

WORLD METEOROLOGICAL ORGANIZATION

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**COMMISSION FOR BASIC SYSTEMS
OPEN PROGRAMME AREA GROUP ON INTEGRATED OBSERVING SYSTEMS
EXPERT TEAM ON SATELLITE SYSTEMS**

SIXTH SESSION

GENEVA, SWITZERLAND

12-15 APRIL 2011

FINAL REPORT



WMO General Regulations

Regulation 42

Recommendations of working groups shall have no status within the Organization until they have been approved by the responsible constituent body. In the case of joint working groups the recommendations must be concurred with by the presidents of the constituent bodies concerned before being submitted to the designated constituent body.

Regulation 43

In the case of a recommendation made by a working group between sessions of the responsible constituent body, either in a session of a working group or by correspondence, the president of the body may, as an exceptional measure, approve the recommendation on behalf of the constituent body when the matter is, in his opinion, urgent and does not appear to imply new obligations for Members. He may then submit this recommendation for adoption by the Executive Council or to the President of the Organization for action in accordance with Regulation 9(5).

EXECUTIVE SUMMARY

The sixth session of the Expert Team on Satellite Systems (ET-SAT) was convened in Geneva, Switzerland from 12 to 15 April 2011. The primary objectives of the session were:

- To refine the new baseline for the space-based Global Observing System proposed by the Coordination Group for Meteorological Satellites (CGMS) at its 38th meeting;
- To review and update accordingly the draft Implementation Plan for the Evolution of Global Observing Systems (EGOS-IP) developed by the Expert Team on the Evolution of Global Observing Systems (ET-EGOS); and
- To discuss the proposed concept of an architecture for climate monitoring from space.

The main outcome of the meeting was:

- A proposed revised baseline for CGMS contribution to the space-based Global Observing System, comprising a description of the available or firmly planned capabilities and services on geostationary or low-Earth orbit, as well as contingency planning, inter-calibration, and data availability aspects (Appendix III);
- A thorough review of the draft EGOS-IP including detailed comments and suggestions for its cross-cutting and space-related actions and recommendations (Appendix IV);
- Strong support to the proposed process to develop an architecture for climate monitoring from space, as a joint effort with space agencies, CEOS, CGMS, GCOS, GEO and WCRP, and a minor amendment suggested to the Draft Resolution 3.7/1 submitted to the Sixteenth Congress on this matter;
- Acknowledgement of the considerable work done by the Secretariat to draft a new part of the CIMO Guide that would be dedicated to space-based observations, thus reflecting the importance of space-based capabilities among the whole observation effort; action taken to review and finalize this draft for submission to the CIMO editorial board in 2011;
- Recommendations pertaining to the preparation for new generations of operational satellites with the aim to ensure user readiness without disruption.

The space agencies represented at the session provided an update on their respective satellite programmes and other significant activities. The session congratulated ROSHYDROMET for Elektro-L1 (launched January 2011), CMA for FY-3B (launched November 2010), and KMA for COMS-1 (launched June 2010 and just commissioned). Each of these satellites has been launched since ET-SAT-5 and initiates a new satellite series. The session was also pleased to note the confirmation and progress of plans for the new generation geostationary systems (FY-4, Himawari-8, GOES-R, MTG) while noting that the impact of NPOESS restructuring still needed to be fully assessed.

The session took note of the regular update of the Dossier on the space-based observing system and welcomed the ongoing effort to convert part of this information on a database with a view to facilitate further updates. It welcomed the gap analysis with respect to the GCOS ECVs that responded to a request from ET-SAT-5 and that would form a good basis for more detailed, thematically focussed, analyses.

The session was also informed on the progress made on Space Weather coordination, radio-frequency protection matters, the development of the WMO Integrated Global Observing Systems (WIGOS), the Global Space-based Inter-calibration System (GSICS), and the preparation of a WMO Workshop on the Impact of Observing Systems in 2012.

Finally the session discussed the implications of adopting WGS84 and EGM96, or their subsequent updates, as primary references for horizontal and vertical positioning respectively, and agreed that CGMS should be requested to update its global HRIT/LRIT specification to make it consistent with these internationally agreed references.



ET-SAT-6 participants. From left to right: Jérôme Lafeuille, Michael Kalb, Peter Albert, Ivan Petiteville, Victor Saulskiy, Lothar Schueller, Yasushi Izumikawa, Dohyeong Kim, Yang Jun. (Not on the picture: Barbara Ryan, Bizzarro Bizzarri, Lars Peter Riishojgaard.)

1. ORGANIZATION OF THE SESSION

The sixth session of the Expert Team on Satellite Systems (ET-SAT) was opened at 09h00 on Tuesday, 12 April 2011, at the WMO Headquarters in Geneva, Switzerland.

Ms Barbara Ryan, Director of the Space Programme, welcomed the participants (See Appendix I) on behalf of the WMO Secretary-General. She underlined the importance of ET-SAT to advise the CBS on satellite matters with a satellite operator's perspective and highlighted that ET-SAT was expected to play an important role towards the definition, implementation and use of space-based capabilities in the context of the WMO Integrated Global Observing Systems (WIGOS) and especially for the emerging architecture for climate monitoring from space that will be discussed by the WMO Congress shortly.

The ET-SAT Chairman, Dr Michael Kalb, welcomed the participants too. After introduction of the participants, he recalled the primary objectives of the session:

- To refine the new baseline for the space-based Global Observing System proposed by the Coordination Group for Meteorological Satellites (CGMS) at its 38th meeting;
- To review and update accordingly the draft Implementation Plan for the Evolution of Global Observing Systems developed by the Expert-Team on Evolution of Global Observing Systems; and
- To discuss and refine the proposed concept of an architecture for climate monitoring from space.

In addition, the session will follow-up the actions initiated at its first meeting, and address the various other aspects of its work

The Chairman introduced the provisional agenda of the meeting, which was adopted as contained in Appendix II.

The chairman of the Open Programme Area Group on Integrated Observing Systems (OPAG-IOS) gave introductory remarks and guidance on behalf of the Commission for Basic Systems (CBS). He emphasized the need for ET-SAT to monitor ongoing changes to the space programmes of WMO Members and other partners, in particular the cancellation or postponement of some programmes, which would impact on the possibility to realize the WMO Vision for the GOS in 2025. ET-SAT is requested to advise WMO on the potential consequences of this, and on possible mitigation strategies.

2. ET-SAT CHAIRMAN'S REPORT

The Chairman described the actions taken by ET-SAT since the fifth meeting and indicated his views regarding the future work of the Expert Team. He expressed a desire that other research and operational agencies involved in space-based observing, would find a way to participate in ET-SAT. He stressed that international cooperation and coordination are vital to ensure the efficiency of the global system, and ET-SAT has an important advisory role to the WMO Commission for Basic Systems and the Executive Council. He suggested there are ways in which ET-SAT can leverage the unique balance of research and operational perspectives among its members to address issues that require both perspectives. For example, ET-SAT might give particular consideration to issues that arise in the following two domains:

- 1) Exploration, assessment, and advocacy for best inter-organizational R2O practices that are based on actual experience internationally;
- 2) Exploration, assessment of the impacts of future advanced technology on next-generation satellite systems, capabilities and observing systems architecture concepts, which would better exploit the research perspectives of the research agencies.

He noted that the planning horizon of operational organizations is typically no more than a couple decades and appropriately focused on extensions of current-generation technologies. WMO has traditionally emphasized this operational perspective, for example in its 2025 Vision for GOS. Research organizations in addition, develop more visionary concepts ideas whose time horizon span decades - focused on next generation (or longer) capabilities, systems, and needs. Michael Kalb suggested the long term vision and perspectives that research agencies bring, might find expression through the ET-SAT to the benefit of WMO Members and to the evolution of future WMO and allied satellite-based observing systems and capabilities.

3. OUTCOME OF MEETINGS WITH RELEVANCE TO ET-SAT

The Secretariat presented a summary of the outcome of major meetings held since the fifth session on topics of direct relevance to ET-SAT. These included the sixty-second Executive Council (EC-LXII), the fifteenth session of the Commission for Instruments and Methods of Observation (CI-MO-XV), the 38th meeting of the Coordination Group for Meteorological Satellites (CGMS-38), the 2010 Extraordinary Session of the CBS (CBS Ext.(10)), the Steering Group on Radio-Frequency Coordination (SG-RFC) and the Workshop on Continuity and Architecture Requirements for Climate Monitoring. ET-SAT noted this information as background for its deliberations.

4. STATUS OF ACTIONS FROM PREVIOUS ET-SAT MEETINGS

ET-SAT reviewed the status of actions agreed at the fifth meeting as listed in Appendix III of the ET-SAT-5 Final Report: <http://www.wmo.int/pages/prog/sat/documents/ET-SAT-5FinalReport.pdf>. It was noted that a number of actions had been completed. The following comments were made on specific actions:

- Action 4.03 from ET-SAT 4, related to the data policy for the missions undertaken by Europe within the framework of Global Monitoring of Environment and Security (GMES): it was noted that the situation was evolving. ESA Member States have agreed to propose a fully open data policy; the decision needs now to be confirmed by the European Commission, which is expected to happen by June 2011. The action is therefore left open, pending notification of the EU policy.
- Action 5.01: EUMETSAT was thanked for its detailed analysis of the relevance of DOORS and of the potential migration of the Dossier to a database.
- Action 5.15 about terrestrial contributions to SCOPE-CM: CMA has recognized the great importance of establishing data records for satellite-based ECVs, and is willing to make possible further contribution to SCOPE-CM. Long term satellite climate datasets based on more than 20 years of satellite data have been established in CMA, some global and regional climate products were developed and made available over the last year including Precipitable Water Vapour, Outgoing Long-wave Radiation, Cloud Mask, Land Surface Temperature, Normalized Differential Vegetation Index, Sea Surface Temperature, and Snow Cover.
- Some actions were completed through the agenda items of the meeting.

Finally, it was concluded that all actions were successfully closed except Actions 4.03, 5.11, 5.12, and 5.15 to 5.19 that remained open, with new due dates, as listed at the end of this report (Appendix V).

5. SATELLITE PROGRAMME UPDATES FROM PARTICIPATING AGENCIES

ET-SAT members were invited to present each a brief update on the programmes of their Organizations, focusing on: highlights of recent programme development, new milestones, organizational changes if any, new technology.

Ivan Petiteville reported on the status of ESA Earth Observation satellites ERS-2 (to be operated until mid 2011), ENVISAT, GOCE, SMOS, and CRYOSAT-2, all operating very successfully. Future Earth Explorer missions are SWARM, ADM-Aeolus, EarthCare, and the seventh and eighth missions currently in the selection process. ESA is now providing a free data set of Earth Explorer mission data online without conditions, which was particularly welcomed by ET-SAT and the WMO Secretariat. Indications were also given on the GMES missions planned with the European Commission, and the ESA Climate Change Initiative.

Yang Jun presented an update on CMA's satellite status and plans including the FY-1, FY-3, FY-2 and future FY-4 series. The FY-3 constellation now includes FY-3A on a morning orbit and FY-3B on an afternoon orbit, and a number of products are being generated. The FY-2 constellation includes two operational spacecraft at 86.5°E and 105°E. The future geostationary series FY-4 will include an advanced 14-channel imager (AGRI), a Geostationary Interferometric Infrared Sounder (GIIS) with 913 spectral channels and a Lightning Mapping Imager (LMI). The launch is now scheduled for 2015. ET-SAT noted that the FY-3 constellation will also include a precipitation radar satellite on an inclined orbit.

Peter Albert summarized EUMETSAT plans including the implementation of an Antarctic data acquisition station to reduce timeliness of global Metop data, the now fully approved Meteosat Third Generation (MTG) programme with four imaging satellites starting in 2017 and two sounding satellites, starting in 2019. He indicated that the current baseline for Phase A studies of the EPS Second Generation is a twin satellite configuration. The Satellite Applications Facilities (SAFs) are preparing their second Continuous Development and Operations Phase covering the period 2012-2017.

Dohyeong Kim reported on the status of COMS-1, launched in June 2010 and now successfully commissioned. KMA started the operational dissemination of COMS images in HRIT and LRIT, and generates a number of products. Preparations for COMS follow-on are underway; it is considered to adopt a twin satellite configuration, with one spacecraft for the Meteorological Imager follow-on (to launch in 2017), also embarking a Space Weather sensor, and the other for the Ocean and Atmospheric Trace Gas monitoring (to launch in 2018).

Yasushi Izumikawa presented the Himawari programme including the current Himawari-6 and -7 (MTSAT-1R and -2) and the future Himawari-8 and 9 planned for launch in 2015 and 2017. The new spacecraft will have a 16-channel advanced imager.

Victor Saulskiy introduced the ROSHYDROMET programmes including the Elektro series (with Elektro-L2 to be located at 14.5°W), the Meteor series of meteorological polar-orbiting satellites, and the Kanopus and Resurs series of environmental satellites. He presented the payload of these respective satellite series and the corresponding ground segment.

Michael Kalb first informed ET-SAT on the new National Space Policy for the United States of America, which explicitly emphasizes NOAA/NASA collaboration in transitioning research capabilities into operational use, and increased emphasis to international partnership in the development of Earth observation from satellites. The National Space Policy explicitly addresses JPSS in these regards. NOAA's new "Next Generation Strategic Plan" follows the National Policy guidance, and calls for the establishment of a NOAA Climate Service (NCS). When the NCS is established (expected in Financial Year 2012), plans call for transition of the three national data centres (National Climate Data Center, National Geophysical Data Center and National Ocean Data Center) from NESDIS into the Climate Service. At that time NESDIS would likely revert to its original name: National Environmental Satellite Service (NESS). He presented an update on the satellite programmes including NPP (now scheduled for launch in early 2012), GOES-R (2015) and JPSS-1 (2016). He underlined the multiple cooperation activities NOAA is involved in, including the plan to proceed with a "COSMIC-2"

The session congratulated ROSHYDROMET for Elektro-L1 (launched January 2011), CMA for FY-3B (launched November 2010), and KMA for COMS-1 (launched June 2010 and just commissioned). Each of these satellites has been launched since ET-SAT-5 and initiates a new satellite series. The session was also pleased to note the confirmation and progress of plans for the new generation geostationary systems (FY-4, Himawari-8, GOES-R, MTG) while noting that the impact of NPOESS restructuring still needed to be fully assessed.

6. CONTINUITY AND TRANSITION ISSUES

6.1 Operational systems continuity and preparation for new generations

ET-SAT members exchanged views on the overall status of the global operational constellations of satellites, and possible areas of risks. The participants were invited to report on the activities initiated or planned towards the user community in preparation for the use of the forthcoming generations of satellites, in particular on the geostationary orbit.

ET-SAT noted a number of new advanced systems being planned for the current and next decade, which is extremely encouraging. There were also instances, however, where planned observing systems and capabilities are facing some delays, and cancellations that can impact the implementation of the 2025 Vision of the GOS, (e.g. for the USA: NPOESS/JPSS payload redefinition, postponement of CLARREO, removal of hyperspectral sounder from GOES-R baseline).

A critical aspect of satellite planning is to ensure smooth transition to upcoming new generations of operational satellites with no disruption for the users. In this respect, Michael Kalb reported on NOAA's "Proving Ground" preparatory activities for GOES-R, whereby a range of new products developed for the ABI instrument are emulated from other spacecraft data (e.g. Aqua/MODIS, Meteosat/SEVIRI) and submitted to pilot users (e.g. aviation forecasters, hurricane centres) for beta-testing and evaluation. The project started about five years in advance of the planned launch date.

A general recommendation was made that proxy datasets should be systematically provided to the user community in advance of the launch of a new generation satellite in order to help users to plan for ingesting such new data and preparing their utilization.

Such proxy datasets could be made available for download through the portal usually used for providing archive data and/or be disseminated through appropriate broadcasting systems when available. The meeting pointed out the advantage of DVB-S systems such as GEONETCast in such cases, since they are multi-purpose, are not dependent of the availability or location of the meteorological spacecraft, and are well suited for users with poor connectivity.

Recommendation 6.01: Proxy data sets should be systematically made available to the user community through data servers and broadcasting systems in advance of the launch of a new generation satellite in order to help users to plan for ingesting such new data and preparing their utilization.

Recommendation 6.02: Multi-purpose DVB-S broadcast systems should be used when available for the dissemination of proxy datasets for new generation satellites in order to provide data in advance of the availability of direct readout services.

ET-SAT was informed that the ET-SUP, through the VLab, intended to draft general principles for information and training of users for new generations of satellites. These principles will be presented to the next CGMS meeting. It was agreed that ET-SAT members will be invited to review and comment on this proposal in advance of CGMS.

Action 6.01: ET-SAT members to review the draft strategy for ensuring user readiness for future operational missions, to be initiated by the ET-SUP and VLab, with a view to submit a proposal to CGMS. (When available from ET-SUP and VLab, in advance of CGMS-39)

6.2 R&D missions and follow-on opportunities

ET-SAT was invited to provide guidance on the opportunities related to current or future R&D and demonstration missions, and the possible way forward to enable follow-on missions if relevant.

ET-SAT was pleased to acknowledge that there were a number of R&D missions that were planned or being operated and were proceeding very well.

It was reaffirmed that not all missions from R&D programmes, even if fully successful, should lead to a follow-on operational mission. (For example, some of them may be specifically aimed at process studies, or experimenting a technology which may not be justified or affordable for recurring missions before long). ET-SAT recommended that the discussion on R2O should primarily focus on those demonstration missions that pave the way for future operational systems. There was an exchange of views on the potential of new missions in this perspective.

First of all, it was expected that current plans for operational geostationary hyperspectral infrared sounding, and radio-occultation constellation, would materialize soon. It was also pointed out that ocean surface wind scatterometry was relying on one operational mission (METOP/ASCAT) and two missions for which the near-real time availability of data was still to be confirmed. EUMETSAT reported that they were cooperating with ISRO on the acquisition and dissemination of Oceansat-2 data. The meeting also very much welcomed the information that CMA was discussing with the State Ocean Administration of China the possible dissemination of HY-2A scatterometer data over CMACast.

Action 6.02: CMA (Yang Jun) to report on the possible dissemination of HY-2A scatterometer data over CMACast.

As concerns missions at the conceptual or demonstration stage, the meeting highlighted in particular the strong potential of e.g. wind Doppler lidar, multi-frequency radar for global precipitation, geostationary microwave, low-frequency MW radiometer for salinity and soil moisture, limb sounding, infrared spectrometry for CO₂/CH₄ monitoring, high-resolution land surface imagery, and arctic area monitoring from highly-elliptical orbits. The meeting agreed that this matter should be kept under review and discussed in more detail at a subsequent meeting.

6.3 GOS Dossier Update

A brief report was provided on the updating status of the Dossier on the Space-based Component of the GOS (<ftp://ftp.wmo.int/Documents/PublicWeb/sat/DossierGOS/>) the latest edition of which was issued in January 2011 (GOS-2011), and the actions planned in this respect.

The session took note of the regular update of the Dossier on the space-based observing system and welcomed the ongoing effort to convert part of this information on a database with a view to facilitate further updates. It was also noted that this work was performed in liaison with ESA, who is maintaining the CEOS Handbook and the Missions, Instruments and Measurements (MIM) database, and the NASA System Engineering Office (SEO), with the aim to harmonize the terminology, share information on items of common interest.

The meeting welcomed the proposed structure of the Table of Contents of future editions of Volume I (Programmes), which will focus on thematic areas rather than on agencies. It was clarified that Volume III (Gap Analysis) and Volume V (Compliance with requirements) were based on a quantitative evaluation of “instrument performances” contained in Volume IV (Performances); this quantitative evaluation results of a model applied to *generic characteristics* of each instrument

category. The evaluation of *actual* performances of each instrument to derive geophysical products would be the subject of another document: "Products and Instruments", the outline of which was introduced by B. Bizzarri. In this new document, however, the evaluation would rather be qualitative. ET-SAT wished to be informed of this new document when available.

Recommendation 6.03: The WMO Space Programme Office should communicate to ET-SAT members the "Products and instruments" document when available.

6.4 Gap Analysis of satellite missions with respect to GCOS ECVs

ET-SAT was informed on the Gap Analysis of satellite missions with respect to GCOS Essential Climate Variables (http://www.wmo.int/pages/prog/sat/meetings/documents/ARCH-WK-1_Doc03-2_ECV-gap-analysis.pdf)

The session welcomed this gap analysis that responded to a request from ET-SAT-5. It was stated that this analysis would form a good basis for more detailed, thematically focused, analyses by the relevant expert communities. It was stressed that such an analysis would be really useful once the relevant expert communities have reviewed it and taken ownership of it. No major development was suggested except to maintain it, if resources allow, in order to take into account the evolution of satellite status and plans and the possible feedback from thematic communities.

7. SPACE-BASED ARCHITECTURE

7.1 Revision of the CGMS baseline for the space-based GOS

At CGMS-38 (New Delhi, November 2010) CGMS Members agreed to proceed with an update of the CGMS baseline for GEO, LEO and HEO satellites within the Global Observing System, and discussed the main features of a proposed target configuration for 2015. It gave the action to WMO with the support of the relevant Expert Teams (i.e. primarily ET-SAT), to prepare an update of the baseline along the lines of the conclusions of CGMS-38, and to circulate it to CGMS Members in advance of CGMS-39, with a perspective of adopting it and submitting it ultimately to the CBS in 2012. This will be one of the priority matters to be addressed by ET-SAT-6.

The scope of the update was clarified in stating that it should apply to the overall configuration available or firmly planned (with approved funding) by the time of adopting the update. It was agreed that the baseline would list the missions committed as a whole by CGMS Members, while the details of the individual contributions of each agency would only appear in a supporting documentation thus providing useful traceability between the baseline and the actual plans. The session pointed out that the baseline should not be limited to listing space-based missions, but should encompass a commitment for data availability and dissemination; inter-calibration and contingency planning should also be referred to. It was agreed that space-based missions could be categorized at the first level by orbit types (GEO, LEO sun-synchronous, other LEO). The session did a thorough review of the draft update, the outcome of which is contained in Appendix III of the present Final Report.

Action 6.03: WMO Space Programme to communicate to CGMS the proposed update of the CGMS baseline for contributing to the space-based GOS, as contained in Appendix III of ET-SAT-6 Final Report (May 2011)

Action 6.04: ET-SAT members to review the draft revision of the Manual of the GOS (Part IV: Space-based sub-system) contained in Appendix B of ET-SAT-6/Doc. 7.1, and send comments to the Chairman (mike.kalb@noaa.gov) and to the Secretariat (jlafeuille@wmo.int). (June 2011).

7.2 Implementation Plan for the Evolution of Global Observing Systems

In the broader context of the Vision for the GOS in 2025, a draft Implementation Plan for Evolution of Global Observing Systems (EGOS-IP) is being prepared under the oversight of the Expert Team on the Evolution of Global Observing Systems (ET-EGOS). The ET-SAT session reviewed this draft implementation plan, focussing its attention on Section 3 (Over-arching, cross-cutting actions) and Section 6 (Space-based observing system). It was highlighted that the scope of the EGOS-IP was to describe the whole path between the present situation and the full implementation of the Vision for the GOS in 2025, whereas the scope of the CGMS baseline discussed under item 7.1 was to describe the present and firmly planned near-term situation. The CGMS baseline should thus be used as a reference to ensure consistency of the EGOS-IP with the actual and planned space-based observing system.

ET-SAT acknowledged that the draft EGOS-IP constituted an important document and expressed several general comments summarized below:

- It would be useful to provide a mapping of the proposed actions to the required elements of the Vision of the GOS e.g. through a requirements/actions verification matrix;
- Several sections of the document would deserve a corresponding action;
- A number of actions are formulated like a requirement rather than an implementation action (e.g. “ensure and maintain at least...”) and it is not clear whether an additional action is required, or the current status is satisfactory; in such cases it will be difficult to report on the progress or completion of the action;
- A new cross-cutting action is proposed regarding data policy and availability;
- Although not mentioned in the Vision for the GOS in 2025, the protection of the radio-frequency spectrum is essential for the implementation of the GOS, especially its space-based component; it is therefore suggested to dedicate a section to this issue;
- For some specific items (e.g. maximum separation of 70 degrees between adjacent geostationary satellite locations), the requirement should be evaluated further through an impact study.

The session then performed a detailed review of the draft EGOS-IP, the outcome of which is contained in Appendix IV of the present final report.

Action 6.05: WMO Space Programme to communicate to the Chairman of ET-EGOS the ET-SAT comments on the draft Implementation Plan for Evolution of Global Observing Systems (EGOS-IP), as contained in Appendix IV of ET-SAT-6 Final Report (1 May 2011).

Recommendation 6.04: An impact study should be performed to evaluate the importance of the requirement of no more than 60 degrees longitude separation between adjacent geostationary satellites.

7.3 Architecture for climate monitoring from space

When discussing the operational monitoring of climate from space, ET-SAT-5 had noted that an architecture “should be defined and implemented through a mechanism that accounts for the different roles and responsibilities of the respective entities while responding to the need for continuous and sustained operation”. It had suggested that a framework document be developed on this issue. When discussing this point, the sixty-second Executive Council (EC-LXII) “*invited the WMO Space Programme, in coordination with GCOS and with the support of relevant technical commissions, to work with space agencies, the CGMS, the Committee on Earth Observation Satellites (CEOS), and the Group on Earth Observations (GEO) in order to develop an architecture for sustained, space-based climate monitoring as a component of the future WIGOS and GFCS, for consideration by next Congress.*”

A draft outline for such a document was circulated to CGMS, CEOS and submitted to CBS Ext.(10) in November 2010. CBS agreed that the proposed architecture should enhance, and be

modelled after, the end-to-end system which has been created for weather observations, research, modelling, forecasting, and services; it should be part of the space-based component of the WMO Integrated Global Observing System (WIGOS). Other components of this end-to-end system would include the inter-calibration activities of the Global Space-based Inter-calibration System (GSICS), additional calibration and validation activities to be conducted in coordination with the Commission for Instruments and Methods of Observation (CIMO), the product generation efforts as done within the Sustained Co-Ordinated Processing of Environmental satellite data for Climate Monitoring (SCOPE-CM) and the training and capacity building activities of the WMO/CGMS (Coordination Group for Meteorological Satellites) Virtual Laboratory (VLab).

In response to this guidance, a first version of the concept document was issued on 20 December 2010 and presented to the Workshop on Continuity and Architecture Requirements for Climate Monitoring (13-14 January 2011). The document was slightly updated for submission to the Sixteenth WMO Congress as contained in the Appendix of ET-SAT-6/Doc. 7.3.

At the Workshop, it had been agreed that:

- A writing team would be established, involving representatives of CEOS, CGMS and the WMO Secretariat, to develop a joint document on this subject in coordination with GCOS and WCRP. Drafting of this joint document is underway and will be completed by October 2011.
- Meanwhile, each organization participating in this effort is welcome to address the architecture issue internally in accordance with its own practices and schedule; in the case of WMO, the WMO Space Programme document submitted to the Congress (Cg-XVI/Doc. 3.7) includes a Resolution on the development of an architecture for climate monitoring from space, which refers to the existing WMO concept document on this subject.

ET-SAT was invited to comment on the concept document on architecture for climate monitoring from space, which has been prepared for submission to the forthcoming Congress, and provide guidance on this matter. It was clarified that ET-SAT views would be communicated to the Consultative Meeting on High-level Policy on Satellite Matters in May 2011 (CM-11) with a view to inform Congress. Furthermore, the input from ET-SAT would be taken into consideration by the WMO Secretariat in its contribution to the writing team.

ET-SAT expressed strong support to the proposed process to develop an architecture for climate monitoring from space, as a joint effort with space agencies, CEOS, CGMS, GCOS, GEO and WCRP. It suggested amending the draft resolution of Cg-XVI with effect to replace “*an architecture be developed on the basis of the concept given in the annex*” by “*an architecture be developed using as a starting point the concept given in the annex*”. This amendment is meant to emphasize that the existing concept document drafted by WMO is expected to be superseded by the joint document to be elaborated by the writing team.

ET-SAT expressed the wish to review the draft document from the writing team in parallel with the review by GCOS, WCRP, and GEO

Action 6.06: WMO Secretariat to circulate to ET-SAT the draft document from the architecture writing team when it will be available for review by CGMS, CEOS and GEO (tentatively by 10 August 2011).

Action 6.07: WMO Secretariat to convey to CM-11 the outcome of ET-SAT deliberations on architecture for climate monitoring from space, including the suggested amendment of Draft Resolution 3.7/1 (Cg-XVI) - Development of an Architecture for Climate Monitoring from Space.

8. INTEGRATION ISSUES

8.1 CIMO Guide Update

The session was introduced to the draft of a new contribution to the Guide on Instruments and Methods of Observation (CIMO Guide) dedicated to satellite observations. This draft text is almost complete, with the exception of some introductory and concluding paragraphs, and considerations to be added on calibration and validation. Since it is a quite substantial volume of information (around 160 pages) this draft has been made available for review one month in advance of the meeting to collect feedback from ET-SAT members. It was presented the week before ET-SAT to the CIMO Management Group, which congratulated the Space Programme for taking this initiative and confirmed the expectation that this document, once finalized, would constitute a new part (Part IV) of the CIMO Guide, entirely dedicated to satellite observations.

ET-SAT acknowledged the considerable work done to draft this new part of the CIMO Guide related to satellite observations that will reflect the importance of space-based capabilities among the whole observation effort. ET-SAT agreed to review the draft and provide comments by end of June to the Secretariat, in order to allow the preparation of a consolidated draft to be submitted by the Space Programme Office to the CIMO Guide Editorial Board by October 2011

Action 6.08: ET-SAT members to review the draft CIMO Guide Part IV and send back comments to the Secretariat by 30 June 2011.

ET-SAT recommended that the Space Programme establish a WIKI to facilitate collaborative updating work, within ET-SAT. This would also enable collecting feedback from a wider community of experts, whose comments would be evaluated by ET-SAT for preparing future updates. In advance of the formal adoption of such updates, interim versions could be made available in a read-only form.

Action 6.09: WMO Secretariat to establish a WIKI – or equivalent capability - to support collaborative work on the CIMO Guide Part IV

Action 6.10: ET-SAT Chair and the WSP Secretariat to evaluate the relevance of using collaborative tools (e.g. WIKI or Google Docs) to support ET-SAT activity, based on the experience of the CIMO Guide WIKI.

8.2 Space-surface integration (Use of ground-based AWS networks)

ET-SAT discussed the use of ground-based networks of Automatic Weather Stations (AWS), in particular to support ground-truth validation of space-based observation. Michael Kalb indicated that existing reference sites were regularly used by NOAA for calibration and validation purposes. In many cases however, for example for the EUMETSAT Satellite Application Facilities (SAF), product developers are reporting difficulties to collect sufficient data for the validation or quality control of their products. The potential for increased use of AWS networks should thus be investigated further. ET-SAT expects an active support from ET-AWS on this matter.

Action 6.11: Lothar Schueller, to inform the SAF network on the availability and potential of the AWS networks and seek feedback on the SAF network requirements for ground-based observation data to support validation activities, to assess the interest of the SAF network for participating in a pilot project as proposed by ET-AWS, and communicate the outcome of these discussions to the ET-AWS through the WMO Secretariat.

9. USER INFORMATION AND DATA ACCESS

The Secretariat indicated that some key activities related to user information and data access had to be postponed. It was agreed that discussion on this subject would be deferred to a subsequent meeting.

10. SPACE WEATHER

An update was given on the work pursued by the Inter-Programme Coordination Team on Space Weather (ICTSW), which now involves 13 countries and six international organizations. A draft work plan was developed by ICTSW, in accordance with its Terms of Reference.

The first accomplishment of the ICTSW has been to define a priority set of variables to be observed, and to develop the corresponding requirements along the lines of the Rolling Requirements Review process. In doing so, attention was given to the difference between fundamental variables to be observed and products that can be derived from these variables. Building on the operational arrangements implemented by the International Space Environment Service (ISES), consideration is now being given to the harmonization of data management practices following WMO Information Systems (WIS) best practices and standards, and to the possible participation of ISES Regional Warning Centres as WIS Data Collection or Production Centres (DCPC).

Some contacts have also been established between the NWP community and the Space Weather modelling community with the view to exchange experience, namely in the area of model assessment and validation. Discussions are now planned on the concept of service centres for operational Space Weather prediction and services, using as possible models the "Regional Specialized Meteorological Centres", "Volcanic Ash Advisory Centres" and "World Area Forecast Centres". Finally the meeting was informed that Space Weather will be discussed at the forthcoming WMO Congress, and that the question of allocating resources to this new programme will have to be raised.

The meeting welcomed the progress done by ICTSW and wished that WMO Members allocate resources to enable this activity to develop as needed.

11. RADIO-FREQUENCY PROTECTION MATTERS

The session was informed on radio-frequency protection matters of relevance to ET-SAT, based on the outcome of the the Steering Group on Radio-frequency Coordination (SG-RFC) meeting held in January 2011. It was informed on the progress of preparatory activities for the next World Radio Conference (WRC-12) along with potentially important emerging issues on radio frequency protection. The presentation emphasized the role of ET-SAT in contributing to the work of the SG-RFC. It highlighted potential benefits to ET-SAT members and other Earth-Observation satellite coordination groups in taking advantage of WMO's observer status with the International Telecommunications Union (ITU) for providing a link into ITU processes. Participants were invited to provide updates and guidance on issues of direct relevance to ET-SAT such as the risk of allocation of part of the L-Band (1.7 GHz) to broadband mobile communications, and the interference observed in soil moisture measurements at 1.4 GHz.

EUMETSAT as a core member of WMO SG-RFC expressed concern about the lack of WMO support to the internal and external (within the framework of the ITU) activities for the protection of radio frequency spectrum used in the field of meteorology and climatology, despite strong requests from Congress (Resolution 4), EC-62 and CBS-EXT10 to put high priority to radio-frequency matters. This concern is supported by the fact that the proposed radio-frequency activity budget for the 2012-2015 period is drastically reduced to 73,500 CHF, i.e. at a level that will not allow relevant and necessary activities. It is considered that this lack of support, manifested in this budget cut for the 2012-2015 period, will have a detrimental effect on WMO's influence as a respected United Nations organization vis-à-vis the ITU and its member states, particularly in the framework of World Radio Communication Conference preparations.

Recommendation 6.05: Sufficient resources should be allocated in a WMO Budget to support the work of the Steering Group on Radio Frequency Coordination (SG-RFC) and an adequate level of representation of WMO in key international frequency coordination meetings.

Action 6.12: ET-SAT members to review the WMO Position Paper on the WRC-12 Agenda and provide feedback on this Position Paper and emerging issues to the SG-RFC through the Secretariat prior to last quarter of 2011.

Recommendation 6.06: ET-SAT members are invited to keep the SG-RFC informed of relevant issues from the space community, revitalize links with the SG-RFC and the WMO Secretariat to ensure effective WMO representation of Earth observation satellite providers and users in ITU processes.

12. NEW TECHNOLOGIES: Sensor web concept

Michael Kalb provided a presentation on an advanced technology concept for a next-generation integrated sensor web-based space (and ground) observing system and weather forecasting system architecture. The presentation was drawn from a NASA "2025 Vision" study to address the grand challenge of extending the useful range of model-based weather forecasts toward the two-week theoretical limit for deterministic prediction. The study explores how progress might be enabled through innovative design and technological advances that might be reasonably projected over a 25-year planning horizon. The study was used to help guide NASA future technology investments.

The study concluded that it may be possible to significantly extend the skill range of model based weather forecasting via a direct two-way feedback between numerical weather prediction models and a sensor web-based observing system. The system architecture, which was conceived to enable operational expression of optimized targeted observing, describes how the entire system might be designed and operated from the perspectives of the underlying science, technology evolution, and system engineering in order to provide the needed coordination between and among space- and ground-based observing and forecast model operations. This offered only an example of an integrated observing system based on the needs of operational weather forecasting. It was noted that architecture developed around the needs of climate observations might follow a similar development process, but would probably look very different.

13. UPDATE ON WIGOS

A brief report was given on the development and planned implementation of the WMO Integrated Global Observing System (WIGOS). It was indicated that the forthcoming Congress will be invited to make decision on the actual implementation of WIGOS and the related schedule and resources.

ET-SAT noted that several activities mentioned at the meeting were contributing to the WIGOS integration effort:

- GSICS: pilot project aiming at better integration among satellite data;
- Use of AWS networks: investigating a better integration of surface and space observations;
- CGMS baseline and EGOS-IP: integrating the objectives of climate monitoring and weather forecasting in a single observing system;
- Use of WIS standards: ensuring integration of data designation and interoperability of data catalogues. ET-SAT members wished to have more information on this latter point.

Action 6.13: The Chairman and the Secretariat plan a briefing in a future meeting on WIS standards, their applicability, and implications for satellite data.

14. UPDATE ON GSICS

A report was given on the latest status of the Global Space-based Inter-Calibration System (GSICS), including the outcome of the joint meeting of the GSICS Research Working Group (GRWG) and the GSICS Data Management Working Group (GDWG) that was held in Daejeon, Republic of Korea on 22-25 March 2011.

The goal of GSICS is to monitor, enhance, and harmonize data quality from operational weather and environmental satellites of the Global Observing System (GOS). GSICS aims at ensuring consistency among space-based observations worldwide for climate monitoring, weather forecasting, and environmental applications. It organizes the inter-calibration of critical components of the global observing system. Organizations contributing to GSICS are: CMA, CNES, EUMETSAT, ISRO, IMD, JAXA, JMA, KMA, NASA, NIST, NOAA, ROSHYDROMET, USGS, WMO. The initial focus of GSICS was on preparing a methodology and infrastructure for the inter-calibration of all geostationary infrared imagers to polar-orbiting reference instruments (IASI, AIRS). Activities are now extended to Visible channels, which was the main subject tackled by the GRWG-GDWG meeting in Daejeon. User workshops are being held every year to inform on developments and plans and to seek user feedback; the next user workshop will be in Oslo, Norway on 6 September 2011 during the EUMETSAT Meteorological Satellite User Conference.

ET-SAT members confirmed the key importance of enhanced calibration and inter-calibration to ensure data consistency and improve traceability to SI standards. It underscored the need for reference instruments (such as foreseen in the CLARREO and TRUTHS projects) for traceability. It was noted that GSICS and the CEOS Working Group on Calibration and Validation (WGCV) were keeping each other informed of their activities through cross-representation at their respective governing meetings, and they had each a different focus of activities.

15. SUGGESTED THEMES FOR THE WMO IMPACT WORKSHOP IN 2012

Lars Peter Risshojgaard informed ET-SAT on the plan to hold the Fifth WMO Workshop on the Impact of Observation Systems in May 2012 in the United States, and sought suggestions on candidate observing components to be evaluated.

Action 6.14: ET-SAT members to consider possible topics to be addressed at the Fifth WMO Workshop on the Impact of Observing System and submit proposals to Lars Peter Riishojgaard (Due date : June 2011)

16. ANY OTHER BUSINESS

- Use of WGS 84:

The session discussed the implications of adopting WGS84 and EGM96, or their subsequent updates, as primary references for horizontal and vertical positioning respectively, in accordance with the Recommendation Rec. 6.1/1 from CBS Ext.(06).

ET-SAT members noted that the differences between the CGMS standard and the references widely adopted by the international community were substantial for regional applications. This discrepancy caused complications and generated a risk of positioning errors when exchanging data with other communities (e.g. for GNSS, NWP and GIS applications). In order to resolve this discrepancy, ET-SAT agreed that CGMS should be requested to update its global HRIT/LRIT specification to make it consistent with these internationally agreed references.

Action 6.15: WMO SP Office to communicate to CGMS the recommendation to update the CGMS HRIT/LRIT specification in order to align it with WGS84/EGM96.

17. REVIEW AND ADOPTION OF THE DRAFT REPORT

A preliminary draft report of the meeting was reviewed. The detailed outcome of the break-out sessions, to be attached the minutes, was adopted subject to editorial finalization after the meeting. It was agreed that the full report would be circulated for adoption after the meeting.

18. DATE, PLACE AND AGENDA OF NEXT MEETING

The session identified April 2012 as a tentative timeframe for its next meeting, possibly in conjunction with ET-SUP. It was also agreed that a short (typically two-hour) web meeting should be organized in the meantime to review the progress of actions during the intersessional period.

Action 6.16: ET-SAT Chair and Secretariat to confirm the date of ET-SAT-7, tentatively scheduled in April 2012

Action 6.17: ET-SAT Chair and Secretariat to convene a short web-meeting in the September 2011 timeframe to review the progress on selected actions.

The Chairman thanked the participants and the Secretariat. The meeting closed on Friday 15 April at 16h30

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PROVISIONAL AGENDA

- 1. ORGANIZATION OF THE SESSION**
 - 1.1 Opening of the session
 - 1.2 Adoption of the agenda
 - 1.3 Working arrangements for the session
 - 1.4 Guidance from the OPAG-IOS Chairman
- 2. ET-SAT CHAIRMAN'S REPORT**
- 3. OUTCOME OF MEETINGS WITH RELEVANCE TO ET-SAT**
(Including Executive Council, CIMO, CGMS, CBS EXT(10), Architecture Workshop)
- 4. STATUS OF ACTIONS FROM PREVIOUS ET-SAT MEETINGS**
- 5. SATELLITE PROGRAMME UPDATES FROM PARTICIPATING AGENCIES**
- 6. CONTINUITY AND TRANSITION ISSUES**
 - 6.1 Operational systems continuity and preparation for new generations
 - 6.2 R&D missions and follow-on opportunities
 - 6.3 GOS Dossier Update
 - 6.4 Gap Analysis of satellite missions with respect to GCOS ECVs
- 7. SPACE-BASED ARCHITECTURE**
 - 7.1 Revision of the CGMS baseline for the space-based GOS
 - 7.2 Implementation Plan for the Evolution of Global Observing Systems
 - 7.3 Architecture for climate monitoring from space
- 8. INTEGRATION ISSUES**
 - 8.1 CIMO Guide Update
 - 8.2 Space-surface integration (Use of ground-based AWS networks)
- 9. USER INFORMATION AND DATA ACCESS**
- 10. SPACE WEATHER**
- 11. RADIO-FREQUENCY PROTECTION MATTERS**
- 12. NEW TECHNOLOGIES: Sensor web concept**
- 13. UPDATE ON WIGOS**
- 14. UPDATE ON GSICS**
- 15. SUGGESTED THEMES FOR THE WMO IMPACT WORKSHOP IN 2012**
- 16. ANY OTHER BUSINESS**
 - Use of WGS84
- 17. REVIEW AND ADOPTION OF THE DRAFT REPORT**
 - 17.1 **Break-out session reports** (summary for the final report and annexes)
 - 17.2 **Plenary session report** (including summary of actions)
- 18. DATE, PLACE AND AGENDA OF NEXT MEETING**

PROPOSED UPDATE TO THE CGMS BASELINE

Satellite missions to be performed on operational/sustained basis

Introduction

In support of the programmes coordinated or co-sponsored by WMO for weather and climate, CGMS Members plan to maintain the capabilities and services described below, that constitute the “CGMS baseline contribution to the GOS”.

The baseline takes into account the running satellite missions and the firmly planned satellite programmes as per 2011.

This baseline comprises a constellation of geostationary satellites, core meteorological missions and other missions in sun-synchronous orbits, missions in non-sun synchronous Low Earth Orbit, contingency planning, as well as provisions for satellite instrument inter-calibration, data dissemination and stewardship.

I. Constellation in geostationary orbit

At least six geostationary satellites shall be operated at evenly distributed locations with in orbit redundancy, and perform the following missions:

- (a) Advanced visible and infrared imagery (at least 16 spectral channels, 2km resolution) over the full disc at least every 15 minutes
- (b) Infrared sounding (hyperspectral on some positions)
- (c) Lightning detection
- (d) Data collection
- (e) Space environment monitoring

On selected positions, the following missions shall be performed :

- (f) Earth Radiation Budget monitoring
- (g) High spectral resolution UV sounding
- (h) Solar activity monitoring

II. LEO sun-synchronous missions

Operational sun-synchronous satellites shall be operated around three orbital planes in mid-morning (“am”, nominally 09:30 descending, 21:30 ascending ECT), afternoon (“pm”, nominally 13:30 ascending ECT) and early morning (nominally 05:30 descending, 17:30 ascending ECT) and, as a constellation, shall perform the following missions:

1) Core meteorological missions nominally on 3 orbital planes

- (i) Multispectral visible and infrared imagery
- (j) Infrared hyperspectral sounding (at least am and pm)
- (k) Microwave sounding
- (l) Microwave imagery

2) Other missions on sun-synchronous orbits

- (m) Wind scatterometry over sea surfaces (at least two orbits)
- (n) Ocean surface topography by radar altimetry (at least on am and pm orbits, supplemented by a reference mission on a high-precision, inclined orbit)

- (o) Radio-occultation sounding (at least am and pm, supplemented by a constellation in specific orbits)
- (p) Broadband VIS/IR radiometer for Earth Radiation balance (at least am and pm)
- (q) Total Solar Irradiance (at least one)
- (r) Contribution to atmospheric composition observations (at least am and pm)
- (s) Narrow-band Vis/NIR imagers (at least one sun-synchronous, am spacecraft) for ocean colour, vegetation and aerosol monitoring
- (t) High-resolution multi-spectral Vis/IR imagers (constellation of sun-synchronous satellites, preferably in am)
- (u) IR dual-angle view imagery for high-accuracy SST (at least one am spacecraft)
- (v) Particle detection and / or electron density (at least am and pm)
- (w) Magnetic field (at least am and pm)
- (x) Solar activity (at least two)
- (y) Data collection

III. Other LEO missions

The following missions shall be performed on an operational basis by Low Earth Orbit satellites on appropriate orbits:

- (z) Ocean surface topography by radar altimetry (A reference mission on high-precision, inclined orbit, complementing two instruments on sun-synchronous am and pm orbit)
- (aa) Radio-Occultation sounding (dedicated constellation of sensors on appropriate orbits)

IV. Contingency Planning

The CGMS baseline as well includes contingency plans for geostationary and polar-orbiting satellite systems, which are detailed in the CGMS Global Contingency Plan (http://www.wmo.int/pages/prog/sat/documents/CGMS_Global-Contingency-Plan_version2_070507.pdf)

V. Inter-calibration

All passive instruments should be inter-calibrated on a routine basis against reference instruments or calibration sites. The routine and operational intercalibration and corrections shall be performed following consistent standards as agreed by the Global Space-based Inter-calibration System (GSICS).

VI. Data availability and dissemination

VI.1. Data open availability with suitable timeliness

All operational environmental observation satellite systems should be designed to ensure the provision of data with suitable timeliness, as appropriate for their intended applications. Data should be documented with metadata allowing their interpretation and utilization. The satellite operators should establish dissemination contents and schedules that take into account the data requirements of users. Re-broadcast via telecommunication satellites should complement and supplement direct broadcast services, which allows cost-efficient access to integrated data streams including data from different satellites, non-satellite data and geophysical products.

VI.2. Direct broadcast for core meteorological missions in LEO

The core meteorological satellite systems in LEO orbits, and other operational observation satellite systems when relevant, should ensure near-real-time data dissemination of imagery, sounding, and other real-time data of interest to Members by direct broadcast. Direct broadcast frequencies, modulations, and formats for polar-orbiting satellites should allow a particular user to acquire data from either satellite by a single antenna and signal processing hardware.

Annex:

The CGMS baseline update was based on an assessment of currently (2011) operated or firmly planned satellite missions. The result of this assessment is summarized in this Annex.

ANNEX TO THE PROPOSED UPDATE TO THE CGMS BASELINE

I. Constellation in geostationary orbit

Missions	Qualifications	135W	75W	0	76E	86.5	93.5E	105E	128E	140E
VIS IR imagery	<i>At least 6 positions</i>	NOAA	NOAA	EUMETSAT	ROSHYDROMET	China	IMD	CMA	KMA	JMA
Advanced VIS/IR imagery (2km resol or better, at least 16 channels, 15min or better)	<i>2 positions 2015 3 positions 2016 8 positions 2017</i>	NOAA (as per 2017)	NOAA(as per 2017)	EUMETSAT (as per 2017)	ROSHYDROMET (2016)	CMA (2017)		CMA (2015)	KMA (as per 2017)	JMA (as 2015)
IR Sounding	<i>3 positions until 2018</i>	NOAA (until 2018) mitigation	NOAA (until 2019) mitigation				IMD			
IR hyperspectral Sounding	<i>1 position 2015, 2 position 2017 3 positions 2018</i>			EUMETSAT (as per 2018)		CMA (as per 2017)		CMA (as of 2015)		
Lightning detection	<i>2 pos. 2015 3 pos. 2016 6 pos. 2017</i>	NOAA (as per of 2015)	NOAA (as per 2017)	EUMETSAT (as for 2017)	ROSHYDROMET (as per 2016)	CMA (as per 2017)		CMA (as per 2015)		
Data collection	<i>At least 6 positions</i>	NOAA	NOAA	EUMETSAT	ROSHYDROMET	CMA	IMD	CMA	KMA	JMA
Space Weather Monitoring	<i>3 pos. 2015 4 pos. 2016 6 pos. 2017</i>	NOAA (as per of 2015)	NOAA (as per 2017)		ROSHYDROMET (as per 2016)	CMA (as per 2017)		CMA (as per 2015)	KMA (as per 2017)	JMA (as per 2015 housekeeping purpose)
Earth radiation budget	<i>1 position 2 position 2016</i>			EUMETSAT (until 2020)	ROSHYDROMET (as per 2016)					
High spectral resolution UV sounding	<i>1 position 2018</i>			EUMETSAT (s per 2018)						
Solar activity	<i>1 position 2015 2 positions 2016 5 positions 2017</i>	NOAA (as per of 2015)	NOAA (as per 2017)		ROSHYDROMET (as per 2016)			CMA (as per 2017)	KMA (as per 2017)	

II. LEO Sun-synchronous missions

II.1 Core meteorological missions required on 3 sun-synchronous orbital planes (AM, PM, EM), with direct broadcast

Missions	Planned Orbital Configuration as available or firmly planned by 2011 <i>(Missions marked with a star are operated in a "sustained" mode by R&D agencies)</i>		
	Mid-morning (AM)	Afternoon (PM)	Early morning (EM)
Multispectral VIS/IR imagery	EUMETSAT CMA ROSHYDROMET (as of 2015)	NOAA CMA	DOD/NOAA
IR hyper-spectral sounders	EUMETSAT CMA (as of 2016) ROSHYDROMET (as of 2015)	NOAA CMA (2014)	
MW sounders	EUMETSAT CMA ROSHYDROMET (as of 2015)	NOAA CMA	DOD/NOAA
MW imagers – some polarimetric	CMA ROSHYDROMET (as of 2015)	NOAA CMA JAXA (*) (no direct broadcast)	DOD/NOAA

II.2 Other operational/sustained missions on various orbits

Missions	Planned Orbital Configuration as available or firmly planned by 2011 (Missions marked with a star are operated in a "sustained" mode by R&D agencies)			
	Sun-synchronous Morning	Sun-synchronous Afternoon	Other sun- synchronous	Non sun-synchronous
Scatterometers (At least 2 on well separated orbital planes)	EUMETSAT ROSHYDROMET (2015)		ISRO(*) <i>ECT=12:00</i>	
Altimeter constellation	EU/ESA/EUMETSAT (as per 2014)		ISRO(*) <i>ECT=12:00</i>	EUMETSAT/CNES/NOAA/NASA (<i>Precision, inclined orbit</i>)
Radio occultation (At least 8 receivers)	EUMETSAT CMA (2016) ROSHYDROMET (2015)	CMA (2014)	ISRO(*) <i>ECT=12:00</i>	NOAA (<i>12 satellites</i>)
Broad-band Vis/IR radiometer –	CMA	NOAA		
Total solar irradiance sensor	CMA	NOAA		
Atmospheric composition (Contribution to)	CMA EUMETSAT ROSHYDROMET (2015)	NOAA CMA		
Narrow-band Vis/NIR imagers (for ocean colour and vegetation)	EU/ESA/EUMETSAT (as per 2014) ROSHYDROMET (as of 2015)			
High-resolution multi-spectral Vis/IR imagers (Land surface imaging constellation)	NASA/USGS INPE/ CNSA (*) EU/ESA (*) (as per 2014)			
IR dual-angle view imager (for high accuracy SST)	EU/ESA/EUMETSAT (as per 2014)			
Particle detection (Electrons, protons, neutrons, etc) and/or electron density	CMA EUMETSAT ROSHYDROMET (as of 2015)	CMA		DOD/NOAA (<i>early morning</i>)
Solar monitoring	CMA	CMA		
Magnetic field	CMA	CMA		
Data Collection System	EUMETSAT	NOAA		

ET-SAT Review of the EGOS IP

NOTE: ET-SAT did not review Section 5 on ground-based observations

General Comments:

1. Document refers to various sources of requirements (e.g. RRR, GCOS-IP, Vision for the GOS in 2025, GFCS, etc.):
 - a. Are all those requirements accessible, including GFCS requirements?
 - b. How is the content of the current document traceable to these requirements? For example could we have a cross-verification *matrix of requirements vs actions* ?
2. Several sections of the document, would deserve corresponding action(s) e.g. line 555 to 565, or Section 3.3, section 3.4, section 4
3. A number of “actions” are formulated like a requirement rather than an implementation action (e.g. “ensure and maintain at least...”) and it is not clear whether an additional action is required, or the current status is satisfactory; in such cases it will be difficult to report on the progress or completion of the action
4. A new cross-cutting action is proposed regarding the data policy.
5. It is suggested to include a section on radio-frequency protection, which is essential for the implementation of the GOS, especially its space-based component;
6. Use automatic heading numbering for the whole document
7. Generate automatically a table of contents with page numbers.

Specific Comments

1. Action C1:

- a. **Issue:** whatever is the success of an R&D mission, there is not necessarily an operational follow-on. Transition from R&D to operations does not necessary apply to ALL R&D missions, even if technology and applications are mature enough.
- b. **Recommendation:** reword such as “*Whenever relevant and feasible, encourage* the sustained operation of research-based observing systems, once their validation has shown they are mature enough”
or
“...sustained operation of *relevant* research-based observing systems, once their validation has shown that they are mature enough *and their cost-effectiveness is assessed.*”

2. Action C2:

- a. **Issue:** the action requests observing components (should be defined) to adhere to WIS standards. Several data providers agencies, which are not NMHSs, are using well defined international standards that might differ completely / slightly from those used in WIS.

8. Action S3

- a. **Issue:** this activity is not written as an action
- b. **Recommendation:** the text shall be reworded as an action with a well defined task, an actionee and a closure date such as “*plan and organize at international level, for all the RRR applications and especially for climate purposes, the time continuity of the key satellite sensors*”

9. Action S4

- a. **Issue:** The actual GEO constellation includes more than 6 satellites already, the main deviation from what is written in S4 is the 80-85° interval between GOES-W and MTSAT. If the EGOS-IP is meant to identify actions to fill the current gaps, and if an interval of 80-85° is a high matter of concern, then the action should be more specific, and require improvement of the geostationary coverage over the Pacific.
The following should however be noted:
 - The location of MTSAT/Himawari at 140°E is very important to meet Japan’s national requirements and is not expected to be changed.
 - The current overlap of MTSAT and GOES-W fields of view provides full coverage of the Pacific between 50 N and 50 S .
 - The coverage of the central Pacific is not only a matter of satellite locations, but also depends on the scanning mode. GOES-R imager will enable wind vector derivation over the full disc every 15 minutes.
- b. **Recommendation:** 1) the concern above the Pacific (interval of 80-85°) shall be added to the paragraph (2270 to 2276) preceding the description of **action S4** ; 2) the action shall call for an *improvement for the spatial and temporal coverage with GEO satellites over the Pacific*

10. Action S5

- a. **Issue:** the action is described as a goal not an action, and more details are needed.
- b. **Recommendation:** 1) the text should precise that the “*2km resolution is at sub-satellite point*”. 2) The action could be more specific in spectral requirements (the new baseline imagers will all have typically around 16 bands) “*with at least 16 channels*”. 3) Replace “*Ensure and maintain*” by “*Implement and maintain*” 4) Add *full disk coverage* as an additional requirement

11. Action S6

- a. **Issue:** the scheduling is critical for AMVs but this is not reflected in the text of the action
- b. **Recommendation:** replaced “*organize the processing of the imagery ...*” by “*organize the scheduling and processing of the imagery ...*”

12. Action S9

- a. **Issue:** There will be hopefully 3 orbital planes with LEO satellites, but more than one spacecraft in some of the planes (or close by): European and Chinese on AM, US and Chinese on PM, and possibly one Russian satellites in either AM or PM. So rather than mentioning “the 3 basic polar orbiting platforms” which de facto excludes some platforms, we could mention “the *core meteorological missions on the three basic orbital planes*”
- b. **Issue:** the action should be clarified reusing the preceding text as it refers to “Meteorological LEO satellites”
- c. **Recommendation:** 1) replace “*the three basic polar orbiting platforms*” by “*the core meteorological missions on the three orbital planes*”

13. Action S10

- a. **Issue:** the statement “*provide rapidly the specific data subsets to the different operational users*” is not sufficient and vague. As written, it is not actionable
- b. **Recommendation:** shall be reworded

14. MW sounders (2475)

- a. **Issue:** since there is a gap on MW sounding on the early morning orbit, this could be the scope of an action.
- b. **Recommendation:** add an action

15. Action S11

- a. **Issue:** ET-SAT thinks that this action is not needed as polar winds are already being produced in operation
- b. **Recommendation:** replace by an action *to implement a WV channel (e.g. 6.7 μm) on all core meteorological polar-orbiting satellites.*

16. Section 6.3.3.1, MW imagers

- a. **Issue:** In accordance with the proposed new CGMS baseline, this mission could be included in the core meteorological LEO missions (Move to section 6.3.2.).

17. Action S12, MW imagers

- a. **Issue:** Check the need for an action on MWI since current plans show MWI on at least 3 orbital planes. If it is only a question of “maintaining” a capability rather than “implementing” it, ET-SAT thinks that it is not the scope of an action.
- b. **Recommendation:** Remove, or define an implementation action as needed.

18. Action S13: Scatterometers

- a. **Issue:** “Maintaining” is not an implementation action. Two scatterometer missions are currently flying (METOP/ASCAT and Oceansat-2). Work is on progress to ensure timely access.
- b. **Recommendation:** Reconsider the need for an action, e.g. on organizing data processing and data delivery; drop the action unless specific issues are identified.

19. Altimeter constellation and Action S15

- a. **Issue:** The generally admitted strategy is not 1 polar-orbiting plus 1 reference mission, but 2 polar-orbiting plus a reference mission.
- b. **Recommendation:** To be consistent with CGMS discussions we could indicate: *“Implement an altimeter constellation comprising a reference mission on high-precision, not sun-synchronous, inclined orbit, and two instruments on well separated sun-synchronous orbits”.*

20. IR dual angle view (2665)

- a. **Issue:** CGMS found this point of the Vision (“dual-angle view”) surprisingly tailored to one specific instrument (ATSR and follow-on) and suggested to reformulate it in a more technology-free manner, e.g., Infra-red imagery for high-accuracy SST.
- b. **Recommendation:** Formulate the header of 6.3.3.5 in a more general way, not bound to a specific instrument technology.

21. **Narrow-band (2690)**
 - a. **Issue:** CGMS has pointed out that “narrow-band”, “high-spectral resolution”, and “hyper-spectral“ were not quite synonyms but largely redundant.
 - b. **Recommendation:** It suggested only mentioning “narrow-band”, which includes the other 2 categories.

 22. **VIS and NIR narrow bands Imagers (2700)**
 - a. **Issue:** the list is not complete.
 - b. **Recommendation:** OCM on the ISRO Oceansat-1 and Oceansat-2 satellites should be mentioned as well.

 23. **Action S17: VIS and NIR narrow bands Imagers**
 - a. **Issue:** LEO seems pretty well addressed. Gaps are mainly on GEO.
 - b. **Recommendation:** Limit Action S17 to the “**implementation of additional GEO components**”.

 24. **Action S18: GPM constellation (2765)**
 - a. **Issue:** the text mentions the value of missions in tropical latitudes. We could be more specific instead of just calling for support to the GPM constellation.
 - b. **Recommendation:** Reword the action to include “**In support of GPM , implement at least one low-inclination passive MW mission**”.

 25. **Instruments contributing to GHG monitoring (2835)**
 - a. **Issue:** SCIAMACHY is a major instrument for atmospheric composition. We could also add AIRS and IASI.
 - b. **Recommendation:** mention at least SCIAMACHY

 26. **Synthetic Aperture Radar (SAR) (2870)**
 - a. **Issue:** future Radarsat constellation covering the period 2015-2023 would deserve to be mentioned
 - b. **Issue:** there no action
 - c. **Recommendation:** mention RADARSAT

 27. **Action S21 : Doppler wind lidars**
 - a. **Issue:** The action has two aspects: one for ADM and one for the follow-on operation mission
 - b. **Issue:** Regarding ADM, there is currently an agreement with ECMWF. In the operational phase ECMWF will produce Level-2B and 2C products for ESA and external users. At that stage, there cannot be more ESA engagement for operational delivery as ADM is an R&D mission.
 - c. **Recommendation:** The first sentence of action S21 should be dropped.

 28. **Action S22: Cloud and aerosol lidars**
 - a. **Issue:** ET-SAT is not aware of detailed plans for operational use of these data, which are primarily aimed at process studies.
 - b. **Recommendation:** Check the relevance of Action S22.

 29. **Gravimetric sensors:**
 - a. In the text, replace “gravimetric sounders” by “gravimetric sensors”.
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LIST OF ACTIONS

I. Outstanding Actions from Previous ET-SAT Meetings

- Action ET-SAT 4.03: WMO Secretariat to seek confirmation from the EC that GMES data would be available to WMO Members as a contribution to the GOS.
- Action ET-SAT 5.11: Space Programme Office to circulate a draft of instrument guidelines based on the representative characteristics of selected instruments, for review by ET-SAT members.
- Action ET-SAT 5.12: CMA (Yang Jun) and ISRO (A.S. Kiran Kumar) to work towards consolidating an initial list of requirements for AWS sensors to contribute to the validation and ground truth of space-based observation (with reference to CBS/OPAG-IOS/ ET-SAT/SUP-4/DOC.18.1, Annex), by December 2010 in consultation with ET-SAT and ET-SUP members.
- Action ET-SAT 5.15: CMA (Jun Yang) and ISRO (Kiran Kumar), to consider possible further contribution to SCOPE-CM and communicate their interest to WMO Space Programme (B. Ryan). (20 May 2010)
- Action ET-SAT 5.16: ET-SAT Chair and Space Programme Office to prepare guidelines describing the desired contents of information that should be made available and forward this request to satellite agencies contributing to the GOS. (End June 2010)
- Action ET-SAT 5.17: ET-SAT members to provide links to web pages containing the required information on data access and related aspects. (November 2010)
- Action ET-SAT 5.18: WMO Secretariat (B. Ryan) will send a query to all R&D space agencies contributing to the GOS about potential relevance of their R&D missions for operational users, as well as data distribution plans when available. (End May 2010)
- Action ET-SAT 5.19: ET-SAT members to coordinate with the relevant point of contact for frequency management within their agencies and supporting national authorities in order to ensure that feedback is provided on the proposed position for WRC-12 (CGMS-37 WMO-WP-01) as agreed at CGMS-37, and to advocate this position at WRC-12. (End May 2010)

II. New Actions from ET-SAT-6

- Action ET-SAT 6.01: ET-SAT members to review the draft strategy for ensuring user readiness for future operational missions, to be initiated by the ET-SUP and VLab, with a view to submit a proposal to CGMS. (When available from ET-SUP and VLab, in advance of CGMS-39)
- Action ET-SAT 6.02: CMA (Yang Jun) to report on the possible dissemination of HY-2A scatterometer data over CMACast.
- Action ET-SAT 6.03: WMO Space Programme to communicate to CGMS the proposed update of the CGMS baseline for contributing to the space-based GOS, as contained in Appendix III of ET-SAT-6 Final Report. (May 2011)
- Action ET-SAT 6.04: ET-SAT members to review the draft revision of the Manual of the GOS (Part IV: Space-based sub-system) contained in Appendix B of ET-SAT-6/Doc.7.1, and send comments to the Chairman (mike.kalb@noaa.gov) and to the Secretariat (jlafeuille@wmo.int). (June 2011)
- Action ET-SAT 6.05: WMO Space Programme to communicate to the Chairman of ET-EGOS the ET-SAT comments on the draft Implementation Plan for Evolution of Global Observing Systems (EGOS-IP), as contained in Appendix IV of ET-SAT-6 Final Report. (1 May 2011)
- Action ET-SAT 6.06: WMO Secretariat to circulate to ET-SAT the draft document from the architecture writing team when it will be available for review by CGMS, CEOS and GEO. (tentatively by 10 August 2011)
- Action ET-SAT 6.07: WMO Secretariat to convey to CM-11 the outcome of ET-SAT deliberations on architecture for climate monitoring from space, including the suggested amendment of Draft Resolution 3.7/1 (Cg-XVI) - Development of an Architecture for Climate Monitoring from Space. (19 May 2011)
- Action ET-SAT 6.08: ET-SAT members to review the draft CIMO Guide Part IV and send back comments to the Secretariat. (30 June 2011)
- Action ET-SAT 6.09: WMO Secretariat to establish a WIKI – or equivalent capability - to support collaborative work on the CIMO Guide Part IV. (July 2011)
- Action ET-SAT 6.10: ET-SAT Chair and the WSP Secretariat to evaluate the relevance of using collaborative tools (e.g. WIKI or Google Docs) to support ET-SAT activity, based on the experience of the CIMO Guide WIKI. (October 2011)
- Action ET-SAT 6.11: Lothar Schueller to inform the SAF network on the availability and potential of the AWS networks and seek feedback on the SAF network requirements for ground-based observation data to support validation activities, to assess the interest of the SAF network for participating in a pilot project as proposed by ET-AWS, and communicate the outcome of these discussions to the ET-AWS through the WMO Secretariat. (September 2011)
- Action ET-SAT 6.12: ET-SAT members to review the WMO Position Paper on the WRC-12 Agenda and provide feedback on this Position Paper and emerging

issues to the SG-RFC through the Secretariat prior to last quarter of 2011. (30 September 2011)

- Action ET-SAT 6.13: The Chairman and the Secretariat to plan a briefing on WIS standards, their applicability and implications for satellite data, on the agenda of a future ET-SAT meeting. (ET-SAT-7)
- Action ET-SAT 6.14: ET-SAT members to consider possible topics to be addressed at the Fifth WMO Workshop on the Impact of Observing System and submit proposals to Lars Peter Riishojgaard. (May 2011)
- Action ET-SAT 6.15: WMO SP Office to communicate to CGMS the recommendation to update the CGMS HRIT/LRIT specification in order to align it with WGS84/EGM96. (In advance of CGMS-39)
- Action ET-SAT 6.16: ET-SAT Chair and Secretariat to confirm the date of ET-SAT-7 tentatively scheduled in April 2012. (September 2011)
- Action ET-SAT 6.17: ET-SAT Chair and Secretariat to convene a short web meeting in the September 2011 timeframe to review the progress on selected actions. (September 2011)

III. Recommendations from ET-SAT-6

Recommendation 6.01: Proxy data sets should be systematically made available to the user community through data servers and broadcasting systems in advance of the launch of a new generation satellite in order to help users to plan for ingesting such new data and preparing their utilization.

Recommendation 6.02: Multi-purpose DVB-S broadcast systems should be used when available for the dissemination of proxy datasets for new generation satellites in order to provide data in advance of the availability of direct readout services.

Recommendation 6.03: The WMO Space Programme Office should communicate to ET-SAT members the "Products and instruments" document when available.

Recommendation 6.04: An impact study should be performed to evaluate the importance of the requirement of no more than 60 degrees longitude separation between adjacent geostationary satellites.

Recommendation 6.05: Sufficient resources should be allocated in a WMO Budget to support the work of the Steering Group on Radio Frequency Coordination (SG-RFC) and an adequate level of representation of WMO in key international frequency coordination meetings.

Recommendation 6.06: ET-SAT members are invited to keep the SG-RFC informed of relevant issues from the space community, revitalize links with the SG-RFC and the WMO Secretariat to ensure effective WMO representation of Earth observation satellite providers and users in ITU processes.