyond 15 microns, resourcing frequency protection activities, and encouraging geostationary high spectral resolution remote-sensing. These are detailed in the working paper. The next meeting will occur in Budapest, Hungary from 27 September to 3 October 2000. WG II noted the effective communications that were ongoing between ITWG and CGMS and encouraged continuance of the relationship. In particular WG II resonated with the recommendation from ITWG toward overarching strategies to coordinate polar-orbiting equator crossing times to optimise satellite utilisation.

The WG II noted that this matter will be taken up as an item of the post 2010 evolution of a GOS under review by WMO as noted in section C.3.

II/4 Other Parameters and Products

EUM-WP-33 gave a detailed report on the prototype algorithm for the cloud masking and cloud products from MSG. The algorithm is based on thresholding techniques and holds promise for utilisation as pre-processor for day-2 products from MSG. The algorithm is very flexible and can also be utilised when channels are missing. Examples are presented for applications to Meteosat and the GOES-8 imager and sounder. This paper will be released as a EUMETSAT technical memorandum.

EUM-WP-34 is a short paper informing CGMS about the products derived from MSG level 1.5 data. Products are listed in tabular form providing the characteristics. The list includes products from the central Meteorological Product Extraction Facility (MPEF) as well as products from the Satellite Application Facilities (SAF) on Ocean and Sea Ice, Support to Nowcasting and Very Short-range Forecasting, and Ozone Monitoring. WG II noted with interest the nowcasting activities and encouraged all satellite operators to submit reports on their activities in this area at future CGMS meetings.

CMA-WP-10 described the products of FY-1C image products, land products, ocean products and atmosphere products. Image products play a great role in disaster monitoring, such as forest fire, flooding, blizzard fatality etc; they include stretched gridded images, special event images, orbital images, image mosaics in regional and globe size and products images. Land products are used to monitor the variation of land cover and environment changes, such as using vegetation index to monitor the crop growing condition over China, using snow cover data in snow disaster monitoring and in research of climate changes. The FY-1C system provides many products over land in both regional and global scale. For ocean products, the FY-1C satellite has 1 short wave IR channel, 2 long wave IR channels and 3 ocean colour observation channels. These data can be used to produce many products such as sea surface temperature, sea ice, and ocean colour and so on. FY-1C atmosphere products include cloud parameters, outgoing long wave radiation (OLR), and water vapour total content. These products are being used for weather analysis and climatological research.

RUS-WP-06 presented a summary of the global geostationary products being processed by SRC PLANETA from Meteosat –7, -5, GMS-5, GOES-W and -E. Several interesting examples of the global cloud mosaics were included.

II/5 Coordination of Code forms for Satellite Data

While no papers were submitted on this subject, WG II noted that coordination was ongoing and effective and that satellite data code forms were being followed.

II/6 Coordination of Data Formats for the Archive and Retrieval of Satellite Data

EUM-WP-25 presented an overview and the status of the development of the Unified Archive and Retrieval Facility (U-MARF) in EUMETSAT. The objective of the U-MARF (see CGMS-XXVI EUM-WP-22) is to implement a unified archive and retrieval facility that supports data from Meteosat, Meteosat Second Generation (MSG) and the EUMETSAT Polar System (EPS) missions. The U-MARF is developed incrementally and thus will be flexible enough to accommodate additional data sets, e.g. from Third Party missions. In early 1998, a U-MARF Project Team was set-up and developed a U-MARF Requirements Specification and a development logic, in agreement with the Meteosat, MSG and EPS customer programmes. Upon successful completion of this task, a contract was awarded and work started in December 1998. Currently version 1 is pending, which includes the archive of Meteosat and MSG data. The EPS archive will follow in version 2.

EUM-WP-36 discussed the potential of the Meteosat archived data to support climate studies. It was noted that ESA had initiated the Meteosat archive that EUMETSAT is now maintaining and continuing. A reprocessing computer environment has been set up at EUMETSAT in support of the derivation of products with advanced algorithm from archived data. The environment has already been used successfully to derive a one-year climatology of a Meteosat surface albedo. The paper also compiles useful information on the performance of previous Meteosat satellites. The paper is published in the Proceedings of the EUMETSAT Users' Conference 1999 in Copenhagen. WG II noted the importance of using the satellite archives for reanalysis and climate studies and thus urged the following recommendation:

Recommendation: All satellite operators are encouraged to reprocess meteorological parameters with the most current peer reviewed algorithms.

Discussions on reprocessing also stressed the need to have a record of instrument changes throughout their operational lifetimes; this information was deemed to be vital for reprocessing of historical satellite data.

ACTION 27.16 **All satellite operators to propose at CGMS XXVIII, which information should be put into a data base to be used in future satellite data reprocessing activities.**

II/7 Conclusion

WG II concluded a full agenda with discussions on the importance of continuing the useful dialogue between the ITWG and the CGMS.

REPORT FROM WORKING GROUP III: SATELLITE TRACKED WINDS

III/0 Introduction

The Working Group on Satellite Tracked Winds (WG III) was chaired by Dr. Paul Menzel and Dr. Zhang Wenjian assisted as secretary. Fourteen papers were presented and discussed.

WG III started with the presentation of EUM-WP-26, which summarised the proceedings of the fourth International Workshop on Winds (IWW4) held in Saennenmoeser, Switzerland in October 1998. Rapporteur Dr. Johannes Schmetz indicated that IWW4 was attended by 38 scientists from 15 countries and four international organisations. The workshop addressed various topics in six sessions (current procedures for tracking atmospheric motion vectors (AMVs), assimilation in NWP, utilisation of AMVs, other space borne AMV, verification and objective quality analysis of AMVs, and new developments and applications). Three working groups (methods, utilisation, and verification/quality indicators) produced several actions and recommendations. The specific accomplishments of IWW4 were felt to be: (a) expansion of the winds user community resulting from enhanced Education and Training efforts as well as improved data communications; (b) inauguration of high density winds and identification of user problems with the high data volume; (c) characterisation of the strengths of automatic quality flags; (d) demonstration of applications in nowcasting as well as forecasting; (e) initial study of additional benefit from direct assimilation of radiances in time sequences in NWP models; (f) expansion of NWP impact studies to a more diverse community; (g) realization of FGGE like data sets with Meteosat-5 over the Indian Ocean; and (h) initiation of dialogue with the scatterometer, passive microwave, and Doppler wind lidar community. A summary report of IWW4 has been published in BAMS (Schmetz, J., D. Hinsman, and W. P. Menzel, 1999: Summary of the Fourth International Winds Workshop. Bull. Amer. Meteor. Soc., 80, 893-899) and Proceedings of IWW4 including the presented papers and detailed reports form the working groups are available as a EUMETSAT Publication. WG III noted that the workshop was successful and achieved its goals. The next workshop IWW5 is planned for 28 February – 3 March 2000 in Lorne, Australia; Chris Velden of CIMSS and Ken Holmlund of EUMETSAT will organise the workshop with Dr. John LeMarshall of BoM as local host.

WG III encouraged IWW5 to include discussion of the following items on their agenda: (a) convergence toward one set of automatic quality flags; (b) international strategies for producing more rapid scan winds; (c) continued study of the benefits from hourly direct assimilation of radiances in NWP models; (d) expanded utilisation of geometric approaches (stereo, shadows) for validation of AMV height assignment with a combination of LEO-GEO sensors; (e) investigation of more uniform approaches for AMV height assignment with multispectral geostationary data; (f) continued study of other methodologies for deriving AMVs from microwave remote-sensing and multispectral polar-orbiting sensors and utilizing surface winds from scatterometry; (g) assessment of AMVs tracked in 3.9 and 9.7 micron images as available from current LEO-GEO sensors; and (h) improved utilization of AMVs in

NWP, especially over land. IWW5 will report at the next CGMS on their progress on these items through the rapporteur.

III/1 Wind Statistics and Procedures for Exchange of Intercomparison Data

WG III noted success of the IWWs in establishing an international standard procedure for reporting wind production and quality by international agencies; these are now readily available on the WMO homepages. WG III also ascribed the continued global improvement in the quality of AMVs (as witnessed by the wind statistics) to the efforts of the IWWs. An example of the quality of current AMV production was given in JPN-WP-19 and USA-WP-22, which presented the current status of the accuracy of AMV production in Japan and the USA, respectively.

In addition, it was noted that most NWP centers still do not use AMVs over land; WG II recommended renewed activity on improved utilisation.

ACTION 27.17 **Satellite wind producers to review utilisation of their AMVs with their respective NWP centers and report on these efforts at CGMS XXVIII.**

EUM-WP-30 reported on the encoding of satellite tracked winds in BUFR format.
It explained the advantages of the BUFR encoding and informed the working group that various wind products from EUMETSAT and the clear sky radiance product are disseminated in BUFR. USA-WP-25 offered information on encoding their wind products using the BUFR format. WG III noted that the BUFR format had expanded the information content of the wind files and recommended that NWP centers be queried on their reaction to this new data format.

ACTION 27.18 **WMO to query NWP centers on the utilisation of the BUFR format and report on this at CGMS XXVIII.**

III/2 Derivation of Atmospheric Motion Vectors

CMA-WP-11 summarised their algorithm for calculating cloud motion winds from FY-2 and GMS-5. Recent efforts have focused on improving wind height assignments for thin cirrus clouds as well as low clouds. Good results were evident from using a correlation analysis of IR and WV tracers and inspecting split window brightness temperature differences. This technique had recently been demonstrated at EUMETSAT with Meteosat data also with very good results.

EUM-WP-27 responded to an action from CGMS XXVI providing a development plan for the wind products from Meteosat-5 and Meteosat-7. The development plan covers a wide scope from pre-processing to new wind products such as high-resolution WV winds. Automatic quality control will be a major area for development.

EUM-WP-28 gave an update on selection/rejection criteria at NWP centres for satellite tracked winds. A similar paper had been presented at CGMS XXVI and WG III felt that updates to the paper should be a standing item on the agenda of the CGMS Working Group on Satellite Tracked Winds. JMA corrected several of the entries in EUM-WP-28 regarding the observation errors they assign to satellite tracked winds. WG III noted that the assigned observation errors are quite different for the various NWP centres; this led to the recommendation to inform NWP centres about the large differences and to request reconsideration of the assigned errors. It was suggested that this paper should be submitted to the Working Group on Numerical Experimentation of JSC and that CGMS should ask for comments.

ACTION 27.19 **JMA on behalf of CGMS to submit the selection criteria at NWP centers for the cloud tracked winds to WGNE/JSC and ask for comments on the wide range of given observation errors.**

A report on the rapid scans with Meteosat-6 in support of the Mesoscale Alpine Experiment (MAP) was given in EUM-WP-29. The novel use of the stand-by spacecraft Meteosat-6 is enabling special rapid scans over the Alpine region that can be provided with a lead time of 12 hours during the special observing period of MAP. WG III commended EUMETSAT on the support to MAP and this use of rapid scans. It recommended that EUMETSAT should make an effort to utilise the 5 minute-scans for wind derivation and to compare such winds with wind fields from the standard 30 minute-scans.

ACTION 27.20 **EUMETSAT to make an effort to utilise the 5 minute-scans for wind derivation and conduct a comparison with wind fields from the standard 30 minute-scans.**

EUM-WP-31 was submitted by the EUMETSAT Satellite Application Facilities (SAF) on numerical weather prediction (NWP). It suggests posting their results from the NWP monitoring of all satellite-tracked winds on the Internet and requests CGMS agreement. WG III welcomed the initiative in principle, but it felt that further clarification was necessary to avoid misinterpretation of the monitoring results. It was suggested that a member of the NWP SAF consortium present the paper at the IWW5 to initiate further discussion; IWW5 should then submit a report at CGMS XXVIII.

ACTION 27.21 **IWW5 to advise the CGMS Members at CGMS XXVIII with regard to the NWP SAF proposal to post their results from NWP monitoring of all satellite tracked winds on the Internet.**

EUM-WP-32 gave a technical report on the derivation of high resolution water vapour winds from Meteosat. The high resolution winds are derived for template sizes of 16x16 pixels as opposed to the standard product based on a template size of 32x32 pixels.

JPN-WP-20 presented their plans for processing winds with MTSAT. These include routine production of 15 minute-interval winds (using a scan strategy of NH, NH, FD, SH, SH) four times daily. Their recent investigations reveal a 20% increase in wind vector yield from the shorter time intervals. JMA will also produce high-density low level winds around typhoons four times daily.

USA-WP-24.1 also considered the benefit of shorter time intervals for tracking winds. Motion vectors were derived from GOES-10 full resolution (oversampled in the East West by 1.75) water vapor (8 km resolution), infrared window (4 km resolution), and visible (1 km resolution) images; results (based on quantity, quality, and comparison with radiosonde observations) indicate that the optimal time elapsed between images for visible low level winds is 5 minutes, for infrared cloud motion winds it is 10 minutes, and for water vapor layer drift in clear skies it is 30 minutes. This reiterates that satellite wind derivation from 30 minute interval images remains less than optimal.

USA-WP-24.2 presented the results of using stereo GOES images to infer cloud heights geometrically. Improvements were noted when the stereo was accomplished with 5 minute rapid scan images. WG III also noted that stereo approaches for cloud height assignment had been demonstrated with Meteosat data during summer 1999 and offered promise for validation of operational H_2O and CO_2 radiometric height assignment techniques.

USA-WP-22 presented their wind plans for the coming year. It includes implementation of a combined EUMETSAT and USA quality indication system and further investigation of tracking winds in 3.9 micron images. The 3.9 micron band is more sensitive to lower-tropospheric radiation than the 10.7 micron counterpart and initial results show a marked increase in vector coverage at night over low-level cloudy regions as well as help in filling data void regions. WG III noted with interest the development of 3.9 micron winds and encouraged further research in this area.

ESA informed WG II that a jointly organised ESA and EUMETSAT workshop on “Emerging scatterometer applications: from research to operations” took place at ESTEC (Netherlands) in October 1998. Proceedings are available from ESA to interested CGMS Members.

III/3 Conclusion

WG III concluded with a brief recollection of the pioneering work of Tetsuya (Ted) Fujita in remote-sensing of atmospheric motion. Fujita passed away in December 1998 and will be honoured with a special session at the January 2000 meeting of the American Meteorological Society. When meteorological satellites were introduced, Fujita developed techniques for precise analysis of satellite measurements (sequences of images from polar-orbiting platforms first and then from geostationary platforms) and used ground stereo cameras to validate the satellite winds. Soon after his initial work, the ability to track clouds and relate them to flow patterns in the atmosphere was transferred into routine operations at national forecast centers. Cloud motion vectors derived from geostationary satellite imagery have evolved from his initial efforts into an important data source of meteorological information. WG III remembered with gratitude his participation in IWW1 and IWW2.

FINAL PLENARY SESSION

SENIOR OFFICIALS MEETING

J.1 APPOINTMENT OF CHAIRMAN

The CGMS XXVII Senior Officials meeting was convened at 10.30 a.m. on 18 October 1999 and elected Professor Xu as Chairman and Dr. Hinsman as Co-Chairman.

J.2 REPORTS FROM THE WORKING GROUPS

Reports from the three Working Groups were presented by their Chairmen: Mr. R. Wolf (WG I on Telecommunications), Mr. N. Sato (WG II on Satellite Products), and Dr. P. Menzel (WG III on Satellite-tracked Winds).

The Senior Officials took note of the reports and thanked the participants, Chairmen and Rapporteurs for their active and fruitful discussions. They endorsed the proposed actions and recommendations formulated by each Group. The Senior Officials congratulated the three Working Groups for their comprehensive reports and for their achievements since the preceding meeting of CGMS.

J.3 NOMINATION OF REPRESENTATIVES AT WMO AND OTHER MEETINGS

The Senior Officials agreed that:

- Dr. P. Menzel will represent CGMS at the next meeting of the ITSC (in Budapest in September 2000),
- The CGMS Secretariat will represent CGMS at the WMO Executive Council in May 2000,
- The CGMS Secretariat will represent CGMS at the WMO CBS Meeting in 2000,
- The CGMS Secretariat will represent CGMS at the OPAG on Integrated Observing Systems Meeting,
- Dr. J. Schmetz will be Rapporteur at the International Winds Workshop,
- Mr. R. Wolf will represent CGMS at the CPM and WRC 2000.
- The CGMS Secretariat will represent CGMS at the CEOS Plenary, November 1999, in Stockholm.
- JMA will represent CGMS at the WGNE/JSC.

J.4 ANY OTHER BUSINESS

In an oral presentation Japan informed CGMS of the Global Change Observation Mission (GCOM), which is being studied by NASDA as a follow-on mission to ADEOS-II. This mission would have a potential performance to support the meteorological satellite observation requirements. CGMS thanked NASDA for this report and proposed the following action:

ACTION 27.22 **JMA to invite NASDA to present further information on the Global Change Observation Mission at CGMS XXVIII.**

CGMS took the opportunity to thank ESA for providing information on ENVISAT and agreed that it should be kept informed on the further development of ENVISAT and the ESA proposed Earth Explorer Mission.

ACTION 27.23 **EUMETSAT to invite ESA to provide further information on ENVISAT and the Earth Explorer Mission at CGMS XXVIII.**

J.5 SUMMARY LIST OF ACTIONS

The meeting agreed that the list of permanent actions could be significantly reduced as many of the requested activities were now being carried out by Members on a regular basis.

(i) Permanent actions

1. All CGMS Members to inform the Secretariat of any change in the status or plans of their satellites to allow the updating of the CGMS Tables of Satellites.

2. The Secretariat to review the tables of current and planned polar and geostationary satellites, and to distribute this updated information, via the WWW Operational Newsletter, via Electronic Bulletin Board, or other means as appropriate.

3. All satellite operators to provide NOAA/NESDIS with information on unexplained anomalies for study, and NOAA to provide solar event information to the satellite operators on request and a status report on the correlation study at each meeting.

Outstanding actions from previous meetings

ACTION 26.50 Japan and PRC to study the possibilities for back-up of product generation and inform CGMS XXVII of the progress in their discussions.

ACTION 26.52 India to study possibilities for supporting the CGMS principles on regional contingency planning and transmit them to higher authorities and report at CGMS XXVII.

ACTION 26.53 India to actively promote the use of INSAT data throughout the Indian Ocean region and inform CGMS XXVII of such use.

(iii) Actions from CGMS XXVII

ACTION 27.01 (1) EUMETSAT, Japan and USA to implement the monitoring of IDCS performance using the agreed set of reporting statistics and report to CGMS Secretariat.
(2) CGMS Secretariat to report on the effectiveness of this scheme at CGMS XXVIII.

ACTION 27.02 NOAA/NESDIS to provide information on the status of its plans for direct broadcast services on the NPOESS satellites at CGMS XXVIII.

ACTION 27.03 CGMS Members to inform USA if they wish to propose experimental payloads for future GOES Satellites by 15 December 1999.

ACTION 27.04 Japan to place the draft MTSAT, HiRID, LRIT and WEFAX schedule on the WMO server.

ACTION 27.05 All CGMS satellite operators to review the Tables in Appendix A of WMO-WP-03 and provide any updates to WMO prior to 31 December 1999.

ACTION 27.06 The Secretariat and Drafting Committee for the CGMS Consolidated Report to complete the following by 31 December 1999:

(i) CGMS Secretariat in cooperation with WMO to draft the "general" CGMS sections and send the drafts for comments and approval to the members of the drafting committee.

(ii) Members of the drafting committee to comment or approve the text.

(iii) Each CGMS Member to update the sections referring to its organisation and to send these to the CGMS Secretariat. The representative of the drafting committee will be responsible for coordinating the inputs of its organisation.

ACTION 27.07 CGMS Members to announce the names of participants of the Conference Preparatory Meeting and the World Radio Conference 2000, which will support meteorological issues. The announcement shall be done using the WMO list server: cgmsfreq@www.wmo.ch

ACTION 27.08 Japan and USA to inform CGMS by 31 December 1999 on their plans and the dates to when the partition plan for the band 1675 – 1710 MHz would be fully complied.

ACTION 27.09 CGMS Members planning the use of the frequency band 7750 – 7850 MHz to start allocating the band from its edges.

ACTION 27.10 CGMS Members to notify national ITU representatives of the benefits of meteorological satellites in seeking an exemption from costing recovery for satellite network filings of theses systems.

ACTION 27.11 All satellite operators to inform their responsible Telecommunication Administration (with copy to JMA) before MTSAT will be operational, that they are convinced that there would be no unacceptable interference between MTSAT and their satellite systems in UHF, S-band and USB.

ACTION 27.12 USA to provide detailed technical information on the new location system for interference to the IDCS to CGMS Members.

ACTION 27.13 Satellite operators performing cross-calibration to study the importance of cloud clearing and near nadir viewing for inter-comparisons and to report at the next meeting.

ACTION 27.14 All satellite operators to initiate investigations whether spectral response functions of current and previous satellites are potentially erroneous and quantify the error if possible.

ACTION 27.15 All satellite operators to report at the next CGMS on activities concerning satellite radiance applications over land (e.g. thermodynamic soundings, surface albedo).

ACTION 27.16 All satellite operators to propose at the next CGMS which information should be put into a data base to be used in future satellite data reprocessing activities.

ACTION 27.17 Satellite wind producers to review utilisation of their AMVs with their respective NWP centers and report on these efforts at the next CGMS.

ACTION 27.18 WMO to query NWP centers on the utilization of the BUFR format and report at CGMS XXVIII.

ACTION 27.19 JMA on behalf of CGMS to submit the selection criteria at NWP centers for the cloud tracked winds to WGNE/JSC and ask for comment on the wide range of given observation errors.

ACTION 27.20 EUMETSAT to make an effort to utilize the 5 minute-scans for wind derivation and conduct a comparison with wind fields from the standard 30 minute-scans.

ACTION 27.21 IWW5 to advise the CGMS at the next meeting with regard to the NWP SAF proposal to post their results from NWP monitoring of all satellite tracked winds on the Internet.

ACTION 27.22 JMA to invite NASDA to present further information on the Global Change Observation Mission at CGMS XXVIII.

ACTION 27.23 EUMETSAT to invite ESA to provide further information on ENVISAT and the Earth Explorer Mission at CGMS XXVIII.

J.6 APPROVAL OF DRAFT FINAL REPORT

The Senior Officials, together with the Plenary, reviewed the draft Final Report of the meeting and approved it with minor amendments. The Secretariat agreed to include all the amendments in a revised version, which would be distributed to CGMS Members for final comments within one or two weeks, prior to full publication. It was also agreed that the final version of the report would be provided to participants via normal and electronic mail.

J.7 DATE AND PLACE OF NEXT MEETINGS

CGMS was pleased to accept an offer from the USA to host CGMS XXVIII in the autumn of 2000, at a date and place to be agreed upon between the host and Secretariat in due course.

On behalf of all participants, Professor Xu Jianmin thanked all CGMS Members and the Secretariat for their work and cooperation during the meeting. Dr. Hinsman thanked Professor Xu Jianmin for his efficient and expert Chairmanship of the meeting. The CGMS Secretariat expressed thanks to NSMC/CMA and, in particularly, the Local Organising Committee, for their great hospitality and for all the organisational arrangements, which made the 27th CGMS Plenary Meeting such a great success and a very enjoyable and memorable event for all participants.

The meeting was adjourned at 1.30 p.m. on 18 October 1999.

ANNEXES:

AGENDA, LIST OF WORKING PAPERS, PARTICIPANTS AND WORKING GROUP PARTICIPANTS

AGENDA OF CGMS XXVII
13-18 October 1999

A. INTRODUCTION

A.1 Welcome
A.2 Election of Chairman
A.3 Adoption of Agenda and Work Plan of Working Group Sessions
A.4 Nomination of WG Chairmen, Rapporteurs and Drafting Committee
A.5 Review of Action Items

B. REPORT ON THE STATUS OF CURRENT SATELLITE SYSTEMS

B.1 Polar-orbiting Meteorological Satellite Systems
B.2 Geostationary Meteorological Satellite Systems
B.3 Anomalies from solar and other events

C. REPORT ON FUTURE SATELLITE SYSTEMS

C.1 Future Polar-orbiting Meteorological Satellite Systems
C.2 Future Geostationary Meteorological Satellite Systems
C.3 Reconfiguration of future combinations of LEO and GEO missions

D. OPERATIONAL CONTINUITY AND RELIABILITY

D.1 Global planning, including orbital positions
D.2 Inter-regional contingency measures
D.3 Long-term global contingency planning

E. SATELLITE REQUIREMENTS OF WMO PROGRAMMES

E.1 World Weather Watch
E.2 Other Programs

F. COORDINATION OF INTERNATIONAL DATA COLLECTION & DISTRIBUTION

F.1 Status and Problems of IDCS
F.2 Ships, including ASAP
F.3 ASDAR
F.4 Dissemination of DCP messages (GTS or other means)

G. COORDINATION OF DATA DISSEMINATION

G.1 Dissemination of satellite images via satellite
G.2 Dissemination of satellite products via satellite, GTS or other means
G.3 Global exchange of satellite image data via satellite or via the GTS

H. OTHER ITEMS OF INTEREST

H.1 Applications of Meteorological Satellite Data for Environment Monitoring
H.2 Search and Rescue (S&R)
H.3 Meteorological Data Distribution via satellite
H.4 Training
H.5 Information
H.6 Any other business

---------- PARALLEL WORKING GROUP SESSIONS ------------

WORKING GROUP I: TELECOMMUNICATIONS

I/1 Coordination of frequency allocations: SFCG, ITU and WRC activities
I/2 Telecommunication techniques
I/3 Issues arising from CGMS XXVII plenary discussion
I/4 Conclusion and preparation of the WG report

WORKING GROUP II: SATELLITE PRODUCTS

II/1 Image processing techniques
II/2 Satellite Data Calibration
II/3 Vertical sounding and ITWG matters
II/4 Other parameters and products
II/5 Coordination of Code forms for satellite Data
II/6 Coordination of Data Formats for the Archive and Retrieval of Satellite Data
II/7 Conclusion and preparation of the WG Report

WORKING GROUP III: SATELLITE TRACKED WINDS

III/1 Preparation of the 5th International Workshop on Winds
III/2 Wind Statistics
III/3 Procedures for the exchange of inter-comparison data
III/4 Derivation of Wind Vectors
III/5 Conclusion and preparation of WG report

------------ FINAL SESSION (SENIOR OFFICIALS MEETING) ---------

J.1 Appointment of Chairman of final session
J.2 Reports from the Working Groups
J.3 Nomination of CGMS Representatives at WMO and other meetings
J.4 Any Other Business
J.5 Summary List of Actions from CGMS XXVII
J.6 Approval of Draft Final Report
J.7 Date and Place of Next Meetings

WORKING PAPERS SUBMITTED TO CGMS-XXVII

ESA

ESA-WP-01	Status of the ENVISAT mission	C.1
ESA-WP-02	Calibration of active microwave sensors at ESA	II.2

EUMETSAT

EUM-WP-01	Review of Action Items	A.5
EUM-WP-02	Status of the Meteosat System	B.2
EUM-WP-03	EPS Programme and Development Status	C.1
EUM-WP-04	Status of Preparation of MSG	C.2
EUM-WP-05	Network of EUMETSAT Satellite Applications Facilities	C.2
EUM-WP-06	Compliance of the post-2000 satellite-based component of GOS with requirements and possible approach to up-date/up-grade future systems	C.3
EUM-WP-07/08	Status and Problems of the IDCS	F.1
EUM-WP-09	CGMS Broadcast Format Guide	G.1
EUM-WP-10	Report on EUMETSAT Training Activities	H.4
EUM-WP-11	EUMETSAT Conferences and Publications	H.5
EUM-WP-12	Report on the 3rd EUMETSAT User Forum in Africa	H.5
EUM-WP-13	Report on CGMS Participation at UNISPACE III	H.5
EUM-WP-14	Proposal for a work plan for the CGMS Home Page and Consolidated Report	H.5
EUM-WP-15	The CGMS Directory of Meteorological Satellite Applications	H.5
EUM-WP-16	Report on preparations for the year 2000 transition	H.6
EUM-WP-17	Preparations for the World Radio Conference 2000	I.1
EUM-WP-18	Report on sources of interference to geostationary meteorological satellite services	I.2
EUM-WP-19	Requirements for future use of IDCS and possible reconfiguration of IDCS	I.3
EUM-WP-20	Impact of higher-rate DCP on nominal IDCS operations	I.3
EUM-WP-21	EUMETSAT AAPP Development – Status as of July 1999	II.3
EUM-WP-22	Operational calibration practices at EUMETSAT	II.2
EUM-WP-23	Satellite inter-calibration of the Meteosat water vapour channel	II.2
EUM-WP-24	Report on the use of satellite data over land	II.3
EUM-WP-25	Report on the status of Unified Archive Retrieval Facility	II.6
EUM-WP-26	Summary of the 4th International Winds Workshop	III.1
EUM-WP-27	Wind products development plan of the EUMETSAT MPEF	III.4
EUM-WP-28	Update on selection/rejection criteria at NWP centres for satellite tracked winds	III.4
EUM-WP-29	Rapid scans from Meteosat in support of MAP	III.4
EUM-WP-30	Report on encoding of satellite tracked winds in BUFR	III.4
EUM-WP-31	Monitoring of satellite winds at the NWP SAF	III.4

EUM-WP-32	High resolution water vapour winds from Meteosat	III.4
EUM-WP-33	Cloud processing for Meteosat Second Generation (MSG)	II.4
EUM-WP-34	Meteorological Products from MSG	II.4
EUM-WP-35	Calibration of Meteosat VIS channels	II.2
EUM-WP-36	Exploitation of the Meteosat Archive for Climate Monitoring: Expectations and Limitations	II.6
EUM-WP-37	Status of LRIT/HRIT Global Specification	G.1
EUM-WP-38	EUMETSAT External Information System – Status update	H.5

INDIA

IMD-WP-01	Status of Indian National Satellite System	B.2

JAPAN

JPN-WP-01	Review of action items from previous CGMS meetings	A.5
JPN-WP-02	Status of the geostationary meteorological satellites	B.2
JPN-WP-03	Actions toward the Leonid Meteor Storms	B.3
JPN-WP-04	Future Plan of the geostationary meteorological satellites	C.2
JPN-WP-05	Status and problems of the GMS IDCS	F.1
JPN-WP-06	The requirements for the future use of the IDCS in the next 10-15 years and the studies of the possibility reconfiguration of the IDCS to narrow bandwidth channels	I.3
JPN-WP-07	The development and operation of High-rate DCP and the study the impact of such systems upon nominal IDCS operations	I.3
JPN-WP-08	Schedules of MTSAT observation and image data dissemination	G.1
JPN-WP-09	Promotion of Asia-Pacific satellite data exchange and utilization	G.2
JPN-WP-10	Mutual cooperation between JMA and the Bureau of Meteorology	G.2
JPN-WP-11	Meteorological data dissemination using the LRIT function	H.3
JPN-WP-12	Development of CAL systems in JMA	H.4
JPN-WP-13	A training plan for MTSAT/LRIT data utilization in National Meteorological Services in Southeast Asia	H.4
JPN-WP-14	The international satellite frequency coordination between the MTSAT networks and other meteorological satellite networks in the UHF band, S band and USB	I.1
JPN-WP-15	Status of JMA’s activities for WRC-2000 with regard to radio frequency matter for the meteorological services	I.3
JPN-WP-16	Image processing method for MTSAT imager data	II.1
JPN-WP-17	Operational Calibration Practices of GMS-5	II.2
JPN-WP-18	Inter-calibration of GMS-5 and NOAA-14 AVHRR Visible channel	II.2
JPN-WP-19	Current status of the accuracy of GMS Cloud Motion Winds and Water Vapor Motion Winds	III.2
JPN-WP-20	Satellite Winds Products Plans with MTSAT	III.2

PEOPLE'S REPUBLIC OF CHINA

CMA-WP-01	The status of FY-1 C Satellite	B.1
CMA-WP-02	The status of FY-2 A Satellite	B.2
CMA-WP-03	The future plan of Chinese Polar-Orbiting Meteorological Satellites	C.1
CMA-WP-04	The future plan of FY-2 Satellite	C.2
CMA-WP-05	The DCP interference FY-2 A satellite suffered	F.1
CMA-WP-06	The evaluation of using higher speed IDCS of FY-2	F.1
CMA-WP-07	The flood monitoring in 1998 in China during the summer season of 1998 by using meteorological satellite data	H.1
CMA-WP-08	Inter-calibration between FY-2A and NOAA	II.2
CMA-WP-09	The Chinese calibration site of remote-sensing satellites	II.2
CMA-WP-10	FY-1 C satellite products	II.4
CMA-WP-11	Cloud Motion Winds from FY-2 and GMS-5 meteorological satellites	III.4
CMA-WP-12	The current Status of Meteorological Sat. data Processing System	B.1

RUSSIAN FEDERATION

RUS-WP-00	Review of action items from previous CGMS meetings	A.5
RUS-WP-01	Status of METEOR Polar-Orbiting Meteorological Systems	B.1
RUS-WP-02	Report on Future Polar-Orbiting Meteorological Satellite System METEOR-3M	C.1
RUS-WP-03	Future Geostationary Meteorological Satellite GOMS/Electro N 2	C.2
RUS-WP-04	The Experience relevant to the interference on DCP Channels in GOMS, Meteosat and FY-2A Area	F.4
RUS-WP-05	Roshydromet activities on coordination of frequency allocation	I.1
RUS-WP-06	New global meteorological products from geostationary satellites	II.4
RUS-WP-07	Status of PC-based AAPP development and implementation	II.3

USA

USA-WP-01	Review of CGMS XXVI Action Items	A.5
USA-WP-02	Polar-orbiting Operational Environmental Satellite (POES)	B.1
USA-WP-03	Geostationary Operational Environmental Satellite (GOES)	B.2
USA-WP-04	Anomalies from solar events	B.3
USA-WP-05	Future polar-orbiting meteorological satellite system	C.1
USA-WP-06	Report on the status of future geostationary meteorological satellite system	C.2
USA-WP-07	GOES Experiment Payload Announcement of Opportunity	C.2
USA-WP-08	Improved satellite system utilization report	E.1
USA-WP-09	Dissemination of DCP messages (GTS or other means)	F.4
USA-WP-10	Status of development of the LRIT	G.1
USA-WP-11	Coordination of the International Data Collection & Distribution (ASAP)	G.2
USA-WP-12	Coordination of the International Data Collection & Distribution (GTS)	G.2
USA-WP-13	Emergency Managers Weather Information Network (EMWIN)	G.2
USA-WP-13.1	Training activities in Costa Rica and Barbados	H.4
USA-WP-14	Plans to address Year 2000 compliance	H.6
USA-WP-14.1	AERONET use of IDCS	H.6
USA-WP-15	Preparations for the WRC-2000	I.2

USA-WP-15.1	WRC –1999	I.2
USA-WP-15.2	SFCG-SWG Report (attachment to USAWP-15.1)	I.2
USA-WP-16	Identification of potential areas of interference	I.2.1
USA-WP-17	Status and future use of the IDCS	I.3.1
USA-WP-18.1	300 bps DCP certifications	I.3.2
USA-WP-18.2	300 bps DCP certifications	I.3.2
USA-WP-19	Future developments and operations of high data rate DCPs	I.3.2
USA-WP-19.1	Spread spectrum demonstration over the GOES	I.3.2
USA-WP-20	Operational calibration practices	II.2
USA-WP-20.1	Post-launch calibration of AVHRR and GOES	II.2
USA-WP-21	Inter-calibration of geostationary and polar IR window radiances	II.2
USA-WP-22	Report on GOES soundings and winds	II.2/3
USA-WP-23	Report on ITSC-X activities	II.3
USA-WP-24.1	Derivation of satellite winds using shorter scan intervals	III.4
USA-WP-24.2	Derivation of satellite winds using Shorter scan intervals	III.4
USA-WP-25	Encoding of wind products using BUFR format	III.4

WMO

WMO-WP-01	Databases	H.5
WMO-WP-02	Review of action items from previous CGMS Meetings	A.5
WMO-WP-03	Matters related to APT/WEFAX and Conversion	G.1
WMO-WP-04	CGMS List Servers and Home Pages	H.5
WMO-WP-05	WMO Strategy to Improve Satellite System Utilization	E.1
WMO-WP-06	Education and Training Strategy	H.4
WMO-WP-07	Statement of Guidance on Feasibility of Meeting WMO Requirements	E.1
WMO-WP-08	Review of satellite related WMO publications	H.5
WMO-WP-09	ASDAR Status Report	F.3
WMO-WP-10	WMO Code Form Changes	G.2
WMO-WP-11	Radio Frequency Matters	I.2
WMO-WP-12	Tropical Cyclone Programme Requirements	E.1
WMO-WP-13	ASAP Status Report	F.2
WMO-WP-14	Year 2000 Problem	H.5

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APPENDIX A:

ADDITIONAL INFORMATION SUBMITTED TO CGMS XXVII

UPDATED LIST OF SAF PRODUCTS

There are four major types of SAF products/services:

1. Software packages for users
   - Application SW (SAF on Nowcasting, SAF on NWP)
   - Data Processing SW : for level 1 products (AAPP)
2. Software development support for central processing
3. Real-time product services
   - Programme-specific (MSG, EPS) & multi-mission
4. Off line product services
   - Programme-specific (MSG, EPS) & multi-mission

The following lists indicate the products and software packages to be delivered by the seven SAFs:

1. Application Software Packages for Users

1.1 SEVIRI (Nowcasting SAF)
- Cloud Mask and Cloud Amount
- Cloud Type (including Fog)
- Cloud Top Temperature/Height
- Precipitating Clouds
- Convective Rainfall Rate
- Total Precipitable Water
- Layer Precipitable Water
- Stability Analysis Imagery
- High Resolution Wind Vectors from HRVIS
- Automatic Satellite Image Interpretation
- Rapid Developing Thunderstorms
- Air Mass Analysis

1.2 SEVIRI (NWP SAF)
- New/improved Observation Operators (for AMVs)
- Geostationary Radiance Assimilation

1.3 AVHRR/AMSU (Nowcasting SAF)
- Cloud Mask and Cloud Amount
- Cloud Type (including Fog)
- Cloud Top Temperature/Height
- Precipitating Clouds

1.4 ATOVS (NWP SAF)
- Improved & Extended RTMs (updated RTTOV etc.)

1.5 IASI (NWP SAF)
- Fast RTM & Associated Observation Operators

1.6 GOME (NWP SAF)
- Observation Operators

1.7 ASCAT/SeaWinds (NWP SAF)
- Improved Observation Operators

1.8 SSM/I (NWP SAF)
- 1DVar Retrieval System (for wind speed, cloud water etc.)
Fast RTM

1.9 SSMIS (NWP SAF)
- 1DVar Retrieval System (for wind speed, cloud water etc.)
- Fast RTM

1.10 AIRS (NWP SAF)
- 1DVAR Retrieval System

2. Data Processing Software (NWP SAF)
- Improved and extended versions of AAPP for annual distribution (e.g. updated ingest function, updated cloud detection, added ICI retrieval module etc.)
- Extension of AAPP to process IASI+AMSU+AVHRR

3. Software Development Support for Central Processing
- Support Global Instability Index (GII) Development (Nowcasting SAF)
- Support Total Ozone from SEVIRI Development (Ozone SAF)
- Other relevant activities in NWP SAF

4. Real-time Products

4.1 Real-time Products from MSG
- Surface Albedo (Land Surface Analysis SAF)
- Aerosol (Land Surface Analysis SAF)
- Scattered Radiance Field (Land Surface Analysis SAF)
- Surface Short-wave Fluxes (Land Surface Analysis SAF)
- Land Surface Temperature (Land Surface Analysis SAF)
- Surface Emissivity (Land Surface Analysis SAF)
- Surface Long-wave Fluxes (Land Surface Analysis SAF)
- Soil Moisture (Land Surface Analysis SAF)
- Evapotranspiration Rate (Land Surface Analysis SAF)

4.2 Real-time Products from EPS
- Near Surface Wind Vector (Ocean & Sea Ice SAF)
- Atlantic High Latitude SST (Ocean & Sea Ice SAF)
- Atlantic High Latitude Radiative Fluxes (Ocean & Sea Ice SAF)
- Regional SST (Ocean & Sea Ice SAF)
- Sea Surface Thermal Fronts (Ocean & Sea Ice SAF)
- Total Ozone from GOME (Ozone Monitoring SAF)
- Total Ozone from HIRS (Ozone Monitoring SAF)
- Ozone Profiles (Ozone Monitoring SAF)

- Aerosol Index (Ozone Monitoring SAF)
- Surface Albedo (Land Surface Analysis SAF)
- Aerosol (Land Surface Analysis SAF)
- Scattered Radiance Field (Land Surface Analysis SAF)
- Surface Short-wave Fluxes (Land Surface Analysis SAF)
- Land Surface Temperature (Land Surface Analysis SAF)
- Surface Emissivity (Land Surface Analysis SAF)
- Surface Long-wave Fluxes (Land Surface Analysis SAF)
- Evapotranspiration Rate (Land Surface Analysis SAF)
- N. Europe Snow Cover (Land Surface Analysis SAF)
- Refractivity Profiles (GRAS Meteorology SAF)
- Temperature, Humidity and Pressure Profiles (GRAS Meteorology SAF)
- Integrated Water Vapour (GRAS Meteorology SAF)

4.3 Multi-Mission Real-time Products

- Atlantic Low & Mid Latitude SST (Ocean & Sea Ice SAF)
- Merged Atlantic SST (Ocean & Sea Ice SAF)
- Atlantic Low & Mid Latitude Radiative Fluxes (Ocean & Sea Ice SAF)
- Merged Atlantic Radiative Fluxes (Ocean & Sea Ice SAF)
- Atlantic Sea Ice Edge (Ocean & Sea Ice SAF)
- Atlantic Sea Ice Cover (Ocean & Sea Ice SAF)
- Atlantic Sea Ice Type (Ocean & Sea Ice SAF)
- Clear-Sky UV Fields (Ozone Monitoring SAF)
- Land Surface Temperature (Land Surface Analysis SAF)
- Surface Emissivity (Land Surface Analysis SAF)
- Surface Long-wave Fluxes (Land Surface Analysis SAF)
- S. & Central Europe Snow Cover (Land Surface Analysis SAF)

5. Off-Line Products

5.1 Off-Line Products from MSG

- Surface Albedo (Land Surface Analysis SAF)
- Aerosol (Land Surface Analysis SAF)
- Scattered Radiance Field (Land Surface Analysis SAF)
- Surface Short-wave Fluxes (Land Surface Analysis SAF)
- Land Surface Temperature (Land Surface Analysis SAF)
- Surface Emissivity (Land Surface Analysis SAF)
- Surface Long-wave Fluxes (Land Surface Analysis SAF)

5.2 Off-Line Products from EPS

- Total Ozone from GOME (Ozone Monitoring SAF)
- Trace Gases (Ozone Monitoring SAF)
- Ozone Profiles (Ozone Monitoring SAF)
- UV Fields with Clouds & Albedo (Ozone Monitoring SAF)
- Surface Albedo (Land Surface Analysis SAF)
- Aerosol (Land Surface Analysis SAF)
- Scattered Radiance Field (Land Surface Analysis SAF)
- Surface Short-wave Fluxes (Land Surface Analysis SAF)
- Land Surface Temperature (Land Surface Analysis SAF)
- Surface Emissivity (Land Surface Analysis SAF)

- Surface Long-wave Fluxes (Land Surface Analysis SAF)
- Refractivity Profiles (GRAS Meteorology SAF)
- Temperature, Humidity and Pressure Profiles (GRAS Meteorology SAF)
- Integrated Water Vapour (GRAS Meteorology SAF)

5.3 Multi-Mission Off Line Products

- Land Surface Temperature (Land Surface Analysis SAF)
- Surface Emissivity (Land Surface Analysis SAF)
- Surface Long-wave Fluxes (Land Surface Analysis SAF)
- Normalised Differential Vegetation Index (Land Surface Analysis SAF)
- Fraction of Green Vegetation (Land Surface Analysis SAF)
- Fraction of Photosynthetic Active Radiation (Land Surface Analysis SAF)
- Leaf Area Index (Land Surface Analysis SAF)
- Fractional Cloud Cover (Climate Monitoring SAF)
- Cloud Classification (Climate Monitoring SAF)
- Cloud Top Temp. & Height (Climate Monitoring SAF)
- Cloud Optical Thickness (Climate Monitoring SAF)
- Cloud Phase (Climate Monitoring SAF)
- Cloud Water Path (Climate Monitoring SAF)
- Components of the Surface Radiation Budget (Climate Monitoring SAF)
- Surface Albedo (Climate Monitoring SAF)
- Components of the Radiation Budget at the top of the atmosphere (Climate Monitoring SAF)
- Sea Surface Temperature (Climate Monitoring SAF)
- Sea Ice Cover (Climate Monitoring SAF)

CGMS Satellite Meteorology Workshop at UNISPACE III
22 July 1999 in Vienna

Conclusions and Recommendations

The following conclusions were drawn at the CGMS Satellite Meteorology Workshop:

It was noted with satisfaction that since its creation in 1972, the Coordination Group for Meteorological Satellites (CGMS) has provided a forum, in which the satellite operators have studied jointly with the WMO the technical and operational aspects of the global network, so as to ensure maximum efficiency and usefulness through proper coordination in the design of the satellites and in the procedures for data acquisition and dissemination. CGMS has therefore performed major accomplishments. These are listed below together with recommendations for the future:

1. CGMS has played a key role in terms of **coordination** of the satellite operators activities. The group has been very successful in coordinating the overall system in terms of orbital positions, contingency, dissemination schedules, data collection systems and frequency. Concerning this last item, CGMS noted that it is absolutely necessary to provide the required protection to passive sensor bands, and to limit the sharing of such bands with active services. ***It was recommended that CGMS should strive to continue to meet user communities' requirements and provide even better coordination to maximise the efficiency of the system as a whole.***

2. CGMS has been very successful in establishing **standards** for the betterment of all users. The group has recently agreed upon standardisation of low rate dissemination services, LRPT and LRIT. ***It was recommended that CGMS should strive to standardise all the dissemination services.***

3. CGMS has **improved the products** delivered to the user through a rigorous exchange of information concerning product development both at plenary meetings, as well as through co-sponsored workshops such as the Winds Workshop series, through International TOVS Working Group meetings and other conferences and workshops. CGMS brings top scientists together to discuss specific problems. The scientific interactions greatly enhance the value of CGMS products. ***It therefore is recommended to continue exchanging information on product development between CGMS Members.***

4. ***It was recommended that CGMS should highlight the landmark contingency planning that has occurred between the various satellite operators.*** The initiatives of EUMETSAT and NOAA/NESDIS have greatly contributed to the stability of the space-based observing systems by providing a reasonable level of assurance to the user communities that the satellite data, products and services will have continuity.

5. CGMS satellite operators have responded directly to the **user community's requirements** through the user community representative, the WMO. The direct interactions between user and provider are mutually beneficial and ***it was recommended that they should continue in the future.***

APPENDIX B:

SELECTED PAPERS SUBMITTED TO CGMS XXVII

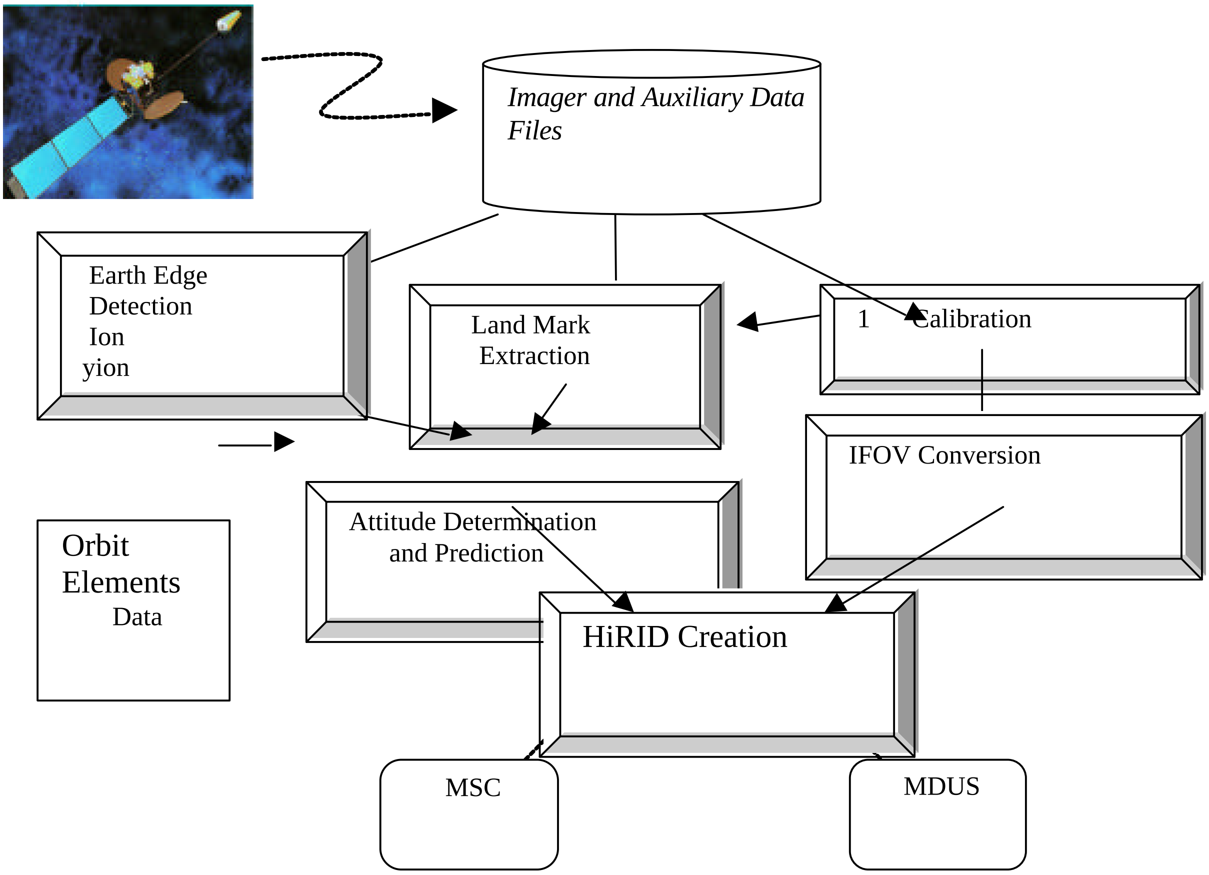
IMAGE PROCESSING METHOD FOR MTSAT IMAGER DATA

This document explains the image processing method to produce HiRID (High Resolution Image Data) from the imager observation data of MTSAT. It contains the description of each processing of the navigation, calibration and IFOV (Instantaneous Field of View) conversion.

1. Introduction

Digital image data for Medium-scale Data Utilization Stations (MDUS) from MTSAT are named High Resolution Image Data (HiRID) and will be disseminated in place of Stretched Visible and Infrared Spin Scan Radiometer (S-VISSR) data of GMS-5. The HiRID is also transmitted to Meteorological Satellite Center (MSC) from the Command and Data Acquisition Station (CDAS) via the microwave line, and used for the analysis, extraction and productions of meteorological products.

The following block diagram shows the outline of the processes to produce HiRID from imager observation data of MTSAT.



2. Characteristics of HiRID

The HiRID format is designed to be upper-compatible with S-VISSR format. Therefore, ground resolutions of HiRID infrared and visible images at the sub-satellite point will be reduced to 5.0 km and 1.25 km, which are originally 4.0 km and 1.0 km respectively. In addition, the brightness levels of the visible data of HiRID remain to be 6 bits or 64 levels while those of the original imager observation data of MTSAT are 10 bits or 1024 levels. The quantization levels of all infrared channels (IR 1-4) of HiRID will be increased to 10 bits or 1024 levels from 8 bits or 256 levels in the case of S-VISSR data.

Calibration tables for IR data of S-VISSR are updated at every observation. On the other hand, fixed calibration tables are used in HiRID. Imager observations with MTSAT are performed using two detectors of each IR channel and eight detectors of VIS channel. In order to correct the difference of characteristics in detectors, calibration is performed for every channel data as described below.

At first, brightness levels of observed data are converted into physical values using conversion coefficients which take the difference in detectors into consideration. The derived physical value is assigned again to a brightness level using the fixed conversion table (temperature level in IR and albedo level in VIS).

HiRID is different from S-VISSR data in the fact that the fixed calibration table is used, and that the relation between the latitude/longitude and line/ pixel is fixed except for the fluctuation of the satellite attitude.

3. Generation of HiRID data

HiRID is produced by the following steps. (Fig.1)

3.1 Calibration

(i). Infrared channel

Infrared brightness counts are calibrated with (formula 1) in order to eliminate the effect of variation in scan mirror emissivity. The calibration coefficients m and b in formula 1 are determined an each line. (Formula 2) (Formula 3)

$$R = \frac{q \cdot C^2 + m \cdot C + b - \varepsilon(\theta) \cdot R_m}{1 - \varepsilon(\theta)} \qquad (1)$$

$$m = \sum^{6} C_n \cdot T^n \qquad (2)$$

$$b = -m \cdot C_{sp} - q \cdot C_{sp}^2 + \varepsilon(sp) \cdot R_{msp} \qquad (3)$$

Where
R: Radiance
C: brightness digital count
C_{sp}: brightness digital count of space data calculated by time interpolation with linear formula using post-clamp data (space data after scan reverse with space clamp operation) and pre-clamp data (space data before scan reverse with space clamp operation).
q: coefficient measured in the ground test (fixed data)
R_m: radiance from the scan mirror calculated by scan mirror temperature telemetry
R_{msp}: radiance from the scan mirror during space look calculated by scan mirror temperature telemetry
$\varepsilon(\theta)$: Scan mirror emissivity ($=a_0+a_1\theta+a_2\theta^2$)
(a_0,a_1,a_2 are coefficients determined in the orbit test, θ is east-west scan angle)
C_n: slope coefficient determined by the non-real-time calibration procedure
T: Modified primary mirror temperature calculated by some telemetry data in the latest 100 lines

(ii). Visible channel

The following formula is used for the visible calibration.

$$R= q\cdot C^2+m\cdot C+b \qquad (4)$$

$$m= \frac{R_{sun}-q\cdot(C_{sun}{}^2-C_{sp}{}^2)}{C_{sun}-C_{sp}} \qquad (5)$$

$$b=-m\cdot C_{sp}-q\cdot C_{sp}{}^2 \qquad (6)$$

R_{sun}: reference sunlight albedo
C_{sun}: brightness digital count of sun light data

3.2 Landmark extraction and Earth Edge Detection

The Landmark extraction is performed using both the visible image and the temperature difference image between the IR-1 and IR-2 before the instantaneous filed of view (IFOV) conversion. The results are used in the procedure 3.3.
The earth Edge detection is performed using the infrared 1 and 2 images before the IFOV conversion. The attitude parameters (Observation starting time, right ascension and celestial declination of the spin axis direction and β angle) in the documentation of HiRID used in the procedure 3.5 are updated by the earth edge data and results of the landmark extraction.

3.3 Attitude Determination and Prediction

The attitude of the satellite and misalignment of detectors are estimated from the landmark extraction data and the orbit prediction data (non-real-time procedure) at every observation.

3.4 IFOV conversion (Image data generation)

(i). The digital count is converted to radiance using formula (1) and (4).

(ii). The following digital filter designated for each channel is applied to make the IFOV conversion to the calibrated radiance data.

$$R(I,J)= \sum^{15}\sum^{15}[NS(i)EW(j)\cdot Raw(I+i, J+j)] \qquad (7)$$

I: position in north-south direction
J: position in east-west direction
R: radiance after IFOV conversion
Raw : radiance before IFOV conversion
NS(i): north-south IFOV conversion filter
EW(j):east-west IFOV conversion filter

(iii). The Whittaker-Shannon sampling theorem is applied to the conversion of image to HiRID on the fixed latitude/longitude coordinate system.

$$H(x,y)= \sum\sum R(n,m)\mathrm{sinc}[(x-n\Delta x)/\Delta x]\cdot \mathrm{sinc}[(y-m\Delta y)/\Delta y] \qquad (8)$$

H:HiRID image(x:HiRID pixel y:HiRID line)
R(n,m): image after IFOV conversion
$\Delta x,\Delta y$: sampling distances after IFOV conversion
$\mathrm{sinc}(x)\equiv\sin(\pi x)/(\pi x)$

(iv). The radiance is converted to digital count using the fixed HiRID calibration table.

3.5 HiRID creation

This process combines image data made in the preceding procedures and non-image such as attitude parameters, and creates HiRID output data. Attitude parameters are updated during the observation in order to compensate image distortion.

3.6 Non-real-time procedure

The following non-real-time procedures are executed.

Orbit Prediction

The orbit prediction is performed twice a day or more, when the new orbit elements are inputted. Trilateration range and range rate (TRRR) for determination of the orbit is performed usually four times a day.

Calibration quality control

The purpose of this step is to check and determine several calibration parameters. The slope coefficients C_n are determined by blackbody calibration data using regression analysis. Blackbody observation is performed before each image observation. The following formula is used for blackbody calibration.

$$m_{bb} = \frac{r_{bb} + q \cdot (C_{bb}^2 + b - C_{sp}^2)}{C_{bb} - C_{sp}} \qquad (9)$$

$$r_{bb} = [1 - \varepsilon(45°)] \cdot R_{bb} + [\varepsilon(45°) - \varepsilon(sp)] \cdot R_{mbb} \qquad (10)$$

C_{bb}: brightness digital count of the black body

R_{bb}: radiance from the black body calculated by the black body temperature telemetry

R_{mbb}: radiance from the scan mirror during the black body observation

Navigation quality control

The purpose of this step is to check and determine several navigation parameters.

References

Weinreb, M., and others "Operation calibration of the Imager and Sounder on the GOES-8 and -9 Satellites" NOAA Technical Memorandum NESDIS 44, Feb.1997

Jonson,R.X., and Weinreb,M.,"GOES-8 imager midnight effects and slope correction" Proceeding SPIE vol.2812 596-608, Aug.1996

Seiichiro Kigawa "Image Pre-processing Algorithm for MTSAT" Meteorological Satellite Center Technical Note 37.1999

CGMS-XXVII EUM-WP-22
Prepared by EUMETSAT
Agenda Item: II.2

OPERATIONAL CALIBRATION PRACTICES AT EUMETSAT

This paper summarises the operational calibration practices at EUMETSAT.

OPERATIONAL CALIBRATION PRACTICES AT EUMETSAT

1 INTRODUCTION

This paper summarises the current operational calibration practices at EUMETSAT.

2 OPERATIONAL CALIBRATION OF THE WV CHANNEL

The calibration of the Meteosat WV channel is performed using external observation data received routinely via the Global Telecommunication System of the World Meteorological Organisation. Radiosonde observations are received twice daily, and they are used as input to a radiative transfer model, which determines the radiance at the top of the atmosphere. These radiances are then used together with the actual spacecraft observations to calibrate the WV channel. The calibration is performed in two independent steps, first deriving the Instantaneous WV calibration, second determining from the latter the operational calibration coefficient.

2.1 Instantaneous Calibration

After reception of all radiosonde data for a given observation time, they undergo a quality control check, and thereafter they are only used for calibration if the segment (an area consisting out of 32x32 WV pixels) in which they are located is free of clouds above 700 hPa. The latter condition is checked using the results of a multispectral image analysis scheme, which analyse every Meteosat image by interpreting every scene found in a segment. Such scenes can be sea surface, various types of land surfaces, clouds of different height levels.

The above mentioned quality control checks imply that the observation is flagged (and not used) when

- The satellite zenith angle for the station location is larger than 55^0.
- The mean radiosonde relative humidity is less than 4 % (0.1 % in setup !!)
- There must be at least three observations of temperature and dew point depression within the relevant layer between 300 and 600 hPa.

The radiance at the top of the atmosphere is determined using the radiosonde temperature and humidity profile as input to a radiative transfer model, and this radiance is converted in a pseudo count using the presently valid operational calibration coefficient. This pseudo count is used in a quality check, and aims to eliminate rogue radiosonde observations. The check compares the radiosonde pseudo count (C_{pseudo}) and the segment averaged satellite observed count (C_{sat}), and fails for the following conditions:

- For UTH ≤ 50 %: ABS($C_{pseudo} - C_{sat}$) > 16 counts
- For UTH > 50 %: ABS($C_{pseudo} - C_{sat}$) > 32 counts

For all radiosonde observations that have passed all quality checks an averaged radiance is determined, and for the collocated segments an averaged satellite WV count is calculated. In a two-dimensional count – radiance diagram the slope of the line though the average and the space count gives the instantaneous calibration coefficient.

2.2 Operational Calibration

As the types of radiosonde observations vary throughout the Meteosat field of view and as the number of radiosonde observations and their originating station will vary because of changing meteorological conditions, the instantaneous calibration has a relatively large fluctuation. Therefore the following smoothing procedure is used for the operational calibration of the WV channel:

- Of the latest six instantaneous calibration coefficients an average and standard deviation is determined.
- A quality check is performed and from these six instantaneous calibration coefficients all are removed that differ more than one standard deviation from the average are flagged.
- Of these six instantaneous calibration coefficients all unflagged values are used to derive a new averaged calibration coefficient.
- The operational calibration coefficient is updated only if it differs by more than 1.0 % from the new averaged calibration coefficient.

3 OPERATIONAL CALIBRATION OF THE IR CHANNEL

The calibration of the Meteosat IR channel is performed using external observation data received routinely via the Global Telecommunication System of the World Meteorological Organisation. The sea surface temperatures from forecasts of the European Centre for Medium Range Weather Forecasts are used. Technically these are the sea surface temperatures produced by the NCEP (National Centres for Environmental Prediction), which in fact are a blend of conventional observations (e.g. buoys), satellite observations (e.g. NOAA polar-orbiting spacecraft) and climatology. The calibration is performed in two independent steps, first deriving the Instantaneous IR calibration, second determining from the latter the operational calibration coefficient.

3.1 Instantaneous Calibration

A multispectral image analysis scheme provides for every segment (an area of 32x32 IR pixels) of the Meteosat IR image information on the scenes within the segment. If one of the analysed scenes is sea surface, quality checks on the sea scene are done and the scene is only used for further processing if all the following conditions are fulfilled:

- The cloud coverage is less than 25 %.
- The scene IR standard deviation is less than 3.0
- The scene VIS standard deviation is less than 3.0
- The scene VIS count is less than 250 (???)

Of all segments, considered for further processing, the mean count and the standard deviation of superpixels (3 x 3 pixel areas for every pixel) are determined. For every segment the above found sea surface count is replaced by the superpixel count fulfilling the following conditions

- The warmest superpixel in the segment is taken for the sea surface count.
- If the a superpixel is found with the same mean count, the superpixel with the lowest standard deviation is selected.

For all valid sea surface scenes the satellite observed counts are averaged. Additionally for those segments the SST received from NCEP is converted into a radiance at the top of the atmosphere, using the ECMWF forecast temperature and humidity profile to calculate the impact of the atmosphere with a radiative transfer model. A pseudo count is derived from the radiance at the top of the atmosphere and compared with the satellite observed count. If the difference is greater than 50 counts the observation is rejected and the segment is not used anymore in the calibration process.

Those radiances, which are corrected for the atmospheric absorption, are then averaged and the slope of the line though these averages and the space count provides the instantaneous calibration coefficient.

3.2 Operational Calibration

Although the external observations are quite stable in time, and although emphasis is laid on the retrieval scheme to exclude cloud contamination, the latter can not be excluded especially for cloud coverage on sub-pixel level. Additionally meteorological conditions can vary, which in turn can lead to the fact that the geographical areas taken for the instantaneous calibration can vary. Therefore the following smoothing procedure is used for the operational calibration of the IR channel:

- Of the latest 24 instantaneous calibration coefficients, for the same representative time period, an average and standard deviation is determined. So if a calibration is determined at 20 UTC, then the last 24 instantaneous calibration coefficients are used going backwards from the same time on the day before.
- The operational calibration coefficient is updated only if it differs by more than a factor 0.0002 from the new averaged calibration coefficient.

3.3 Calibration during Eclipse

Eclipse periods are characterised by rapid temperature changes within the satellite and the radiometer, especially for night-time images, while the detector temperature is kept constant at 90 K by a passive cooler system. Therefore it is not appropriate to take a 12 hour-average (IR channel) nor a three day-average (WV channel) for the operational calibration. So within the eclipse season, the instantaneous calibration values for the same relevant image for the last six days will be used to determine the operational calibration. The latter is done for both infra red channels. The above-described checks on the instantaneous calibration coefficients remain the same.

CGMS-XXVII-JPN-WP-17
Prepared by JAPAN
Agenda Item : II/2

OPERATIONAL CALIBRATION PRACTICES OF GMS-5

The purpose of this document is to report on the generation of calibration tables and its application. A problem in the GMS-5 calibration is also described (A/I-26.35).

OPERATIONAL CALIBRATION PRACTICES of GMS-5

1. Operational Data Processing of GMS-5

The GMS-5 is a spin-stabilized satellite. The Visible and Infrared Spin Scan Radiometer (VISSR), the imaging instrument of GMS-5, scans the Earth with one visible channel and three infrared channels from north to south as the rotation of the spacecraft. The size of image of VISSR consists of 2,500 lines by 2,500 pixels for the IR channels and 10,000 lines by 10,000 pixels for the visible channel.

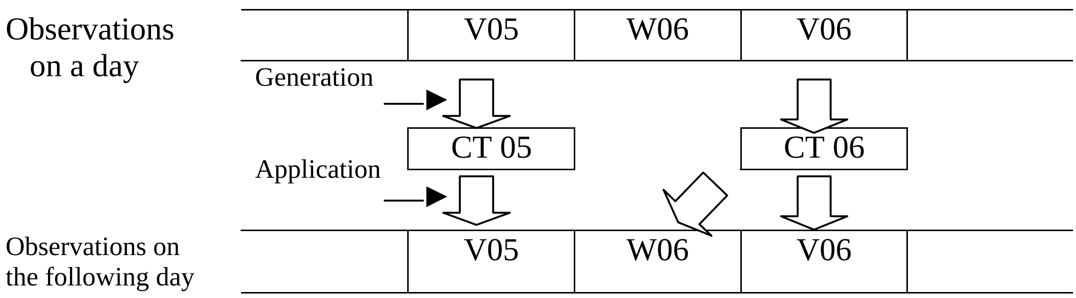
Electric voltages of VISSR sensors are sampled and converted to digital counts, i.e., eight bits for the infrared channels, and six bits for the visible channel. The sensor counts are sent to the Command and Data Acquisition Station (CDAS) and converted to the Stretched-VISSR (S-VISSR) signal, and disseminated to the Medium scale Data Utilization Stations (MDUSs) via GMS-5. Calibration tables and navigation parameters are sent with the S-VISSR image.

2. Calibration table of the infrared channels

The calibration tables for infrared channels define the relationship between raw S-VISSR counts and brightness temperatures. There is a calibration table for each of the three infrared channels. Each table is generated using a warm blackbody and the cold space as reference. The warm blackbody is an internal radiation source inserted into the optical path of VISSR, and its radiance is detected by IR sensors. The detected counts appear in the fourth line of the imaging frame. The cold space is VISSR counts of space area observed in the imaging frame.

A set of calibration tables is generated for each of hourly observations and twenty-four sets of tables are generated per day. A set of tables generated from a particular observation will be applied to the observation at the same hour on the following day.

No calibration tables are generated for wind observations, and calibration tables included in the wind observations are appropriated from the calibration tables for the following hourly observations. The relation between table generations and its applications are illustrated in Figure.1.



Vnn: Routine Observation at nn-UTC
Wnn: Wind Observation at nn-UTC
CTnn: A set of Calibration Tables at nn-UTC

Figure.1 Relationship between generation and application of calibration tables.

The one-day delay between generation and application of the calibration tables may affect the precision of brightness temperature especially in equinox seasons. Its effects on the calibration were evaluated and it was confirmed that the effect is well kept within a half of the brightness resolution of each channel even in the equinox seasons.

3. Calibration table of the visible channel

The calibration tables for the visible channel define the relationship between raw S-VISSR counts and albedos. The VISSR has four visible detectors and one calibration table is defined for each detector. As no brightness reference object for the visible channel is available operationally, the calibration tables in S-VISSR for the visible channel have fixed values that are generated from pre-launch measurements. No operational calibration is applied to the visible channel.

4. Spectral Response Function of WV channel

When the GMS calibration process was reviewed, it was revealed that the response function of IR3 (water vapor channel) may have been affected by atmospheric water vapor during the pre-launch measurement. The VISSR manufacturer admitted it but the atmospheric conditions at the measurement site weren't recorded.

Figure.2 shows an example of the response function of the water vapor channel and the transmissivity that is calculated by MODTRAN for a four-meter path under the standard atmosphere conditions i.e., 20 degrees Celsius, and 50 percent relative humidity. As transmissivity is critical to conditions, it is not possible to determine the real response function of the channel. Therefore, we continue to carry out the calibration as usual without modifying the response function of WV channel.

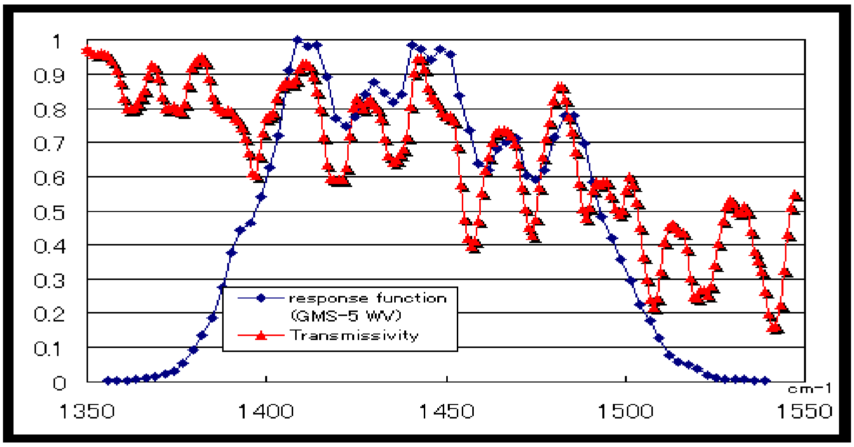


Figure.2 Example of relationship between spectral response function of WV channel of GMS-5 and transmissivity of 4 meter path in standard atmosphere.

5. Operational Calibration of MTSAT

MTSAT disseminates the High Resolution Image Data (HiRID) in place of S-VISSR. Though HiRID is upper compatible with the S-VISSR, operational calibration of MTSAT differs from GMS. Details of the operational calibration methods of MTSAT are described in the other document (WP-16).

CGMS-XXVII-PRC-WP-09
Prepared by CMA
Agenda Item: II/2

THE CHINESE RADIOMETRIC CALIBRATION SITE FOR REMOTE-SENSING SATELLITE

Summary and purpose of paper:
To provide the information on the measure and construction of radiometric calibration site of remote-sensing satellites in China.

The Chinese Radiometric Calibration Site
for Remote-sensing Satellites

1. BACKGROUND

Along with quantitative application development of satellite remote-sensing technology, the need of high-accuracy radiometric calibration of satellite sensor is increasing.

The radiometric calibration of on-board satellite sensor is restricted for a long time; thus a vicarious method of radiometric calibration on test site is used. It is an available method for improving calibration accuracy. Since 1970’s, NASA and Optical Science Center, Arizona University U.S, and CNES and INRA France, have made the absolute radiometric calibration method research in ground-based test site. In recent years the establishment of China Radiometric Calibration Site and the radiometric calibration method research have been taken by some scientists and organizations in China.

2. BASIC THEORY OF THE RADIOMETRIC CALIBRATION OF THE TEST SITE

Basic concept of the radiometric calibration on ground-based test site is: to select a flat, optical characteristic uniform and stable test site as observation target, then to make the synchronous satellite-ground observations with measurement instruments. Inputting the measured data into the ground-based system makes the radiant transfer calculation later. An incidence aperture apparent radiance or apparent reflectance of the in-flight satellite sensor is obtained. A calibration coefficient is obtained by the comparisons of apparent radiance with the observation count of satellite sensor’s waveband. Thus a process of absolute radiometric calibration is achieved. For different spectral waveband of satellite sensors, the measurement items and physics model in the radiometric calibration is different.

A. Visible and near infrared spectral wavebands

For visible and near infrared wavebands, the in-flight passive satellite sensor incepts the signal of reflective radiance from the earth-atmosphere system that is relative to the solar irradiance. In the synchronous satellite-ground observations, the ground-based measurements of test site include bi-direction reflectance (ρ_s) from targets and solar irradiance (E_s), atmospheric optical parameters and meteorological parameters etc. And a satellite synchronous observation image of the same surface target area is obtained. Based on geometry and angle of view of the sun and satellite during satellite overpass as well as the spectral response of sensors etc., the radiant transfer calculation is made and the satellite incidence aperture apparent radiance is obtained then. A formula is as following:

$$L = \frac{r_s}{p} E_s \cdot t + L_p \qquad (1)$$

τ: atmospheric transmittance , L_p: atmospheric path radiance

In general, observation value of satellite sensor is presented by appearance reflectance ρ^* , it is as

$$r^* = \frac{pL}{E_o m_s} \qquad (2)$$

E_0 : extra-atmospheric solar irradiance, $\mu_{s:}$ cosine of solar zenith

The quantitative relation between calculated spectral radiance and count value (c_i) by satellite sensor is as:

$L = (a_1 c_1 + a_2)A$ (3)

a_1 and a_2 are calibration coefficients on board , A is vicarious calibration coefficient by ground test site.

B. Thermal infrared waveband

For the thermal infrared band with wavelength longer than 3 micron, it incepts the radiance signal from the earth-atmosphere system itself. For this waveband, the test site with an uniform temperature distribution and clear water body is proper. In satellite-ground synchronous observations, the ground-based measurements of test site include water surface temperature (T_s), emissivity(ε), spectral radiance (B_s), atmospheric optical parameters and meteorological parameters etc.. And a satellite synchronous observation image of same target area is obtained. Based on geometry and angle of view of the sun and satellite during satellite overpass, as well as the spectral response of sensors etc, the radiant transfer calculation is made. A satellite incidence aperture apparent radiance is obtained. The formula is following as:

P_s

$$I = B_s \cdot t(P_s) - \int_{p_0}^{p_s} B(p) \partial t(p) / \partial p dp \qquad (4)$$

$$B_s = eB(P_s) + (1-e)L_a$$

$\tau(P_s)$: atmospheric transmittance , P_s and P_0: atmospheric pressure at ground level and top atmosphere level, L_a: the downward radiance obtained at ground, B_s and B(p) are the Planck functions at ground surface and pressure P respectively.

The quantitative relation between the incidence aperture radiance I and count value c_i of satellite sensor is as:

$L = (b_1 c_1 + b_2)b$ (5)

$b_1$and b_2 are calibration coefficients on board , β is vicarious calibration coefficient of infrared band on ground test site.

3. TEST SITE

In order to achieve a high accuracy of radiometric calibration, the following are important.

To select a fit test site, it should be flat and with uniform optical characteristic, stable and sufficient large. Besides, the clear-sky condition should often exist around the site. After the investigation and analysis on test sites, finally the DUN HUANG Gobi desert test site has been defined as the calibration test site for visible and near-infrared bands of satellite sensor, and the QINGHAI lake test site has been defined as the calibration test site of thermal infrared band of satellite sensor. It is also used for the calibration of lower reflectance object in visible and near-infrared band.

Table 1 Basic characteristic parameter at Dunhuang and Qinghai test site

DunHuang test site	QingHai lake test site
Location: at suburbs of DunHuang city, Gansu Province,Northwest China, 40°07′ N, 94°20′E .	Location: at QingHai Province,China, 36°45′ N,100°20′E
Elevation: 1194m above sea level.	Elevation: 3196m above sea level.
Area: 30*30km^2.	Area: 4635km^2.
Character: flat Gobi desert, small stone No vegetation in 20*20km^2. Reflectance 15% and 30% in visible and near infrared.	Character: It is thin salt lake in the mainland Average depth 20 m, max depth 28m, the temperature change <1°C reflectance 5% -8% ,from 0.4-
Meteoric-parameter: air pressure(hpa): 887.6	Meteoric-parameter: air pressure(hpa): 686.6
temperature(°C) : 9.5	temperature(°C) : 0.83
Precipitation (mm) 34.1	precipitation(mm) 434.5
relative humidity(%): 43.9	relative humidity(%): 69.8
time of sunshine(hour): 3270.1	time of sunshine(hour): 2981.2
days of clear sky: 112.2	days of clear sky: 56.9
visibility(days/year, >10km): 288.2	visibility(days/year, >10km): 358.1
days of no strong wind, cloud free, no floating dust and no sand storm 87.9	days of no strong wind cloud free, no floating dust and no sand storm 43.7

Note: The information is in yearly average from 1984—1993.

4. MEASUREMENT EQUIPMENTS OF THE SITE

With the equipment and instrument importation and domestic technique development, a high accuracy ground measurement system has been established. Now the China Remote-sensing Satellite Radiometric Calibration Site possesses an advanced radiometric calibration technical system.

It includes:

- High spectral resolution and waveband measurement instruments for atmospheric optical characteristic.
- High spectral resolution and waveband measurement instruments for ground optical characteristic.
- High accuracy radiant standard , instrument calibration and standard transfer system.
- High accuracy atmospheric parameter , environment parameter and meteorological observation instruments.
- Location , communication and other support equipment.

The parameters of primary instruments for the test site are as following :

A. Instruments for measuring ground and atmosphere optical characteristics:

Table 2 High spectral resolution instruments

FT-IR radiometer and Sun tracker	IFS120M A547/2m	Germany BRUKER Inc	range: 0.4—16.6um, resolution: 0.008cm-1
Spectroradiometer	TRIAX190	U.S. EG&G.	range : 0.4—5um , resolution: 0.3nm
FT spectroradiometer	MR154	Canada . Bomem Inc	range :0.7—15um, resolution: 1cm-1
Field radiometer	Fildspec FR	U.S. ASD	range :0.35—2.5um resolution: 3.5nm
Portable illuminometer	OL—754	U.S .LIBERO Inc	range: 0.2—1.6um resolution : 0.05nm
Field radiometer	VF921	China.	range :0.4—1.1um, resolution: 2.7nm
Short-wave IR radiometer	IR981	China.	range :1.3-2.5um, resolution: 6.4nm
Illuminometer	VIR981	China	range : 0.4—2.5um resolution : 20nm

Table 3 The waveband of measurement instruments

Automatic sun tracking photometer	CE318	France Cimel Inc.	8 channel (stand band) 440, 670 ,870 ,937 ,1020 870*3(polarization) special band 430-480 ,630-690 ,480-530, 770-890 ,530-580 ,840-890, 580-680 ,900-965 (nm)
Field radiometer	CE313-21	France Cimel. Inc.	8 channel 400-430,430-480,450-520, 480-530,530-580,520-590, 580-680,630-690(nm)
Field radiometer	CE313-23	France Cimel.Inc	6 channel 0.77-0.89,0.84-0.89,0.90-0.965, 1.55-1.75,1.58-1.64,2.08-2.35(μm)
Thermal infrared radiometer	CE312	France Cimel Inc.	5 channel 8.0-14.0, 8.2-9.2, 10.3-11.3, 10.5-12.5, 11.5-12.5(μm)
Infrared radiometer	CE312-1	France Cimel Inc	1 channel 3.55-3.93(μm)

B. Radiant standard and standard transfer equipment

Table 4 Radiant standard and standard transfer equipment

High accurate radiant calibration system	cryorad Absolute radiometer Hamatsu	U.S	accuracy: 0.02%
Standard lamp calibration system	1000w quartz Halogen		range: 350-2500nm
Intergraph calibration system		China	Diameter: 500mm, out . ϕ85mm 1200, out ϕ 400mm
Reference panel		China	400*400mm, 500*500mm
Monochromator	sp-307	U.S	range: 0.35-13um
Blackbody source		China	ϕ120, t:273-343k ε: 0.995

C. Measurement Instruments for atmospheric and environmental parameter

Table 5 Instruments for meteorological and environmental parameter

automatic weather station		VATSALA , Finland	
Buoy		China	
Water thermometer		China	
Visibility instrument		U.S	0.03-60km
Soil Humidity ins..		U.S	range: 2%-100% Accuracy:2%
GPS	RTK	Canada	Location accuracy: 5mm
GPS	2000x	U.S	Location accuracy: 10m

D. Data processing, archive and information service sub-system

This sub-system is as a center of data collection, processing, archiving and information service for China Remote-sensing Satellite Radiometric Calibration Site. It is a system for the processing, archiving and service of the distributed data in a computer network. The center consists of a Web server based on a SQL server database and some micro-computers . Through Internet, the system exchanges information with the long-distance terminal in the radiometric calibration site and the related users. And through FDDI in National Satellite Meteorological Center, the system is also connected with the meteorological satellite data acquisition and processing system. Thus with the system, various meteorological satellite data can be direct obtained to support the radiometric calibration service of the in-flight satellite sensor. On the basis of network computer and system software, the system has integrated various data processing application software for the radiometric calibration. After a tried running of this software, an operation data processing and information service system of radiometric calibration would be formed.

5. FLOWCHART OF THE RADIOMETRIC CALIBRATION

According to satellite orbit parameters and technological characteristic as well as the observation mode of satellite sensor, the measuring equipment are used to confirm the synchronous satellite-ground observation program. In order to ensure the perfection and high quality of the observation, some rules of synchronous observation must be drawn..

Main task for data processing is as:

- Synchronous observational data correction at test site:

  Pre-processing of satellite observation data, calibration and correction of ground based measuring instruments, correction of spectral response and nonlinear of instruments, correction of Bi-direction reflectance of measured data etc.

- Data matching processing of satellite-ground observation:

  Observational time synchronous, pixel resolution matching, observational direction matching, location and registration of pixels and spectral response of instruments matching etc .

- Radioactive transfer code :

  Based on the radioactive transfer codes, such as Lowtran, 6S, Modtran, Fastcode, to develop the radiant transfer calculating code for fitting the radiometric calibration of China remote-sensing satellite.

- Calibration coefficient calculating model :

  According to different status and in-orbit parameters of each satellite, it makes vicarious radiometric calibration for domestic satellites, and to develop calculating model of calibration coefficient for each domestic satellite. During June and August. We made a synchronous observation for FY-1C and FY-2 meteorological satellites, and the calibration processing for FY-1C. We will do the radiometric calibration for CBERS satellite next year. In the near future the vicarious calibrations for the sensors of GMS-5, NOAA-15 and SPOT etc foreign satellites will be taken on China test site.

6. ACHIEVING OBJECT AND APPLICATION PROSPECTS FOR THE RADIOMETRIC CALIBRATION SITE

The projects of setting up a China radiometric calibration site and making related scientific researches will be finished in the end of 1999. With the site it is able to perform the vicarious calibration experiments for satellite sensors, then to execute radiometric calibration task. Firstly, it will make vicarious radiometric calibration for the meteorological satellite, resources satellite and other remote-sensing platform of China. Besides, the site can also be used for the calibration of foreign satellites. The completion of the calibration site will improve the development of quantitative remote-sensing technology. The technology system and the achievement made in scientific research of the radiometric calibration site of China have had a wide application prospects.

1. Combining closely the vicarious calibration on test site with the preflight

   Calibration and the on-board calibration, which will improve the absolute calibration accuracy of satellite sensors. And it will enhance the extent and depth of the quantitative application of remote-sensing data. It will also increase the social economical benefit with the application of remote-sensing data.

2. The radiometric calibration on test site is an effective method for the monitoring of sensibility degeneration of satellite sensor.

3. The radiometric calibration on test site is helpful for the observation data matching among more satellite sensors and difference observation time. It will improve the comprehensive application of remote-sensing data on climate research and environment monitoring. In addition, the radiometric calibration is also an important fashion for validating in orbit instrument performance and improving the development of remote-sensing technology. The calibration site is also a radiometric measurement system that is in the lead of domestic remote-sensing equipment and technology. This system will play an active role in the international cooperation on radiometric calibration technology.

CGMS-XXVII-USA-WP-20
Prepared by: M. P. Weinreb
Agenda Item: II/2

OPERATIONAL CALIBRATION PRACTICES - THERMAL INFRARED AND MICROWAVE

An overview of operational calibration procedures at NOAA/NESDIS for the polar-orbiting AMSU-A instrument and the thermal infrared channels of the AVHRR and HIRS, and for the thermal infrared channels of the GOES Imager and Sounder is presented.

OPERATIONAL CALIBRATION PRACTICES -THERMAL INFRARED AND MICROWAVE

The meteorological satellite radiometers calibrated by NOAA/NESDIS include the AVHRR (Advanced Very High Resolution Radiometer), the HIRS (High resolution Infrared Radiation Sounder), and the AMSU-A (Advanced Microwave Sounding Unit-A), which are carried on the NOAA polar-orbiting system of satellites, and the Imager and the Sounder on the GOES (Geostationary Operational Environmental Satellite) system of satellites. Collectively, these satellite radiometers sense upwelling radiation from the Earth/atmosphere system in the visible, near infrared, thermal infrared, and microwave parts of the spectrum. The on-orbit calibration procedures for the polar-orbiting satellite instruments are described fully by Kidwell[1]. Specific calibration procedures, both pre-launch and on orbit, for the AMSU-A are described by Mo[2,3]. On-orbit calibration procedures for the geostationary instruments are documented by Weinreb et al.[4,5] The purpose of this paper is to provide an overview of the calibration process for the channels in the thermal infrared and microwave. The visible and near-infrared channels, lacking on on-board calibration device, are calibrated on orbit with vicarious techniques, as is described in a companion paper[6].

The thermal infrared and microwave channels of all these instruments are calibrated essentially the same way, regardless of their wavelength location. Each instrument utilizes views of space and an on-board warm blackbody for calibration on orbit. The blackbody is in front of the scan mirror (infrared) or the reflector (microwave) and fills the instrument=s aperture, thereby providing a full-system calibration. The relationship between the incident radiant intensity and instrument output, the Acalibration function,@ is assumed to be quadratic. The quadratic term is small but is significant in some channels. It contributes just under 1% of the radiance in many of the microwave channels and the thermal infrared channels that utilize HgCdTe detectors. But it is negligible in the shortwave infrared channels that utilize InSb detectors. The coefficients of the quadratic terms are determined in pre-launch tests as functions of instrument and detector temperature, and these relationships are assumed to remain invariant throughout the life of each instrument. In orbit, the coefficient of the quadratic term is inferred from the appropriate instrument temperatures. Thereupon the coefficients of the remaining two terms of the gain function can be determined from observations of the two targets--space and the on-board blackbody.

Before launch, each instrument is calibrated in a thermal-vacuum chamber. Its output is recorded as it is illuminated by radiation from a laboratory blackbody, whose temperature is cycled over a number of discrete temperatures between approximately 180K and 320K. This process determines the calibration function. It is usually done several times, with the instrument held at several different temperatures within the range encountered on orbit, and in some cases for several different settings of the detector temperature, if, as in the case of the GOES instruments, there is more than one available. The only data from these tests that are carried forward to the on-orbit calibration are the coefficients of the quadratic terms of the calibration equation, as was mentioned previously. The laboratory measurements of the other coefficients (slope and intercept) are kept as a reference, but they are replaced on orbit by values determined continually from the space and blackbody data. The laboratory calibration functions, however, are used in an important diagnostic test before launch: they are applied to the count output of the instrument's internal blackbody to derive its radiance temperature. The temperature of the internal blackbody measured in this way should be within approximately 0.1K of the temperature of the blackbody measured directly with its platinum resistance thermometers. If it is not (as occurs frequently with the GOES instruments), it implies that the laboratory calibration process is not fully understood at the 0.1K level of precision. NESDIS is soliciting the assistance of the National Institute of Standards and Technology to resolve these inconsistencies in tests of future instruments.

Besides the coefficients of the quadratic terms, there are two other quantities determined before launch that are applied in the calibration on orbit. One is the coefficients required to convert to temperature the raw count output of the thermistors (or platinum-resistance thermometers) of the internal blackbodies. The other is the spectral response functions of all the channels of each instrument. Accurate measurements of the spectral response functions may be difficult to obtain, but we cannot over-emphasize their importance. Accuracy in the knowledge of the spectral response functions is required not only for accurate calibration, but also for success in inferring properties of the Earth's surface and atmosphere from the satellite data.

The basic on-orbit calibration, as described above, is sometimes enhanced to handle unanticipated instrument anomalies. Examples of anomalies include the rapid changes in calibration intercepts affecting the HIRS in parts of the orbit when instruments change most rapidly[7,8,1], interference in calibration measurements by direct solar radiation or solar heating that affects the AVHRR[9] and the GOES imagers and sounders[5,10] in parts of their orbits, the east-west scan-position dependence of the reflectivities of the GOES scan mirrors[4], and striping in frames of data from the GOES imagers and sounders[5,11]. An additional step (but not an anomaly) in the calibration of the AMSU is the need to apply antenna-pattern corrections[12], derived from pre-launch tests, to measurements of antenna temperature to generate brightness temperatures of the Earth/atmosphere scenes.

We conclude with a few statements on calibration accuracy and stability, with examples from the GOES imagers and sounders. Uncertainties in absolute calibration arise primarily from three sources: (1) transfer of the calibration of a primary standard (at, e.g., the National Institute of Standards and Technology) to the secondary standard in the laboratory where the instruments are tested; (2) transfer from the secondary standard to the instrument's blackbody during pre-launch tests; (3) on-orbit calibration procedures. For the GOES infrared instruments, the uncertainty in the absolute calibration was estimated by an analysis[13] performed while the instruments were being designed to be approximately 0.5K in the long-wave infrared channels and 0.6K in the short-wave channels. These numbers should be increased by at least 0.1K to account for the effects of most of the unanticipated instrument anomalies mentioned in the preceding paragraph. In addition, solar heating and scattered solar radiation cause uncompensated errors as large as 1K in short-wave-channel observations during the hours near satellite midnight for approximately six months of each year[10]. Radiometric precision, e.g., variability from scan line to scan line or frame to frame (not at satellite midnight), is estimated from on-orbit observations[14] to be between 0.05K and 0.18K (rms), depending upon channel, for scenes at 300K. We have not determined repeatability over time periods longer than a few hours. To do this requires inter-comparisons with stable independent observations, which are difficult to obtain.

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CGMS-XXVII-USA-WP-21
Prepared by: USA
Agenda Item: II/2

INTER-CALIBRATION OF GEOSTATIONARY (GOES, METEOSAT, GMS) AND POLAR-ORBITING (HIRS AND AVHRR) INFRARED WINDOW RADIANCES

An overview of procedures and results for intercalibrating the geostationary infrared window radiances using one polar-orbiting sensor as a reference.

INTER-CALIBRATION OF GEOSTATIONARY (GOES, METEOSAT, GMS) AND POLAR-ORBITING (HIRS AND AVHRR) INFRARED WINDOW RADIANCES

INTRODUCTION

Inter-calibration of the polar-orbiting and geostationary satellite systems is necessary to achieve consistency of data sets involving more than one sensor. The community of satellite operators is exploring viable approaches for inter-calibration of their operational sensors that would minimize the calibration uncertainty and maximize calibration uniformity. This paper presents recent work at the NESDIS Cooperative Institute for Meteorological Satellite Studies (CIMSS) for calibrating the geostationary satellites with a single polar-orbiting satellite using temporally and spatially collocated measurements in the infrared window channels. Currently NOAA-14 HIRS and AVHRR are being compared to GOES-8, GOES-10, METEOSAT-5, METEOSAT-7, and GMS-5.

APPROACH

As indicated in previous CGMS papers, collocation in space and time (within thirty minutes) is required. Data is selected within 10 degrees from nadir for each instrument in order to minimize viewing angle differences. Measured means of brightness temperatures of similar spectral channels from the two sensors are compared. Data collection is restricted to mostly clear scenes with mean radiances greater than 80 $mW/m^2/ster/cm^{-1}$, no effort is made to screen out clouds from the study area. Data from each satellite is averaged to 100 km resolution to mitigate the effects of different field of view (fov) sizes and sampling densities (HIRS undersamples with a 17.4 km nadir fov, AVHRR GAC achieves 4 km resolution by undersampling within the fov, GOES imager oversamples 4 km in the east west by 1.7, and METEOSAT-5, METEOSAT-7, and GMS-5 have a nadir 5 km fov). Mean radiances are computed within the study area. Clear sky forward calculations (using a global model for estimation of the atmospheric state) are performed to account for differences in the spectral response functions. The observed radiance difference minus the forward-calculated clear sky radiance difference is then attributed to calibration differences.

Thus

$$? R_{cal} = ? R_{mean} - ? R_{calc}$$

or for a comparison of a geostationary satellite to HIRS

$$? R_{cal} = [R^{GEO}_{mean} - R^{GEO}_{calc}] - [R^{HIRS}_{mean} - R^{HIRS}_{calc}]$$

where GEO indicates geostationary, HIRS indicates the HIRS instrument, mean indicates the mean measured radiance, and calc indicates the forward calculated clear sky radiance. Conversion to temperatures for a comparison between a geostationary satellite to HIRS is accomplished by

$$? T_H = \left[\frac{R^{GEO}_{mean}}{dB/dT^{GEO}_{mean}} - \frac{R^{GEO}_{calc}}{dB/dT^{GEO}_{calc}} \right] - \left[\frac{R^{HIRS}_{mean}}{dB/dT^{HIRS}_{mean}} - \frac{R^{HIRS}_{calc}}{dB/dT^{HIRS}_{calc}} \right]$$

An identical method is used for calculating the temperature difference between a geostationary satellite and the AVHRR instrument (? T_A).

RESULTS

Table 1 shows the results for all five geostationary satellites. In all cases the temperature difference between geostationary and NOAA-14 instruments is within 0.5K. The absolute mean indicates the mean of the absolute value of all the differences; this is an absolute magnitude of how far from a difference of 0K each satellite is. The mean indicates the normal mean of all cases and a negative sign indicates HIRS or AVHRR is measuring higher radiances on average than the geostationary instrument. In nearly all cases the geostationary instruments measure lower radiances, or colder temperatures, than the polar-orbiting instruments. This data covers February through July of 1999 and does not show a seasonal trend or any trends based on time of day.

Table 1. Feb to Jul 1999 IR window comparison of geostationary satellites and NOAA-14 HIRS/AVHRR.

Delta (geo – leo)		GOES-8	GOES-10	MET-5	MET-7	GMS-5
Number of Comparisons	? T_H	9	36	9	18	6
	? T_A	8	36	9	18	6
Absolute Mean	? T_H	0.31 K	0.23 K	0.28 K	0.40 K	0.40 K
	? T_A	0.34 K	0.16 K	0.27 K	0.39 K	0.37 K
Mean	? T_H	-0.06 K	-0.13 K	-0.24 K	-0.40 K	0.05 K
	? T_A	0.08 K	-0.12 K	-0.27 K	-0.37 K	-0.15 K
Standard Deviation	? T_H	0.36 K	0.23 K	0.26 K	0.19 K	0.59 K
	? T_A	0.49 K	0.14 K	0.25 K	0.21 K	0.42 K

Figure 1 shows a comparison of GOES-10 and HIRS mean brightness temperatures. The two are highly correlated and compare well over a wide range of temperatures. Figure 2 shows a comparison of GOES-10 mean radiance values to the corresponding temperature difference between GOES-10 and HIRS (? T_H). There is a strong inverse correlation between ? T_H and GOES mean radiance. The inverse correlation persists in the absence of a spectral response correction (not shown). There is a similar relationship between ? T_A and GOES mean radiance (not shown). METEOSAT-7 does not exhibit this behavior. The number of comparisons is too small for the other sensors to infer any correlations. Onboard calibration differences in the sensors are being explored; inaccurate estimation of responsivity in one or both sensors could produce such comparisons.

AUTOMATION

Routine inter-calibration is needed. Ample comparisons must be achieved to assist in trend analyses. However comparisons are not easily achieved. Table 2 shows the percentage of comparisons successfully completed for each geostationary instrument. Cloudy indicates the percentage when the comparison was not attempted because the scene was too cloudy. Failure indicates the percentage when comparison failed due to missing sensor data, missing model data, or other causes. Successful comparisons occur less than 50% of the time, except for GOES-10 where over 60% of the comparison attempts succeeded (there was no cloud interference during this period). It is not likely that this approach to inter-calibration can be easily accomplished with aperiodic efforts; some level of automation appears to be desireable but difficult to achieve. In the near term, manual intercomparisons will be continued.

Table 2. Efficency of data comparisons.

Geostationary Satellite	Success (%)	Cloudy (%)	Failure (%)
GOES-8	29	29	42
GOES-10	62	0	38
MET-5	24	40	36
MET-7	49	13	38
GMS-5	16	42	42

CONCLUSIONS

This paper describes and analyzes one approach for calibrating all geostationary sensors with respect to a single polar-orbiting sensor. Radiances from two sensors near nadir view containing mostly clear sky are averaged to 100 km resolution. Differences in mean scene radiances are corrected for spectral response differences through a clear sky forward calculation. The corrected mean differences are attributed to calibration differences. These results, based on between 6 and 36 cases per satellite, suggest the infrared window sensors on GOES-8, GOES-10, MET-5, MET-7, and GMS-5 are within 0.5 C of each other (and within 0.4 C of the NOAA-14 HIRS and AVHRR). Further studies are ongoing to explore seasonal or diurnal effects.

This inter-calibration approach works well, but currently requires a considerable time commitment from one individual. Computer automation will be investigated, but it is likely that some human interaction will still be required for quality control of the intercomparison data sets.

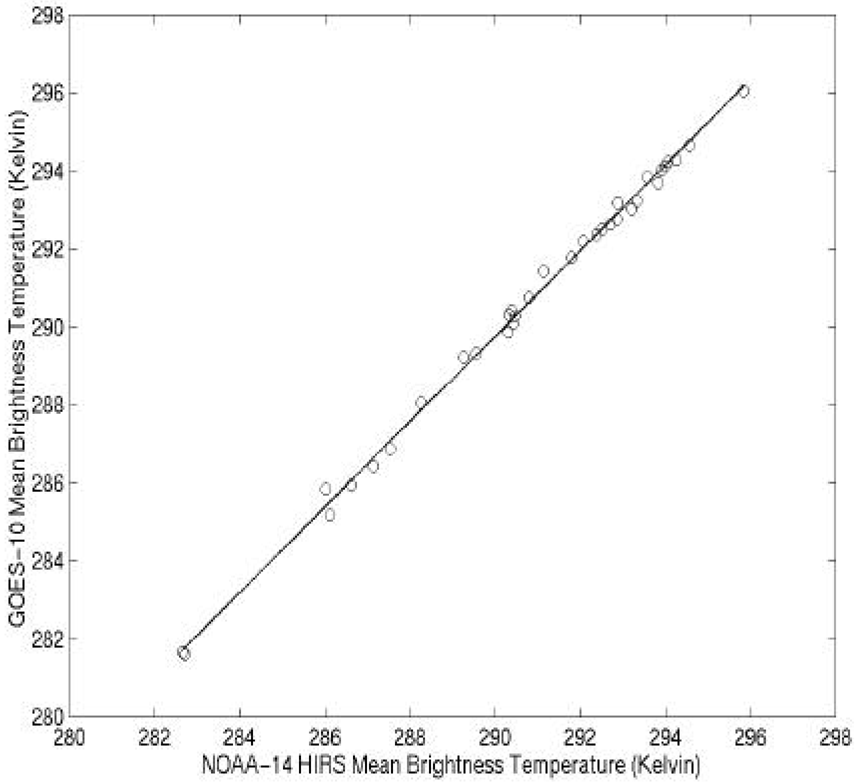

Figure 1. GOES-10 Brightness Temperature vs NOAA-14 HIRS Brightness

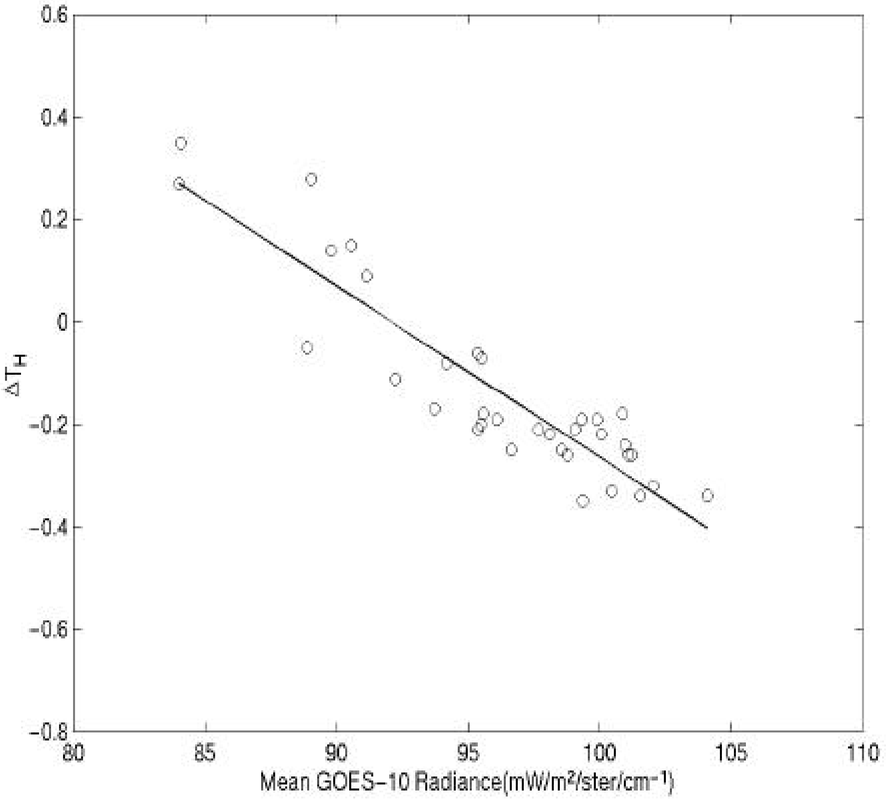

Figure 2. GOES-10 Mean Radiance vs ? T_H

CGMS-XXVII-USA-WP-23
Prepared by: USA
Agenda Item: II/3

REPORT ON THE TENTH INTERNATIONAL TOVS STUDY CONFERENCE (ITSC-X)

A report on the findings and recommendations produced at the ITSC-X for CGMS consideration.

REPORT ON THE TENTH INTERNATIONAL TOVS STUDY CONFERENCE (ITSC-X)

I. Introduction

The tenth meeting of the International TOVS Working Group was held in Boulder, CO from 27 January through 2 February. The co-chairs are Dr. Guy Rochard from CMS, Lannion, France and Dr. John LeMarshall from BMRC, Melbourne, Australia. About 120 scientists from 25 countries participated in presentations and working group deliberations. This was the largest ITSC ever, and quite possible the most productive. The recent launch of NOAA-15 with the new instrument suite provoked a number of intriguing presentations and lively discussions.

II. Major Conclusions

ITSC-X had several significant conclusions; (a) AMSU-A is proving to be a well characterized instrument that is providing valuable information for NWP and atmospheric understanding, (b) international collaboration within the ITWG has produced an AVHRR and ATOVS Processing Package (AAPP) that is freely available to all users to develop their ATOVS processing capabilities, (c) NWP assimilation of satellite data continues to advance (e.g. 4DVAR) and forecasts continue to show positive impact from utilization of NOAA data in both hemispheres, (d) a majority of NWP centers still rely on NESDIS retrievals, (e) transmittance model performances are improving, but spurious spectral response errors need further investigation (especially in the water vapor sensitive bands), (f) 20 years of TOVS pathfinder data is a good start and providing indications of interesting trends, (g) coordination with the reconfigured CBS is a high priority for the ITWG (and communications with GCOS and GOSSP), and (h) preparations for EOS must quicken to ensure timely readiness.

Items from CGMS

CGMS XXVI requested that ITSC-X consider the following items for discussions.

The use of satellite radiances or retrievals over land needs further attention as there is a growing need for improved use of satellite data in some land areas of the globe; surface emissivity effects must be accommodated to achieve positive results. ITSC-X accepted this challenge; several members are already working on this problem and will report at the next study conference.

The am and pm polar satellites will likely have different sounding capabilities. ITSC-X agreed that members will study how to mitigate the effect of these differences in weather applications (including NWP) and report at future study conferences.

The importance of good characterization of total system spectral response functions has been stressed in past reports. ITSC-X agreed to investigate how good current estimates are and how good they need to be in various parts of the infrared spectrum. A report will be forthcoming.

Geostationary sounding is evolving toward greater capability with higher spectral resolution. What are the tradeoffs between spectral and spatial resolution and the information content of geostationary soundings in an era of polar-orbiting satellites with high spectral resolution sounders on three platforms? ITSC-X noted that several operational satellite simulation experiments are underway to explore this issue and would hear progress reports at their next conference.

Items for CGMS

When discussing the ITSC-IX recommendation to CGMS to develop a mechanism for an overarching strategy to best address individual country needs as well as international requirements, ITSC-X felt that while the short and medium range satellite operator plans were well coordinated the long-range plans could benefit from better coodination especially with regard to gaps and overlaps in missions and instruments. In this regard, ITSC-X noted that WMO's CBS Working Group on Satellites had prepared a preliminary statement of guidance regarding how well satellite capabilities met WMO user requirements in several application areas. It felt that such guidance provided a valuable input to the satellite operators in developing long range plans and it was pleased to note that the CBS Open Programme Area Group for Integrated Observing Systems - OPAG IOS (the successor to the Working Group on Satellites) would prepare a second iteration of the statement of guidance.

ITSC-X noted that some CGMS satellite operators (NOAA/NESDIS, EUMETSAT, China and the Russian Federation) have plans to launch polar-orbiting satellites and that coordination of their equator crossing times was very desireable. Additionally, it was suggested that CGMS take into consideration the plans of non-CGMS satellite operators who have plans to utilize the present frequency allocations for HRPT downlinks. Finally, the ITSC-X encouraged CGMS to consider contingency plans that would be comparable for all three polar orbits (early AM, AM and PM).

Recommendation (to CGMS): ITWG encourages CGMS: to consider coordination of polar-orbiting equator crossing times to optimize satellite utilization while minimizing potential conflicts in data reception, to consider non-CGMS satellite operator plans to utilize the present downlink frequency allocations, and to consider comparable contingency plans for all polar orbits.

While ITSC-X felt the action item for further information concerning access to direct readout data from MODIS and AIRS had been obtained, it encouraged a continuing update of such information. A planning group was nominated to do this.

With regard to promoting well-resourced national activities towards protection of frequency allocations, ITSC-X also suggested that CGMS consider means to provide for such dedicated resources. The ITSC-X also agreed that the new ITU/WMO Handbook on the use of frequency for meteorological applications would be a most valuable reference for use by National Meteorological and Hydrological Services (NMHS).

Recommendation (to CGMS): ITWG encourages CGMS to consider means to provide for well-resourced activities towards protection of frequency allocations.

ITSC-X reiterated the need for instrument designers to utilize only those frequencies for which approved allocations existed. The use of non-approved allocations would be detrimental to the sounding community for several reasons.

With regard to education and training and the use of small workstations, the ITSC-X was pleased to learn of recent decisions to make the AAPP software widely available and hoped that such decisions could be extended for wider use on workstations by the meteorological community in general. Thus, it felt it appropriate to note the need for the availability of AAPP software capable of running on small reception systems as well as on workstations. The ITSC-X also noted the work program for the OPAG IOS that included an expert team dedicated to improve satellite system utilization. Expected improvements were through the use of improved education and training techniques, in particular the use of a virtual laboratory, and through the provision of guidance to manufacturers of satellite ground receiving equipment. A standard portfolio of applications as well as specific methods for presentation as defined by WMO would form the basis for the design of satellite ground receiving equipment.

The ITSC-X recalled that concern had been expressed for the capacity of WMO's present Global Telecommunication System to handle large volumes of satellite data. The ITSC-X was informed of WMO's initiatives in upgrading the present GTS from a store and forward system to one of a distribute database, similar in operation to the Internet. It noted that WMO Members had already agreed upon TCP/IP specifications to enable Internet-like communications. It also was informed that many European meteorological services where starting to use a new satellite based GTS. The ITSC-X commended these developments and requested the WMO to keep ITWG informed of further developments at future ITSCs. It also suggested that WMO undertake an activity to make its Members aware of the availability of existing satellite products through use of the WWW Operational Newsletter and the WMO Satellite Activities Home Pages.

With regard to the need for radiances, the ITSC-X strongly endorsed the inclusion of radiance products as part of the suite of NPOESS EDRs.

Recommendation (to CGMS): ITWG encourages CGMS to endorse the inclusion of radiance products as part of the suite of NPOESS EDRs.

The ITSC-X reaffirmed its requirement for the provision of direct readout on operational meteorological satellites. It further noted the important potential contribution of the AIRS instrument on the EOS PM satellite to WMO's World Weather Watch. In particular, it would provide advanced sounder data to the meteorological community to allow preparations for the operational advanced sounders to be tested as well as providing data for potential operational use. Thus, the ITSC-X encouraged NASA to consider activities with the ITWG community towards the establishment of a direct readout software package for AIRS (and MODIS) allowing timely use of the data for operations and research. In order to ensure the effective use of AIRS (and MODIS) data by the meteorological community, it is important for NASA and NESDIS to provide for the transfer of such data in near real-time.

Recommendation (to CGMS): ITWG encourages CGMS to endorse provision of near real-time data from AIRS (and MODIS). In particular, it recognizes the importance of the global provision of radiance and derived products in near real-time.

The ITSC-X noted the positive results of the World Radio Conference held in 1997 (WRC-97) concerning the better protection of the band 50-60 GHz for temperature sounding as well as the consolidated protection of the 31.3 to 31.8 GHz window. However, it was noted that the commercial and military pressures to obtain portions of the microwave spectrum continue to grow without a comparable activity by the meteorological community.

A draft ITU/WMO Handbook on the use of frequencies in meteorological applications will be available in March 1999. The Handbook will be distributed to all WMO Members with the expectation that each NMHS would actively encourage its national Post, Telegraph and Telecommunication Administrations (PTT) to protect the frequencies needed for meteorological operations at the WRC-2000. The ITSC-X noted that most of the preparatory work needed to be accomplished within the next six months. It was hoped that several NMHSs would send representatives to their respective ITU regional organizations in preparing for WRC-2000 (CITEL for the Americas, CEPT for Europe and Africa and APT for Asia and the Pacific).

The ITSC-X noted three specific issues of high and immediate priority:

- Protection of 50-60 GHz from high density fixed links to respect the 0.01% maximum of contaminated pixels,
- Protection of 18.6-18.8 GHz with a world-wide allocation
- Appropriate allocations around 118, 150 and 183 GHz for atmospheric sounding.

The ITSC-X also noted that the new 500 MHz allocation between 31.3 to 31.8 GHz should be fully utilized to avoid losing it. Thus, it strongly encouraged satellite operators to modify existing instrument plans and use a center frequency of 31.55 GHz with a bandwidth of 500 MHz in this atmospheric window.

ITSC-XI

The next meeting will occur in Budapest, Hungary 27 September through 3 October 2000.

CGMS-XXVII-EUM-WP-22
Prepared by EUMETSAT
Agenda Item: III.4

WIND PRODUCTS DEVELOPMENT PLAN OF THE EUMETSAT MPEF

This paper summarises the plans for development of the EUMETSAT MPEF wind products from Meteosat-5 and Meteosat-7.

WIND PRODUCTS DEVELOPMENT PLAN
OF THE EUMETSAT MPEF

1 USER REQUIREMENTS

The key driving forces for the development of the Meteosat products have been the support to the global NWP operators, the support to the synoptic forecasters and the support to the WMO climate programs. By and large this will remain so in the coming years. The following key developments in the user community are foreseen in the coming years and should be supported by the MPEF.

1.1 Variational data assimilation

The migration of the optimum interpolation analysis schemes to variational methods has already started. ECMWF has for several years employed variational schemes for assimilation of TOVS radiances and is planning the operational assimilation of METEOSAT clear-sky radiances. The variational methods make possible the assimilation of data containing non-model variables by the use of so-called observation operators, which define a relation between model variables and observed data. An example of an observation operator is a forward radiative transfer model, defining a relationship between a profile of temperature and humidity and observed radiances in specific channels. The variational methods then makes it possible to assimilate satellite radiances, even if they cannot be directly converted into a real profile.

The variational technique can also be used to assimilate bulk data like deep-layer mean winds. Such a procedure could be employed for clear-sky WV winds, but no significant development work in this area has yet been done in the user community.

1.2 4-D data assimilation

The analysis schemes of at least the major NWP centres will over the next decade be migrated to the next generation 4-D variational methods and this will considerably change the data requirements. Whereas the NWP analysis schemes now depend almost solely on synoptic data, they will evolve into continuous data-assimilation systems with no special dependency on synoptic hours. As the geostationary satellites are the main continuous source of asynoptic data this will become a very important driving force for the METEOSAT products.

An ongoing debate in the NWP community addresses the issue of 4-D assimilation of satellite geophysical products, e.g. winds, vs. direct assimilation of satellite radiances. Theoretical arguments would suggest that 4-D assimilation of cloud-cleared radiances would generate a wind field consistent with the wind field derived directly from the images. This would indicate no need to assimilate clear-sky winds directly. This is however a theoretical argument, as direct assimilation of the radiances at instrument resolution in space and time is quite out of reach with current assimilation systems. Therefore a more pragmatic approach seems to prevail, namely the concurrent assimilation of radiances and winds at an appropriate resolution in space and time.

The major technical challenge in the 4-DVAR scheme is the correct handling of physics, especially in the tropics, but these issues have been satisfactorily resolved for the ECMWF model. ECMWF introduced 4-DVAR operationally in November 1997.

Other major NWP operators are monitoring the ECMWF progress with 4-D Var, but are currently not committed to operational implementation schedules.

2 DEVELOPMENT PLANS

2.1 Pre-processing

2.1.1 Calibration

Based on data collected on the performance of the METEOSAT-7 black-body calibration a new calibration scheme is under development to be based on black-body measurements performed at least twice a day, as well as a simplified front-optics model. This scheme gives promising results, and tests on its performance in the eclipse season are under way.

A scheme for routine calibration monitoring, using level 1b data from HIRS and the MPEF Radiative Transfer Model, is under development. It is expected to be particularly useful for METEOSAT-5, which does not have a functioning black-body mechanism.

2.1.2 Improved spatial resolution of forecast data

On March 1 1999, the migration of ECMWF forecast data used in MPEF from GRID fields with very coarse horizontal and vertical resolution (3x3 deg, 10 pressure levels), to high-resolution GRIB data (1.5x1.5 deg, model hybrid-sigma levels (currently 50) was completed. The high-resolution forecast data provides very significant improvements in the description of deep low-level trade inversions and together with the new inversion height assignment scheme, this has significantly improved the quality of the low-level wind products in the subtropics.

2.1.3 Improved resolution of diurnal cycle

Improving the resolution of the diurnal cycle in surface temperature is important for the prediction of IR radiances for surface scenes. Because of the 6-hour resolution in time, the diurnal cycle variation has to be simulated in a separate step. The present scheme will be improved by the use of 3 hourly forecast fields, to provide a better resolution of the diurnal cycle.

2.1.4 Improved Semi-Transparency correction

Studies indicate that the height assignment of IR and WV winds in many cases fail because of failure to apply a correct semi-transparency correction to the cloud clusters. Several factors can contribute to an improvement in this area:

The Semi-Transparency correction can be calculated by using a linear regression on the individual pixels. This eliminates the requirement for background scene identification.
The quality of the humidity forecast is crucial in determining the radiance curve, and with the rapidly improving humidity fields supplied from the NWP centres an improvement will be expected.

A posteriori adjustment of the radiance curve to fit the observed background clusters could be investigated.

The Semi-Transparency model could be refined to more truly represent semi-transparent clouds. Improvements of the stability of the WV vicarious calibration will have a significant effect on the semi-transparency correction.

An improved semi-transparency correction scheme, primarily based on the linear regression technique, is being development as part of MSG MPEF prototyping, and will, after completion of an extensive validation, be tested for at least partial integration into MTP MPEF.

2.1.5 Improved radiosonde quality control

The quality control procedures for radiosondes used for calibration and verification will be improved. The need for this has especially become apparent after the start of the METEOSAT-5 mission at 63°E and the associated different area of radiosondes received.

3 WIND PRODUCTS

3.1 General

The wind products are computed by identifying and localising the same pattern ("tracer") in consecutive METEOSAT images (Buhler and Holmlund, 1993). This tracking is done in all 3 spectral channels independently. Using the knowledge of the tracer displacement, combined with the measurement of its temperature, the following values are extracted which constitute the wind product : wind location, wind speed, wind direction, temperature and pressure level.

The first operation performed is the selection of the structures that will be used as the tracers, based on the information provided by the Histogram Analysis. This tracer selection is done in a channel-specific way, including cluster merging or rejection when necessary. When a useful tracer has been identified, height assignment is performed and the corresponding wind component can be extracted. The wind-component extraction process comprises the definition of the Target and Search areas taken from the current and previous image, their enhancement, followed by their cross-correlation.

For CMW and ELW the tracers are clouds identified from 5 km imagery from all channels, for HRV clouds clouds identified from 2.5 km visible imagery and for WVW the tracers are cloud-free tracers identified from 5km WV imagery.

The extracted wind components are thereafter subject to automatic quality control (AQC) (Holmlund, 1996). The AQC process calculates a number (currently 5) of consistency indicators for the extracted wind, and combines these as a weighted mean into an overall reliability indicator. The intermediate wind products contain all extracted winds and associated reliability indicators. No manual quality control is applied.

The intermediate wind products are encoded into GTS formats. For the CMW product the best wind per geographical location, as determined by the value of the overall reliability indicator, is selected from this intermediate product, and encoded into SATOB, if the reliability indicator exceeds a certain threshold value (currently 80%). For the ELW, HRV and WVW products, the winds are encoded in BUFR, together with the reliability indicators themselves. All winds down to a low reliability (30%) are included, but for each product, a suggested reliability indicator threshold is provided in the BUFR format. The BUFR and SATOB products are distributed on the GTS. The original intermediate products are archived in the Meteosat archive facility (MARF) and are thus available for historical retrievals.

Further details about the wind extraction process are provided in (Rattenborg and Holmlund 1996) and (Schmetz et.al.).

The following areas can be identified, where further improvement of the current MPEF wind products are desired:

- Low level coverage around developing tropical systems. The deficient cloud motion-wind coverage in the vicinity of developing and developed tropical disturbances is an important issue for hurricane forecasting.
- Low-level height assignment in trade wind inversion areas. In the inversion areas, the Temperature-to-Pressure transformation is multi-valued. This results in low-level IR height assignment problems.
- Medium-level coverage. Although this area presents fundamental meteorological problems, the MPEF wind coverage at medium levels seems to be too low.

- High-level height assignment for cloud tracked winds. Significant scope for improvements to the semi-transparency correction.
- Provision of reliability indicators for speed, direction, pressure and temperature

The needs of the user community will be addressed partly through improvements to the existing operational wind products (CMW and HRV) and partly through the introduction of new wind products.

3.2 HRV tracer selection improvements

The tracer selection and height assignment for HRV will be based on averaging pixel counts over the target area in the pixel-classified image instead of using the segment-based cluster information. This will provide more HRV winds in mixed cloud segments and better coverage in areas with developing systems.

3.3 Medium-level IR winds

The quality and coverage of the medium level IR winds is relatively poor. This is mainly a reflection of the complex physics and dynamics of the mid-level atmosphere, especially over the continents, and no single internal problems causing this have been identified, but the medium-level winds issue will continue to be investigated.

3.4 WV winds from cloud-free areas

The tracking of water vapour in cloud-free areas provides a wind product with extensive coverage. This product (WVW) at a resolution of 160 km is now available as an operational product, using the single-level height assignment based on the cluster EBBT. With the new unified BUFR template, is it possible to provide the user with alternative height assignments, and it is planned to include height assignment information based on the WV contribution function calculated in the Radiative Transfer Model.

3.5 Low-level tracking over land

The tracking of low-level clouds over land presents significant problems because of the short lifetime of low-level clouds over land, the impact of surface features on the tracking and of flow deformation/curvature effects. The feasibility of advanced techniques to address these issues using the MSG spacecraft is being addressed in a EUMETSAT study, and if the results of this study are promising and applicable an implementation in the MTP system will be considered.

3.6 High Resolution WV winds

The Meteosat Second Generation prototyping activities for the Atmospheric Motion Vector (AMV) product have suggested that the production of 80km resolution, cloud tracked vapour motion winds from Meteosat images would be feasible. The present processing segment used for CMW is split into 4 quadrants each of 16×16 pixels, and each of these in turn is used as a target area in the extraction of a wind vector. The search area is then a 56×56 pixel region centred on the target area, and extending 20 pixels beyond it on each side. This ensures that tracers moving at up to ~78 ms^{-1} (28 pixels per slot) at the sub satellite point can be successfully tracked. The height assignment method for HWW makes use of the classification of each pixel within a quadrant to determine the coldest cluster of self-similar pixels that fall, to a configurable minimum extent, within the quadrant. The water vapour count of this cluster is then used to derive the height. This method allows height assignment and classification of cloud winds on a per quadrant basis.

The HWW product has been distributed to ECMWF and the UK Met Office for testing since July 1 1999 and it is planned to introduce the product as fully operational in 4^{th} quarter of 1999.

Investigations have shown, that tracking with 16x16 targets is not feasible in cloud-free areas with the current tracking algorithm. Further investigations will assess whether improvements can be expected from other methods.

3.7 Better geographical positioning

Presently the extracted winds are positioned at the segment centres, introducing an inaccuracy of up to half a segment size. A better positioning can be obtained by explicit tracer location in the image. Initial results are encouraging and this change will be introduced operationally in 4th quarter of 1999.

3.8 Increased time-frequency of winds distribution

The MPEF distributes winds in BUFR format every 1.5 hours. A further reduction of the wind extraction cycle to 1 hour, made possible by more powerful workstations, will bring the schedule inline with the MSG baseline and is planned for early 2000.

3.9 Move winds derivation to synoptic times

To leave enough time for manual quality control, the derivation of the wind products has historically been performed 1 hour before the main synoptic hours, e.g. 12Z products were derived from the three images ending at 10:30Z, 11:00Z and 11:30Z. As all procedures are now fully automated, this is no longer required, and the wind extraction times will be moved to match the synoptic hours. Planned for 1st quarter of 2000.

3.10 Automatic Quality Control

A core issue to be addressed for the MPEF CMW product is the definition of the AQC processes and parameters. The process is essential to ensure a maximum yield of high-quality winds for all channels and all levels and to ensure the availability of stable reliability indicators for the user community. A very important aim is also to provide quality indicators which are independent of the forecast wind fields. The AQC tuning is based on the continuously growing data set of collocated radiosondes and MPEF satellite winds, as well as on comparisons with ECMWF first-guess fields. The AQC definition process is ongoing with continuous improvements over the next year.

With an optimal AQC the size and coverage of the SATOB encoded product can be increased and meaningful reliability indicators for the BUFR product, including individual reliability indicators for speed, direction and height, can be provided, as well as quality indicators with and without forecast information. It could also be investigated whether estimates for the error distribution functions can be produced, which could be used in the NWP data assimilation schemes.

The optimised AQC system will be used as a basis for tuning the MSG MPEF, as the MSG system will employ the same AQC system as MTP.

3.11 Verification improvements

The verification of the CMW product is currently based exclusively on radiosondes and forecast fields. Use of other data (e.g. AIREP/ASDAR/ACARS) for verification is foreseen.

CGMS-XXVII-PRC-WP-11
Prepared by CMA
Agenda Item: III/4

CLOUD MOTION WINDS FROM FY-2 AND GMS-5 METEOROLOGICAL SATELLITES

Summary and purpose of paper:
Cloud Motion Winds (CMW) from FY-2 and GMS-5 meteorological satellites were calculated. The algorithm was described in the previous paper "Calculation of Cloud Motion Wind with GMS-5 in China" presented at the third international winds workshop. The test operation showed that one of the major errors came from inappropriate height assignment. To reduce height assignment error, the following modifications to the algorithm were made:
Further distinction between high and low level clouds was achieved by correlation analysis between IR and WV measurements in tracer regions.
For GMS-5 CMWs, brightness temperature (BT) difference of split window channels (BTDIR) was adopted as one of the thresholds for the distinction between high and low level clouds.
The above mentioned procedures improved the height assignments greatly. With the improved algorithm, FY-2 and GMS-5 CMWs were calculated. Error analysis was made.

Cloud Motion Winds from FY-2 and GMS-5 Meteorological Satellites

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Abstract

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The above mentioned procedures improved the height assignments greatly. With the improved algorithm, FY-2 and GMS-5 CMWs were calculated. Error analysis was made.

1. Introduction

At the third international winds workshop, the authors submitted a paper "Calculation of Cloud Motion Wind with GMS-5 Images in China" (Xu and Zhang, 1996) which described an algorithm developed in National Satellite Meteorological Center (NSMC) China for CMW calculation. This algorithm has been put into operation for GMS-5 winds since Oct. 1996. The calculation results were compared with radiosonde data. The comparison showed that one of the major error sources came from inappropriate height assignment. The worst cases were found at places where high level winds were assigned as low, or vise versa. Thin cirrus clouds are good tracers. But some thin cirrus clouds are so thin that their BTs are almost same in magnitude as the one of low-level clouds. Thus, it becomes difficult to distinguish them. In order to reduce errors caused by inappropriate height assignment, horizontal coincidence check and height adjustment methods were tested. Those procedures did not show ideal results. After careful exam to the data, a revised algorithm was achieved. This paper describes our approach to seek proper height assignment. Section 2 of this paper describes contribution from IR-WV channel correlation analysis. Section 3 refers to the utilization of split window channels of GMS-5 at height assignment. Section 4 compares our calculation results to the radiosonde observations.

2. Contribution of IR-WV Channel Corrections in Tracer Regions to Height Assignment

As described in the introduction of this paper, inappropriate height assignment is one of the major error sources for CMW calculation. Fig. 1 shows the scatter diagram of IR and WV BTS at different cloud conditions (from Xu and Zhang, 1996). It gives an insight to the physical reason why it is difficult to distinguish thin cirrus clouds from low clouds. The explanation to Fig. 1 may be found in Xu and Zhang's paper (1996). In Fig 1. Cirrus clouds are located along a slope line, with dense cirrus at the down-left part, and thin cirrus at the up-right part; while low clouds are located along a horizontal line, with middle level clouds at the left part and lower clouds at the right part. For cirrus clouds, the more thinner (thicker), the further to the up-right (down-left) part along the slope line; for low clouds, the more lower (higher), the further to the right (left) part along the horizontal line. Since the thin cirrus clouds and low clouds are both quite close on the scatter diagram to the cross point of the slope line and the horizontal line which represents the surface. It becomes difficult to distinguish them.

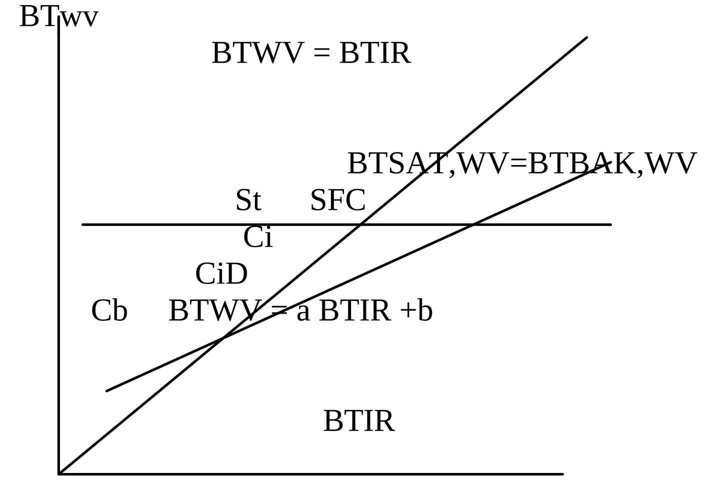


Fig. 1 Scatter diagram of IR and WV BTs at different cloud conditions (from Xu and Zhang, 1996)

Notice that when we make height adjustments with the scatter diagram. Only the coldest 5% BT or their adjustment values are used. The distributions of IR and WV measurements in the tracer regions are ignored. By examination to many cases, we mentioned that although extreme BT values of IR and WV in the tracer regions may not be sensitive in some cases to the distinction between high and low clouds, the distributions of them do have such ability. For tracers with high level clouds, IR and WV measurements have high correlation values; while such correlation values are very low for tracers with low level clouds. It is in the distribution of IR and WV measurements, in their relationship, there is information based on which we can make distinction between high and low level clouds. And the distinctions between high and low clouds consists of the majority of the height assignment. Correct allocation of cloud types (high or low), may reduce much error of CMWS, The examples are shown as below:

Fig. 2 is an example of high level clouds. This example is taken from FY-2 at 5.3 N 100.27 E 06Z 11 Sept. 1998. Fig. 2 a is scatter diagram of IR and WV BTS, Fig. 2 b is radiosonde diagram. Radiosonde observation was taken at 00Z. The IR (left) and WV (right) images in the tracer region, are at the top of Fig. 2 b. For this tracer, the correlation coefficient between IR and WV measurements is 0.942, The good relation between IR and WV measurements can also be noticed from IR and WV images. Their distribution patterns are quite similar. The radiosonde data verifies that the height assignment is correct. The wet level top shown at radiosonde diagram is at high level above 200 hPa.

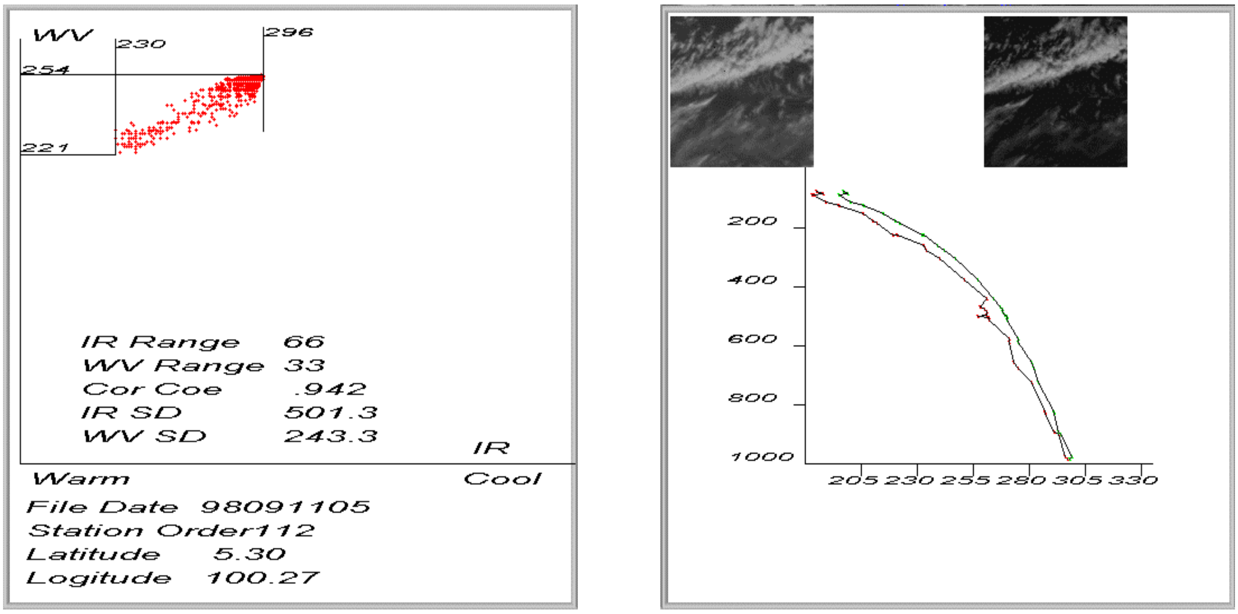


Fig. 2 scatter diagram of IR / WV measurements (a), radiosonde diagram and IR (left), WV (right) images (b), for a FY-2 tracer at 5.3 N 100.27 E 06z 11 Sept. 1998.

Fig. 3 is an example of low-level clouds. This example is taken from FY-2 at 26.2 N 127.68 E 06Z 17 Sept. 1998. The key for Fig. 3 is same as Fig. 2. For this tracer, the correlation coefficient between IR and WV measurements is -0.105. In Fig. 3, while the IR image of the tracer visuals low clouds, the WV image of the tracer appears very smooth. This indicates the absent of high level cloud in this tracer region. Radiosonde curve in Fig. 3 b verifies that the wet layer top is at low level around 850 hPa.

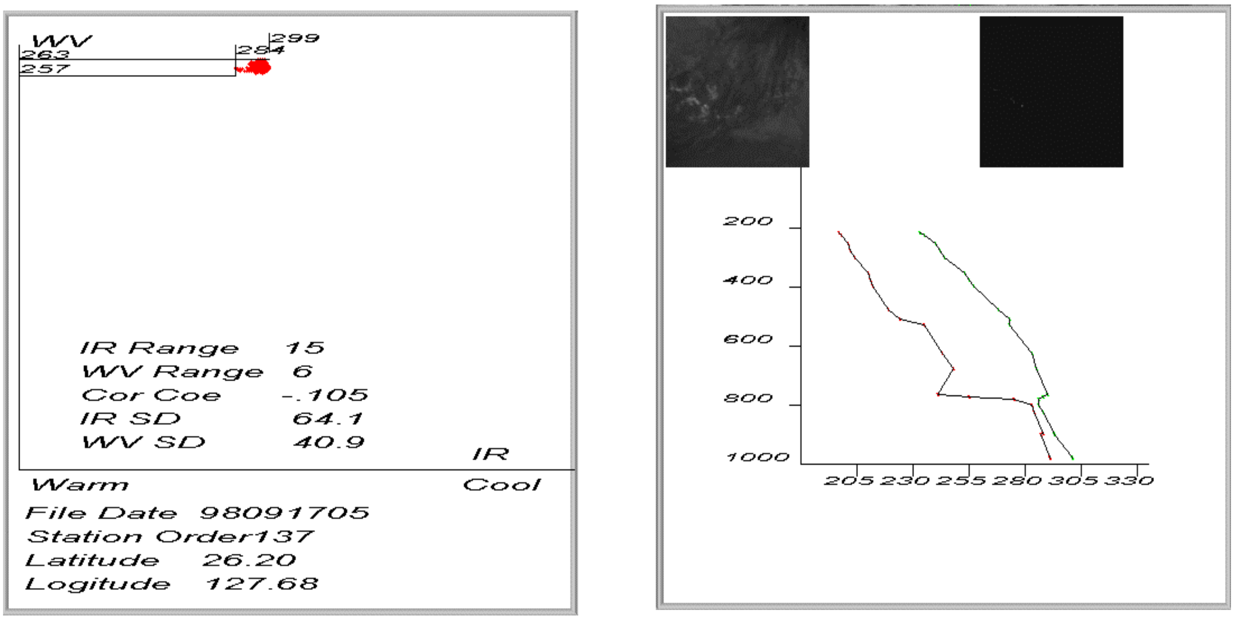


Fig. 3 scatter diagram of IR / WV measurements (a), radiosonde diagram and IR (left), WV (right) images (b), for a FY-2 tracer at 26.2 N 127.68 E 06Z 17 Sept. 1998.

The above case study shows that correlation between IR and WV measurements can be used to distinguish tracers with high level clouds from the ones with low level clouds. After examination to a big amount of tracer data, the following thresholds were adopted in our new algorithm:

Threshold 1: Tracers with correlation between IR and WV measurements greater than 70% should perform height adjustment procedure. Those are normally high level clouds .

Threshold 2: Tracers with correlation between IR and WV measurements less than 30% should not perform height adjustment procedure. Those are normally low-level clouds.

IR-WV correlation with values between 70% and 30% are in a mixed region. Tracers with such intermediate correlation values are possible to be high, middle or low-level clouds. As we described in the previous paper (Xu and Zhang, 1996), slopes in WV-IR scatter diagrams have some ability to make the distinction. Those are:

Threshold 3: Tracers with IR-WV correlation between 70% and 30% and with slope at the WV-IR scatter diagram less than 0.1 should not perform height adjustment.

Threshold 4: Tracers with IR-WV correlation between 70% and 30% and with slope at the WV-IR scatter diagram greater than 0.1 should perform height assignment.

3. Contribution of BTDIR in Tracer Region to Height Assignment

When individual data were examined, it was noticed that among the tracer group which fit threshold 4, some are thin cirrus clouds, some are low level clouds, inappropriate height assignments still exist. Fig. 4 and Fig. 5 are examples. Fig. 4 is taken at 33.58 N 130.38 E, 00z 12 Sept. 1998, Fig. 5 is taken at 27.08 N 142.17 E, 00z 12 Sept. 1998. They are both from GMS-5 images. The keys for Fig. 4 and Fig. 5 are same as Fig. 2, except IR/BTDIR scatter diagram and split window channel difference image BTDIR are contained.

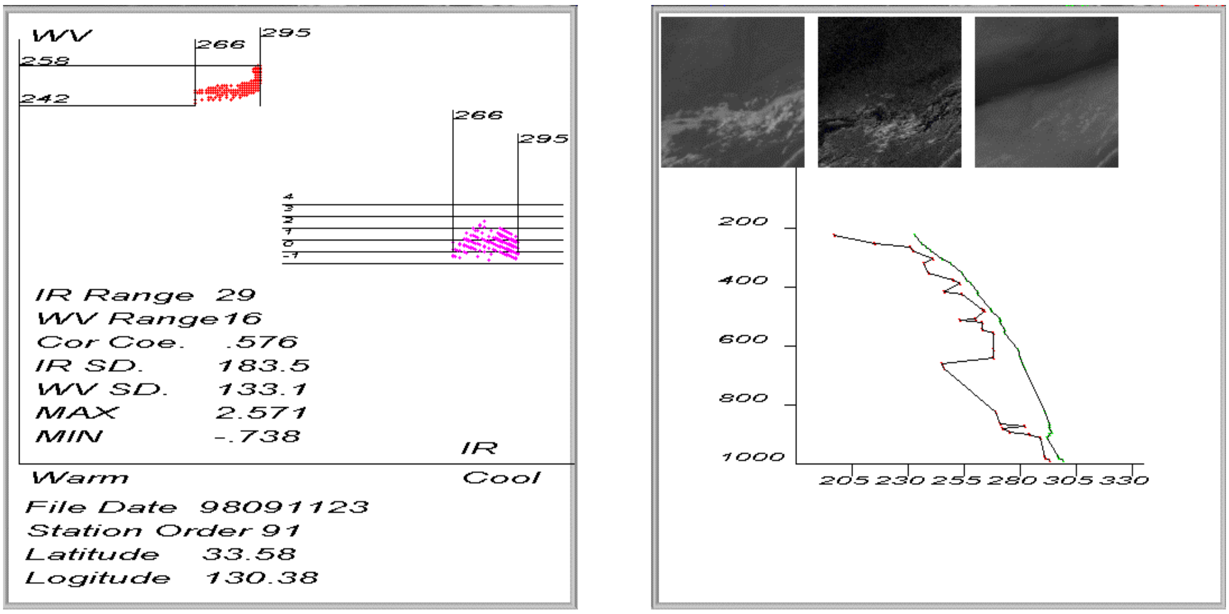


Fig. 4 scatter diagrams of IR / WV(up left) and IR / BTDIR (down right) measurements (a), radiosonde diagram and IR (left), BTDIR (middle) WV (right) images (b) for a GMS-5 tracer at 33.58 N 130.38 E, 00z 12 Sept. 1998.

From IR and WV images in Fig. 4b, we may judge that the tracer in Fig. 4 contains high clouds. The thin cirrus clouds are both apparent at IR and WV images. From IR and WV images in Fig. 5 a and b, we may judge that the tracer in Fig. 5 contains middle or low clouds. The low clouds are visual at IR image, rather than at WV image. The correlation coefficients between IR and WV measurements are 0.576 and 0.6333 for Fig. 4 and Fig.5 respectively. Although the cloud heights are apparently shown at the radiosonde diagrams, based on the parameters from the image scatter diagrams, we unable to make distinguishment to heights of tracers in Fig. 4 and Fig.5.

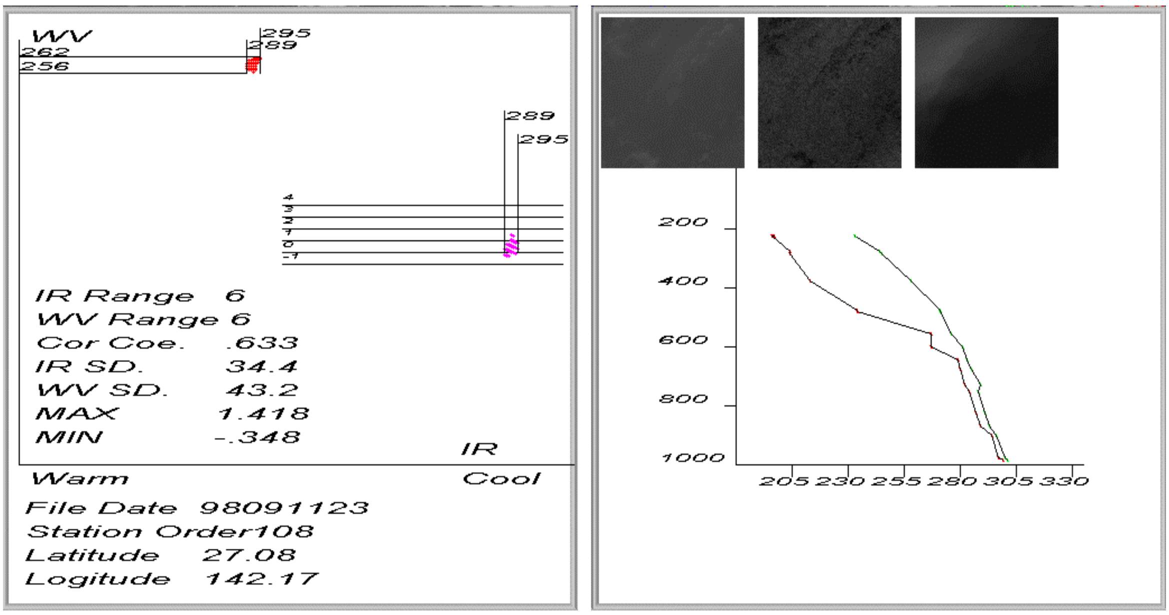


Fig. 5 scatter diagrams of IR / WV(up left) and IR /BTDIR (down right) measurements (a), radiosonde diagram and IR (left), BTDIR (middle) WV (right) images (b) for a GMS-5 tracer at 27.08 N 142.17 E, 00z 12 Sept. 1998.

Is there further information exists in the tracer images based on which we may make batter distinction between high and low level clouds? In our new algorithm, for GMS-5 data, BTDIR for split windows is adopted to improve the distinction. The reason why split window channels contain information on cloud heights may be explained as below.

Fig. 6 is BTDIR from GMS-5 at 17z 3 Sept. 1998. Fig. 6 shows that the BTDIR values are normally higher near the boundary of the major cloud systems where thin semi-transparent cirrus are usually exist, such as the boundaries of a tropical cyclone and cloud clusters in the image. In the region with low clouds, BTDIR values are lower. This phenomenon has been indicated by many authors, such as Inoue (1985), Parol etc (1991) Baum etc. (1994).

Fig. 7 a is an image taken from NOAA at 2036z 2 Aug. 1993. In this image, we take two small regions to make scatter diagrams of BTDIR to BTIR. Fig. 7 b is scatter diagram in sub region 1 (39.1-39.5 N 116.1-116.5 E) where high level clouds are exist. Fig. 7 c is scatter diagram in sub region 2 (42.5-43.0 N 117.8-118.5 E) where low clouds are exist. It is apparent that the BTDIR peaks are much bigger in magnitude for thinner high cloud region 1 (Fig. 7 b) than for low cloud region 2 (Fig. 7 c). The above case study shows that BTDIR may be used to distinguish tracers with high level cloud from the ones with low-level clouds. After many data are examined, the threshold 5 is supplemented to threshold 4 for GMS-5 CMW calculations (For FY-2 CMW calculations, threshold 4 is still used).

Threshold 5: For GMS-5 tracers that meet the condition of threshold 4, further exam to BTDIR should be performed. Those with BTDIR less than 1.9 K should not perform height adjustment.

Note that BTDIR values are normally small in magnitude at dense high cloud regions. This phenomenon may be noticed in Fig 6. But dense cloud region normally have high IR / WV correlation coefficients. They have already been classified into high cloud group by threshold 1. Note that BTDIR values are normally small in magnitude at dense high cloud regions. This phenomenon may be noticed in Fig 6. But dense cloud region normally have high IR / WV correlation coefficients. They have already been classified into high cloud group by threshold 1.

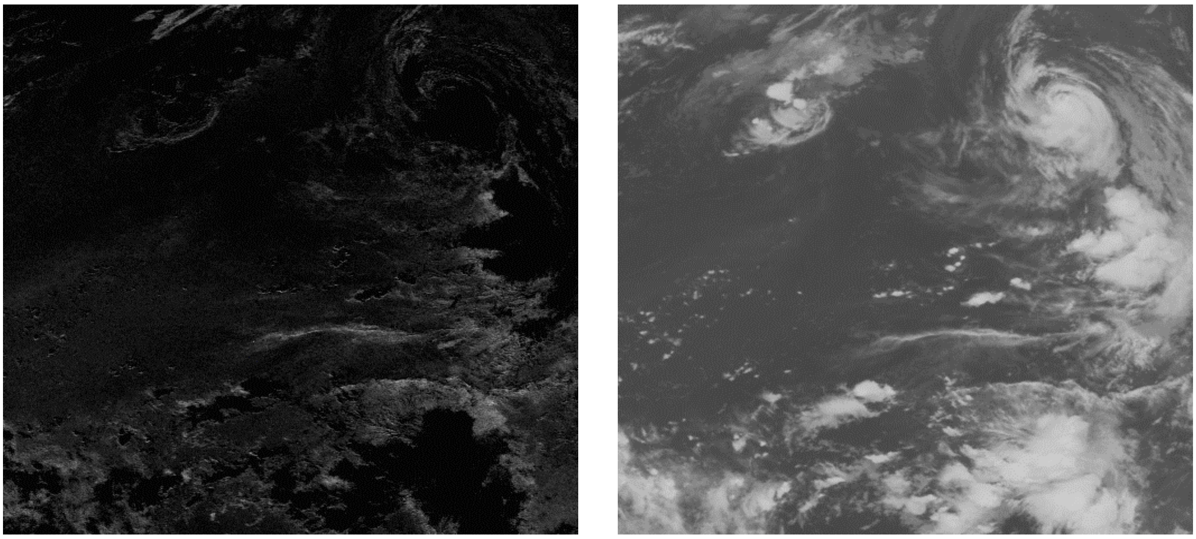


Fig. 6 BTDIR(a) and IR(b) images for GMS-5 at 17z 03 Sept. 1998.

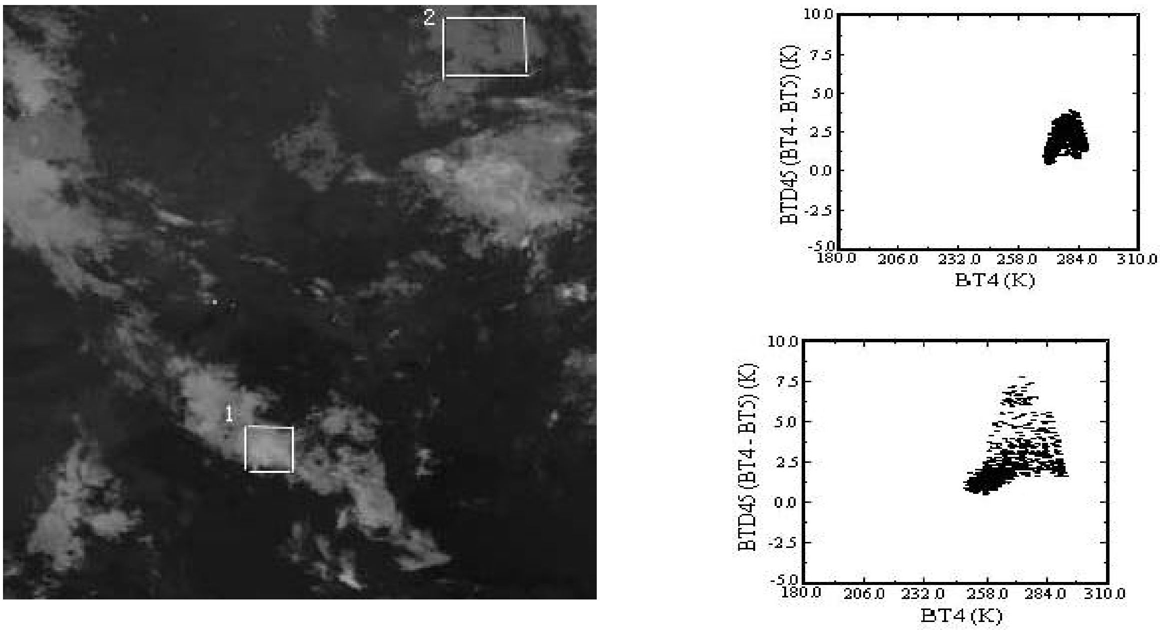


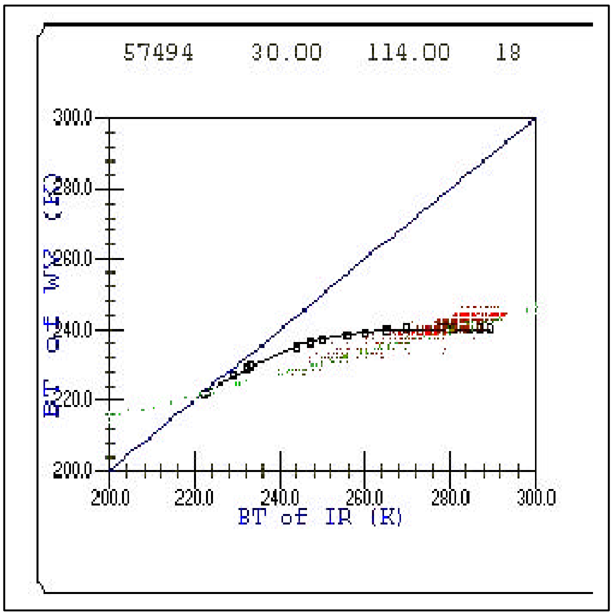
Fig. 7 a IR image from NOAA at 2036z 2 Aug. 1993,
b Scatter diagram of BTDIR- BTIR for high cloud region 1 in Fig. 7 a,
c Scatter diagram of BTDIR- BTIR for low cloud region 2 in Fig. 7 a.

4. Discussion on Possible Error Sources of the Algorithm

The physical basis of our algorithm is laid on the linear relationship between WV-IR measurements in tracer region with high clouds that was first indicated by Schejwach (1982). From Fig. 1, we see that since the height adjustments are made based on the cross point of the two lines: BTWV= BTIR, and BTwv = BTIR+ b, the possible errors may be caused by one of the following two reasons:

4.1 Inappropriate expression of opaque cloud WV-IR BT relationship

In our algorithm, we use BTWV=BTIR to express high opaque cloud BTIR-BTWV relationship. Schmetz etc. (1993) used numerical simulation calculation based on radiation transmission equation. In order to exam the difference of the two expressions, at places with radiosonde data, comparisons were made. Fig 8 is an example. Fig. 8 shows WV and IR measurement relationship (curve line) for different level opaque clouds calculated with lowtran-7, and BTWV=BTIR (straight line) which we use to express WV IR measurements relationship for opaque clouds at high levels. The comparison shows that at high levels where height adjustment values are usually located , the two lines are very close with each other. Such comparisons show that our hypothesis BTIR=BTWV may not cause big errors to the height assignments for high level clouds.



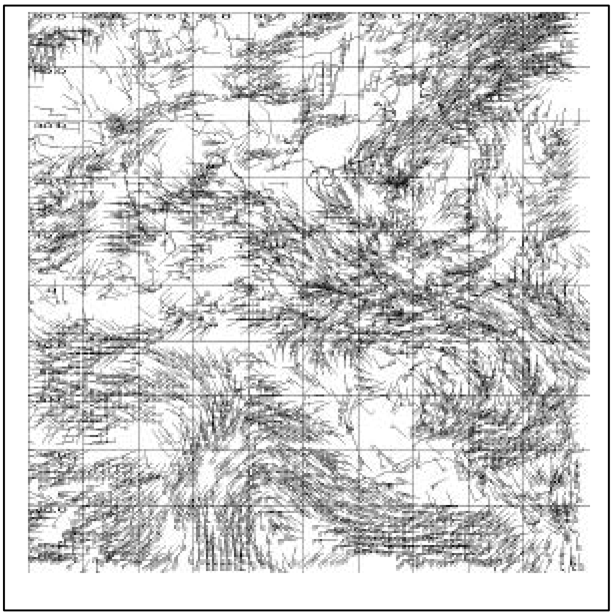
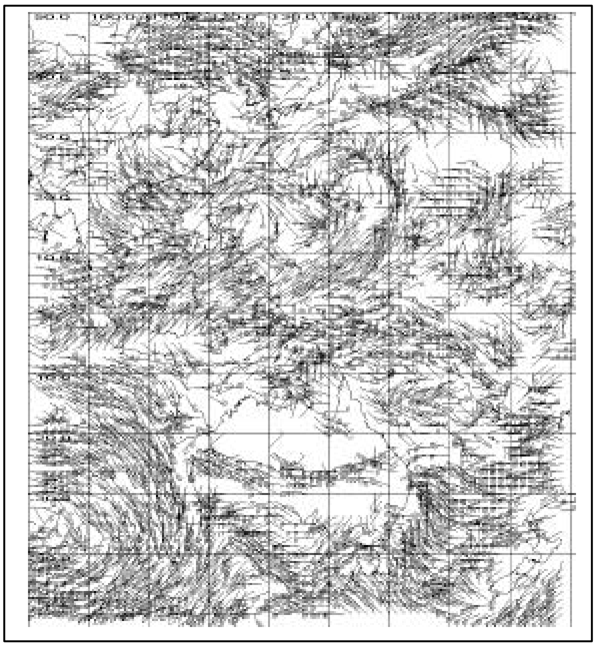


Fig. 8 Comparisons of IR / WV measurement relationship for opaque clouds with different hypothesis.
Fig. 9 FY-2 CMWs at 06z 15 Oct. 1998



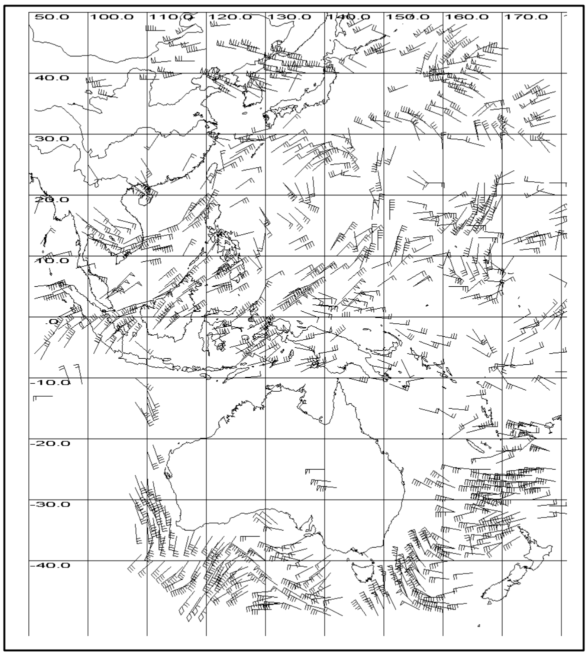


Fig. 10 GMS CMWs form NSMC at 00z 13 Sept. 1998.(left)
Fig. 11 GMS CMWs from the GTS at 00z 13 Sept. 1998(right).

4.2 Errors in statistical relationship BTIR = a BTIR +b.

Efforts made in this paper are attempted to reduce errors caused by the IR-WV statistical relationship. We suggest in this paper to use IR-WV correlation and BTDIR to judge if it is needed to make height adjustment. By doing so, the distribution of cloud motion winds become more reasonable. The following Figs show FY-2 CMWs (Fig.9), GMS CMWs form NSMC (Fig. 10) and GMS CMWs from the GTS (Fig. 11) .

Acknowledgment

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CGMS-XXVII-JPN-WP-20
Prepared by JAPAN
Agenda Item: III/2

SATELLITE WINDS PRODUCTS PLANS WITH MTSAT

This paper provides information on the plans for the satellite winds products derived from MTSAT imagery.

SATELLITE WIND PRODUCTS PLANS WITH MTSAT

1 INTRODUCTION

MSC will partly change the way of producing satellite winds when MTSAT is put into operation, shortening the interval between images for wind tracking from 30-minute to 15-minute. It is expected that this change will bring an increase of the number of inferred wind vectors by about 20% more than the present product, as was shown in the WP presented at CGMS XXVI meeting (JMA, 1998). Some other plans for the satellite wind products with MTSAT are shown below.

2 LOW-LEVEL WINDS IN THE VICINITY OF TYPHOONS

MSC has operationally derived low-level winds in the vicinity of typhoons for the last decade in addition to the global coverage of cloud motion winds and water vapor motion winds (See Figure1). The low level winds are produced when typhoons are within the area from 100E to 180E in the Northern hemisphere. They are utilized for typhoon analyses at the Forecast Division of JMA headquarter. They are presently produced once a day in the daytime for only one typhoon, but with MTSAT the application will be produced to four times a day for all observed typhoons. It is planned that the information on the low-level winds will be transmitted on LRIT to national Met Services that may be affected by the typhoons.

3 PLANS FOR SATELLITE WIND PRODUCTS

JMA has plans to transfer the software to produce satellite wind products from MSC's mainframe computer system to workstations.
It will enable JMA to develop algorithms which are able to efficiently calculate high density wind vectors, improve matching accuracy, assign vector heights more effectively and disseminate products with quality flag on the BUFR code.
It is also planned to conduct a study of producing satellite winds from the new 3.7µm sensor’s data.

4 REFERRENCES

JMA, 1998: Satellite Wind Products by MTSAT. Report of the 26th Meeting of the Coordination Group for Meteorological Satellites held 6-10 July 1998 in Nikko, Japan. CGMS publications. A77-A80.

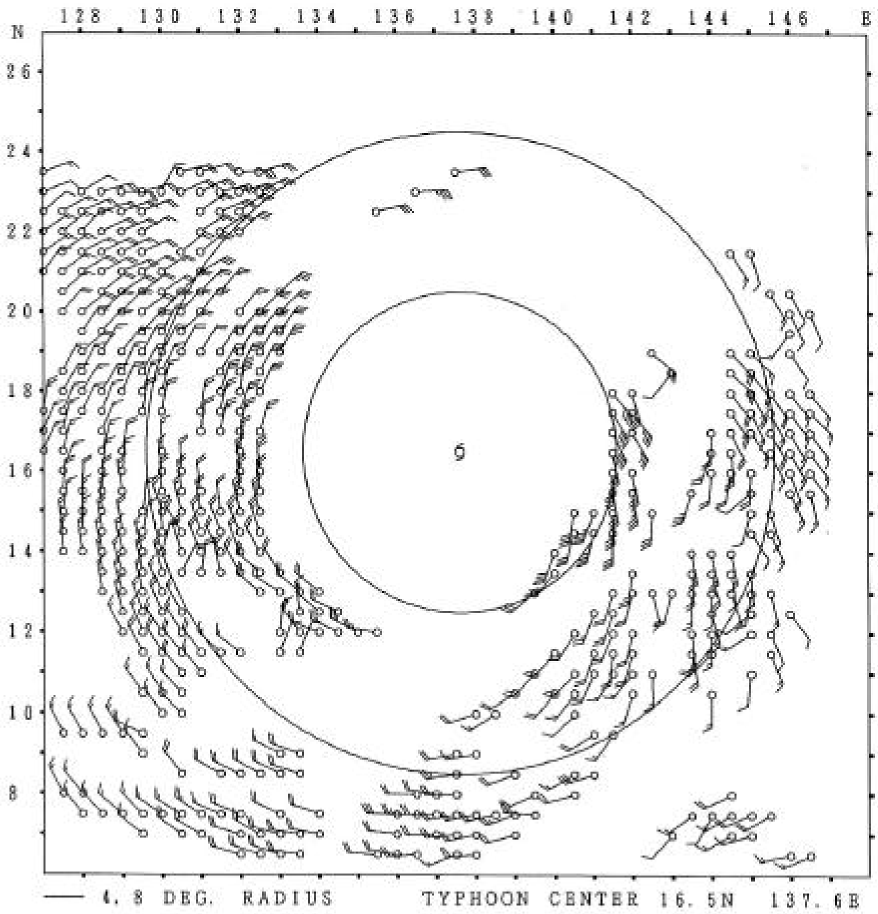

Fig.1 Low-level winds in the vicinity of a typhoon. 6 is the typhoon center and radiuses of two circles are 4 and 8 longitude degrees respectively. Three visible images at 15-minute intervals are used for the calculation.

APPENDIX C:

GENERAL CGMS INFORMATION

CHARTER FOR THE
COORDINATION GROUP FOR METEOROLOGICAL SATELLITES (CGMS)

PREAMBLE

RECALLING that the Coordination on Geostationary Meteorological Satellites (CGMS) has met annually as an informal body since September 1972 when representatives of the United States (National Oceanic and Atmospheric Administration), the European Space Research Organisation (now the European Space Agency), and Japan (Japan Meteorological Agency) met to consider common interests relating to the design, operation and use of these agencies planned meteorological satellites,

RECALLING that the Union of Soviet Socialist Republics (State Committee for Hydrometeorology), India (India Meteorological Department) and the People's Republic of China (State Meteorological Administration) initiated development of geostationary satellites and joined CGMS in 1973, 1978, and 1986 respectively,

RECOGNIZING that the World Meteorological Organization (WMO) as a representative of the meteorological satellite data user community has participated in CGMS since 1974,

NOTING that the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) has, with effect from January 1987, taken over responsibility from ESA for the METEOSAT satellite system and the current Secretariat of CGMS,

CONSIDERING that CGMS has served as an effective forum through which independent agency plans have been informally harmonized to meet common mission objectives and produce certain compatible data products from geostationary meteorological satellites for users around the world,

RECALLING that the USA, the USSR, and the PRC have launched polar-orbiting meteorological satellites, that Europe has initiated plans to launch an operational polar-orbiting mission and that the polar and geostationary meteorological satellite systems together form a basic element of the space based portion of the WMO Global Observing System,

BEING AWARE of the concern expressed by the WMO Executive Council Panel of Experts over the lack of guaranteed continuity in the polar orbit and its recommendation that there should be greater cooperation between operational meteorological satellite operators world-wide, so that a more effective utilisation of these operational systems, through the coordination and standardisation of many services provided, can be assured,

RECOGNIZING the importance of operational meteorological satellites for monitoring and detection of climate change,

AND RECOGNIZING the need to update the purpose and objectives of CGMS,

AGREE

I. To change the name of CGMS to the Coordination Group for Meteorological Satellites

II. To adopt a Charter, establishing Terms of Reference for CGMS, as follows:

<u>OBJECTIVES</u>

a) CGMS provides a forum for the exchange of technical information on geosta-tionary and polar-orbiting meteorological satellite systems, such as reporting on current meteorological satellite status and future plans, telecommunications matters, operations, inter-calibration of sensors, processing algorithms, products and their validation, data transmission formats and future data transmission standards.

b) CGMS harmonises to the extent possible meteorological satellite mission pa-rameters such as orbits, sensors, data formats and downlink frequencies.

c) CGMS encourages complementarity, compatibility and possible mutual back-up in the event of system failure through cooperative mission planning, compatible meteorological data products and services and the coordination of space and data related activities, thus complementing the work of other international satellite coordinating mechanisms.

MEMBERSHIP

d) CGMS Membership is open to all operators of meteorological satellites, to prospective operators having a clear commitment to develop and operate such satellites, and to the WMO, because of its unique role as representative of the world meteorological data user community.

e) The status of observer will be open to representatives of international organisations or groups who have declared an intent, supported by detailed system definition studies, to establish a meteorological satellite observing system. Once formal approval of the system is declared, membership of CGMS can be requested by the observer.

Within two years of becoming an observer, observers will report on progress being made towards the feasibility of securing national approval of a system. At that time CGMS Members may review the continued participation by each Observer.

f) The current Membership of CGMS is listed in an annex to this charter.

g) The addition of new Members and Observers will be by consensus of existing CGMS Members.

ORGANISATION

h) CGMS will meet in plenary session annually. Ad hoc Working Groups to consider specific issues in detail might be convened at the request of any Member provided that written notification is received and approved by the Membership at least 1 month in advance and all Members agree. Such Working Groups will report to the next meeting of CGMS.

i) One Member, on a voluntary basis, will serve as the Secretariat of CGMS.

j) Provisional meeting venues, dates and draft agenda for plenary meetings will be distributed by the Secretariat 6 months in advance of the meeting, for approval by the Members. An agreed Agenda will be circulated to each Member 3 months in advance of the meeting.

k) Plenary Meetings of CGMS will be chaired by each of the Members in turn, the Chairman being proposed by the host country or organisation.

l) The Host of any CGMS meeting, assisted by the Secretariat, will be responsible for logistical support required by the meeting. Minutes will be prepared by the Secretariat, which will also serve as the repository of CGMS records. The Secretariat will also track action items adopted at meetings and provide CGMS Members with a status report on these and any other outstanding actions, four months prior to a meeting and again at the meeting itself.

PROCEDURE

m) The approval of recommendations, findings, plans, reports, minutes of meetings, the establishment of Working Groups will require the consensus of Members. Observers may participate fully in CGMS discussions and have their views included in reports, minutes etc., however, the approval of an observer will not be required to establish consensus.

n) Recommendations, findings, plans and reports will be non-binding on Members or Observers.

o) Once consensus has been reached amongst Members on recommendations, findings, plans and reports, minutes of meetings or other such information from CGMS, or its Working Groups, this information may be made publicly available.

p) Areas of cooperation identified by CGMS will be the subject of agreement between the relevant Members.

COORDINATION

q) The work of CGMS will be coordinated, as appropriate, with the World Meteorological Organisation and its relevant bodies, and with other international satellite coordination mechanisms, in particular the Committee on Earth Observation Satellites (CEOS) and the Earth Observation International Coordination Working Group (EO-ICWG) and the Space Frequency Coordination Group (SFCG).

Organisations wishing to receive information or advice from the CGMS should contact the Secretariat; which will pass the request on to all Members and coordinate an appropriate response, including documentation or representation by the relevant CGMS Members.

AMENDMENT

r) These Terms of Reference may be amended or modified by consensus of the Members. Proposals for amendments should be in the hands of the Members at least one month prior to a plenary meeting of CGMS.

EFFECTIVE DATE AND DURATION

s) These Terms of Reference will become effective upon adoption by consensus of all CGMS Members and will remain in effect unless or until terminated by the consensus of CGMS Members.

MEMBERSHIP OF CGMS

The current Membership of CGMS is:

EUMETSAT	-	joined 1987, currently CGMS Secretariat
India Meteorological Department	-	joined 1979.
Japan Meteorological Agency	-	founder member, 1972
China Meteorological Administration of the PRC	-	joined 1989
NOAA/NESDIS	-	founder member, 1972
Hydromet Service of the Russian Federation	-	joined 1973
WMO	-	joined 1973

(The table of Members shows the lead Agency in each case. Delegates are often supported by other Agencies, for example, ESA (with EUMETSAT), NASDA (with Japan Meteorological Agency) and SRC Planeta (with Hydromet Service of the Russian Federation).

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LIST OF ABBREVIATIONS AND ACRONYMS

AboM	Australian Bureau of Meteorology
ACARS	Automated Communications Addressing and Reporting System
ACC	ASAP Coordinating Committee
ADC	Atlantic Data Coverage
AERONET	remote-sensing aerosol monitoring network programme
AHRPT	Advanced High Rate Picture Transmission
AMDAR	Aircraft Meteorological Data Relay
AMS	American Meteorological Society
AMSU	Advanced Microwave Sounding Unit
AMV	Atmospheric Motion Vectors
APT	Automatic Picture Transmission
ARGOS	Data Collection and Location System
ASAP	Automated Shipboard Aerological Programme
ASCAT	C-band dual swath scatterometer (Metop)
ASCII	American Standard Code for Information Interchange
ASDAR	Aircraft to Satellite Data Relay
ATOVS	Advanced TOVS
AVHRR	Advanced Very High Resolution Radiometer
BBC	Black Body Calibration (Meteosat)
BCCP	Business Continuity and Contingency Plan (USA)
BUFR	Binary Universal Form for data Representation
CAL	Computer Aided Learning
CBS	Commission for Basic Systems
CCD	Charged Couple Device (INSAT-2E)
CCIR	Consultative Committee on International Radio
CCSDS	Consultative Committee on Space Data Systems
CD	Compact Disk
CDMA	Code Division Multiple Access
CEOS	Committee on Earth Observations Satellites
CEPT	Conference Européenne des Postes et Télécommunications
CGMS	Coordination Group for Meteorological Satellites
CHRPT	Chinese HRPT (FY-1C and D)
CIIS	Common Instrument Interface Studies
CIS	Commonwealth of Independent States
CLS	Collecte Localisation Satellites (Toulouse)
CMD	Cyclone Warning Dissemination Service
CMS	Centre de Meteorologie Spatiale (Lannion)
CMV	Cloud Motion Vector
CMW	Cloud Motion Wind
COSPAR	Committee on Space Research
CPM	Conference Preparatory Meeting (WRC)

DAPS	DCS Automated Processing System (USA)
DCP	Data Collection Platform
DCS	Data Collection System
DIF	Directory Interchange Format
DOD	Department of Defence (USA)
DOMSAT	Domestic telecommunications relay Satellite (USA)
DPT	Delayed Picture Transmission
DRS	DCP Retransmission System (Meteosat)
DRT	Data Relay Transponder (INSAT)
DSB	Direct Soundings Broadcast
DUS	Data Utilisation Station (USA) (Japan)
DWS	Disaster Warning System (India)
EBB	Electronic Bulletin Board
EC	Executive Council (WMO)
ECMWF	European Centre for Medium range Weather Forecasts
EEIS	EUMETSAT External Information System
EESS	Earth Exploration Satellite Service (Frequency Management)
ENVISAT	ESA future polar satellite for environment monitoring
EO	Earth Observation
EOS	Earth Observation System
EPS	EUMETSAT Polar System
ERBE	Earth Radiation Budget Experiment
ESA	European Space Agency
ESJWG	Earth Sciences Joint Working Group
ESOC	European Space Operations Centre (ESA)
EUMETSAT	European Meteorological Satellite Organisation
FAA	Federal Aviation Authority (USA)
FAO	Food and Agriculture Organisation (UN)
FAX	Facsimile
FXTS	Facsimile Transmission System (USA)
FY-1	Polar-orbiting Meteorological Satellite (PRC)
FY-2	Future Geostationary Meteorological Satellite (PRC)
GCOM	Global Change Observation Mission (NASDA)
GCOS	Global Climate Observing System
GIMTACS	GOES I-M Telemetry and Command System
GMR	GOES-Meteosat Relay
GMS	Geostationary Meteorological Satellite (Japan)
GNSS	Global Navigation Satellite System
GOES	Geostationary Operational Environmental Satellite (USA)
GOMS	Geostationary Operational Meteorological Satellite (Russ. Fed.)
GOS	Global Observing System
GSLMP	Global Sea Level Monitoring Programme
GPCP	Global Precipitation Climatology Project

GPS	Global Positioning System
GRAS	GNSS Receiver Atmospheric Sounding
GTS	Global Telecommunications System
GVAR	GOES Variable (data format) (USA)
HDFS	High Density Fixed Service
HiRID	High Resolution image data
HIRS	High Resolution Infra-red Sounder
HR	High Resolution
HRDCP	High Rate DCP
HRPT	High Rate Picture Transmission
HSRS	High Spectral Resolution Sounder (MSG)
ICWG	International Coordination Working Group (EO)
IDCP	International DCP
IDCS	International Data Collection System
IDN	International Directory Network (CEOS)
IFRB	International Frequency Registration Board
IMT-2000	International Mobile Telecommunication 2000 (before FPLMTS)
INSAT	Indian geostationary satellite
IPOMS	International Polar-orbiting Meteorological Satellite Group
IR	Infrared
IRTS	Infrared Temperature Sounder (EPS)
ISCCP	International Satellite Cloud Climatology project
ISY	International Space Year
ITT	Invitation to Tender
ITU	International Telecommunications Union
ITWG	International TOVS Working Group
IWW	International Winds Workshop
JMA	Japanese Meteorological Agency
LR	Low Resolution
LRIT	Low Rate Information Transmission
LRPT	Low Rate Picture Transmission
LST	Local Solar Time
MAP	Mesoscale Alpine Experiment
MARF	Meteorological Archive and Retrieval Facility (EUMETSAT)
MBWG	MSG Biosphere Working Group
MCP	Meteorological Communications Package
MDD	Meteorological Data Distribution (Meteosat)
MDUS	Medium-scale Data Utilization Station (for GMS S-VISSR)
MetAids	Meteorological Aids Service (frequency regulation)
METOP	Future European meteorological polar-orbiting satellite
METEOR	Polar-orbiting meteorological satellite (CIS)

METEOSAT	Geostationary meteorological satellite (EUMETSAT)
MetSat	meteorological satellite systems (frequency regulation)
MHS	Microwave Humidity Sounder (EPS)
MIEC	Meteorological Information Extraction Centre (ESOC)
MOCC	Meteosat Operational Control Centre (ESOC)
MOP	Meteosat Operational Programme
MPEF	Meteorological Product Extraction Facility (EUMETSAT)
MSC	Meteorological Satellite Centre (Japan)
MSC-CAL	Computer Aided Learning system by MSC/JMA
MSG	Meteosat Second Generation
MSS	Mobile Satellite Services (frequency regulation)
MSU	Microwave Sounding Unit
MTP	METEOSAT Transition Programme
MTS	Microwave Temperature Sounder (EPS)
MTSAT	Multifunctional Transport Satellite (Japan)
MVIS	Multi-channel VIS and IR Radiometer (FY-1C and D of PRC)
NASA	National Aeronautics and Space Agency
NASDA	Japanese National Space Agency
NEDT	Noise Equivalent Delta Temperature
NESDIS	National Environmental Satellite Data and Information Service
NGDC	National Geophysical Data Centre (USA)
NGSO	Non-geostationary systems
NMC	National Meteorological Centre
NOAA	National Oceanographic and Atmospheric Administration
NOS	National Ocean Service (USA)
NSMC	National Satellite Meteorological Center of CMA (PRC)
NTIA	National Telecommunications and Information Agency (USA)
NWP	Numerical Weather Prediction
NWS	National weather service (USA)
OCAP	Operational Consortium of ASDAR Participants
OPAG-IOS	Open Programme Area Group in Integrated Observing Systems (successor of CBS WG on Satellites)
OWSE-AF	Operational WWW Systems Evaluation for Africa
PC	Personal Computer
POEM	Polar-orbiting Earth Observation Mission (ESA)
POES	Polar-orbiting Operational Environmental Satellite (USA)
PRC	Peoples Republic of China
PTT	Post Telegraph and Telecommunications authority
RA	Regional Association of WMO
RAMSDIS	menu-driven system for analysing digital satellite imagery (McIDAS, USA)

RDCP	Regional DCP (Japan)
RMS	Root Mean Square
RMTC	Regional Meteorological Training Centre (WMO)
RSMC	Regional Specialised Meteorological Centre
S&R	Search and Rescue mission
SAM	Satellite Anomaly Manager
SAF	Satellite Applications Facility (EUMETSAT)
SAFISY	Space Agency Forum on the ISY
SARSAT	Search And Rescue, Satellite supported facility
SATOB	WMO code for Satellite Observation
SBUV	Solar Backscattered Ultra-Violet (ozone)
SEAS	Shipboard Environmental (data) Acquisition System
SEM	Space Environment Monitor
SEVIRI	Spinning Enhanced Visible and Infra-Red Imager (MSG)
S-FAX	S-band facsimile broadcast of FY-2 (PRC)
SFCG	Space Frequency Coordination Group
SMA	State Meteorological Administration (PRC)
SRS	Space Research Service (frequency regulation)
SSP	Sub Satellite Point
SST	Sea Surface Temperature
SSU	Stratospheric Sounding Unit
S-VISSR	Stretched VISSR
TD	Technical Document
TIROS	Television Infrared Observation Satellite
TOMS	Total Ozone Mapping Spectrometer
TOVS	TIROS Operational Vertical Sounder
TTC	Telemetry Tracking Control
U-MARF	United Meteorological Archive Retrieved Facility (EUMETSAT)
UHF	Ultra High Frequency
UK	United Kingdom
UMTS	Universal Mobile Telecom System
UN	United Nations
UNISPACE	3rd United Nations Space Conference
UN-OOSA	UN Office of Outer Space
USA	United States of America
UTC	Universal Time Coordinated
VAS	VISSR Atmospheric Sounder
VHF	Very High Frequency
VIRSR	Visible and Infra-Red Scanning Radiometer (EPS)
VIS	Visible channel
VISSR	Visible and Infra-red Spin Scan Radiometer
VL	Virtual Laboratory (USA training concept)
VLSI	Very Large Scale Integrated circuit

WARC	World Administrative Radio Conference
WCRP	World Climate Research Programme
WEFAX	Weather facsimile
WG	Working Group
WGNE	Working Group on Numerical Experimentation
WMO	World Meteorological Organization
WP	Working Paper
WRC	World Radio Conference
WV	Water Vapour
WWW	World Weather Watch
X-ADC	Extended Atlantic Data Coverage
Y2K	Year 2000 compatibility