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

CGMS XXVIII

Woods Hole, Massachusetts, USA, 16 - 20 October 2000

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Woods Hole Lighthouse
by Audrey Hinsman,
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Please note that this report is published together
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TWENTY-EIGHTH MEETING OF CGMS
FINAL REPORT OF THE PLENARY SESSION

A. INTRODUCTION

A.1 Welcome

CGMS-XXVIII was convened by NOAA/NESDIS at 1:40 p.m. on 16 October 2000 in Woods Hole, Massachusetts. Mr. Greg Withee, Assistant Administrator for Satellite and Information Services, opened the twenty-eighth meeting of CGMS. He warmly welcomed the participants at the J. Erik Jonsson Center, National Academy of Sciences in Woods Hole (MA). NOAA expressed appreciation to the National Academy of Sciences for making their facilities available for CGMS XXVIII. He gave a brief outline of the history of this area. Furthermore, he mentioned three important anniversaries taking place this year: NOAA was celebrating its 30th anniversary, the 40th anniversary of the first meteorological satellite TIROS-1, launched on 1 April 1960 and the 50th anniversary of WMO. He recalled that CGMS plans are not driven by planners but by the users who depend on CGMS doing a good job. There were a lot of new opportunities not just in areas such as preserving the environment, but also in new areas such as measuring greenhouse gases. CGMS Members needed to make progress on further cooperation and coordination. He passed the floor to Dr. Joe Friday, Director, Atmospheric Sciences Department of the National Academy of Sciences, who also extended a very warm welcome to the participants and wished them success in this meeting.

A.2 Election of Chairman

Mr. Gary Davis, Director of the Office of Systems Development of NOAA/NESDIS, was unanimously nominated as Chairman of CGMS XXVIII.

A.3 Adoption of Agenda and Work Plan of WG Sessions

The agenda (see Annex 1) was adopted. It was agreed that Working Group II dealing with Satellite Products would meet on Thursday morning. Working Groups I and III, dealing with telecommunications and satellite-tracked winds, respectively, would work in parallel on Tuesday afternoon.

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

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

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

WG I (Telecommunications)	- Mr. R. Wolf
WG II (Satellite Products)	- Dr. P. Menzel
WG III (Satellite Tracked Winds)	- Dr. J. Schmetz

The Drafting Committee was appointed, comprising Mr. G. Bridge, Dr. A.K.S. Gopalan, Mr. Y.

Kozawa, Prof. Xu Jianping, Dr. V. Asmus, Mr. M. Perkins and Dr. D. Hinsman. All CGMS Members were invited to provide inputs to the final report through this drafting committee.

A.5 Review of Action Items from Previous Meetings

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

(i) Permanent actions

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

   Ongoing*. Tables have been distributed to all delegations at the meeting for updating.*

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

   Ongoing*. Comments have been received and updates will be distributed to all delegations via the WWW Operational Newsletter and Electronic Bulletin Board.*

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.

   Closed*. No information on unexplained anomalies received by NOAA from other CGMS members. (see USA-WP-04).*

(ii) Outstanding actions from previous meetings

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

Closed. *Discussions have taken place between JMA and CMA.*

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

Closed. *India sent a reply by e-mail on 7 September 2000 that it is already supplying INSAT data in MDD mode to Sri Lanka and Maldives under bilateral cooperation. It was also explained that INSAT data are available on the IMD website http://www.imd.ernet.in.*

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

Closed*. Report on INSAT plans received at CGMS XXVIII.*

(iii) Actions from CGMS XXVII

ACTION 27.01 (1) EUMETSAT, Japan and USA to implement the monitoring of IDCS performance using the agreed set of reporting statistics and report to CGMS Secretariat.

Closed*. JMA sent information on 17/07/2000 and 30/08/00. USA provides monitoring statistics via GOES DCS homepage http://www.dcs.noaa.gov.*

(2) CGMS Secretariat to report on the effectiveness of this scheme at CGMS XXVIII.

Closed. *EUM-WP-07 reports on this under agenda item F1.*

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

Closed. *(See USA-WP-06).*

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

Closed. *No proposals were received from CGMS Members.*

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

Closed. *Draft schedules from JMA have been received at WMO and will be placed on the server.*

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

Closed *for EUMETSAT, Russia, CMA and USA. E-mails sent in January 2000.*

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

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

(i) + (ii) general section in the process of being updated.
(iii) The structure has been reviewed and members have been asked to provide input to the new structure by ***15 June 1999.***

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

EUMETSAT reported on the status in a memo on 11/07/00.

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

Closed. *Inputs received from all CGMS Members. EUM-WP-12 reports on the update of CGMS Homepage Consolidated Report under item H.5.*

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

Closed. *Inputs were received from Japan, China and Russia.*

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

Closed. *Japan informed the Secretariat on its plans in an e-mail on 19/07/00. USA informed that it could not indicate the dates of the partition plan for at least ten years. Further discussion on this were to take place in WG I.*

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

Closed *for EUMETSAT, Japan, India and USA. (see EUM-WP-13, USA-WP-17).*

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

Closed. *This will not be acted on as the fee is relatively small. JMA sent an e-mail on this action on 18/07/00. (see USA-WP-17).*

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

Action to be deferred*. JMA plans to provide detailed information on radio frequency for MTSAT-1R and MTSAT-2 at CGMS XXVIII. (See JPN-WP-10, USA-WP-17(1)).*

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

Closed. *(See USA-WP-09).*

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

Closed *for EUMETSAT, JMA and USA. (See EUM-WP-16, JPN-WP-11, USA-WP-19).*

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

Closed *for EUMETSAT and USA. (See EUM-WP-17 and* http://www.oso.noaa.gov/goes/goes_8and_10_srfs.html).

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

Closed *for EUMETSAT and USA. (See EUM-WP-21, USA-WP-20).*

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

Closed *for EUMETSAT and USA. (see EUM-WP-22)*

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

Closed *for EUMETSAT, JMA, USA and India. Has been mentioned at ECMWF bilateral. (See EUM-WP-27, JPN-WP-13 and USA-WP-01).*

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

Closed. *WMO will report on this under agenda item III.3.*

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

Closed. This has been mentioned at ECMWF and IWW.
(See JPN-WP-14).

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

Closed. *(See EUM-WP-25).*

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

Closed. *(See EUM-WP-26).*

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

Closed. *Report will be given by NASDA at CGMS XXVIII under agenda item H.*

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

Closed. *(See ESA-WP-01).*

B. REPORT ON THE STATUS OF CURRENT SATELLITE SYSTEMS

B.1 Polar-orbiting Meteorological Satellite Systems

China reported in PRC-WP-01 on the status of FY-1C, launched on 10 May 1999. The satellite is operating well. The CHRPT (High Resolution Picture Transmission) and GDPT (Global Delayed Picture Transmission) data have been received and provided to users for 18 months. The CHRPT data transmission is open to all users worldwide. The on-board data storage capacity of FY-1C is increased to 300 minutes. Besides real-time CHRPT data received within the acquisition areas of the three ground stations in Beijing, Guangzhou and Urumuqi, global coverage data of four selected channels with reduced resolution can be received. WMO congratulated China for making available CHRPT data to all users.

Russia informed CGMS in RUS-WP-01 that two satellites of the Meteor-2 and -3 series are operated in circular orbit inclined at approximately 82°. They are operated beyond their lifetime and with reduced capabilities. TV image data from the MR-900 scanning instrument are available through direct broadcast in APT mode (137 MHz), as well as from the RESURS-01 N4 satellite, which is equipped with a similar imager. Additional satellite information, used in meteorological and hydrological applications, is provided by OKEAN-O1 N7 and OKEAN-O. Their core payload includes, in particular, side-looking radar RLSBO, as well as an ensemble of tracking and scanning MW radiometers, and a multi-zonal scanning device of low resolution MSU-M. The Meteor-2 N 21, Meteor-3 N5, Okean-01 N7 and Okean-O and Resurs-01 N4 orbital data needed for APT data direct readout are distributed via GTS in "ORBIT" code. The Dissemination schedules are placed on the SRC Planeta Internet server http://sputnik.infospace.ru.

NOAA reported on the USA polar-orbiting meteorological satellite systems in USA-WP-02. The Polar Operational Environmental Satellite (POES) constellation includes two primary, three secondary and one recently launched satellite. The operational spacecraft, NOAA-14 and NOAA-15, are in sun-synchronous afternoon and morning orbits, respectively. NOAA-15 is the primary morning satellite and operates in an orbit with a 7:30 a.m. descending node. NOAA-14 is the primary afternoon satellite and operates in an orbit with a 1:30 p.m. ascending node. The secondary spacecraft NOAA-11, NOAA-12, and NOAA-10 provide additional payload operational data and support minimal SAR functions. NOAA-16, previously NOAA-L, was successfully launched on 14 September 2000. It is undergoing a 45-day verification test and will become operational in January 2001 when it will replace NOAA-14 as the operational afternoon spacecraft. NOAA-M is scheduled for launch in late Spring/early Summer 2001. USA also reported on the current DMSP constellation that consists of two primary, two secondary and one back-up operational spacecraft. The first satellite in the new converged system designed to meet both military and civilian needs is planned to be available for launch in July 2008.

B.2 Geostationary Meteorological Satellite Systems

EUMETSAT reported in EUM-WP-02 that Meteosat-7 is fully operational at 0°, Meteosat-6 is in stand-by mode at around 9°W. Meteosat-5 is located over 63°E providing the Indian Ocean Data Coverage (IODC) Service. The orbital inclination of Meteosat-5 is 3.65° and increasing. With an estimated 5.728 kg remaining hydrazine fuel on board, it is anticipated that the satellite will continue operating until the orbital inclination exceeds 5°

Table 1: Current Polar-Orbiting Satellites Coordinated within CGMS

(as of 20 October 2000)

Orbit type **(equatorial crossing times)**	**Satellites in orbit** (+operation mode) P=pre-operational Op=operational B=back-up L=limited availability	**Operator**	**Crossing Time** A=North-west D=South-west +Altitude	**Launch date**	**Status**
Sun-synchr. "Morning" (06:00 – 12:00) (18:00 – 24:00)	NOAA-15 (Op)	USA/NOAA	7:30 (D)	05/98	Functional (problems with primary imager)
	NOAA-12 (B)	USA/NOAA	06:40 (D) 850 km	05/91	Functional (except sounding)
	NOAA-10 (L)	USA/NOAA	10:00 (D) 840 km	12/86	Search and Rescue only
	DMSP-F15 (Op)	USA/NOAA	21:45 (A) 850 km	12/99	Defence satellite. Data available to civilian users through NOAA
	DMSP-F14 (B)	USA/NOAA	20:42 (A) 852 km	04/97	Defence satellite. Data available to civilian users through NOAA.
	DMSP-F12 (B)	USA/NOAA	21:13 (A)	8/94	Defence Satellite. Data available to civilian users through NOAA.
	RESURS-01-N4 (P)	Russia	09:30 (A) 835 km	7/98	Partly meteorological mission (APT broadcast of TV images)
Sun-synchr. "Afternoon" (12:00 – 16:00) (00:00 – 04:00)	NOAA-16 (P)	USA/NOAA	14:00 (A) 870 km	09/00	Functional, one OBP is unusable
	NOAA-14 (Op)	USA/NOAA	14:00 (A) 850 km	12/94	
	NOAA-11 (L)	USA/NOAA	14:00 (D)	09/88	Search and Rescue and Ozone
Sun-synchr. "Early morning" (04:00 – 06:00) (16:00 – 18:00)	DMSP-F13 (Op)	USA/NOAA	17:40 (A) 850 km	03/97	Defence satellite. Data available to civilian users through NOAA.
	DMSP-F11 (B)	USA/NOAA	19:32 (A) 850 km	11/91	
Sun-synchr. "morning"	FY-1C (Op)	China	8:40 (A) 860 km	5/99	Functional
Non-sun-synchronous or unspecified orbits	METEOR 2-N21 (Op)	Russia	950 km	08/91	Functional, except IR scanning instrument (APT only)
	METEOR 3-N5 (Op)	Russia	1200 km	08/91	Functional, except IR scanning instrument (APT only)

at the end of 2001. Possibly, it may even be agreed that the satellite will not be de-orbited but operate for a longer period. India reported on the status of the Indian National Satellite (INSAT) System in IND-WP-02. INSAT satellites are three-axis stabilised operational multi-purpose spacecraft including a meteorological payload, as well as telecommunications and broadcast services. The operational INSAT system includes the first generation INSAT-1D (launched in 1990) positioned at 74°E and the second generation INSAT-2E satellite (launched in 1999) located at 93.5°E. INSAT-2B and INSAT-2A are in stand-by mode at 93.5°E and 74°E, respectively. INSAT-2E has a new payload, a Charged Coupled Device camera, capable of taking 1km resolution images in VIS, IR and mid IR bands. The meteorological imaging capability has also been upgraded on this satellite by providing a Water-Vapour channel with 8 km resolution on the VHRR in addition to VIS and IR channels. However, due to an on-board anomaly, VIHRR operations have been discontinuing. INSAT-1D and INSAT-2B are also continued to be used operationally, however the latter is only used for receiving VIS data. VHRR images are received on a three-hourly basis with a possibility of rapid scans during special weather situations. In addition data from NOAA satellites as well as from Meteosat-5 satellite located at 63°E are also received for operational use.

Japan reported on the status of GMS-5 and GMS-4 in JPN-WP-02. GMS-5 will be kept as an operational satellite until Summer 2003 due to MTSAT-1's unsuccessful launch. There were two problems affecting GMS-5 operations, i.e. lubricant build-up in the mirror scanning mechanism and the lack of fuel for manoeuvres, but no effect on image data utilisation was anticipated. Because of a critical degradation of the battery, the operation of GMS-4 was terminated on 24 February 2000.

In PRC-WP-02 CMA informed CGMS that on 25 June 2000 the second Chinese geostationary meteorological satellite FY-2B was launched successfully. FY-2B has been located at 105°E and good VIS, IR and WV images have been received. The results of the check-out showed that all performances were the same as during the testing at the launch site before launch. So far, most of the whole ground system works well. CMA informed that there is still stray light affecting FY-2B VIS and IR images. WMO suggested that satellite operators provide related information to CMA on how to solve this problem. CMA expressed thanks to WMO and satellite operators. It is expected that from 1 January 2001 FY-2B will start routine operations.

The first Chinese geostationary meteorological satellite FY-2A, which was launched on 10 June 1997, was moved to the back-up position of 86.5°E on 26 April 2000. FY-2A still works except for the S-band antenna which cannot point at the Earth for long because of a defect of the de-spin subsystem. FY-2A imagery maintains the same quality as three years ago.

ACTION 28.01 **Satellite operators to provide information to CMA on avoiding stray light in the radiometer.**

ACTION 28.02 **CMA to inform WMO when the FY-2B broadcast will become operational and WMO to assist with the distribution of this information, by 15 December 2000.**

Table 2: Current Geostationary Satellites Coordinated within CGMS

(as of 20 October 2000)

Sector	Satellites currently in orbit (+type) P: pre-operational Op: operational B: back-up L: limited availability	Operator	Loca-tion	Launch date	Status
EAST-PACIFIC (180°W-108°W)	GOES-10 (Op)	USA/NOAA	135°W	04/97	Inverted, solar array anomaly, DCP interrogator on back-up
WEST-ATLANTIC (108°W-36°W)	GOES-8 (Op)	USA/NOAA	75°W	04/ 94	Minor sounder anomalies, loss of redundancies on some subsystems
	GOES-11 (B)	USA/NOAA	105°W	05/00	in orbit back-up, 48 hours availability
	GOES-9 (L)	USA/NOAA	106°W	05/95	in stand-by, attitude control problems
EAST ATLANTIC (36°W-36°E)	METEOSAT-6 (B)	EUMETSAT		11/93	Minor gain anomaly on IR imager
	METEOSAT-7 (Op)	EUMETSAT	0°	02/97	Functional
INDIAN OCEAN (36°E-108°E)	METEOSAT-5 (Op)	EUMETSAT	63°E	03/91	IODC, functional but inclination
	GOMS-N1 (B)	Russia	76°E	11/94	Since 9/98 in stand-by
	FY-2B (P)	China	105°E	06/00	Operational in 1/01
	FY-2A (L)	China	86.5°E	06/97	Experimental Satellite (defect of de-spin subsystem - problems w. S-band antenna)
	INSAT II-B (B)	India	93.5°E	07/93	Imagery data (1km res.) for operational use.
	INSAT II-E (Op)	India	83°E	04/99	
	INSAT I-D (Op)	India	74°E	06/90	Cloud imagery data obtained for routine operational use. Derived CMVs disseminated on GTS.
WEST-PACIFIC (108°E-180°E)	GMS-5 (Op)	Japan	140° E	03/ 95	Operational, 1° inclination becoming 3° by 2004

In USA-WP-03, the USA reported on the status of its geosynchronous meteorological satellites. The current Geostationary Operational Environmental Satellites (GOES) are three-axis stabilised spacecraft in geosynchronous orbits. The current primary satellites, GOES-8 and GOES-10, are stationed over the east and west coasts of the United States. These satellites are used to provide simultaneous images and soundings of the Western Hemisphere. GOES-11, launched in May 2000, is currently located at 105°W, and GOES-9 in storage near 105°W, has limited capacity. GOES-2, GOES-3 and GOES-7, spin-stabilised satellites from the previous GOES series, continue a track record of more than 55 years of combined service via continued support for non-NOAA users in a data relay mode (non-imaging).

The primary instrument payload for the current series of GOES spacecraft is the imager and sounder. 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. A data collection system on the GOES spacecraft receives and relays environmental data sensed by widely dispersed surface platforms such as river and rain gauges, seismometers, tide gauges, buoys, ships and automatic weather stations. Platforms transmit sensor data to the satellite at regular or self-timed intervals, upon interrogation by the satellite, or in an emergency alarm mode whenever a sensor receives information exceeding a preset level.

It was noted by WMO that when the GOES satellite was operated in a rapid scan mode that coverage of the southern hemisphere south of about 12°N is not available on a routine basis. This inhibited the use of half-hourly GOES data necessary to meet the requirement to provide associated forecast services in the Southern Hemisphere.

ACTION 28.03 **USA to consider options to meet the WMO requirements for satellite images in the Southern Hemisphere (half-hourly, full disc, multi-spectral) and inform CGMS Members at CGMS XXIX.**

B.3 Anomalies from solar and other events

NOAA's Space Environment Center (SEC) announced a change in the consensus forecast of the occurrence of the solar maximum for Cycle 23. In USA-WP-04, the USA informed the CGMS that the SEC has changed the expected date of sunspot maximum from March 2000 to December 2000 and the expected size downwards from 160 to 140. A period of intense solar activity occurred during the period of 10-19 July 2000. A large magnetically complex active region on the sun successively produced four major flares. Two of the flares were accompanied by coronal mass ejections (CMEs). Three interplanetary shocks associated with these CMEs were experienced by NASA's ACE satellite stationed at the L1 point. A geomagnetic storm, reaching category 5 (extreme) occurred later in the period as a consequence of this activity. Fortunately, the extreme geomagnetic storm was not as lengthy in duration as the geomagnetic storm of March 1989. Nevertheless many utility system impacts were reported. Three nuclear plants lowered their plants capacity for protection but one experienced significant transformer damage. Several industry monitoring systems reported geomagnetically-induced currents on transmission lines. There were also several reports of capacitor banks tripping, and voltage swings were noted. HF Communications systems were unusable for days due to a polar cap absorption event. The experience of July 2000 illustrates a point made at CGMS XXVII that multiple space weather phenomena in differing combinations and sequences can have unique impacts on a particular space weather customer

community. Customers should expect such situations during solar maximum, and expect to experience new vulnerabilities. SEC's space weather projections indicate it is likely that strong to extreme (category 3 to 5) space weather storms will occur during the remaining years of Cycle 23. Based on these projections, the majority of category 3 to 5 storms will occur during the next three years with year 2002 expected to be the most active year.

C. REPORT ON FUTURE SATELLITE SYSTEMS

C.1 Future Polar-orbiting Meteorological Satellite Systems

EUM-WP-03 presented the status of the EPS programme as of August 2000. The Metop satellite is currently being developed by ESA, in cooperation with EUMETSAT. The Metop Engineering Model is now well advanced, with successful integration of AVHRR, HIRS, AMSU-A, SEM, A-DCS and SEM payload completed.

Concerning the EPS Ground Segment, it is expected that the kick-off of industrial activities will commence later in 2000. The launch of the first Metop satellite is currently expected in December 2005.

India gave a brief report on its future polar-orbiting satellite systems (OCEANSAT) in IND-WP-01.

ESA informed CGMS in ESA-WP-01 that ESA has several Earth Observation programmes, including the current ERS series, plus MSG and Metop (both in cooperation with EUMETSAT). ENVISAT preparations are proceeding well in line with a planned launch in June 2001. The so-called Envelope Programme includes two types of missions: Earth Explorers and Earth Watch. In the paper, and responding to an action from the last CGMS, only the status of the former was presented. Earth Explorers are missions aimed at responding to scientific issues. The core missions being more ambitious, both in terms of cost (up to 400 MEuro) and objectives than the opportunity missions (up to 80 MEuro). A total of four missions have started, to be launched in the 2003-2005 timeframe. They are: GOCE (Gravity Field and Steady State Ocean Circulation Explorer), ADM (Atmospheric Dynamics Mission) (lidar winds), CRYOSAT (Polar Ice Monitoring) and SMOS (Soil Moisture and Ocean Salinity). A new call for core missions was issued in June 2000 to choose up to three additional missions by 2002.

CGMS was informed by PRC-WP-03 that FY-1D, the fourth satellite of the first generation of polar-orbiting satellites, will be launched in 2001. This will be followed by the FY-3 series, the second generation of polar-orbiting meteorological satellites. It is planned that this satellite series will be operated from 2004 to 2018. The working paper described the planning, instrumentation, progress and future consideration for the FY-3 series.

Table 3: Future Polar-Orbiting Satellites Coordinated within CGMS

(as of 20 October 2000)

Orbit type **(equatorial crossing times)**	**Future Additional Satellites**	**Operator**	**Planned launch date**	**Other information**
Sun-synchr. **"Morning"** **(06:00 – 12:00)** **(18:00 – 24:00)**	METOP-1 METOP-2 METOP-3 FY-1D FY-3A FY-3B METEOR 3M-1 METEOR 3M-2	EUMETSAT EUMETSAT EUMETSAT China China China Russia Russia	12/2005 12/2009 06/2015 2001 2004 2006 12/2000 8/2003	(827 km) (9:30) AHRPT (827 km) (9:30) AHRPT (827 km) (9:30) AHRPT (8:40) CHRPT (9:30) (9:30) (9:15) (10:30) or (16:30) HRPT
Sun-synchr. **"Afternoon"** **(12:00 – 16:00)** **(00:00 – 04:00)**	NOAA-M NOAA-N NOAA-N' NPOESS-1 NPOESS-3	USA/NOAA USA/NOAA USA/NOAA USA/NOAA USA/NOAA	05/2001 6/2004 03/2008 2009 2013	(13:30) (13.30) (13.30) (13:30) (13.30)
Sun-synchr. **"Early morning"** **(04:00 – 06:00)** **(16:00 – 18:00)**	DMSP-S16 DMSP-S17 DMSP-S18 DMSP-S19 DMSP-S20 NPOESS-2 NPOESS-4	USA/NOAA USA/NOAA USA/NOAA USA/NOAA USA/NOAA USA/NOAA USA/NOAA	2001 2002 2003 2005 2007 2010 2016	

Russia reported on the status of the first polar-orbiting meteorological satellite Meteor-3M series in RUS-WP-02. Meteor-3M N1 is being prepared for its launch, which is planned in the first quarter of 2001. The second satellite Meteor-3M N2 launch is planned in 2003.

The Meteor-3M satellites will operate with an inclination of 99.6° at an altitude of 1024 km and period of 105.3 minutes. The ascending node of the equator crossing time will be at 09:15 for the former and 10:30 (16:30) for the latter. The exact time for Meteor-3M N2 will be coordinated with CGMS later.

The payload of Meteor-3M N1 includes the scanning (IR and VIS) instrument MR-2000M (similar to those flown on Meteor-3) and KLIMAT-2 (improved KLIMAT scanning IR radiometer installed on board Meteor-3). Meteor-3M N1 will carry the MIVZA microwave scanning radiometer (5 channels in the range 18–90 GHz) and the MTVZA radiometer (20 channels in the range of 18.7–183.36 GHz). The latter instrument will provide data for

atmospheric temperature and humidity soundings, as well as for oceanographic research into diagnostics of the active ocean layer processes. The following new sensors for imaging and sounding missions are planned to be installed on board Meteor-3M N2:

- multichannel scanning radiometer (MSR) (four channels in visible and IR, similar to channels 1,2,4,5 of AVHRR, spatial resolution is close to 1 km).
- advanced IR atmospheric sounder (IRFS) based on Fourier transform spectrometer (spectral range of 2–4.5 μm and 5.0–16 μm; spectral resolution is equal or better than 0.5 cm^{-1}. The IRFS primary mission is to provide data on temperature and humidity profiles and to meet WMO requirements on vertical resolution and accuracy of sounding in the troposphere.

Further it is planned to install the SAGE-III (USA, NASA) sensor on board the Meteor-3M N1 satellite (in the framework of the agreement between NASA and Rosaviakosmos).

Both satellites of the Meteor-3M series will provide standard 1.7 GHz down-link channels. HRPT mode is foreseen on Meteor-3M N2.

The USA discussed its future polar-orbiting meteorological satellite system in USA-WP-05. NOAA has in place a follow-on polar satellite programme to replace current satellites as they reach the end of their operational life. The new fifth-generation POES ATN follow-on satellites are designated NOAA-K, -L, -M, -N, and -N'. NOAA-K, -L, and -M will be upgraded with new primary environmental instruments, followed by NOAA-N and -N' updated to a later instrument baseline. The major changes to the environmental instrument baseline for the NOAA-K, -L, and -M satellites, described above, include the AVHRR/3, the HIRS/3, and the AMSU-A and -B. Instrument changes for NOAA-N and -N' include the HIRS/4 which will provide 10 km field of view versus 20 km on the previous model, and the Microwave Humidity Sounder, provided by EUMETSAT, which will replace the AMSU-B.

NOAA-K, now designated NOAA-15, was successfully launched into a morning orbit on 13 May 1998. NOAA-L (which will be designated NOAA-16) was launched 21 September 2000 into an afternoon orbit and will replace the aging NOAA-14. The planned launch dates for the remaining ATN follow-on satellites are as follows:

– NOAA-M May 2001
– NOAA-N June 2004
– NOAA-N' March 2008

To support the new satellites, elements of the ground segment have also been updated to accommodate the new and updated satellite data formats, generate S-band commands, ingest new satellite environmental data, product processing, and product distribution and archiving. To provide the latest information on the specifics of these changes, NOAA has prepared a user guide for the new POES satellites. This information is now available on the polar satellite homepage on the Internet at the following URL: http://www2.ncdc.noaa.gov/POD/intro.html.

The NPOESS development and acquisition plan is designed to make best use of production and existing POES and DMSP assets, to reduce risk on critical sensor payloads and algorithms, and to leverage civil, governmental, and international payload and spacecraft developments. In 1997, the IPO initiated a robust sensor risk reduction effort that is focused on early development of the critical sensor suites and algorithms necessary to support NPOESS. In 2000, the IPO initiated a programme definition and risk reduction contract to define the requirements for total system

architecture, including space, ground, and communications components, as well as to develop specifications for sensor/spacecraft integration. NPOESS will provide significantly improved operational capabilities and benefits to satisfy the critical civil and national security requirements for space-based, remotely-sensed environmental data. These activities represent a sound beginning for achieving the planned national and international programmes in the new millennium and ensuring continuous support to a variety of users.

The USA provided an overview of the NPOESS direct broadcast concepts in USA-WP-06. The total rate at which data will be generated by the NPOESS spacecraft is expected to be more than twenty times the rate for the current Polar-orbiting Operational Environmental Satellite (POES) and Defense Meteorological Satellite Program (DMSP) satellites, and will be formatted according to current Consultative Committee for Space Data Systems (CCSDS) conventions. Because of these significantly higher data rates, NPOESS will require equally significant increases in the bandwidth required for the communications links. Regulatory constraints on the current spectral allocations for POES and DMSP, as well as constraints on power spectral density, have significant impacts on the trade space for the high rate data (HRD) and low rate data (LRD). The HRD broadcast link will provide data from all of the NPOESS instruments at "full quality" at a data rate of about 20 Mbps, and will require a bandwidth of nearly 50 MHz. Because of the higher bandwidth requirement, the legacy spectrum at L-Band is not sufficient to support the HRD broadcast. The IPO has reviewed alternative spectrum availability and has determined that the WARC-95 EESS allocation at 7750–7850 MHz would be suitable for this application.

The LRD broadcast link will provide data at a rate of 230 Kbps with full CCSDS convolutional coding, Viterbi decoding, and Reed Solomon encoding/decoding. This data rate is about three times the current POES and DMSP APT rates. With improved data compression on NPOESS, the LRD link is expected to provide significantly better quality imagery.

ACTION 28.04 **WMO to place USA Future Polar-Orbiting Meteorological Satellite System and NPOESS presentations on the CGMS website by 15 November 2000.**

ACTION 28.05 **USA to investigate whether global or a selection of NPOESS level 1B data can be made available to end-users in near real-time, and report to CGMS XXIX.**

C.2 Future Geostationary Meteorological Satellite Systems

EUM-WP-04 reported that the MSG programme is under full development in line with the Mission and the End Users Requirements Document (EURD) which was updated in 1999 to include requirements covering the products and deliverables developed by the Satellite Application Facility (SAF) on Support to Nowcasting and Very Short Range Forecasting. The EURD will be further updated in due course to capture products and services offered by other SAFs.

In June 1999, the EUMETSAT Council approved the procurement of two additional Global Earth Radiation Budget (GERB) instruments for flight on MSG-2 and -3, thus ensuring an important and long-term contribution to climate monitoring.

In parallel, a worldwide MSG Research Announcement of Opportunity (MSG RAO) was jointly released by EUMETSAT and ESA in 1999. This MSG RAO provides a structured framework for demonstrating the value of the MSG mission to innovative research in various Earth Science disciplines and for investigating the potential implications for the evolution of the operational services.

Concerning the MSG space segment, the Flight Acceptance Review will take place between August and October 2000. The MSG Engineering Model (EM) has completed the nominal test programme and presently runs additional tests to confirm the resolution of open issues. The first part of compatibility tests with the MSG Ground Segment has started. The subsystems Flight Models (FM) and SEVIRI FM have also been delivered. The Satellite FM has been Integrated and the testing programme is largely completed. The production of the MSG-2 and MSG-3 satellites is also well advanced.

Ariane-4 has been chosen for the launch of MSG-1 whilst Ariane-5 remains the baseline for MSG-2 and MSG-3. Further tests are planned to confirm and document the compatibility of the MSG-2/3 satellites with the second batch of Ariane-5 launchers. The SEVIRI EM and FM tests have indicated very promising results regarding performance.

Concerning the MSG Ground Segment, the Critical Design Review was successfully held between December 1998 and February 1999 and the ground segment development has entered the production and tests phases at facility level and the preparation for system integration at EUMETSAT. The Central Facility, the Primary Ground Station and the Image Processing Facility have encountered delays beyond six months during the system test phase at the contractor premises, despite various recovery actions, including important increase of resources by the contractors. These delays are postponing the start of the Ground Segment integration and affect the MSG-1 launch date (earliest launch date currently January 2002).

The detailed design, development and tests of the high rate and low rate MSG User Stations have been completed as part of the ground segment development. The design documentation for the user stations was made available for potential manufacturers from the beginning of 1999 on the EUMETSAT homepage (www.eumetsat.de), and then updated to reflect the successful tests of the MSG Users Station Baseband Module.

Discussions have progressed with the EUMETSAT Council aimed at revisiting the content of the High Rate and Low Rate Information Transmission data streams to increase the overall data disseminated and to make the two data streams more complementary, whilst keeping the LRIT service attractive. Users have been informed about these possible changes, as HRIT users may wish to procure Users Stations with both HRIT-LRIT receiving capability.

Currently the transition period with parallel operations of Meteosat-7 and MSG-1, starting from the commissioning of MSG-1 in 2002, extends until the end of 2003. It is technically possible to further extend the overlap until 2004 assuming continued nominal operations of Meteosat-7.

EUM-WP-05 presented the status of the network of approved Satellite Application Facilities (SAF) currently under development in the EUMETSAT Member States. The Pilot SAFs on “Nowcasting and Very Short Range Forecasting” and “Ocean and Sea Ice” are expected to start their Initial Operations Phases in 2002.

The paper also described the status of the seven SAF projects and provided an updated list of planned products. The SAFs under development address the following themes:

- Support to Nowcasting and Very Short Range Forecasting
- Ocean and Sea Ice
- Ozone Monitoring
- Climate Monitoring
- Numerical Weather Prediction
- GRAS Meteorology
- Land Surface Analysis.

SAFs will use data from Meteosat, MSG and EPS and, in some cases, data from non-EUMETSAT missions. Until such data become available, information from current satellites will be used for development.

It is expected that the Initial Operational Phase will give a major opportunity for users to initiate their activities based on SAF Products and Services. Lessons learnt will generate benefits for all the other SAF Projects.

In IND-WP-01 India informed CGMS of its plans for future geostationary satellites, INSAT-3A (similar in capability to INSAT-2E), Metsat (similar to VHRR of INSAT-2E) and INSAT-3D (6-channel imager with 1km resolution and 19-channel sounder).

JPN-WP-03 gave a report of future plans for the Multi-functional Transport Satellites MTSAT. MTSAT-1R and MTSAT-2 will be launched in 2003 and in 2004, respectively. On MTSAT-1R, LRIT will be added to WEFAX (for reception by SDUS) and HRIT and HiRID transmissions will be introduced (for reception by MDUS). In the transition period of WEFAX to LRIT and HiRID to HRIT, image data will be disseminated by using a time sharing method on each broadcast centre frequency.

CMA informed CGMS in PRC-WP-04 that China plans to develop three successive satellites: FY-2C, -D, and -E, with improvements based on experience with two experimental satellites FY-2A and -2B. It is expected that FY-2C will be launched in 2003, FY-2D in 2006 and FY-2E in 2009. The VISSR on board these satellites will have five channels (VIS, three IR and WV).

ACTION 28.06 **China and Japan to exchange detailed information on their planned LRIT broadcasts and to inform the CGMS Members in parallel by 31 May 2001.**

In RUS-WP-03 Russia indicated that the GOMS/ELECTRO N2 spacecraft is presently being integrated. Payload and mission are similar to those of GOMS/ELECTRO-N1. The spacecraft will rely on three-axis stabilised platform carrying as a core payload the BTVK imager (VIS and IR in atmospheric window and in 6.7 μm water vapour absorption band), as well as a meteorological communication package (DCS and ensemble of retransmitters). The satellite is planned to be launched by a Proton launch vehicle in 2003 and will be placed into geostationary orbit at 76°E.

Table 4: Future Geostationary Satellites Coordinated within CGMS

(as of 20 October 2000)

Sector	Future additional satellites	Operator	Planned launch	(Planned location) Other remarks
EAST-PACIFIC (180°W-108°W)	GOES-M GOES-N GOES-O	USA/NOAA USA/NOAA USA/NOAA	07/2001 10/2002 04/2004	135°W and 75°W
WEST-ATLANTIC (108°W-36°W)	GOES-P GOES-Q GOES-R	USA/NOAA USA/NOAA USA/NOAA	2007 2010 TBC	
EAST-ATLANTIC (36°W-36°E)	MSG-1 MSG-2 MSG-3	EUMETSAT EUMETSAT EUMETSAT	1/2002 2003 2007	0° 0° 0°
INDIAN OCEAN (36°E-108°E)	GOMS-N2 INSAT III-A INSAT III-D METSAT FY-2C FY-2D FY-2E	Russia India India India China China China	2001 2001 2003 2001 2003 2006 2009	76°E Dedicated meteorological mission Improved FY-2 series, 5-channel VISSR, LRIT
WEST-PACIFIC (108°E-180°E)	MTSAT-1R MTSAT-2	Japan Japan	2003 2004	Multi-functional Transport Satellite 140°E

USA-WP-07 discussed NOAA's future geostationary meteorological satellite system. GOES-M, last in the current series of spacecraft, will complete system-level thermal vacuum testing in October 2000, and is scheduled to be available for a planned launch in the July 2001 time frame. The USA is in the process of purchasing a new series of satellites, GOES-N, -O, -P, -Q, with similar instrumentation as the current series. The new series of GOES spacecraft will support the new LRIT digital service. The first two spacecraft, GOES-N and -O, are in the hardware development and integration phase. The first set of imager and sounder instruments is scheduled for delivery in early 2001. The completed GOES-N spacecraft is scheduled to be available for launch in October 2002 and GOES-O in April 2004. Contractual options for GOES-P and GOES-Q are not yet exercised.

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

Dr. Bizzarro Bizzarri, at the invitation of NOAA, provided a discussion in USA-WP-08 that was a follow-on to "Compliance of the post-2000 satellite-based component of GOS with requirements and possible approach to update/upgrade future systems" that was presented and discussed at CGMS XXVII. These discussions were centred around whether important gaps exist in the post-2000 satellite-based component of GOS and how they could be filled at best by minimal efforts and how to prepare for the replacement of the elements currently in use or being developed, in view of next generation satellite systems to be used in the post-2015 era. CGMS recognised the need to revise the concept of Global Observing System and to consider the possible role of scientific satellite programmes in support of GOS. Dr. Bizzarri showed that with evolving GOS assets, the compliance of the CGMS-provided satellite system could improve considerably provided that:

- investments are made possibly in the 2010 time frame, to fill major gaps, possibly by adding small satellite missions to the backbone GOS large satellites;
- consistent planning is carried out in view of replacing geostationary satellites and certain end of life series (such as Metop) in the 2015 time frame.

However, Dr. Bizzarri considered that the range of requirements to be fulfilled is so large that it is not possible to fully comply with them within the limits of resources available to CGMS Members. He then presented a list of requirements, which could be better met by cooperating with non-CGMS satellite providers operating in the scientific/technological/commercial fields. Dr. Bizzarri provided a number of examples to show that the upgrading of geostationary satellites and the addition of future low orbiters (for cloud/radiation interactions, for oceans salinity/soil moisture, for measurements requiring constellations of micro/mini satellites, for wind profiling) could be implemented within the "small satellites" context. His final recommendations were:

a) CGMS to agree on "the minimum common performances" of geostationary satellites beyond 2015 (to include high-vertical-resolution frequent sounding and faster imagery);
b) CGMS to agree on a "manifest" of small-satellite missions possibly to be developed (as far as the prototype is concerned) by R&D Space Agencies;
c) CGMS to agree on a "manifest" of observations unlikely to be affordable within GOS-proper, thus to be acquired from scientific/technological/commercial satellite programmes;
d) A suggestion to include an "Atmospheric Dynamic Theme" in the IGOS consideration was put forward to ensure that the need for the backbone satellite system for weather prediction and general circulation modelling is not forgotten.

A discussion took place on these four recommendations and CGMS agreed that a workshop should be held, concurrent with the WMO Expert Team on Observational Data Requirements and Redesign of the Global Observing System. Draft Terms of Reference of this workshop were developed (see Appendix A). WMO noted the need for full financial support for the workshop by CGMS satellite operators.

ACTION 28.07 **USA-WP-08 to be submitted to the Expert Team on Redesign of the Global Observing System as input for consideration and the draft Terms of References to be finalised by the Chairman of the Expert Team in preparation for the workshop.**

D. OPERATIONAL CONTINUITY AND RELIABILITY

At a special evening session hosted by NOAA on contributions to a future polar observation system, WMO-WP-14 formed the basis of a presentation given by the Deputy Secretary General of WMO.

The working paper discussed the history of the space-based Global Observing System (GOS), its present configuration and a possible expansion to include several new mission areas. The Global Observing System was established during the formation of the World Meteorological Organization's (WMO) World Weather Watch (WWW). During the nearly four decades since the formation of the WWW, the space component of the GOS has evolved from a constellation of one or more polar-orbiting meteorological satellites to two constellations comprised of at least two near-polar-orbiting satellites and at least five geostationary environmental observation satellites.

Four important events have occurred since 1998 that have direct relevance to the future of the space-based component of the GOS:

- the Commission for Basic Systems at its Extraordinary Session in 1998 recognised the need to review and update the GOS.
- the Twenty-seventh session of the Coordination Group for Meteorological Satellites, held in Beijing, China, 13-18 October 1999, discussed the present configuration of the space-based component of the GOS.
- the WMO Executive Council convened a high level meeting in January 2000 between the satellite operators and senior representatives of the WMO user community (WMO WP-16).
- WMO became a Partner within the Integrated Global Observing Strategy (IGOS).

The following changes to the present space-based component of the GOS were proposed:

- soundings of temperature and humidity should be provided from both constellations of satellites;
- the operational polar-orbiting satellites should have the capability to provide surface wind vectors over the ocean;
- there is a need for at least six geostationary satellites spaced around the globe to provide full global coverage from 60°N to 60°S.

WMO-WP-14 also proposed to add a constellation of experimental satellites covering several different mission areas such as oceanographic, atmospheric chemistry, high-resolution land use and hydrological. Such a constellation would require at least four polar-orbiting experimental satellites. The selected mission areas (oceanography, atmospheric chemistry, high-resolution land use and hydrology) served as an expedient to group together similar geophysical parameters. The parameters listed within the four mission areas would support important application areas beyond those of operational meteorology to include climate change, monitoring and detection, operational oceanography, hydrology and agricultural meteorology.

E. SATELLITE REQUIREMENTS OF WMO PROGRAMMES

E.1 World Weather Watch

In WMO-WP-05, CGMS was informed of developments in the Strategy to Improve Satellite System Utilisation. WMO, after consideration of each of three corner stones (data access, system use and education and training), had prepared a set of preliminary guidelines for the Strategy to Improve Satellite System Utilisation. The preliminary guidelines would be used as part of a rolling review of the Strategy to Improve Satellite System Utilisation. The rolling review process would be initiated by the issue of a biennial questionnaire. An analysis of the questionnaire would provide one input to the guidelines for the Strategy to Improve Satellite System Utilisation. The questionnaire would be analysed with regard to each cornerstone in seeking problem areas and solutions that would enable increased utilisation of the satellite system.

In WMO-WP-07, CGMS noted the further development of the Statement of Guidance (SOG) on Feasibility of Meeting WMO Requirements. WMO has continued to follow the CBS-approved Rolling Review of Requirements process (User Requirements, Expected Observing System Performances, Critical Review and Statement of Guidance). A second iteration of the Statement of Guidance based only on space-based expected performances has been finalised and distributed as WMO/TD No. 992 (SAT-22). The database of expected instrument performances has been greatly expanded to contain information related to all *in situ* observing systems within the surface-based Global Observing System. A third iteration of the Statement of Guidance is in preparation that is based on both space-based and *in situ* expected performances. Draft observational data requirements for Seasonal and Inter-Annual (SIA) Forecasting and Aeronautical Meteorology have been prepared and are under review by appropriate Technical Commissions. Finally, a new technical document is under preparation describing candidate observing systems for consideration in the redesign of the Global Observing System.

In WMO-WP-12, CGMS noted that the WMO/ESCAP Panel on Tropical Cyclones for the Bay of Bengal and the Arabian Sea at its twenty-seventh session had welcomed an extension of the operation by EUMETSAT to implement the Indian Ocean Data Coverage (IODC) mission until the end of 2001. CGMS noted that WMO had sent a letter to EUMETSAT, requesting that it consider the possibility to continue, on a permanent basis, its coverage of the Indian Ocean in order to provide the necessary data in support of the national mandates of WMO Members in the region of coverage. WMO expressed deep appreciation to EUMETSAT for its initiative in providing such valuable coverage over this data-sparse area.

E.2 Other Programmes

In WMO-WP-16, CGMS was informed of activities with regard to the formation of the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) which was formally established by the WMO Congress and the IOC Assembly in mid-1999. IOC explained that JCOMM was the result of a merger between the WMO's Commission for Marine Meteorology (CMM) and the IOC/WMO Integrated Global Ocean Services System (IGOSS). It reflected the long tradition of WMO and IOC working together in joint bodies to collect observations in which the marine meteorological and oceanographic communities share a mutual interest. Another example was the IOC/WMO Data Buoy Cooperation Panel (DBCP), which was responsible for drifting buoys, and which will become one of the

subsidiary bodies of JCOMM. The establishment of JCOMM also reflected the consensus that in forecasting El Niños and other climate variations, oceanographic data contributed to increased forecast model skill, and to the continual improvement of these models through validation. The creation of JCOMM should also meet the increasing need for the operational forecasting of ocean conditions relating to coastal protection, search and rescue, offshore industry, shipping, fishing and recreation.

CGMS noted the results of the First and Second Transition Planning Meetings for JCOMM. It also noted that JCOMM-I was scheduled to take place 19-29 June 2001 in Akureyri, Iceland.

With regard to the JCOMM structure, CGMS noted that it would include at least one ocean satellite expert to be a member of the Observations Programme Area (PA) Coordination Group and provide the necessary liaison with and input to, *inter alia*, GOOS and CBS. WMO-WP-16 also described other substantive issues addressed and decisions agreed upon at the Planning Meetings including:

- Strong support for the proposal for a JCOMM Observing Systems Coordination Centre (JCOMMOPS), to be based around the existing DBCP/SOOP/Argo coordination unit in Toulouse, France;
- Support for the proposals regarding both the interim and long-term Argo Information Centre, as well as for the eventual integration of Argo into operational observing networks under JCOMM, to be coordinated through the proposed Observations Coordination Group;
- Reconfirmation that JCOMM should participate fully in the CBS Rolling Requirements Review process and contribute to the maintenance of the requirements database;
- Agreement that JCOMM should be directly involved in the implementation of the strategy for *in situ* ocean observations contained in the Ocean Theme Team Report of the IGOS-Partners.

CGMS was informed that the IGOS Partners included IOC, WMO and other representatives of in-situ observation agencies, plus representatives of CEOS. The Partners were working together to make global observations more efficient and effective. They decided to take a thematic approach to implement the Integrated Global Observing Strategy (IGOS), starting with an Oceans Theme that was about to be published by NASA. The Oceans Theme contains two sets of challenges: (i) to continue key satellite observations; and (ii) to undertake critical research (the knowledge challenge). The Oceans Theme requirements are consistent with the needs identified by the combined research and operational community at a conference on ocean observations for climate that took place in St Raphael in October 1999 (OceanObs99).

The key observational requirements included:

Ocean Topography – continuation of a TOPEX/Poseidon-class high-precision satellite (eg Jason-1 and its successor), and an ERS/ENVISAT-class altimeter;
Ocean Vector Winds – continuation of a morning and afternoon ERS/QuikSCAT-type of data service, with a coverage equal to or better than a dual sided scatterometer, to close gaps in global coverage by two scatterometers in the 2000-2008 time period;
Ocean Biology – continuation of global satellite missions for global colour, such as SeaWIFS and MODIS, refining and coordinating the products from such missions;
Sea Surface Temperature – continuation of the geostationary and low-earth-orbit meteorological satellites that produce merged sea surface temperature data products;

Sea Ice – continuation of the DMSP passive microwave systems, Radarsat and EOS Terra and post-ENVISAT systems to provide long-term observations of ice extent and type. A key issue is funding for Radarsat-2.

The key knowledge challenges include:

Precision Gravity Field or Geoid – to implement the GRACE/GOCE-class missions;
Salinity – to develop and demonstrate space technologies for salinity;
Sea Surface Temperature – to provide global SST to better than +/- half a degree C.

CGMS noted that JCOMM participated actively in the meeting of the CBS Expert Team on Observational Data Requirements and the Redesign of the Global Observing System (June 2000). It provided status reports on existing *in situ* marine observing systems, and used the meeting as a starting point in the development of a statement of guidance on how well marine data requirements were being met by existing and planned *in situ* and satellite marine observing systems.

Finally, CGMS was informed that the IOC Executive Council, at its 33rd session (Paris, June 2000), noted with interest the increasing involvement of CGMS in oceanographic satellites. It therefore requested the IOC Secretariat to consider the possibility that IOC might join WMO as a member of CGMS, and to report on this to the next IOC Assembly (July 2001). CGMS also noted that there was strong WMO support for such consideration.

F. COORDINATION OF INTERNATIONAL DATA COLLECTION & DISTRIBUTION

F.1 Status and Problems of the IDCS

EUM-WP-07 reported on the status and use of the International DCP channels. At the present time around 610 International DCPs (IDCPs) are registered worldwide for use with the IDCS, using 18 of the 33 available channels. Of these, 20 are Aeronet DCPs operating on channels I23-I24 and 154 are "Regional" DCPs belonging to WMO agro-meteorological and hydro-meteorological networks and operating on channels I27-I33.

CGMS recalled that channels I23-I24 and I27-I33 are currently being used within the Meteosat IDCS on a temporary basis with the special agreement of CGMS until such time that those DCPs can be transferred to the MSG Data Collection System (now expected 2002).

Reference to the online listing of IDCS allocations (www.eumetsat.de/idcs/) shows that there have been very few allocations during the last year. At the present time the following Members have read/write access: EUMETSAT, Japan and USA. WMO has read-only access for system monitoring purposes. CGMS Members may access this database at any time and the CGMS Secretariat (EUMETSAT) is responsible for keeping the database up-to-date.

The EUMETSAT Mission Data Reception System (MDRS), which allows certain DCP users to access their data via the World Wide Web, has continued to operate during the last year. Various system performance parameters are also provided through this system. Access to the system is via a link on the website and operators first have to register with EUMETSAT so that they can be provided with a user name and password.

A basic set of DCP performance monitoring statistics, jointly developed by Japan, USA and EUMETSAT, was agreed by CGMS during 1999. These statistics were designed to provide satellite operators and WMO with an overview of the operation of the IDCS in general. CGMS were informed that archiving of these statistics by EUMETSAT (for the Meteosat field of view) only commenced in July 2000 because of other high priority commitments linked to the developments of the MSG ground segment. In conclusion, it was reported that during the last twelve months there appeared to have been negligible interference affecting users of IDCS channels within the Meteosat telecommunications field of view.

In JPN-WP-04 CGMS were informed that 347 IDCPs were registered with the GMS system as of June 2000. It was noted that over the last 12 months around 22 IDCS channels had been affected by severe interference. Some discrepancies in the number of messages received and those sent to the GTS had been recorded, mainly caused by either incomplete messages or messages containing no data.

RUS-WP-04 described the establishment of a data collection system that is close to operational status. This data collection system will use two international DCP channels (I25 and I26) which have been authorised for use on a temporary basis by CGMS. The first batch of DCPs are being manufactured and in early 2001 the DCP will be certified for use with the Meteosat system.

Russia reported that it had detected some use of I25 and I26 and requested that EUMETSAT confirm the availability of these channels for use by Roshydromet.

USA-WP-09 provided an update on the Channel Interference Monitoring System, CIMS. The CIMS provides continuous automatic testing and reporting for the IDCS channels. Its expanded capabilities include scheduled testing of all channels, international and domestic. Along with statistical reporting of radio frequency interference, the CIMS is able to capture, archive and analyse spectrum plots for all test signals. A monthly report is produced showing the percentage of time when a channel is experiencing interference. These reports are available in text format at http://www.dcs.noaa.gov/internat.html.

F.2 Ships, including ASAP

WMO-WP-13 discussed the Automated Shipboard Aerological Programme (ASAP). The number of soundings taken in the frame of the ASAP has averaged around 5400 soundings annually over the last 5 to 10 years. There were fairly large fluctuations from year to year, mainly through the influence of enhanced activities in specific observational programmes such as FASTEX. This programme was carried out in 1997 and led to a decrease in soundings in the following year. This decrease was more than compensated for in 1999 with a nearly 20% increase in the number of soundings compared to 1998. This increase could largely be ascribed to special programmes carried out by the United States and Japan. But also the fact that the United Kingdom started a new unit in mid-1999 led to the increase. The total number of ASAP or similar shipboard sounding units operated in 1999 was 21; the operators are: Denmark (2 units), France (4 units), Germany (3 units), Japan (7 units), Russia (1 unit), Sweden-Iceland (1 unit), United Kingdom (2 units) and the United States (1 unit).

The total number of ASAP soundings in 1999 corresponded approximately to the number of soundings which could be performed annually by a little less than eight ocean weather ships. Most of the soundings were taken in the northern Atlantic Ocean.

Under EUMETNET, which is a network grouping of 18 European national meteorological services, a programme has been started, called E-ASAP. It is intended to establish two ASAPs, one on a route within the Mediterranean, the other on a route between the English Channel and the South-eastern Seaboard of the United States. E-ASAP is jointly funded by the EUMETNET members, taking into account existing activities providing upper-air profile data from the oceans.

WMO-WP-13 noted that both the French and German ASAP units continued to use the IDCS, as did several of the Japanese ship-based upper air sounding systems. The remainder use Inmarsat-C for data collection, despite the increased cost, as this was perceived to be both more reliable and more flexible for operators. The future may thus see an increasing trend towards Inmarsat-C usage.

F.3 ASDAR

WMO-WP-09 discussed the ASDAR Programme. The programme peaked early in 1998 with 21 operational systems. However, there has been a substantial reduction in the size of the ASDAR programme since January 2000 as all five remaining systems on board British Airways (BA) B747s were decommissioned and removed. These same aircraft have been fitted with AMDAR software along with 45 other aircraft in the B747-400 fleet. Approximately half of these aircraft were expected to be operational in August 2000. This completed the decommissioning programme with BA that has seen a reduction of ten operational systems in two years. The decommissioned units will be checked and made available as spares to support the 12 remaining equipped aircraft belonging to other carriers. The last AMDAR Panel meeting held in 1999 noted the decline of the number of reporting ASDAR units as a result of faults occurring in the ASDAR software now becoming increasingly obsolescent and likely to be uneconomical to maintain in the future. Although the ASDAR programme was in decline, there were several units seen to have a priority and which should be kept operating for a few more years as they will still form the main source of aircraft observations in critical data-void areas of the world. These include units on aircraft from Air Mauritius (2), KLM (3) and Aerolineas (2) that operate respectively over the Indian Ocean and South America. South African units (2) will eventually be replaced by AMDAR systems as will be the two units operated by Saudi Arabia, but not for another year.

WMO-WP-09 noted that the operational ASDAR programme would continue for a further two years (until December 2002) but would be reviewed annually. The AMDAR Panel would be in a better position in 12 months time to assess the possibility of any further extensions of up to three years beyond 2002. The ASDAR programme would continue to use up to 15 of the 30 currently available time slots in international channel number 18 of the IDCS for the next two to five years of operation. There was no further requirement to use the remaining 15 time slots, which would be available for use by other programmes.

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

USA-WP-10 reported on the status of disseminating IDCS messages over the Internet. The USA described improvements in the system that will allow users better access to the data. These features were described as “PUSH”, “PULL” and FTP. The PUSH technique has been partially developed through activities with the US Geological Survey for building a system that receives data directly from the GOES spacecraft and places it on the Internet. This new

receiver station is known as the Local Receiver Ground Station (LRGS). Such a system has been installed at the Wallops CDA to provide back-up for the field unit. PUSHING data requires the USA to process the information and send it to the user. PULLING data entails the user logging on to the system and making a specific request. Finally, the FTP service will encompass the process of scripts to collect the requested data and forward the results to the requestor in a single burst.

G. COORDINATION OF DATA DISSEMINATION

G.1 Dissemination of satellite images via satellite

JMA presented the draft schedule of MTSAT-1R observations and image data dissemination in JPN-WP-05. Observations will consists of hourly full disc observations, hourly observations of the northern hemisphere, and six-hourly sequential hemisphere observations for wind vector extraction. All of the observed images will be disseminated by HRIT and HiRID. In addition to image data, meteorological data and numerical predictions (Grid Point Value) will be disseminated by LRIT.

ACTION 28.08 **WMO to place the MTSAT-1R observation and dissemination schedule on the CGMS server by 15 November 2000.**

ACTION 28.09 **Japan to regularly keep the CGMS Secretariat informed of potential changes in the MTSAT-1R observation and dissemination schedules.**

The USA addressed its plans for implementing LRIT in USA-WP-11. The current series of GOES spacecraft (GOES-8, 9, 10, 11, M) have the capability of transmitting either analogue WEFAX or digital LRIT data streams. The GOES-N, -O, -P, -Q series can only transmit the digital LRIT signal. NOAA's transition plan allows an orderly transition to the LRIT without the need to be sensitive to the specific GOES-N launch date. In the January 2002 time frame, a test signal will be provided for a few weeks through a GOES spacecraft other than the operational GOES-East and GOES-West. During that period, GOES-East and GOES-West will continue to provide routine WEFAX data. This LRIT test signal will allow users to test new or modified receiver equipment without disrupting normal WEFAX transmissions. Around November 2002, GOES-East will be converted from WEFAX to LRIT transmission and will cease transmitting WEFAX data. The conversion of GOES-West to LRIT will be based on the needs of the users. The date for GOES-West conversion will be announced as soon as practical.

The LRIT digital WEFAX product list will be similar to the current analogue service. LRIT will provide improved quality over the current WEFAX products and offer additional products and information. Transition to the new format will require either upgrading or replacement of the existing WEFAX terminals. The USA will help the users get access to WEFAX and LRIT broadcast schedules and information on the availability of user receiver equipment. The USA has scheduled a WEFAX Users' Workshop for 14 November 2000 to inform the WEFAX community of NOAA's plan to migrate to the new digital format. Information pertaining to the NOAA LRIT implementation can be found at http://noaasis.noaa.gov/WEFAX/. WMO thanked USA for this paper which closed a request for clarification expressed at CGMS XXVII and proposed to help USA to disseminate this information to WMO Members.

ACTION 28.10 **WMO and USA to coordinate their efforts to inform WMO Members on the transition period from analogue WEFAX to LRIT dissemination scheme for GOES satellites and inform CGMS Members at CGMS XXIX.**

In WMO-WP-03, the current status of WMO activities for the LRIT/LRPT transition was discussed. CGMS recalled that one method in which WMO intended to inform its Members of the LRIT/LRPT improved capabilities was in the form of a new WMO Satellite Activities Technical Document. A draft of the new Technical Document was reviewed by the CBS OPAG IOS Expert Team Meeting on Satellite System Utilisation held in Melbourne in October 1999. The draft was based on materials provided by CGMS satellite operators. The Technical Document would be distributed in late 2000 with the expectation that a new updated Technical Document would be issued later to include similar information for the high resolution services (HRIT (High Rate Information Transmission) and AHRPT (Advanced High Resolution Picture Transmission)), as appropriate.

CGMS also agreed that tables indicating the planned implementation dates for the new services would be most valuable and that such tables should be current and contain any necessary explanations. CGMS agreed to review the tables contained in WMO-WP-03 and provide any necessary updates before 30 November 2000.

CGMS noted that WMO had reviewed the present WWW goals for the percentage of implementation for WMO Members equipped with satellite receiving equipment. The goals were 100% for polar-orbiting satellite data receivers (either APT or HRPT) and 100% for geostationary satellite data receivers (either WEFAX or HR). This meant that each WMO Member should be equipped with at least one polar-orbiting satellite data receiver and one geostationary satellite data receiver. The goals had been used since 1992. WMO was of the opinion that the goals were consistent with the basic design for most satellite programmes that had been approved so far, and would be valid to a large extent for the next 10 to 15 years. However, considerations on possible changes in the concept for the direct broadcast service from meteorological satellites and in the long-term development of data dissemination would have to take into account the development of users' information needs as well as rapidly emerging telecommunication technologies. Thus, WWW goals may need to be updated to reflect real-time data access and processing capability. With regard to data access, the goals could be prioritised as follows:

- first priority should be access to both LEO and GEO satellite imagery and sounding data from the space-based component of the Global Observing System;

- second priority should be access to additional data from relevant earth observation and research satellites.

With regard to data processing, the goals should reflect the needs in appropriate application areas such as Hydrology, Agricultural Meteorology, Nowcasting and Very Short-Range Forecasting (VSRF), Aeronautical Meteorology, Public Weather Service and Global and Regional NWP.

In WMO-WP-18, CGMS was informed that WMO had made a preliminary review of the concept of direct broadcast from the space-based Global Observing System paying particular

attention to advantages, limitations and challenges. WMO took into consideration rapid technological advances, in particular telecommunications, now occurring and expected to accelerate in the future. WMO recalled that the Direct Broadcast Service (DBS) was a broadcast service available from most of the meteorological satellites operated by members of CGMS. Such broadcasts allowed the transmission of satellite sensor data and products in real or near real-time to user reception stations located within the broadcast field of view of the satellite.

In WMO-WP-18 WMO had considered several possible evolution paths for the DBS. WMO noted that user requirements were being developed, sophisticated instrument payloads were being proposed and designed to take advantage of developing technology, and alternative data dissemination schemes were being considered. These alternatives included: the use of data relay between satellite systems; the use of commercially-provided higher data rate services; and the use of services such as the Internet. Commercially-provided services could be more reliable, as they may have greater potential for system redundancy. Furthermore, in the case of the geostationary satellites solely dedicated to meteorology or climate monitoring, not including the broadcast capability could simplify the design of the satellite, could reduce development costs, relax the need for very accurate station keeping, and thereby possibly extend the lifetime of the satellite. Additionally, the use of commercially-provided broadcast services could facilitate the global development of low cost standard classes of user stations with smaller antennas with less stringent requirements for pointing accuracy and for a significant reduction in the need for specific training as concerns the operation and maintenance of the equipment. Relying on higher bandwidth telecommunication systems offered the potential of improving the overall timeliness; however, WMO noted that an important point to consider with such broadcasts would be the telecommunication coverage. In order to ensure coverage within a region similar to that currently available from the meteorological satellite broadcasts, use of more than one telecommunications system may be required. WMO stressed, however, that to make any commercial proposal viable, the cost to the user of the telecommunication service should not offset these advantages, also bearing in mind the timeliness and coverage requirements.

Thus, in WMO-WP-18, WMO considered that any implementation of such a possible evolution would be a long-term objective and could be considered selectively in the following categories of satellite data flows:

- A gradual implementation of near-real-time satellite data available through high bandwidth telecommunication means as a complement to the DBS: for example, GEO imagery from “foreign” satellites, satellite products derived from GEO and/or LEO satellites, global data from polar-orbiting satellites;

- With the start of operations of the future generation of meteorological satellites, a full set of real-time GEO data disseminated by normal telecommunication satellites, or other means as a replacement to the DBS, assuming it offers a more cost-efficient solution with the same timeliness and coverage performance as dissemination by the meteorological spacecraft itself.

WMO had also considered that real-time direct broadcast from LEO spacecraft would continue to be received through tracking L-band antennas, for reasons of timeliness, as long as no equivalent service could be provided via a telecommunication satellite constellation. Such a change was only expected to occur in the long-term (10-15 years). WMO stressed that any

change to the broadcast concept would need long periods of notice for the users and long transition periods, which should be compatible with the life cycle of receiving equipment and of relevant satellite series. WMO also agreed that there was a requirement for system studies and demonstration before the impact of such major changes in broadcast system on the users could be assessed in more detail. WMO noted that new dissemination concepts could offer many opportunities for the wider distribution of satellite imagery and derived products from both GEO and LEO satellites on a more global scale and include both operational and R&D satellites.

In summary, WMO agreed that direct broadcast service on board meteorological satellites be complemented and supplemented by alternative telecommunications services, with the ultimate goal for a smooth and orderly transition to the full use of alternative telecommunications service for broadcast service starting with the future generation of satellites.

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

In WMO-WP-10, CGMS was informed of WMO activities related to the requirements for additions to BUFR tables for encoding satellite data, and recommended changes to Tables of the BUFR WMO Code Form for implementation on 8 November 2000. WMO did not recommend any addition to the traditional alphanumeric codes (SARAD; SATEM; SATOB) used for encoding satellite data. WMO had recommended that all new data types or parameters should be coded using the table-driven codes BUFR or GRIB which offered self description, flexibility and easy expandability. WMO had also recommended to CBS XII (November 2000) the implementation of Edition 2 of FM 92 GRIB, which would permit the encoding in grid representation of all types of processed satellite data. GRIB Edition 2 will be operational on 7 November 2001.

H. OTHER ITEMS OF INTEREST

H.1 Applications of Meteorological Satellite Data for Environment Monitoring

No working papers were presented.

H.2 Search and Rescue (S&R)

USA-WP-12 reported on the COSPAS-SARSAT system with emphasis on interference mitigation in the 406 MHz band. The USA provided information on the types of interference monitored in the COSPAS-SARSAT system and the methods used to mitigate them, domestically and internationally. The Doppler location solution, the automatic gain control (AGC) and the dot plot solutions were outlined as the primary methods used to quantify and characterise the effects of interference in the 406 MHz band. Successful rescue attempts by the COSPAS-SARSAT system are due to the ability to readily distinguish between legitimate and interfering signals. Future improvements in the COSPAS-SARSAT system include an automatic interference monitoring system (AIMS) to track an interfering site and, when certain parameters are met, will generate a report to be sent to the appropriate communication authority. The AIMS will allow continuous monitoring and reporting of interference that will reduce false alarms within the system and increase the possibility of lives saved.

H.3 Meteorological Data Distribution via satellite

No working papers were presented.

H.4 Training

EUM-WP-10 described training activities carried out over the last twelve months and presented an outline plan of activities for the coming year.

MSG/EPS training courses, to prepare both English- and French-speaking African NMS for changes arising with the new EUMETSAT satellite systems, were held in Nairobi in late 1999 and in Niamey in February 2000 with participation from over 20 African countries at each event. MSG/EPS training courses were also held in Austria and Germany in May and June 2000, respectively, for the benefit of a large number of European NMS.

A satellite data application training course benefiting, in particular, the Nordic countries was hosted by the Finnish Meteorological Institute in Helsinki in March 2000. These are annual events and prove to be extremely popular with forecasters.

EUMETSAT held its Eastern European User Forum, in Budapest, Hungary, in April 2000. Much interest was shown in training activities and it is expected that the current three new EUMETSAT Cooperating States (Poland, Hungary and Slovakia) will each host a training event in the coming years.

The development of Computer Aided Learning (CAL) material by various groups has continued over the last year and an MSG CAL Workshop, bringing together interested Member and Cooperating States and CAL experts from Europe and Africa, was held in August 2000 to provide a route map for the future development of CAL material by EUMETSAT.

CGMS was informed that several MSG/EPS and/or satellite data applications courses are scheduled to take place in several European and African countries in the coming months. Additionally, EUMETSAT will participate in a training course hosted by China, in Nanjing, in December 2000, where a first trial of the concept of a global virtual training laboratory will take place, with participation of several interested parties and CGMS partners.

At the Fourth EUMETSAT User Forum in Africa, held in Kampala from 25 to 29 September 2000, where nearly all NMS in Africa were presented, training was a major discussion topic and many important recommendations were drawn up.

A very full schedule of training activities will continue in 2001, with training activities already foreseen in Niger, France, Kenya, Turkey, Greece, Lithuania, Germany, Poland, Spain and Slovakia. Three training workshops based on the output of the EUMETSAT Satellite Application Facilities (SAF) are also foreseen in this period (Climate, Ozone and GRAS).

India reported on its training programme in satellite meteorology in IND-WP-02. A new institute has been set up in 1998 at Ahmedabad, India, to teach Satellite Meteorology and other related subjects to national and foreign personnel. This institution is named as “Centre for Space Science and Technology Education for Asia and the Pacific (CSSTE-AP)” and is affiliated to the United Nations. IMD’s experts are delivering lectures on satellite meteorology

in post-graduate training courses conducted periodically by this Institute.

JPN-WP-06 reported on the CAL system developed in the Meteorological Satellite Center (MSC) of JMA. MSC-CAL has been used in nephanalysis training courses and contributed to the improvement of trainee's understanding. It has also been applied to the Monthly Reports of the MSC, the Nephanalysis Case Study Reports and the attached database of the Annual Report of the RSMC Tokyo as a browser. JMA reported on developing the LRIT data browser based on MSC-CAL. The software was expected to be an effective tool for utilising the MTSAT LRIT data and products.

JPN-WP-07 gave an outline of a training plan for MTSAT/LRIT data utilisation. In order to encourage National Meteorological Services (NMS) to use the MTSAT/LRIT data extensively, especially in South-east Asia, JMA is planning a series of seminars/workshops in 2000-2002 in cooperation with the Ministry of Transport. The first seminar is to be held in Tokyo in February 2001. WMO thanked Japan for this paper and proposed support to inform WMO Members on training activities developed in Japan.

A description of the National Weather Service's satellite meteorology training was provided in USA-WP-13. The National Weather Service Satellite Meteorology Training Program has evolved from computer-based modules and the traditional classroom setting to distance learning to provide cost-effective training. NESDIS is assisting the NWS in satellite training by providing funding for the COMET program and making resources available via the cooperative institutes at CIRA and CIMSS. In an effort to integrate satellite information with observations from other sensors, the Integrated Sensor Training (IST) PDS was established. VISIT and the IST PDS programme are working together to make satellite meteorology distance training a reality. Through the development of various training materials, the operational forecaster and the on-station training officer can access a virtual classroom and laboratory. This virtual classroom is composed of a diverse and rapidly growing set of materials: tutorials, online classroom presentations, GOES gallery, satellite interpretation discussions, technical attachments and Web-based modules. The Virtual Laboratory for Satellite Meteorology has been endorsed by the World Meteorological Organization (WMO) Commission for Basic Systems (CBS). These Web-based and teletraining approaches can be included into the development of the Virtual Laboratory for Satellite Meteorology.

The use of strictly remote training sessions and tutorials runs into two major limitations at most weather offices: limited network bandwidth and limited instructor interaction. The bandwidth limitation is especially serious when loading large animation files. To address these limitations, an interactive training tool called VISIT view was developed by the Virtual Institute for Satellite Integration Training (VISIT) at CIMSS and CIRA. VISIT view is a platform-independent distance learning and collaboration software program that allows multiple users to view the same series of images containing graphics and text with a large number of user features. For more information on the evolution of satellite meteorology training as part of the IST PDS, see the homepage at http://www.meted.ucar.edu/ist.

In WMO-WP-06, CGMS was informed of WMO activities related to education and training. It noted the progress in the development of the concept of a WMO Virtual Laboratory for Training in Satellite Meteorology. WMO had agreed that such a virtual laboratory should be ***a global network of specialised meteorological satellite training institutions*** that would utilise modern technology to provide a range of training opportunities and materials to WMO Members. The virtual laboratory framework should build upon and enhance the WMO

Education and Training Strategy with regard to satellite data utilisation[1]. The enhancement to training would be accomplished through this global network, which would use modern technologies to provide access to high quality, up-to-date training for users worldwide in the use of satellite data and products. WMO had agreed that the accumulated expertise in satellite meteorology training and modern information technology, as well as established links to the science community, would make it possible to implement the virtual laboratory in a cost-effective manner. The current under-utilisation of satellite data coupled with the anticipated dramatic increase in satellite capabilities and the large number of people requiring training would make implementation of the virtual laboratory imperative.

WMO-WP-06 noted that the Virtual Laboratory for Training in Satellite Meteorology would be composed of specialised meteorological satellite training institutions and their sponsoring satellite agencies. This would initially be comprised of the training centres located in Costa Rica, Barbados, Nanjing, Nairobi, Niamey and Melbourne, and the satellite operators NESDIS, EUMETSAT, JMA and CMA. With the three centres of excellence for satellite meteorology in RA II and RA V, all WMO Regions were now served through close cooperation between the satellite operators and the RMTCs. Thus, the full implementation of the WMO Strategy for Education and Training in Satellite Matters had been achieved.

CGMS agreed with and endorsed the background, objectives, current status and guidance for a WMO Virtual Laboratory for Training in Satellite Meteorology as contained in the Appendix to WMO-WP-06. CGMS also agreed that the Virtual Laboratory for Training in Satellite Meteorology would strengthen training in satellite system utilisation through:

- continued sponsorship of the initial six “centres of excellence” by the satellite operators;
- expansion of the training component by linking the “centres of excellence”;
- user involvement;
- relevant science groups participation in a systematic manner;
- use of the Internet for advancement of continuing education and training;
- extensive use of proven and emerging instructional technologies.

WMO-WP-06 also noted the possible need for two streams of learning skills (basic and specialist) and a virtual resource library within the Virtual Laboratory for Training in Satellite Meteorology. A Virtual Laboratory for Training in Satellite Meteorology for Basic Skills would cover the core subject material needed by personnel who would be expected to use meteorological satellite data and products as part of their normal daily activities, as stated in WMO Publication No. 258. However, these forecasters would not be specialists in the field of satellite meteorology. A Virtual Laboratory for Training in Satellite Meteorology for Specialist Skills would focus on personnel whose main tasks included the development, testing, implementation and maintenance of new satellite techniques, data and products. Many NHMS would only have a small number of specialists working in this area. A Virtual Laboratory for Training in Satellite Meteorology for Specialised Skills would focus on those already in or moving into a specialist meteorological satellite role. The virtual resource library links materials and information available through the “centres of excellence”, the satellite operators and the science working groups. The virtual resource library would provide background theory, examples of use, libraries of code, possible implementation details and a mechanism for interactions with the scientific working groups and satellite operators.

1 "to systematically improve the use of satellite data for meteorological and hydrological applications over the next 10 years in all Member countries, with a focus on meeting the needs of the developing countries".

WMO noted the importance of the coordination and the need to oversee the Virtual Laboratory for Training in Satellite Meteorology and suggested the chairman of OPAG request that CGMS, in partnership with WMO, form an "International Satellite Data Utilisation and Training Focus Group". A major function of the working group would be to help foster the Virtual Laboratory for Training in Satellite Meteorology to realise the challenges set forth by the WMO Executive Council Panel on Education and Training.

EUMETSAT highlighted the importance of the concept presented by WMO, and noted that this concept did not change the focus of the WMO strategy for education and training in satellite matters for training the trainers. WMO also noted that the virtual laboratory was a means to facilitate the exchange of competencies and to facilitate the integration of training activities, which would strengthen the WMO training strategy.

H.5 Information

EUM-WP-11 presented a summary of EUMETSAT conferences, which had taken place since the last meeting of CGMS. Included were summaries of the Third Central and Eastern European Forum held in Budapest in April 2000, the EUMETSAT Satellite Data Users' Conference held in Bologna, Italy in May/June 2000 and the Fourth African User Forum held in Kampala, Uganda, in September 2000. The document also provided an indication of user conferences in coming years.

CGMS were informed that the next EUMETSAT Scientific Data Users' Conference will be held in Antalya, on the Mediterranean coast of Turkey in October 2001. Venues for further conferences have been offered as follows: 2002: Dublin, Ireland; 2003: Germany (location TBD); 2004: Prague, Czech Republic.

A list of EUMETSAT's latest publications was included in the document, all of which can be downloaded from the EUMETSAT website at http://www.eumetsat.de.

EUM-WP-12 reported on the status of preparation of an updated version of the CGMS Consolidated Report.

CGMS recalled that at CGMS XXVII, it was agreed that the CGMS Consolidated Report should be updated (Action 27.06). The revised Consolidated Report would also serve as a basis for the upgrade of CGMS Web pages and would be structured to allow regular and easy update. A new structure for the Consolidated Report, proposed by the Secretariat, was agreed by CGMS Members in January 2000.

CGMS were informed that preparation of the Consolidated Report had progressed well and inputs from all CGMS Members had been received. Preliminary text editing and harmonisation of format and style had been carried out but further work was needed in these areas once CGMS Members had checked their inputs. CGMS Members were invited to review the first draft of the document, a copy of which was distributed to each Member at the meeting, and to provide comments to the Secretariat no later than 30 November 2000.

ACTION 28.11 CGMS Members to review the draft CGMS Consolidated Report and to send comments to CGMS Secretariat by 30 November 2000.

JMA reported on the activities to promote Asia-Pacific satellite data exchange and utilisation in

JPN-WP-08. JMA hosted the first and second meetings on "Asia-Pacific satellite data exchange" in 1999 and 2000, respectively. The third meeting will be coordinated by JMA and held by the Bureau of Meteorology (BoM), Australia, in late January 2001.

In WMO-WP-01, WMO described the latest status of the database for satellite receiving equipment. The present database contained 11,325 unique receiving stations for APT, HRPT, WEFAX and High Resolution broadcasts, which represented an increase of 2559 stations since the last CGMS. A copy of the database was provided to all CGMS Members. WMO indicated that queries to the database were also available on the WMO Satellite Activities Web pages. CGMS recalled that since 1995, a permanent action item has existed that "all satellite operators will provide WMO regularly with information on the number of meteorological satellite reception stations in their areas of responsibility". CGMS agreed to maintain the permanent action item to provide new updates of satellite station data. WMO thanked the satellite operators for their inputs, which will be used in part to justify frequency utilisation.

In WMO-WP-04, CGMS Members were informed of the various List-Servers used by CGMS focus groups, i.e. the Plenary, Cloud Track Winds and Frequency Matters.

In WMO-WP-08, WMO noted that the latest update to WMO Publication No. 411 was nearing completion. Inputs from most CGMS Satellite Operators had been received. The Publication will be made available in both hard copy and on the WMO Satellite Activities Web pages. WMO suggested that a review of the final draft text be completed within one month.

ACTION 28.12 CGMS Members to review the content of WMO publication No. 411 and to provide comments and/or updates to WMO by 30 November 2000.

In WMO-WP-15, CGMS was informed of WMO activities resulting in the formation of Consultative Meetings on High-Level Policy on Satellite Matters. CGMS noted that the WMO Thirteenth Congress considered, within the structure of WMO, a suitable mechanism to address policy level issues regarding present and future environmental satellite programmes. The fifty second session of the WMO Executive Council agreed that a mechanism for such interactions should be provided through the convening of "Consultative Meetings on High-Level Policy on Satellite Matters" at one-to-two-year intervals and endorsed the guidelines for these meetings. The Executive Council was of the view that the Consultative Meetings should give early consideration to:

- Evaluating satellite missions to ensure, *inter alia*, the better use of existing and planned R&D missions in support of WMO Programmes and provide an assessment on their operational utility;

- Reviewing and revising the space-based component of the Global Observing System to take into account both operational and R&D opportunities and the need to maximise cost efficiency and effectiveness of satellite observing programmes.

CGMS noted the early preparatory activities by WMO for the first Consultative Meeting on High-Level Policy on Satellite Matters that will occur in early 2001. CGMS noted that WMO would develop, in partnership with the space agencies providing environmental observation satellites, guidelines for minimum requirements that would be agreed upon in order to provide

operational users a measure of confidence in the availability of operational and R&D observational data. CGMS also noted that the Consultative Meetings would provide the necessary high-level forum for a review of the present configuration of the space-based Global Observing System. Finally, CGMS was informed that a draft agenda and explanatory memorandum for the first session had been prepared to include:

- An evaluation on the utility of some current and planned R&D missions;

- Draft guidelines for minimum requirements to provide confidence in the availability of operational and R&D observational data;

- An initial draft of a possible configuration for the space-based component of the GOS;

- Needs of developing countries;

- A draft WMO Technical Document on "The Role of Satellites in WMO Programmes in the 2010s".

In WMO-WP-21, CGMS noted that WMO had analysed the benefits from and agreed upon the need to foster further development of focused science groups. The success of both the International TOVS Working Group (ITWG) and the CGMS International Wind Workshop (IWW) in focusing the scientific community on a specific application area's issues and problems, strongly suggested similar benefits could be gained by development of science teams and workshops that could deal with application areas of satellite meteorology such as quantitative precipitation estimates, NWP and ocean and land surface properties. The current existence of many scientific groups operating in these areas could facilitate this easier task. For example, in the area of quantitative precipitation estimation, groups of scientists were currently involved in the World Climate Research Programme (WCRP) and in particular the Global Precipitation Climatology Project (GPCP) and had already exchanged information on data requirements and algorithm development.

WMO-WP-21 noted that the fifty-second session of the WMO Executive Council had recommended involving relevant science groups in a systematic manner and the positive indication from the GPCP for WCRP's GEWEX to serve as a nucleus for such a working group. Thus, WMO strongly encouraged the formation of an International Precipitation Working Group with active participation by WMO and GPCP within the framework of CGMS.

ACTION 28.13 The CGMS Secretariat to initiate the establishment of a Working Group on Precipitation, with co-sponsorship of WMO and CGMS, and to report to CGMS XXIX on progress.

In WMO-WP-20, CGMS was informed of WMO discussions concerning a Virtual Laboratory (VL) for Training in Satellite Meteorology. WMO had noted the importance of the coordination and overseeing needed for the VL and thus suggested that CGMS in partnership with WMO form an "International Satellite Data Utilisation and Training Focus Group". A major function of the focus group would be to help foster the VL to realise the challenges set forth by the WMO Executive Council Panel on Education and Training and in support of the WMO Strategy for Education and Training in Satellite Matters. CGMS agreed to activities that could lead to the formation of such a focus group and endorsed the proposed structure for the

"International Satellite Data Utilisation and Training Focus Group" as illustrated in Appendix A.

ACTION 28.14 **WMO to work with CGMS Secretariat to initiate the establishment of a focus group on satellite data utilisation and training within the Virtual Laboratory Framework and report back to CGMS XXIX on its findings and need for future activities in this area.**

H.6 ANY OTHER BUSINESS

According to CGMS Action 27.22, Japan reported on the status of GCOM. The presentation can be found on the CD-ROM published with the final report and the Working Papers to CGMS XXVIII. CGMS thanked Japan for the very useful information provided in the paper.

PARALLEL WORKING GROUP SESSIONS

WORKING GROUP I:
TELECOMMUNICATIONS

I/0 Introduction

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

I/1 Coordination of Frequency Allocations

Results of the World Radio Conference (WRC) 2000

The World Radio Conference 2000 (WRC-2000) was held in Istanbul from 8 May to 2 June 2000. More than 2000 participants were registered from 130 administrations, numerous observers and ITU sector members.

A number of very important items regarding Space Research, Earth Exploration by Satellite, Meteorology and Space Operations were on the agenda of this conference. In general, it can be said that the results achieved are very satisfactory. The majority of agenda items were completed at this conference, but a few items remained for consideration at WRC-2003. In addition, several new items of interest to CGMS were added to the agenda of WRC-2003.

Several documents related to the results of the WRC-2000 were presented, i.e. EUM-WP-15, USA-WP-14, JPN-WP-09 and WMO-WP-11. The USA document USA-WP-16 included the report of the working group on Earth Exploration and Meteorological Satellites of the Space Frequency Coordination Group from its 1999 meeting.

The main WRC-2000 agenda points of relevance to CGMS Members were:

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

It was agreed that the WG chairman give a summary presentation of the WRC-2000 results taking into account the individual input documents. The main decisions of WRC-2000 relevant to meteorological activities are summarised as follows:

Meteorological requirements in the band 401–406 MHz for meteorological aids (radiosondes) and meteorological satellite operation were acknowledged for the foreseeable future. Resolution 219 (WRC-97), which requested the assessment of meteorological requirements in the band 401–406 MHz and the possible transition out of the band 405–406 MHz, is suppressed. This decision is an important achievement for meteorological operations, concluding a tough debate since 1992;

Current allocations were not changed in the band 1670–1710 MHz, which is a main band for

meteorological satellite operation worldwide and for radiosondes in the lower part of the band. The possible allocation of part of the band to the mobile-satellite service has also been debated since 1992. WRC-2000 suppressed Resolution 213 (Rev. WRC-95) that addressed the whole band 1675–1710 MHz and adopted a new resolution on sharing studies and possible allocations to the mobile-satellite service in the 1–3 GHz range, including consideration of the band 1683–1690 MHz and the assessment, with the participation of WMO, of the current and future meteorological spectrum requirements;

The allocations to spaceborne passive remote sensing in the Earth Exploration-Satellite Service in the frequency range 71–275 GHz were re-organised to meet present and foreseeable future requirements, taking into account technological and scientific advances. These decisions complement those taken by WRC-97 in the frequency range 50–71 GHz;

The band 18.6–18.8 GHz was allocated a primary status on a worldwide basis to spaceborne passive remote sensing, solving an issue that was debated for 15 years;

Regulatory provisions were decided to ensure an acceptable protection of spaceborne passive sensors in the band 55.78–56.26 GHz (oxygen absorption band);

The 2700–2900 MHz band, which is worldwide allocated to meteorological radars and aeronautical radionavigation radars, was not retained as a band for the IMT-2000 operation (third generation of mobile phones).

Agenda item 1.3 considered the results of ITU-R studies related to Appendix S7 of the Radio Regulations on the method for determination of the coordination area around an Earth station in frequency bands shared among space services and terrestrial radiocommunication services. A number of proposals were received regarding the scope of the systems covered, the methodologies employed, the applicable frequency ranges, the applicable time percentages, propagation aspects, and the table of system parameters. The modifications adopted by WRC-2000 will have an impact on separation/coordination areas for new or modified earth stations operating in various frequency bands, in particular in the 1675–1710 MHz range, in the 26 GHz, the 32 GHz and the 38 GHz range. Resolution RES227 includes Appendix S7 in one of its considerations justifying a review of separation distances determined in earlier studies.

Main issues for future World Radio Conferences

The preliminary agenda for the next World Radiocommunication Conference (WRC-2003) includes items of importance for CGMS Members and in particular the following:

Agenda Item 1.8.1 – Boundary between Spurious and Out-of-Band Emissions

This agenda item considers the results of studies regarding the boundary between spurious and out-of-band emissions with a view to include the boundary in Appendix S3 of the Radio Regulations. This item is important as it provides a mechanism to reduce interference to reception of meteorological and earth exploration satellites.

Agenda Item 1.8.2 – Protection of Passive Services from Unwanted Emissions

This agenda item considers the results of studies and proposals for regulatory measures regarding the protection of passive services from unwanted emissions, in particular from space services transmissions, in response to recommendations 5 and 6 of Recommendation 66.

Agenda Item 1.13 – HAPS Up-link Emissions around 31.3 GHz

This agenda items considers regulatory provisions and possible identification of existing frequency allocations for services which may be used by high altitude platform stations, taking into account S5.5RRR of the Radio Regulations and the results of ITU-R studies in accordance with Resolutions 122 and 734. The band 31.3–31.5 GHz is a very important band for calibration of passive sensor measurements.

EUM-WP-14 presents the results of a study on the impact of transmissions from HAPS systems to sensors of the Earth Exploration Satellite Service. The study shows that it will be necessary to use filters in HAPS transmitters to avoid interference to the sensors. The EUMETSAT study was already injected into the ITU process.

Agenda Item 1.16 – New MSS Feeder Link Allocations in Bands near 1400–1427 MHz

This Agenda Item considers allocations on a worldwide basis for feeder links in the bands around 1.4 GHz to the non-GSO MSS with service links operating below 1 GHz, taking into account the results of ITU-R studies conducted in response to Resolution 127 provided that due recognition is given to passive services taking into account S5.340 of the Radio Regulations. The band 1400 to 1427 MHz is also a very important passive sensor band requiring very good protection.

Agenda Item 1.20 – Additional MSS Allocations below 1 GHz

This agenda item considers additional allocations on a worldwide basis for the non-GSO MSS with service links operating below 1 GHz in accordance with Resolution 214. This item needs to be closely monitored as several MetSat and MetAids applications could be affected. Although Resolution 219 (WRC-97) on the band 401–406 MHz was suppressed, it shall be noted that Resolution 214 (Rev.WRC-2000) makes it still possible to address any band below 1 GHz with respect to possible additional allocations for the non-GSO MSS. Developments on this matter should be carefully watched.

Agenda Item 1.31 – Additional MSS Allocations in the Range 1–3 GHz

This agenda item considers additional allocations to the MSS in the range 1–3 GHz in accordance with Resolutions 226 and 227. Under this item it will be determined whether MetSat down-links can share with MSS which imposes significant interference potential.

Resolution 227 (WRC-2000) requests that the technical and operational studies on the feasibility of sharing between MSS and MetSat in the band 1683–1690 MHz be completed. Previous studies concluded that “sharing between MetSat and MSS in the band 1675–1690 MHz is feasible if appropriate separation distances are maintained”. This request is an opportunity to revisit criteria for sharing and coordination with a view to an outcome possibly more favourable to MetSat stations (e.g. increased separation distances), taking due account of GVAR and S-VISSR stations that were not fully recognised in the current recommendation ITU-R SA.1158-2.

Resolution 227 (WRC-2000) also requests to assess, with the participation of WMO, the current and future spectrum requirements (of the MetAids service, taking into account improved characteristics, and) of the MetSat service in the band 1683–1690 MHz, taking into account future developments. The Resolution notes “that sharing between MetSat and MSS

may not be feasible in those countries where a large number of MetSat stations are deployed". In this regard, CGMS Members shall provide to ITU-R Working Party 7C all the relevant information on the current status and future plans of MetSat receiving stations in all countries, in particular with respect to GVAR and S-VISSR stations.

ACTION 28.15 **CGMS Members, through their national representatives, shall provide to ITU (ITU-R WP 7C) all relevant information on the current status and future plans of GVAR and S-VISSR stations.**

WMO considers dispatching a questionnaire to all NMS concerned, but complementary investigation, such as involving manufacturers, should be devised in order to reach and assess all current and potential users.

ACTION 28.16 **WMO to dispatch a questionnaire to its members to update the database of receiving stations including GVAR and S-VISSR stations and to forward the updated information to the ITU.**

The assignment plan for space-borne passive remote sensing in the Earth Exploration Satellite Service in the frequency range above 275 GHz will only be on the agenda for WRC 2005 (2006). Frequency bands used for future sensors in this band are presently only protected by a footnote in the Radio Regulations.

Partitioning of the frequency band 1670–1710 MHz

ACTION 27.08 requested the USA and Japan to inform CGMS on their plans and dates as to when the partition plan for the frequency band 1670–1710 MHz as agreed by CGMS would be fully complied.

The present CGMS partition plan divides the band 1675–1710 MHz into three sub-bands, which are being used and are expected to continue to be used as follows:

1675–1690 MHz: Main earth stations at fixed locations for reception of raw image data, data collection data and spacecraft telemetry from geostationary meteorological satellites.

1690–1698 MHz: User stations for direct readout services from geostationary meteorological satellites. (Some MetSat service operators currently use frequencies below 1690 MHz to provide direct readout services from geostationary meteorological satellites.)

1698–1710 MHz: User stations for direct readout services and pre-recorded image data at main earth stations from non-geostationary meteorological satellites.

Japan and the USA reported that for the foreseeable future (up to 20 years) they would not be in a position to fully comply with this partition plan. GVAR and S-VISSR operations will have to be operated in the band 1683–1690 MHz, which is part of the band designated for main earth stations.

It was noted that the CGMS partition plan has become part of ITU Recommendation ITU-R 1158.2 and that this is used as a technical basis for sharing studies between ITU services. The

operations of user stations (GVAR and S-VISSR) in the band designated for a limited number of main Earth receiving stations changes the sharing possibilities considerably. It is therefore necessary for CGMS to modify the present partition plan in the band 1675–1710 MHz and inform ITU accordingly.

Working Group I discussed the way forward and concluded that the present partition plan shall be modified as follows:

1675–1683 MHz: Main earth stations at fixed locations for reception of raw image data, data collection data and spacecraft telemetry from geostationary meteorological satellites.

1683–1690 MHz: Main earth stations at fixed locations for reception of raw image data, data collection data and spacecraft telemetry from geostationary meteorological satellites; user stations for direct readout from geostationary meteorological satellites (GVAR and S-VISSR).

1690–1698 MHz: User stations for direct readout from geostationary meteorological satellites.

1698–1710 MHz: User stations for direct readout services and pre-recorded image data at main earth stations from non-geostationary meteorological satellites.

It will be necessary to inform the relevant ITU bodies urgently on this revision to allow the modification of the ITU recommendation accordingly.

ACTION 28.17 Japan and USA to prepare technical inputs to the Space Frequency Coordination Group and ITU-R indicating the revision of CGMS partition agreement and to provide technical justification for this change.

China informed CGMS that user stations of the FY-1 systems are subject to harmful interference in the frequency band close to 1710 MHz. It is therefore foreseen to switch to lower portions of the band 1698–1710 MHz for future operations.

Plans on the use of the frequency band 7750–7850 MHz

The World Radio Conference 1997 allocated the frequency band 7750–7850 MHz to the Meteorological Satellite Service on a primary basis. The allocation was made for all three regions of the ITU. A footnote in the Radio Regulations limits the use of the band by the Meteorological Satellite Service to NGSO (Non-GeoSynchronised Satellites).

CGMS ACTION 27.09 called for indications on plans of how to use the new band. Two input documents were received, i.e. USA-WP-17(2) and EUM-WP-13.

EUM-WP-13 informs that in the beginning of the year 2000 ESA and EUMETSAT have issued the “Form of Notice (ApS4/V)” for the Metop satellites to the ITU. This is the first step for registration of the Metop satellite network. The notifying administration is France (F/ESA). Distribution of this “advanced publication” by the ITU to all member organisations is in progress.

In the preparation of this notification process it was discussed how much bandwidth would be required for the down-link transmissions of Metop data in the band 7750–7850 MHz. It was concluded that the required bandwidth would be approximately 70 MHz for the first spacecraft but could increase up to 100 MHz for follow-on spacecraft. This depends on the instrumentation of the various models. The quoted bandwidth in the ITU forms was therefore set to 100 MHz.

USA-WP-17(2) informs on the plans of the Integrated Program Office (IPO) in NOAA to use the band for direct readout transmissions replacing the present HRPT service. This would be necessary to accommodate the many required environmental data amounting to significant numbers. Transmission of these data at rates in excess of 50 Mbps exceeds the available polar-orbiting meteorological satellite spectrum at L-band (1698–1710 MHz). Known as High Rate Data (HRD), this NPOESS data stream is planned for transmission on a frequency near 7825 MHz, requiring a bandwidth close to 40 MHz.

China informed CGMS verbally that there are plans to operate a direct readout system in the band 7750–7850 MHz from satellites of the FY-3 series. The FY-3 system will consist of eight satellites. The operation period will cover the years 2004 - 2018.

Discussions in Working Group I on this subject included not only the frequency aspects of the announced plans, but also questions related to commonality of future direct readout services of CGMS Members.

Regarding frequency management issues it is obvious that the bandwidth requirements of the announced services exclude a frequency separation process between the various satellite systems and it would be necessary to plan for time separation. This requires coordination concerning the various transmission times and it will be necessary to interrupt transmissions of broadcasts when more than one satellite is in the reception area of the same data acquisition station.

It was also noted that the band 7750–7850 MHz is also used by the Fixed Service on a co-primary basis and that there are thousands of installations of this service operated in all regions of the world. Sharing of these services with a direct readout system will be very difficult if not impossible.

With regard to the USA intention to broadcast the LRD service in the 400.3–400.8 MHz band, Working Group I recalled that an ITU allocation in the 400.15–401.0 MHz band already existed on a co-primary basis for Meteorological Aids. Radiosondes were a primary user in this band and thus careful consideration and coordination would be required if the LRD service were to also co-share the allocation.

Commonality of future direct readout services of CGMS Members

At the request of the Plenary, WG-1 then discussed future direct readout services of CGMS Members. The Working Group recalled the principles that have guided CGMS in coordinating direct readout services. Firstly, it recalled that CGMS satellite operators for both past and present systems had provided two types of direct broadcast services, low and high resolution. It also recalled that the low and high resolution services had vastly improved during the more than thirty years of service and were now referred to as low and high rate services.

With regard to data formats within the low and high rate services, CGMS Members had developed and agreed upon the concept of global and mission-specific specifications. The global

specifications would be followed by all CGMS Members while mission-specific specifications would be provided by each CGMS Member for an individual satellite mission. The global specifications provided sufficient structure to allow any ground receiving station to receive data while the mission-specific specification would allow ground receiving stations to process data unique to a specific satellite. In this fashion, WMO Members need purchase only one type of receiving station for LRIT, LRPT, AHRPT or HRIT data.

Each of the four services would be provided in the 137–138 MHz (for LRPT) or 1675–1710 MHz (for LRIT, AHRPT or HRIT data) bands. The Working Group also noted that these requirements were contained within the Manual and Guide for WMO's Global Observing System. The use of the concept for coordinated use of data formats and frequency had allowed WMO National Meteorological and Hydrological Services to operate over 1,300 ground receiving stations world wide and over 11,000 ground receiving stations used by WMO Members in general.

The Working Group also recalled the proposal by WMO that direct broadcast service on board meteorological satellites be complemented and supplemented by alternative telecommunications services with the ultimate goal for a smooth and orderly transition to the full use of alternative telecommunications service for broadcast service starting with the future generation of satellites. The Working Group noted that planning for NPOESS was in the preliminary stages with regard to a frequency plan and data formats. The Working Group noted that another issue which was relevant and should be considered, in the light of the proposed plans for polar-orbiting satellites by at least four CGMS Members, was the need to coordinate equator-crossing times. Thus the Working Group suggested that all CGMS satellite operators consider activities that would follow the agreed concept for data formats and coordinated frequency plans. In order to further the dialogue in this important area, the Working Group suggested that a small task force meet before the next CGMS to discuss the possibilities to coordinate the data formats and frequency plans for all satellites especially those in polar-orbit including their equator crossing times. WMO offered to host such a task force meeting.

ACTION 28.18 **WMO to host a task force meeting to discuss coordination of data formats and frequency planning for all polar-orbiting satellites including their equator crossing times, by early 2001.**

Coordination of MTSAT frequency plans

JPN-WP-10 provides information on activities related to the frequency registration of the MTSAT satellite network after the launch failure of the first MTSAT spacecraft in November 1999. Information is given on the current status of the registration process of MTSAT with the ITU including those related to MTSAT-1R. The launch of MTSAT-1R is planned before August 2003, which is the expiration of the MTSAT filing. Frequency bands of UHF, S-band and USB used by JMA for the BUS and the meteorological missions of MTSAT-1R and MTSAT-2 are the same as those of MTSAT and GMS-5. The procedure of the MTSAT-1R will be planned to proceed as the additional and/or the modification of MTSAT filings. JMA requested CGMS Members to agree with JMA's proposal that ACTION 27.11 would be kept "open" and modified as necessary for the new MTSAT satellites. JMA expressed sincere thanks for kind cooperation of all CGMS Members in these matters.

CGMS Members are again requested to support the frequency registration process. ACTION 27.11 was modified accordingly.

ACTION 28.19 **CGMS Members located within the telecommunication coverage of MTSAT satellites to inform their responsible Telecommunication Administration (with copy to JMA) a few months before MTSAT will be launched, that they are convinced that there would be no unacceptable interference between their systems and MTSAT satellites.**

USA-WP-17 summarised the potential for interference from MTSAT into NOAA operational satellites, both polar-orbiting (POES) and geostationary (GOES). Two frequencies were identified as being vulnerable to interference, i.e. 468 MHz used by GOES for DCP interrogation (DCPI) and 2026 MHz used for commanding POES spacecraft from the Fairbanks Alaska CDMA station (FCDAS). Careful analysis of the interference levels to be expected indicated that due to the large longitude separation between the GOES-West (135°W) and MTSAT (135°E, 140°E, 145°E) satellites, the interference will be at a level considered not harmful to NOAA operations. NOAA has therefore notified the ITU in 1997 of the favourable coordination with Japan's MTSAT network.

Satellite network cost recovery for ITU

USA-WP-17 provides the USA response for notification of the benefits of meteorological satellites in seeking an exemption from costing recovery for satellite network filings of these systems.

It is stated that the use of meteorological satellites is strictly non-profit, non-commercial and supports safety of life services. Additionally, meteorological satellites constitute a small number (less than 1%) of the total ITU satellite network filings. NOAA therefore request to exempt meteorological satellites from the ITU cost recovery for satellite network filing.

ACTION 28.20 **NOAA to inform CGMS Members on the response of ITU regarding NOAA's request to exempt meteorological satellites from the ITU cost recovery for satellite network filing.**

I/2 Telecommunication Techniques

Status of the Interference Location System in USA DCP Systems

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

USA-WP-18 provided a detailed description of plans to develop and implement a transmitter location system for the IDCS in the USA. The GOES DCS differs from the typical TLS application in that the signals are a much narrower bandwidth and the frequency bands are much lower. Adapting the TLS to the GOES IDCS service presents numerous technical challenges that will impact both the ability of the system to acquire the needed measurements and the resulting accuracy of the derived geolocation. For this reason, the USA proposes that the effort begin with a detailed study of these issues to develop the optimum system configuration and operating strategy. The proposed study will consist of the following tasks:

- Site performance and system definition
- Proof of concept demonstration
- Construction and delivery of a TLS for the GOES IDCS

The USA plans to continue its investigation of the transmitter location system and evaluate the benefits it has on the IDCS and possibly the entire GOES system.

ACTION 28.21 NOAA to inform CGMS Members on the progress of development and implementation of the Interference Location System for the DCS.

Use of Code Division Multiple Access (CDMA) overlay system for the GOES DCP system

USA-WP-15 provided an update on the USA's long-term plans of spread spectrum use within the IDCS. The USA had two successful demonstrations of overlaying the CDMA signal on the existing UHF transmission without interference to the GOES operation. The CDMA overlay system proposed for GOES DCP provides additional channels for data transmission that do not occupy slots in the current system time/frequency allocations. Rather, the CDMA signals will raise the system noise floor about 0.25–0.5 dB in the centre of the band (less at the band edges). The proposed CDMA overlay system will employ non-linear interference cancellation techniques to remove the interference caused to the CDMA overlay system by the current GOES DCP signals. This increases the capacity of the CDMA overlay system, allowing it to operate in a nearly noise-limited environment, as opposed to interference-limited. Thus, the two systems should be nearly independent of one another. In order to maximise the capacity of the CDMA overlay system, forward error correction techniques will be employed. Self-interference and the receiver hardware limit the maximum number of simultaneous users the CDMA overlay system can support. The self-interference limit is given by the ratio of the spreading gain to the required signal to noise (plus interference) ratio. This limit is on the order of several hundred, depending upon user bit rate and the forward error correction scheme. The USA plans to build a test transmitter and receiver as prototype of the new service. The receiver for the proposed system is based on a software radio architecture, so the limit of the number of channels that can be simultaneously decoded depends on the speed of the processor and the efficiency of the software. Development activities for the CDMA prototypes is scheduled to start early 2001.

ACTION 28.22 NOAA to distribute information on the CDMA-based DCP System to CGMS Members by e-mail by 30 November 2000.

Study on the use of High Rate DCP's in the MSG System

EUM-WP-29 presents the results of a study performed to assess the suitability of High Speed Data Collection Platforms for Meteosat Second Generation operations.

The MSG system uses an "electronically switched and de-spun antenna" with two sets of 16 and 32 antennas symmetrically distributed around the satellite body. The antenna elements are switched in order to face the up-link and down-link beacons with maximum gain towards the Earth surface. The switching between the antenna elements introduces phase jumps in the signals. The impact of these phase jumps to the signal of the planned HRDCP were simulated and

studied.

The simulation results indicate that the parallel operation of HRDCP and nominal DCP would not be feasible. Advanced signal processing techniques could improve the situation. This would nevertheless have to be carefully studied. There are no immediate actions proposed at the present time.

WORKING GROUP II:
SATELLITE PRODUCTS

II/0 Introduction

Working Group II on Satellite Products was chaired by Dr. Paul Menzel of NOAA/NESDIS and Dr. Johannes Schmetz assisted as rapporteur. Seventeen working papers were discussed. Several of these papers were in response to the four actions from CGMS XXVII (regarding cross-calibration, spectral response errors, satellite applications over land, and meta data for reprocessing); all past actions were addressed. Several new actions and recommendations resulted.

II/1 Image Processing Techniques

There were no papers on image processing techniques.

II/2 Satellite Data Calibration

EUM-WP-17 reports on the accuracy of the Meteosat spectral response functions (SRF). The accuracy of the Meteosat IR and WV SRFs are estimated to be ±10% for Metesoat-5/6 and ±6% for Meteosat-7. Meteosat-5/6 VIS SRFs have previously been shown to be inconsistent from detector to detector; Meteosat-7 has benefited from improved pre-launch measurement techniques and the spectral response has been acquired with an error of ±5% and with a variation from detector to detector smaller than 10%. This paper suggests replacing the VIS SRF of Meteosat-5/6 by the mean value of the four detector spectral responses of Meteosat-7. It further suggests for future satellites that special care be given to measuring the spectral filter response functions; such efforts are indispensable if the satellite data are used for climatological and climate analysis from different satellites.

USA (in an oral presentation) summarised recent developments regarding GOES spectral response functions. Reinvestigation of laboratory tests have suggested modest spectral shifts; these were found to have negligible effect on the window or water vapour channels but there are some concerns regarding the CO_2 absorption band channels. Accounting for the spectral shifts causes a modest improvement in the total precipitable water vapour product in both bias and rms with respect to raobs, but the improvement is less than the rms accuracy of the product. Thus NESDIS is not recommending any changes to the operational processing of GOES-8 or -10; the efforts to make these changes outweigh the anticipated benefits in improved product performance. A website announces the new spectral response functions (along with the old) and gives an explanation of the effects of the change (http://www.oso.noaa.gov/goes/goes_8_and_10.srfs.html).

Discussion on spectral response issues prompted WG II to note that the action from CGMS to explore these issues had been completed (see also the report from the ITOVS in section II/3) and to recommend the following action.

Recommendation: CGMS XXVIII is requested to note the recommendation that instrument vendors characterise spectral response functions so that (a) associated uncertainties should be well below instrument noise; (b) spectral response characterisations be referenced to total system response in vacuum; and (c) good records of these characterisations be maintained.

EUM-WP-16 was submitted in response to an action from CGMS XXVII requesting satellite operators study the importance of cloud-clearing and near-nadir viewing for calibration inter-comparisons. It reported that: (a) all-sky target areas can be used effectively for the satellite inter-calibration, but that time collocation (better than 10 minutes) between the two satellite observations becomes more critical because cloud movement could cause substantial differences in brightness temperatures; and (b) off-nadir observations can also be used, provided viewing angle differences are less than 5°.

EUM-WP-18 reports on the proposed MSG/SEVIRI solar calibration method; it relies on radiative transfer computations over a series of targets. Accuracy estimates are close to 5% based on experience with Meteosat-7. Good results are achieved over sea and desert. Overestimates of cloudy radiances were corrected with optical thickness adjustments in the radiative transfer codes. Aerosol corrections assisted by MISR data are planned.

EUM-WP-19 presents the results of an inter-calibration of the Meteosat IR channel with HIRS channel 8 for 25 cases throughout a year; agreement to within 2-3% with the operational calibration is found. Intercalibration with AVHRR split window channels produces better results (within 1-2%), however there seems to be a systematic difference between cross-calibration values obtained from channel 4 and channel 5 prompting correction for differing spectral filter response functions. This difference warrants further investigation.

EUM-WP-28 announces that since 29 May 2000 a new calibration method for the Meteosat-7 infrared channels uses the on-board black body observations. The method replaces the vicarious calibration method to calibrate the infrared channels in the atmospheric window and the water vapour absorption band. It provides calibration coefficients that are more stable in time than the previous vicarious calibration.

JPN-WP-11 presents the MSC/JMA study of the inter-calibration of the visible channels on GMS-5 VISSR and NOAA-14 AVHRR. GMS-5 visible was found to be linearly related to NOAA-14 AVHRR visible in four different cases with very good correlation (RR greater than 99%); however, the fitting equations vary from case to case. ISSCP found similar results. MSC concludes that this method could lead to useful monitoring of the visible calibration of NOAA and GMS; further evolution of the technique and increased sampling would be carried out.

JPN-WP-12 describes a new calibration method developed at MSC that can be applied in case of shutter malfunction (which occurs infrequently). Time extrapolation of previous shutter views are used. The method provides calibration data with standard errors of less than one count out of the eight bit 256 counts.

USA-WP-19 reports on the routine inter-calibration of five geostationary sensors with respect to a single polar-orbiting sensor over the past year. The procedure has been automated so that more statistically significant inter-comparisons could be achieved. The results, based on between 20 and 153 cases per operational geostationary satellite, indicate that the IRW sensors on GOES-8, GOES-10, Meteosat-5, Meteosat-7 and GMS-5 are within 0.5°C of each other (and within 0.5°C of NOAA-14 HIRS and AVHRR). The GOES-8 water vapour sensor is also within approximately 0.5°C of NOAA-14 HIRS. The two cases for GOES-11 and MODIS appear to indicate these two satellites are within the same range of differences. The large number of intercomparisons has enabled early analysis of seasonal and diurnal effects for the

first time; none were found. More data must be processed to confirm this. In the future, as more data are being collected, the effect of age on the instruments can be also explored.

USA-WP-20 presents an update on visible and near-infrared intercalibration efforts, using AVHRR as a reference. It suggests general criteria that should be met in order for inter-calibration of satellite sensors in the visible and near-infrared to be meaningful; they are: (1) there should be considerable overlap in the spectral regions covered by the two sensors (candidate and reference sensor); (2) atmospheric (e.g., scattering and absorption by the gaseous and particulate constituents) and surface (e.g., wavelength dependence of surface reflection) effects over the spectral regions covered by the two sensors should be similar; and, (3) the effective wavelengths of the two sensors must be close to each other.

EUM-WP-30 summarises activities within the CGMS regarding satellite intercalibration of IR radiance measurements; various approaches for intercalibration of different sensors on different platforms have been investigated. The CGMS Members have been collaborating to define techniques for cross-calibration of all the geostationary and polar-orbiting sensors. Initial focus has been on comparing the infrared window radiances measured by these systems; as some of the previous papers indicate, there is good progress toward calibration within 1°K for IR bands. CGMS Members are expanding efforts to other parts of the spectrum (e.g. water vapour bands, visible bands). An attachment to this paper presents experience and recommendations from the ISCCP (International Satellite Cloud Climatology Project); ISCCP was compelled to make calibration adjustments that would best be made by the community of satellite operators. WG II suggested that satellite operating agencies embrace and begin a programme to intercalibrate their current sensors. It remains for CGMS to embrace these algorithms for intercalibrations on a routine or operational basis.

In Plenary CGMS XXVIII (a) approved the continued contact between ISCCP and CGMS on the issues of satellite intercalibration and (b) encouraged satellite operators to establish a routine satellite intercalibration with regular reporting of their results in CGMS reports and on the CGMS homepage (http://www.wmo.ch/hinsman/cgmsp01.html) with the format of the reports to be decided at the next CGMS.

Thus, in the interim and before CGMS XXIX, the following action was placed:

ACTION 28.23 **Each satellite operator to post on the CGMS homepage available relevant papers and results on satellite radiance (VIS, IR, WV) inter-comparisons in convenient format and to update them periodically throughout the period until CGMS XXIX.**

II/3 Vertical Sounding and ITWG Matters

EUM-WP-20 discusses the status of the EUMETSAT ATOVS and AVHRR Processing Package (AAPP) for locally received direct readout HRPT data from the NOAA-K, -L, -M spacecraft. AAPP development is now being completed by EUMETSAT's Numerical Weather Prediction Satellite Application Facility (NWP SAF). The AAPP version 2.0 was released in February 2000; this includes bug-fixes, code improvements, improved portability, and the retrieval scheme Inversion Coupled with Imager (ICI) version 2.0. Some incremental releases are planned to allow for instrument calibration changes and updates of the corrections for the AMSU-B interference problem. The release of AAPP V3.0 is foreseen for early 2001. Further information is available on the EUMETSAT homepage: http://www.eumetsat.de/en/area4.

Rapporteur Dr. Paul Menzel of International TOVS Working Group (ITWG) presented USA-WP-22 reporting on the eleventh International TOVS Study Conference (ITSC-XI) held in Budapest, Hungary on 20-26 September 2000. About 100 scientists from 25 countries participated in presentations and working group deliberations. ITSC-XI had several significant conclusions: (a) ATOVS continues to provide positive impact on global NWP in both hemispheres and an increasing number of NWP centres are assimilating radiances directly; (b) AMSU is a critical component of the polar sounding system with HIRS providing complementary moisture and cloud information; (c) international collaboration within the ITWG continues to develop (inclusion of NOAA-16, improved cloud detection, more efficient HIRS and AMSU collocation, retrieval refinements) the AVHRR and ATOVS Processing Package (AAPP) that is freely available to all users developing their ATOVS processing capabilities; (d) transmittance model performances are improving, but spurious spectral response errors need further investigation (especially in the water vapour sensitive bands); (e) upcoming reanalysis at NCEP, ECMWF and TOVS pathfinder will be including more data and improved algorithms for discerning indications of interesting climate trends; (f) coordination with the reconfigured CBS is progressing well with active ITWG participation in several of the WMO's Commission for Basic Systems (CBS) Open Program Area Group for Integrated Observing Systems (OPAG IOS) expert teams; (g) early examples of MODIS data are demonstrating exciting possibilities for enhanced land, ocean and atmosphere (especially cloud) characterisations; and (i) enhanced preparations for EOS have assured timely development of packages for processing direct broadcast data from MODIS, AIRS, and AMSU as well as global distribution of sounding data.

ITSC-XI had also responded on four issues posed by CGMS. (1) Firm evidence of the utility of TOVS/ATOVS data over land in the northern hemisphere NWP is emerging; non-surface viewing spectral radiances are being assimilated directly with positive impact and there is progress in improving vertical profiles of temperature and moisture retrieved from broadband infrared spectral measurements by accounting for the surface emissivity. (2) With regard to product distribution from a.m. and p.m. satellites, ITSC-XI requested CGMS to coordinate a consistent policy regarding distribution via the GTS within the Initial Polar System of NOAA/NESDIS and EUMETSAT (Metop a.m. satellites and NOAA p.m. satellites). This policy should address production and distribution on the GTS of IPS products in order to avoid duplication. (3) With regard to spectral response (SR) characterisation, ITSC-XI noted that the associated uncertainties should be well below instrument noise. For high spectral resolution infrared instruments and microwave instruments, this seems within reach. But for broadband infrared instruments, renewed efforts must be encouraged. (4) Finally with regard to enhanced geostationary soundings, ITSC-XI concluded from their discussions that hourly high spectral resolution infrared radiances offer unique observations that would benefit nowcasting, very short range forecasting, as well as regional numerical weather prediction. Moisture gradients would be determined at commensurate temporal and spatial (both horizontal and vertical) resolutions for the first time.

ITSC-XI made several recommendations to CGMS, which are summarised and presented in USA-WP-22. The recommendations are listed below in italics, followed by the response of CGMS XXVIII:

- *ITWG encourages CGMS and WMO to consider coordination of polar-orbiting equator crossing times to optimise satellite utilisation while minimising potential conflicts in data reception.* This will be covered by ACTION 28.18.

- *ITWG encourages NASA/IPO to consider placing the NPP sounder in a p.m. orbit. ITWG also encourages RASA to finalise manufacturing of the very high spectral resolution IFRS and launch it on METEOR-3M N2 in 2003.* RASA acknowledges this encouragement and will seek ways to realise the request.

- *ITWG encourages CGMS and WMO to review the monitoring procedures and practices for satellite data and products placed on the GTS with a goal towards improving them. The review should also identify the future monitoring policy once the Initial Polar System of NOAA/NESDIS and EUMETSAT becomes operational*. With regard to the latter, CGMS placed the following action:

ACTION 28.24 **NOAA/NESDIS and EUMETSAT to report at CGMS XXIX on their monitoring procedures and practices for satellite data and products placed on the GTS.**

ACTION 28.25 **WMO to report at CGMS XXIX on the future monitoring policy for the IPS.**

- *ITWG encourages WMO to increase the GTS capacity through the implementation of the Distributed Database System Concept.*

- *ITWG requests CGMS clarify the situation concerning the availability of SSMIS data.* This resulted in the following action:

ACTION 28.26 **NOAA/NESDIS to report at CGMS XXIX on availability of SSMIS data.**

- *ITWG requests information from CGMS as to plans for IPS products and their distribution over the GTS*. This is addressed under ACTION 28.24 above.

- *ITWG requests CGMS seek clarification from the NPOESS IPO as to the availability of radiance products (referenced to level 1b as is heritage from FGGE onwards) as part of the suite of NPOESS SDRs.* This is covered by ACTION 28.06.

II/4 Other Parameters and Products

USA-WP-21 gives an update on the operational production of hourly GOES-8/10 soundings over North America and the nearby oceans. During the past year (a) sounder-derived product images became operational, (b) NWS forecasters gave a positive assessment of the operational utility of sounder products, (c) parallel tests in regional models quantified the positive impact of sounder moisture data, (d) comparisons at the DOE ARM CART site showed the sounder moisture to be within 2-3 mm of other data, (e) GOES-11 was launched and is in the process of being checked-out, (f) single 10 km FOV soundings (improving on the current operational 5x5 soundings) are being investigated, and (g) effects of surface emissivity in profile retrievals are being studied. This working paper includes several references detailing progress in these areas.

EUM-WP-21 reports on satellite applications over land as requested by CGMS XXVII. A new land surface albedo retrieval algorithm has been developed by the Space Applications Institute of the European Commission and implemented in the reprocessing environment of EUMETSAT. This algorithm derives the surface albedo in the Meteosat VIS band every 10 days at single pixel resolution and accounts for water vapour and ozone absorption, aerosol scattering and surface anisotropy. EUM-WP-21 further reports on a workshop on "Land surface observations from space for hydro-meteorological and climate applications" that took place at ECMWF on 16 May 2000. ECMWF expects that the use of sounding data over land will lead to a more realistic depiction of surface energy fluxes over land as well as benefit the analysis of the atmospheric state. A precondition is an improved modelling of the surface characteristics. ESA presented the "Land surface processes and interactions mission" (LSPIM). Primary research objectives would be to further Carbon Cycle and Hydro-meteorological modelling by i) increasing the understanding of land surface processes and their interactions with the atmosphere, ii) advancing the understanding of these processes across spatial and temporal scales.

RUS-WP-06 describes the latest developments in their technique for retrieval of global ocean surface temperatures (SST) from geostationary IR window radiance measurements. Meteosat-7, Meteosat-5, GMS, GOES-E and GOES-W are used for the latitude zone ±60° over the globe. Careful attention to accurate absolute radiometric calibration, screening of cloud-contaminated pixels, correction of atmospheric radiance attenuation, and mapping to regular grid points is producing an SST product with small systematic biases and rms errors in the range of 1.5-2.0°C. These global SST maps are produced every 5 to 7 days and will be available at http://sputnik.infospace.ru.

PRC-WP-01 reported on the satellite data products being developed using FY-1C data. To meet the demand of users in meteorology, hydrology, climate research, agriculture and environment monitoring, the FY-1C system has developed many kinds of products. These include image mosaic from FY-1C in polar stereographic projection over the northern hemisphere, three channels colour image, global vegetation index, contours of OLR, global SST, and snow cover maps. Archived and latest images from FY-1C are available at http://nsmc.cma.gov.cn.

II/5 Coordination of Code forms for Satellite Data

No papers were submitted on this subject. Coordination is ongoing and satellite data code forms are being followed.

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

In response to CGMS XVII ACTION 27.16, EUM-WP-22 presents preliminary considerations of requirements for additional information necessary for future reprocessing activities. Information about spacecraft, rectification, calibration and meteorological conditions affect the use of the instrument data at level 0 and level 1. Pre-launch determination of spectral responses, black body characteristics, optical reflectances and obscurations, misregistration changes with system temperature, in-flight monitoring of station-keeping manoeuvres as well as telescope component and black body temperatures, and ancillary meteorological data are part of the necessary additional information. The paper is based on the EUMETSAT Archive Reprocessing Project where Atmospheric Motion Vectors from Meteosat-2 data (1981-1988) are being reprocessed in support of the ECMWF 40-year reanalysis project.

In response to the same action, USA-WP-01 identified the following key data sets that would be needed for reprocessing purposes: (a) GOES imager and sounder data (McIDAS and/or simple binary format); (b) calibration and radiance bias correction coefficients; (c) model data and surface observations (in GRIB or McIDAS format); and (d) validation datasets (mandatory/significant level radiosonde data; model, and analyses data; etc). The primary format of this data should be McIDAS since all of our geostationary product processing is done within the McIDAS environment. This would make any reprocessing effort a bit easier.

EUM-WP-23 presented the status of the development of the Unified Archive and Retrieval Facility (U-MARF) in EUMETSAT. The U-MARF (see CGMS-XXVI EUM-WP-22) is intended to support data from Meteosat, Meteosat Second Generation (MSG) and the EUMETSAT Polar System (EPS) missions. The U-MARF is being developed incrementally; version 1 includes the archive of Meteosat and MSG data and the EPS archive will follow in version 2. An Architectural Design Review was held in May 1999 and good progress on the U-MARF milestones was apparent. The Acceptance Review will occur in late 2000.

II/7 Conclusion

WG II concluded a full agenda noting good progress on two of the CGMS actions (satellite data over land, cross-calibration) and conclusion of two more (spectral response characterisation, meta data for reprocessing). Communications with the ITWG was also felt to be active and useful.

WORKING GROUP III:
SATELLITE-TRACKED WINDS

III/0 Introduction

The Working Group on Satellite-Tracked Winds (WG III) was chaired by Dr. Johannes Schmetz and Dr. Paul Menzel assisted as rapporteur. In total eight papers were presented and discussed by the Working Group.

III/1 Results from the 5th International Winds Workshop

The first paper presented to WG III was EUM-WP-24, which provided a detailed summary of the fifth International Winds Workshop (IWW5) held in Lorne, Australia from 28 February to 3 March 2000. The CGMS Rapporteur at the IWW, Dr. Johannes Schmetz, reported that IWW5 was hosted by the Australian Bureau of Meteorology and co-organised by the University of Wisconsin Cooperative Institute for Meteorological Satellite Studies (CIMSS) and EUMETSAT. The workshop was attended by 40 scientists from 13 countries and four international organisations. The workshops addressed topics in six sessions (Current systems to derive atmospheric motion vectors (AMVs), verification and objective quality analysis, assimilation and impact of AMVs in NWP, new retrieval systems, new techniques and new space-borne systems). Three working groups (methods, utilisation, and verification and quality) provided fora for in-depth discussions and produced several actions and recommendations.

A lively discussion in WG III was sparked off by EUM-WP-24 embracing a wide range of scientific and technical issues related to winds observations from space. Salient points of this discussion can be summarised as follows:

- WG III noted the progress made in the derivation of quality indicators associated with satellite-tracked wind vectors. As suggested by IWW, the standard software package for the computation of quality indicators has been requested by different wind producers and there is promise for a standard set of quality indicators to be distributed with the winds as requested by the NWP user community. In this context WG III fully supports the message of IWW5 to CGMS recommending the use of a standardised BUFR format to encode satellite wind data.

ACTION 28.27 **Satellite wind producers to report at CGMS XXIX on their implementation of BUFR encoding of satellite-tracked wind products.**

- WG III noted the discussion and recent progress on winds derived from rapid scans and echoed earlier suggestions on enhanced utilisation. A pertinent action has been formulated in the context of discussions on EUM-WP-25.

- WG III addressed the long-standing problem of a speed bias and encourages satellite wind producers to maintain further research concerning that problem.

- WG III also discussed possible causes of the speed bias. Considering that height assignment of semi-transparent clouds is a potential cause of a bias, WG III noted the need to review the current operational height assignment techniques. This led to the following action and recommendation:

ACTION 28.28 **CGMS Members to provide working papers to CGMS XXIX on operational multi-spectral methods used for the height assignment of cloud-tracked winds. The analysis should also include accuracy estimates for the heights of semi-transparent clouds.**

Recommendation of WG III.1: Noting the importance of cloud height assignment to the utility and accuracy of cloud-tracked winds CGMS encourages further research into multi-spectral cloud height assignment techniques.

A brief discussion on stereo techniques for the allocation of cloud heights recalled the potential of those techniques as an independent tool for the validation of other height assignment techniques. This led to the following recommendation:

Recommendation of WG III.2: Following the suggestions of IWW5, CGMS recommends the use of stereo height techniques for the validation of multi-spectral methods used for cloud height assignment.

WG III also discussed new technologies for the derivation of winds from space. Recognising the great potential and prospects of those technologies, it felt that more information should be presented at the next CGMS and at the next IWW meeting. Therefore WG III placed the following two actions on USA and ESA, respectively. It also formulated an early recommendation to the organisers of IWW6.

ACTION 28.29 **In view of the imminent development toward high spectral resolution measurements from geostationary orbit, CGMS XXVIII invites USA to provide a paper on wind retrievals from advanced sounding instruments to the Workshop on "Long-term future of the basic sounding and imagery missions" to be organised by WMO in conjunction with the Expert Team on Redesign of the global observing systems. A report should be provided to CGMS XXIX.**

ACTION 28.30 **CGMS XXVIII requests EUMETSAT to invite ESA to provide a working paper on wind retrievals from advanced sounding instruments to the Workshop on "Long-term future of the basic sounding and imagery missions" to be organised by WMO in conjunction with the Expert Team on Redesign of the global observing systems. A report should be provided to CGMS XXIX.**

Recommendation WG III.3: CGMS XXVIII suggests that organisers of IWW6 solicit presentations on active and passive remote-sensing of ocean surface winds and stimulate discussions on the important issues and advantages of both methods.

WG III noted with interest the report of IWW5 on the potential of reprocessing existing archives for the derivation of satellite-tracked winds. It noted the potential of such a

reprocessing not only for future reanalysis projects but also as an independent data set for research studies.

ACTION 28.31 CGMS Members to report at CGMS XXIX on plans and progress of the reprocessing of satellite-tracked winds from archived image data with state-of-the-art algorithms.

With regard to the success of recent experiments (e.g. FASTEX) addressing targeted observations, WG III recognises the usefulness of further work:

ACTION 28.32 CGMS Members to report on experiments on targeted observations using rapid scans and to explore the impact on NWP.

A summary report of IWW5 has been submitted to the Bulletin of the American Meteorological Society (Holmlund, Velden and LeMarshall, 2000: Proceedings of the Fifth International Winds Workshop). The Workshop Proceedings with extended summaries of all papers and detailed reports from the working groups are published as EUMETSAT Publication EUM P 28. CGMS WG III noted with satisfaction the high scientific level maintained by IWW5. The workshop was successful and achieved its goals, and thanks are due to the co-organisers C. Velden, K. Holmlund and J. Le Marshall. The next workshop IWW6 is planned for spring 2002 in Madison, Wisconsin (USA) and C. Velden of CIMSS in Madison and Ken Holmlund of EUMETSAT will again organise the workshop.

JPN-WP-13 reviewed the status and current plan for the future utilisation of AMVs in the NWP model at JMA. The replacement of the JMA NWP model planned for March 2001 might not affect the utilisation of AMVs. However, observation errors of AMVs will be reassigned for use in 3D-VAR analysis, which will replace the 3D-OI analysis. Investigations on the impact of GMS-5 AMVs on the performance of JMA's NWP model showed that the AMVs are very important in the lower atmosphere in the southern hemisphere. Forecasts beyond five days are significantly deteriorated in the southern hemisphere when satellite-tracked winds are not assimilated.

JPN-WP-14 was provided in response to Action 27.19. It presented a summary of comments from NWP centres represented in WGNE (Working Group on Numerical Experimentation) on the large differences in satellite wind observation errors assigned at NWP centres. It was not surprising that the observation errors are different among centres since each NWP centre uses different thinning, quality control and assimilation methods. Information and/or advice from CGMS to NWP centres on the observation errors of satellite winds would be quite useful for NWP centres to improve their operational NWP systems. WG III commended Japan on this excellent summary paper. It was felt that the information provided in the paper should be maintained. The rapporteur on winds will seek ways to include the relevant information on a Web page.

III/2 Wind Statistics

JPN-WP-15 summarised the current status of GMS Cloud Motion Winds (CMWs) and Water Vapour Motion Winds (WVMWs). The paper presented comparisons with radiosondes using the CGMS standard method for the period June 1995 through April 2000. RMS vector

differences for low-level and high-level CMWs are better than 5.2 m/s and 10.0 m/s, respectively. The corresponding value for WVMVs is also around 10 m/s.

USA-WP-21 gave an update on NOAA/NESDIS GOES winds. The paper presented the operational imaging schedules, the use of higher frequency interval imagery, low level cloud tracer height assignments, product distribution, quality of operational winds products and wind research areas. WG III noted the continued progress being made by NESDIS and commended NESDIS on the pioneering research work on the utility of different scan intervals for the derivation and the quality of winds.

III/3 Derivation of Wind Vectors

EUM-WP-25 gave a report on the use of rapid scans for wind derivation. Starting with a summary of previous experience with rapid scans mainly from other satellite operators, the paper shows examples of rapid scan results from Meteosat-6 for the tropical and Alpine region. Clearly, shorter time intervals provide more consistent wind fields, thus corroborating earlier findings. The paper also reports on recent rapid scan trials at EUMETSAT, which paved the way for quasi-operational rapid scans. The discussion then addressed the utility of rapid scans in general. Recalling suggestions from IWW5 and recent progress, WG III expressed the need to obtain a coherent picture of current activities on rapid scans (operational and pre-operational) at the centres producing satellite-tracked winds. Therefore WG III requests the following action:

ACTION 28.33 **CGMS Members, performing rapid scans, to provide at CGMS XXXIX an update on rapid scan schedules and applications of rapid scans including an impact assessment. This should include an NWP experiment with and without the improved winds. The analysis should also address the dependence of wind retrieval on the accuracy of the operational image navigation.**

EUM-WP-26 presented the NWP SAF proposal to post results from NWP monitoring of satellite-tracked winds on the Internet. The paper was provided in response to ACTION 27. 21 whereupon the issue of NWP monitoring was referred to IWW5 for discussion and endorsement. Following the IWW5 endorsement, CGMS XXVIII approves the endeavour of the EUMETSAT NWP SAF (Satellite Application Facility) as consistent and valuable activity that constitutes a reference for the quality of all satellite-tracked winds. In order to make sure that the published results on the Internet are complete and acknowledged by the satellite wind producers, CGMS places the following action on all satellite wind producers:

ACTION 28.34 **All satellite wind producers to provide comments to the CGMS Secretariat on the satellite wind monitoring results provided on the Web page of the EUMETSAT NWP SAF (Satellite Application Facility) (http://www.met-office.gov.uk/sec5/NWP/NWPSAF) by 31 March 2001.**

EUM-WP-27 reported on the utilisation of AMVs with NWP centres. Similar papers had been presented at previous meetings and the current paper provided some updates. WG III noted the close relationship to JPN-WP-14 and suggests a combination or at least a cross-reference of the content of both papers once they are publicly accessible on the Web. WG III also felt that

JPN-WP-14 does provide additional key information that had been requested by EUM-WP-27 for inclusion in the future.

III/4 Conclusion

WG III concluded with a short summary of the actions and recommendations. The chairman thanked all participants for the lively discussion, which covered a fair amount of science issues and illustrated the good prospects for further developments of operational systems for the retrieval of winds from space.

SENIOR OFFICIALS MEETING

J.1 APPOINTMENT OF CHAIRMAN

The CGMS XXVIII Senior Officials meeting was convened at 9.00 a.m. on 20 October 2000 and elected Mr. Gary Davis as Chairman.

J.2 REPORTS FROM THE WORKING GROUPS

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

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

J.3 NOMINATION OF CGMS REPRESENTATIVES AT WMO AND OTHER MEETINGS

The Senior Officials agreed that:

- Dr. P. Menzel will represent CGMS at the next meeting of the ITSC.
- The CGMS Secretariat will represent CGMS at the WMO Fifty-third Executive Council (EC-LIII) in June 2001.
- The CGMS Secretariat will represent CGMS at the WMO CBS Meeting in 2000.
- The CGMS Secretariat will represent CGMS at the next OPAG Meeting on Integrated Observing Systems.
- Dr. J. Schmetz will be Rapporteur at the next International Winds Workshop in 2002.
- Mr. R. Wolf will represent CGMS at the SFCG in 2001.
- The CGMS Secretariat will represent CGMS at the CEOS Plenary, November 2000, in Rio de Janeiro.
- JMA will represent CGMS at the next WGNE/JSC.

J.4 ANY OTHER BUSINESS

WMO proposed for IOC to become a CGMS Member. CGMS welcomed this proposal and decided to admit IOC as an observer for this coming year with a view of becoming a CGMS Member at CGMS XXIX.

It was decided that the final report of CGMS XXVIII would be distributed on CD-ROM together with all the working papers presented during the meeting. Therefore there would be no requirement to specifically highlight working papers as annexes to the final report.

J.5 SUMMARY LIST OF ACTIONS

(i) Permanent actions

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

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

3. EUMETSAT, Japan and USA to provide the agreed set of reporting statistics on IDCS performance and report to CGMS Secretariat and WMO on a regular basis.

4. CGMS Members to update the CEOS/WMO Consolidated Database as appropriate and at each CGMS meeting ***(new permanent action).***

5. USA to keep CGMS Members regularly informed about anomalies from solar events at CGMS meetings ***(new permanent action).***

6. All CGMS satellite operators to review the Tables in Appendix A of WMO-WP-03 and provide any updates to WMO as appropriate and at every CGMS plenary meeting ***(new permanent action).***

(ii) Actions from CGMS XXVIII

ACTION 28.01 Satellite operators to provide information to CMA on avoiding stray light in the radiometer.

ACTION 28.02 CMA to inform WMO when the FY-2B broadcast will become operational and WMO to assist with the distribution of this information by 15 December 2000.

ACTION 28.03 USA to consider options to meet the WMO requirements for satellite images in the Southern Hemisphere (half-hourly, full disc, multi-spectral) and inform CGMS Members at CGMS XXIX.

ACTION 28.04 WMO to place USA Future Polar Orbiting Meteorological Satellite System and NPOESS presentations on the CGMS website by **15 November 2000**.

ACTION 28.05 USA to investigate whether global or a selection of NPOESS level 1B data can be made available to end-users in near real-time and report to CGMS XXIX.

ACTION 28.06 China and Japan to exchange detailed information on their planned LRIT broadcasts and to inform the CGMS Members in parallel by **31 May 2001.**

ACTION 28.07 USA-WP-08 to be submitted to the Expert Team on Redesign of the Global Observing System as input for consideration and the draft Terms of References to be finalised by the Chairman of the Expert Team in preparation for their workshop.

ACTION 28.08 WMO to place the MTSAT-1R observation and dissemination schedule on the CGMS server by **15 November 2000.**

ACTION 28.09 Japan to regularly keep the CGMS Secretariat informed of potential changes in the MTSAT-1R observation and dissemination schedules.

ACTION 28.10 WMO and USA to coordinate their efforts to inform the WMO Members on the transition period from analogue WEFAX to LRIT dissemination scheme for GOES satellites and inform CGMS Members at CGMS XXIX.

ACTION 28.11 CGMS Members to review the Draft CGMS Consolidated Report and to send comments to CGMS Secretariat by **30 November 2000.**

ACTION 28.12 CGMS Members to review the content of WMO publication No. 411 and to provide comments and/or updates to WMO by **30 November 2000.**

ACTION 28.13 The CGMS Secretariat to initiate the establishment of a Working Group on Precipitation, with co-sponsorship of WMO and CGMS, and to report to CGMS XXIX on progress.

ACTION 28.14 WMO to work with CGMS Secretariat to initiate the establishment of a focus group on satellite data utilisation and training within the Virtual Laboratory Framework and report back to CGMS XXIX on its findings and need for future activities in this area.

ACTION 28.15 CGMS Members, through their national representatives, shall provide to ITU (ITU-R WP 7C) all relevant information on the current status and future plans of GVAR and S-VISSR stations.

ACTION 28.16 WMO to dispatch a questionnaire to its members to update the database of receiving stations including GVAR and S-VISSR stations and to forward the updated information to the ITU.

ACTION 28.17 Japan and USA to prepare technical inputs to the Space Frequency Coordination Group and ITU-R indicating the revision of CGMS partition agreement and to provide technical justification for this change.

ACTION 28.18 WMO to host a task force meeting to discuss coordination of data formats and frequency planning for all polar-orbiting satellites, including their equator crossing times, **by early 2001**.

ACTION 28.19 CGMS Members located within the telecommunication coverage of MTSAT satellites to inform their responsible Telecommunication Administration (with copy to JMA) by a few months before MTSAT will be launched, that they are convinced that there would be no unacceptable interference between their systems and MTSAT satellites.

ACTION 28.20 NOAA to inform CGMS Members on the response of ITU regarding NOAA's request to exempt meteorological satellites from the ITU cost recovery for satellite network filing.

ACTION 28.21 NOAA to inform CGMS Members on the progress of development and implementation of the Interference Location System for the DCS.

ACTION 28.22 NOAA to distribute information on the CDMA-based DCP System to CGMS Members by e-mail by **30 November 2000**.

ACTION 28.23 Each satellite operator to post on the CGMS homepage available relevant papers and results on satellite radiance (VIS, IR, WV) inter-comparisons in convenient format and to update them periodically throughout the period until CGMS XXIX.

ACTION 28.24 NOAA/NESDIS and EUMETSAT to report at CGMS XXIX on their monitoring procedures and practices for satellite data and products placed on the GTS.

ACTION 28.25 WMO to report at CGMS XXIX on the future monitoring policy for the IPS.

ACTION 28.26 NOAA/NESDIS to report at CGMS XXIX on availability of SSMIS data.

ACTION 28.27 Satellite wind producers to report at CGMS XXIX on their implementation of BUFR encoding of satellite-tracked wind products.

ACTION 28.28 CGMS Members to provide working papers to CGMS XXIX on operational multi-spectral methods used for the height assignment of cloud-tracked winds. The analysis should also include accuracy estimates for the heights of semi-transparent clouds.

ACTION 28.29 In view of the imminent development toward high spectral resolution measurements from geostationary orbit, CGMS XXVIII invites USA to provide a paper on wind retrievals from advanced sounding instruments to the Workshop on "Long-term future of the basic sounding and imagery missions" to be organised by WMO in conjunction with the Expert Team on Redesign of the Global Observing Systems. A report should be provided to CGMS XXIX.

ACTION 28.30 CGMS XXVIII requests EUMETSAT to invite ESA to provide a working paper on wind retrievals from advanced sounding instruments to the Workshop on "Long-term future of the basic sounding and

imagery missions" to be organised by WMO in conjunction with the Expert Team on Redesign of the global observing systems. A report should be provided to CGMS XXIX.

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ACTION 28.32 CGMS Members to report on experiments on targeted observations using rapid scans and to explore the impact on NWP.

ACTION 28.33 CGMS Members, performing rapid scans, to provide at CGMS XXIX an update on rapid scan schedules and applications of rapid scans including an impact assessment. This should include an NWP experiment with and without the improved winds. The analysis should also address the dependence of wind retrieval on the accuracy of the operational image navigation.

ACTION 28.34 All satellite wind producers to provide comments to the CGMS Secretariat on the satellite wind monitoring results provided on the Web page of the EUMETSAT NWP SAF (Satellite Application Facility) (http://www.met-office.gov.uk/sec5/NWP/NWPSAF) by 31 March 2001.

J.6 APPROVAL OF DRAFT FINAL REPORT

The Senior Officials, together with the Plenary, reviewed the Draft Final Report of the meeting and approved it with minor amendments. The Secretariat agreed to include all the amendments in a revised version, which would be distributed to CGMS Members for final comments at the beginning of November 2000, prior to full publication. It was agreed that the final version of the report would be provided to participants first via electronic mail and after publishing also via normal mail including a CD-ROM with an electronic version of the final report and all the working papers of CGMS XXVIII.

J.7 DATE AND PLACE OF NEXT MEETINGS

EUMETSAT made a proposal to host CGMS XXIX in the autumn of 2001 and CGMS was pleased to accept this offer. With regard to the date EUMETSAT indicated possibilities of organising the meeting either in the last week of September or the second half of October. The exact date and place would be communicated to the Members in due course. India mentioned that it would be interested in hosting CGMS XXX in 2002. CGMS was very pleased to accept this kind offer.

On behalf of Mr. Greg Withee, Mr. Gary Davis thanked all participants for attending CGMS XXVIII in Woods Hole and for the good work and cooperation during the meeting. He thanked the rapporteurs and secretaries for preparing the report and also expressed gratitude to the National Academy of Sciences for the use of the beautifully located J. Erik Jonsson Woods Hole Center. The CGMS Secretariat thanked the USA for hosting the 28th CGMS meeting and also for organising a side meeting on collaboration in future polar satellite systems on the evening of 17

October. This meeting had been very valuable, as it helped to lay the foundations for coordination and closer cooperation in future polar satellite systems. The CGMS Members agreed that in terms of both content and context this CGMS meeting has been very important. WMO was pleased to note that CGMS satellite operators clearly showed at this meeting that they were interested in working together and strengthening their cooperation further. All the CGMS participants thanked NOAA/NESDIS and the National Academy of Sciences for their hospitality and for all the organisational arrangements that contributed to the success of the meeting. In addition the participants thanked the Chairman for his expert control of the meeting. The meeting adjourned at 10.30 a.m. on 20 October 2000.

ANNEXES:

AGENDA OF CGMS XXVIII
16 - 20 October 2000

A. INTRODUCTION

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

B. REPORT ON THE STATUS OF CURRENT SATELLITE SYSTEMS

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

C. REPORT ON FUTURE SATELLITE SYSTEMS

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

D. OPERATIONAL CONTINUITY AND RELIABILITY

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

E. SATELLITE REQUIREMENTS OF WMO PROGRAMMES

E.1 World Weather Watch
E.2 Other Programmes

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

H. OTHER ITEMS OF INTEREST

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

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

WORKING GROUP I: TELECOMMUNICATIONS

I/1 Coordination of frequency allocations: SFCG, ITU and WRC activities
I/2 Telecommunication techniques

WORKING GROUP II: SATELLITE PRODUCTS

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

WORKING GROUP III: SATELLITE TRACKED WINDS

III/1 Results from the 5th International Winds Workshop
III/2 Wind Statistics
III/3 Derivation of Wind Vectors
III/4 Conclusion and preparation of WG report

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

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

WORKING PAPERS SUBMITTED TO CGMS-XXVIII

ESA

ESA-WP-01	Status of the ENVISAT and Earth Explorer Missions	C.1

EUMETSAT

EUM-WP-01	Review of Action Items	A.5
EUM-WP-02	Status of the Meteosat System	B.2
EUM-WP-03	Status of Preparation of EPS (Space and Ground Segment)	C.1
EUM-WP-04	Status of Preparation of MSG	C.2
EUM-WP-05	Network of EUMETSAT Satellite Application Facilities	C.2
EUM-WP-07	Status and Problems of the IDCS	F.1
EUM-WP-10	Report on EUMETSAT Training Activities	H.4
EUM-WP-11	EUMETSAT Conferences and Publications	H.5
EUM-WP-12	Update of CGMS Homepage Consolidated Report	H.5
EUM-WP-13	Plans on the use of the frequency band 7750–7850 MHz	I/1
EUM-WP-14	Interference analysis from high altitude platform stations (HAPS) to passive sensors in the band 31.3–31.5 GHz	I/3
EUM-WP-15	Outcome of the World Radio Conference 2000	I/1
EUM-WP-16	The importance of using clear radiances and near-nadir views for satellite intercalibration	II/2
EUM-WP-17	Report on investigations on spectral response functions of current and previous satellites	II/2
EUM-WP-18	MSG/SEVIRI solar channel calibration	II/2
EUM-WP-19	Concluding results from EUMETSAT with IR satellite inter-calibration work	II/2
EUM-WP-20	EUMETSAT AAPP Development	II/3
EUM-WP-21	Report on satellite applications over land	II/4
EUM-WP-22	Proposal on information to be included in a database for future satellite data reprocessing activities	II/6
EUM-WP-23	Report on the Status of Unified Archive Retrieval Facility (U-MARF)	II/6
EUM-WP-24	Report of the Fifth International Winds Workshop	III/1
EUM-WP-25	Report on use of rapid scans for wind derivation	III/4
EUM-WP-26	NWP SAF proposal to post results from NWP monitoring of satellite-tracked winds on the Internet	III/4
EUM-WP-27	Report on the review of the utilisation of AMVs with the NWP centres	III/4
EUM-WP-28	An improved calibration mechanism for the Meteosat-7 Infrared channels using on-board black body calibration mechanisms	II/2
EUM-WP-29	Report on study on High Rate DCP (27.26) including analysis of suitability of 300/1200 BPS data collection platforms to Meteosat Second Generation	I/3
EUM-WP-30	The CGMS Programme for Intercalibration of Satellite Sensors	II/2

INDIA

IND-WP-01	Indian Initiatives and Status of Meteorological Oceanographic Satellite Programmes	C.1
IND-WP-02	Status of Indian National Satellite System	B.2

JAPAN

JPN-WP-01	Review of Action Items from Previous CGMS Meetings	A.5
JPN-WP-02	Status of Geostationary Meteorological Satellites	B.2
JPN-WP-03	Future Plan on Multi-functional Transport Satellites	C.2
JPN-WP-04	Status and Problems of the GMS IDCS	F.1
JPN-WP-05	Schedules of MTSAT-1R Observations and Image Data Dissemination	G.1
JPN-WP-06	Improvement of CAL Systems in JMA	H.4
JPN-WP-07	A Training Plan for MTSAT/LRIT Data Utilization	H.4
JPN-WP-08	Promotion of Satellite Data Exchange and Utilization in Asia-Pacific Region	H.5
JPN-WP-09	Results of the World Radiocommunication Conference 2000	I/1
JPN-WP-10	The International Frequency Coordination between the Multi-functional Transport Satellite (MTSAT) and Other Meteorological Satellite Networks in UHF band, S-band and USB	I/1
JPN-WP-11	Preliminary Study on Inter-calibration of the Visible Channels between GMS-5 and NOAA-14	II/2
JPN-WP-12	Calibration Method for Emergency Case when Calibration Shutter Data are not available	II/2
JPN-WP-13	Utilization of AMVs data in the global NWP model at JMA	III/1
JPN-WP-14	Summary of Comments from NWP Centres Represented in WGNE on the Large Differences in Satellite Wind Observation Errors Assigned at NWP Centres	III/1
JPN-WP-15	Current Status of the accuracy of GMS Cloud Motion Winds and Water Vapour Motion Winds	III/2

PEOPLE'S REPUBLIC OF CHINA

PRC-WP-01	The current status of FY-1C	B.1
PRC-WP-02	The current status of FY-2A and B	B.2
PRC-WP-03	The future polar-orbiting meteorological satellites of China	C.1
PRC-WP-04	The future meteorological orbiting meteorological satellites of China	C.2

RUSSIAN FEDERATION

RUS-WP-00	Review of action items from previous CGMS meetings	A.5
RUS-WP-01	Status of METEOR polar-orbiting meteorological systems	B.1
RUS-WP-02	Future polar-orbiting meteorological satellites METEOR-3M	C.1
RUS-WP-03	Future geostationary meteorological satellite GOMS/Electro N 2	C.2
RUS-WP-04	Current status and future use of Russian DCS	I/2
RUS-WP-06	World ocean surface temperature derived from geostationary weather satellites – new global meteorological product.	II/4

USA

USA-WP-01	Review CGMS XXVII Action Items	A.5
USA-WP-02	Polar-orbiting Operational Environmental Satellite (POES)	B.1
USA-WP-03	Geostationary Operational Environmental Satellite (GOES)	B.2
USA-WP-04	Anomalies due to solar events	B.3
USA-WP-05	Future Polar-orbiting Meteorological Satellite System	C.1

USA-WP-06	NPOESS Direct Broadcast Concepts	C.1
USA-WP-07	Report on the status of future Geostationary Meteorological Satellite Systems	C.2
USA-WP-08	Requirements and Possible Approach to Update/Upgrade the Satellite-based Component of GOS	C.3
USA-WP-09	The Channel Interference Monitoring System	F.1
USA-WP-10	Dissemination of DCP messages (GTS or other means)	F.4
USA-WP-11	Status of the LRIT	G.1
USA-WP-12	Search and Rescue Interference Monitoring and Coordination	H.2
USA-WP-13	Satellite Meteorology Training for the National Weather Service	H.4
USA-WP-14	The Results of WRC-2000	I/1
USA-WP-15	Code Division Multiple Access (CDMA) overlay system for GOES DCP	I/3
USA-WP-16	Summary of the 1999 Space Frequency Coordination Meeting	I/1
USA-WP-17	Working Group on Satellite Network Cost Recovery Based on Products and Services	I/1
USA-WP-17.1	Possible Interference to NOAA Satellite Systems from Operations of MTSAT Satellites	I/1
USA-WP-18	Status of Interference Location System	I/2
USA-WP-19	Inter-Calibration Practices of GOES and POES Infrared Windows and Water Vapour Radiances	II/2
USA-WP-20	Inter-calibration of satellite sensors in the Visible and Near-Infrared	II/2
USA-WP-21	1999/2000 Report on NOAA/NESDIS GOES Soundings and Winds	III/2
USA-WP-22	Report on the Eleventh International TOVS Study Conference (ITSC-XI)	II/3

WMO

WMO-WP-01	CGMS satellite ground receiving database	H.5
WMO-WP-02	Review of action items from previous CGMS meetings	A.5
WMO-WP-03	Matters related to APT/WEFAX and conversion	G.1
WMO-WP-04	CGMS list-servers	H.5
WMO-WP-05	WMO Strategy to Improve Satellite System Utilization	E.1
WMO-WP-06	Virtual Laboratory for Training in Satellite Meteorology	H.4
WMO-WP-07	Statement of Guidance on Feasibility of Meeting WMO Requirements	E.1
WMO-WP-08	Review of satellite related WMO publications	H.5
WMO-WP-09	ASDAR status report	F.3
WMO-WP-10	WMO code form changes	G.2
WMO-WP-11	Radio Frequency matters	I/1
WMO-WP-12	Tropical Cyclone Programme requirements	E.1
WMO-WP-13	ASAP status report	F.2
WMO-WP-14	Global planning, including orbital positions	D.1
WMO-WP-15	WMO Executive Council Consultative Meetings	H.5
WMO-WP-16	Other programmes, Joint WMO/IOC Technical Commission	E.2
WMO-WP-17	Document cancelled	F.4
WMO-WP-18	Dissemination of satellite images via satellite	G.1/G.2
WMO-WP-19	Nomination of CGMS Representatives at WMO and other meetings	J.3
WMO-WP-20	International Satellite Data Utilization and Training Working Group	H.5
WMO-WP-21	International Precipitation Working Group	H.5
WMO-WP-22	Document cancelled	H.3

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Mr. Zhang Wenjian	SMC/CMA, PRC
Prof. Jianping Xu	SMC/CMA, PRC
Dr. Vassily Asmus	SRC Planeta, Russia
Mr. Gary Davis	NOAA/NESDIS, USA
Mr. David McGinnis	NOAA/NESDIS, USA
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Dr. Paul Menzel	NOAA/NESDIS, USA
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Annex 4

APPENDIX A:

ADDITIONAL INFORMATION SUBMITTED TO CGMS XXVIII

DRAFT TERMS OF REFERENCE

WORKSHOP ON LONG-TERM FUTURE OF THE BASIC SOUNDING AND IMAGERY MISSIONS

Purpose: in connection to the need to replace certain elements of the GOS satellite system in the 2015 time frame, the basic temperature/humidity sounding and medium-resolution imagery missions could be re-thought in terms of optional split between geostationary and low-orbiting satellites. The workshop should review the status of requirements and the perspective technological capabilities, possibly outlining a strategic approach.

Items to be covered:

1. Review of user requirements for basic sounding and imagery
2. Review of planned programmes, which will be "current" across 2015.
3. Review of proposed concepts for advanced geostationary satellites and comparative analysis of alternative concepts.
4. Review of requirements optimally met by low orbiters.
5. "Vision" of optimal split of roles between geostationary and low orbiting satellites.

Output:

1. Proceedings of the workshop
2. Short statement on requirements, capabilities and strategy to CGMS.

Mode: invited papers and panel discussions

Number of attendees: 20-30

INITIAL STRUCTURE
FOR THE
CGMS INTERNATIONAL SATELLITE DATA UTILIZATION AND TRAINING FOCUS GROUP

Structure:

Co-chaired by one satellite operator and one representative from the "centres of excellence".
Served by the WMO Satellite Activities Office as the Secretariat.
Membership should include:

- representatives of appropriate science teams;
- remaining satellite operators and RSSTCs;
- other interested parties as appropriate.

Activities:

- Consolidate documentation of the range of skills/competencies for operational meteorologists and specialists.
- Examine what online (Web-based learning), Computer Aided Learning (CDs) and hard copy learning materials are currently available for use in the Virtual Laboratory. This activity will include contacting groups such as ASMET, COMET, CIRA, EuroMET, BMTC and CIMSS who have complementary projects under way and relevant science groups (such as the EUMETSAT SAFs, the TOVS Working Group, the WINDS Working Group and the proposed quantitative precipitation working group).
- Negotiate with the copyright holders of the training material rights to either link to their material and/or to acquire the rights to use their material at the designated centres of satellite training expertise (this includes the centres making the material available to on- and off-site users).
- Working with groups such as ASMET, COMET or EuroMET, design and test possible user interfaces, educational approaches for delivering the material, and examine methods for online tracking of student participation.
- On a trial basis, evaluate the proposed Virtual Laboratory material in conjunction with one of the WMO satellite training workshops for more user feedback.
- Incorporate user feedback into the educational approach and review the content of the Virtual Laboratory.
- Move to a wider implementation of the material.
- Undertake periodic review of the Virtual Laboratory sites in conjunction with reviews of the skills and competencies of the operational meteorologists and specialists.
- Prepare sample data sets for the various data streams now being provided or planned for in the near future. The data sets would be used within the VL concept.

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 China 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 worldwide , 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, inter-calibration of sensors, processing algorithms, products and their validation, data transmission formats and future data transmission standards.

b) CGMS harmonises to the extent possible meteorological satellite mission 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
China Meteorological Administration of the PRC	-	joined 1989
NOAA/NESDIS	-	founder member, 1972
Hydromet Service of the Russian Federation	-	joined 1973
WMO	-	joined 1973

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

ADDRESSES FOR PROCURING ARCHIVE DATA

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Appendix B

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

COSPAR	Committee on Space Research
CPM	Conference Preparatory Meeting (WRC)
DAPS	DCS Automated Processing System (USA)
DCP	Data Collection Platform
DCS	Data Collection System
DIF	Directory Interchange Format
DOD	Department of Defense (USA)
DOMSAT	Domestic telecommunications relay Satellite (USA)
DPT	Delayed Picture Transmission
DRS	DCP Retransmission System (Meteosat)
DRT	Data Relay Transponder (INSAT)
DSB	Direct Soundings Broadcast
DUS	Data Utilisation Station (USA) (Japan)
DWS	Disaster Warning System (India)
EBB	Electronic Bulletin Board
EC	Executive Council (WMO)
ECMWF	European Centre for Medium-Range Weather Forecasts
EDR	Environmental Data Records (NPOESS)
EEIS	EUMETSAT External Information System
EESS	Earth Exploration Satellite Service (Frequency Management)
ENVISAT	ESA future polar satellite for environment monitoring
EO	Earth Observation
EOS	Earth Observation System
EPS	EUMETSAT Polar System
ERBE	Earth Radiation Budget Experiment
ESA	European Space Agency
ESJWG	Earth Sciences Joint Working Group
ESOC	European Space Operations Centre (ESA)
EUMETSAT	European Meteorological Satellite Organisation
FAA	Federal Aviation Authority (USA)
FAO	Food and Agriculture Organisation (UN)
FAX	Facsimile
FXTS	Facsimile Transmission System (USA)
FY-1	Polar-orbiting Meteorological Satellite (PRC)
FY-2	Future Geostationary Meteorological Satellite (PRC)
FY-3	Future generation of Polar-orbiting Meteorological Satellite
GCOM	Global Change Observation Mission (NASDA)
GCOS	Global Climate Observing System
GIMTACS	GOES I-M Telemetry and Command System
GMR	GOES-Meteosat Relay
GMS	Geostationary Meteorological Satellite (Japan)
GNSS	Global Navigation Satellite System

GOES	Geostationary Operational Environmental Satellite (USA)
GOMS	Geostationary Operational Meteorological Satellite (Russ. Fed.)
GOS	Global Observing System
GSLMP	Global Sea Level Monitoring Programme
GPCP	Global Precipitation Climatology Project
GPS	Global Positioning System
GRAS	GNSS Receiver for Atmospheric Sounding
GRIB	Numerical weather prediction data in gridpoint form, expressed in binary
GTS	Global Telecommunication System
GVAR	GOES Variable (data format) (USA)
HDFS	High Density Fixed Service
HiRID	High Resolution Imager Data
HIRS	High Resolution Infrared Sounder
HR	High Resolution
HRDCP	High Rate DCP
HRPT	High Rate Picture Transmission
HSRS	High Spectral Resolution Sounder (MSG)
ICWG	International Coordination Working Group (EO)
IDCP	International DCP
IDCS	International Data Collection System
IDN	International Directory Network (CEOS)
IFRB	International Frequency Registration Board
IMT-2000	International Mobile Telecommunication 2000 (before FPLMTS)
INSAT	Indian geostationary satellite
IPOMS	International Polar-orbiting Meteorological Satellite Group
IR	Infrared
IRTS	Infrared Temperature Sounder (EPS)
ISCCP	International Satellite Cloud Climatology Project
ISY	International Space Year
ITT	Invitation to Tender
ITU	International Telecommunication Union
ITWG	International TOVS Working Group
IWW	International Winds Workshop
JMA	Japan Meteorological Agency
LR	Low Resolution
LRIT	Low Rate Information Transmission
LRPT	Low Rate Picture Transmission
LSPIM	Land Surface Processes and Interactions Mission (ESA)
LST	Local Solar Time
MAP	Mesoscale Alpine Experiment
MARF	Meteorological Archive and Retrieval Facility (EUMETSAT)

MBWG	MSG Biosphere Working Group
MCP	Meteorological Communications Package
MDD	Meteorological Data Distribution (Meteosat)
MDUS	Medium-scale Data Utilization Station (for GMS S-VISSR)
MetAids	Meteorological Aids Service (frequency regulation)
Metop	Future European meteorological polar-orbiting satellite
METEOR	Polar-orbiting meteorological satellite (CIS)
Meteosat	Geostationary meteorological satellite (EUMETSAT)
MetSat	meteorological satellite systems (frequency regulation)
MHS	Microwave Humidity Sounder (EPS)
MIEC	Meteorological Information Extraction Centre (ESOC)
MOCC	Meteosat Operational Control Centre (ESOC)
MODIS	Moderate resolution imaging spectroradiometer
MOP	Meteosat Operational Programme
MPEF	Meteorological Products Extraction Facility (EUMETSAT)
MSC	Meteorological Satellite Centre (Japan)
MSC-CAL	Computer Aided Learning system by MSC/JMA
MSG	Meteosat Second Generation
MSS	Mobile Satellite Services (frequency regulation)
MSU	Microwave Sounding Unit
MTP	Meteosat Transition Programme
MTS	Microwave Temperature Sounder (EPS)
MTSAT	Multi-functional Transport Satellite (Japan)
MVIS	Multi-channel VIS and IR Radiometer (FY-1C and D of PRC)
NASA	National Aeronautics and Space Agency
NASDA	National Space Development Agency of Japan
NEDT	Noise Equivalent Delta Temperature
NESDIS	National Environmental Satellite Data and Information Service
NGDC	National Geophysical Data Centre (USA)
NGSO	Non-geostationary systems
NMC	National Meteorological Centre
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service (USA)
NSMC	National Satellite Meteorological Center of CMA (PRC)
NTIA	National Telecommunications and Information Agency (USA)
NWP	Numerical Weather Prediction
NWS	National Weather Service (USA)
OCAP	Operational Consortium of ASDAR Participants
OLR	Outgoing Longwave Radiation
OPAG-IOS	Open Programme Area Group in Integrated Observing Systems (successor of CBS WG on Satellites)
OWSE-AF	Operational WWW Systems Evaluation for Africa
PC	Personal Computer

POEM	Polar-orbiting Earth Observation Mission (ESA)
POES	Polar-orbiting Operational Environmental Satellite (USA)
PRC	People's Republic of China
PTT	Post Telegraph and Telecommunications authority
RA	Regional Association of WMO
RAMSDIS	Menu-driven system for analysing digital satellite imagery (McIDAS, USA)
RAOBS	Radiosonde Observations
RASA	Russian Aviation and Space Agency
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 Application 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 Infrared Imager (MSG)
S-FAX	S-band facsimile broadcast of FY-2 (PRC)
SFCG	Space Frequency Coordination Group
SMA	State Meteorological Administration (PRC)
SRF	Spectral Response Function
SRS	Space Research Service (frequency regulation)
SSP	Sub-Satellite Point
SST	Sea Surface Temperature
SSU	Stratospheric Sounding Unit
S-VISSR	Stretched VISSR
TD	Technical Document
TIROS	Television Infrared Observation Satellite
TOMS	Total Ozone Mapping Spectrometer
TOVS	TIROS Operational Vertical Sounder
TTC	Telemetry Tracking Control
U-MARF	United Meteorological Archive Retrieval Facility (EUMETSAT)
UHF	Ultra High Frequency
UK	United Kingdom
UMTS	Universal Mobile Telecom System
UN	United Nations
UNISPACE	Third United Nations Space Conference

UN-OOSA	UN Office of Outer Space Affairs
USA	United States of America
UTC	Universal Time Coordinated
VAS	VISSR Atmospheric Sounder
VHF	Very High Frequency
VIRSR	Visible and Infrared Scanning Radiometer (EPS)
VIS	Visible channel
VISSR	Visible and Infrared Spin Scan Radiometer
VL	Virtual Laboratory (USA training concept)
VLSI	Very Large Scale Integrated circuit
WARC	World Administrative Radio Conference
WCRP	World Climate Research Programme
WEFAX	Weather facsimile
WG	Working Group
WGNE	Working Group on Numerical Experimentation
WMO	World Meteorological Organization
WP	Working Paper
WRC	World Radio Conference
WV	Water Vapour
WVMW	Water Vapour Motion Winds
WWW	World Weather Watch
X-ADC	Extended Atlantic Data Coverage
Y2K	Year 2000 compatibility