CGMS-XXXI
WMO WP-5
Prepared by WMO
Agenda item: D1/D2

CGMS WORKING GROUP ON GLOBAL CONTINGENCY PLANNING

(Submitted by WMO)

Summary and purpose of document

Members to discuss information presented in this document with regard to CGMS Global Contingency Planning taking into consideration recent changes in the space-based component of the WWW GOS, GCOS Climate Monitoring Principles, regional implementation of contingency plans and the use of Alternative Dissemination Methods (ADM).

ACTION PROPOSED

CGMS should discuss the following topics with a goal to develop Global Contingency Plans for the new space-based component of the GOS:

- the revised GOS baseline for six geostationary satellites;
- a revised CGMS Global Contingency Plan for geostationary orbit;
- the revised GOS baseline for four polar orbiting satellites;
- a CGMS contingency plan for the new operational Jason (OSTM) series;
- a CGMS response for the newly adopted GCOS Climate Monitoring Principles; and
- the use of ADM in contingency planning.

Appendices: A. Final report of the CGMS Working Group on Global Contingency Planning held in Geneva, February 2002

B. GCOS Climate Monitoring Principles

DISCUSSION

Background

1. The following events occurred leading up to and after CGMS-XXX that are considered relevant to CGMS Global Contingency Planning. These events have greatly expanded the complexity for contingency planning. Thus, CGMS Global Contingency Planning should be reviewed and updated as appropriate.

2. The first important issue is the change to the WMO baseline space-based component of the GOS. With regard to the geostationary orbit, there is a new WMO requirement for at least six geostationary satellites. With regard to the polar orbit, there is a new WMO requirement for at least four polar orbiting satellites, two in the AM and two in the PM orbit. Additionally, while R&D satellite missions do not require contingency planning themselves, they could provide back-up to operational meteorological satellite missions.

3. The GCOS Climate Monitoring Principles, reviewed and commented upon at CGMS-XXX, have subsequently been approved by the Fourteenth WMO Congress.

4. With the formal commitment by CNES that Jason-1 now forms part of the space-based component of the GOS within the R&D constellation and the expectation that the now approved Jason-2 Ocean Surface Topography Mission (OSTM) – a four way joint mission with participation by CNES, NASA, NOAA and EUMETSAT – will also become part of the space-based component of the GOS, the Jason series will become de facto an operational system and contingency plans should be considered for this important operational oceanographic series.

WMO Executive Council (June 2002)

5. The fifty-fourth session, (June 2002) of the Executive Council of WMO (EC-LIV) was informed that the meeting of the CGMS Working Group on Global Contingency Planning had occurred immediately following the second session of the Consultative Meetings. Since WMO requirements for satellite data for climate purposes as contained in the GCOS principles, were relevant to both geostationary and especially polar-orbiting satellites and could involve significant resources to meet, the CGMS Working Group felt it would be appropriate if such requirements could be formulated as a resolution by the WMO Congress. The Executive Council agreed and requested the Global Climate Observing System (GCOS) Programme to prepare the necessary draft resolution for consideration by the fourteenth WMO Congress.

CGMS-XXX (November 2002)

6. The following items were noted and addressed at CGMS-XXX:

- The report from the CGMS Working Group on Global Contingency Planning, held in Geneva, Switzerland on 20 February 2002;
- GCOS draft Climate Monitoring Principles including ones specifically for satellite systems;
- Consider reviewing of the status of contingency planning at all future CGMS Plenaries;
- Regional contingency plans that could be consolidated into an overarching global contingency plan;
- Consider developing an outline of the content for a “standard” regional contingency plan.

Commission for Basic Systems, Extraordinary Session (CBS Ext. 2002) December 2002

7. CBS Ext. 2002 approved 20 specific recommendations for the space-based component of the GOS (nine for operational geostationary and polar orbiting, 11 for R&D satellites) built upon the known plans of the operational and R&D satellite operators. CBS called for rigorous calibration of remotely-sensed radiances as well as improved spatial, spectral, temporal and radiometric accuracies. The wind profiling and global precipitation measurement missions were singled out BY CBS for their importance to the GOS.

8. The vision for the evolution of the GOS to 2015 and beyond included:

(a) For the space-based component:

(i) Six operational GEOs:
- *(a)* All with multispectral imager (IR/VIS);
- *(b)* Some with hyperspectral sounder (IR);

(ii) Four operational LEOs:
- *(a)* Optimally spaced in time;
- *(b)* All with multispectral imager (MW/IR/VIS/UV);
- *(c)* All with sounder (MW);
- *(d)* Three with hyperspectral sounder (IR);
- *(e)* All with radio occultation (RO);
- *(f)* Two with altimeter;
- *(g)* Three with conical scanning MW or scatterometer;

(iii) Several R&D satellites serving WMO Members and comprised of:
- *(a)* A constellation of small satellites for radio occultation (RO);
- *(b)* LEO with wind lidar;
- *(c)* LEO with active and passive microwave precipitation instruments;
- *(d)* LEO and GEO with advanced hyperspectral capabilities;
- *(e)* GEO lightning;
- *(f)* Possibly GEO microwave;

(iv) Improved inter-calibration and operational continuity;

(v) For satellite data in particular:
- *(a)* Use of ADM including regional/special DCPC in the context of FWIS;
- *(b)* DB for special local applications in need on minimal time delay and as backup.

9. With regard to polar orbiting satellites, CBS Ext. 2002 agreed that four operational LEOs were required and should be reflected in the update to the Manual on the GOS.

10. It should be noted that the updated Manual on the GOS contains the following description:

> The number of satellites in polar orbit should be sufficient to provide global coverage at least eight times per day for instruments with horizon-to-horizon scanning. Typically this will require two satellites in ante-meridian (a.m.) orbit and two in post-meridian (p.m.) orbit.
>
> The number of satellites in geostationary orbit should be sufficient to obtain observations, typically at 30 or 15 minute intervals and throughout a field of view between 60^0 S and 60^0 N. This implies the availability of at least six satellites, near-equally spaced around the equator.

Data from polar satellites should be acquired on a global basis, without gaps (blind orbits), and delivered to users to meet timeliness requirements. Imagery and sounding data should be available from at least four polar orbiting satellites, two in a.m. and two in p.m. orbit, on not less than 99% of occasions. The system design should provide for ground segment, instrument and satellite redundancy, and rapid call up of replacement launches or AM and PM spares, to achieve this.

Imagery from at least six equi-spaced geostationary satellites should be accessible on not less than 90% of occasions and from four such satellites on 99% of occasions. Contingency plans, involving the use of in-orbit stand-by flight models and rapid call up of replacement systems and launches, should be in place to maximise the utility of the available data.

WMO Congress XIV (May 2003)

11. The Fourteenth WMO Congress, Cg-XIV, adopted a set of 20 Global Climate Observing System (GCOS) Climate Monitoring Principals, of which 11-20 addressed the space based component of the GOS, in appropriate text below.

12. WMO Cg-XIV noted with appreciation in 3.1.6, paragraph 3.1.6.2, a portion which follows:

> "…Congress noted that most space agencies contributing operational polar-orbiting and geostationary satellites had in place contingency plans for satellite systems that would guarantee the continued daily flow of satellite data, products and services WMO Members had come to depend on. In that regard, WMO Members in Regions II and V expressed their profound gratitude for the efforts of Japan and the United States of America to initiate the back-up operation of GMS-5 with GOES-9 on 22 May 2003. Congress noted that advanced notification and implementation plans had ensured that there would be no adverse impacts to operations in NMHSs."

13. WMO Cg-XIV further noted with appreciation the Indian Ocean coverage provided by EUMETSAT in 3.1.6, paragraph 3.1.6.4, and urged continuation of that coverage as follows:

> "…Dr Tillmann Mohr, Director-General of EUMETSAT, briefed Congress on the current status and plans for EUMETSAT… Congress expressed its deep appreciation to EUMETSAT for its activities in the PUMA Project, its continued coverage of the Indian Ocean with Meteosat-5, its co-sponsoring of two RMTCs in RA I, convening User Fora in RA I, II and VI, and its new initiative to provide satellite data and products through Alternative Dissemination Methods (ADM) with the potential to expand the present data flow to WMO Members. Congress urged EUMETSAT to consider increasing the available data beyond that currently contained in the MDD data stream for inclusion in ADM. Congress also urged EUMETSAT to continue coverage over the Indian Ocean."

14. It is essential that CGMS Members discuss the issue of geostationary positions especially over the Indian Ocean as the present plans indicated the potential for radio frequency interference between satellites. At present, and according to satellite operators' plans, the possibility exists for five geostationary satellites over the Indian Ocean in 2005 (Meteosat, KALPANA, GOMS N-2, FY-2 and GIFTS);

15. WMO Cg-XIV, 3.1.6, paragraph 3.1.6.5, "noted with deep satisfaction and appreciation the ongoing dialogue between the United States of America and Europe over the harmonization of satellite missions in polar-orbiting for both the near- and long-term, as well as the excellent coordination between the respective organizations based on their inter-dependence for full data sets and needs for complementary instruments. Congress was pleased to note that the dialogue

had already resulted in an agreement between NOAA/NESDIS and EUMETSAT that would provide for optimized and efficient polar-orbiting capabilities for the next decade. Congress also noted in the same spirit of international cooperation and in recognition of the requirement for the continuation of the valuable altimeter data from JASON-1 that four organizations, namely CNES, EUMETSAT, NASA and NOAA/NESDIS, had jointly agreed to the JASON-2 mission. JASON-2 would represent a milestone in the transition from research to an operational oceanographic satellite mission."

16. WMO Cg-XIV, 3.1.6, paragraph 3.1.6.6, "India described its current national meteorological satellites systems including INSAT-2E, INSAT 3A and KALPANA . India noted that in the past, technical constraints in the INSAT data dissemination service limited its ability to distribute data. However, due to new Alternative Dissemination Methods, India would make satellite data and products, including imagery, GTS data, weather charts and NWP model analyses and forecasts, available through a commercial telecommunication satellite provider, World Space. The data would be in conformance with WMO's data policy for free and unrestricted access. The Asia Star telecommunication satellite could provide data to all WMO Members in RA II from its eastern extreme to the Middle East through an inexpensive reception system comprised of a digital decoder and a UNIX based workstation.

Geostationary Contingency Planning

17. Cg-XIV noted with gratitude NOAA/NESDIS and the Japan Meteorological Agency (JMA) had instituted a short-term back up agreement whereby NOAA/NESDIS had moved the GOES-9 satellite to back up GMS-5 on 22 May 2003. The advanced notification and implementation plans ensured that there would be no adverse impacts to operations in NMHSs.

(i) Japan informed Cg-XIV of its future plans for geostationary orbit and in particular for MTSAT-1R and MTSAT-2 scheduled to be launched in 2004 and 2005 respectively.

(ii) The United States of America informed Congress of the transition in the eastern GOES position (75 degrees West) from GOES-8 to GOES-12. GOES-12 would provide for the first time real time solar imagery. It also described its plans for the next generation geostationary satellite system, GOES-R.

(iii) The People's Republic of China briefed Cg-XIV on the ongoing plans to continue its geostationary and polar-orbiting satellites with the launch of FY-2C in 2004 as well as its plans for the next generation geostationary satellite series, FY-4. CMA's intentions remain to launch a geostationary satellite every three years but would have the capability to launch a satellite, if required, with only one year's notice. CMA noted that it planned to maintain a nominal two satellite configuration, one at 86 and one at 105 degrees East longitude with the contingency to use an "on-demand launch" if required.

(iv) The Russian Federation briefed Cg-XIV on its plans to continue the GOMS series geostationary satellite series. CG-XIV also noted that ROSHYDROMET intended to maintain its nominal one geostationary satellite configuration at 76 degrees East longitude.

(v) The Republic of Korea described to Cg-XIV its multi-purpose satellites that were expected to be available commencing in 2008.

(vi) EUMETSAT briefed Cg-XIV on the current status and plans for the continuation of satellite systems in geostationary orbit and the commissioning of the first Meteosat Second Generation satellite (MSG-1). Congress expressed its deep appreciation to EUMETSAT for its continued coverage of the Indian Ocean with Meteosat-5, and urged EUMETSAT to continue coverage over the Indian Ocean.

(vii) India briefed Cg-XIV on the current status and plans for satellite systems in geostationary orbit that would be dedicated to Meteorological activities. Of particular interest were India's plans to use Alternative Dissemination Methods to make satellite data and products, including imagery, GTS data, weather charts and NWP model analyses and forecasts, available in an unrestricted manner to all Members. The data would be in conformance with WMO's data policy for free and unrestricted access.

Polar orbiting contingency planning

18. Cg-XIV was briefed on EUMETSAT's plans for a new polar-orbiting satellite series called Metop, as well as a new joint oceanographic mission called JASON-2.

19. The People's Republic of China described their ongoing plans to continue its polar-orbiting satellites with the launch of FY-3A in 2005.

20. The Russian Federation described its plans to continue the Meteor 3M polar-orbiting satellite series and the GOMS series geostationary satellite series.

21. The United States of America informed Congress of its plans for the next generation of polar orbiting environmental satellite systems, NPOESS.

22. With regard to polar orbiting contingency planning, the Cg-XIV noted that the CGMS Working Group had first discussed the principles for such plans. The CGMS Working Group had noted that the basic WMO requirement for the polar orbit was for two satellites - one in the AM and one in the PM orbit. The CGMS Working Group had agreed that in order to meet WMO's requirement for contingency planning a constellation of four polar-orbiting satellites would be required, two in the AM orbit capable of serving as backup to the other and two in the PM orbit also capable of serving as backup to the other.

23. [It should be noted that the above description was based on the CGMS Working Group on Global Contingency Planning's Report from February 2002. Given the new operational requirement for four satellites, the contingency requirement to satisfy the operational requirement should be for six polar orbiting satellites, three in the AM and three in the PM orbits.]

24. The Cg-XIV was pleased to note that both ROSHYDROMET and CMA, taking into account their respective national requirements, would be willing to consider the possibility of using the PM orbit for their future Meteor 3M and FY-3 series to assure the necessary redundancy in order to meet WMO's contingency requirements.

WMO Space Programme and Contingency Planning

25. Recognizing the importance of satellite data to all WMO programmes, and the addition of research and development satellite data to the GOS, Cg-XIV felt it appropriate to elevate WMO Satellite Activities to the status of a Major WMO Programme (see WMO WP-6).

26. The addition of the R&D satellite component to the GOS casts contingency for polar orbiting satellites in a new light.

27. CGMS-XXX also addressed regional contingency plans that could be consolidated into an overarching global contingency plan and considered developing an outline of the content for a "standard" regional contingency plan. Furthermore, CGMS XXX asked WMO to develop regional contingency plans and this task has been assigned to the CBS OPAG IOS Expert Team on Satellite System Utilization and Products. Due to financial considerations, the Expert Team will meet again to discuss this task in 2004. However, it is apparent that the satellite operators have some regional contingency plans that have already been implemented, e.g. the regional

contingency plan between EUMETSAT and NOAA for XADC and the present use of GOES-9 to back up GMS-5.

GCOS Climate Monitoring Principles and associated requirements

28. Cg-XIV adopted the set of 20 GCOS Climate Monitoring Principles presented in Appendix B. Note that principles 11-20 focus on space based observations.

29. It should be noted that the GCOS Climate Monitoring Principles have far reaching effects on how Satellite Operators approach system planning to meet requirements, specifically 11, 12 & 13, i.e.:

(a) (11) Constant sampling within the diurnal cycle (minimizing the effects of orbital decay and orbit drift) should be maintained.

(b) (12) A suitable period of overlap for new and old satellite systems should be ensured for a period adequate to determine inter-satellite biases and maintain the homogeneity and consistency of time-series observations.

(c) (13) Continuity of satellite measurements (i.e. elimination of gaps in the long-term record) through appropriate launch and orbital strategies should be ensured.

Alternative Dissemination Methods (ADM)

30. WMO WP-21 discusses Alternative Dissemination Methods (ADM). ADM has already been implemented by at least three CGMS satellite operators, i.e. EUMETSAT with EUMETCast, JMA in the back-up of GMS-5 and distribution of GOES-9 data and India in the redistribution of KALPANA data. ADM offers many advantages for the dissemination of data and products as well as providing a value means to implement contingency plans. Thus, discussions for CGMS Global Contingency Planning should also include the dissemination service in use by each satellite operator and the possibility for use of ADM to implement contingency plans.

Summary for further discussions

31. CGMS should discuss the following topics with a goal to develop Global Contingency Plans for the new space-based component of the GOS:

- the revised GOS baseline for six geostationary satellites. CGMS should discuss the appropriate geographical positions for the set of expected geostationary satellites to be provided by CGMS Members;
- a revised CGMS Global Contingency Plan for geostationary orbit. WMO will continue to develop regional contingency plan data, product and service requirements and CGMS Members should provide information related to existing regional contingency plans;
- the revised GOS baseline for four polar orbiting satellites. CGMS should consider the role that R&D satellite missions could possibly play within a revised CGMS Global Contingency Plan for polar orbit;
- a CGMS contingency plan for the new operational Jason (OSTM) series;
- a CGMS response for the newly adopted GCOS Climate Monitoring Principles including:

    (a) Global satellite system intercalibration possibilities;

    (b) Relevance of geostationary, polar and other orbits in satisfying climate monitoring in a systems context;

(c) Roles and requirements of operational and research geostationary, polar and other orbits in satisfying climate monitoring in a systems context;

(d) Possibility of addressing climate requirements in novel manners, such as a CGMS cooperative International Geostationary Laboratory (IGL) that would carry instrumentation to allow for intercalibration of the space based GOS, and support of missions such as GPM which employs active microwave instrumentation for intercalibration of the space based GOS for precipitation measurements; and

- the use of ADM in contingency planning.

CGMS WORKING GROUP MEETING ON GLOBAL CONTINGENCY PLANNING

WMO HEADQUARTERS

GENEVA

20 FEBRUARY 2002

1. ORGANIZATION OF THE MEETING

1.1 Opening of the meeting *(Agenda item 1.1)*

The CGMS Working Group Meeting on Global Contingency Planning was held at the World Meteorological Organization (WMO) Headquarters in Geneva, Switzerland on 20 February 2002. The meeting was opened at 09:00 hours.. The list of participants is attached as Annex II.

1.2 Adoption of the Agenda *(Agenda item 1.2)*

The agenda for the meeting was adopted and is reproduced in Annex I.

1.3 Working arrangements for the meeting (*Agenda item 1.3*)

The working arrangements for the meeting were agreed upon.

2. ELECTION OF CHAIRMAN

The Working Group unanimously elected Dr Tillmann Mohr, Director-General of EUMETSAT, as chairman.

3. GLOBAL CONTINGECY PLANNING

Background

3.1 The Working Group recalled that the CGMS Consolidated Report contained the following information related to Global Contingency Plans:

In 1991, the forty-fourth Executive Council of WMO recommended the development of contingency plans by the satellite operators to increase the reliability of the space-based global observation system. WMO considered that space segment contingency planning was the core of the statement of WMO requirements for system continuity. It was anticipated that CGMS would continue its role of coordination and standardisation such that ground receiving equipment would be able to receive and process services from any contingency satellite provided by another operator, e.g. by using standardised down-link broadcasts and data formats. In 1992, the statement of WMO requirements for continuity was subsequently endorsed by the satellite operators, who subsequently established a CGMS Working Group on Global Contingency Planning.

However, at the first meeting of this Working Group in October 1992, CGMS concluded that no single satellite operator could be expected to guarantee satellite availability in all circumstances and that the establishment of joint contingency plans was essential in order to achieve a reliable global system at a realistic cost. A proposal for a contingency concept, which could meet global needs, was thus established. This concept was based upon a philosophy of assisting neighbouring satellite operators by *using data transfer techniques similar to that already developed for the Europe-USA Extended Atlantic Data Coverage scheme mentioned above.*

In 1994, the CGMS Working Group on Global Contingency Planning agreed a technical strategy based upon the "help your neighbour" concept. This strategy assumes that each satellite operator tries, with its best efforts, to maintain its nominal configuration, in accordance with its own constraints. Any CGMS satellite operator faced with a contingency situation, whereby priority satellite based services cannot be supported, should immediately discuss the situation with other satellite operators who, in good faith, should try to find a solution.

In 1997, CGMS considered that it would be beneficial for the user community to develop similar arrangements to cover unexpected contingencies affecting services provided by the satellite operators.

In 1998, Japan and China looked into possible contingency arrangements to support each other's services. The GMS and FY-2 satellite systems have a high level of compatibility with regard to area of the globe covered and transmission characteristics. However, it was decided that long-term contingency arrangements could only be considered if respective launch schedules allowed sufficient in-orbit redundancy. A constraint to the provision of a back-up of MTSAT or FY-2 was the incomplete overlap (70%) in the fields of view of GMS/MTSAT and FY-2.

Bearing this in mind, the Working Group on Global Contingency Planning considered that in the event of a major system failure, back-up in areas such as product generation might be an appropriate solution. As a consequence, the satellite operators are currently actively studying such possibilities for support to product generation using data from neighbouring satellite systems.

Additionally, in 1998, discussions were initiated between EUMETSAT and the ROSHYDROMET with a view to investigating possibilities for the use of Meteosat-5 at 63°E to relay ROSHYDROMET DCP messages and provide a temporary WEFAX image dissemination service in the region.

Also in 1998, India agreed to transmit to its higher authorities the need for regional contingency planning as stipulated in the CGMS Contingency Strategy. To this end, EUMETSAT has concluded an Agreement with ISRO for the possible relay of some INSAT imagery and products via the Meteosat system. In return, India will have access to imagery provided by Meteosat-5 located at 63°E.

3.2 The Working Group also recalled that at CGMS-XXIX (October 2001), the Working Group on Global Contingency Planning had convened and discussed the need to further develop CGMS contingency plans.

3.3 The Working Group (WG) at CGMS-XXIX had reviewed the status of the current contingency plans existing amongst the satellite operators. It had noted that a formal contingency agreement existed between EUMETSAT and NOAA/NESDIS that could be activated when both satellite operators were in a defined nominal configuration. The WG had noted that other plans, similar to contingency plans, existed between some other CGMS satellite operators. The WG also had recalled that in 1991, the forty-fourth Executive Council of WMO had recommended the development of contingency plans by satellite operators to increase the reliability of the space-based global observation system. WMO had considered that space segment contingency planning was the core of the statement of WMO requirements for system continuity. It was anticipated that CGMS would continue its role of coordination and standardization, such that ground receiving equipment would be able to receive and process services from any contingency satellite provided by another operator, e.g., by accessing standardized down-link broadcasts and data formats.

3.4 In 1992, the statement of WMO requirements for continuity was, subsequently, endorsed by the satellite operators who then established a CGMS Working Group on Global Contingency Planning. At CGMS-XXIX, the satellite operators also noted that they were presently processing and disseminating other satellite operators' imagery and products and thus they relied on each other to maintain a global satellite system. A main strength in such a system was through contingency and reliability. It also acknowledged that the concept of "help your neighbour" also implied that a satellite operator would be willing to be "helped by its neighbour". The duality of the concept, i.e., to help and be helped, would allow sets of regional contingency plans to be the foundation for a global contingency plan for both the geostationary and polar-orbits.

3.5 At CGMS-XXIX, each satellite operator indicated a willingness to discuss regional contingency plans with its neighbours and within CGMS. With regard to the polar-orbiting satellites, a global plan should be developed with respect to the morning and afternoon orbits. It also agreed that a nominal configuration should be a basis for the activation of any regional contingency plan.

Discussion

3.6 The Working Group then agreed that it would be appropriate to structure the present meeting in two parts, geostationary contingency planning and polar-orbiting planning. In doing so, the Working Group agreed that it would be appropriate to take into consideration the recent discussion at the second session of the Consultative Meetings on High-Level Policy on Satellite Matters on equator crossing times for polar-orbiting satellites since that discussion was also relevant to contingency planning. It recalled the second session of the Consultative Meetings had stressed that WMO should formally articulate its requirements for satellite data for climate purposes as contained in the GCOS principles. Since the requirements were relevant to both geostationary and especially polar-orbiting satellites and could involve significant resources to meet, it would be appropriate if such requirements could be formulated as a resolution at the highest level within WMO preferably by the WMO Congress.

Geostationary Contingency Planning

3.7 In following the CGMS agreed philosophy to "help your neighbour", the Working Group noted that there were six CGMS geostationary satellite operators and considerable progress had already been achieved towards the development of regional contingency plans. The Working Group noted the already established contingency plan between NOAA/NESDIS and EUMETSAT. It also recalled that a bilateral cooperation agreement existed between EUMETSAT and the ROSHYDROMET part of which related to contingency planning.

3.8 NOAA/NESDIS and JMA have begun discussions of a short-term back up agreement whereby NOAA/NESDIS will be in a position to move the GOES-9 satellite to back up GMS-5 if required prior to the launch of JMA's MTSAT-1R. Concurrently, NOAA/NESDIS and JMA will begin discussions on a long-term contingency back up agreement. Such a long-term agreement would take effect once both agencies had established their planned baseline configuration. This baseline configuration, planned to be in place sometime in the next decade will provide for a robust national programme and will also have some capability to back up the other agency's programme in an emergency situation.

3.9 CMA noted that it currently had three registered positions (86, 105 and 123 degrees East longitude) that it intended for use by the FY-2 series. At present, it intended to launch FY-2C by the end of 2003 with plans that it would become operational by March 2004 before the monsoon season. Meanwhile, FY-2B would remain operational except during the eclipse seasons. CMA's intentions were to launch a geostationary satellite every three years but would have the capability to launch a satellite, if required, with only one year's notice. It noted that this form of contingency was an "on-demand launch" instead of an "in-orbit spare". CMA noted that if the lifetime of the satellites could be extended, then it planned to maintain a nominal two satellite configuration, one at 86 and one at 105 degrees East longitude with the contingency to use an "on-demand launch" if required. Its ground segment would allow simultaneous operation of two geostationary satellites. Thus with its present launch schedule, it was possible that CMA could achieve its full nominal configuration by 2006 or partial nominal configuration by 2003.

3.10 ROSHYDROMET noted that it will maintain its nominal one geostationary satellite configuration at 76 degrees East longitude. ROSHYDROMET indicated that GOMS N2 was an approved programme with a planned launch date in 2005. The imager, MSU-GS, on GOMS N2 would be similar in capabilities to SEVIRI on the MSG series of EUMETSAT satellites. The data will be disseminated in standard HRIT, LRIT, WEFAX formats.

3.11 CMA, JMA and ROSHYDROMET will start discussions on development of regional contingency plans to be implemented when achieving a nominal configuration for their geostationary satellite systems.

3.12 The Working Group felt that a major milestone had been achieved in the discussions on geostationary contingency planning. First, most CGMS satellite operators had either in place, were developing or would consider when nearing nominal configuration, regional contingency plans. Secondly, the satellite operators would follow the principles of "help your neighbour" and be willing to be "helped by your neighbour". Thirdly, nominal configurations for most satellite operators included either an "in-orbit spare" or an "on-demand launch". The Working Group agreed that the set of regional contingency plans would constitute a global contingency plan in response to the WMO requirements.

3.13 In order to have a complete overview of all CGMS satellite operator plans, the Working Group suggested that the CGMS Secretariat contact India to obtain its latest plans for geostationary orbit. Furthermore, the Working Group noted that it would meet again at the next CGMS Plenary to review the status of contingency planning and that such reviews should occur at all future meeting of Plenary. Finally, it suggested that the next CGMS Plenary consider the issue of geostationary positions especially over the Indian Ocean as the present plans indicated the potential for radio frequency interference between satellites.

Polar orbiting contingency planning

3.14 With regard to polar orbiting contingency planning, the Working Group first discussed the principles for such plans. It noted that the basic WMO requirement for the polar orbit was for two satellites - one in the AM and one in the PM orbit. It agreed in order to also meet WMO's requirement for contingency planning that a constellation of four polar-orbiting satellites would be required, two in the AM orbit capable of serving as backup to the other and two in the PM orbit also capable of serving as backup to the other.

3.15 The Working Group recalled the discussions at the second session of the Consultative Meetings on equator crossing times. It noted that at present four satellite operators (EUMETSAT, CMA, NOAA/NESDIS and ROSHYDROMET) had plans to fly satellites in the AM orbit while only one satellite operator (NOAA/NESDIS) had plans to fly in the PM orbit.

3.16 The Working Group was pleased to note that both ROSHYROMET and CMA, taking into account their respective national requirements, would be willing to consider the possibility of using the PM orbit for their future Meteor 3M and FY-3 series to assure the necessary redundancy in order to meet contingency requirements. The Working Group recalled that ROSHYDROMET and CMA had already made preliminary indications at CGMS-XXIX of such a willingness and looked forward to future CGMS meetings for progress in this area.

Climate requirements

3.17 With regard to climate applications, the Working Group noted that there were several issues to be considered for the utility of data from polar-orbiting satellites and their continuity. There was compelling evidence that the climate is changing. The Working Group agreed that one could argue about the degree, nature and cause of the climate variations and whether there was in fact a change, but the only way to settle these arguments would be with solid information. This required improved global observations of the state variables and the forcings, the means to process these and understand them, and the ability to set them in a coherent physical (and chemical and biological) framework with models. Meanwhile, the information that helped settle these arguments and reduce uncertainties was also extremely valuable for many other practical applications for business, industry, government, and the general public. The implications are given for the climate observing system. The Working Group noted the word "system" meant a comprehensive approach that included:

> Climate observations from both space-based and *in situ* platforms that were taken in ways that addressed climate needs and adhered to the ten principles outlined by the National Research Council (NRC, 1999).

3.18 The Working Group noted that a major effort would be required to produce satisfactory climate data records from operational data. Over the past decade a number of basic principles had been developed for the delivery of long-term data with minimal space- and time-dependent biases (NRC, 1999) including:

> Continuity of Purpose: Maintain a stable, long-term commitment to the observations, and develop a transition plan from serving research needs to serving operational purposes.

3.19 Hence for space-based platforms, climate monitoring requirements could be more stringent than weather requirements. As a consequence the following were recommendations from the climate communities:

- Satellites intended for monitoring should be launched into stable orbits designed to minimize drift in time of observation to within 2 hours over the lifetime of the satellite, or boosters are required to stabilize the orbit;
- Sufficient satellites should be operating to enable the diurnal cycle to be adequately sampled;
- Satellites should be launched on schedule, rather than on failure of the previous mission, as is the case today, to ensure overlap of measurements which is essential for the climate record;
- All instruments must be calibrated and extensive ground truth validation should be sustained.

3.20 In recalling that it had requested WMO to seek formal statements of the requirements for climate in this area, the Working Group felt it appropriate to suggest that future CGMS meetings include an appropriate agenda item where climate issues could be discussed.

3.21 The Working Group, in recognizing the need to keep WMO informed of progress for contingency planning, requested WMO to inform its next Executive Council of the important progress made by CGMS satellite operators as recorded in this report.

Annex to draft Resolution 3.2.3/1 (Cg-XIV)

GCOS CLIMATE MONITORING PRINCIPLES

Effective monitoring systems for climate should adhere to the following principles:*

1. The impact of new systems or changes to existing systems should be assessed prior to implementation.

2. A suitable period of overlap for new and old observing systems is required.

3. The details and history of local conditions, instruments, operating procedures, data processing algorithms and other factors pertinent to interpreting data (i.e., metadata) should be documented and treated with the same care as the data themselves.

4. The quality and homogeneity of data should be regularly assessed as a part of routine operations.

5. Consideration of the needs for environmental and climate-monitoring products and assessments, such as IPCC assessments, should be integrated into national, regional and global observing priorities.

6. Operation of historically-uninterrupted stations and observing systems should be maintained.

7. High priority for additional observations should be focused on data-poor regions, poorly-observed parameters, regions sensitive to change, and key measurements with inadequate temporal resolution.

8. Long-term requirements, including appropriate sampling frequencies, should be specified to network designers, operators and instrument engineers at the outset of system design and implementation.

9. The conversion of research observing systems to long-term operations in a carefully-planned manner should be promoted.

10. Data management systems that facilitate access, use and interpretation of data and products should be included as essential elements of climate monitoring systems.

Furthermore, operators of satellite systems for monitoring climate need to:

(a) Take steps to make radiance calibration, calibration-monitoring and satellite-to-satellite cross-calibration of the full operational constellation a part of the operational satellite system; and

(b) Take steps to sample the Earth system in such a way that climate-relevant (diurnal, seasonal, and long-term interannual) changes can be resolved.

Thus satellite systems for climate monitoring should adhere to the following specific principles:

11. Constant sampling within the diurnal cycle (minimizing the effects of orbital decay and orbit drift) should be maintained.

12. A suitable period of overlap for new and old satellite systems should be ensured for a period adequate to determine inter-satellite biases and maintain the homogeneity and consistency of time-series observations.

13. Continuity of satellite measurements (i.e., elimination of gaps in the long-term record) through appropriate launch and orbital strategies should be ensured.

14. Rigorous pre-launch instrument characterization and calibration, including radiance confirmation against an international radiance scale provided by a national metrology institute, should be ensured.

15. On-board calibration adequate for climate system observations should be ensured and associated instrument characteristics monitored.

16. Operational production of priority climate products should be sustained and peer-reviewed new products should be introduced as appropriate.

17. Data systems needed to facilitate user access to climate products, metadata and raw data, including key data for delayed-mode analysis, should be established and maintained.

18. Use of functioning baseline instruments that meet the calibration and stability requirements stated above should be maintained for as long as possible, even when these exist on de-commissioned satellites.

19. Complementary in situ baseline observations for satellite measurements should be maintained through appropriate activities and cooperation.

20. Random errors and time-dependent biases in satellite observations and derived products should be identified.