CGMS XXV

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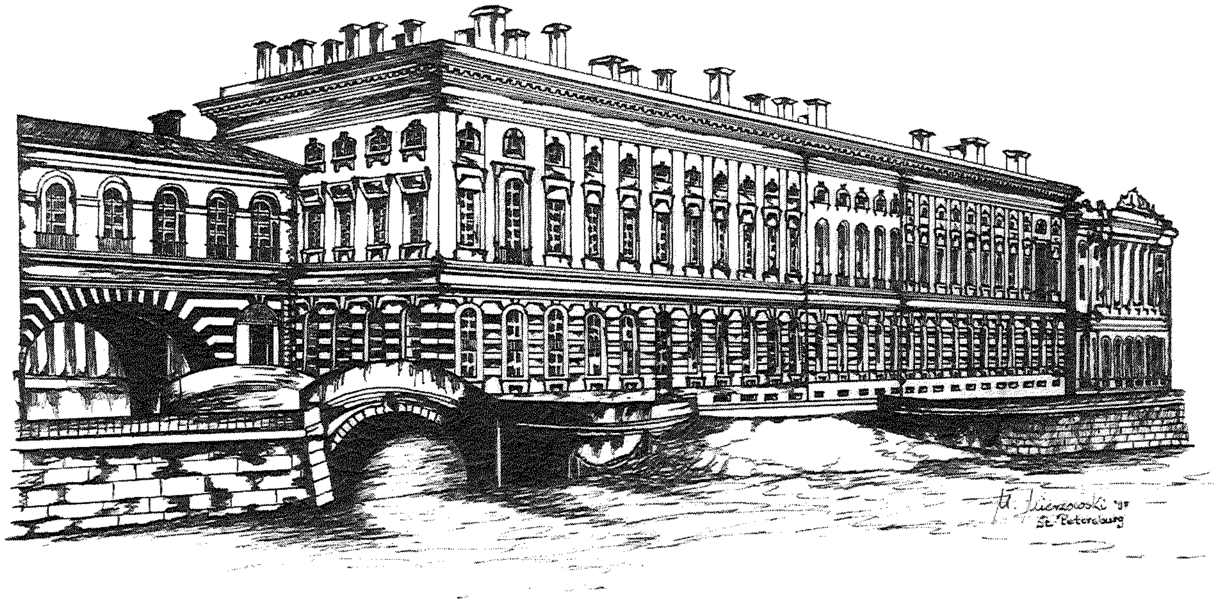

REPORT OF THE TWENTY-FIFTH MEETING OF THE COORDINATION GROUP FOR METEOROLOGICAL SATELLITES

St. Petersburg, Russia, 2-6 June 1997

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Report edited on behalf of CGMS by:
CGMS Secretariat
EUMETSAT
Postfach 10 05 55
64205 Darmstadt
Germany

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

A. PRELIMINARIES

A.1 Introduction

CGMS-XXV was convened by Roshydromet at 10:00 a.m. on 2 June 1997 in the State Educational Center (SEC) in St. Petersburg, Russia. Professor Avdiushin, Deputy Head of Roshydromet, welcomed the delegations from EUMETSAT, Japan, the People's Republic of China (PRC), the United States and WMO. On behalf of the Head of Roshydromet he expressed his pleasure to be able to host this twenty-fifth session of the Coordination Group for Meteorological Satellites.

With regards to the participants he noted with satisfaction that CGMS was able to mobilise considerable expertise in diversified areas, which should ensure a rapid progress of the work. He stressed that the current economic situation reinforced the importance of meteorology and of a careful management of meteorological tools, in particular of the space-based infrastructures.

In conclusion he recalled that Roshydromet was pleased to host the twenty-fifth session of CGMS, wished the participants every success and thanked them in advance for their time and effort.

A.2 Election of Chairman

Professor Avdiushin was unanimously nominated as Chairman of CGMS XXV and Dr. Hinsman as Vice-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 Groups I and II, dealing with telecommunications and satellite products respectively, would work in parallel on Wednesday morning, while Working Group III dealing with wind vectors would meet on Tuesday afternoon.

The Secretariat provided the list of working papers submitted to CGMS XXV, as well as a provisional order of business that was used as a basis for the subsequent discussions.

A.4 Arrangements for the Drafting Committee

The Drafting Committee was appointed, comprising Mr. Gordon Bridge, Dr. Donald Hinsman, Dr. Nobuo Sato, Dr. Alexander Uspensky, Mr. Jonas Wechsler 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 reminded the participants of the outstanding actions from previous meetings, taking into account the input provided in EUM-WP-01, JAPAN-WP-01, USA-WP-01 and WMO-WP-02. All these actions were then reviewed as follows:

(i) Permanent actions

1. *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 was published in the Final Report of CGMS-XXIV. A further update is submitted to CGMS-XXV for review. On-line distribution is being considered.

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

   This is routinely done.

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.*

   Reports are regularly provided by EUMETSAT. Information on unexplained anomalies are presented in JAPAN-WP-05.

4. *USA to issue quarterly to all other admitting authorities the consolidated DCP assignments.*

   This is routinely done.

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

   This is routinely done.

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

   This is routinely done.

7. *CGMS Members generating CMW to check that the following monthly statistics are sent and received on a quarterly basis: number of co-locations, temporal and spatial co-location thresholds, and radiosonde inclusion/exclusion criteria.*

   CGMS stressed the importance of this action.

(ii) Outstanding actions from previous meetings

ACTION 21.17 — *All CGMS Members are requested to indicate planned introduction dates of LRIT by CGMS XXV.*

Closed. Japan will implement LRIT in time sharing with WEFAX on MTSAT, planned to be launched in August/September 1999. EUMETSAT will implement LRIT on MSG, planned for late 2000. NOAA anticipates that future GOES N, O, P, Q spacecraft will be capable of broadcasting in LRIT format. Russia will implement LRIT on Elektro-3 in 2002.

ACTION 23-04 — *CGMS Members to review and comment on the GCOS Space Plan version 1.0, with respect to achievability and proposed priority of implementation into their own plans, by CGMS XXV.*

Closed. Comments were expressed by Japan and EUMETSAT at CGMS XXIV and by NOAA directly to GCOS.

ACTION 23-13 — *The USA to provide CGMS Members with information on the number of APT reception stations worldwide, by 1 August 1996.*

Closed. The USA indicated that 900 APT stations had been registered as of 13 January 1997. It was also suggested that a further number of stations might be operated but not registered.

ACTION 23-15 — *WMO to address any resulting problems relating to the onward relay of DCP messages via the GTS and report to CGMS XXV.*

Closed. This action related to Action 23.14 establishing a period of end-to-end monitoring of DCP, as reported in EUM-WP-06. A new action was identified under Item F.1.

ACTION 23-29 — *CGMS winds operators to explore the establishment of standard guidelines for quality marking and report on their progress at CGMS XXV.*

Closed. This issue was addressed at the 3rd International Winds Workshop, as reported in EUM-WP-24 and USA-WP-19. The outcome of this monitoring experiment is addressed in EUM-WP-06 to be discussed under Item F.1.

(iii) Actions from CGMS-XXIV

ACTION 24.01 — *CGMS Secretariat to develop a document summarising the instruments on CGMS Members' missions and to submit the sketch of such a document for review by CGMS XXV.*

Closed. CGMS Secretariat was advised that such a document would duplicate available CEOS documentation. Instead, a new format is proposed in EUM-WP-32 for the tables of current and planned satellites.

ACTION 24.02 *WMO to provide CGMS Members with a preliminary report on the critical review from the CBS Working Group on Satellites by 1 November 1996.*

Closed. WMO has mailed this report to CGMS Members' representatives in CBS Working Group SAT.

ACTION 24.03 *CGMS Members to comment on the preliminary report on the critical review from the CBS Working Group on Satellites prior to CGMS XXV.*

Closed. Comments from CGMS Members were incorporated in a revised version.

ACTION 24.04 *EUMETSAT to report at CGMS XXV about its experience on detection and localisation of interference sources in the 401-403 MHz band.*

Closed. EUM-WP-07 explains why this activity has been postponed.

ACTION 24.05 *USA to provide EUMETSAT with information on the certification procedure for DCP using the GOES DCS, by 1 August 1996.*

Closed. The USA provided the latest version pointing out however that this dated from 1981.

ACTION 24.06 *The Russian Federation to provide CGMS Members with details of IDCP channel frequencies on GOMS, by 1 September 1996.*

Closed. Such details are provided in RUS-WP-07 and RUS-WP-08.

ACTION 24.07 *EUMETSAT to provide CGMS Members with the results of recent studies on the performance of lossless and lossy compression techniques, by 1 August 1996.*

Closed. These results were mailed to CGMS Members on 19 July 1996.

ACTION 24.08 *CGMS Members to indicate by 1 October 1996 to WMO whether the interim requirement for the exchange of digital image data as expressed, once approved by CBS, would be sufficient for formal consideration and response.*

Closed. WMO-WP-09 describes the status of these requirements, as a basis for discussion under Items G.1/G.3.

ACTION 24.09 *CGMS Members to inform the Secretariat about ground stations operating in the frequency band 1670 - 1690 MHz, by 1 September 1996.*

Closed. Information was received from Japan, EUMETSAT, USA and PRC as reported in EUM-WP-17 (Item I.3) and PRC-WP-04 (Item H.6). Russia will inform the Secretariat, in the coming months. WMO-WP-01, addressed under Item H.5, describes a database of ground receiving equipment, which is made available to all members.

ACTION 24.10 *The Russian Federation to report at CGMS XXV on its efforts to remove interference affecting the 401-403 MHz frequency band used for DCP.*

Closed. The issue is addressed in RUS-WP-08 under Item I.2.

ACTION 24.11 *NOAA to provide to all CGMS Members its design specifications and certification procedures for 300 bps DCP, by 1 September 1996.*

Open. Contract delays prevent provision. A new deadline was proposed after discussion in Working Group I.

ACTION 24.12 *CGMS Members to review and provide comments to NOAA regarding NOAA's 300 bps DCP design and certification procedures, by 1 February 1997.*

Open. Pending completion of Action 24.11. A new deadline was proposed after discussion in Working Group I.

ACTION 24.13 *NOAA to present at CGMS XXV, a proposed design and certification plan for 300 bps DCPs for acceptance as a "standard" by CGMS Members at CGMS XXV.*

Open. Contract delays prevent completion. A new deadline was proposed after discussion in Working Group I.

ACTION 24.14 *CGMS Members to recommend to DCP manufacturers the inclusion of GPS or other GNSS clock modules in future design of DCP, by CGMS XXV.*

Closed. This is routinely done by EUMETSAT and NOAA as permanent action (e.g. EUMETSAT has included such recommendation in its documentation).

ACTION 24.15 *CGMS Members to encourage the use of GPS and other GNSS clock controlled DCP for future DCS applications, by CGMS XXV.*

Closed. The same applies as in Action 24.14.

ACTION 24.16 *WMO to prepare a timetable of planned satellite launches indicating the proposed implementation of LRPT and its expected overlap with APT systems, by 1 August 1996.*

Closed. This draft timetable was sent by WMO by e-mail on 13 January 1997.

ACTION 24.17 *CGMS Members to review by 1 September 1996, prior to distribution to WMO Members, the draft timetable prepared by the WMO indicating the proposed implementation of LRPT.*

Closed. The outcome of this review is given in WMO-WP-03, addressed under G.1. LRPT is foreseen on Metop-1 (EUMETSAT) from 2002 onwards. It is also considered for Meteor 3M-N2 (Russia) starting from 2000. NOAA plans to continue broadcasting APT throughout the operational lifetimes of the NOAA-K, -L, -M, -N, and -N' missions. Following the launch of NOAA-N', NOAA will replace APT with the LRPT broadcasts on NPOESS-1, tentatively in 2009.

ACTION 24.18 *NOAA to provide CGMS with the results of the analysis of the questionnaire and details of a global LRPT specification, by 1 September 1996.*

Closed. 1: The analysis of the 1996 LRPT survey was circulated to CGMS Members on 16 August 1996.
2: Details of LRPT specification: in EUM-WP-09, EUMETSAT is proposing a standard for the compression scheme and the physical layer parameters for LRPT. NOAA and EUMETSAT will provide CGMS Members in 1998 with details of the ground systems necessary to process LRPT broadcasts.

ACTION 24.19 *EUMETSAT and Japan to provide CGMS with details of their LRIT formats as appropriate during 1996 and 1997.*

Closed. A report is provided by EUMETSAT in EUM-WP-08, and by Japan in JAPAN-WP-10, to be addressed under Agenda Item G.1.

ACTION 24.20 *CGMS Members to announce their individual implementation of homepages, submit new information for the CGMS homepage and provide Universal Resources Locator (URL) to allow links between the various Homepages, by 1 July 1996.*

Closed. Japan indicated preparation for links between homepages. EUMETSAT is reporting on this issue in EUM-WP-18. NOAA is making its whole homepage available twice a week. This issue is also addressed by WMO-WP-15 (Item I.4).

ACTION 24.21 *WMO to consider inclusion of the "Handbook of Frequencies used for Meteorological Applications" in the CGMS homepage and report at CGMS XXV.*

Closed. WMO will include in its homepages a reference to this Handbook, which will become an ITU Document.

ACTION 24.22 *CGMS Secretariat to continue to forward calibration related papers to CEOS Cal/Val Working Group and seek report on recent CEOS activities, by CGMS XXV.*

Closed. This is due on a regular basis. A presentation was given at CEOS Cal/Val. A report is provided in EUM-WP-29.

ACTION 24.23 *CGMS points of contact on calibration, Dr. Menzel, Dr. Schmetz and Dr. Harada, to prepare a draft strategy for inter-calibration and report to CGMS XXV.*

Closed. EUM-WP-19 and USA-WP-15 refer to this issue (Item II.3).

ACTION 24.24 *CGMS Members to report at CGMS XXV on their plans to implement data processing packages supporting future instrumentation on the model of the ATOVS software package.*

Closed. As concerns ATOVS, an update is given in EUM-WP-21 and USA- WP-18 (Item II.4). Further plans will be discussed in Working Group II.

ACTION 24.25 *CGMS Members to forward comments to WMO, by 31 July 1996, on the proposed modification of WMO codes regarding identification of satellites and processing centres.*

Closed. These comments were received and taken into account.

ACTION 24.26 *CGMS Secretariat to submit to the CBS Working Group on Data Management for comment, the digital imagery Data Uniform Format (DUF) for image archiving and distribution developed by RPA "Planeta" as described in CGMS XXIV RUS-WP-09 by 1 June 1996.*

Closed. Document was submitted on 13 May 1996. WMO informed that written comments had been prepared and will be forwarded soon to Russia.

ACTION 24.27 *CGMS Members to provide Dr. Xu Jianmin, PRC, with current information on their archiving systems by 30 June 1996.*

Closed. Dr. Xu acknowledged receipt, with thanks, of the information received from all members. The consolidated information will be published in a WMO Satellite Activities Technical Document.

ACTION 24.28 *WMO, through the Chairman of CBS Working Group on Satellites, to contact by 1 June 1996 the Chairpersons of CBS Working Groups on Telecommunications and on Data Management concerning the distribution of satellite data and products, to review the progress of these Working Groups on evolving an appropriate strategy and to inform CGMS XXV.*

Closed. Through an exchange of letters between the Chairmen of the CBS Working Group on Satellites, on Telecommunications and on Data Management it was agreed that the requirement for Digital Satellite Image Data and Extracted Product Exchange over the GTS presented in the draft Interim WMO Requirement Document should be considered as valid noting that final approval can only be granted at next session of CBS. (See Action 24.08 and WMO-WP-09). CGMS noted that the issue would be reviewed by Working Group I.

ACTION 24.29 *The CGMS Working Group on Telecommunications to prepare a satellite-based strategy for distribution of satellite products, with input from ITWG and WMO CBS Working Group SAT, for presentation at CGMS XXV.*

Closed. CGMS noted that the issue would be reviewed by the Working Group on Telecommunications.

ACTION 24.30 *CGMS wind operators to exchange details of the algorithms used for the derivation of wind speed from pixel displacement, by 1 June 1996.*

Closed. As reported in EUM-WP-31 (Item III.2).

ACTION 24.31 *CGMS wind operators to provide details of the algorithms used for the vertical treatment of radiosondes at the next meeting of the International Workshop on Winds in June 1996.*

Closed. As reported in EUM-WP-31 (Item III.2).

ACTION 24.32 *CGMS Members, through their relevant points of contacts, to submit to EUMETSAT their input to the CGMS Directory of Meteorological Satellite Applications by 1 November 1996.*

Closed. EUMETSAT thanked the members for their input, which has been incorporated.

ACTION 24.33 *EUMETSAT to proceed with the preparation of a first edition of the CGMS Directory of Meteorological Satellite Applications and report to CGMS XXV.*

Closed. A report is provided in EUM-WP-13, for discussion under Item H.5.

B. REPORT ON THE STATUS OF CURRENT SATELLITE SYSTEM

B.1 Polar Orbiting Meteorological Satellite Systems

Russia informed CGMS in RUS-WP-01 on the status of the Meteor polar orbiting satellite system, which includes Meteor-2-N20 launched in 1990, Meteor-2-N21 launched in 1993 and Meteor-3-N5 launched in 1991. These space systems provide the global observation of the earth surface in visible spectrum. On Meteor-2-N21 and Meteor-3-N5, the TV imagery data for global observation (MR-2000) is recorded and transmitted to the main receiving centres in Moscow, Novosibirsk and Khabarovsk (466.5 MHz). The TV data from MR-900 scanning instruments is directly transmitted to APPI's (137 MHz).

As described in USA-WP-02, the current polar spacecraft configuration includes two primary, one secondary and two stand-by spacecraft in circular orbits inclined at approximately 98° (retrograde). The primary operational spacecraft, NOAA-12 and NOAA-14, are in sun-synchronous morning and afternoon orbits, respectively. The secondary spacecraft, NOAA-9, provides Search and Rescue (S&R) and back-up science data, while the stand-by spacecraft, NOAA-10 and NOAA-11, support minimal S&R functions and are only contacted once a week.

The NOAA-12 and NOAA-14 instrument payload includes:

- the Advanced Very High Resolution Radiometer (AVHRR), a radiation detection instrument used to remotely determine cloud cover and surface temperatures,
- the High Resolution Infrared Radiation Sounder (HIRS), which detects and measures energy emitted by the atmosphere to construct a vertical temperature profile from the Earth to an altitude of about 40 km,
- the Microwave Sounding Unit (MSU), which detects and measures microwave energy from the troposphere to construct a vertical temperature profile to an altitude of about 10 km,
- the Space Environment Monitor (SEM), a multichannel charged particle spectrometer that measures the energy deposited by solar particles in the upper atmosphere,
- the Data Collection System (DCS), which collects data from more than 2000 remote platforms, including buoys, balloons river gauges and remote weather stations.

The NOAA-14 instrument payload includes in addition the following system:

- The Solar Backscatter Ultraviolet Spectral Radiometer (SBUV), which is used to measure solar irradiance (backscattered solar energy), total ozone concentrations and the vertical ozone profile in the atmosphere.
- The Stratospheric Sounding Unit (SSU), used to complement the HIRS and MSU sounding data, measures temperature in the upper atmosphere.

NOAA-K is slated for launch on February 18, 1998 and will be used as an operational replacement for NOAA-12. As such, it will be placed in an orbit with a 7:30 am descending node (morning orbit) and will have a similar set of instruments as NOAA-12. The primary payload difference is that three Advanced Microwave Sounding Units (AMSU-A1, AMSU-A2 and AMSU-B) will replace the MSU and SSU instruments to provide comprehensive microwave radiometric coverage for atmospheric soundings.

B.2 Geostationary Meteorological Satellite Systems

EUM-WP-02 reported on the status of Meteosat satellites and missions. At the time of the meeting, Meteosat-5 launched in March 1991 was stored at 10° W in a stand-by, whilst Meteosat-6, launched in November 1993, was the operational satellite at 0°. The hydrazine reserves are estimated sufficient to allow the operation of these spacecraft until 1999 and 2001, respectively, if no major anomaly occurs. It is planned to launch Meteosat-7 in September 1997 and to use it as the operational satellite by the end of 1997. Meteosat-6 would then become the back-up satellite and Meteosat-5 would be available for other projects such as the Indian Ocean Experiment (INDOEX). The CGMS was informed of the enhancements brought to the product extraction chain.

Japan reported on the status of GMS-5 and -4 in JAPAN-WP-02 and WP-03. GMS-5 is stationed at 140° E above the equator and nominally performs three major missions, i.e. VISSR (Visible and Infrared Spin- Scan Radiometer) observations producing 28 full-disk images per day, dissemination of cloud images and collection of meteorological data. The orbital inclination angle is 0.5 degrees as of January 1997. The amount of remaining fuel is 30.32 kg as of 3 February 1997.

GMS-4 has been stationed at 120° E since 21 July 1995 as the back-up satellite of the GMS-5, which has been operational since 13 June 1995. The VISSR and DCP repeaters are turned off, but the telemetry and S-band high power transmitters are activated. The satellite is functioning, however with a reduced power during summer solstice seasons due to secular deterioration of the solar panels.

The East-West manoeuvres have approximately been performed every 45 days; however, North-South manoeuvres were not performed in order to save the hydrazine reserve, now estimated to be about 9.7 kg. The orbit inclination of GMS-4 is 2.29 degrees as of 12 February 1997. JAPAN-WP-04 provided details on the anomalies observed on GMS-4 and GMS-5. In addition, updated calibration tables for GMS-5 were provided to the users, as reported in JAPAN-WP-05.

Russia informed CGMS in RUS-WP-02 on the status of the GOMS-Elektro satellite. The attitude control system currently allows 95% availability of the spacecraft, which corresponds to a maximum of 17 IR images per day. No visible images can be acquired, due to a malfunction which will be corrected on GOMS-Elektro 2. Images are down-linked at 7.5 GHz, then disseminated on 8.2 and 1.7 GHz. Because of the interference on 401-403 MHz frequency, the DCP mission can only be completed through systematic repetition of DCP messages. This will be facilitated by increasing the data rate to 1.2 kbit/s.

WMO expressed its deep appreciation for the efforts of Russia to disseminate IR images over the Indian Ocean. PRC also confirmed its great interest in this dissemination, adding that it wished to receive these images in high resolution. EUMETSAT also encouraged Russia to make this data regularly available.

Russia underlined that no high resolution imagery retransmission was foreseen via GOMS. Nevertheless, it is possible to acquire raw data from GOMS, down-linked in 7.5 GHz band within a limited area.

Action 25.01 **Russia to provide CGMS Secretariat by 1 July 1997, with description of the raw image data transmission from GOMS.**

USA-WP-02 reported that the current Geostationary Operational Environmental Satellites (GOES) are three-axis stabilised spacecraft at geosynchronous altitudes. The current primary satellites, GOES-8 and GOES-9, are stationed over the East Coast (75°W) and West Coast (135°W) of the United States and are used to provide simultaneous images and soundings of the Western hemisphere. GOES-7, a spin-stabilised spacecraft from the previous series, is in a stand-by mode at about 90° West longitude. GOES-2 and GOES-3 launched in June of 1977 and 1978, respectively, support non-NOAA users in a data relay mode (non-imaging).

The primary instrument payload for the current series of GOES spacecraft consists of:

- the imager, which is a multichannel instrument designed to sense radiant and solar reflected energy,
- the sounder, which provides data for atmospheric temperature and moisture profiles, surface and cloud top temperature and ozone distributions.

The imager and sounder both have the capability to sense stars during non-imaging times for use in Image Navigation and Registration (INR). In addition, the spacecraft can apply compensation signals to the instrument servomotors to compensate for repeatable long-term orbit and attitude effects. The GOES spacecraft also have Space Environmental Monitor (SEM) systems to measure magnetic fields, solar-X-ray flux and high-energy electrons, protons and alpha particles. Both GOES-8 and GOES-9 SEM subsystems are operating nominally.

GOES-10 was launched on April 25, 1997, to a longitude of about 105° W and is currently undergoing checkout. An anomaly on the solar panel drive is under investigation. GOES-10 will remain in a spin-stabilised passive attitude and will be used as an on-orbit spare in the event of a GOES-8 or GOES-9 failure.

B.3 Anomalies from solar and other events

No report was provided on this matter at CGMS XXV.

C. REPORT ON FUTURE SATELLITE SYSTEMS

C.1 Future Polar Orbiting Meteorological Satellite Systems

EUMETSAT reported in EUM-WP-03 on the development status of the EUMETSAT Polar System (EPS), the European contribution to the Initial Joint Polar System (IJPS) with the USA. The EPS will provide coverage from the morning polar orbits, while the NOAA POES Programme will continue to cover the afternoon orbits. The EPS will be based on the Metop satellites currently under development by the European Space Agency (ESA) and will fly the following payload:

- Advanced Very High Resolution Radiometer (AVHRR)
- Advanced Microwave Sounding Unit-A (AMSU-A)
- Microwave Humidity Sounder (MHS)
- High-resolution Infrared Sounder (HIRS, for Metop-1 and -2)
- Infrared Atmospheric Interferometric Sounder (IASI)
- GNSS Receiver Atmospheric Sounder (GRAS)
- Scatterometer (ASCAT)
- Global Ozone Monitoring Experiment (GOME-2 for Metop-1 and -2)
- Data Collection System Argos
- Space Environment Monitor (SEM)
- Search & Rescue (S&R)

The CGMS was informed that EPS activities were progressing in 1997 within the framework of a "Bridging Phase" which is expected to continue until the approval of the full EPS Programme. The launch of Metop-1 is foreseen by the end of 2002 or early 2003, Metop-2 in 2007 and Metop-3 in 2011.

WMO appreciated the efforts of EUMETSAT and NOAA to set up an Initial Joint Polar System and encouraged EUMETSAT to pursue the approval process of the EPS Programme.

CGMS was informed by PRC-WP-01 that FY-1C polar orbiting satellite will be launched in the second half of 1998. Developments are now being done on the ground receiving and processing systems in order to enhance the overall processing capacities, to handle the 10-channel radiometer data and to process the limited global CHRPT data.

In RUS-WP-03 Russia reported on the development of the Meteor-3M-N1 and Meteor-3M-N2 satellites planned for launch in 1998 and 2000 respectively, on a sun-synchronous orbit at 9:15 Equatorial Crossing Time. The microwave sounding instruments foreseen for Meteor-3M-N1 are MTZA and MIVZA, while Meteor-3M-N2 will fly MTZA and MVZA. In the frame of the agreement between RSA and NASA it is planned to install the SAGE III and TOMS instruments on Meteor-3M-N1 and Meteor-3M-N2, respectively. It was confirmed that Meteor-3M-N2 will include HRPT dissemination capability.

USA reported that, in partnership with NASA, it is procuring the NOAA-K, -L, -M, -N, -N' follow-on spacecraft of the Advanced TIROS-N (ATN) series to be launched in 1998, 1999, 2001, 2003, and 2007, respectively. The operational requirements for these future satellites are essentially identical to those of NOAA-12 and -14, except that the Microwave Sounding Unit (SSU) will be replaced by the Advance Microwave Sounding Unit (AMSU). The operational system will continue in a two-satellite configuration with orbital altitudes and associated crossing times at 830 km (7:30 a.m.) and 870 km (1:30 p.m.).

The U.S. Presidential Decision of May 5, 1994 directed the U.S. Departments of Commerce and Defense to converge their separate polar-orbiting environmental satellite programs into a single program to serve both civil and military needs. This led to the establishment of the Integrated Program Office of the National Polar-orbiting Operational Environmental Satellite System (NPOESS). The first NPOESS satellite is projected to be available for launch sometime toward the middle to latter half of the next decade. "Early Convergence" of the DMSP and POES will occur in 1998 by consolidating DMSP and POES operations at the NOAA Satellite Operations Center in Suitland, Maryland. The NPOESS program will also continue international cooperation with EUMETSAT. The operational concept for this joint U.S.-European cooperative system is detailed in USA-WP-03 and USA-WP-04. CGMS was also informed that NPOESS requirements are now available and that further studies are needed to refine the mission specifications. It was confirmed that all NPOESS data will be disseminated without restrictions.

C.2 Future Geostationary Meteorological Satellite Systems

The status of development of Meteosat Second Generation (MSG) was described in EUM-WP-04. It was recalled that MSG will be a spin-stabilised satellite carrying as a main instrument the 12-channel scanning visible and infrared imager "SEVIRI". The main mission of MSG will be to acquire and disseminate multispectral imagery, airmass analysis and high-resolution imagery every 15 minutes. Additional missions of MSG include data collection, Search & Rescue relay and a global earth radiation experiment. The satellite development has passed the Preliminary Design Review and will continue towards a launch of MSG-1 by the end of 2000, MSG-2 in 2002 and MSG-3 around 2007. It was explained that a capacity of 40 International DCP Channels is foreseen on MSG, in anticipation of a possible expansion of the DCS by CGMS.

Noting that EUMETSAT is funding LRUS and HRUS stations prototypes and is planning to make the design publicly available, WMO expressed its gratitude for this initiative, which should contribute to lowering the cost of the user stations.

The architecture of the MSG ground segment is now defined and procurement activities have been initialised. The ground segment will include central facilities located in EUMETSAT Headquarters, ground stations in sites still to be determined and decentralised Satellite Application Facilities (SAF) hosted by National Meteorological Services of EUMETSAT Member States. As explained in EUM-WP-05, the extraction of core meteorological products such as wind vectors will be performed by the central Meteorological Product Extraction Facility (MPEF), whilst the SAF will concentrate on additional products for specific applications. EUMETSAT has already started the development of 2 pilot SAF, addressing the "Support for Nowcasting and Very Short Range Forecasting", and the "Ocean and Sea Ice Monitoring" respectively, to be followed soon by another SAF on "Ozone Monitoring". A full network of 6 SAF is expected to be completed by 2003 in order to take full advantage of both the MSG and the EPS systems, as well as of the satellite data of other parties.

Japan presented in JAPAN-WP-06 the future geostationary Multi-functional Transport Satellite (MTSAT) planned to be launched in August or September 1999 in cooperation with the Japan Civil Aviation Bureau, Ministry of Transport. MTSAT has two missions: the meteorological mission, which succeeds the GMS-5, and the aeronautical mission.

The 1.6 ton MTSAT will perform hourly full disk earth observations as currently performed by GMS-5 and will disseminate them in a format compatible with current S-VISSR format. However, the scanning area will have to be restricted around local midnight during equinox periods, in order to avoid excess mirror heating.

CGMS was informed by PRC in PRC-WP-03 that the FY-2 geostationary satellite has been shipped to the launch centre for a launch in June 1997. End-to-end system tests have been performed repeatedly on the ground segment. (By the time this report had been printed, FY-2 had been successfully launched on 10 June 1997).

Russia reported in RUS-WP-04 on the manufacturing of GOMS-Elektro 2. This satellite is similar to GOMS-Elektro 1 with the addition of a COSPAS/SARSAT system. Final tests will be performed in 1998, for a launch in 1999, in view of an operation period of at least 3 years at a location of 76°E.

USA-WP-05 reported on GOES-L, -M, -N, -O, -P, and -Q. GOES-M is to be completed before GOES-L because it is the only spacecraft of this series being manufactured with special accommodation for a Solar X-ray Imager (SXI). Plans are to launch GOES-M in the 2000 time frame to gather as much data as possible during the solar maximum, expected to peak near 2000. GOES-L is scheduled for launch near 2002. It will have the same instrumentation as GOES-10. One important change is in the imager channels. One channel at 12.0 μm will be replaced with one at 13.3 μm for a better accuracy on cloud top height determination.

The four-spacecraft series, GOES N-Q, will be developed as a follow-on to GOES I-M. Plans are to carry on with the present five channel imagers and filter wheel sounders, at least on GOES-N and GOES-O. Horizontal resolution of these imagers will be improved.

In a presentation following the discussion on geostationary plans, Prof. Trifonov described a proposed concept including two or more high inclination geosynchronous satellites optimised for the coverage of middle latitudes. It was suggested that such a system be undertaken as an international cooperative endeavour.

D. OPERATIONAL CONTINUITY AND RELIABILITY

WMO expressed its appreciation to the satellite operators with respect to the status and plans of CGMS Members, including prospects of several satellites to be launched in a very near future. At the same time it invited them to give further consideration to the issue of contingency plans.

WMO recalled that the recommendation to develop contingency plans had been endorsed by the WMO Congress in 1991 and that CGMS had subsequently developed a contingency strategy based on the "help-your-neighbour" concept. This strategy assumes that each satellite operator tries with its best efforts to maintain its nominal configuration, in accordance with its own constraints. WMO underlined the importance for the user community of any indication that CGMS may express on possible additional global or regional contingency arrangements.

EUMETSAT recalled that a bilateral agreement between NOAA and EUMETSAT was ensuring a back-up over three fifths of the globe and it was noted that if similar arrangements were devèloped between Japan, Russia and China, this would provide an additional safety for the benefit of the user community. As an intermediate step towards possible overall back-up agreements, NOAA suggested that partial back-up arrangements could be worked out, addressing e.g. the dissemination of DCP missions. Japan expressed the need to know the detailed characteristics of relevant spacecraft and ground segments in order to investigate the level of compatibility amongst them.

CGMS satellite operators felt it was appropriate to initiate internal consultations on this matter and to explore the possibility of regional arrangements in line with the CGMS Contingency Strategy. The following actions were agreed:

Action 25.02 **EUMETSAT to circulate by 1 July 1997 to Russia, PRC and Japan a copy of the EUMETSAT-NOAA bilateral agreement on contingency back-up, to be used as a reference for future contingency arrangements.**

Action 25.03 **All operators to report at CGMS XXVI about the outcome of consultations on the possibility to develop regional contingency arrangements.**

E. METEOROLOGICAL SATELLITES AS PART OF WMO PROGRAMMES

E.1 World Weather Watch

In WMO-WP-05, CGMS was informed of the latest status of WMO observational requirements. It recalled that at CGMS-XXIV WMO reported on a relational database that contained a description of observational requirements and of the expected performances of present and future satellite systems. Since CGMS-XXIV, four meetings had occurred that furthered the development of the relational database and its relevance to the Rolling Review of Requirements approved by the Commission for Basic System at its eleventh session. The Expert Meeting of the WGSAT Subgroup on Data, Product and Service Requirements held in Paris, 27-30 May 1997 reviewed the present observational requirements and the estimated instrument performances, developed a "Critical Review" and an outline of a Statement of Guidance on Feasibility of Meeting Requirements. CGMS was pleased to note the progress to date and invited WMO to present the Statement of Guidance on the Feasibility of Meeting Requirements at its twenty-sixth session with the aim of reviewing pertinent recommendations in order that CGMS can respond.

CGMS also noted the ongoing activities within the CEOS Analysis Group and Strategic Implementation Team and encouraged WMO to consider how the analyses being performed by the CEOS Analysis Group and by WMO could converge.

Action 25.04 **WMO to present the Statement of Guidance on Feasibility of Meeting Requirements to CGMS-XXVI.**

In WMO WP-17, CGMS was informed that a Task Force meeting of the CBS WGSAT Sub-group to Improve Satellite System Utilisation (ISSU) was held in Rome, Italy from 21 to 23

April 1997. It recalled that actions had been defined by the WGSAT, and endorsed by CBS, in order to improve satellite system utilisation. The Task Force reviewed the status of these actions and developed a new Strategy to Improve Satellite System Utilisation.

The two primary thrusts of the new strategy were to improve data access in both the near and long-term and to increase application of satellite data through better awareness of the potentials. To maintain a focus on rectifying deficiencies, the strategy will use specific projects and involve a review and monitoring activity. CGMS strongly endorsed the new strategy and noted that it was well established. Furthermore, CGMS supported the proposal to initially implement projects focused on increasing the availability of satellite data that would include feedback mechanisms from the onset of the project to its completion. This approach was considered most promising to enhance the users' capabilities.

E.2 Other Programs

In USA-WP-20 the USA introduced the North-American Atmospheric Observing System (NAOS) program, which includes a review and optimisation of ground and space-based observation means. Information was provided on the objectives of the NAOS programme, its scientific basis, organisation, methodology and the status of its early work. Details were provided of a NOAA Whitepaper on Observing Systems, an observing strategy focused upon the next 3-5 years and the long-term outlook for opportunities for enhancing to observing systems.

The first hypothesis to be tested within the NAOS programme will be the impact of reducing the radiosondes over North America when replaced by aircraft ascent/descent data and a new airborne water vapour sensing system. A second hypothesis to be tested is the assimilation, by numerical models, of GOES sounder data on precipitable water, water vapour drift winds and direct radiances, in order to improve the 0-to-4 day forecasts over North America. A broad array of information about the NAOS programme is available on its internet homepage at "http://ISL715.noaa.gov/naos/".

CGMS wished to be informed as early as possible on the outcome of the testing of GOES sounder data assimilation. CGMS also recognised the importance of providing strong justification for observing system choices during a time of heavy budget pressure. It was pointed out that the direct assimilation of radiance data instead of vertical profiles will not be applicable to interferometric data. CGMS tasked the Working Group II on Satellite Products to consider this issue.

In WMO-WP-13, CGMS was informed of the latest status of the Global Climate Observing System (GCOS). GCOS was established in 1992 to provide the observations needed to meet the requirements for monitoring the climate, detecting climate change, and for predicting climate variations and change. It was initiated via a MOU among WMO, IOC of UNESCO, UNEP, and ICSU, which set up a Joint Scientific and Technical Committee (JSTC) and a Joint Planning Office (JPO) to develop the plans and strategy for implementation of the system. Most recently, the GCOS Space Panel had expanded its responsibilities to include GCOS, the Global Ocean Observing System (GOOS) and the Global Terrestrial Observing System (GTOS) and held its second session in Paris. CGMS welcomed the status report and wished to be kept informed on this important WMO sponsored activity.

F. COORDINATION OF INTERNATIONAL DATA COLLECTION & DISTRIBUTION

F.1 Status and Problems of IDCS

EUMETSAT reported in EUM-WP-06 on the status of the IDCS. CGMS noted that, during 1996, 410 International DCP, were registered worldwide for use with IDCS, using 9 of the 33 available channels. Channels I6, I7, I12, I13, I14, I15, I16, I18 and I20 were regularly in use. In addition, channels I29, I30, I31, I33 and I32 were used to accommodate WMO networks of agrometeorological and hydrometeorological DCP.

EUMETSAT also reported on the end-to-end monitoring period conducted in April-May 1996. It was noted that around 92% of the Ship weather bulletins messages were received and put into the GTS by the Bracknell, JMA and Washington monitoring centres used in the study. However, it was noted that of all such messages relayed via the IDCS, around 80% did not contain meteorological information.

EUMETSAT also proposed to keep a centralised allocation database on the EUMETSAT Internet FTP server and make regular reports available to CGMS Members and DCP operators.

JAPAN introduced JAPAN-WP-07, WP-08 and WP-09 including an information on analysis of missing DCP messages. JAPAN suggested to CGMS Members to take proper actions to improve operational efficiency of the IDCS.

CGMS expressed its concern over the fact that a large part of IDCS capacity was being so inefficiently used and urged the satellite operators, in coordination with WMO, to closely monitor the situation, making contact with the operators of the Ship DCP as necessary and if possible to provide them with regular Ship performance reports.

WMO informed CGMS that the next period of WMO monitoring of the GTS would take place from 1-15 October 1997, and suggested that it might be appropriate to take advantage of such a monitoring period by carrying out another IDCS end-to-end system test at the same time, thereby achieving a *full* end-to-end test of the system. WMO agreed to provide the results of the IDCS end-to-end test to the appropriate WMO bodies (e.g. CMM, CBS).

CGMS then agreed on the following actions:

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

Action 25.06 **JAPAN, with the assistance of the CGMS Secretariat, to identify a DCP observation data set and analysis scheme, suitable for an IDCS end-to-end system test.**

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.**

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 1997, and report results to CGMS XXVI.**

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).**

EUMETSAT reminded CGMS that 40 IDCS channels could be supported by its future MSG satellites, and invited CGMS Members to consider how the IDCS might be expanded from the current 33 available channels and to identify where potential expansion in the IDCS user communities was foreseen.

Action 25.10 **CGMS Members to provide the Secretariat with proposals for an expansion of the IDCS in the year 2000 time frame.**

In conclusion, the Secretariat reminded CGMS that it was around 5 years since the last issue of the IDCS User Guide, and it noted that some sections required revision. CGMS Members were invited to submit revisions and/or corrections to the Secretariat by 30 September 1997, with a view to publishing a revised edition in time for the next meeting of CGMS.

Action 25.11 **CGMS Members to inform the Secretariat of any revision or corrections to the IDCS User Guide (Issue 7) by 30 September 1997.**

Action 25.12 **CGMS Secretariat to prepare an update of the IDCS guide for review by CGMS Members at CGMS XXVI.**

EUMETSAT informed CGMS, in EUM-WP-07, on the plan to implement a system to detect and locate sources of interference in the 401- 403 MHz band in the near future.

F.2 Ships, including ASAP

The USA submitted USA-WP-06 including a status report on the ASAP.

WMO reported on the outcome of the ASAP Coordination Committee in WMO-WP-18, and it was noted that, in 1996, 23 ASAP units were operated by the following countries: Denmark (2), France (4), Germany (6), Japan (5), Russia (1), Spain (1), Sweden/Iceland (1), United Kingdom (1) and the USA (2). The number of ASAP soundings during 1996 corresponds to the number of soundings from around 8 ocean weather ships.

F.3 ASDAR

A status report was presented in WMO-WP-10 on ASDAR and CGMS noted that 19 out of 23 units were installed with 18 being fully operational.

Russia expressed its intention to develop the capability to process ASDAR data in the GOMS-Elektro system and requested to be informed of the necessary details.

Action 25.13 **WMO to provide Russia with the detailed information necessary to process ASDAR data, by 31 July 1997.**

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

Russia presented RUS-WP-07 on the status of DCP. DCP data are disseminated at 1696 - 1698 MHz. The up-link frequency band 401- 403 MHz is unfortunately affected by an interference source, which cannot be eliminated. This prevents a normal operation of the IDCS on GOMS. Russia intends to cope with this difficulty in performing multiple messages transmission with a higher data rate.

The USA submitted USA-WP-07 including a status report on DCP received by GOES and transmitted over the GTS. NOAA confirmed its support to plan an expansion of the IDCS.

G. COORDINATION OF DATA DISSEMINATION

G.1 Dissemination of images via Satellite

NOAA summarised the status of the LRPT (space and ground segments), which is being developed in cooperation between the USA and EUMETSAT for the forthcoming generation of polar orbiting satellites (Metop, NPOESS, and Meteor-3-M). Pointing out that there have been numerous slips of both the Metop and NPOESS schedules, and assuming a five-year lead-time from planning to implementation given to the user community, NOAA stressed that LRPT development is still on schedule. Outstanding issues still need to be solved in the areas of data compression, transmitter power, and power modulation. Meanwhile, much progress has been made over the past year including:

- a two-phase study to define natural and man-made sources of noise in the 137-138 MHz range,
- a LRPT Demonstration Study on the feasibility of developing a LRPT system with off-the-shelf parts,
- and a User Symposium in Annapolis in June 1996 where important feedback was received from the user community.

EUMETSAT, introducing EUM-WP-09, recalled the need to agree on an internationally coordinated system in view of the global use of polar-orbiting satellites. EUMETSAT stressed that the global specification should be frozen within one year at the latest, with regard to the development schedule of Metop and Meteor 3-M and to the lead-time necessary for the user community. EUMETSAT submitted a proposal for the HRPT/LRPT Broadcast Services Specification and proposed to adopt the specified LRPT Compression Scheme and the HRPT/LRPT physical layer parameters as standards for future polar orbiting meteorological spacecraft. EUMETSAT pointed out that the development of the Metop space segment is currently based on the LRPT specification as presented to CGMS XXV, and that delays in the agreement process could cause high additional costs.

WMO confirmed the urgency of finalising such a specification, from a user point of view. It was proposed to hold a special meeting of experts in order to speed up the definition and agreement process.

Action 25.14 **The USA to convene a special meeting of experts with participation of EUMETSAT, ESA and WMO on the LRPT specification, by 30 September 1997.**

Action 25.15 **All CGMS Members to review the draft LRPT Specification proposed in EUM-WP-09 by 1 January 1998.**

China presented in PRC-WP-02 the details of the CHRPT format foreseen for the FY-1C and FY-1-D Satellites. CGMS noted that this will handle data from 10 channels at 1.33 Mbs. It was pointed out that the data format of FY-1-C/D is similar to the data format of NOAA satellites except that the sector of Earth data is 20480 words for FY-1-C/D and 10240 words for NOAA satellites.

The USA reported in USA-WP-08 on the study conducted by NTIA to quantify man-made and natural sources of noise that may cause interference in the broadcast of LRPT imagery. It was noted that the requirement of achieving 90% of all images without data drop-out or noise will need to be re-evaluated. The objective is to design a reliable but inexpensive system for the user community.

JAPAN–WP-10 presented the plan for implementation of LRIT in time-sharing with WEFAX on MTSAT, for a transition period of 3 to 5 years.

WMO submitted in WMO-WP-03 a consolidated schedule of transition from the APT/WEFAX to the LRPT/LRIT services, established on the basis of the input forwarded by CGMS satellite operators. It further introduced the action plan, known as the "LRIT/LRPT Project", developed by WMO to facilitate the adaptation of the user ground segment upon transition to these digital services. CGMS confirmed the importance of providing such support to the user community and recommended that satellite operators and WMO continue to their joint efforts in this matter.

CGMS took note of the draft initial requirements for the Application and Presentation Layer Specifications for LRIT/LRPT/HRIT/HRPT Data Format, which were developed by the Chairman of the CBS Working Group SAT Subgroup on Small Workstations. CGMS Members agreed to review these requirements as included in WMO-WP-16.

Action 25.16 **CGMS satellite operators to review the draft initial requirements for the Application and Presentation Layer Specifications for LRIT/LRPT/HRIT/HRPT Data Format, which were developed by the Chairman of the CBS Working Group SAT Subgroup on Small Workstations, and provide comments to WMO prior to 1 November 1997.**

EUMETSAT distributed an updated issue of the LRIT/HRIT global specification, included in EUM-WP-08. CGMS Members were invited to review this update, and to note the details of the Mission Specific Implementation of LRIT on MSG.

Action 25.17 **CGMS Members to review by 30 September 1997 the proposed update to the LRIT/HRIT Global Specification Issue 2.4 and express comments or approval to EUMETSAT.**

Russia reported in RUS-WP-05 on the status of WEFAX dissemination via GOMS-Elektro satellite.

G.2 Dissemination of products via GTS or other means

WMO introduced WMO-WP-11 and drew the attention of CGMS Members to the changes in the WMO codes for satellite identifiers.

Japan reported in JAPAN-WP-11 about the quality control of sea surface winds retrieved by NESDIS from NSCAT/ADEOS data. These data are delivered to JMA via NASDA around 4 hours after observation time.

G.3 Global exchange of satellite image data via satellite or via the GTS

EUMETSAT described in EUM-WP-10 the final configuration of the Foreign Satellite Data Relay on Meteosat. CGMS noted that a Meteosat WEFAX user could currently receive some images of all other operational geostationary satellites (GOES-E, GOES-W, GOMS, and GMS). Dissemination is also performed in digital form on Meteosat for GOES-E, GOES-W and GMS and is planned for GOMS data.

RPA Planeta noted in RUS-WP-06 that 8 infra-red full disk WEFAX images from GOMS will be daily transmitted to EUMETSAT for dissemination via Meteosat every 3 hours, in the framework of a bilateral agreement between Roshydromet and EUMETSAT.

WMO commended all satellite operators for the WEFAX dissemination service, which is important for a wide user community. It also underlined the value of the exchange and relay of data from neighbouring satellites via WEFAX, such as GOMS data on Meteosat, and Meteosat data on GOMS.

WMO in introducing WMO-WP-09 informed CGMS that the draft requirement expressed in 1996 had been confirmed by the chairmen of the CBS Working Group on Telecommunications and on Data Management. WMO added that this requirement would be an important input for any future review of the design of the GTS. WMO however, clarified that the requirement for the exchange of global data should be considered as technology-free.

EUMETSAT indicated that it was not planned to use the GTS for disseminating images from EUMETSAT satellites, since the images were disseminated and relayed by the satellites themselves.

CGMS stated that the satellite operators would respond to the requirement for global exchange of data through the use of direct broadcast systems on the polar orbiting and geostationary satellites. CGMS also noted that with the implementation of LRIT and LRPT the global relay of satellite images will be performed in digital form according to internationally standardised formats.

H. OTHER ITEMS OF INTEREST

H.1 Applications of Meteorological Satellite Data for Environment Monitoring

The USA introduced USA-WP-09 describing a strategy for ocean remote sensing in accordance with NOAA's strategic plan "A vision for 2005". CGMS noted that NOAA will develop a comprehensive system to acquire and process data from existing and planned satellites for a better knowledge of the ocean, its natural processes and its influence on global climate. It is foreseen to use all relevant data sources, including NOAA and non-NOAA satellites (e.g. ERS-2, RADARSAT, ADEOS, EOS) as well as in-situ, historical and other remotely sensed data. Data will be processed in coastwatch nodes and further distributed to scientific users, other US agencies or commercial customers.

The USA then described the concept of the remote sensing aerosol monitoring programme AERONET supported by NASA, CNES and NASDA and expanded by many international collaborations. The project includes the worldwide implementation of a ground-based network of sun and sky scanning automatic radiometers with data collection through DCP on geostationary satellites GOES and Meteosat. Given the international collaboration and scope of this programme, AERONET requested the authorisation to use assignments in the international bands normally reserved for moving platforms. This would allow for collection on GMS and provide a better consistency in data reporting. The AERONET network includes at present 70 automatic stations and is expected to be expanded.

CGMS expressed support to this plan and noted that such developments would reinforce the need to update the IDCS guide.

H.2 Search and Rescue (S&R)

EUMETSAT informed CGMS that a GEOSAR transponder will be accommodated onboard Meteosat Second Generation, in response to a request expressed by COSPAS-SARSAT and supported by CGMS. As described in EUM-WP-11, it was noted that this will allow to relay simultaneously up to 4 distress messages from 406 MHz beacons located within the field of view of the satellite. The GEOSAR relay capability would become operational in 2001 after launch of MSG-1. CGMS expressed its appreciation for this contribution to the Search and Rescue service.

The USA then outlined a description of the international system set up by COSPAS-SARSAT in support of S&R operations. It was indicated in USA-WP-10 that 70000 S&R beacons were deployed and that more than 26 countries have now joined the agreement. As the system expands and is supported by more polar orbiting and geostationary satellites, it is recommended to use now 406 MHz beacons instead of the earlier 121.5 MHz beacons.

H.3 Meteorological Data Distribution

No discussion on this item, noting however that EUM-WP-02 submitted under Item B.2 included a status of the MDD Meteosat mission.

H.4 Training

In EUM-WP-12, EUMETSAT provided information on its scheme for training in satellite meteorology, which has been in operation since the beginning of 1994. Courses are normally either presented in Europe, primarily for the benefit of meteorological services in EUMETSAT Member States, or at two WMO RMTCs in Africa. In addition, CGMS was informed that several Computer Aided Learning (CAL) modules relating to satellite meteorology were currently in preparation and were expected to become a key component of the above training scheme within the coming year.

The USA informed CGMS on its demonstration project for Satellite Meteorology Applications focused on Regional Meteorological Training Centres in Costa Rica and Barbados. NESDIS and NWS have utilised the NOAA Co-operative Institutes for Research and Atmosphere (CIRA) and on Meteorological Satellites (CIMSS), to initiate a demonstration project for two satellite-specialised RMTCs: one in Costa Rica, a Spanish language RMTC, and the other in Barbados, an English language RMTC. RAMSDIS (i.e. Regional mesoscale meteorology team Advanced Meteorological Satellite Demonstration Interpretation System) units were configured at CIRA for each RMTC. Both Costa Rica and Barbados are receiving case study data from CIRA on CD ROMs and minicartridge tapes. Applied research tasks are underway and training cases are being developed at each RMTC using digital satellite imagery on RAMSDIS.

The funding is provided by the National Weather Service's Interagency Activities for a demonstration project for Satellite Meteorology Applications focused on Regional Meteorological Training Centres in Costa Rica and Barbados. Near real-time GOES-8 digital imagery is being provided to the Costa Rica RMTC via Internet using the NESDIS server, as is currently done for NWS RAMSDIS. Scientists from Costa Rica and Barbados visited CIRA for a week for intensive training on RAMSDIS. CIRA scientists have visited both RMTCs. CIRA and CIMSS will continue the current level of activity with both RMTCs. This includes: a) continued technical support of real-time ingest in Costa Rica; b) continued provision of special case study data to each RMTC; c) continued guidance in the utilisation of satellite imagery, including joint research activity and the development of training case studies.

The Meteorological Satellite Centre (MSC) of Japan has been developing since 1994 a Computer Aided Leaning (CAL) system for the use of satellite imagery. As described in JAPAN-WP-12 the system, designed for self-training of weather forecasters, runs on a PC or a workstation and enables to view GMS imagery, display explanations, extract parameters and overlay other meteorological information.

Japan in JAPAN -WP-13, and WMO in WMO-WP-6, informed CGMS on the recent Asia-Pacific Satellite Applications Training Seminar (APSATS) for RA II and V which was held at the BMTC in Melbourne, Australia, 18-29 November 1996 and co-sponsored with the Australian Bureau of Meteorology (BoM) and the Japan Meteorological Agency (JMA). About 70 people from 17 countries in the Asia Pacific region attended this training seminar, focused on the interpretation of satellite imagery from GMS-5 and NOAA POES in weather forecasting, with special emphasis on the use of the water vapour channel. This seminar consisted of lectures and self-training, using the CAL modules developed by BoM and JMA, in a multimedia and network environment. The training event was considered successful and was the second to be conducted under the new WMO Strategy for Education and Training in Satellite Matters. The first training event conducted under the new WMO Strategy for Education and Training in Satellite Matters was held in Costa Rica in 1995. The success of APSATS can be attributed, in part, to the predominant use of high technology.

H.5 Information

EUM-WP-13 and EUM-WP-14 informed CGMS about EUMETSAT's conferences and publications. A Satellite Data Users' Conference was held in Vienna in September 1996. The next conferences are foreseen in Brussels, Belgium in September 1997 and in Paris in May 1998. EUMETSAT's Second User Forum in Africa was convened in Harare, Zimbabwe in December 1996 together with WMO and the Meteorological Service of Zimbabwe. 85 participants from 40 African countries exchanged information on current and future EUMETSAT satellite systems and services and expressed a number of recommendations. Furthermore, the Forum emphasized the need for the users to prepare the transition to the new satellite system MSG well in advance of the launch of the first satellite in the series, expected in late 2000.

In addition, CGMS was informed about new EUMETSAT publications and the current status of the CGMS Directory of Meteorological Satellite Applications. A first batch of 64 topics of this Directory will be printed by June 1997. CGMS Members were invited to provide outstanding submissions as soon as possible, in order that a comprehensive first edition could be prepared for distribution by the end of 1997.

The Secretariat introduced in EUM-WP-32 the tables of current and future satellites that are coordinated within CGMS. CGMS expressed its appreciation for the new format proposed and recommended the regular updating and distribution of such information. All CGMS Members were invited to review carefully the information included in these tables and report any corrections to the Secretariat.

Action 25.18 **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.**

Action 25.19 **WMO and EUMETSAT to jointly prepare the on-line distribution of CGMS Tables of Satellites.**

JAPAN WP-15 presented the Monthly Report of the MSC, which since July 1996, is distributed on CD-ROM. Each monthly report is on one CD-ROM containing GMS images, GMS products and TOVS production, as well as a viewer programme.

WMO WP-01 informed CGMS of the latest statistics in the WMO database of satellite ground receiving equipment now containing over 8,000 satellite receiving stations. A copy of the database was provided to all CGMS Members. CGMS expressed thanks to WMO for maintaining this database which is essential to support the protection of telecommunication frequencies.

The addresses for the various CGMS list servers were presented in WMO-WP-04 and updated. Finally, WMO-WP-08 informed CGMS of the status of WMO publications related to WMO Satellite Activities and in particular three technical documents expected to be completed during 1997.

H.6 Any Other Business

In PRC WP-04 CGMS was informed that there are now about 110 direct receiving stations able to receive S-VISSR data and 58 stations to receive HRPT data in China.

CGMS was informed, in WMO WP-07, that 30 low-cost low-resolution receivers had been purchased under the Switzerland/WMO Satellite Receiving Project and installed in countries that previously had no receiving capability. CGMS was pleased to note that an additional ten units were being considered.

PARALLEL WORKING-GROUP SESSIONS

REPORT FROM WORKING GROUP I: TELECOMMUNICATIONS

I/1 Introduction and Election of a Chairman

The Working Group elected Mr. Robert Wolf as its Chairman. Mr. Gordon Bridge served as Rapporteur.

I/2 Coordination of Frequency Allocations

The World Radio Conference 1997 (WRC 97) will take place between 27 October and 21 November 1997 at the International Telecommunication Union (ITU) in Geneva. Documents USA-WP-12, WMO-WP-12, RUS-WP-08 and EUM-WP-15 were presented in this context. Furthermore USA-WP-13 gave a summary on discussions of the recent meeting of the Space Frequency Coordination Group meeting which took place in Moscow in the autumn of 1996.

The agenda of the WRC 97 includes many topics related to the operations of Meteorological Satellite Service (MetSat), Earth Exploration Satellite Service (EESS), and Meteorological Aids Service (MetAS). Several issues of imminent importance to the exploitation of meteorological satellites will be discussed. There will be proposals to introduce new services, mainly Mobile Satellite Services (MSS), in the bands which are presently used for meteorological operations. Care has to be taken that the introduction of such new services will not limit nor disturb present and future operations of CGMS coordinated systems, or interfere with measurements from passive sensors on-board meteorological or other Earth Observation satellites.

The Working Group on Telecommunications addressed the most important frequency bands for CGMS applications as follows:

137 - 138 MHz

This band is presently used for Automatic Picture Transmissions (APT) from NOAA and Meteor satellites and is also the band for planned LRPT transmissions from future polar orbiting meteorological satellites. MSS have been allocated at a co-primary status in 80% of the band during WRC 92. There are two sub-bands at the upper and lower edge (150 kHz /175 kHz) where MSS was not allocated. This was to protect MetSS. Draft proposals were presented which request to expand the primary status of MSS over the complete band. It has to be expected that the proposals for MSS expansion will be presented to WRC 97 and that a time sharing mode between MetSS and MSS will be proposed. The feasibility of such an operating mode has not been demonstrated.

401 - 406 MHz

This band is used for MetAS (radiosondes) on a primary level and for EESS and MetSat (Data Collection Platforms) on a secondary level. The latter are only operated in the sub-band 401 - 403 MHz and include DCPs operating with geostationary spacecraft (IDCS) as well as polar orbiting spacecraft (ARGOS).

Two types of proposals are expected to be presented to WRC 97:

a) to upgrade the MetSat and EESS allocation in the band 401 - 403 MHz from its present secondary to a primary status and

b) to allocate parts of the band 401 - 406 MHz to MSS on a co-primary status.

Proposal a) will be forwarded by several agencies and is supported by a Resolution from WRC 92. It can be expected that there will be international support to this upgrade.

The Working Group noted that the upgrade of EESS to primary status could allow commercial systems to operate in this band. The use of the frequency band has therefore to be closely monitored by CGMS Members. This has to include ARGOS applications.

The proposal(s) related to b) are expected to be forwarded by the US and will be supported by some other delegations. The need of the full spectrum for MetAS is questioned and partial re-allocation is proposed. WMO has demonstrated that for the near future no reduction of the required bandwidth can be envisaged.

Russia provided further information on its attempts to solve the problem of interference to its DCS operating in the 401 - 403 MHz band. It was noted that to date limited progress had been made to circumvent the problem by increasing the DCP transmission data rate to 1200 bps.

ACTION I-1 **Russia to report on progress on removing interference on the DCP frequency band, at CGMS XXVI.**

ACTION I-2 **The Secretariat to contact CLS/ARGOS in order to seek information on the long-term plans for future ARGOS services, including any possible expansion in use of frequency band.**

ACTION I-3 **WMO to establish a list server for WRC 97. Details of server content to be provided to CGMS Members in the near future.**

ACTION I-4 **CGMS Members to provide WMO with WRC 97 list server participant lists.**

1670 - 1710 MHz

This band is used by Meteorological Satellite Service for data acquisition and dissemination services from geostationary and polar orbiting satellites. There are three subbands identified:

- 1670 - 1690 MHz for transmissions from geostationary satellites to main reception stations. This includes raw image, spacecraft telemetry, and DCP transmissions as well as stretched images (GVAR, S-VISSR) from GOES and GMS satellites.

- 1690 - 1698 MHz for dissemination services from geostationary satellites. This includes present WEFAX, HRI, MDD and is foreseen for future LRIT and HRIT transmissions.

- 1698 - 1710 MHz for direct readout services and data transmissions of present and future polar orbiting satellites.

Sharing does not appear to be feasible in the two upper sub-bands due to the large amount of user stations operated in these bands. Limited sharing within some areas of the world could be possible in the lower band if protection of the few main ground stations could be guaranteed by operators of other services. Such protection methods have not yet been demonstrated. Studies performed by MSS attempt to demonstrate the feasibility of time sharing operations between MSS and polar orbiting MetSat in this band. A EUMETSAT study including present and future meteorological polar orbiting satellites proves that sharing is not feasible. Both studies have been introduced to the ITU.

Presently, it seems that there will be no proposal for MSS allocations in the lower band presented by the US or Canada (which earlier had plans to do so). There will be only a European proposal which has been elaborated at the request of INMARSAT. This proposal foresees the allocation of 8 MHz, most probably from 1682 to 1690 MHz for MSS in direction Earth to Space.

The Working Group also took note of document WMO-WP-12 which provided information on the request of delegations at the ITU conference preparatory meeting to plan for GVAR and S-VISSR services to be re-allocated to frequency bands above 1690 MHz for future systems. This would be in line with CGMS definitions of frequency sub-bands in the range 1670 – 1710 MHz.

Re-allocation in the band around 7-8 GHz

The band around 7-8 GHz is used and planned for data transmissions of meteorological spacecraft to main Earth stations. This includes future Metop as well as NOAA, Meteor and GOMS operations.

The presently allocated band is used by geostationary spacecraft of governmental use. High numbers of such spacecraft are already in operation and new systems are planned. Sharing between geostationary and polar orbiting spacecraft operating in the same band is not feasible. It has therefore to be expected that MetSat requests for assignment of bands for their operation could create major problems. A way out of this situation could be the re-allocation of MetSat into another band in the area 7-8 GHz. A corresponding proposal was presented to CGMS XXIV and was supported by Members. A proposal for the frequency re-allocation for new satellite systems will be submitted to WRC 97 by European countries.

Re-allocations in the band 50 - 70 GHz

This frequency band is used for passive sensor (sounding) measurements from meteorological and other Earth observation satellite systems. Several lines of the oxygen absorption band are located in this frequency range. The band is also used for other services including Fixed and Mobile as well as Intersatellite Service.

With regards to sharing conditions between Fixed/Mobile service and passive sensor operations many discussions took place and various studies were produced. Agreement on required re-allocations were reached and are reflected in an European proposal which is expected to be submitted to WRC 97. Fixed services will acquire additional allocations previously reserved for passive sensors and will free such areas where sharing is not feasible (due to lack of energy absorption).

A remaining problem is the existence of an allocation for Intersatellite Service within the band. Large size systems (up to 900 spacecraft) are projected for operations commencing around the year 2000. These systems are intended to perform data transmissions between their spacecraft by using the allocations in the band around 60 GHz. Analysis of such a scenario have highlighted that measurements from passive sensors would be heavily disturbed by such operations and would become unusable. This situation was brought to the attention of WRC 95 and a resolution to elaborate proposals to solve the situation was issued at the meeting.

A proposal was elaborated and forwarded by SFCG and was discussed in ITU Working Groups. This proposal foresees the re-allocation of ISS to a band from 65 to 70 GHz and to release the present allocations below 60 GHz. ISS operators have indicated that they would support such re-allocations but made also clear that they would insist on assignments in the present range should there be no conclusion at WRC 97.

Other Passive Sensor Frequency Bands

Within the framework of WMO and SFCG it has been discovered that frequency bands for the operations of passive sensor measurements are not sufficiently protected in many areas. Such measurements are increasingly important for the retrieval of atmospheric parameters including temperature, water vapour content, concentration of ozone and other gases, and play an increasing role in several WMO programmes including WWW, GCOS and WCRP. Some frequency bands are unique natural resource due to special attenuation characteristics. On the other hand there are technical developments, which allow the operations of active services (such as Fixed, Mobile) in higher frequency bands (above 50 GHz) and sharing with these services has to be envisaged.

WMO established and is presently refining frequency requirements for such measurements. Technical justification for allocations proposed in this list is elaborated and will be submitted to ITU. Because of time constraints, it has to be expected that not all topics will be discussed at WRC 97, however, it is important to ensure that passive sensor issues are included in the agenda of future conferences.

Documents WMO-WP-14 and EUM-WP-16 both stressed the importance of registering all meteorological user stations with ITU. A sample completed registration form was presented in the EUMETSAT document.

The Working Group also took note of USA-WP-13 which provided information on the 1996 SFCG meeting.

In WMO-WP-14, the Working Group were informed about the registration of satellites and receiving stations with ITU. The Working Group noted with concern that ITU records currently indicate an apparent decrease in the number of registered stations and, furthermore, some countries known to be operating earth or user stations were not even registered with

ITU. The Working Group appreciated the efforts being taken by WMO to bring discrepancies in ITU registration lists to the attention of ITU and welcomed its efforts to ensure that all satellite systems and user stations of CGMS Members were correctly registered with ITU.

Some CGMS Members commented on the complexity of registering earth and user stations with ITU.

The Chairman reminded all CGMS Members of the importance of registering all satellites and receiving stations with ITU (see also Permanent Action 8).

Members of the Working Group on Telecommunications stressed the importance of frequency allocations for the above services. Due to the importance of the results of WRC 97 in relation to the MetSat, MetAS and EESS frequency allocations, CGMS Members have agreed to follow closely the preparations for the conference, which take place in their national frequency administrations and to support the positions of MetSat, MetAS and EESS in these discussions.

I/3 Telecommunication Techniques

In response to CGMS Action 24.09, EUM-WP-17 informed the Working Group about the number of CGMS Member ground stations operating within the band 1670-1690 MHz. WMO, noting some discrepancies between this list and WMO station registration database, suggested that a consolidated registration list should be prepared. WMO offered to assist with the creation of such a list. Concluding the discussion, the Chairman added that this list will be used in discussions related to possible MSS allocations in this frequency band.

Concerning actions from the plenary meeting relating to the development of DCP operating at 300 bps (Actions 24-11, -12 and -13) it was proposed by the Working Group that these actions be maintained but with new deadlines (t.b.c.).

In addition Russia informed the group about its development of a DCS running at 1200 bps using a dedicated transmission system on GOMS and agreed to present details at the next meeting of CGMS.

ACTION I-5 **Russia to provide CGMS with information about the development of a DCP relay system operating at 1200 bps.**

Noting information from Japan on its development of a higher rate DCS, the following action was agreed:

ACTION I–6 **Japan to provide CGMS with information about its development of a DCP relay system operating at higher data rates.**

I/4 Online information systems

Three documents related to on-line information systems operated by CGMS Members were presented. WMO-WP-15 presented the latest status on homepages of the INTERNET related to CGMS activities. The online systems at NOAA's Satellite Active Archive were described in document USA-WP-14. EUM-WP-18 informed about the evolution of the EUMETSAT WWW Service.

In response to a question from WMO concerning the usefulness of the CGMS homepage, the Working Group stressed the importance and benefit of such an information source. It was recommended that the homepage be maintained and kept up-to-date.

ACTION I-7 **CGMS Members to provide WMO with ideas on content and further enhancements of the CGMS homepage.**

REPORT FROM WORKING GROUP II: SATELLITE PRODUCTS

II/1 Introduction and Election of a Chairman

Dr. Uspensky (Russia) was elected Chairman of Working Group II on Satellite Products. Dr. Oriol (ESA) was appointed as Rapporteur.

The Working Group started by reviewing the actions of CGMS XXIV and noted that all actions were successfully closed.

II/2 Image processing techniques

No paper was presented under this topic, however an intensive discussion took place on integrated products that make use of both satellite data and conventional data. The Working Group felt that future products will increasingly use different data sources for product generation and the US provided current examples of such products.

ACTION II-1 **USA to report on their development of integrated products at CGMS XXVI.**

II/3 Satellite data calibration

EUM-WP-19 outlined a satellite intercalibration method based on co-located clear radiances observations from Meteosat-5 IR and NOAA-14 AVHRR channels 4 and 5, respectively. The intercalibration gave results within 2% of the operational calibration, which is considered encouraging. The purpose of developing satellite intercalibration methods is to establish a viable tool for the monitoring of operational calibration.

USA-WP-15 presented the approach developed at NESDIS/CIMSS for calibrating the GOES with HIRS using temporally and spatially co-located measurements. Initial focus has been on the infrared window radiances measured by these systems. Collaboration continues between US and EUMETSAT towards defining techniques for cross-calibration of all geostationary and polar orbiter sensors.

ACTION II-2 **USA, Japan and EUMETSAT to report at the next CGMS meeting on their continuing development work for the intercalibration of polar and geostationary satellites.**

EUM-WP-20 presented a feasibility study of the absolute calibration of the Meteosat-5 VIS channel using a radiation model. The estimated error of the calibration is of the order of 10%. This error falls short in comparison to aircraft calibration campaigns (5%), however it was pointed out that better input parameters for the radiation model (notably surface characterisation and aerosol profiles) would enhance the accuracy of VIS calibration based on radiation models. The Working Group also noted the current lack of firm accuracy requirements for solar calibration from the operational meteorological community.

EUM-WP-29 informed about the commonality of satellite calibration activities performed within CGMS and by the CEOS Working Group on Cal/Val. The discussion highlighted the need for synergy between both activities.

ACTION II-2 **CGMS Members also participating in CEOS Cal/Val should ensure the complementarity of activities and report at CGMS and CEOS Cal/Val meetings as required.**

USA-WP-16 suggested a CGMS programme to establish scientific collaboration towards defining techniques for cross-calibration of meteorological satellites. The goal is calibration amongst different satellites within 1°K for IR and WV channels. The paper recommended that the satellite cross-calibration should be taken up by all CGMS Members as an important future activity. The Working Group accepted the following actions as first steps towards this goal.

ACTION II-3 **Each CGMS Member to commence satellite intercalibration activities and to identify a coordinator for such activity.**

The following persons were proposed at the meeting as co-ordinators: Dr. Menzel (USA), Dr. Schmetz (EUMETSAT), Dr. Uspensky (Russia), Dr. Tokuno (Japan), Mr. Xu Jianmin (PRC).

Recommendation: The Working Group recommended that each satellite operator should develop methods for satellite intercalibration.

ACTION II-4 **All CGMS operators to request an AVHRR and/or HIRS dataset for cross-calibration with their geostationary satellite by October 1997 and NOAA/NESDIS to provide the data on request.**

ACTION II-5 **All CGMS satellite operators to perform if possible additional cross-calibration activites using foreign satellite data and report on this at CGMS XXVI. This implies that each operator can request the relevant data from another operator for satellite cross-calibration.**

II/4 Vertical sounding and ITWG matters

EUM-WP-21 discussed the status of the ATOVS software development for locally received direct readout HRPT data from NOAA-K, -L, -M spacecraft. The development has reached a major milestone since integrated software for ingest, navigation, calibration and pre-processing is available for TOVS data. The code for ATOVS is being produced and will be tested once NOAA-K is in space. The inclusion of a retrieval software into the package is being discussed.

The Working Group addressed the question of software distribution and it was stated that only standard procedures will be applied following the general rules. Software is freely available to researchers upon signature of a license agreement. The Working Group approved the ATOVS approach as an example for a general strategy to prepare pre-processing software for new satellite instruments.

USA-WP-17 presented significant events related to GOES sounder temperature and moisture retrievals. An improved version of the algorithm was completed and impact tests of the moisture retrievals at NCEP turned out positively. The algorithm has been implemented operationally and the retrieval quality also increased after correction for an East-West radiance bias. The Working Group commended the US on their achievement and encouraged both satellite operators and NCEP to continue their efforts in establishing the successful utilisation of sounder products and radiances. A general discussion emerged, related to more frequent generation of products, as operational NWP users are going to use new assimilation techniques.

ACTION II-6 **EUMETSAT to provide results at the next CGMS meeting from initial tests at ECMWF with the forthcoming 4-D variational analysis.**

USA-WP-18 reported on the recent International TOVS Study Conference-IX. Substantial progress has taken place in the use of TOVS data to improve NWP. The Working Group noted with delight that CGMS activities were recognised in several of the ITSC list of discussion items. The Working Group took note of the report.

II/5 Other parameters and products

EUM-WP-22 described the possibility of monitoring deep convection and convective overshooting via a temperature difference observed between the IR and WV channel where the WV channel is warmer. The Working Group noted in the discussion of this paper the general need for a better transfer of research results into operations and suggested that all CGMS Members report on their procedures to transfer research results into operations at the next CGMS.

Recommendation: All CGMS Members to report on their ways for transferring research results into operations at the next CGMS meeting.

EUM-WP-23 reported on the distribution of high resolution visible winds and clear sky water vapour radiances produced from Meteosat in BUFR code via the GTS. The Working Group took note and pointed out the advantages of BUFR over the SATOB code.

EUM-WP-31 presented the status of the plans for products from MSG as of fall 1997. A verbal update considering more recent progress with the Satellite Application Facilities (SAF) was given. The Working Group noted the continuity and enhancement of MSG products in comparison to current Meteosat operational products.

JAPAN-WP-14 presented a concise summary of products from GMS-5 and reported on their accuracy. The Working Group welcomed the report and suggested to include the paper in the proceedings of the conference.

RUS-WP-09 discussed the mapping of SST from GOMS and NOAA. The accuracy obtained with GOMS is comparable to other SST retrievals based on a single IR channel. A comparison with the performance of the NOAA AVHRR split-window retrieval again clearly illustrated the superior performance of a dual-channel approach.

RUS-WP-10 provided an interesting documentation of current work on the operational diagnosis of specific severe weather phenomena using OKEAN data. In particular, methods were described on how to arrive at an operational method to identify zones of high speed wind. The Working Group recommended that this paper be included in the proceedings.

RUS-WP-11 presented results from an exploratory study to monitor polar ice cover from jointly analysing radar data from the OKEAN side-looking radar (SLR) and the ERS SAR. The study convincingly shows the utility of the satellite data to classify the ice cover. The study is an ESA pilot project jointly performed by Planeta and the Nansen Center. It will recommend a concept for the integrated use of different satellite radar data for sea ice monitoring. The Working Group recommended that this paper be included in the proceedings.

An additional paper on "Methodology of environmental regional monitoring based on combined implementation of satellite and ground network data" by Professor Pokrovky was presented and distributed.

II/6 Coordination of code formats for satellite data.

No paper discussed.

II/7 Coordination of data formats for the archive and retrieval.

No paper discussed.

II/8 Responses to ITWG.

No paper discussed.

REPORT FROM WORKING GROUP III: SATELLITE TRACKED WINDS

III/1 Introduction and Election of a Chairman

Dr. Sato (Japan) was elected Chairman of Working Group III, on Satellite Tracked Winds. Mr. Staton (USA) was appointed as Rapporteur.

III/2 Outcome of the 3rd International Workshop on Winds

The Working Group noted that all action items from CGMS XXIV were closed. Specifically EUM-WP-31 describes the closing of Action 24.30 "CGMS wind operators to exchange details of the algorithms used for the derivation of wind speed from pixel displacement" and Action 24.31 "CGMS wind operators to provide details of the algorithms used for the vertical treatment of radiosondes".

The status of the actions from the Third International Workshop on Winds were discussed in EUM-WP-24 and the following actions were completed:

- An appropriate reporting format for the comparison of CMW's with radiosonde data has been defined and is being suggested for adoption by all CGMS wind operators.

- A report has been compiled (in EUM-WP-26) on the accuracies assigned to winds during the assimilation process at NWP centres. It is noted that EUMETSAT takes this item as a future action and will report on the utilisation of satellite tracked winds at NWP Centres at the next CGMS meeting.

- The scope of future International Workshops on Winds has been expanded to include wind retrieval from microwave instruments.

Furthermore the suggestion of the Third International Workshop to produce a summary report of the product development plans has been taken up by the Working Group as an action of all CGMS wind operators.

ACTION III-1 **All CGMS wind operators to present their wind product development plan at the next CGMS meeting.**

The Working Group invited WMO to consider hosting the 4th International Winds Workshop. The Working Group noted that optimum arrangements for such a workshop would require not only suitable facilities for meetings during the day but also during the evenings. Such arrangements had greatly enhanced the effectiveness of previous workshops and discussions. The Working Group felt it important that the venue be at a secluded site to best meet such requirements. It encouraged WMO to take these factors into consideration when selecting a venue in Switzerland.

ACTION III-2 **WMO to consider hosting the 4th International Workshop on Winds in Switzerland.**

Following EUM-WP-31 (Report on the 3rd International Winds Workshop), the Working Group members also agreed that the International Winds Workshop should continue to discuss schemes for improving the height assignment of winds vectors. The 3rd International Workshop also noted with interest the continued participation of the Indian meteorological service in the winds workshop, the improvement in the winds derived from INSAT and that utilization of these satellite winds should be considered by NWP centres.

III/3 Winds Statistics

USA-WP-19 and EUM-WP-25 contained examples of the agreed upon format for reporting cloud motion winds statistics by all CGMS wind operators. It was recommended that one of these two papers should be included in the final CGMS XXV report. JAPAN-WP-16 was also presented on this subject. Since the recent Winds Workshop recommended adoption of the proposed format for reporting wind statistics on a quarterly basis the following action was placed on satellite wind operators.

ACTION III-3 **CGMS Members to report quarterly winds statistics via the CGMS server supported by WMO.**

USA-WP-19 was then presented and discussed. It was noted that high density winds are being generated by NOAA (4 times daily, non-operational) and by EUMETSAT (visible winds 5 times daily as BUFR product, operational) and made available for NWP models. NOAA, NCEP and ECMWF are preparing for parallel testing and assessment of these high density winds sets. NOAA/NESDIS indicated that it will operationally produce high density winds for the upcoming hurricane season and supply these data sets to the NCEP Tropical Prediction Center. Since such winds are not currently included in the quarterly statistics the Working Group suggested to wind operators to do so in future.

ACTION III-4 **CGMS wind operators to include all operational winds (low and high density) in the operational statistics following the approved reporting format.**

EUMETSAT introduced EUM-WP-26 on the utilization of satellite derived winds at the NWP centres. The Working Group noted that the error characteristics assigned to satellite winds differ significantly amongst NWP centres. It was also noted that products from some channels were not used in NWP models. Improvements reported recently on INSAT winds suggest to consider their use in NWP centres. EUMETSAT took a standing action to maintain a list on the utilization of satellite winds at NWP centres and report at the next CGMS meeting.

ACTION III-5 **EUMETSAT to report on regular basis on the use of satellite tracked winds at NWP centres.**

JAPAN-WP-16 presented results on the comparison between GMS satellite winds and rawinsonde winds. Results show a stable performance since July 1995.

III/4 Procedures for the exchange of inter-comparison data

No papers were submitted for this agenda item.

III/5 Derivation of Wind Vectors

EUM-WP-27 reported that high resolution winds from the Meteosat visible channel had a positive impact on the short-term forecasts at ECMWF. Improvements were verified by independent ERS scatterometer data.

EUM-WP-28 described the current status of the prototyping of atmospheric motion vectors for MSG. Various height assignments are being tested and will be reported as appropriate. The complexity of the automated quality control was cited and members were referred to the working paper for the details. The group noted the potential improvements due to these two schemes.

The Working Group discussed the new concept of "adaptive observations" as applied to satellite winds. The concept of "adaptive observations" in which intensive observations focus on areas of rapid forecast error growth, was introduced and its implications on the design of future data processing was discussed. It was pointed out that cloud tracked winds naturally provided detailed information on wind fields where mesoscale disturbances are present. It was also noted that descriptions of large scale wind fields were needed for tropical cyclone forecasts.

PRC-WP-05 described the calculation of cloud motion winds from GMS-5 in China. This was a follow on to PRC's presentation at CGMS-XXIV and the 3rd International Winds Workshop. The Working Group cited the PRC efforts for their continued analysis and implementation of winds derivation in China and the sharing of the results with the international winds community.

PRC-WP-05, EUM-WP-26 and USA-WP-19 were cited by the Working Group to be included in the final CGMS XXV report.

III/6 Derivation of Sea Surface Winds

The group noted the necessity to include reports on the development of passive and active microwave remote-sensing of sea surface winds in the future agenda of the Winds Working Group. JAPAN-WP-11 reported that the assimilation of sea surface winds data from ADEOS/NSCAT and ERS-2 had positive impact on the global medium-range forecast.

The Working Group concluded the session by thanking the Chairman and the Rapporteur for the efficient and diligent work.

FINAL PLENARY SESSION:

SENIOR OFFICIALS MEETING

J.1 APPOINTMENT OF CHAIRMAN

The CGMS XXV Senior Officials meeting was convened at 9.15 a.m. on 6 June 1997 and elected Dr. Hinsman and Dr. Uspensky as Co-Chairmen.

J.2 REPORTS FROM THE WORKING GROUPS

The reports from the three Working Groups were presented by their Chairmen: Mr. R. Wolf (Working Group I on Telecommunications), Dr. A. Uspensky (Working Group II on Satellite Products) and Dr. Sato (Working Group III on Satellite-tracked Winds).

The Senior Officials took note of the reports and endorsed the proposed actions and recommendations formulated. They thanked the participants, Chairmen and Rapporteurs for their fruitful discussions and for their comprehensive reports.

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 ITWG,
- Dr. T. Mohr	will represent CGMS at the WMO EC in June 1997,
- Mr. W. J. Hussey	will represent CGMS at the WMO CBS/WG-SAT,
- Dr. J. Schmetz	will be Rapporteur at the Winds Workshop,
- Mr. R. Wolf	will represent CGMS at the SFCG and WRC,
- The Secretariat	will represent CGMS at CEOS plenary.

J.4 ANY OTHER BUSINESS

Mr. Bridge recalled the earlier suggestion to increase the number of IDCS channels and proposed to consider such an increase in order to accommodate data collection from the HYCOS project. The senior officials invited EUMETSAT to forward a detailed request on this matter.

J.5 SUMMARY LIST OF ACTIONS

(i) Permanent actions

1. 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.

2. All satellite operators to circulate regular satellite operational reports.

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.

4. USA to issue quarterly to all other admitting authorities the consolidated DCP assignments.

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

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

7. 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.

(ii) Outstanding actions from previous meetings

ACTION 24.11 NOAA to provide to all CGMS Members its design specifications and certification procedures for 300 bps DCP before CGMS XXVI.

ACTION 24.12 CGMS Members to review and provide comments to NOAA regarding NOAA's 300 bps DCP design and certification procedures, before CGMS XXVI.

ACTION 24.13 NOAA to present at CGMS XXV, a proposed design and certification plan for 300 bps DCPs for acceptance as a "standard" by CGMS Members at CGMS XXVI.

(iii) Actions from CGMS XXV

ACTION 25.01 Russia to provide the CGMS Secretariat by 1 July 1997, with description of the raw image data transmission from GOMS.

ACTION 25.02 EUMETSAT to circulate by 1 July 1997 to Russia, PRC and Japan a copy of the EUMETSAT-NOAA bilateral agreement on contingency back-up, to be used as a reference for future contingency arrangements.

ACTION 25.03 All operators to report at CGMS XXVI about the outcome of consultations on the possibility to develop regional contingency arrangements.

ACTION 25.04 WMO to present the Statement of Guidance on Feasibility of Meeting Requirements to CGMS XXVI.

ACTION 25.05	EUMETSAT to provide CGMS Members with direct FTP access, via Internet, to the IDCS database.
ACTION 25.06	Japan, with the assistance of the CGMS Secretariat, to identify a DCP observation data set and analysis scheme, suitable for an IDCS end-to-end system test.
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 WMO on a quarterly basis.
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 1997, and report the results to CGMS XXVI.
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).
ACTION 25.10	CGMS Members to provide the Secretariat with proposals for an expansion of the IDCS in the year 2000 time frame.
ACTION 25.11	CGMS Members to inform the Secretariat of any revision or corrections to the IDCS User Guide (Issue 7) by 30 September 1997.
ACTION 25.12	CGMS Secretariat to prepare an update of the IDCS guide for review by CGMS Members at CGMS XXVI.
ACTION 25.13	WMO to provide Russia with the detailed information necessary to process ASDAR data, by 31 July 1997.
ACTION 25.14	The USA to convene a special meeting of experts with participation of EUMETSAT, ESA and WMO, on the LRPT specification, by 30 September 1997.
ACTION 25.15	All CGMS Members to review the draft LRPT Specification proposed in EUM-WP-09, by 1 January 1998.
ACTION 25.16	CGMS satellite operators to review the draft initial requirements for the Application and Presentation Layer Specifications for LRIT/LRPT/HRIT/HRPT Data Format, which were developed by the Chairman of the CBS Working Group SAT Subgroup on Small Workstations, and provide comments to WMO prior, by 31 October 1997.
ACTION 25.17	CGMS Members to review by 30 September 1997 the proposed update to the LRIT/HRIT Global Specification Issue 2.4 and express comments or approval to EUMETSAT.

ACTION 25.18	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.
ACTION 25.19	WMO and EUMETSAT to jointly prepare the on-line distribution of CGMS Tables of Satellites.
ACTION 25.20	Russia to report at CGMS XXVI on its efforts to remove interference affecting the 401 – 403 MHz frequency band used for DCP.
ACTION 25.21	The CGMS Secretariat to contact CLS/ARGOS in order to seek information on the operation of long-term future ARGOS services, including any possible expansion in use of frequency band, by 30 September 1997.
ACTION 25.22	WMO to establish a list server for WRC 97 on the basis of participants list to be provided by CGMS Members. Details of server content to be provided to CGMS Members in the near future.
ACTION 25.23	Russia to provide CGMS with information about the development of a DCP relay system operating at 1200 bps before CGMS XXVI.
ACTION 25.24	Japan to provide CGMS with information about its development of a DCP relay system operating at higher data rates before CGMS XXVI.
ACTION 25.25	CGMS Members to provide WMO with ideas on content and further enhancements of the CGMS homepage before CGMS XXVI.
ACTION 25.26	The USA to report on its development of integrated products at CGMS XXVI.
ACTION 25.27	The USA, EUMETSAT and Japan to report at CGMS XXVI on their continuing development work for the intercalibration of polar and geostationary satellites.
ACTION 25.28	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.
ACTION 25.29	Each CGMS operator to commence satellite intercalibration activities and to identify a coordinator for such activity before CGMS XXVI.
ACTION 25.30	All CGMS satellite operators to request an AVHRR and/or HIRS dataset with the assistance of NOAA/NESDIS, for cross-calibration with their geostationary satellite, by 31 October 1997 and NOAA/NESDIS to provide the data on request.
ACTION 25.31	All CGMS satellite operators to report at CGMS XXVI on their additional cross-calibration activities using foreign satellite data.

ACTION 25.32 EUMETSAT to provide at CGMS XXVI the results of initial tests by ECMWF of the forthcoming 4D-variational analysis.

ACTION 25.33 All CGMS Members to report on their procedures for transferring into operation the results of their research on product development, at CGMS XXVI.

ACTION 25.34 All CGMS wind operators to present their wind product development plan at CGMS XXVI.

ACTION 25.35 WMO to consider hosting the 4th International Workshop on Winds in Switzerland in 1998.

ACTION 25.36 CGMS Members to report quarterly winds statistics via the CGMS server supported by the WMO.

ACTION 25.37 CGMS wind operators to include all operational winds (low and high density) in the operational statistics following the approved reporting format.

ACTION 25.38 EUMETSAT to report at CGMS XXVI on the use of Satellite Tracked Winds at NWP Centres.

ACTION 25.39 EUMETSAT to forward a formal and detailed proposal regarding the possible use of one IDCS channel to support the WMO-HYCOS project, and CGMS satellite operators to respond by 31 July 1997.

J.6 APPROVAL OF DRAFT FINAL REPORT

The plenary session, with all Senior Officials present, 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 comment prior to publication.

It was agreed that the final version of the report would be made available through normal and electronic mail to the participants.

J.7 DATE AND PLACE OF NEXT MEETINGS

CGMS was very pleased to accept the offer by Japan to host CGMS XXVI in 1998, at a date and place to be agreed upon between the host and Secretariat.

CGMS was also very pleased to note that the People's Republic of China was preparing to host CGMS XXVII.

On behalf of all participants, Dr. Hinsman thanked Roshydromet for its hospitality and for the arrangements, which allowed fruitful discussions in the beautiful city of St. Petersburg.

Dr. Uspensky thanked all the participants and the Chairman for their contribution, which resulted in so much progress being made over these five days. He wished success to all participants in their undertakings.

Mr. Hussey thanked the CGMS Secretariat and all the organisation team for their valuable support to the meetings.

Dr. Mohr expressed his high appreciation of the progress made on all CGMS actions and of the effectiveness of CGMS as a global coordination body. He thanked WMO for representing the user community and Dr. Hinsman for his skillful chairmanship.

The meeting was adjourned at 11.00 a.m. on 6 June 1997.

AGENDA OF CGMS XXV
St. Petersburg, 2-6 June 1997

A. PRELIMINARIES

A.1 Introduction
A.2 Election of Chairman
A.3 Adoption of Agenda and Work Plan of Working Group Sessions
A.4 Arrangements for the 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

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 Introduction and election of a Chairman
I/2 Coordination of frequency allocations: SFCG, ITU WP and WRC activities
I/3 Telecommunication techniques
I/4 Online information system
I/5 Conclusion and preparation of the Working Group report

WORKING GROUP II: SATELLITE PRODUCTS

II/1 Introduction and election of a Chairman
II/2 Image processing techniques
II/3 Satellite Data Calibration
II/4 Vertical sounding and ITWG matters
II/5 Other parameters and products
II/6 Coordination of Code forms for satellite Data
II/7 Coordination of Data Formats for the Archive and Retrieval of Satellite Data
II/8 Conclusion and preparation of the Working Group Report

WORKING GROUP III: SATELLITE TRACKED WINDS

III/1 Introduction and election of a Chairman
III/2 Outcome of the 3rd International Workshop on Winds
III/3 Wind statistics
III/4 Procedures for the exchange of inter-comparison data
III/5 Derivation of Wind vectors
III/6 Conclusion and preparation of Working Group 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 XXV
J.6 Approval of Draft Final Report
J.7 Date and Place of Next Meetings

WORKING PAPERS SUBMITTED TO CGMS-XXV

EUMETSAT

EUM-WP-01	Review of Action Items	A.5
EUM-WP-02	Status of the Meteosat System (incl. Meteosat 7)	B.2
EUM-WP-03	Status of Preparation of the EUMETSAT Polar System	C.1
EUM-WP-04	Status of Preparation of MSG	C.2
EUM-WP-05	Plans for the EUMETSAT Satellite Applications Facilities (SAF)	C.2
EUM-WP-06	Status of the IDCS	F.1
EUM-WP-07	Detection and Localisation of Interference Sources in the 401-403 MHz Band	F.1
EUM-WP-08	Current status of the LRIT/HRIT Global Specification and the MSG Mission Specific Implementation	G.1
EUM-WP-09	EUMETSAT Polar System (EPS) METOP HRPT/LRPT Broadcast Services Specification	G.1
EUM-WP-10	Status of Foreign Satellite Data Relay via Meteosat	G.3
EUM-WP-11	Search and Rescue on MSG	H.2
EUM-WP-12	Report on EUMETSAT Training Activities and Plans	H.4
EUM-WP-13	EUMETSAT Conferences, Publications and the CGMS Directory of Meteorological Satellite Applications	H.5
EUM-WP-14	Report from the 2nd EUMETSAT User Forum in Africa	H.5
EUM-WP-15	Preparations for the World Radio Conference 1997	I.2
EUM-WP-16	Registration of Meteosat User Stations	I.2
EUM-WP-17	Ground Stations of CGMS Members Operating in the Frequency Band 1670 -1690 MHz	I.3
EUM-WP-18	Status of EUMETSAT External Information System	I.4
EUM-WP-19	A Satellite Intercalibration Strategy: Application to Meteosat and AVHRR IR-Window Observations	II.3
EUM-WP-20	Vicarious Calibration of Solar Radiance Measurements from Satellites – Application to Meteosat-5	II.3
EUM-WP-21	ATOVS Development	II.4
EUM-WP-22	Monitoring Deep Convection and Convective Overshooting with Meteosat	II.5
EUM-WP-23	Operational and Test BUFR Products from the MPEF	II.5/6
EUM-WP-24	Summary of The Third International Winds Workshop	III.2
EUM-WP-25	Radiosonde Collocation Statistics for Meteosat Cloud Motion Winds	III.3
EUM-WP-26	Use of Satellite Winds at NWP Centers	III.3
EUM-WP-27	Low-Level Cloud Motion Winds from Meteosat High-Resolution Visible Imagery	III.5
EUM-WP-28	Prototyping of Atmospheric Motion Vectors for Meteosat Second Generation	III.5
EUM-WP-29	CEOS CAL/VAL Cross-Satellite Calibration Activities	II.3
EUM-WP-30	Operational products from Meteosat Second Generation	II.5
EUM-WP-31	Summary of CGMS Rapporteur on Winds in Response to Actions of CGMS XXIV in Lauenen	III.2
EUM-WP-32	List of Geostationary and Polar Satellites Coordinated within CGMS	H.5

JAPAN

JAPAN-WP-01	Review of Action Items from Previous CGMS Meetings	A.5
JAPAN-WP-02	Status of GMS-5	B.2
JAPAN-WP-03	Status of GMS-4	B.2
JAPAN-WP-04	Report on Status of Satellite Systems: Present Status of Geostationary Meteorological Satellites	B.2
JAPAN-WP-05	Correction of IR calibration table for GMS-5	B.2
JAPAN-WP-06	Future Geostationary Meteorological Satellite Systems	C.2
JAPAN-WP-07	Status of IDCS	F.1
JAPAN-WP-08	Monitoring of interference in IDCS channels	F.1
JAPAN-WP-09	Summary of IDCP message transaction	F.4
JAPAN-WP-10	Plan of LRIT service	G.1
JAPAN-WP-11	Quality Control, Assessment and Distribution of NSCAT Data for Use in NWP	G.3
JAPAN-WP-12	Development of CAL	H.4
JAPAN-WP-13	Report from APSATS	H.4
JAPAN-WP-14	Products of GMS-5 and Evaluation of their Accuracy	II.5
JAPAN-WP-15	Issue of CD-ROM Monthly Report of the MSC	H.5
JAPAN-WP-16	Results of comparison between GMS Cloud Motion and Water Motion Wind and the rawinsonde data	III.3

PEOPLE'S REPUBLIC OF CHINA

PRC-WP-01	The Status of FY-1 C Program	C.1
PRC-WP-02	The CHRPT Data Format of FY-1 C & D	G.1
PRC-WP-03	The Status of FY-2 Program	C.2
PRC-WP-04	The Deployment of Satellite Data Direct Receiving Station in China	H.6
PRC-WP-05	Calculation of Cloud motion Wind with GMS-5 Images in China	III.5

RUSSIAN FEDERATION

RUS-WP-01	Status of METEOR Polar Orbiting Meteorological Systems	B.1
RUS-WP-02	Status of GOMS/ELEKTRO Geostationary Operational Meteorological System	B.2
RUS-WP-03	Future Polar Orbiting Meteorological Systems	C.1
RUS-WP-04	Future Geostationary Meteorological Satellite GOMS N2	C.2
RUS-WP-05	Status of WEFAX dissemination via GOMS/ELEKTRO Satellite	G.1
RUS-WP-06	Status of the system of GOMS IR Data Dissemination via METEOSAT	G.3
RUS-WP-07	Status of DCP Message Dissemination via GOMS/ELEKTRO Satellite	F.4
RUS-WP-08	Roshydromet Activities on Coordination and Frequency Allocation	I.2
RUS-WP-09	Technology of SST mapping using Data from GOMS and NOAA	II.5
RUS-WP-10	Hazards Diagnosis using OKEAN Satellite Data	II.5
RUS-WP-11	Satellite Radar Data Monitoring of Polar Ice Cover	II.5

USA

USA-WP-01	Review of CGMS XXIV Action Items	A.5
USA-WP-02	Report on the status of Current Operating Systems	B.1-2
USA-WP-03	Polar Orbiting Operational Environmental Satellite (POES)	C.1
USA-WP-04	Future Polar Orbiting Meteorological Satellite System	C.1
USA-WP-05	Report on the Status of Future Geostationary Meteorological Satellite System	C.2
USA-WP-06	Coordination of International Data Collection & Distribution (ASAP)	F.2
USA-WP-07	Coordination of International Data Collection & Distribution (GTS)	F.4
USA-WP-08	Status of Development of the Low Rate Picture Transmission System	G.1
USA-WP-09	Ocean Remote Sensing: A Comprehensive Program to Observe Oceanographic Phenomena from Space	H.1
USA-WP-10	International Cospas-Sarsat System	H.2
USA-WP-11	AERONET: Network Aerosol Monitoring Program	H.1
USA-WP-12	Preparations for WRC-97	I.2
USA-WP-13	Summary of the 1996 Space Frequency Coordination Group Meeting	I.2
USA-WP-14	The Online Systems at NOAA's Satellite Active Archive	I.4
USA-WP-15	Intercalibration of GEOS, Meteosat, and HIRS Infrared Radiances	II.3
USA-WP-16	Suggested Program for Intercalibration of GMS, GOMS and METEOSAT, Versus HIRS and AVHRR Infrared Radiances	II.3
USA-WP-17	GOES Sounder Temperature and Moisture Retrievals in 1996	II.4
USA-WP-18	Report on ITSC-IX to CGMS XXV	II.4
USA-WP-19	1996 Performance of the NOAA-NESDIS Automated Cloud- Motion Vector System	III.3
USA-WP-20	North American Atmospheric Observation System (NAOS) Programme	E.2

WMO

WMO-WP-01	Satellite Ground Receiving Equipment Database	H.5
WMO-WP-02	Review of Action Items from previous CGMS Meetings	A.5
WMO-WP-03	APT and WEFAX Conversion	G.1
WMO-WP-04	List Servers	H.5
WMO-WP-05	Report, WMO and CEOS Affiliates' Satellite Data Requirements and Databases	E.1
WMO-WP-06	Report, Training event in Melbourne, Australia	H.4
WMO-WP-07	Swiss/WMO Satellite Receiving Project	H.6
WMO-WP-08	Review of Satellite Related Publications	H.5
WMO-WP-09	Digital Satellite Image Data and Extracted Product Exchange over the GTS	G.3
WMO-WP-10	ASDAR	F.3
WMO-WP-11	WMO Code Form Changes	G.2
WMO-WP-12	Radio Frequency Matters	I.2
WMO-WP-13	Report on GCOS Activities	E.2
WMO-WP-14	Registration of Satellite and Receiving Stations with ITU	I.2
WMO-WP-15	CGMS Homepage	I.4
WMO-WP-16	Application Layer and Presentation Layer Specifications for LRIT/LRPT/HRIT/HRPT Data Format	G.1
WMO-WP-17	WMO Strategy to Improve Satellite System Utilization	E.1
WMO-WP-18	ASAP Performance in 1996 – An Overview	F.2

LIST OF PARTICIPANTS IN CGMS XXV

EUMETSAT

Mr. Gordon **BRIDGE**
CGMS Secretariat
User Service Manager

Dr. Eva **ORIOL-PIBERNAT**
METOP and MSG Mission Manager
European Space Agency

Mr. Jérôme **LAFEUILLE**
CGMS Secretariat
Head of International Affairs

Ms. Maria Ruth **ROBSON**
CGMS Secretariat
International Affairs Assistant

Dr. Tillmann **MOHR**
Director

Dr. Johannes **SCHMETZ**
Head of Meteorological Division

Ms. Angela **NICHOLAS**
Assistant to the Director

Mr. Robert **WOLF**
Head of Ground Support Division

JAPAN METEOROLOGICAL AGENCY

Mr. Kazuo **IDE**
Japan Meteorological Agency

Mr. Kunio **TAKASE**
Associate Senior Engineer
Earth Observation Satellite Department
NASDA

Mr. Nobuo **SATO**
Head, Office of Met. Sat. Planning
Japan Meteorological Agency

STATE METEOROLOGICAL ADMINISTRATION OF THE PRC

Prof. **XU** Jianping
Satellite Meteorology Center
China State Meteorological Administration

HYDROMET SERVICE OF THE RUSSIAN FEDERATION

Prof. Serguei I. **AVDIUSHIN**
Deputy Head
Roshydromet

Mrs. Tatiana N. **BOURTSEVA**
RPA "Planeta"

Mr. Valeri L. **FERBEROV**
Roshydromet

Mr. Alexander I. **GUSEV**
Roshydromet

Mr. Vladimir F. **KHARITONOV**
VNIIEM

Mr. Anatoli D. **KUSNETSOV**
LGMI (State Meteorological Institute of Leningrad)

Mrs. Elena B. **MANAENKOVA**
RPA "Planeta"

Mr. Nikolai F. **MIKHAILOV**
RSC RSA (Scientific and Research Centre of Remote Sensing of the Atmosphere)

Mr. Oleg M. **POKROVSKI**
GGO (Main Geophysical Observatory)

Mr. Rashid S. **SALIKHOV**
NIEM

Mr. Georgi G. **SHUKIN**
RSC RSA (Scientific and Research Centre of Remote Sensing of the Atmosphere)

Prof. Urij V. **TRIFONOV**
Deputy Director
VNIIEM

Mr. Alexander U. **TRUDOVOI**
RPA "Planeta"

Dr. Alexander B. **USPENSKY**
General Director
RPA "Planeta"

Mr. Alexander V. **VLADIMIROV**
NIEM

NOAA/NESDIS OF THE USA

Mr. John **HUSSEY**
Director
Office of Systems Development
NOAA/NESDIS

Mr. Carl **STATON**
Deputy Chief
Information Processing Division
NOAA/NESDIS

Mr. Jonas **WECHSLER**
International Affairs
NOAA/NESDIS

Mr. Fred **ZBAR**
Chief
Technology and Forecast Systems
NOAA/National Weather Service

WORLD METEOROLOGICAL ORGANIZATION

Dr. Donald **HINSMAN**
Senior Scientific Officer
WMO Satellite Activities

MEMBERS OF WORKING GROUP I
TELECOMMUNICATIONS

Mr.	Gordon Bridge	EUMETSAT
Mr.	Robert Wolf	EUMETSAT
Mr.	Kazuo Ide	JMA, Japan
Mr.	Kunio Takase	NASDA, Japan
Prof.	Xu Jianping	SMC/CSMA, PRC
Mr.	Valeri L. Ferberov	Roshydromet, Russian Federation
Mr.	Alexander I. Gusev	Roshydromet, Russian Federation
Mr.	Alexander U. Trudovoi	RPA “Planeta”, Russian Federation
Mr.	John Hussey	NOAA/NESDIS, USA
Mr.	Jonas Wechsler	NOAA/NESDIS, USA

MEMBERS OF WORKING GROUP II
SATELLITE PRODUCTS

Dr.	Johannes Schmetz	EUMETSAT
Mr.	Nobuo Sato	JMA, Japan
Mr.	Valeri L. Ferberov	Roshydromet, Russian Federation
Dr.	Alexander B. Uspensky	RPA "Planeta", Russian Federation
Mr.	Carl Staton	NOAA/NESDIS, USA
Mr.	Fred Zbar	NOAA/Nat. Weather Service, USA

MEMBERS OF WORKING GROUP III
CLOUD MOTION WINDS

Dr.	Tillmann Mohr	EUMETSAT
Dr.	Johannes Schmetz	EUMETSAT, Rapporteur
Dr.	Eva Oriol-Pibernat	ESA
Mr.	Kazuo Ide	JMA, Japan, Chairman
Mr.	Nobuo Sato	JMA, Japan
Mr.	Kunio Takase	NASDA, Japan
Prof.	Xu Jianping	SMC/CSMA, PRC
Dr.	Alexander B. Uspensky	RPA "Planeta", Russian Federation
Mr.	John Hussey	NOAA/NESDIS, USA
Mr.	Carl Staton	NOAA/NESDIS, USA
Mr.	Fred Zbar	NOAA/Nat. Weather Service, USA

CURRENT AND FUTURE GEOSTATIONARY SATELLITES COORDINATED WITHIN CGMS

Update: June 1997

Sector	Satellites currently in orbit (+type) Op: Operational P: Pre-operational B: Back-up L: Limited availability	Operator	Loca-tion	Launch date, Status	Future additional satellites	Operator	Planned launch (Planned location) Other remarks
EAST-PACIFIC (180°W-108°W)	**GOES-9 (Op)**	US/NOAA	135°W	(05/ 95) minor imager anomalies	GOES-M GOES-L GOES-N GOES-O GOES-P GOES-Q	US/NOAA US/NOAA US/NOAA US/NOAA US/NOAA US/NOAA	2000 2002 2002 2005 2007 2010
WEST-ATLANTIC (108°W-36°W)	**GOES-8 (Op)** GOES-10 (P) GOES-7 (B)	US/NOAA US/NOAA US/NOAA	75°W 105°W 90°W	(04/ 94) minor sounding anomalies (04/97) in commissioning (02/87) stand-by			
EAST - ATLANTIC (36°W-36°E)	**METEOSAT-6 (Op)** METEOSAT-5 (B)	EUMETSAT EUMETSAT	0°	(11/ 93) minor gain anomaly on IR imager (03/91) Functional, minor imager anomaly	Meteosat-7 MSG-1 MSG-2 MSG-3	EUMETSAT EUMETSAT EUMETSAT EUMETSAT	08/1997 (0°) 2000 (0°) 2002 (0°) 2006 (0°)
INDIAN OCEAN (36°E-108°E)	GOMS-N1 (P) FY-2 (P) INSAT II-B (L) INSAT I-D (L)	RUSSIA CHINA INDIA INDIA	76°E 105°E 93.5°E	(11/94) Disseminates 3-hourly IR images (06/97) Experimental Satellite (07/93) Cloud imagery for domestic use but wind products available on WMO GTS	GOMS-N2 INSAT II-E	RUSSIA INDIA	(76°E) 1998
WEST-PACIFIC (108°E-180°E)	**GMS-5 (Op)**	JAPAN	140° E	(03/ 95) operational	MTSAT-1	JAPAN	09/1999, Multi-functional Transport Satellite

Annex 6

CURRENT AND FUTURE POLAR-ORBITING SATELLITES COORDINATED WITHIN CGMS

Update: June 1997

Orbit type **(equatorial crossing times)**	**Satellites in orbit (+operation mode)** **Op=operational** **B=back-up** **L=limited availability**	**Operator**	**Crossing Time** **A=Northw** **D=Southw** **+Altitude**	**Launch date, Status**	**Future Additional Satellites**	**Operator**	**Planned launch date Other information**
Sun-synchr. **"Morning"** **(6:00 - 12:00)** **(18:00 - 24:00)**	**NOAA-12 (Op)** NOAA-11 (B) NOAA-9 (B)	USA/NOAA USA/NOAA USA/NOAA	06:40 (D) 850 km 07:20 (D) 10:00 (D) 840 km	05/ 91 Functional 09/88 Sounding only 12/ 84. Partly functional	NOAA-K METOP-1 METOP-2 METOP-3 METEOR 3M-1 METEOR 3M-2	USA/NOAA EUMETSAT EUMETSAT EUMETSAT Russia Russia	02/1998 (850 km) (7:30) 2002 (827 km) (9:30) 2007 (827 km) (9:30) 2010 (827 km) (9:30) 1998 (9:15) 2000 (9:15)
Sun-synchr. **"Afternoon"** **(12:00 - 16:00)** **(00:00 - 04:00)**	**NOAA-14 (Op)**	USA/NOAA	14:00 (A) 850 km	12/ 94 Functional	NOAA-L NOAA-M NOAA-N NOAA-N' NPOESS-1 NPOESS-3	USA/NOAA USA/NOAA USA/NOAA USA/NOAA USA/NOAA USA/NOAA	12/1999 (13.30) 04/2001) (13:30) 12/2003 (13.30) 07/2007 (13.30) 2008 (13:30) 2013 (13.30)
Sun-synchr. **"Early morning"** **(4:00 - 6:00)** **(16:00 - 18:00)**	DMSP-F12 (L)	USA/DOD	05:30 (D) 830 km	(01/95) Defense satellite. Data partly available to civilian users	NPOESS-2 NPOESS-4	USA/NOAA USA/NOAA	2010 (05:30) 2015 (05:30)
Non sun-synchronous or unspecified orbits	**METEOR 2-21 (Op)** **METEOR 3-5 (Op)**	Russia Russia	950 km 1200 km	08/ 93 Operational 08/ 91 Operational	RESURS 01-4 FY-1 C FY-1 D	Russia China China	1997. Partly met. mission 1998 2000

Appendix A:

SELECTED PAPERS SUBMITTED TO CGMS XXV

CGMS-XXV USA-WP-3
Prepared by: USA
Agenda Items: C.1

Future Polar Orbiting Meteorological Satellite Systems

POLAR-ORBITING OPERATIONAL ENVIRONMENTAL SATELLITE POES

ABSTRACT

The NOAA Polar-orbiting Operational Environmental Satellite (POES) system has been providing continuous observations of the earth since April, 1960. This highly successful program continues today with a two satellite constellation providing a variety of meteorological, oceanographic, climatic and other specialized data collection services. Currently, we are operating NOAA-12 as the primary AM satellite and NOAA-14 as the primary PM satellite. Our next satellite, NOAA-K (which will become NOAA-15 after it is launched) represents a new generation of polar satellites. There will be new microwave sounding instruments (AMSU-A and AMSU-B) and improved versions of the visible/infrared imager/radiometer (AVHRR/3) and infrared sounder (HIRS/3). We are also upgrading the ground processing software to handle the new NOAA-K capabilities. Our long term plans call for increasing cooperation with EUMETSAT as METOP will become the operational AM satellite in 2002. Finally, NOAA and EUMETSAT, in cooperation with the U.S. Department of Defense, are in the initial phases of developing a new three satellite polar constellation which will also meet the United States national security requirements for remotely sensed environmental data.

History / Background

For more than 30 years the United States has provided a satellite based, global meteorological and environmental monitoring system. The present system collects imagery and measures atmospheric temperature and humidity, sea surface temperature, cloud cover, water-ice boundaries, ozone concentrations, aerosol distributions, vegetation indices, snow cover, earth radiation and proton and electron flux near the Earth. Data are also retransmitted from balloons, buoys and remote automatic stations for in-situ collection. In addition, the satellites provide Search and Rescue location and rescue services to downed aircraft and vessels in distress at sea. All of the aforementioned data are transmitted, in real time and at no cost, to all users with necessary receiving equipment under an "open-skies" policy. Currently, about 1000 wide band (HRPT) and several thousand small (APT) users worldwide receive and use POES data.

The current NOAA Polar-orbiting Operational Environmental Satellite constellation is comprised of two satellites flying in complementary, circular, sun-synchronous orbits:

1. A "morning" or AM orbit (833km altitude, 98.86 degree inclination, 102 minute period).

2. An "afternoon" or PM orbit (870km altitude, 98.70 degree inclination, 101 minute period).

In the United States the "afternoon" mission is primary with the "morning" mission providing supplementary and back-up coverage. In Europe the converse is true with the "morning" mission providing the primary coverage.

On-Orbit Satellites

The present on-orbit satellites represent the fourth generation of the NOAA series of spacecraft. The baseline instruments for this fourth generation series of satellites are:

Advanced Very High Resolution Radiometer/2 (AVHRR/2): The AVHRR is a five channel scanning radiometer providing two channels in the visible/near infrared and three infrared channels. The visible and the near IR channels observe vegetation, clouds, lakes, shorelines, snow and ice. The other three IR channels detect heat radiation from clouds, land, and water to determine sea surface temperatures, aerosols and radiation budget.

High Resolution Infrared Radiation Sounder (HIRS/2): The HIRS/2 is a filter wheel infrared radiometer. The HIRS takes radiance measurements in 19 spectral regions of the IR band and one in the visible band for relatively high resolution soundings to an altitude of about 40km.

Microwave Sounding Unit (MSU): The MSU is a four channel scanning microwave radiometer which supplements HIRS measurements especially in cloudy regions.

Stratospheric Sounding Unit (SSU): Provides temperature measurements in the upper stratosphere from radiance measurements made in three channels using pressure modulated gas (CO2) to accomplish selective band pass filtering of the sampled radiance.
Space Environmental Monitor (SEM): The SEM is a multichannel, charged particle spectrometer that measures the population of the Earth's radiation belts and the particle precipitation phenomena resulting from solar activity.

Solar Backscatter-Ultraviolet Spectral Radiometer (SBUV): The SBUV is a spectrally scanning ultraviolet radiometer that measures solar irradiance and scene radiance (backscattered solar radiance) in the 160 to 400 nanometers ultraviolet spectral range. From those measurements both the total ozone concentration and the vertical distribution of atmospheric ozone are determined.

Search and Rescue (S&R): The S&R receives distress signals from emergency beacons on the 121.5 Mhz, 243 Mhz and 406 Mhz international distress frequencies and retransmits them at 1544.5 MHz. The 406 MHz signals are also stored onboard for relay to local user terminals.

ARGOS/Data Collection System (DCS): Data collection platforms (buoys, free floating balloons,

remote weather stations) of the DCS system collect relevant data and transmit them to the satellite. This data is stored and later relayed to ARGOS processing centers.

Currently, the primary afternoon satellite is NOAA-14 and the primary morning satellite is NOAA-12. In additional we are using two older satellites--NOAA-9 and NOAA-11--to provide some additional data to our user community.

Next Series of Satellites

The next satellite to be launched will be the first of the fifth generation of NOAA satellites. The complement of baseline instruments has been modified discontinuing the MSU and SSU and adding two Advanced Microwave Sounding Units (AMSU-A and AMSU-B). All instruments are designed for a three year life.

The AMSU-A is a 15 channel microwave sounding unit providing higher resolution temperature sounding capability compared to the MSU. In addition, three window channels will provide information on precipitation, sea ice, snow cover and surface emissivity.

The AMSU-B, provided by the U.K. Met Office, is a five channel water vapor profiler allowing moisture measurements of the atmosphere. Three channels are centered on the 183.31 Ghz water vapor line. The other two are at 89 and 150GHz.

In addition to these new instruments, a number of modifications have been made to older designs. The AVHRR/2 has been updated to the AVHRR/3 by adding a sixth channel at 1.6 microns for improved snow/cloud discrimation and aerosol detection. This will be referred to as channel 3A and will operate during the daylight part of the orbit. Channel 3B corresponds to the previous channel 3 on the AVHRR/2 instrument and will operate during the night portion of the orbit. The exact timing of the operational switching of the channel between 3A and 3B has not been precisely determined yet but will most likely not be used in the morning orbit. A flag in word 22 of the telemetry will indicate which of the two channels is operating. The AVHRR/3 visible and near infrared channels (1,2 and 3A) all have "split gains" that require the use of two calibration equations per channel to increase sensitivity at low light levels.

CGMS-XXV USA-WP-3
Prepared by: USA
Agenda Items: C.1

The HIRS/2 has been replaced by the HIRS/3 with the primary change being a change in the calibration sequence. On HIRS/2, the calibration mode required the use of three calibration targets (space view, cold target and warm target). On HIRS/3, the cold target will not be used in the calibration sequence, resulting in one additional scan line of Earth data.

Other changes include an increase in the ARGOS system data transmission rate (from 1200 to 2560 bits per second), the SEM has added in-flight calibration capabilities and improved particle detection, and the Search and Rescue Processor has an additional data recovery unit.

While these changes individually seem relatively minor, they do have a significant impact on the data
formats coming from the satellites. We are making end-to-end changes in our data processing systems at NOAA to handle the new data formats. For users receiving the full raw data stream, we are providing the new stored formats. For direct readout users, both the Automatic Picture Transmission (APT) and the High Resolution Picture Transmission (HRPT) will change. The APT will incorporate channel 3A or 3B, whichever is operational. The HRPT change involves the minor frame format. Currently, the minor frame is repeated three times. Beginning with NOAA-K, the first minor frame will contain the HIRS/3, DCS, SEM and SBUV (in PM orbit configuration), the second minor frame will be spare, and the third minor frame will be the AMSU-A AND AMSU-B data. Within the first minor frame, the deletion of the MSU and SSU instrument will make available several words so specific data locations will change.

In addition to these real time format changes, we have also modified our NOAA 1b formats for all stored data. These changes are in response to user interaction and will improve the utility of these data.

This information is provided to alert users of the changes. We are currently developing a new polar-orbiting satellite user's guide which will detail the specifics of these changes to inform both direct readout and retrospective users of how to use the new data formats. This user's guide will be implemented on the polar satellite home page on the Internet. This information, along with other user help information will be on our NOAA service bulletin board at URL htt://psbsgil.nesdis.noaa.gov:8080/noaasis.html.

CGMS-XXV USA-WP-3
Prepared by: USA
Agenda Items: C.1

Projected Launches

The current planning launch dates are:

Satellite	Planning Launch
NOAA-K	Feb 1998
NOAA-L	Late 1999
NOAA-M	Mid 2001
NOAA-N	Late 2003
NOAA-N'	Mid 2007

Cooperation with Eumetsat

NOAA and EUMETSAT have agreed in principal and are in the final stages of formal approval of a cooperative joint polar program. The purpose of this cooperation is to continue and improve the operational meteorological and environmental forecasting and global climate monitoring services of the agencies. These services contribute to the wider objective of the World Meteorological Organization Global Observing System, the Global Climate Observing System, the United Nations Environmental Programme, the Intergovernmental Oceanographic Commission, and other related programs. The

NOAA/EUMETSAT joint program will continue the long-term continuity of observations from polar orbit furnished by the United States since 1960.

The basis of the agreement is that NOAA will provide spacecraft for flight in the afternoon orbit and EUMETSAT will provide spacecraft for flight in the morning orbit. NOAA will provide the full set of instrumentation currently flying on its morning satellite to EUMETSAT for inclusion on its morning satellite. EUMETSAT will provide a new Microwave Humidity Sounder to fly on both the NOAA and EUMETSAT satellites. Both agencies will make available to each other data collected from their respective satellites.

Convergence

On May 5, 1994, the President of the United States directed convergence of the Department of Commerce (DoC) NOAA POES program and the Department of Defense (DoD) Defense Meteorological Satellite Program (DMSP). These two programs will become the National Polar-orbiting Operational Environmental Satellite System (NPOESS) which will satisfy civil and national security operational requirements for environmental monitoring of the earth from polar orbit. This will be a cooperative effort between the DoC, DoD and NASA as defined in a Memorandum Of Agreement signed by the heads of these three agencies on May 26, 1995. An Integrated Program Office (IPO) has been established to develop, acquire, and implement NPOESS.

The operational concept involves a three satellite constellation with nodal crossing times of 0530,0930, and 1330. (The need for three platforms is driven by the U.S. DoD's global imagery refresh requirement.) Our plans would have the U.S. provide the early morning and afternoon platforms and EUMETSAT provide the mid-morning platform. While it is too early to define specifics on such arrangements, NOAA and EUMETSAT have begun dialog to determine the process by which METOP-3 and NPOESS can optimize instrumentation allocation across the platforms to achieve continuity and efficiency in both or our programs.

Summary

The NOAA POES program has provided continuous service to the world for over 35 years. Our next launch representing the fifth generation of satellites, combined with our planning efforts with the METOP and NPOESS reflect a great deal of changes over the next 10 years. We desire to maintain close ties with our user community through this time of change to ensure continuity and improved services and products.

CGMS-XXV WP-10
Prepared by Japan
Agenda Item : G . 1

Plan of LRIT service via the MTSAT

1. Introduction

JMA plans to implement LRIT service via the MTSAT. In the plan, imagery observed by the MTSAT will be provided. In addition, Grid Point Values (GPVs) produced by the Numerical Weather Prediction (NWP) of JMA will be provided to the meteorological organizations in Asian countries including typhoon committee members to fulfill one of the tasks of regional specialized meteorological center (RSMC). The present WEFAX service will be continued for a few years even after the commencement of LRIT service by time sharing transmission. The details of LRIT specifications are under consideration, they will be announced to users in this summer.

This paper describes a summary of draft plan of LRIT service via the MTSAT.

2. Dissemination data

Following data and products will be provided.

2.1 Image data

Image data will be provided as listed in Table-1.

Table-1 Projection type and observation channel

Projection type	Observation channel
Full earth disk of normalized geostationary projection	IR1 (11μm), IR3 (6.7μm)
Polar-stereographic projection covering East Asia	VIS, IR1, IR3, IR4 (3.7μm)
Polar-stereographic projection covering Japan	VIS

2.2 Products

GPVs produced by the NWP of JMA will be provided.

Observation data such as SYNOP, TEMP and SHIP will be provided.

3. Summary of specifications

Mission specific implementations are described in the following sections.

3.1 Physical layer

The characteristics of physical layer are shown in Table-2.

Table-2 Characteristics of physical layer

Length of coded VCDU	1020 octets
Center Frequency	1691.0 MHz
Bandwidth	[TBD]
Polarization	Linear horizontal
Packetized data rate	64 kbps
Total coded data rate	150 kbps
Modulation	PCM/NRZ-L/BPSK
Coding	Reed-Solomon (255,223) + convolution coding (1/2 rate, k=7)

3.2 Compression

Both lossless and lossy JPEG compression methods will be applied to the data as in Table-3. Compressed data including quantization and coding tables necessary for decompression will be described in the JPEG file interchange format.

Table-3 Compression methods

Data	Compression methods
Image data (Full earth disk)	lossless
Image data (Polar-stereographic)	lossy
NWP GPV data	lossless/ not compressed

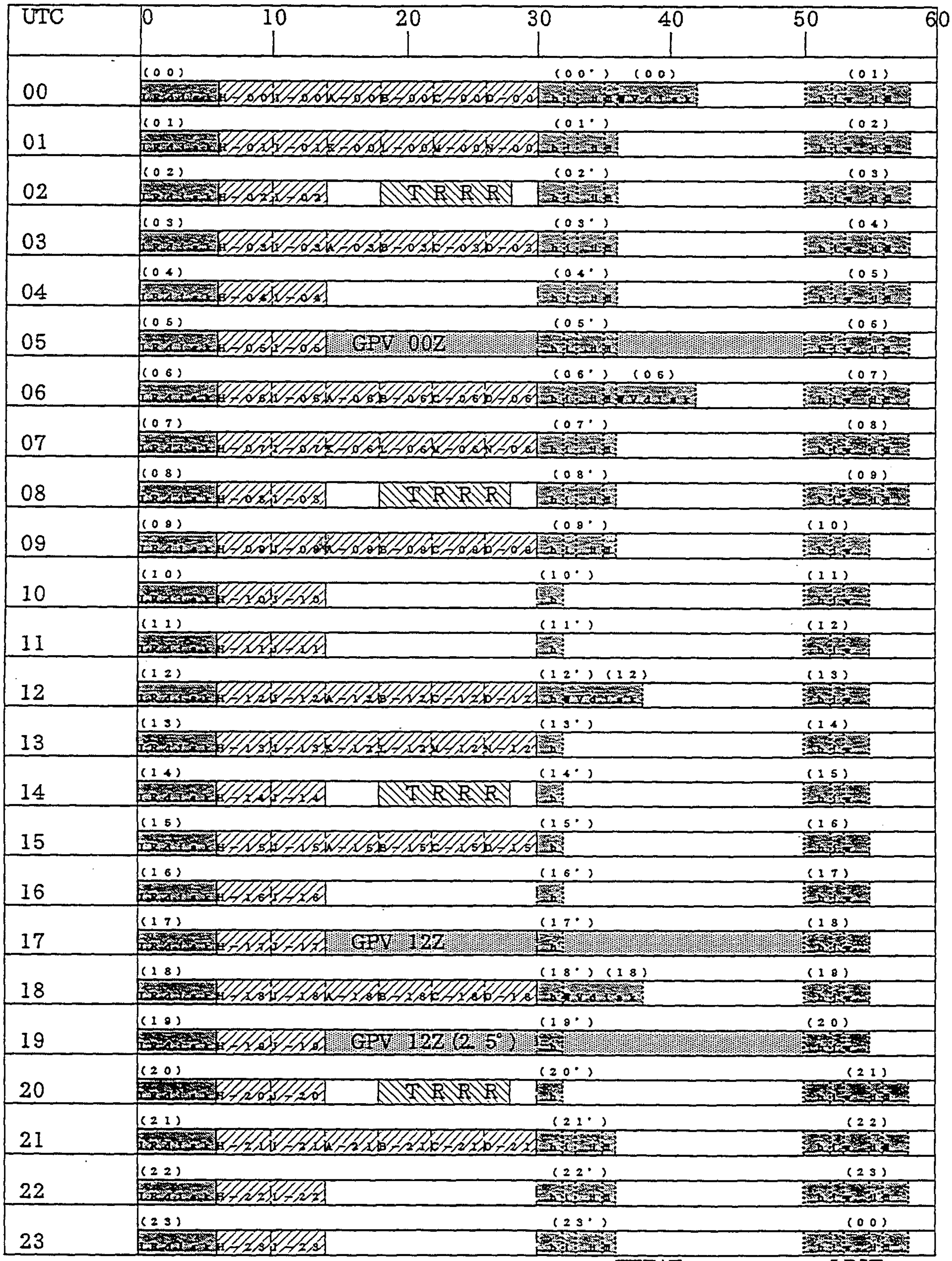
3.3 Encryption

In principle, data will be encrypted in the Electronic Code Book (ECB) mode of Data Encryption Standard (DES) algorithm.

4. Dissemination schedule

A draft schedule of LRIT/WEFAX dissemination is attached to this paper. LRIT will be transmitted irregularly within the scheduled time slots.

Schedule of LRIT/WEFAX dissemination (draft) Attachment



Remarks:			WEFAX	LRIT
: WEFAX	IR–PS	:	H	h:IR1
	IR–PS	:	J:enhanced	j:IR4
	VS–PS	:	I	i
: LRIT	VS–PS (detailed)	:		ii, iii
	WV–PS	:		w
	IR–Disk (partial)	:	A, B, C, D	IRdisk
: (trilateration)	WV–Disk (partial)	:	K, L, M, N	WVdisk

CGMS-XXV PRC WP-02
Prepared by China
Agenda Item: G.1

The CHRPT Data Format of FY-1 C &D

Summary

The data format of CHRPT of FY-1 C & D is described in detail. It is similar to the data format of NOAA satellite series.

The CHRPT Data Format of FY-1 C & D

The High Resolution Picture Transmission of FY-1 C & D is named CHRPT. CHRPT is transmitted in real time. The data format of CHRPT is similar to the data format of NOAA satellite series and is shown as follows:

Function	Frame Sync	ID	Time Code	Telemetry (Ramp)	Telemetry (Temperature)	Black Body	Space	Spare	Earth Data	Aux. Sync
Number of words	6	2	4	10	10	60	100	1408	20480	100

The CHRPT Parameters are as follows:

* Number of words of frame: 22180
* Number of channels: 10, 2048 words/channel
* Rate of frame: 6 frames/second
* Number of bits of word: 10 bits/word
* Rate of bit: 1.3308 Mbps
* Bit format: split phase
  Data 1, from high level to low level
  Data 0, from low level to high level

CHRPT Frame Format

Function	No. of Words	Word Position	Bit No. Meaning and Meaning
Frame Sync	6	1 2 3 4 5 6	1010000100 0101101111 1101011100 0110011101 1000001111 0010010101 First 60 bits are a 63 -bit PN generator started in the all 1's state. The generator polynomial is X + X + X + X + 1
I D	2	7 8	1-4 bit 1100 satellite ID 5-10 bit spare spare word
Time Code	4	9 10 10 11, 12	1-9 bit binary day count 10 bit 0, 1-3 bit 101 4-10 bit part of binary msec of day count part of binary mse of day count
Telemetry (Ramp Calibration)	10	13-22	Ramp Calibration of 10 channels of Multispectral Visible and IR Scan Radiometer (MVISR).
Telemetry (Temperature Measuring)	10	23	Temperature of the first stage of radiant cooler A
		24	Temperature of the first stage of radiant cooler B
		25	Temperature of the second stage of radiant cooler A
		26	Temperature of the second stage of radiant cooler B
		27	Temperature controlling voltage for the second stage of radiant cooler A
		28	Temperature controlling voltage for the second stage of radiant cooler B
		29-32	Temperature of sheath of radiometer, 1 word for one platinum resistance bulb.

CHRPT Frame Format
(continued)

Function	No. of Words	Word Position	Bit No. Meaning and Meaning
Reference Black Body	60	33-92	6 sampling words for every channel
Space	100	93-192	10 sampling words for every channel
Spare Words	1408	193-1600	00000 11101 Derived by inverting the 00000 01100 output of a 1023 bit PN 10010 01010 sequence provided by a ⋮ feedback shift register ⋮ generating the 00100 11110 polynominal: 11111 11000 X + X + X + X + 1 11000 01101 11011 00101
Earth Data	20480	1601-22080	2048 words for every channel from CH.1 to CH.10. Each frame contains the data obtained during one Earth scan of the MVISR sensor. The data from 10 sensor channels of the MVIRS are time multiplexed
Auxiliary Sync	100	22081-22180	11111 00010 Derived from the non-inverted 11111 10011 output of a 1023-bit PN 01101 10101 sequence provided by a ⋮ feedback shift register ⋮ generating the polynominal: 01111 10000 X + X + X + X + 1 11110 01100

CGMS-XXV EUM-WP-10
Prepared by EUMETSAT
Agenda Item: G.3

STATUS OF FOREIGN SATELLITE DATA RELAY VIA METEOSAT

This paper informs about the final configuration of the Foreign Satellite Data Relay at CMS Lannion and includes information on the required changes to the Meteosat Dissemination Schedule to allow for the inclusion of the additional Foreign Satellite Data.

STATUS OF FOREIGN SATELLITE DATA RELAY VIA METEOSAT

1 INTRODUCTION

After an upgrade of the so-called 'Foreign Satellite Data Relay' (FSDR) which is operated by Météo-France via the Centre de Météorologique Spatiale (CMS) in Lannion on EUMETSAT' behalf, additional Foreign Satellite Data (FSD) from GMS, GOES-W and GOMS has been included in the Meteosat Dissemination Schedule.

This paper provides information about:

-the final FSDR configuration,
-the required upgrade of existing SDUS/PDUS to allow for the operational use of the new WEFAX/HRI formats
-the calibration of GOES-W and GMS digital data,
-the implemented dissemination schedule changes and their rationale.

2 FINAL FSDR CONFIGURATION

In early 1997 the following activities had started to make additional FSD available via the FSDR in Lannion:

- installation/upgrade of communication links
- upgrade of the FSDR with an additional GOMS acquisition workstation
- modification of the FSDR dissemination computer H/W and S/W

In a first step the necessary communication infrastructure was established. Table 1 and figure 1 show the characteristics of the final communication infrastructure for the acquisition of all FSD.

link	data rate	type of data flow	link status
CMC Dorval - UKMO Bracknell	56.0 kbps	GOES-W	shared
ABoM Melbourne - UKMO Bracknell	19.2 kbps	GMS	shared
UKMO Bracknell - MF Toulouse	128 kbps	GOES-W + GMS	shared
MF Toulouse - CMS Lannion	128 kbps	GOES-W + GMS	shared
Roshydromet Moscow - CMS Lannion	9.6 kbps	GOMS	dial-up

Table 1 Communication link characteristics

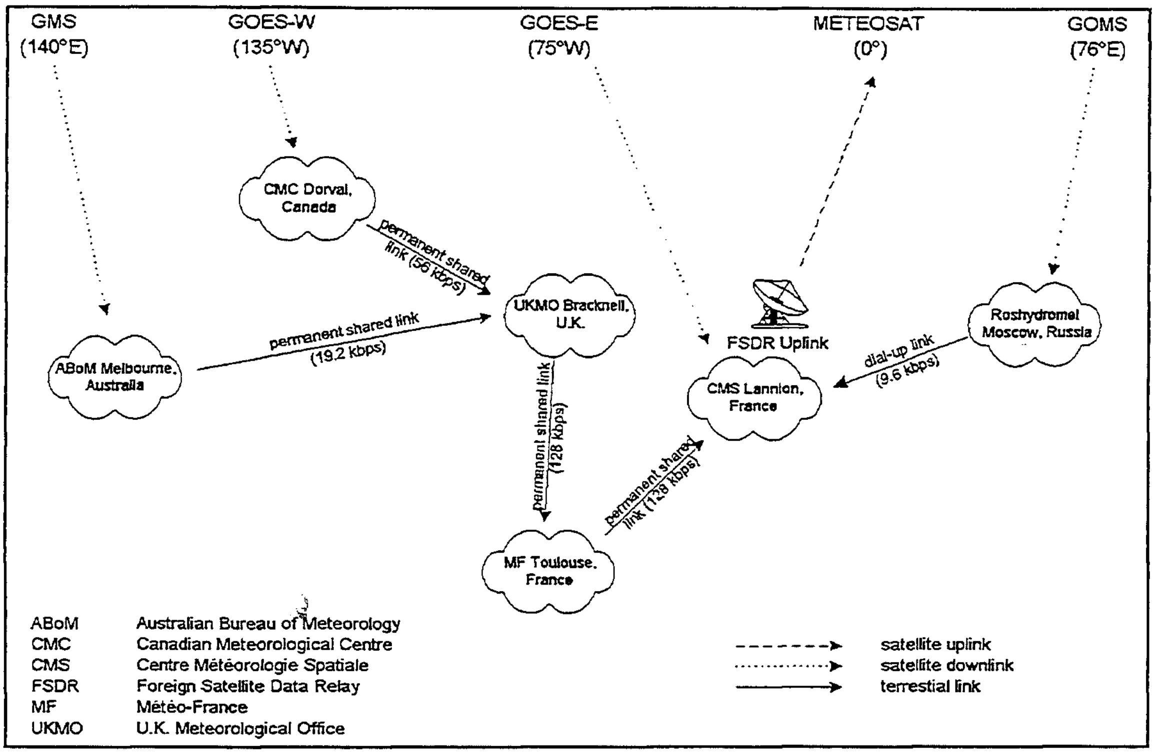


Figure 1 Communication Infrastructure 'around the Foreign Satellite Data Relay'

The analogue phone link to the GOES-Tap which has been in use for the acquisition of the WEFAX formats GMSA-GMSD since mid-1993 was terminated on 31/3/97. With the introduction of the new dissemination schedule starting from 1/4/97 'new' GMS WEFAX formats were introduced which are based upon digital data.

The dial-up link to Roshydromet in Moscow was frequently exercised from Darmstadt in early 1997. It was noted that the availability of the communication link is irregular at times and will have further to be monitored.

The final FSDR configuration is shown in figure 2.

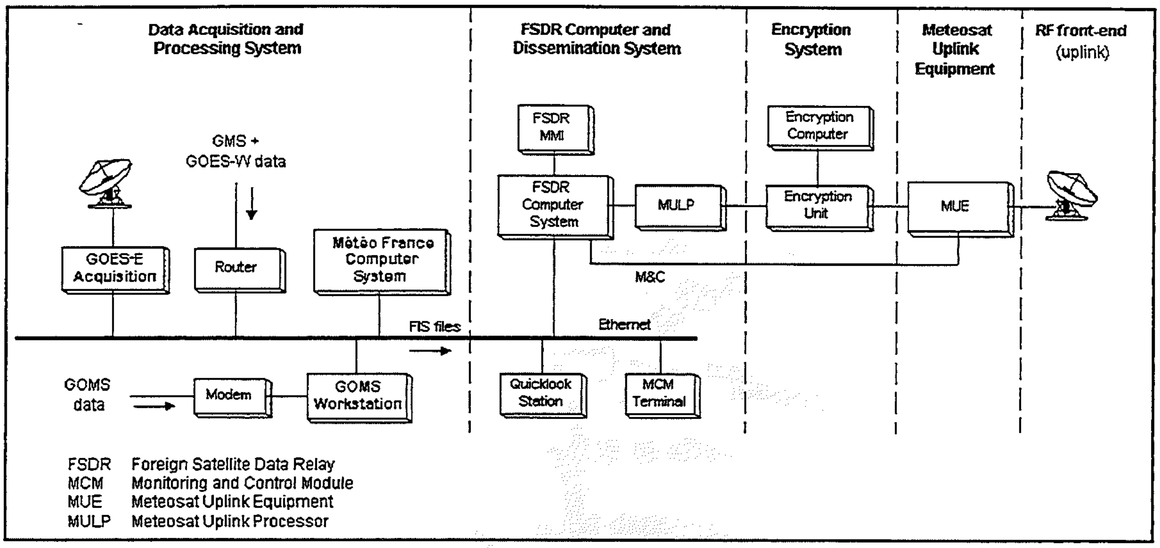


Figure 2 Final FSDR Configuration

3 CHANGES TO METEOSAT DISSEMINATION FORMATS

3.1 HRI Format Modifications due to additional FSD

3.1.1 Satellite Indicator and Sub-satellite Points

The dissemination of GOES-W and GMS data via X-formats requires an amendment of the *satellite indicator* and the *sub-satellite point* fields to distinguish between the various data sources. The *satellite indicator* is located in bytes 1-2 of the *identification field* of the HRI header subframes. The current definition uses either '0000' for GOES-E or EBCDIC coded representations of 'MT', 'M2', 'M3' ... 'M6' for Meteosat. The *sub-satellite point* longitude values are defined in bytes 25-26 of the *identification field.*

The following definitions specifications are used to identify the various foreign satellite data sources:

satellite name	identification field byte 1 byte 2 (in hex)	sub-satellite point (coded as I*2 integer)
GOES-E	00 00	-75
GOES-W	00 01	-135
GMS	00 02	140
GOMS	00 03	76 (for future use only, no HRI dissemination foreseen yet)

3.1.2 New 'XVH' format

The existing X-formats as defined in the HRI format description documentation (EUM TD02) used by the FSDR were:

XI (duration: 94") and XIV (duration: 7' 23")

A work-around for the not defined half-resolution visible X-format was in use since 1992. It 'abuses' the NIT to identify XI-formats containing visible data to reduce dissemination slot occupancy in channel A2.

With the advent of further foreign satellite data a 'proper' half-resolution visible X-format (called 'XVH') has been introduced with the new dissemination schedule. The new XVH-format is identified by the following header label field settings:

byte 13	0F	X-format indicator
bytes 14-17	FF 00 00 00	VISs indicator only (like in AIVH, identifying reduced information)

The complete structure and sequence of XVH subframes are shown in figure 3.

Heading Subframes	Line 1 VIS sH	Line 2 VIS sH	Line 3 VIS sH	Line 4 VIS sH	Line 5 VIS sH		Line 1247 VIS sH	Line 1248 VIS sH	Line 1249 VIS sH	Line 1250 VIS sH	Conclusion
90 SF = 360 F	1250 subframes (SF) = 5000 frames (F)										1 SF = 4 F

Figure 3 Structure of XVH-format

3.1.3 Calibration of new X-formats

As the FSD cannot easily be mapped to the Meteosat calibration system they are disseminated already calibrated. Users who wish to convert grey values into temperatures or albedo have to apply different look-up tables depending on the satellite and spectral channel.

The FSD acquired from GMS and GOES-W are processed by different centres and arrive in already calibrated form at the U.K. Met. Office. No further re-calibration is applied and the FSDR relays the data as received.

The relevant look-up tables and formulas for all spectral channels of the new X-formats are provided in annex 1-2. For the sake of completeness it is recalled that the current GOES-E data are already distributed calibrated. The formulas can be found in annex 3.

3.2 WEFAX Format Modifications

3.2.1 New 'GOMS' WEFAX format

The WEFAX format 'GOMS' will provide a total earth disk's view in the IR channel from the geostationary position of 76°E. The nominal coverage is shown in annex 4.

3.2.2 New GMS WEFAX formats

It is recalled that the GMS WEFAX formats which were received by the FSDR from the NOAA GOES-Tap facility from 7/93 - 4/97 represented the original GMS WEFAX sectors.

With the availability of digital data a higher flexibility of formatting GMS images for WEFAX dissemination is possible. To avoid over-sampling of the acquired 1250x1250 resolution and to reduce the currently allocated dissemination channel A2 bandwidth for GMS WEFAX, three new GMS WEFAX formats (either 'GMSN' + 'GMSS' or 'GMST' only) have been defined. The new Meteosat dissemination schedule makes use of 'GMSN' and 'GMSS' which are based on a 700x700 area of the original 1250x1250 as shown in annex 4.

3.3 Impact on current PDUS/SDUS

With the introduction of new FSD, all PDUS which need to receive and process them will require a software update w.r.t. the recognition of additional satellite indicators and processing of XVH formats. The E_XI can further be received without any modification. The E_XI containing visible data (the so-called 'work-around') was replaced by an E_XVH.

As the Meteosat WEFAX format structure remains unchanged, SDUS operators will usually be able to receive new formats without any major modifications. However, minor SDUS reception schedule changes for correct storage/processing is to be anticipated.

The technical documentation EUM TD02 (HRI) and TD03 (WEFAX) is going to be updated to include the new format descriptions.

4 DISSEMINATION SCHEDULE CHANGES

The new dissemination schedule S9704M01 became valid on 1/4/97 with an initial inclusion of GMS and GOMS WEFAX formats. In a second step in May '97, all new XI and XVH HRI formats were introduced to the indicated dissemination slots and corrections to the WEFAX digital headers were performed.

S9704M01 is attached as annex 5. All additional/modified FSD is identified by grey shading.

The following list describes in brief the differences between the former and the new dissemination schedule:

- deletion of all GMSA, GMSB, GMSC and GMSD
- correction of GOES-E slot numbers
- replacement of current 'even slot' LXIs by new E_XVH-formats
- insertion of GOMS WEFAX format right after the LY/LR/LZ block
- insertion of J_XI/XVH and W_XI/XVH HRI formats after the GOMS WEFAX
- insertion of GMSN and GMSS WEFAX formats after the GMS and GOES-W HRI formats
- minor re-configuration of ATEST02, ADMN and TEST formats in the 3rd transmission hour

Without modifying the placement of the existing A-, B- and GOES-E formats it was possible to achieve the following priorities within the available channel bandwidth:

1. Meteosat data
2. 'neighbouring' S/C formats (GOES-E and GOMS)
3. 'distant' S/C formats (GMS and GOES-W)
4. test and administrative formats

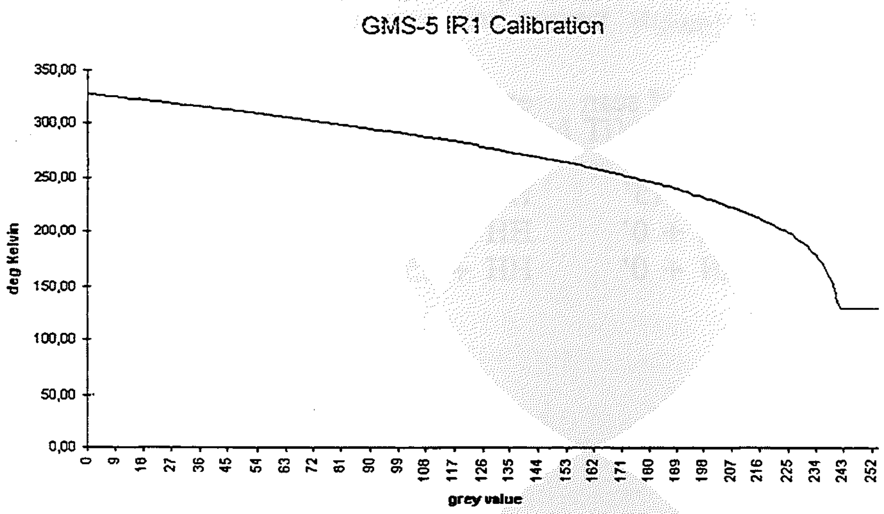
The slot numbers contained in the schedule are based on the respective scan times of the foreign satellites and have been adjusted in accordance with the 'Meteosat rule'. The scan times are as follows:

spacecraft	start of scan	end of scan	resulting slot numbers
GMS	HH - 28'	HH - 03'	48, 06, 12, ...
GOES-E	HH - 15'	HH +11'	48, 06, 12, ...
GOES-W	HH + 0'	HH + 26'	01, 07, 13, ...
GOMS	HH + 0'	HH + 25'	01, 07, 13, ...

ANNEX 1: GMS-5 IR1-LEVEL TO TEMPERATURE (°K) CONVERSION TABLE

(applicable to J_XI-format)

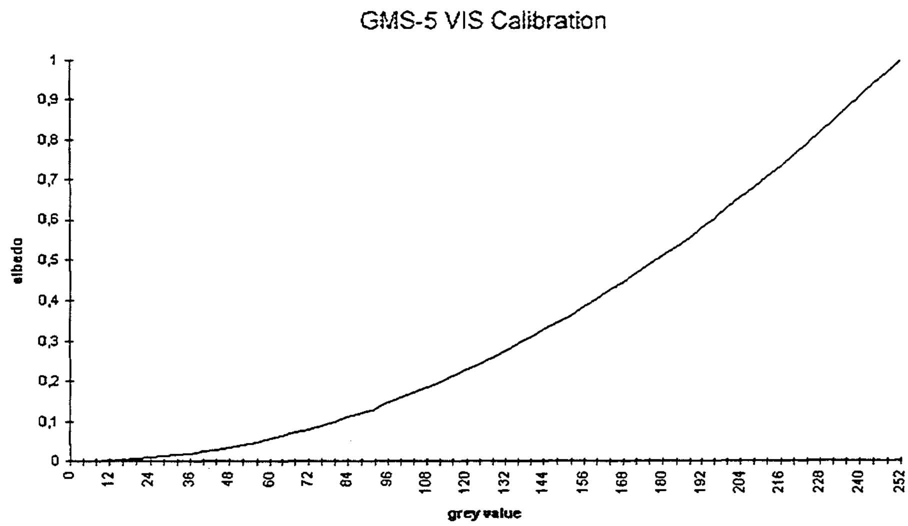
0	327.73	32	316.83	64	304.97	96	291.84	128	276.92	160	259.2	192	236.39	224	199.76
1	327.4	33	316.47	65	304.58	97	291.41	129	276.41	161	258.58	193	235.54	225	198.03
2	327.07	34	316.12	66	304.19	98	290.97	130	275.9	162	257.96	194	234.68	226	196.22
3	326.74	35	315.76	67	303.8	99	290.53	131	275.39	163	257.33	195	233.81	227	194.33
4	326.41	36	315.4	68	303.41	100	290.09	132	274.88	164	256.7	196	232.93	228	192.35
5	326.08	37	315.04	69	303.01	101	289.65	133	274.37	165	256.07	197	232.03	229	190.26
6	325.75	38	314.68	70	302.62	102	289.2	134	273.85	166	255.42	198	231.12	230	188.05
7	325.41	39	314.32	71	302.22	103	288.75	135	273.33	167	254.78	199	230.2	231	185.7
8	325.08	40	313.96	72	301.82	104	288.31	136	272.8	168	254.12	200	229.26	232	183.18
9	324.74	41	313.6	73	301.42	105	287.86	137	272.28	169	253.47	201	228.3	233	180.47
10	324.41	42	313.24	74	301.02	106	287.4	138	271.75	170	252.8	202	227.33	234	177.64
11	324.07	43	312.87	75	300.62	107	286.95	139	271.21	171	252.13	203	226.35	235	174.4
12	323.74	44	312.51	76	300.22	108	286.49	140	270.68	172	251.46	204	225.35	236	170.77
13	323.4	45	312.14	77	299.81	109	286.04	141	270.14	173	250.77	205	224.33	237	166.62
14	323.06	46	311.77	78	299.41	110	285.58	142	269.6	174	250.08	206	223.29	238	161.75
15	322.72	47	311.4	79	299	111	285.11	143	269.05	175	249.39	207	222.23	239	155.73
16	322.38	48	311.03	80	298.59	112	284.65	144	268.5	176	248.69	208	221.15	240	147.65
17	322.04	49	310.66	81	298.18	113	284.18	145	267.95	177	247.98	209	220.05	241	134.19
18	321.7	50	310.29	82	297.77	114	283.71	146	267.39	178	247.26	210	218.92	242	130
19	321.36	51	309.92	83	297.36	115	283.24	147	266.83	179	246.54	211	217.78	243	130
20	321.01	52	309.54	84	296.94	116	282.77	148	266.27	180	245.81	212	216.6	244	130
21	320.67	53	309.17	85	296.52	117	282.3	149	265.7	181	245.08	213	215.4	245	130
22	320.32	54	308.79	86	296.11	118	281.82	150	265.13	182	244.33	214	214.17	246	130
23	319.98	55	308.42	87	295.69	119	281.34	151	264.56	183	243.58	215	212.91	247	130
24	319.63	56	308.04	88	295.27	120	280.86	152	263.98	184	242.82	216	211.62	248	130
25	319.28	57	307.66	89	294.84	121	280.37	153	263.4	185	242.05	217	210.29	249	130
26	318.94	58	307.28	90	294.42	122	279.89	154	262.81	186	241.27	218	208.92	250	130
27	318.59	59	306.9	91	293.99	123	279.4	155	262.22	187	240.48	219	207.52	251	130
28	318.24	60	306.51	92	293.57	124	278.91	156	261.62	188	239.68	220	206.07	252	130
29	317.88	61	306.13	93	293.14	125	278.41	157	261.03	189	238.87	221	204.57	253	130
30	317.53	62	305.74	94	292.71	126	277.92	158	260.42	190	238.06	222	203.02	254	130
31	317.18	63	305.36	95	292.28	127	277.42	159	259.81	191	237.23	223	201.42	255	130



ANNEX 2: GMS-5 VIS-LEVEL TO ALBEDO CONVERSION TABLE

(Note: original 6 bit data are multiplied by 4 to expand them to 8 bit)
(applicable to J_XVH-format)

0	0.000000	64	0.064500	128	0.258000	192	0.580499
4	0.000252	68	0.072814	132	0.274376	196	0.604938
8	0.001008	72	0.081633	136	0.291257	200	0.629882
12	0.002268	76	0.090955	140	0.308642	204	0.655329
16	0.004031	80	0.100781	144	0.326531	208	0.681280
20	0.006299	84	0.111111	148	0.344923	212	0.707735
24	0.009070	88	0.121945	152	0.363820	216	0.734694
28	0.012346	92	0.133283	156	0.383220	220	0.762157
32	0.016125	96	0.145125	160	0.403124	224	0.790123
36	0.020408	100	0.157470	164	0.423532	228	0.818594
40	0.025195	104	0.170320	168	0.444444	232	0.847569
44	0.030486	108	0.183673	172	0.465860	236	0.877047
48	0.036281	112	0.197531	176	0.487780	240	0.907029
52	0.042580	116	0.211892	180	0.510204	244	0.937516
56	0.049383	120	0.226757	184	0.533132	248	0.968506
60	0.056689	124	0.242126	188	0.556563	252	1.000000



ANNEX 3: GOES-W LEVEL TO TEMPERATURE (°K)/ALBEDO CONVERSION TABLE

For GOES-W a linear relationship between temperature/albedo and the received numerical counts exist.

For the IR channel:

The following formula has to be applied to W_XI-formats to establish as a relationship between grey value and temperature:

$$Temp[°K] = \frac{(255 - NC) * (T_{max} - T_{min})}{255} + T_{min}$$

where NC = numerical count (grey value) between 0 and 255
T_{max} = 318.1 °K
T_{min} = 159.1 °K

For the VIS channel:

The following formula has to be applied to W_XVH-formats to establish as a relationship between grey value and albedo:

$$Albedo(\%) = 100 * \frac{NC}{255}$$

where NC = numerical count (grey value) between 0 and 255

GOES-E LEVEL TO TEMPERATURE (°K)/ALBEDO CONVERSION TABLE (for completeness only)

For the IR channel:

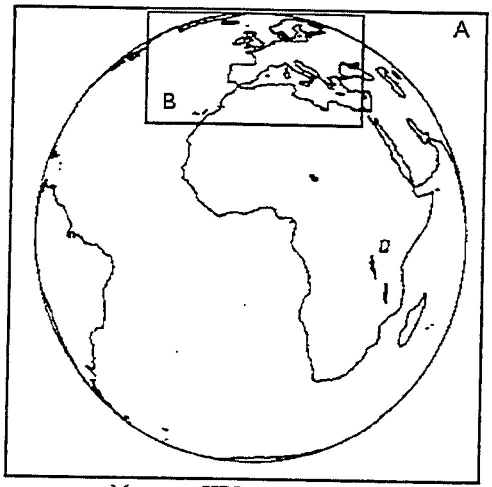
$$Temp[°K] = NC + 163 \quad \textit{for NC between } 0 - 79$$

$$Temp[°K] = \frac{NC + 405}{2} \quad \textit{for NC between } 79 - 255$$

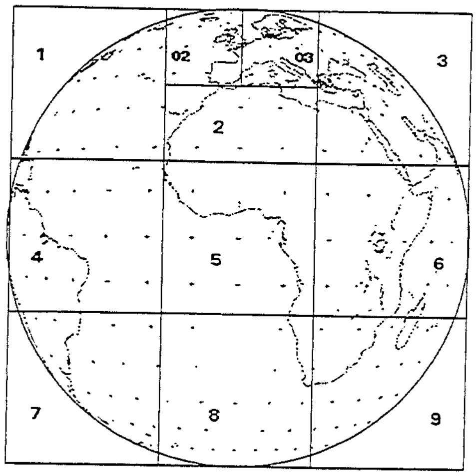
For the VIS channel:

same as GOES-W

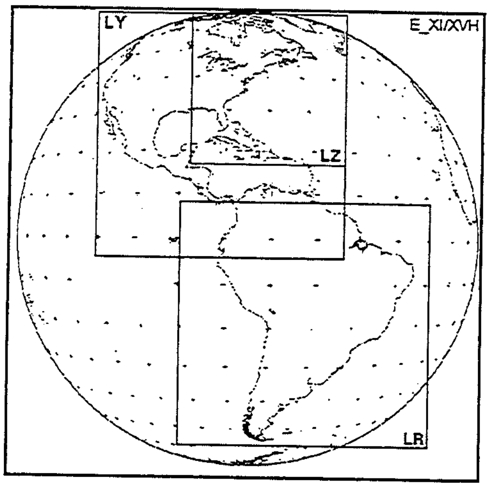
ANNEX 4: Dissemination Formats via Meteosat



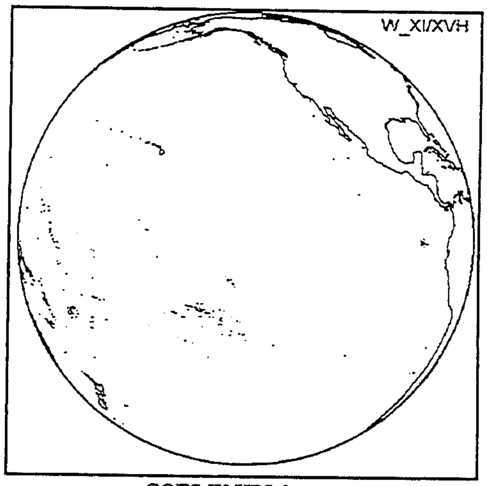
Meteosat HRI A-,B-formats



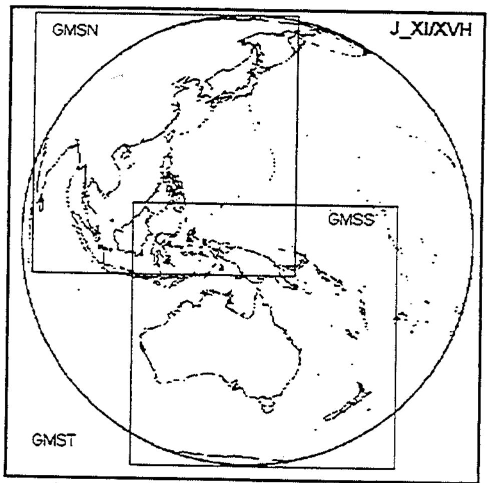
Meteosat C-, CnD-, D-, E-formats



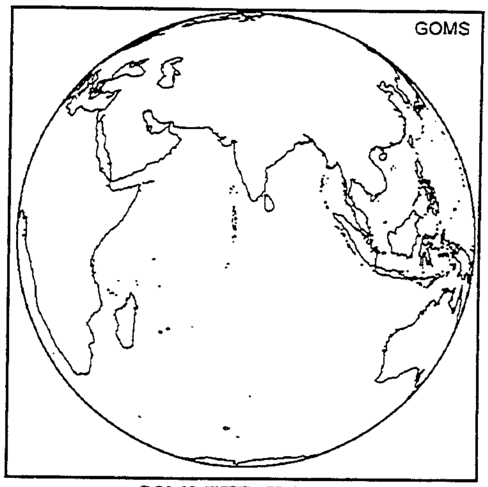
GOES-E WEFAX + HRI formats



GOES-W HRI format



GMS WEFAX + HRI formats



GOMS WEFAX format

CGMS-XXV
WMO WP-9
Prepared by WMO
Agenda item: G.3

DIGITAL SATELLITE IMAGE DATA AND EXTRACTED PRODUCT EXCHANGE OVER THE GTS

(Submitted by the WMO Secretariat)

Summary and purpose of document

The document contains the WMO Requirement for Digital Satellite Image Data and Extracted Product Exchange over the GTS.

ACTION PROPOSED

CGMS is invited to note the WMO Requirement for Digital Satellite Image Data and Extracted Product Exchange over the GTS as contained in Appendix A.

Appendix: WMO Requirement for Digital Satellite Image Data and Extracted Product Exchange over the GTS

DISCUSSION

Introduction

CGMS ACTION 24.08 requested CGMS Members to indicate, by 30 September 1996, WMO whether the interim requirement for the exchange of digital image data as expressed, once pproved by CBS, would be sufficient for formal consideration and response.

CBS, at its eleventh session in Cairo, Egypt, November 1996, was informed of the evelopment of a WMO Requirement for Digital Satellite Image Data and Extracted Product Exchange ver the GTS and requested the various working groups involved to continue the development of the quirement with the expectation it could endorse the requirement at its next session.

CGMS ACTION 24.28 requested WMO, through the Chairman of CBS Working Group on atellites, to contact by 1 June 1996 the Chairpersons of CBS Working Groups on elecommunications and on Data Management concerning the distribution of satellite data and oducts, to review the progress of these Working Groups on evolving an appropriate strategy and inform CGMS-XXV.

On 24 June 1996, the Chairman of the CBS Working Group on Satellites forwarded a opy of the "draft Interim WMO Requirement for Digital Satellite Image Data and Extracted Product xchange over the GTS" to the Chairmen of the CBS Working Groups on Telecommunications and Data Management for review and comments. Through an exchange of letters between the three hairmen, it has been agreed that the requirement is now valid and should be referred to as the WMO equirement for Digital Satellite Image Data and Extracted Product Exchange over the GTS while oting that final approval can only be granted at the next session of CBS. Therefore, for CGMS urposes, the requirement should be considered as approved to allow the CGMS Working Group on elecommunications to continues the development of a strategy as described in Action 24.29.

The WMO Requirement for Digital Satellite Image Data and Extracted Product Exchange ver the GTS can be found in the Appendix.

WMO REQUIREMENT FOR DIGITAL SATELLITE IMAGE DATA AND EXTRACTED PRODUCT EXCHANGE OVER THE GTS

A. INTRODUCTION

1. Satellite image data and extracted products are now fundamental to operational and research activities of WMO Programmes and represent a unique and irreplaceable source of information.

2. Considerable resources are expended globally developing, implementing and supporting the space based sub-system of the Global Observing System by satellite operators. It has long been recognized that appropriate resources must be devoted to ground based systems able to exploit the data provided by such systems - in the past this effort has, for valid reasons, concentrated on the reception of data from systems using local reception systems. Increasingly, the WMO Programmes involved with operational meteorology and hydrology demand satellite image data and extracted products which can not be received locally. This document states the requirement of WMO Members for satellite image exchange beyond the local reception foot print of the geostationary or polar orbiting satellite which captures the data. It briefly addresses the characteristics of the entailed telecommunication requirement and reviews the capability of current data management methods and the capacity of the Global Telecommunication System (GTS) to meet the need.

3. This WMO requirement for satellite imagery is based on the WMO satellite data requirements as described in the Final Report from the EC Panel of Experts on Satellites. It should be noted that satellite imagery is used to determine many types of products including the following:

- sounding data,
- winds,
- snow and sea ice parameters,
- surface temperature (land and sea)
- cloud parameters,
- etc.

4. The WMO requirement for satellite image data and extracted products explicitly describes requirements for:

- satellite
- resolution
- frequency and
- timeliness.

5. This document describes the reasons why specific data are required but deliberately excludes detailed specification of how data will be used and presented to users.

6. WMO recommends that the *ad hoc* systems used at present be replaced by a well ordered system for the exchange of satellite image data and extracted products.

B CURRENT SITUATION WITH RESPECT TO SATELLITE IMAGE DATA AND EXTRACTED PRODUCTS EXCHANGE

7. Certain satellite image data and extracted products are already exchanged internationally using a variety of systems. For example, the WEFAX broadcast from METEOSAT also contains WEFAX images from geostationary satellites other than METEOSAT.

8. These arrangements for the exchange of satellite data have developed in a somewhat *ad hoc* fashion to meet specific requirements. Due to this *ad hoc* nature, many of the links are used in a less than optimum manner. As an example, Europe receives analogue fax image data (one-way) over a dedicated 64 kbps digital link. This bandwidth could be used much more effectively for the two way exchange of digital image information.

9. There is also a current lack of standard formats for the transmission and storage of satellite image data and extracted products. A number of 'standard formats' exist but each is tuned to specific requirements - for example, one format is able to accommodate raw satellite data including spacecraft engineering data. Such a format is too complex for the more restricted requirements of the meteorological community.

10. WMO has defined binary codes such as BUFR and GRIB which are capable of handing digital satellite image data and extracted products. Unfortunately, there has been a lack of agreement on precisely how such codes should be utilized for image data. The lack of widely accepted and supported codes dictates that unnecessary effort are needlessly expended on conversion software.

C. APPLICATIONS

11. The primary reasons for exchanging satellite data beyond the local foot print are to enable global and regional centres to accurately determine the position and characteristics of major synoptic features - particularly where these are upstream, are moving or evolving rapidly and are associated with severe, hazardous weather. Such data are also useful in conceptualizing weather systems, both for professional meteorologists and their end users.

12. At such centres satellite image data and extracted products are used in a number of ways:

Analysis: Satellite imagery plays an important role in the analysis of meteorological features at all scales from the broad to the meso-scale. Here, the meteorological requirement is to understand the current behaviour of the atmosphere and weather in terms of a number of conceptual models, such as fronts, air masses and cloud clusters. On the broad scale, identification of major cloud masses helps to position dynamic features such as fronts and troughs, whilst on the meso-scale, detailed imagery allows cloud conditions to be assessed at specific locations. Imagery in the infra-red (IR) spectrum adds a vertical dimension by distinguishing between surface and cloud top temperature. This allows discrimination between high and low cloud and, if the images are calibrated, then, by reference to upper air soundings, the level and vertical extent of cloud. On the meso-scale such imagery, particularly when used in conjunction with visible images, may enable forecasters to identify, and distinguish between, fog and low cloud. Analysis may be further improved by the use of derived products such as surface wind fields, sea temperatures etc.

Forecasting: The use of imagery directly in Numerical Weather Prediction (NWP) is in its infancy, but such data provide a useful source of quality control information; firstly at the initialization stage and subsequently in verifying, and as appropriate, modifying the guidance obtained from NWP. Thus, skilled analysts are able to generate so called bogus observations, particularly in the vicinity of tropical cyclones, which can be used in initializing a numerical model while forecasters make extensive use of timely remotely sensed data - from satellites and radar networks - in judging the quality of very short period NWP forecasts as a guide to subsequent predictions.

Presentation: Reference to an appropriate satellite image is an effective way of indicating cloud distribution to a customer. Satellite images now form an important part of TV presentation and also as a briefing aid for aviation purposes especially where cloud cover is a feature important to the task such as aerial photograph, low level reconnaissance or maritime patrol flights.

D. THE WMO REQUIREMENT FOR DIGITAL SATELLITE IMAGE DATA AND EXTRACTED PRODUCTS EXCHANGE OVER THE GTS

13. Detailed specifications for the exchange of geostationary and polar-orbiting satellite image data and extracted products can be found in Annexes A and B, respectively. The image projection to be employed in the exchange is relatively unimportant, provided that available resolution and accurate referencing to geographical co-ordinates are maintained; most receiving centres will have the ability to re-project. In describing the WMO requirement, the following definitions have been utilized:

Acceptable - the minimum level required to provide a worthwhile service to the user.

Goal - if met would provide maximum advantages to the user.

E. ADDITIONAL REQUIREMENTS

14. It is recommended that digital satellite image data and extracted products be exchanged using a standard system over the GTS. Since the present bandwidth of the GTS is insufficient for the requirements contained in Annexes A and B, the GTS capacity must be increased. The standard system should have the following characteristics:

(a) data should be available to any co-operating centre on the GTS;

(b) use standard communications protocols (e.g., TCP/IP);

(c) use a standard data format for image data (e.g., a standard WMO binary representation form);

(d) use a file transfer mechanism rather than the bulletin format presently in use on the GTS;

(e) provide expected performance and response times;

(f) provide appropriate levels of security;

(g) operate automatically.

F. COMMUNICATIONS ASPECTS

15. The existing GTS system is optimized for the regular transmission of relatively short bulletins. Unfortunately these characteristics make it unsuitable for the transmission of large files associated with satellite image data and extracted products.

16. The GTS also has rather limited capacity. Although the fastest links are 64 kbps, typical links are only 4.8 or 9.6 kbps. A full disk Meteosat 5 km resolution image would take more than one hour to be sent over a 9.6 kbps link.

17. WMO has agreed to implement the Distributed Data Base System (DDBS) which is based on TCP/IP and allows data transfer using higher level protocols. DDBS depends on TCP/IP being implemented on the GTS. It should be noted that the DDBS satisfies most of the required characteristics described in paragraph 14. The only unsatisfied characteristic is that of a standard data format for image data and the CBS Working Group on Data Management Sub-group on Codes and Data Representation Formats is addressing this issue.

18. Using the acceptable and goal requirement figures for Meteosat full-disk images involves the transfer of the following amounts of data.

Target	*Satellite*	*Channels*	*Width*	*Height*	*Size (Mbytes)*	*Tx. time (mins)*	*Implied bandwidth*
acceptable	Meteosat	IR	1250	1250	1 x 1.56	20	11 kbps
goal	Meteosat	IR, Vis, WV	2500	2500	3 x 6.25	10	250 kbps

19. Thus to meet the acceptable target for distribution of the data from one satellite requires a bandwidth of 11 kbps; to distribute the goal data would require a bandwidth of 250 kbps.

20. These figures can be reduced by compression of the data - typically full disk satellite images can be losslessly compressed to below 50% of their original size. The figures will however be increased by the requirement to exchange data from all the geostationary satellites. Assuming that 5 are operational and that data are exchanged over a 'ring' network which allows two-way data exchange then the above figures will be increased by a factor of 2.5 (625 kbps).

G. CONCLUSIONS

21. It can be seen that the present bandwidth available on the GTS is inadequate and that much higher bandwidths are required (typical available is 4.8 kbps while required is almost an order of magnitude larger). Therefore, the GTS must be increased to accommodate bandwidths of at least 625 kbps.

22. The decision has already been taken to implement the Distributed Data Base System (DDBS). Therefore, its implementation must occur as well as its accompanying requirement to utilize TCP/IP.

23. The CBS Working Group on Data Management Sub-group on Codes and Data Representation Formats should make a recommendation as to a standard data format for image data.

Annex A
WMO requirement for geostationary digital image data

1. SATELLITES

All current and future geostationary satellites (GOES, METEOSAT, INSAT, GOMS, GMS). The bit depth of an image pixel will correspond to that utilized by the particular satellite, e.g. 10 bit for GOES, 8 bit for METEOSAT, etc.

2. CHANNELS

acceptable - IR (longwave Infrared)
goal - all available channels

3. RESOLUTION

acceptable - 8 km at sub-satellite point
goal - 4 km at sub satellite point

4. FREQUENCY

acceptable - 60 minutes
goal - 30 minutes

5. TIMELINESS (available for display)

acceptable - within 45 mins of nominal image time.
goal - within 20 mins of nominal image time.

6. FORMAT

a standard WMO binary representation form

7. CALIBRATION

navigation and calibration files for raw satellite data

Annex B
WMO requirement for polar orbiter digital image data

1. SATELLITES

All current and future polar orbiting platforms (NOAA, METEOR, EPS, FY-1 series). The bit depth of an image pixel will correspond to that utilized by the particular satellite.

2. CHANNELS

acceptable - IR
goal - all available channels

3. RESOLUTION

acceptable - 4 kmGAC (Global Area Coverage)
goal - 1 kmLAC (Local Area Coverage)

4. FREQUENCY

Daily (A full global coverage once per day from each satellite to be made available pass-by-pass when the GAC coverage is recorded)

5. TIMELINESS

acceptable - within 60 mins of pass ending or 90 mins after pass time.
goal - within 40 mins of pass ending or 60 mins after pass time.

6. FORMAT

a standard WMO binary representation form

7. CALIBRATION

navigation and calibration files for raw satellite data

CGMS-XXV
WMO WP-17
Prepared by WMO
Agenda item: E.1

WMO STRATEGY TO IMPROVE SATELLITE SYSTEM UTILIZATION

(*Submitted by the WMO Secretariat*)

Summary and purpose of document

This document informs CGMS of the development of a new Strategy to Improve Satellite System Utilization

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ACTION PROPOSED

CGMS to review the WMO Strategy to Improve Satellite System Utilization, provide comments, and take action as appropriate.

DISCUSSION

1. A Task Force meeting of the CBS Working Group on Satellites Sub-group to Improve Satellite System Utilization (ISSU) was held in Rome, Italy from 21 to 23 April 1997. The Task Force reviewed actions resulting from the work plan developed at the second session of the CBS Working Group on Satellites (WGSAT-II) on the need for a strategy to improve satellite system utilization. It noted that CBS-XI had requested the Working Group on Satellites to complete the development of the strategy.

2. The Task Force reviewed two documents towards the development of a strategy to improved satellite system utilization. It was agreed that both documents highlighted specific concepts that should be incorporated into a strategy that addressed present and future deficiencies. The Task Force recalled the successful implementation of the Strategy for Education and Training in Satellite Matters and agreed that it should serve as a model for a strategy to improve satellite system utilization. An underlying concept for the Strategy for Education and Training was the involvement of organizations involved in Education and Training. Such involvement was focussed to allow the other organizations to continue their plans while, at the same time, meeting WMO objectives.

3. The Task Force also agreed that the new strategy must visibly contain the user requirements, state its assumptions and provide a clear vision for the future.

4. The Task Force reviewed responses to the initial questionnaire distributed in preparation for WGSAT-II and also discussed the present trends in technological advances. The present utilization of satellite data within WMO Members was limited in two general categories, lack of access to the data and lack of knowledge on how to utilize the data to meet specific needs of a Member.

5. With regard to technological advances, it was clear in the near future (2-8 years) that the present method of providing data would remain the same but in the longer term the means for providing data would change from the present method. The change in the future will start within ten years and thus the Task Force felt it imperative to commence preparations for such a change immediately while retaining a focus on the near term needs as well.

6. The Task Force noted that an analysis of the present utilization of satellite data indicates that utilization is increased in those countries that have access to the data while utilization is less than optimal in those countries that have decreased access to data. Thus emphasis should be placed to improve data distribution. Pivotal to this improvement will be the direct involvement of the satellite operators as well as the CBS Working Groups on Telecommunications, Data Management and Satellites.

7. The Task Force also noted that the present application of satellite data indicates that considerable expertise exists within WMO Members in the use and understanding of applications that process satellite data into useful product. However, the expertise is normally shared between Members on a limited, and sometimes bilateral, basis. Thus emphasis to improve the application of satellite data will be through increased awareness of the expertise within WMO Members. Pivotal will be the direct involvement of WMO Members in identifying resident expertise that can be shared on a WMO-wide basis with those countries requiring increased awareness.

8. The Task Force noted that the strategy takes into consideration that future satellite systems may no longer have S-band data distribution systems but rather would utilize X-band. Because of the high cost of X-band receiving stations, many countries, especially developing countries, would not be able to afford such stations. A realistic solution to overcome this problem would be the use of Internet or Intranet type services. The result will produce two consequences: global and regional hubs will be needed which can offer different types of data or services required by the countries at different processing levels and resolutions; and the users will have to change. Presently, the users are provided with data and products according to dissemination schedules

defined by the satellite operators. In the future, the users will have to be more active and make decisions on which data and products are required depending on the actual weather situation or application area. This also implies the need for an improved information service.

9. The Task Force then developed the new Strategy to Improve Satellite System Utilization as contained in Annex I. The two primary thrust for the new strategy are aimed at improving data access in both the near and long term and increased application of satellite data through better awareness of the potentials utilizing specific applications. To maintain a focus on rectifying deficiencies, the strategy will use specific projects and a review and monitoring activity.

10. CGMS is invited to review the new strategy and provide comments to WMO prior to 1 November 1997 in order that such comments can be incorporated into the documentation for the third session of the CBS Working Group on Satellites.

STRATEGY TO IMPROVE SATELLITE SYSTEM UTILIZATION

The WMO Strategy to Improve Satellite System Utilization is composed of four components: a strategic vision, a long term strategic goal, major objectives and a methodology to meet the objectives and satisfy the goal.

STRATEGIC VISION 1997-2012

Overall, there are some exciting prospects for the achievement of major advances in operational meteorology and hydrology over the next 15 years. Potentially, there will be a much greater density and variety of satellite data available for use, a much greater capacity for rapid data processing and delivery, and a much greater capacity for data assimilation and integration into increasing powerful numerical models, which will be the main tool for improved predictive capability over a wide range of time and space scales.

Paradoxically, this will create some immediate difficulties for the developing countries who are now in the process of establishing low cost satellite reception and processing systems whose capacity could easily be swamped by the higher data volumes, thus pricing the developing nations out of the full benefits of the information explosion. Nevertheless, with careful strategic planning, this problem can be overcome.

The major strategic vision that emerges is the prospect of substantially improved transfer to communities around the world, of the benefits of meteorological science and technology via rapidly evolving global and regional communications and computer networks. This network connectivity and capacity is envisaged to be the key to improvement in system utilization for all WMO members. It is the key to:

- improved cycle times for satellite data processing, acquisition and display;
- improved integration of different types of satellite data and data from different satellites;
- improved systems interaction between the developed and developing countries and a conduit to support new applications development and on-line education and training activities;
- improved nowcasting services featuring integrated use and display of high resolution satellite imagery, local radar imagery and high density three dimensional data from various mass detection observing systems;
- improved applications and output products for a wide range of users; and
- improved methods and improved speed of user access to data and products.

STRATEGIC GOAL 1997-2012

The strategic goal is :

> ***To improve systematically the utilization of satellite systems by National Meteorological and Hydrometeorological Services with emphasis on improving utilization in the developing countries.***

This will be an ongoing goal with a 15 year horizon which will be regularly reviewed and updated to take into account new developments in satellite technology, data processing and communications infrastructure, and changes in socio-economic conditions and user requirements. The fundamental issued to be addressed by the new Strategy is the need to improve access and application of satellite data.

MAJOR STRATEGIC OBJECTIVES 1997-2012

In support of the Strategic Goal are three major strategic objectives:

(a) ***To focus on the needs of the developing countries:***

- improved coverage of satellite observations required by developing countries;
- improved access to systems for distribution of satellite data and products to developing countries;
- improved education and training in satellite systems operation, maintenance and applications;
- improved locally affordable systems for integration of satellite data and local observations;
- improved public education material on the local economic and community benefits of satellite system utilization;

(b) ***To improve the access to satellite data through increased effectiveness in the distribution of satellite system data and products at major hubs, in particular those maintained by the satellite operators, WMO WMC's, RSMCs and other entities as appropriate,***

- improved responsiveness to satisfying the user requirements for access to satellite data and products;
- improved communications links between major satellite data acquisition and processing centres and WMCs;
- improved communication links connecting WMCs and RSMCs;
- improved output product development and presentation with particular emphasis on products for agrometeorology, hydrology, marine meteorology, environmental monitoring, and severe weather warning;
- improved systems and facilities at the satellite operators, WMCs and RSMCs for the distribution and/or access of data and products by WMO members;

An analysis of the present utilization of satellite data indicates that utilization is increased in those countries that have access to the data while utilization is less than optimal in those countries that have decreased access to data. Thus the emphasis to meet this objective will be through improve distribution. Pivotal to meeting this objective will be the direct involvement of the satellite operators as well as the CBS Working Groups on Telecommunications, Data Management and Satellites.

(c) ***To improve the use of satellite data through increased capabilities in its applications by direct involvement of existing WMO Member expertise:***

- improved applications of satellite derived observations of atmospheric stability, vertical temperature, moisture and profiles, and chemical composition;
- improved applications of satellite data for the monitoring and prediction of environmental

hazards such as volcanic eruptions and volcanic ash dispersal, earthquakes, air pollution and ocean pollution;

- improved focus on utilization of emerging new satellite system data and products for hydrometeorology and hydrology;
- improved focus on utilization of emerging new satellite system data and products for agrometeorology;
- improved focus on utilization of emerging new satellite system data and products for marine meteorology;

An analysis of the present application of satellite data indicates that considerable expertise exists within WMO Members in the use and understanding of applications that process satellite data into useful product. However, the expertise is normally shared between Members on a limited, and sometimes bilateral, basis. Thus the emphasis to meet this objective will be through improve awareness of the expertise within WMO Members. Pivotal to meeting this objective will be the direct involvement of WMO Members in identifying resident expertise that can be shared on a WMO-wide basis with those countries requiring increased awareness.

3. METHODOLOGY TO IMPROVE SATELLITE SYSTEM UTILIZATION

3.1 The methodology to improve satellite system utilization is an iterative process linking ongoing monitoring with action needed to ensure continuous improvement. It commences with a monitoring of the accessibility and application of satellite data and products within WMO Members followed, by an assessment of their impact. Based on the assessment, specific projects will be identified that overcome deficiencies. These projects will then be implemented and their results monitored.

3.2 The monitoring activity implies two specific steps:

(a) the distribution of a standardized questionnaire;

(b) the evaluation of the responses.

3.3 The questionnaire will be forwarded to WMO Members on a bi-annual basis. The questionnaire will provide for:

(a) the assessment of the status of data availability, through enquiries on the status of reception facilities (update of the status report on satellite ground receiving equipment in WMO regions);

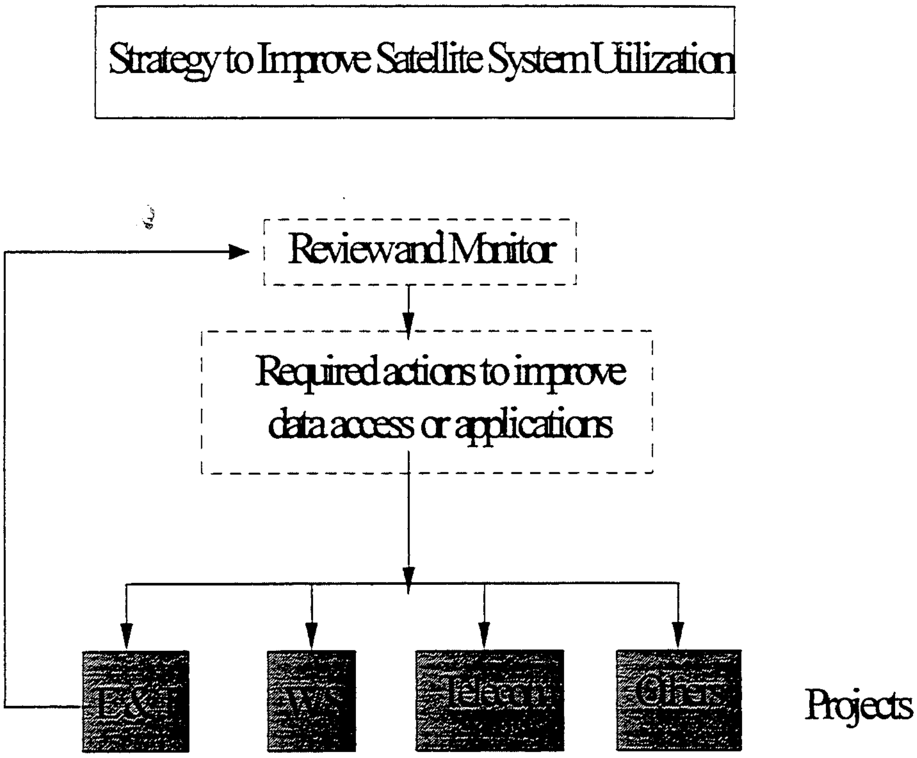
(b) the assessment of the level of use of satellite-derived data for various application areas;

(c) the assessment of the level of processing of the various parameters derived from satellite data.

3.4 Evaluation of the responses will be performed in the initial phase by the Sub-group on Improvement of Satellite System Utilization (SgISSU) in order to generate an appropriate data base and will be later performed on a regular basis by a Monitoring Centre.

3.5 The next necessary step will be to analyse and identify deficiencies from the evaluation of the responses to the questionnaire. The analysis will indicate which necessary steps will have to be taken in order to improve the utilisation of satellite systems, either through improved access or application of satellite data. The necessary steps to improve the utilization will be developed and implemented through the use of specific projects with stated goals and milestones. Integral to each project will be a monitoring activity to measure the progress of the project and provide feedback for the overall Review and Monitoring function.

3.6 The overall methodology is demonstrated in the Figure below and the Table attached.



STRATEGIC GOAL	MAJOR OBJECTIVES	IMPLEMENTATION PLANS
To systematically improve the utilization of satellite systems by WMO Members with emphasis on improving utilization in the developing countries	(a) To focus on the needs of developing countries	- Critical review process linking monitoring to action plans - Demonstration Project evaluating Swiss aid project to Estonia - CEOS help for better Indian Ocean/RA II satellite coverage - Links to WMO satellite education and training strategy - Major WMO Project on low-cost satellite workstation - Expand EUMETSAT MDD system use in RA I & II - Focus on effective use of LRIT in RA II & V (with MTSAT-1 - Expand US-based virtual lab. network in RA III & IV - Satellite utilization hubs/networks for developing countries - Initial funding focus on work stations and networking - Expand use of DCP/DRS for agriculture and hydrology - Focus on better use of polar-orbiting data and products - Strategies for system utilization in early/mid 2000s - Improved promotion of system, use at User Forums - Multi agency strategy promoting satellite system benefits
	(b) To improve the access to satellite data through increased effectiveness in the distribution of satellite system data and products at major hubs, in particular those maintained by the satellite operators, WMO WMC's, RSMCs and other entities as appropriate	- Upgrade MTN and GTS performance - Implement operational distributed database system - Better use of Internet and systems such as VSAT - Specialized WMO centres for satellite system utilization - Improved integration of satellite data into NWP - Specifications for improved WMC/RSMC satellite products
	(c) To improve the use of satellite data through increased capabilities in its applications by direct involvement of existing WMO member expertise.	- Review WMO requirements for new Earth Observations Satellite data research satellite data - Better research/operational applications system transfer - Focus on high identified priority requirements for satellite applications - Focus on improved applications of atmospheric stability monitoring, soil moisture, radiation budget, precipitation fields and surface winds - Focus on improved applications for environmental hazards such as volcanic ash, earthquakes and ocean pollution, etc - Closer operational development links with Pis

Products of GMS-5 and Evaluation of their Accuracy

The Meteorological Satellite Center (MSC) developed some new products and improved the conventional products by combining image data from thermal infrared split window sensors and water vapor sensor of GMS/VISSR as shown in Table 1.

Their accuracy are evaluated by comparing with the in situ. data. The results are published in the Meteorological Satellite Center Product Monitoring Report once a month.

The major products and their accuracy are shown in this paper.

Current products of the MSC and frequency of distribution (output frequency) are summarized in Table 2.

Table 1 The relation between new and improved products and image data from the used sensors (○).

Type of products	IR1	IR2	IR3 (WV)
Water vapor motion vectors	○	–	○
Sea surface temperature	○	○	–
OLR (out-going long wave radiation)	○	–	○
Upper tropospheric air humidity	○	–	○
Precipitable water amount	○	○	–

Bandwidth (μm) : IR1 (10.5-11.5), IR2 (11.5-12.5), IR3 (6.5-7.0)

Table 2 List of products of MSC

Distributed on the GTS

Type of data	Description	Region of interest	Output frequency
Cloud/Water Vapor motion vectors	Cloud/Water Vapor motion vectors data derived from time-sequential images	50° N-49° S 90° E-171° W	00Z,06Z,12Z,18Z: 4 times/day
Sea surface temperature	Average of the sea surface temperature in 1° × 1° area	50° N-50° S 90° E-170° W	every 5 days
Typhoon analysis report (SAREP)	Location and velocity of the typhoon center (Special hourly observation)	For the typhoon in EQ-60° N 100° E-180° E	8 times/day (24 times/day)
	Estimation of the typhoon intensity		4 times/day

Domestic distribution

Cloud amount data	Mean and anomaly of the total, high-level, and low-level cloud amount in 1° × 1° area	59.5° N-59.5° S 80.5° E-160.5° W	every 5 days, 1 month, 3 months (in chart only)
Mean TBB data	Average equivalent blackbody temperature (TBB)in 2.5° × 2.5° area	60° N-60° S 80° E-160° W	every 5 days, 1 month, 3 months (in chart only)
VISSR grid data	Minimum TBB for the whole area, cloud amount in five layers, mean and standard deviation of TBB for cloudy-area sea surface temperature upper water vapor amount OLR, precipitable water amount, convective cloud information in 0.5° × 0.5° area	60° N-60° S 80° E-160° W	00Z,06Z,12Z,18Z: 4 times/day (8 times/day:OLR)
Satellite cloud information chart (Vicinity of Japan)	Characteristics and temporal change of cloud distribution, TBB and other information	Vicinity of Japan	8 times/day
Satellite cloud information chart (Far East)	Characteristics of cloud distribution, cloud top height	60° N-Equator 90° E-170° W	24 times/day
Satellite meteorological analysis information	Information for weather forecast (cloud distribution, characteristics and temporal change of cloud system, etc.) Information on cloud system of severe rain/snow fall	60° N-Equator 90° E-170° W	4 times/day Ocasionally (Ocasionally in typhoon)
Sea surface temperature chart	Enhanced picture of sea surface temperature	50° N-50° S 90° E-170° W	daily
Sea-ice chart	Enhanced picture of sea-ice detection	Sea of Okhotsk Bohai	7 times/day
Satellite-derived index of precipitation intensity	Precipitation intensity estimated from GMS data	Vicinity of Japan	24 times/day
VISSR histogram data	Histogram data calculated from VISSR infrared/visible data in 0.25° × 0.25° area	60° N-60° S 80° E-160° W	8 times/day
Cloud grid data	Physical parameters (Ex.Cloudy/Open indices, mean of TBB and albedo, etc.) in 0.25° × 0.25° area	60° N-60° S 80° E-160° W	8 times/day
VTR of image movie	Infra-red(IR) and water vapor (WV) image movie for cloud analysis	Full Disk coverage Northern Hemisphere	8 times/day 24 times/day
Photographic negative film	Inrfa-red(IR), visible and water vapor (WV) images	Full Disk C. etc Vicinity of Japan	8 times/day 24 times/day
High Density cloud motion vectors around Typhoon	High density low level wind vector derived from time-sequential images at 15 minute intervals	20° lat.X20° lon. Centered on the Typhoon center	daily when a typhoon exists
OLR(out-going long wave radiation)	Mean of OLR in 0.5° × 0.5° area	50° N-50° S 90° E-170° W	8 times/day
	Mean of OLR in 2.5° × 2.5° area	60° N-60° S 80° E-160° W	every 5 days monthly every 3 months (in chart only)
Sea surface temperature	Mean of sea surface temperature in 0.5° × 0.5° area	50° N-50° S 90° E-170° W	daily
	Mean of sea surface temperature in 1° × 1° area		every 5 days monthly every 3 monthly (in chart only)
Upper tropospheric air humidity	Upper tropospheric air humidity in 0.5° × 0.5° area	50° N-50° S 90° E-170° W	00,06,12,18UTC 4 times/day
Precipitable water amount	Precipitable water amount in 0.5° × 0.5° area	50° N-50° S 90° E-170° W	00,06,12,18UTC 4 times/day
Solar radiation	day-time (from 05 to 18 JST) total downward solar radiation at the surface in 0.25° × 0.25° area	60° N-60° S 80° E-160° W	daily
Snow-ice index	snow-ice index in 0.25° × 0.25° area	60° N-20° N 80° E-160° W	daily
Image data	IR, visible and WV images of GMS	Full Disk coverage	8 times/day (00,03,06UTC:VS)
		Polar stereo	24 times/day (22-09UTC:VS) (8 times/day:WV)

Products disseminated via GTS

Cloud motion winds and water vapor motion winds

Both low and high level cloud motion winds (CMWs) have been produced by using visible and infrared images. The techniques of target cloud selection and height assignment were modified in September 1995. In the target selection, a new processing was introduced to exclude the areas containing cumulonimbus by using brightness temperature difference between IR and WV sensors. In the height assignment, an IR and WV intercept technique was newly introduced to correct brightness temperature of non-black body clouds.

Water vapor motion winds (WVMWs) are derived at middle and high levels in the troposphere from WV images. The WVMW extraction scheme is basically the same as that of CMW. However, its quality check is applied only by the automatic procedure, in which homogeneity of the speed, direction and height are controlled. WVMWs have been operationally disseminated via GTS since 28 March 1996 after the quality of the data was proved good enough to be used in numerical prediction at JMA.

Accuracy of CMWs and WVMWs is evaluated in WP-16.

Sea surface temperature (SST)

SST is estimated by applying using the operational SST algorithm to GMS-5 data that was developed on the basis of multichannel sea surface temperature (MCSST) retrieval algorithm. The main feature is the atmospheric correction using the temperature differences in the split-window channels.

The RMS value of SST of GMS-5 is thus improved by 5℃ in comparison with that of GMS-4 as shown in Table 3.

Table 3 Comparison of the SST retrieval algorithms for GMS-4 and GMS-5 retrieval algorithm.
(data used : GMS-4 in January 1995, GMS-5 in January 1996)

Satellite	bias	RMS	correlation
GMS-4	-3.02	6.27	0.85
GMS-5	-0.38	1.20	0.97

Fig. 1 shows the monthly monitoring of the accuracy of calculated SST in comparison with measurements of moored and drifting buoys located in GMS coverage in 1996. The RMS value of SST is about 1.2℃ through a year with no distinct variation, while, a seasonal fluctuation is recognized in the bias of SST.

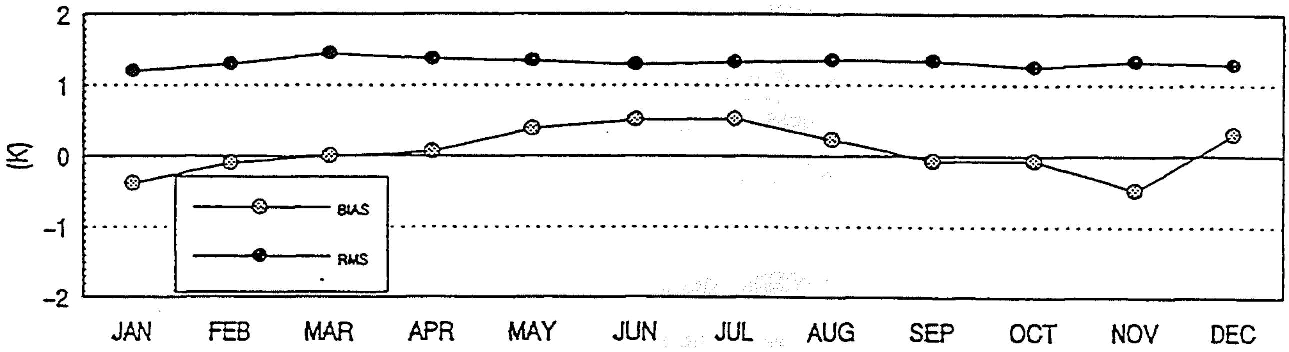


Fig. 1 Monthly monitoring of the accuracy of calculated SST in 1996.

Products for domestic users

Cloud amounts

Two kinds of cloud amounts are operationally derived from image data as in the past. One of them is for the purpose of climate monitoring of climate and its processing method is not basically changed to keep the characteristic of the data in the same condition for a long period. The other kind of cloud amount is for the purpose of numerical weather forecasting and the height assignment method is improved by correcting the height of semi-transparent cirrus by using IR-1 and WV data.

Fig. 2 shows the monthly monitoring of the accuracy of total cloud amount in 1996 in comparison with its surface observation data (0 to 8) at the radiosonde stations located in the GMS coverage. Its RMS value is about 3. A seasonal fluctuation in the bias of the data is recognized. The cloud amount in the Northern Hemisphere has a tendency to be overestimated in winter and underestimated in summer.

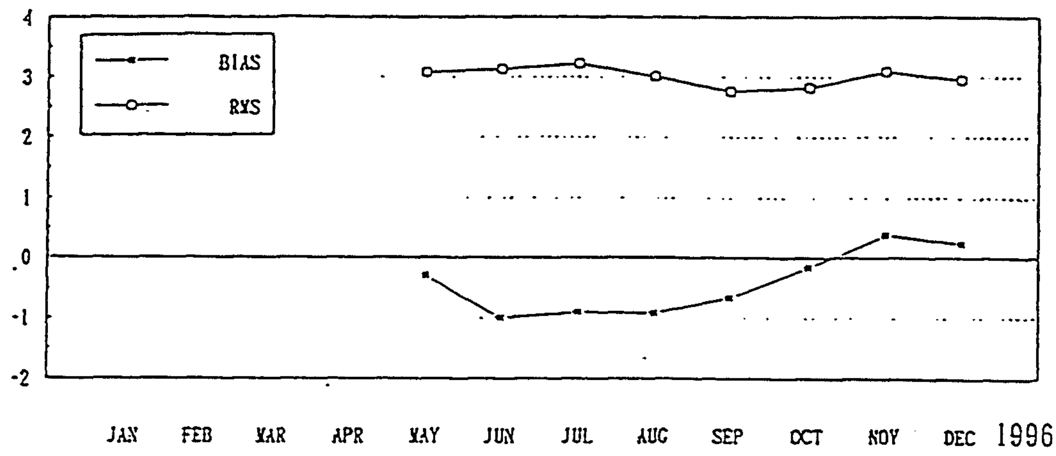


Fig. 2 Monthly monitoring of the accuracy of calculated total cloud amount in 1996.

Equivalent black body temperature/outgoing longwave radiation

The equivalent black body temperature is derived from IR-1 data and the processing method is not changed from that for the GMS-4.

Outgoing longwave radiation (OLR) is estimated by a multi-regression equation using the observed data of IR-1 and WV channels.

The parameters in the regression equation were derived by calculating OLR and radiance of IR-1 and WV for various vertical temperature and moisture profile by a radiative transfer model (LORTRAN-7).

Upper tropospheric air humidity (UTH)

UTH is the mean relative humidity in the layer between 300 hPa and 600 hPa in the troposphere. UTH is estimated over the clear areas free from high/middle clouds by using an operational UTH algorithm for GMS-5 data, which was developed on the basis of the algorithm of the European Space Operational Center (ESOC).

Its main feature is to compare the WV radiance calculated by the radiative transfer model using the vertical profiles of relative humidity of objective analysis in the layer between 300 and 600hPa (namely URH, the upper relative humidity) as its input data with that of the image data observed by the satellite, and to determine the URH at which the both are fit by controlling the input conditions of the radiative transfer model.

Fig. 3 shows the monthly monitoring of the accuracy of UTH in comparison with the average of humidity calculated at 100 hPa intervals between 300 hPa and 600 hPa from radiosonde data in the GMS coverage in 1996.

The RMS value of UTH is about 15 % and its bias is within 5 %.

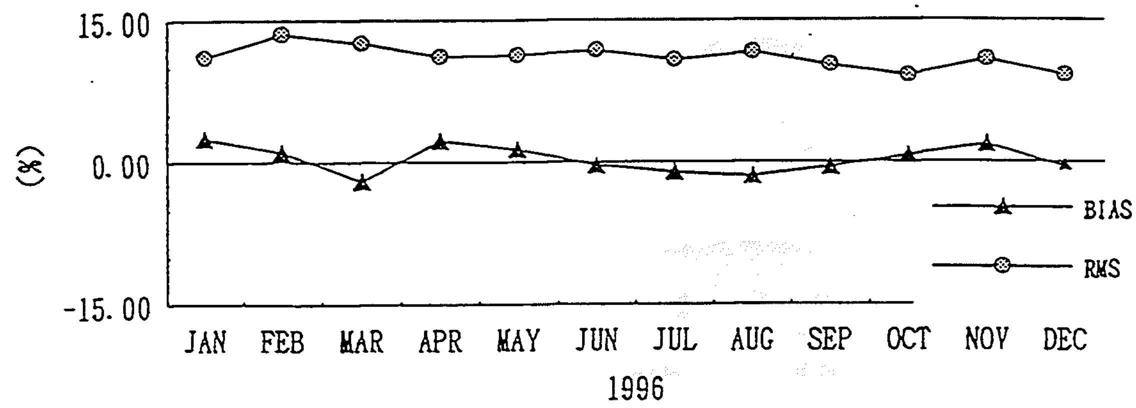


Fig. 3 Monthly monitoring of the accuracy of calculated UTH in 1996.

Precipitable water amount (PWA)

PWA is derived over the clear sky region from split-window channel data by using an algorithm for GMS-5 data developed on the basis of the operational retrieval algorithm of the GOES program.

Its main point is to determine the PWA based on the multiple-regression equation prepared by making the brightness temperature data observed by the GMS-5 split-window-channel IR-1 and IR-2, and air temperature at 700hPa of the vertical profiles of objective analysis as the dependent variables, and the PWA obtained by radiosonde as the objective variables.

Fig. 4 shows the monthly monitoring of the accuracy of calculated PWA in comparison with PWA obtained from radiosonde data in the GMS coverage in 1996.

The RMS value of PWA is about 9 mm and its bias is about 1 mm.

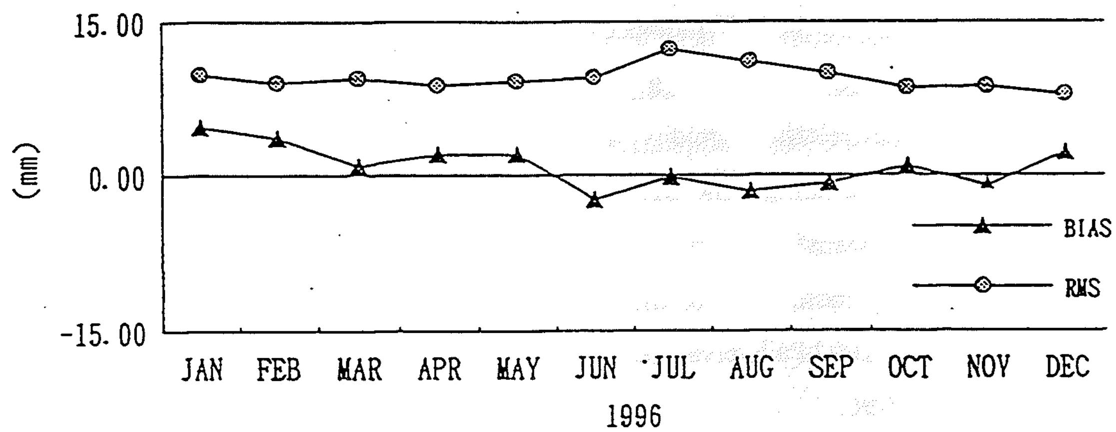


Fig. 4 Monthly monitoring of the accuracy of calculated PWA in 1996.

Satellite-derived index of precipitation intensity (SI)

SI is calculated over Japan and its vicinity based on the multiple-regression equation prepared by visible and IR data as dependent variables and quantified radar echo data as an objective variable. It is utilized as the supplementary data in the very short-range precipitation forecast in the area outside of the effective radar ranges of JMA.

Fig. 5 shows the monthly monitoring of the accuracy of SI. The intensity disparities between the SI and the radar echo compared at each five-kilometer-size mesh are shown. HIT, MIS and OF in the figure are ratios of samples with disparities within one level, less or equal minus one level, more or equal plus one level, respectively, to the total number. Samples of null intensity in both SI and radar echo are eliminated.

These are averaged results of SIs derived from the 03 UTC (day time) and the 12 UTC (night time) images. The accuracy is improved approximately by 10% if it is computed just by using the 03 UTC SIs because of the visible data.

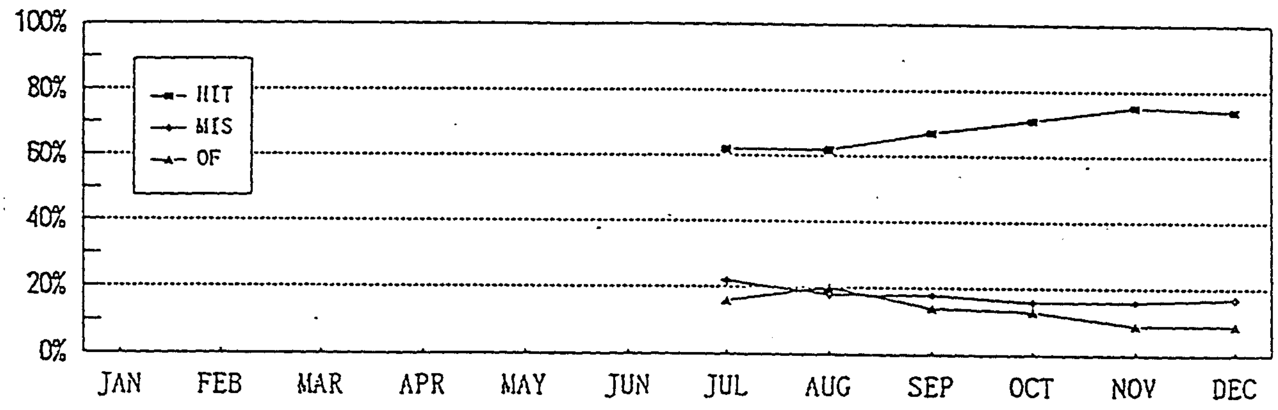


Fig. 5 Monthly monitoring of the accuracy of calculated SI in 1996.

New products and their use in Numerical Weather Prediction

HAZARDS DIAGNOSIS USING OKEAN SATELLITE DATA

Summary and purpose of document

This document is provided to present to CGMS-XXV participants the results of the works on operative diagnosis of the dangerous phenomena using the information of a radiophysical equipment of OKEAN satellite

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Action

No action required

Hazards diagnosis using OKEAN satellite data

The radiophysical equipment (RPE) of the Satellite "Okean" consists from the Side looking Radar (SLR) 3-centimetric ranges and from the scanning microwave radiometer (RM-08), working on a length of a wave 0.8 sm. Both device give the spatial coinciding images of the same regions and are by sensitive tools for study of the mesoscale characteristics of fields with the wind speed, contents of a liquid water in the clouds and intensity of precipitation in regions with dangerous and especially dangerous atmospheric processes.

For the account of the high space footprint of the SLR (about 1-2 km) satisfactory detailed elaboration of borders of regions of wind speed amplification up to 25,30, 35 and 40 m/c, observed is provided at gust, squall and storm. Some worse space footprint (about 25 km) has the microwave radiometer RM-08.

The developed algorithms and software for theme processing of digital data RPE permit operatively to restore significance of a wind speed, integrated contents of a liquid water in the clouds and intensity of precipitation in ranges 5-40 m/c, 0.2-1.2 kg/m^2 and 0-5 mm/h accordingly. Besides on images of SLR is revealed hail precipitation and hailstones in powerful Cb clouds over a land. The processing is executed with application of interactive procedures on algorithms and programs, realising by regression functions, the description of which is given in articles [1, 2].

The conducted analysis has shown satisfactory conformity (a standard deviation about 2-3 m/c) between results of restoration of wind speeds on the base of a SLR data and actual significance of maximum wind speeds, was registered in nearest synoptic terms.

The example of theme data processing of SLR and RM-08 Is indicated on fig. 1. On the colour image, the results of processing are decoded considerably faster, than on black-and-white.

Analysis of a ice conditions in a given region has shown, that the opened water, for which results of restoration are fair, are placed by west, north-west and south-west from a island the New Earth. For these regions ranges of change of restored significance of wind speed have made accordingly 5-15, 15-20 and 25-30 m/s.

Actual wind was registered only on one station of western coast of the New Earth and it will be well agreed with restored for this region by speed, equal 10 m/s. The received wind variability on west and north-west from the New Earth can be explained by influence of anticyclone 1020 hPa located on north-west.

However the opportunity of occurrence on south-west of local zones of wind amplification up to 25-30 m/s, revealed on a SLR data, is in the obvious contradiction with results of interpolation of actual synoptic data.

The additional synoptic analysis has shown, that on south-western region are observed significant termobarical gradients (up to 4 hPa/100 km and 4.5 C/100 km), which was connected with large-scale atmospheric front (wind speed at the ground 12-15 m/s), possessing by jet current and has length from northern coast of Scandinavia up to Novosibirsk. In a considered region, on Images of a Satellite the NOAA-14 (23 h. 32 min. - 1 h. 12 min.), are observed Cb, Sc and Ci clouds. To the west from the New Earth is located the mesoscale cyclone with a centre 45 E 73 N, consisting of spiral bands of convective clouds.

Clouds in a form of a spiral consisted from separate convective cells (diameter of 26 km), of Cb and Sc clouds of significant vertical development, clouds type of cirrus, especially on the north and north-east from a centre of cyclone, i.e. in a zone of maximum significances of wind speed up to 25-30 m/s. But the precipitation, the most probable, are snow, as the contents of a liquid water in clouds In this region is small. The contents of a liquid water in clouds was calculated on the base of synchronous data of RM-08 and low temperatures of air at the ground (-14 C) on a meteostations data.

Hereinafter, by 9 h. 24 min. 19.94.96 were begun the process of destruction of the convective mesowhirlwind and reduction of quantity of clouds spirals. In 9 h. the centre of mesowhirlwind was displaced by east on 500 kms, and in zones of observed maximum significance of wind, were formed banks of Sc and Cu clouds from convective cells with a diameter about 26 km.

Thus, the occurrence of two revealed regions with the squall wind speed up to 25-30 m/s was observed in period of the maximum development of mesowhirlwind activity (probably about two hours).

In spite of the fact that in a researched region low significance of temperature of air, analysis of the synchronous data of the scanning microwave radiometer RM-08, indicated on fig. 2, b, has shown presence of liquid water components in atmosphere of this region. The content of liquid water was from 0.1 up to
0.5 kg/m2, that corresponds clouds of St, Sc and Cu types.

The field, pursuant to SLR data, wind speeds in a region of a arrangement of the cloud whirlwind, repeats its form. In a central part of a head of the whirlwind, where is no clouds, wind speed is minimum, about 5 m/s. Further by south from a head of the whirlwind, where spirals of clouds in form of a St are located, wind speed changes from 10 up to 15 m/s. And in contiguous to a head of the whirlwind, northern and north-east parts, depending on a type of clouds, the speed changes from 15-20 up to 25-30 m/s. And the maximum wind speed 25-30 m/s is observed in comparison small on the sizes (extent about 50 * 100 km) region engaged by group powerful Cb, Cu cong clouds, and 15-20 m/s - in a region, where is observed dense Sc clouds.

The listed conditions testify to a opportunity of occurrence in this region a gust wind and squall, at which the maximum wind speed appears essentially higher (on 8-10 m/s and more) of its average significance and sometimes reaches 30 m/s [3].

It should note, that the situations, when over the arctic seas the speed of wind at gust and squall reaches 30 m/s and more, belong to natural hydrometeorological disasters. Therefore detection of such zones by results of processing of the digital information of satellite SLR, as well as the calculation of parameters of atmosphere in such regions presents doubtless interest not only for navigation, but also with the purposes of perfection of methods of their advance prediction.

Thus, the analysis of results of processing digital data of SLR and RM-08 of satellite the "Okean" testifies to their doubtless utility for the purposes of operative detection natural hydrometeorological disasters over a marine surface and for study of properties of atmospheric processes at such phenomena.

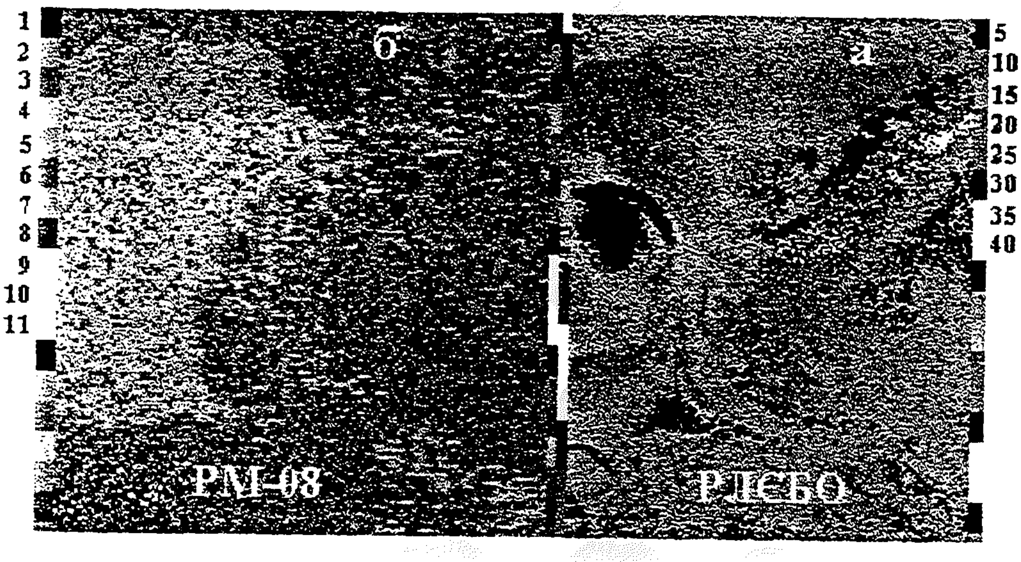


Fig. 1. The results of processing of SLR (a) and RM-08 (6) data of satellite the "Ocean" N 7, 19.04.96. (1 h. 33 min.).

List of the literature

1. M.V.Bukharov. Study of conditions of recognition of hall precipitations on the of satellite SLR Images. - Earth research from space, 1991, v. 8, N 4, p. 74-82.

2. M.V.Bukharov. Application of satellite side looking radar for calculation of wind amplifications in regions with convective precipitations. - Earth research from space, 1991, v. 8, N 5. p. 61-70.

3. M.A.Masterskih. About account of wind speed at gusts In narrow zones of cold fronts.- Meteorology and hydrology, 1981, N 11, p. 93-94.

CGMS-XXV RUS-WP-11
Prepared by RUSSIA
Agenda Item: II/5

New products and their use in Numerical Weather Prediction

SATELLITE RADAR DATA MONITORING OF POLAR ICE COVER

Summary and purpose of document

This document is provided to present to CGMS-XXV participants the results of the Arctic sea ice monitoring using OKEAN and ERS satellites radar data.

Action

No action required

CGMS-XXV RUS-WP-11
Prepared by RUSSIA
Agenda Item: II/5

Satellite radar data monitoring of polar ice cover

V.Asmus, O.Johannessen, V.Krovotyntsev, O.Milekhin

Sea ice researches using OKEAN satellites side-looking radars (SLR) data are carried out since 1983 in Research and Production Association PLANETA (Moscow). Since 1995 sea ice radar monitoring of the Northern Sea Route have been carried out in the frame of joint project between PLANETA and Nansen Center in Bergen (Norway). The objective of the project is to implement satellite monitoring by combined use of OKEAN SLR, ERS SAR and other remote sensing data to support ice navigation in the Northern Sea Route , offshore industry and environmental studies. Sea ice conditions monitoring was realised in real-time.

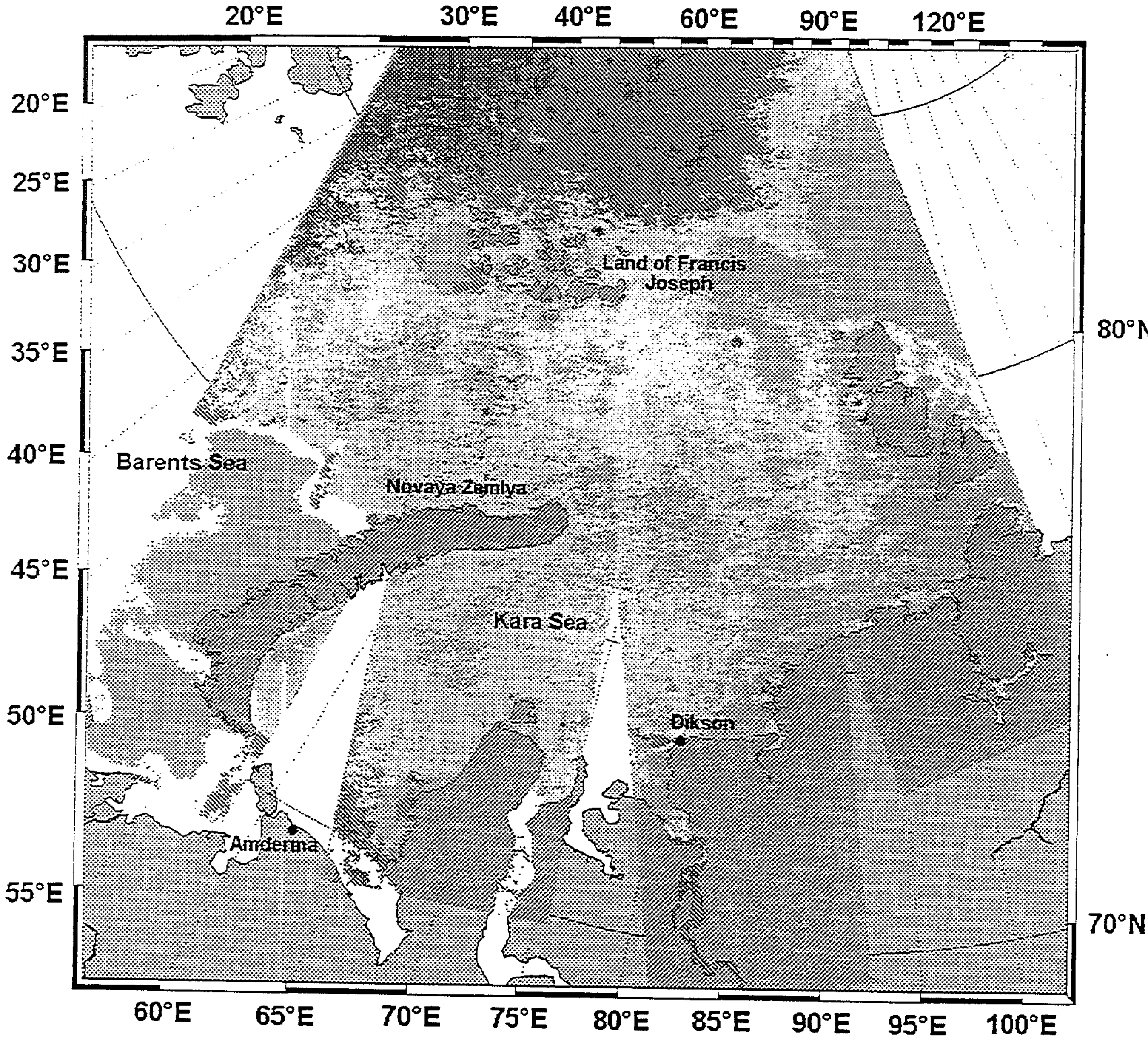
On the base of OKEAN and ERS radar images ice thematic maps were constructed. Study of radar backscatter characteristics of different sea ice types also was fulfilled in the frame of this work.

The results of this project will be used to recommend a concept for integrated use of the different types of radar data in sea ice monitoring.

An example of the sea ice distribution map derived from OKEAN data is presented in fig. 1.

RPA Planeta
Department of thematic processing

Sat. Okean N7, SLR, RM08
Orbits:8592, 8606, 8622, 8652
Date: 1996, May, 16 - 21



Thematic Map of the Sea Ice Distribution in the Kara Sea, Obtained as Result of Supervised Classification

Polar Stereographic Projection
0 100 200 300 400 km

open sea
smooth first year ice
multy year ice
land
rough first year ice
rough multy year ice
shore line

CGMS-XXV EUM-WP-26
Prepared by EUMETSAT
Agenda Item: III.3

USE OF SATELLITE WINDS AT NWP CENTRES

This paper provides information on accuracies assigned to satellite tracked winds at different NWP Centres. It has been compiled in response to a request from the Third International Winds Workshop in Ascona, June 1996.

The following conclusions are drawn:

- Observational errors of satellite winds differ significantly from different NWP centres
- Established products are not used at all centres
- At least at ECMWF low-level satellite winds have a better accuracy than radiosondes
- Improvements reported recently on INSAT winds suggest to consider their use in NWP as well.

USE OF SATELLITE WINDS AT NWP CENTERS

1 INTRODUCTION

This paper presents a compilation of accuracies assigned to satellite tracked winds at different NWP Centres. The paper has been requested at the Third International Winds Workshop in Ascona, June 1996. The data have been kindly collected by G. Kelly of ECMWF.

2 THE OBSERVATIONAL ERRORS OF SATELLITE TRACKED WINDS

The observational errors are compiled in Table 1 where radio sonde errors are also given for comparison. The table shall serve as discussion basis for the Working Group III meeting at the CGMS XXV.

The following sub-sections provide more details on the selection/rejection of data from different satellites and for different geographical regions as performed at the individual NWP Centres.

2.1 ECMWF

The following data selection is applied to the CMW product. All data is monitored regardless of the fact whether they pass or do not pass the data selection checks.

a) Check on longitude/latitude:
   - Data are used only if within a circle of 55 degree from the sub-satellite point

b) Checks on levels depending on the computational method or channel are as follows:
   - The infrared CMW are used at all levels
   - The water vapour CMW are used only above 400 hPa
   - The visible CMW are used only below 700 hPa

c) Check on land/sea:
   - Data over sea are always used
   - If data is over land, then it is used only if south of 20N and above 500 hPa (for Meteosat instead 20°N a threshold of 35°N is used in order to allow usage of these data over North Africa)

d) Check on satellite:
   At present the following satellites and channels are used:
   - Meteosat IR (not at medium level), VIS, WV and HRVIS (not at asynoptic time)
   - GOES IR & WV
   - GMS IR & VIS

2.2 German Weather Service (DWD)

a) Check on geographical area:
   - where available, except over land poleward of 20 degrees.

b) Check on satellites:
   - all, except from India

c) Check on spectral band:
   - IR and VIS, no water vapour yet!

2.3 National Center for Environmental Prediction (NOAA/NWS/NCEP)

At NCEP satellite winds from GOES 8 and GOES 9 and Meteosat are used everywhere south of 20°N, and only over ocean north of 20°N. Satellite winds from Japan GMS are used everywhere.

2.4 UK Meteorological Office

Neither GOES nor GMS WV winds are being used, while Meteosat WV winds in SATOB code are used.

2.5 Météo France

There is no a priori blacklisting except that winds are only used within a circle arc around the sub-satellite point. High resolution VIS winds (from Meteosat) sent in BUFR are not yet used.

2.6 Australian Bureau of Meteorology/Research Center (BMRC)

All GTS wind products are used except those from INSAT. A special local wind data set is produced for the Australian region from GMS.

2.7 Japan Meteorological Agency (JMA)

All satellites are being used except INSAT.
Observational errors for levels other than those provided in Table 1 are interpolated and errors for levels higher than 200 hPa are reassigned to 200 hPa.

Normal cloud track winds and water vapour track winds are processed in completely the same way, since the quality of both data sets are almost the same. For GMS the water vapour winds are even slightly better than the IR winds.

2.8 US Navy Global (NOGAPS)

All the satellite winds decoded from the bulletins for GOES, GMS and METEOSAT are used. In addition high-density multispectral wind observations produced by the University of

Wisconsin-CIMMS from the GMS-5 and GOES-8 imagery are used. These observations are being used only from 40°S-40°N and are combined into superobs at an approximate resolution of 200 km. The observation errors assigned to these superobs are given in Table 1 in column 'high-dens. CIMMS'.

3 CONCLUDING REMARKS

- Observational errors of satellite tracked winds differ significantly for different NWP centres.
- Established products, like WV winds, are not used at all centres (e.g. DWD, UKMO).
- At least at ECMWF low-level satellite winds have a higher accuracy than radiosondes.
- In view of the recent improvements observed in INSAT winds as reported at the Third International Winds Workshop CGMS should encourage NWP centres to all consider the use of INSAT winds.

hPa	R/S	ECMWF	DWD	NCEP			UK MO	Météo France			BMRC	JMA	US-Navy (Nogaps)	
				Current All Sat.	New GOES	New OTHER		Meteosat/ GOES	GMS	INSAT			All	high.-dens CIMMS
1000	2.3	2	3	3.9	1.8	1.8	1.8	2.75	3.25	3.5	3	3	2.8	1.7
850	2.3	2	3				1.8	2.86	3.38	3.64	3		2.8	1.7
700	2.5	2	3				1.9	3.08	3.64	3.92	3		3.8	2.3
500	3.0	3.5	3	3.9	2.1	2.1	2.1	3.85	4.55	4.9	3		4.8	2.5
450				6.1	3	5					3			
400	3.5	4.5	6		3		4.0	4.29	5.07	5.46	6		5.8	3.5
300	3.7	5	6		3	5	4.6	4.62	5.46	5.88	6		6.5	3.9
250	3.5	5	6		3	5	5.0	4.84	5.72	6.16	6		6.5	
200	3.5	5	6		3	5	5.0	5.06	5.98	6.44	6	3	6.5	
100	3.3	5	6		3	5	5.0	5.06	5.98	6.44	6	4.5	6.5	

Table 1: Observation errors in m/s assigned to satellite tracked winds at various NWP centres. Values pertain to u and v components. For comparison the first column gives the observation error of radiosonde winds as applied at ECMWF.

III. Performance of Operational Winds

Operational GOES-8 cloud-drift and water-vapor wind quality throughout 1996 (Figure 1) has been similar to the quality reported for 1995 (Menzel et al., 1996). Mean vector difference (MVD) of the cloud-drift winds compared to radiosondes was consistently between 5 and 6 ms^{-1}. Water-vapor winds exhibited a similar MVD during the summer, but were more than 0.5 ms^{-1} higher during the winter. Mean bias for both products remained small (assisted by the speed bias adjustment incorporated in the algorithm since 1994), hovering around zero during the winter and approaching -1 ms^{-1} in the summer. 1996 was the first full year of operational GOES-9 cloud-drift and water-vapor wind production. As expected, the GOES-9 statistics (Figure 2) are remarkably similar to those for GOES-8 production; the same error characteristics are evident in both sets of satellite winds.

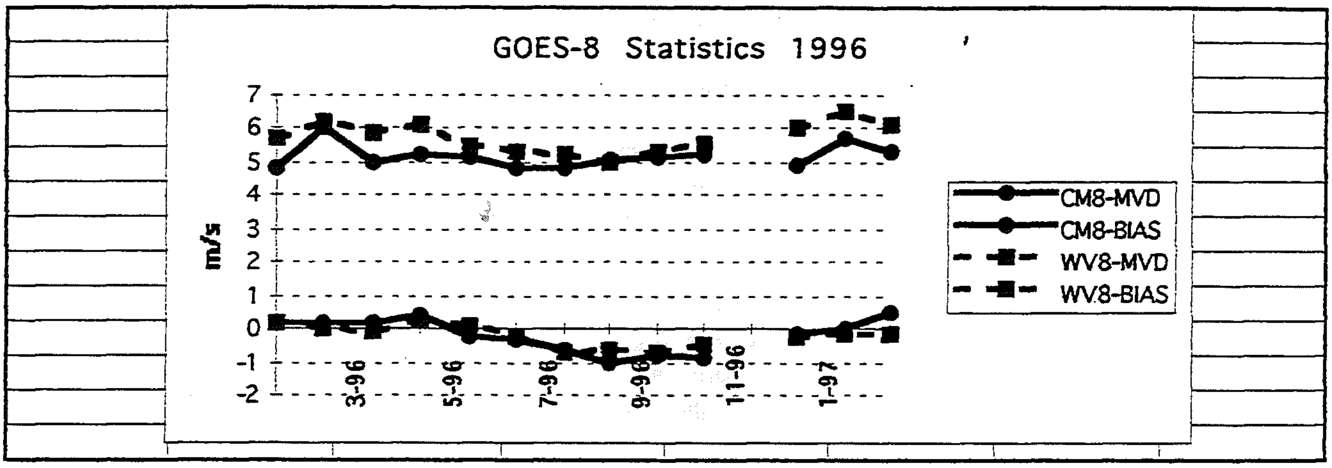


Figure 1. The GOES-8 cloud motion vector (CM) and water vapor motion (WV) winds compared to radiosondes for the last 14 months

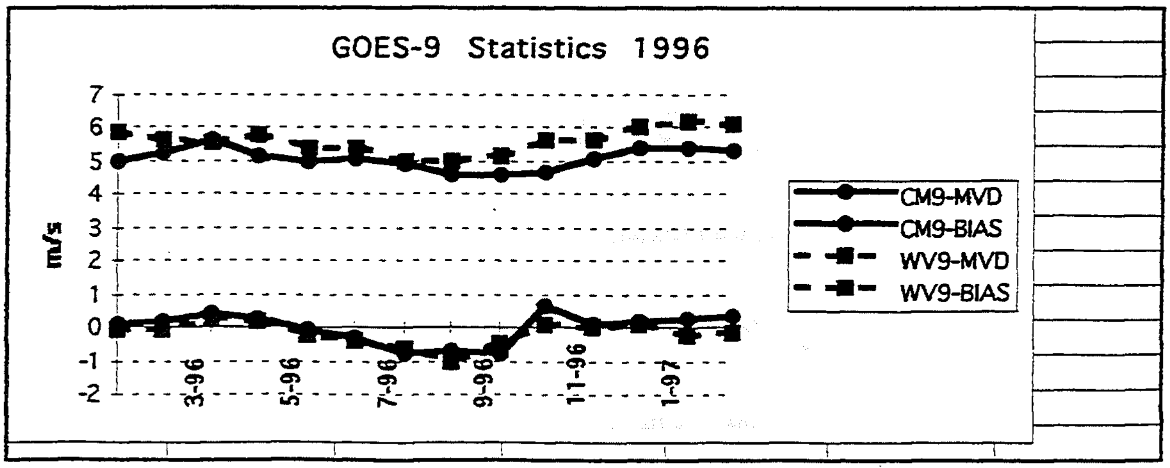


Figure 2. The GOES-9 cloud motion vector (CM) and water vapor motion (WV) winds compared to radiosondes for the last 14 months. Missing statistics in November are the result of verification problems

Wind statistics for the month of February 1997 are presented as an example. They are separated by level and latitudinal belt in Tables 1 through 4 in accordance with the recommended reporting format. Although wind measurement density is equal in both hemispheres, the verification totals are much lower in for the southern hemisphere extra-tropical region because there are fewer radiosondes and southern hemisphere imager coverage is less frequent. GOES-9 wind production is somewhat lower due to restricted imager coverage at 1200 UTC mid-way through February when imager motor winding protection operations commenced. Water-vapor winds are not produced at low levels.

GOES-8 and GOES-9 products show similar quality. Overall MVD for both cloud-drift wind products is slightly lower than 5.5 ms^{-1} and the mean bias is slightly positive. Overall MVD for the water-vapor motion products is about 6 ms^{-1} and the mean bias is slightly negative. Wind performance is somewhat correlated to mean speed of the observations, with higher wind mean wind speeds exhibiting higher errors. Thus, the MVD improvement of about 1 ms^{-1} in the tropical regions is likely due to decreased wind speeds. The relatively large negative mean bias of mid-level winds in the extra-tropical regions continues to be a concern, especially for water-vapor winds.

	ALL REGIONS	NH EX-TROP	TROP	SH EX-TROP
ALL	5.24	5.48	4.59	5.02
MVD	3.98	4.04	3.84	3.05
SD	.49	.54	.52	-.96
BIAS	21.58	24.57	13.15	17.47
SPD	778	564	190	24
N				
HI	5.37	5.41	5.17	5.38
MVD	3.70	3.78	3.44	3.20
SD	.84	1.10	.16	-1.47
BIAS	26.69	29.07	16.58	19.21
SPD	476	381	75	20
N				
MID	5.74	5.79	5.57	5.32
MVD	4.37	4.40	4.35	1.42
SD	-.50	-.76	.60	1.81
BIAS	16.00	17.46	9.45	10.74
SPD	166	135	30	2
N				
LOW	4.18	5.10	3.73	2.42
MVD	4.25	4.89	3.85	1.51
SD	.46	-.17	.82	.63
BIAS	10.50	8.85	11.44	10.33
SPD	136	48	85	2
N				

Table 1. Rawinsonde verification statistics for GOES-8 operational cloud-drift winds during February 1997. The collocation match radius is 150 km. N indicates the number of collocations. SPD gives the mean raob wind speeds.

	ALL REGIONS	NH EX-TROP	TROP	SH EX-TROP
ALL	6.10	6.28	5.49	5.33
MVD	4.26	4.40	3.68	3.40
SD	-.14	-.18	.24	-.65
BIAS	27.11	30.37	15.02	15.40
SPD	2716	2136	442	139
N				
HI	5.93	6.03	5.63	5.40
MVD	4.12	4.22	3.82	3.53
SD	.30	.34	.41	-.63
BIAS	28.51	32.23	16.07	15.94
SPD	2194	1690	383	122
N				
MID	6.83	7.20	4.63	4.80
MVD	4.73	4.93	2.46	2.30
SD	-1.98	-2.16	-.90	-.83
BIAS	21.20	23.29	8.22	11.48
SPD	521	445	59	17
N				
LOW	----	----	----	----
MVD	----	----	----	----
SD	----	----	----	----
BIAS	----	----	----	----
SPD	1	1	0	0
N				

Table 2. Rawinsonde verification statistics for GOES-8 operational water-vapor winds during February 1997. The collocation match radius is 150 km. N indicates the number of collocations. SPD gives the mean raob wind speeds.

	ALL REGIONS	NH EX-TROP	TROP	SH EX-TROP
ALL	5.37	5.69	4.65	4.38
MVD	3.87	4.16	2.91	3.26
SD	.35	-.03	1.64	-.68
BIAS	18.94	22.84	9.49	9.53
SPD	349	247	86	16
N				
HI	5.88	6.20	5.17	4.54
MVD	4.26	4.60	2.84	3.61
SD	.80	.70	1.65	-.89
BIAS	22.96	27.45	11.01	10.41
SPD	214	156	45	13
N				
MID	4.67	4.72	4.57	3.72
MVD	2.98	2.96	3.20	1.27
SD	-.87	-1.44	1.21	-.97
BIAS	14.49	16.28	8.69	7.27
SPD	99	76	21	2
N				
LOW	4.28	5.25	3.58	----
MVD	3.14	3.76	2.55	----
SD	1.04	-.43	2.06	----
BIAS	7.26	8.01	6.93	----
SPD	36	15	20	1
N				

Table 3. Rawinsonde verification statistics for GOES-9 operational cloud-drift winds during February 1997. The collocation match radius is 150 km. N indicates the number of collocations. SPD gives the mean raob wind speeds.

	ALL REGIONS	NH EX-TROP	TROP	SH EX-TROP
ALL	6.21	6.39	5.79	4.67
MVD	4.29	4.32	4.56	2.22
SD	-.18	-.60	1.44	1.23
BIAS	22.91	25.47	13.61	12.26
SPD	1121	885	175	61
N				
HI	5.94	6.03	6.00	4.68
MVD	4.03	3.98	4.69	2.25
SD	.47	.13	1.62	1.34
BIAS	24.57	28.02	14.21	12.65
SPD	861	652	152	57
N				
MID	7.10	7.42	4.39	4.50
MVD	4.95	5.03	3.37	2.15
SD	-2.43	-2.63	.29	-.24
BIAS	17.41	18.35	9.71	7.04
SPD	260	233	23	4
N				
LOW	----	----	----	----
MVD	----	----	----	----
SD	----	----	----	----
BIAS	----	----	----	----
SPD	0	0	0	0
N				

Table 4. Rawinsonde verification statistics for GOES-9 operational water-vapor winds during February 1997. The collocation match radius is 150 km. N indicates the number of collocations. SPD gives the mean raob wind speeds.

IV. Performance of High Density Cloud-Drift Winds

NESDIS operational wind production will soon increase the measurement density of both cloud-drift and water-vapor winds (Nieman et al., 1997). The Forecast Products Development Team within NESDIS has been refining higher density wind production as a research effort for most of 1996 (Gray et al., 1996). GOES-8 and GOES-9 high-density products are being generated, with emphasis on GOES-8 winds to support the 1996 Atlantic hurricane season and the Fronts and Atlantic Storm-Track Experiment (FASTEX). As a result, GOES-8 production was often confined to the northern hemisphere. Statistics describing high-density GOES-8 cloud-drift and water-vapor winds are shown in Tables 5 and 6 respectively.

GOES-8 high-density wind statistics are very similar to those presented for the normal-density operational winds, except the sample size has increased roughly ten-fold for the cloud-drift winds and five-fold for the water-vapor winds. By producing a much greater number of vectors with the same error characteristics, the wind products are allowed to deviate further from the guess (Nieman et al., 1997) and have a better chance to positively impact model forecasts (Velden et al., 1997).

	ALL REGIONS	NH EX-TROP	TROP	SH EX-TROP
ALL	5.16	5.26	4.55	----
MVD	3.52	3.58	3.06	----
SD	.30	.30	.33	----
BIAS	23.20	24.89	11.71	----
SPD	8076	7042	1036	0
N				
HI	5.50	5.55	5.14	----
MVD	3.76	3.82	3.51	----
SD	.85	1.05	-.77	----
BIAS	29.44	31.20	15.24	----
SPD	4503	4005	498	0
N				
MID	4.96	5.01	4.56	----
MVD	3.26	3.31	2.72	----
SD	-.61	-.78	1.06	----
BIAS	17.80	18.88	6.78	----
SPD	2453	2235	220	0
N				
LOW	4.24	4.50	3.61	----
MVD	2.68	2.81	2.18	----
SD	.14	-.42	1.53	----
BIAS	9.94	10.08	9.58	----
SPD	1120	802	318	0
N				

Table 5. Rawinsonde verification statistics for GOES-8 high-density cloud-drift winds during February 1997. The collocation match radius is 150 km. N indicates the number of collocations. SPD gives the mean raob wind speeds.

	ALL REGIONS	NH EX-TROP	TROP	SH EX-TROP
ALL MVD SD BIAS SPD N	6.15 4.15 .17 28.71 13035	6.21 4.18 .12 30.31 11776	5.59 3.87 .65 13.79 1262	---- ---- ---- ---- 0
HI MVD SD BIAS SPD N	5.95 3.99 .85 30.06 10422	5.98 4.00 .85 32.02 9275	5.69 3.96 .85 14.29 1149	---- ---- ---- ---- 0
MID MVD SD BIAS SPD N	6.94 4.66 -2.55 23.30 2613	7.04 4.70 -2.61 23.96 2501	4.61 2.51 -1.29 8.63 113	---- ---- ---- ---- 0
LOW MVD SD BIAS SPD N	---- ---- ---- ---- 0	---- ---- ---- ---- 0	---- ---- ---- ---- 0	---- ---- ---- ---- 0

Table 6. Rawinsonde verification statistics for GOES-8 high-density water-vapor winds during February 1997. The collocation match radius is 150 km. N indicates the number of collocations. SPD gives the mean raob wind speeds.

VI. Summary

Operational cloud-drift and water-vapor wind production within NESDIS has continued unchanged through 1996 and into early 1997. Verification statistics for the past year show that product quality has remained steady, and that winds produced from GOES-8 and GOES-9 show similar error characteristics. The next major operational change will be increased wind measuring density for both the cloud-drift and water-vapor products. Verification statistics of the research production of these high-density winds show similar characteristics to the normal-density operational products.

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CALCULATION OF CLOUD MOTION WIND WITH GMS-5 IMAGES IN CHINA

Xu Jianmin   Zhang Qisong

Satellite Meteorological Center
Beijing 100081, China

ABSTRACT

With GMS-5 images, cloud motion wind was calculated. For more accurate result and less calculation amount, the algorithm includes three major essentials:

Geometric Formula

In calculation of wind direction and speed, spiracle triangle formulas under great circle principle were adopted.

Height Assignment

For clouds above peak of water vapor channel weighting function, IR and WV channels were both used to identify heights, and a simple arithmetic resolution avoids the need of upwelling radiance integration; for clouds below peak of weighting function, only IR channel was used to identify heights.

Calculation Procedure

Rather than full correlation coefficient matrix being calculated, a calculation procedure was adopted. With this procedure, only about 1/8 points on the matrix need to be calculated for the maximum to be picked out. This procedure was tested by big amount of data and was improved effective. With this procedure the cloud motion wind program was run at a PC 486. A full disk 2.5 deg. grid wind field calculation with three images took about 40 minutes.

1. Introduction

Since the automated technique based on the use of cross correlation was introduced by Leese et al. (1971) for determine cloud motion wind from geostationary meteorological satellite images, the cross correlation technique has been adopted by all major operational satellite data processing centers (Merrill et al, 1991; MSC, 1989; Schmetz, 1993). Improvements to the technique include: height assignment by using water vapor channel (Schejwach, 1982), height assignment by using CO_2 absorbent channel (Menzel et al, 1983), tracer image filtering (Hoffman, 1990) and automatic quality control (Hyden, 1995). Satellite Meteorological Center of China tested to calculate cloud motion winds with GMS-5 data from JMA.

This paper introduces three major essentials in our wind calculation technique which are different from the other techniques or are the ones not yet been described by the published papers. Section 2 of this paper describes the formula used for wind direction and speed calculation on spheroidal earth. Section 3 refers to our height assignment procedure. For semi-transmisparent cirrus clouds, both IR and WV channels are used to assign cloud height, and a simple arithmetic resolution avoids the need of upwelling radiance integration. Section 4 illustrates a quick search procedure which catches maximum of the correlation coefficient matrix with about 1/8-1/10 amount of calculation.

2. Wind Direction and Speed on Spheroidal Earth

Fig 1 shows a tracer moving from A(φ_A, λ_A) to B(φ_B,λ_B). φ_A and φ_B are latitudes of A and B respectively; λ_A, λ_B longitudes ; $\Delta\lambda$ the longitude difference between B and A; r earth radius; N north pole. Note that all three arcs of a spherical triangle are on the great circles of the sphere. That means $\gamma = \angle AOB = AB$, $\angle N = \lambda_B - \lambda_A = \Delta\lambda$. Wind direction should be angle A of the spherical triangle NAB. Wind speed should be arc length AB of the spherical triangle NAB.

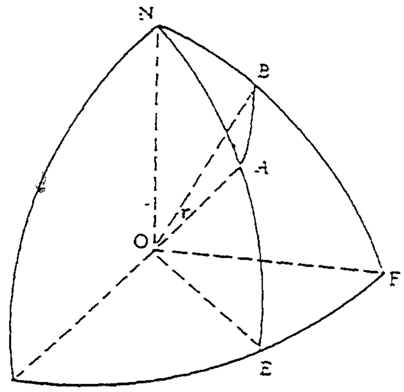

Fig 1. Tracer movement on sphere earth

In case of spherical earth, based on law of cosines for spherical triangle NAB,

$$\cos\gamma = \cos(90^\circ - \varphi_A)\cos(90^\circ - \varphi_B) + \sin(90^\circ - \varphi_A)\sin(90^\circ - \varphi_B)$$
$$= \sin\varphi_A \sin\varphi_B + \cos\varphi_A \cos\varphi_B \cos\Delta\lambda \qquad (1)$$

Thus arc length $AB = \gamma r$, Wind speed

$$fff = \gamma r / \Delta t \qquad (2)$$

In formula (2) , Δ t is time interval from the time the radiometer to scan point A at the first image, to the time the radiometer to scan point B at the second image. Further, based on low of cosines for spherical triangle ABN,

$$\cos(90^\circ - \varphi_A) = \cos\gamma \cos(90^\circ - \varphi_A) + \sin\gamma \sin(90^\circ - \varphi_A)\cos A$$

Thus

$$A = \cos^{-1}[(\sin\varphi_B - \cos\gamma \sin\varphi_A)/(\sin\gamma \cos\varphi_A)] \qquad (3)$$

In case of $\lambda_B > \lambda_A$, Wind direction

$$DD = A \qquad (4)$$

In case of $\lambda_B < \lambda_A$, Wind direction

$$DD = 360^\circ - A \qquad (5)$$

Formulas (1) – (5) are used to calculate wind direction and speed on spherical earth. For spheroidal earth, the earth radius is not a constant. It is a function of latitude:

$$r = r_P \sqrt{(1 + tg^2\varphi)/(1 + tg^2\varphi - \varepsilon^2)} \qquad (6)$$

In formula (6), r_P is earth radius at the pole, ε is the eccentricity of the earth.

3. Height Assignment

Height assignment with IR and WV channels was firstly introduced by Szejwach (1982). He discovered the linear relationship between IR and WV radiance viewing different cloud amounts. This relationship combined with radiation transfer integration at variety of opaque cloud condition gives height estimation for opaque cloud.

The height assignment procedure we used avoids to make radiation transfer integration. Fig 2 and Fig 3 are scheme diagrams to illustrate the physical bases of our procedure. Fig 2 shows origins of IR and WV channel radiance at different cloud conditions. In Fig 2, the curves labeled with WV and IR at the most left part of the figure show the priority function of the two channels with height. IR and WV represent infrared and water vapor respectively.

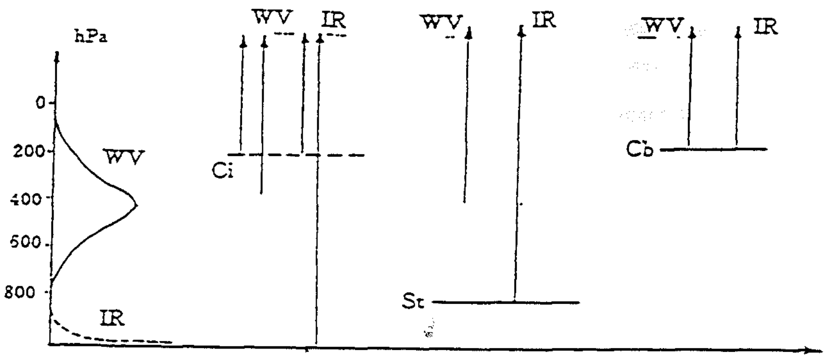

Fig 2 Origins of IR and WV channel radiance at different cloud conditions

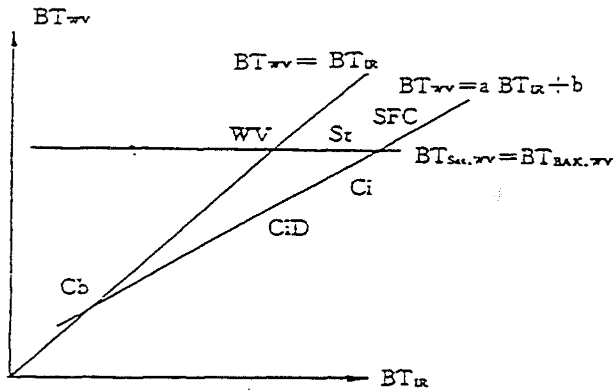

Fig 3 Scatter diagram of IR and WV brightness temperature at different cloud conditions.

3.1 Semi-transmittance Cirrus Cloud

In case of Semi-transmittance cirrus cloud, parts of the radiance origin from the background under the cloud. For IR channel the background radiance is from the surface, for WV channel it is from the upper troposphere. This can be expressed as

$$R_{SAT,WV} = (1 - NE_{WV})R_{RKG,WV} + NE_{WV}R_{CLOUD,WV} \quad (7)$$

$$R_{SAT,IR} = (1 - NE_{IR})R_{BKG,IR} + NE_{CLOUD,IR} \quad (8)$$

In formulas (7) and (8), R is radiance, N cloud amount, E cloud emissivity, SAT value received by the satellite, BKG originated from background, CLOUD originated from cloud. Suppose $NE_{WV} = NE_{IR} = NE$, combines (7) and (8), we get,

$$R_{SAT,WV} = aR_{SAT,IR} + b \quad (9)$$

$$a = \frac{R_{CLOUD,WV} - R_{BKG,WV}}{R_{CLOUD,IR} - R_{BKG,IR}}$$

$$b=\frac{R_{CLOUD,IR}R_{BKG,WV}-R_{BKG,IR}R_{BKG,WV}-R_{CLOUD,WV}R_{BKG,IR}+R_{BKG,IR}R_{BKG,WV}}{R_{CLOUD,IR}-R_{BKG,IR}}$$

The above linear relationship between radiance of the two channels was indicated by Schejwach (1982). In practice, as an approximation, we use brightness temperature to replace radiance in (9), that is

$$BT_{SAT,WV}=a\,BT_{SAT,IR}+b \tag{10}$$

$$a=\frac{BT_{CLOUD,WV}-BT_{BKG,WV}}{BT_{CLOUD,IR}-BT_{BKG,IR}}$$

$$b=\frac{BT_{cloud,IR}BT_{BKG,WV}-BT_{BKG,IR}BT_{BKG,WV}-BT_{cloud,WV}BT_{BKG,IR}+BT_{BKG,IR}BT_{BKG,WV}}{BT_{cloud,IR}-BT_{BKG,IR}}$$

Due to linear relationship between brightness temperature of the two channels expressed by (10), brightness temperature scatter diagrams do have linear characteristics as shown in scheme diagram Fig 3. Suppose there is no water vapor absorption above the cloud top, for opaque cloud, we have

$$BT_{SAT,WV}=BT_{SAT,IR} \tag{11}$$

Combine (10) and (11), we can easily get $BT_{SAT,IR}$. And $BT_{SAT,IR}$ should represent environmental temperature for the level cloud exists.

3.2 Opaque Middle or Low Level Cloud

When clouds are at the levels below water vapor channel peak priority function level, as we can see from Fig 2 that water vapor channel radiance origins from the background atmosphere. The water vapor channel brightness temperature keeps at a constant value. It does not bring us any information on the cloud. In that case, we have to assign cloud height based on IR channel only. Fortunately, most middle or low level clouds consists of water drops. Except for broken cloud with sub pixel size, these clouds are opaque. In scheme diagram Fig 3, the data points are along a line with water vapor brightness temperature as a constant. By watching many individual cases, we see that the slope a in IR-WV brightness temperature diagram is a good indicator to separate semi-transmittance cirrus cloud from opaque middle or low level clouds. The semi-transmittance cirrus cloud is along a line with slope, the opaque middle or low level cloud along a line with a constant water vapor brightness temperature.

The tracer with low level cloud can be distinguished from the tracer with cloud free area by the motion of the tracer. The tracer with cloud free area does not move.

3.3 Opaque High Level Cloud

For high level opaque clouds, we can also assume that there is no water vapor absorption above cloud level. Thus $BT_{WV}=BT_{IR}$. In the scatter diagram Fig 3, these clouds are around the cross point of formulas (10) and (11), labeled as Cb.

3.4 Height Assignment Procedure

Based on the above discussion, we get the following high assignment procedure shown in Fig 4.

4. Quick Search Procedure for Target Tracing

Target tracing with cross correlation is very computer time consuming. Fig 5 is a typical correlation coefficient matrix. In Fig 5, we calculate 33 × 33 =1089 correlation coefficients just for a maximum value 0.93 at line 21 column 14. After watching many correlation coefficient matrix, we see that most correlation coefficient fields are very smooth, e.g. the

The quick search procedure works well, this is due to the common pixels in the neighboring tracer target windows. Since the existence of common pixels, the neighboring correlation coefficients are related with each other. To exam why we do not lose any possible maximum by quick search procedure. Let us simplify our problem to an one dimensional image and take an assumption that the second image is exactly a displacement of the first image.

.58 .61 .52 .49 .18

.56 .58 .61 .50 .20

.64 .63 .64

.63 .67 .71 .74 .72

51 .58 .63 .70 .79 .84 .80 .69 .57 .48

.72 .77 .82 .86 .88 .87 .84

.65 .75 .80 .86 .89 .91 .90 .86 .81 .75 .62

.78 .83 .89 .92 .92 .91 .87 .82 .75

.53 .68 .80 .86 .90 .93 .92 .90 .86 .81 .75 .64

.82 .87 .90 .92 .91 .88 .84 .79 .74

.72 .82 .86 .89 .89 .87 .84 .81 .72 .64

86 .86 .84 .81 .77

.58 .74 .79 .82 .81 .75 .68 .64 .62 .61 .59

.77 .76 .72 .67 .65

.72 .74 .73 .68 .66 .64

.63 .65 .68 .69 .67 .59 .44 .33

Fig 6 A typical correlation coefficient matrix calculated by quick search procedure

Suppose the target window of the first image moves and become image window "f" of the second image. At the first step of quick search procedure, we take "g" of the second image as search window, name "f" as tracer window, "g" as search window. Normally "g" is some pixels away from "f". Because, at the first search step, we take 8 as grid length. The distance between "f" and "g" should not exceed 4 pixels. In case of o pixel distance, we happen to catch the tracer at the first step. In case of 1 - 4 pixel distances, we may catch the tracer at the later steps. Remember that our image window size is 32 pixels. Now let us calculate correlation coefficients between "f" and "g".

Tracer window "f" and search window "g" are functions expressed at space field

f (j) *(j=0,1,....M-1)*

g (j) *(j=0,1,....M-1)*

Take fourier expression of "f" and "g", "f" and "g" can be expressed at frequency field.

$$f(j)=\sum_{K=1}^{M-1} a_{fk}\cos\frac{k\pi i}{M}+b_{fk}\sin\frac{k\pi i}{M}=\sum_{K=1}^{M-1} A_{fk}\cos(\frac{k\pi i}{M}-\theta_{fk})$$
$$g(j)=\sum_{K=1}^{M-1} a_{gk}\cos\frac{k\pi i}{M}+b_{gk}\sin\frac{k\pi i}{M}=\sum_{K=1}^{M-1} A_{gk}\cos(\frac{k\pi i}{M}-\theta_{gk}) \quad (13)$$

In (13), $A_{fk}=\sqrt{a_{fk}^2+b_{fk}^2}$, $A_{gk}=\sqrt{a_{gk}^2+b_{gk}^2}$, $\theta_{fk}=tg^{-1}(b_{fk}/a_{fk})$, $\theta_{gk}=tg^{-1}(b_{gk}/a_{gk})$

Correlation coefficient R_{fg} can be expressed at frequent field as

$$R_{fg=}=\sum_{i=0}^{M-1} f(i)\ g(i)=\sum_{K=1}^{M-1} a_{fk}a_{gk}+b_{fk}b_{gk}=\sum_{K=1}^{M-1} A_{fk}A_{gk}\cos(\theta_{fk}-\theta_{gk}) \quad (14)$$

Formula 14 shows that both amplitude and phase of "f" and "g" make contribution to the correlation between them. In case of "g" is a displacement of "f", the correlation between them depends on the phase shifts of the specific fourier waves. Depending on the cosines of the phase differences, the specific fourier waves can make positive or negative contribution to the correlation coefficient. When an image shifts for some distance away, the larger scale characteristics of the image will have the same tendency as the original image, while smaller scale characteristics may have positive or negative tendency depending on the ratio between the shift distance and the scale of characteristics. Thus, the correlation coefficients mainly depend on larger scale characteristics of the tracer image windows. That is, when we use cross correlation method to trace tracers, what we traces are the over all pattern of the image window rather than individual clouds. This is why a 4 pixel shift of tracer does not lose any possible maximum of the correlation coefficient.

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Appendix B:

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:

OBJECTIVES

a) CGMS provides a forum for the exchange of technical information on geostationary and polar orbiting meteorological satellite systems, such as reporting on current meteorological satellite status and future plans, telecommunications matters, operations, intercalibration 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 parameters 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
State Meteorological Administration of the PRC	-	Joined 1989
NOAA/NESDIS	-	Founder Member, 1972
Hydromet Service of the Russian Federation	-	Joined 1973
WMO	-	Joined 1973

ADDRESSES FOR PROCURING ARCHIVE DATA

EUMETSAT

The Meteosat Data Archive Manager
Attention: Mr. R. Francis
EUMETSAT
Am Kavalleriesand 31,
64295 Darmstadt
Germany

INDIA

India Meteorological Department
Attention: Director (Satellite Service)
Lodi Road
New Delhi
110003 India

JAPAN

Meteorological Business Support Center
3-17 Kanda Nishiki-cho
Chiyoda-ku
Tokyo 100
Japan

PRC

Mr. Xu Jianmin
Satellite Meteorological Center
China Meteorological Administration
46 Baishiqiaolu
Beijing, 100081
People's Republic of China

RUSSIA

Dr. A. Uspensky
NPO Planeta
B. Predtechenskii Per. 7
123242 Moscow
Russia

USA

Satellite Data Services Division (E/CC6)
Room 100, World Weather Building
NOAA/NESDIS
Washington DC 20233
U.S.A.

CONTACT LIST FOR OPERATIONAL ENGINEERING MATTERS

EUMETSAT

Dr. R. Husband
EUMETSAT
Am Kavalleriesand 31,
64295 Darmstadt, Germany
Telex: 4197335 emet d
Telephone: +49 6151 807-7

INDIA

Dr. R. R. Kelkar
Directorate of Satellite Meteorology
India Meteorological Department
Lodi Road
New Delhi 110003, India
Telex: 3166412
Telephone: +91 11611710

JAPAN

Mr. Naoto Matsuura
Earth Observation Planning Department
NASDA
World Trade Center Bldg 27F
2-4-1 Hamamatsu-cho Minato-ku
Tokyo 105, Japan
Telephone: +813 3438 6342
Fax: +813 5401 8702
E-mail: matsuura.naoto@nasda.go.jp

Mr. A. Nakazono
Head/System Engineering Division
Meteorological Satellite Center
3-235 Nakakiyoto, Kiyoseshi
Tokyo 204 , Japan
Telex: 2222163 METTOK J
Telephone: +81 424 93 4970
Fax: +81 424 92 2433

PRC

Mr. Xu Jianmin
Satellite Meteorological Center
China Meteorology Administration
46 Baishiqiaolu
Beijing, 100081
People's Republic of China
Telex: 22094
Telephone: +86-10-62172277, Ext. 2367

RUSSIAN FEDERATION

Mrs. T. Bourtseva
Planeta
7, Bolshoy Predtechenskiy per.,
123242 Moscow
Russia
Telex: 411117 RUMS RF
Telephone: +7 095 255 2421
Fax: +7 095 200 42 10

USA

Mr. G. Davis
Director, Office of Satellite Operations
NOAA/NESDIS, (E/S01)
4700 Silver Hill Road
Room 0226, Mail Stop 9909
Washington DC 20233-9909, USA
NASCOM: GTOS
Telex: RCA 248376
Telephone: +1 301 457 5130
Fax: +1 301 457 5828
E-mail: gdavis@nesdis.noaa.gov

ADDRESS LIST FOR THE DISTRIBUTION OF CGMS DOCUMENTS

ESA
Dr. E. Oriol-Pibernat
METOP and MSG Mission Manager
ESA (D/OEE/MMODYM)
8-10 rue Mario Nikis
75738 Paris Cedex 15, France
Tel: +33 1 53697726
Fax: +33 1 53697674

EUMETSAT
Mr. G. C. Bridge
User Service Manager
EUMETSAT
Am Kavalleriesand 31,
64295 Darmstadt, Germany
Tel: +49 6151 807-7
Fax: +49 6151 807-555
Tx: 4197335 emet d

EUMETSAT
Dr. R. Husband
Head of Operations Division
EUMETSAT
Am Kavalleriesand 31
64295 Darmstadt, Germany
Tel: +49 6151 807-364
Fax: +49 6151 807-555

EUMETSAT
Mr. J. Lafeuille
International Affairs Officer
EUMETSAT
Am Kavalleriesand 31,
64295 Darmstadt, Germany
Tel: +49 6151 807-604
Fax: +49 6151 807-555
Tx: 4197335 emet d

EUMETSAT
Dr. T. Mohr
Director
EUMETSAT
Am Kavalleriesand 31,
64295 Darmstadt, Germany
Tel: +49 6151 807-600
Fax: +49 6151 807-555
Tx: 4197335 emet d

EUMETSAT
Dr. J. Schmetz
Head of Meteorological Division
EUMETSAT
Am Kavalleriesand 31,
64295 Darmstadt, Germany
Tel: +49 6151 807-590
Fax: +49 6151 807-555
Tx: 4197335 emet d

EUMETSAT
Mr. A. Ratier
Head of Technical Department
EUMETSAT
Am Kavalleriesand 31
64295 Darmstadt, Germany
Tel: +49 6151 807-500
Fax: +49 6151 807-555

EUMETSAT
Mr. R. Wolf
Head of Ground Segment Division
EUMETSAT
Am Kavalleriesand 31,
64295 Darmstadt, Germany
Tel: +49 6151 807-580
Fax: +49 6151 807-555
Tx: 4197335 emet d

INDIA
Dr. R. R. Kelkar
Deputy Director General of Meteorology
India Meteorology Department
Lodi Road
10003 New Delhi, India
Tel: +91 11 611 710
Fax: +91 11 69 9216
Tx: 3166494

JAPAN
Mr. Ryuii Hasegawa
Director-General
Meteorological Satellite Center
Japan Meteorological Agency
3-235 Nakakiyoto, Kiyoseshi
Tokyo 204, Japan
Fax: +81 424 92 2433

JAPAN
Dr. Nobuo Sato
Head, Office of Met. Sat. Planning
Observations Department
Japan Meteorological Agency
1-3-4, Otemachi, Chiyoda-ku
Tokyo 100, Japan
Tel: +81 3 32 01 86 77
Fax: +81 3 3217 1036
Tx: 2222163
E-mail:cgms_jma@hq.kishou.go.jp

JAPAN
Mr. Makio Ichihara
Director
Earth Observation Satellite Department
NASDA
World Trade Center Bldg 27F
2-4-1 Hamamatsu-cho, Minato-ku
Tokyo 105, Japan
Tel: +813 3438 6329
Fax: +813 5401 8702
E-mail: ichihara.makio@nasda.go.jp

PRC
Mr. Huang Hanwen
Senior Engineer
Shanghai Institute of Satellite Engineering
251 Hua-Yin Road
200240 Shanghai
People's Republic of China
Tel: +86 21 43 01 091 ext. 30
Fax: +86 21 43 00 410

PRC
Mr. Xu Jianmin
Satellite Meteorological Center
China Meteorological Administration
46 Baishiqialou
100081 Beijing, People's Republic of China
Tel: +86 10 6217 2277 ext. 2367
Fax: +86 10 6217 2724
Tx: 22094

PRC
Mr. Xu Jianping
Satellite Meteorological Center
China Meteorological Administration
46 Baishiqialou
100081 Beijing, People's Republic of China
Tel: +86 10 6217 2277 ext. 2437
Fax: +86 10 6217 2724
Tx: 22094

RUSSIAN FEDERATION
Dr. A. V. Karpov
Chief/International Coop. Dept.
Russian Federal Service for
Hydrometeorology and
Environmental Monitoring
Novovagan'kovsky Street, 12
123242 Moscow, RUSSIA
Tel: +7 095 252 3873
Fax: +7 095 252 11 58
Tx: 411117 RUMS RF

RUSSIAN FEDERATION
Mr. A. I. Gusev
Russian Federal Service for
Hydrometeorology &
Environmental Monitoring
Novovagan'kovsky Street, 12
123242 Moscow, RUSSIA
Tel: +7 095 255 24 87
Fax: +7 095 252 07 08
Tx: 411117 RUMS RF

RUSSIAN FEDERATION
Dr. A. Uspensky
NPO Planeta
7, B. Predtechenskii Per.
Moscow, 123242
RUSSIA
Tel: +7 095 252 37 17
Fax: +7 095 200 42 10
Tx: 411117 RUMS RF
E-mail:uspensky@mail.imp.kiae.ru
trudovoy@planeta.mskw.mecom.ru

USA
Mr. W. J. Hussey
Director, Office of Systems Development
NOAA/NESDIS
Room 3301C, FB4 (E/OSD)
Mail Stop 9909
4700 Silver Hill Road
Washington DC 20233-9909, USA
Tel: +1 301 457 5277
Fax: +1 301 420 0932
E-mail: jhussey@nesdis.noaa.gov

USA
Mr. C. P. Staton
Deputy Chief/Inf. Processing Div.
NOAA/NESDIS E/SP1
Room 0301, FB4 Mail Stop 9909
4700 Silver Hill Road
Washington DC 20233-9909, USA
Tel: +1 301 457 5165
Fax: +1 301 457 5199
E-mail: cstaton@nesdis.noaa.gov

USA
Mr. J. Wechsler
International & Interagency Affairs
NOAA/NESDIS
E/IA, SSMC3, 3620
1315 East West Highway
Silver Spring, Maryland 20910-3282
Tel: +1 301 713 2024
Fax: +1 301 713 2032
Tx: 7407641
E-mail: jonas.wechsler@noaa.gov

USA
Dr. P. Menzel
Advanced Satellite Processing Project
NOAA/NESDIS
1225 West Dayton St.
Madison, WI 53706, USA
Tel: +1 608 264 5325
Fax: +1 608 262 5974
E-mail: paulm@ssec.wisc.edu

USA
Mr. Marin Perkins
NOAA/NESDIS E/SP2
5627 Allentown Road, Suite 200
Camp Springs
MD 20746
USA

USA
Mr. F. S. Zbar
Chair/CBS WG on Observations
NOAA/National Weather Service
Office of Systems Development (OSD)
Advanced Development & Demonstration
Laboratory (ADDL)
1325 East-West Highway, Office 12236
Silver Spring, Maryland 20910, USA
Tel: +1 301 713 0468
Fax: +1 301 713-0003
E-mail: frederick.zbar@noaa.gov

WMO
Dr. D. Hinsman
Senior Scientific Officer
Satellite Activities
WMO
41 avenue Giuseppe-Motta
Case Postale 2300
1211 Geneva 20, Switzerland
Tel: +41 22 730 8285
Fax: +41 22 734 0357
Tx: 045414199
E-mail: hinsman@www.wmo.ch

WMO/CBS
Dr. J. R. Eyre
Head of Satellite Applications
Meteorological Office
London Road
Bracknell
Berkshire, RG12 2SZ, UK
Tel: +44 1344 85 66 87
Fax: +44 1344 85 40 26
E-mail: jreyre@meto.gov.uk

E-MAIL LIST SERVERS

The following list servers have been installed by WMO

CONTACT POINTS FOR CGMS PLENARY:

cgmsplen@www.wmo.ch

marlin.perkins@noaa.gov
dexter@www.wmo.ch
hinsman@www.wmo.ch
kimura@www.wmo.ch
landis@www.wmo.ch
schiessl@www.wmo.ch
rmasters@nesdis.noaa.gov
mohr@eumetsat.de
wolf@eumetsat.de
uspensky@planeta.msk.ru
uspensky@mail.imp.kiae.ru
cgms_jma@hq.kishou.go.jp
fzbar@smtpgate.ssmc.noaa.gov
jreyre@meto.gov.uk
jhussey@nesdis.noaa.gov
jxusmc@public.bta.net.cn
matsuura.naoto@nasda.go.jp
lafeuille@eumetsat.de
jonas.wechsler@noaa.gov

CONTACT POINTS FOR CGMS FREQUENCY MATTERS:

cgmsfreq@www.wmo.ch

rbarth@noaa.gov
guettlich@eumetsat.de
hinsman@www.wmo.ch
schlapia@nesdis.noaa.gov
wolf@eumetsat.de
vkh@hymet.msk.ru
dmcginnis@rdc.noaa.gov
fzbar@smtpgate.ssmc.noaa.gov
jxusmc@public.bta.net.cn
trudovoy@planeta.mskw.mecom.ru
cgms_jma@hq.kishou.go.jp
matsuura.naoto@nasda.go.jp
jonas.wechsler@noaa.gov
(temp)takase.kunio@nasda.go.jp

CONTACT POINTS FOR CGMS WIND MATTERS:

cgmswind@www.wmo.ch

imk122@ucla.hdi.kfk.d400.de
graeme.kelly@ecmwf.co.uk
jhalle@cmc.aes.doe.ca
jreyre@meto.gov.uk
hinsman@www.wmo.ch
kholmlun@esoc.bitnet
jlm@bom.gov.au
rwlunnon@email.meto.govt.uk
paulm@ssec.wisc.edu
purdom@terra.cira.colostate.edu
qwu@gih.grace.cri.nz
ccheasman@meto.govt.uk
schmetz@eumetsat.de
bernard.strauss@ecmwf.co.uk
rmasters@nesdis.noaa.gov
szantai@lmdx07.polytechnique.fr
/g=SED/s=MSC/o=MSC/admd=ati/c=jp/@sprint.com
chrisv@ssec.wisc.edu
woick@eumetsat.de
gaertner@eumetsat.de
rattenborg@eumetsat.de
uspensky@mail.imp.kiae.ru
trudovoy@planeta.mskw.mecom.ru
jxusmc@public.bta.net.cn

CONTACT POINTS FOR CGMS HOME PAGE:

hinsman@www.wmo.ch
cstaton@nesdis.noaa.gov
elen@planeta.uipe.ru
sat_jma@hqkishou.go.jp
jxusmc@public.bta.net.cn
bridge@eumetsat.de
gaertner@eumetsat.de
matsuura.naoto@nasda.go.jp
(temp) takase.kunio@nasda.go.jp

LIST OF ABBREVIATIONS AND ACRONYMS

ACARS	Automated Communications Addressing and Reporting System
ACC	ASAP Coordinating Committee
ADC	Atlantic Data Coverage
AMDAR	Aircraft Meteorological Data Relay
AMS	American Meteorological Society
AMSU	Advanced Microwave Sounding Unit
APT	Automatic Picture Transmission
ARGOS	Data Collection and Location System
ASAP	Automated Shipboard Aerological Programme
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)
BUFR	Binary Universal Form for data Representation
CBS	Commission for Basic Systems
CCIR	Consultative Committee on International Radio
CCSDS	Consultative Committee on Space Data Systems
CD	Compact Disk
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)
CIS	Commonwealth of Independent States
CIIS	Common Instrument Interface Studies
CLS	Collecte Localisation Satellites (Toulouse)
CMS	Centre de Meteorologie Spatiale (Lannion)
CMV	Cloud Motion Vector
CMW	Cloud Motion Wind
COSPAR	Committee on Space Research
DAPS	DCS Automated Processing System (USA)
DCP	Data Collection Platform
DCS	Data Collection System
DIF	Directory Interchange Format
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
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)
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)
HR	High Resolution
HRPT	High Resolution Picture Transmission
HIRS	High Resolution Infra-red Sounder
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
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
JMA	Japanese Meteorological Agency
LR	Low Resolution
LRIT	Low Rate Information Transmission
LRPT	Low Rate Picture Transmission
LST	Local Solar Time
MARF	Meteorological Archive and Retrieval Facility (EUMETSAT)
MCP	Meteorological Communications Package
MDD	Meteorological Data Distribution (Meteosat)
MDUS	Medium-scale Data Utilization Station (for GMS S-VISSR)
METOP	Future European meteorological polar orbiting satellite
METEOR	Polar orbiting meteorological satellite (CIS)
METEOSAT	Geostationary meteorological satellite (EUMETSAT)
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)
MSG	Meteosat Second Generation
MSU	Microwave Sounding Unit
MTP	METEOSAT Transition Programme
MTS	Microwave Temperature Sounder (EPS)
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)
NMC	National Meteorological Centre
NOAA	National Oceanographic and Atmospheric Administration
NOS	National Ocean Service (USA)
NTIA	National Telecommunications and Information Agency (USA)
NWP	Numerical Weather Prediction
NWS	National weather service (USA)
OCAP	Operational Consortium of ASDAR Participants
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

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)
SSP	Sub Satellite Point
SST	Sea Surface Temperature
SSU	Stratospheric Sounding Unit
S-VISSR	Stretched VISSR
TIROS	Television Infrared Observation Satellite
TOMS	Total Ozone Mapping Spectrometer
TOVS	TIROS Operational Vertical Sounder
UHF	Ultra High Frequency
UK	United Kingdom
UN	United Nations
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
VLSI	Very Large Scale Integrated circuit
WARC	World Administrative Radio Conference
WCRP	World Climate Research Programme
WEFAX	Weather facsimile
WG	Working Group
WMO	World Meteorological Organization
WP	Working Paper
WV	Water Vapour
WWW	World Weather Watch
X-ADC	Extended Atlantic Data Coverage