W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N

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COMMISSION FOR BASIC SYSTEMS

OPEN PROGRAMME AREA GROUP ON INTEGRATED OBSERVING SYSTEMS

EXPERT TEAM ON SATELLITE SYSTEMS

SEVENTH SESSION

GENEVA, SWITZERLAND

17-19 APRIL 2012

FINAL REPORT

EXECUTIVE SUMMARY

The seventh session of the Expert Team on Satellite Systems (ET-SAT-7) was held from 17 to 19 April 2012 in Geneva. Among its major outcomes, the session has:

- Developed a new specification of the space-based subsystem for inclusion in the Manual on the Global Observing System (GOS Manual). This proposed update to the GOS Manual reflects the new baseline adopted by the Coordination Group for Meteorological Satellites (CGMS) for their contribution to the GOS, which was a major outcome of the previous ET-SAT session. The update represents a major step in implementing the Vision for the GOS in 2025. Its inclusion into the GOS Manual (or its equivalent in the context of WIGOS) will officialise and publicize at WMO level the commitments made by satellite operators within CGMS.

- Delivered a revision of the satellite-related parts (Chapter 6) of the Implementation Plan for Evolution of Global Observing Systems (EGOS-IP). The EGOS-IP identifies the implementation actions required for incremental improvement of global observing systems towards full realization of the Vision for the GOS in 2025, including surface- and space-based sub-systems as central components of the WMO Integrated Global Observing System (WIGOS).

- Reviewed the prototype of the "Satellite Observation Capabilities Review and Analysis Tool" (SOCRAT), which includes an online database of space-based observing capabilities with search and filter functionalities to support gap analyses, and which will replace the Dossier on the space-based observing system. The meeting welcomed this development, provided feedback and defined a roadmap for its validation and operational implementation. This new tool, together with the database of observational requirements is a major component of the RRR process and should play a key role in the context of WIGOS and for global satellite planning activities within CGMS. The meeting stressed the need to ensure reliability and sustainability of this effort through adequate resources and procedures.

- Reviewed and updated the evaluation of satellite missions against the reference observation strategy (derived from the Vision for the GOS in 2025). It noted anticipated gaps related to: early morning orbit imagery and sounding, geostationary infrared hyperspectral sounding, and limb sounding for stratospheric greenhouse gas monitoring. The meeting recommended urging Members to take initiatives to fill such gaps.

- Identified several items in the Vision for the GOS in 2025 that should be clarified or updated in order to set a clear goal for the evolution of global observing systems, in particular:
    - the specification of the required radio-occultation constellation,
    - the need for a multi-angle multi-polarization imager,
    - the atmospheric composition constellation, and in particular the distinction between nadir and limb sounders.

- Completed the review of a proposed new volume of the Guide on Instrument and Methods of Observation (CIMO Guide) dedicated to satellite observation. The proposed text was found a very substantial material of great relevance for satellite actual or potential users. It was reviewed with particular attention to correctness, completeness, and structure. It was recommended to submit this document to the CIMO editorial board after final editorial checking.

Finally, the session discussed options for its future scope and modalities of work for the next CBS intersessional period. It reaffirmed its readiness to continue to support WMO satellite activities in holding sessions independently from, but closely interacting with CGMS.

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Participants in the seventh session of the Expert Team on Satellite Systems, Geneva, 19 April 2012.

From left to right: Yasushi Izumikawa, Dohyeong Kim, Spephan Bojinski, Jun Yang, Kashyap N. Mankad,Nils Hettich, Jérôme Lafeuille, Michael Kalb, Barbara Ryan, Lars-Peter Riishojgaard, Wenjian Zhang.
(Not appearing in the picture: Lorenzo Sarlo, Peter Albert, Ivan Petiteville)

FINAL REPORT

1. OPENING OF THE SESSION

1.1 Introduction

The seventh session of the Expert Team on Satellite Systems (ET-SAT-7) opened at 9h00 on Tuesday, 17 April 2012, in the WMO Headquarters in Geneva, Switzerland. The ET-SAT Chairman, M. Kalb, welcomed the participants (See Annex 1). J. Lafeuille also welcomed the participants on behalf of the Secretariat.

1.2 Adoption of the agenda

The Chairman recalled the main focus of the session:

- To review the database of space-based capabilities and the Gap Analysis of the space-based component of the WMO Global Observing System (GOS),
- To update the Manual on the GOS with a view to align it with the new CGMS baseline,
- To review the draft Satellite Observation part of the Guide on Instrument and Methods of Observation (CIMO Guide) and define a roadmap for its completion.

The session should also follow up the actions initiated at previous meetings, and discuss future orientations of the team to be proposed to the Commission for Basic Systems (CBS).

The provisional agenda was adopted as contained in Annex 2.

1.3 Working arrangements for the session

The session agreed to work in plenary. All working documents and related background material were available on line : http://www.wmo.int/pages/prog/sat/meetings/ET-SAT-7.php.

1.4 Guidance from the OPAG-IOS Chairman

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 highlighted the value to CBS of the input provided by the team since its creation, and the emphasis put by WMO on observing systems, in the context of the WMO Integrated Global Observing System (WIGOS). He recalled that the outcome of ET-SAT would be discussed in June by the Implementation/Coordination Team on Integrated Observing Systems (ICT-IOS) with a view to submit recommendations to the fifteenth session of CBS from 10 to 15 September 2012 in Jakarta, Indonesia.

He expressed the view that while the value of ET-SAT's work was clear for CBS it may not be equally perceived by all the participating space agencies because of their involvement in multiple international activities with potential overlap e.g. CGMS and CEOS. He suggested that, when discussing the future work plan of ET-SAT (agenda item 12), a broad range of options be considered regarding the scope of activity and the modalities of work. One should ensure that on one hand, the team continues to provide useful advice to WMO and, on the other hand, the participating agencies perceive the benefit of being actively engaged in the team.

2. ET-SAT CHAIRMAN'S REPORT

The ET-SAT Chairman described the actions taken by ET-SAT since the sixth session and indicated his views on future steps to be accomplished. He underlined the good articulation between ET-SAT and the Coordination Group for Meteorological Satellites (CGMS), noting that

several key outcomes of the previous session had be submitted to and adopted by CGMS, in particular the new baseline for the operational contribution of CGMS to the GOS.

He emphasized two strategic directions to be pursued, within ET-SAT's mandate:

- Integration of observing systems, which may be understood at different levels, namely integration among various space-based systems, among space and ground, and among research and operational systems;
- Supporting the relationship between research & development and operational programmes, and facilitating transition –when relevant- from mature research capabilities to operation.

3. OUTCOME OF MEETINGS WITH RELEVANCE TO ET-SAT

J. Lafeuille presented a summary of the outcome of major meetings of direct relevance to ET-SAT since the sixth session. These included the sixteenth World Meteorological Congress (Cg-XVI), the sixth meeting of the Expert Team on Evolution of Observing Systems (ET-EGOS-6), the sixth meeting of the Expert Team on Satellite Utilization and Products (ET-SUP-6), the 39th meeting of CGMS and the eighteenth International TOVS Scientific Conference (ITSC-18).

The team noted that the new description of the WMO Space Programme adopted by Cg-XVI (See ET-SAT-7/Inf. 01) had now four components including Space Weather as a new activity:

(a) Integrated space-based observing system;
(b) Availability and use of satellite data and products;
(c) Information and training;
(d) Space Weather coordination.

The Congress has also adopted a Resolution tasking the WMO Space Programme to lead the WMO effort on Architecture for Climate Monitoring from Space in collaboration with CGMS and the Committee on Earth Observations Satellites (CEOS).

CGMS-39 has adopted the new baseline for its contribution to the GOS (as described in ET-SAT-7/Inf. 02), endorsed the conclusions of the Gap Analysis provided by WMO for GCOS ECVs, and agreed to amend the CGMS LRIT/HRIT Global Specification as recommended by ET-SAT.

During ITSC-18, the working group on International Issues and Future Systems discussed frequency protection, global planning and continuity issues, and stressed the need for atmospheric sounding in early morning orbits. The working group has discussed the emerging possibility of private undertaking for geostationary satellites, or private-public partnership, and has stressed that such initiatives should respect the global coordination effort and preserve open data exchange. It highlighted several issues related to data access and to the availability of pre-processing software for Direct Readout data from polar-orbiting satellites. In the same conference, another technical subgroup discussed the extension of the Regional ATOVS Retransmission System (RARS) to Suomi-NPP and Metop data, which was strongly supported by ITSC as a cost-efficient means to provide rapid access to multi-regional (if not global) sounding data.

L-P. Riishojgaard briefly reported on the outcome of the 11th International Winds Workshop held in Auckland, New Zealand, in February 2012. The workshop revealed the increasing impact of satellite winds on NWP, significant progress on wind derivation algorithms, and improved integration of wind data of various sources including LEO and GEO satellites.

S. Bojinski reported on the outcome of the sixth session of ET-SUP in December 2011, where issues on data and product availability and use were addressed. A Product Access Guide is being prototyped. ET-SUP has developed a web-based inventory of data access information and pre-processing software (See ET-SAT-7/Inf.04), which ET-SAT Members will be invited to review

and complete. The Virtual Laboratory for Training on Satellite Meteorology (VLab) is expanding its scope of activity and will work in partnership with the Committee of Space Research (COSPAR).

It was clarified that the Product Access Guide would point to web-based pages of the space agencies, describing the subset of their products falling into selected categories. These pages would be linked to the WMO website but would remain under full responsibility and control of the Space Agencies. ET-SAT acknowledged that this would require a certain level of harmonization. The pages should include disclaimers and should document the quality and validation domain of the products, clarifying in particular whether the products are operational or not. The Secretariat mentioned the Space Weather product portal as a possible model for such an approach (http://www.wmo.int/pages/prog/sat/spaceweather-productportal_en.php) .

4. STATUS OF ACTIONS FROM PREVIOUS ET-SAT MEETINGS

ET-SAT reviewed the status of actions agreed at the sixth meeting. The following actions were closed:

Nr.	Action	Observation
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.	The EU data policy for GMES is not yet finalized although it is expected to be open, as recommended by ESA Members. The action is closed and replaced by a **new Action ET-SAT 7.01**.
ET-SAT 5.13	WMO Secretariat to request from the ET-AWS an updated list of geophysical parameters currently available from AWS & radio sondes, with measurement accuracy, spatial & temporal resolution. (End June 2010)	Request completed. Follow-up action by ET-AWS is still outstanding, and was recalled to ET-AWS during its meeting in Geneva in parallel with ET-SAT-7.
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.	Closed following ET-SUP discussions and ET-SAT-7/Inf.4.
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)	Was replaced by an action to review the information contained in ET-SAT-7/Inf.4. See **new action ET-SAT 7.02**
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.	The scope of this action is unclear. Replaced by a **new Action ET-SAT 7.03**.
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.	WRC-12 is now completed. Report will be given under agenda item 11.
ET-SAT 6.02	CMA (Yang Jun) to report on the possible dissemination of HY-2A scatterometer data over CMACast.	CMA has investigated with SOA the possibility to disseminate HY-2A data. This is currently not possible since the HY-2A scatterometer, which is experimental, is not fully functional.
ET-SAT 6.03	WMO Space Programme to communicate to CGMS the proposed update of the CGMS baseline	Was submitted to the CGMS Working Group on Continuity and contingency

	for contributing to the space-based GOS, as contained in Appendix III of ET-SAT-6 Final Report. (May 2011)	planning and subsequently adopted by CGMS-39 (See ET-SAT-7/Inf.2)
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).	Was reviewed by ET-SUP. Further revision by ET-SAT-7 will be completed under agenda item 8.3.
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.	ET-SAT input was communicated to ET-EGOS and incorporated into EGOS-IP V10. Further review will be performed under agenda item 8.2, the outcome of which will be submitted to ET-EGOS in May 2012.
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.	Completed in October 2011. A revised draft was provided in Appendix to Document 7.1 for discussion under agenda item 7.1.
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)	The amendment suggested by ET-SAT was included in the Resolution adopted by Congress (See ET-SAT-7/Doc. 7.1)
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)	The draft was revised, taking into account the comments received. Will be further discussed by ET-SAT-7 under agenda item 8.3
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)	A Google Document was created and shared with ET-SAT. It was however not used because of size limitations for file conversion from WORD to Google Docs.
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)	Experience reveals some volume limitations for the conversion of WORD documents to Google docs.
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)	Interest confirmed by EUMETSAT LSA SAF and communicated to ET-AWS Chair in July 2011. ET-AWS confirmed its appreciation and intention to coordinate with the LSA SAF. Point of contact: Karl Monnik, (ET-AWS Chair), Australia
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)	WRC-12 is now completed. Report will be given under agenda item 11.
ET-SAT 6.13	The Chairman and the Secretariat to plan a briefing on WIS standards, their applicability and	Briefing was provided under agenda item 9.1

	implications for satellite data, on the agenda of a future ET-SAT meeting.	
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)	The workshop programme is now closed. Two impact studies were proposed: - limited geostationary coverage over the Pacific (ET-SAT-6). It was recommended to forward this proposal to the IWWG. **See new action ET-SAT 7.04.** - low-inclination sounding mission for humidity in the tropics (ET-SUP Chair) This suggestion was unclear.
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)	The proposal (CGMS-39 WMO-WP-25) was submitted to CGMS Working Groups on Telecommunications and on Data Dissemination, and accepted by CGMS-39. Action was taken by EUMETSAT to prepare a revised specification for adoption by CGMS-40.
ET-SAT 6.16	ET-SAT Chair and Secretariat to confirm the date of ET-SAT-7 tentatively scheduled in April 2012.	ET-SAT-7 was convened on 17-19 April.
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)	The web meeting was convened in January 2012.

The following actions remained open:

Nr.	Action	Observation
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. (1 month before ET-SAT 6)	Postponed until completion of the draft contribution to the CIMO Guide. New due date to be defined depending on future ET-SAT work plan.
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 ET-SAT/SUP-4/DOC.18.1, Annex), by December 2010 in consultation with ET-SAT and ET-SUP members.	Related document: http://www.wmo.int/pages/prog/www/OSY/Meetings/ET-AWS6-2010/Doc6.doc New due date: 1 September 2012
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)	CMA has stated its interest at ET-SAT-6, and is encouraged to contact the SCOPE-CM Secretariat (Lothar Schueller, EUMETSAT) to submit a proposal for one or several products, preferably in the terrestrial domain.
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)	Waiting for input from ET-SUP.

ET-SAT adopted the following new actions:

Action ET-SAT 7.01: WMO Secretariat to send a letter to the European Commission expressing the interest of the WMO community for GMES missions and the wish that GMES data (in particular from Sentinel 3, 4, 5) will be openly and freely accessible in order to maximize the benefit from these missions that are important European contributions to climate monitoring and applications.

Action ET-SAT 7.02: Members to review and update the list of web links to data access information and pre-processing software package which is contained in ET-SAT/Inf.4 and provide feedback to the WMO Secretariat (Stephan Bojinski: SBojinski@wmo.int)

Action ET-SAT 7.03: WMO Secretariat to send a letter to R&D space agencies not represented at ET-SAT-7, in order to express the interest of WMO for R&D missions of particular relevance for operational users, and to seek update on the plans for near-real time data accessibility.

Action ET-SAT 7.04: WMO Secretariat to forward to IWWG the recommendation to investigate the impact of the longitude separation between adjacent geostationary satellites over the Pacific for wind field derivation, noting that with current plans the requirement for no more than 70 degrees separation cannot be satisfied over that area.

ET-SAT reviewed the recommendations from ET-SAT-6 and reiterated the following:

Recommendation 1 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 2 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 3 Sufficient resources should be allocated 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.

(ET-SAT was pleased to note that a strong representation of WMO was ensured at WRC-12 by SG-RFC members and the Secretariat.)

Recommendation 4 ET-SAT members should keep the Steering Group on Radio Frequency Coordination (SG-RFC) informed of relevant issues from the space community, maintain links with the SG-RFC and the WMO Secretariat on frequency matters, to ensure effective WMO representation of Earth observation satellite providers and users in ITU frequency management processes.

5. PROGRAMME UPDATES FROM PARTICIPATING AGENCIES

5.1 NOAA

M. Kalb reported on NOAA satellite programme status, priorities and challenges. GOES-R is scheduled for the end of 2015 and user preparation activities are actively being pursued. The commissioning of Suomi-NPP is progressing. The instruments are producing high quality initial data, and cal/val activities are proceeding well. Apart from concerns regarding two near-IR channels on VIIRS, NPP is expected to be fully successful. Free flyer missions are under consideration to supplement NPP and JPSS with instruments that were demanifested from the former NPOESS baseline. The Cosmic follow-on programme is approved and will provide

enhanced radio-occultation sounding capabilities, but a gap of one or two years is anticipated between the current and the new generation of COSMIC satellites. Jason-3 is planned in international cooperation. DSCOVR is scheduled for 2014 for a Space Weather mission at L1.

5.2 CMA

J. Yang reported on CMA satellite programme status and plans. FY-2-D and -2E are operational at 86.5 E and 105 E while FY-2F is currently in storage. Simultaneous operations of two GEO satellites allow rapid scanning every 10 minutes, to be reduced to 5 minutes as of with FY-2-F and FY-2-G . FY-3A and 3B are operational on AM and PM orbit respectively, and the following satellites will have improved instruments. CMA is investigating the possibility to fly FY-3C and FY-3E on an early morning orbit. The new generation geostationary satellite FY-4 is being prepared and should fly enhanced imager, lightning mapper and an interferometric infrared sounder (GIIRS).

5.3 ESA

I. Petiteville reported on ESA satellite programme status and plans. The ERS 1, 2 , ENVISAT and PROBA-1 missions have been particularly successful in providing useful data well beyond their design lifetime (ENVISAT only stopped operating on 8 April 2012). ESA is operating three Earth Explorer missions: GOCE, Cryosat, and SMOS, and is planning for SWARM, to be followed by ADM-Aeolus and EarthCare. Phase A studies are ongoing for the following two Earth Explorer missions. The Sentinel satellites and instruments are under development.

5.4 ISRO

K.N. Mankad reported on ISRO satellite programme status and plans. Oceansat-2 is fully operational. The ISRO-CNES mission Megha-Tropiques is reaching the end of its commissioning phase. INSAT-3A and Kalpana are continuing to provide operational imagery. INSAT-3D is prepared for launch, possibly end of 2012. RISAT is on the launch pad and will be launched on 26 April, followed by the ISRO-CNES altimetry mission SARAL. Initial specifications of GISAT – an R&D mission having Hyperspectral VNIR and SWIR Imagers in addition to the multispectral VNIR and LWIR imaging capability were presented. ISRO is engaging in calibration activities within GSICS and preparing for INSAT-3D intercalibration with IASI and AIRS.

5.5 EUMETSAT

L. Sarlo reported on EUMETSAT satellite programme status and plans. Metop-B was prepared for launch on 23 May 2012. After the ET-SAT meeting, EUMETSAT and ESA have been informed by the launch service provider, Starsem, that the launch of the Metop-B satellite by a Soyuz rocket had to be postponed. This is due to additional measures required to ensure the availability of safe drop zones for parts of the launcher after liftoff. The launch has been postponed for some weeks, until appropriate measures are implemented. It is expected to take place in the second half of July, after the launch of MSG-3, which is scheduled for 19 June.. The biggest programmatic challenges at the moment are the preparation for Meteosat Third Generation (first launches in 2018 and 2019) and EPS Second Generation (first launch in 2020). The CNES-EUMETSAT-NASA-NOAA mission Jason-3 is still planned for 2013 to be followed by Jason-CS for continuity of service.

5.6 JMA

Y. Izumikawa reported on JMA satellite programme status and plans. MTSAT-1R and -2 are operational. The next generation Himawari-8 and -9 is planned for launch in 2014 and 2016 for operations as of 2015. It will fly a 16-channel high-resolution imager of ABI-class allowing full disc imagery in 10 minutes. Dissemination will be via Internet as a baseline, but satellite broadcast systems are being investigated as a possible complement.

5.7 KMA

D. Kim reported on KMA satellite programme status and plans. COMS is operated successfully and a number of products are generated. Its follow-on will be KOMPSAT-2A, under development in view of a launch in 2017. Preliminary concept studies have been initiated for a KMA mission in LEO that would contribute to the global climate monitoring system.

5.8 General remarks

In conclusion of these agency reports, the meeting noted the active programmes of all ET-SAT participating agencies and the many challenges to be faced with upcoming new generation satellites flying novel technology instruments. As concerns geostationary satellites, a striking trend is the extension of rapid-scan capabilities and the increasing convergence of high resolution imager capabilities.

6. GAP ANALYSIS OF SPACE-BASED MISSIONS

6.1 Information on the 2012 update of the GOS Dossier

ET-SAT was informed that the Dossier on the Space-based Global Observing System (referred to as "the Dossier") had been updated and significantly expanded in January 2012 (ftp://ftp.wmo.int/Documents/PublicWeb/sat/DossierGOS/). Efforts are now concentrated on migrating the contents of the Dossier to an online database to improve the accessibility and consistency of the information whilst facilitating its maintenance.

6.2 Conversion of the Dossier to a database: status and open issues

The Secretariat reported on the development of the "Satellite Observation Capabilities Review and Analysis Tool" (SOCRAT), which includes an online database recording all the relevant space-based observing capabilities, together with online search and filter functionalities to analyze these capabilities. The database is built as an extension of the Observational Requirements Database developed by the Secretariat in 2011. The SOCRAT tool will replace the Dossier, with the following aims:

- To provide a one-stop source of verified information on relevant space capabilities;
- To consolidate information that used to be maintained in parallel in the Dossier and diverse other media (Excel files, web pages);
- To improve the accessibility of information through a user-friendly online search interface;
- To facilitate the updating of information, and ensuring its consistency;
- To support monitoring of the evolution of the space-based GOS over time ;
- To support Gap Analyses in the Rolling Requirements Review (RRR) process for WIGOS.

The main contents of "SOCRAT" can be compared to the Dossier as follows:

(i) Factual information on instruments and satellite programmes, is as contained in Volumes 1 and 2 of the Dossier. Information from the January 2012 issue of the Dossier has been migrated almost in totality and will from now on be maintained in this new environment only.

(ii) Comparison between capabilities and the "Vision for the GOS in 2025". The SOCRAT tool visualizes the actual/planned capabilities with relevance to each element in the Vision. This replaces the "Gap Analysis" contained in Volume 3 of the Dossier;

(iii) Gap Analysis for individual variables, using a qualitative assessment of the suitability of instruments to measure these variables. This is based on a detailed categorization of instruments according to design characteristics and theoretical performances. This information was not contained in the Dossier.

(iv) In addition, it is envisaged to provide a quantitative comparison of instrument performances

with the RRR requirements, which would replace Volumes 4 and 5 of the Dossier. This new functionality is still under investigation.

ET-SAT acknowledged the development of SOCRAT as a remarkable breakthrough. The interface was found very convenient for consultation. Bearing in mind that it was still at prototype stage, ET-SAT anticipated that, once completed and validated, SOCRAT would become an essential reference for satellite users. Although the gap analysis was based on generic assessment of performances, ET-SAT considered that such a first level analysis could be a valuable starting point for studies and global planning activities. SOCRAT analysis tool was thus expected to play a useful role, particularly in the context of WIGOS and CGMS. It was expected to have much wider audience than the Dossier

ET-SAT stressed the need to ensure reliability and sustainability. In particular, the updating process should be well controlled within the Secretariat, and the factual contents on satellite programmes and instruments shall be consistent with the information provided by authorized agency sources. There should be a commitment by the Secretariat to maintain this tool, in order to arouse corresponding interest and commitment from satellite operators to provide input.

The maintenance has several aspects, with different implications in terms of resources:

(i) IT development and maintenance, for which it would be a great advantage to keep the resources and skills existing within the Secretariat;
(ii) Routine update of high-level information on satellite programmes (e.g. change of programme status, satellite names, launch dates, payload..), which is an on-going, transparent task within the Space Programme Office;
(iii) Detailed update of instruments technical characteristics (spectral, scanning, etc.), based on information shared annually within ET-SAT, CGMS and CEOS; this requires dedicated time and adequate technical background, either within the Secretariat or through consultancy support, to ensure information completeness and quality;
(iv) Instrument categorization, scientific evaluation of instrument relevance for particular missions, and of theoretical performance for particular variables; this also requires dedicated time and technical background, and would benefit of being reviewed by relevant expert groups (e.g. ET-SAT, ET-SUP, Science Advisory Groups, ITWG subgroup, etc.).

ET-SAT discussed ways to streamline the maintenance of the factual contents, taking into account the overall effort involved both on WMO Secretariat side and on agencies side. In order to facilitate the submission of input by agencies, ET-SAT recommended exploring the development of a tool enabling agencies to directly enter their updates. ET-SAT also recalled the on-going activity by ESA and NASA to maintain the CEOS “Measurement, Instrument and Missions” (MIM) database; it was noted that CEOS and WMO are keeping mutually aware of their developments in this respect and sharing information. To avoid unnecessary duplication, ET-SAT members recommended investigating ways to use SOCRAT to feed the CEOS MIM database.

Action ET-SAT 7.05: The Secretariat will develop a procedure for the management of the SOCRAT updating process, in order to ensure that the process is efficient and that satellite programme data are consistent with authorized information from agencies.

Recommendation 5: Given the pivotal role of the capabilities database in the RRR process and in support of global coordination of satellite planning, and the need to ensure its sustainability and reliability, it is recommended to assign resources with high priority within the Secretariat for technical maintenance, first level contents updating, and - through consultancy - for technical level updating and quality control.

Recommendation 6: Satellite operators, including ET-SAT and CGMS Members, and expert groups, should support the database updating process through submitting inputs and providing reviews and feedback.

Action ET-SAT 7.06: The Secretariat will investigate a mechanism or tool to facilitate provision of inputs and of feedback on the database contents.

Action ET-SAT 7.07: The Secretariat will investigate a mechanism for sharing SOCRAT data with e.g. the CEOS MIM.

ET-SAT then reviewed the "Mission review" and "Gap analysis" functionalities. The general approach was found relevant, however with scope for improvements.

As regards the "Mission review":

- The ranking of instrument performances for a given "Mission" is too detailed, which leads in some cases (e.g. Sea surface wind or Solid Earth) to a meaningless number of levels. For the purpose of the "Mission Review" 3 or 4 levels should generally be sufficient.

- It should be explained that the "ranking" does not mean a judgment on the overall value of the instruments, but an indication of their relevance for the specific objectives of the selected "Mission". "Ranking" could be renamed, e.g. as "Contribution".

- The term "Mission", which has been used in the Dossier for many years, is still misleading. No particular suggestion is made, however, for a better word (Objective? Reference? Sensing element?).

- It would be helpful to display the "reference observation strategy" in parallel with the actual plans, in order to better visualize the gaps.

As regards the "Gap Analysis", ET-SAT noted that instrument "relevance" was evaluated on the basis of design features, which is one important aspect, but from the user viewpoint the actual relevance of the instrument depends on a whole chain including also other factors such as: actual status of the instrument, of the spacecraft, of the ground segment, data accessibility. Therefore the qualification along 3 criteria (relevance of measurement, processing maturity, operational limitations) characterizes well a class of instruments with similar features, but the actual suitability of an instrument can only be documented individually. It would be helpful to insert links to quality information, if such information could be provided by the satellite operator as recommended by the Quality Assurance for Earth Observation (QA4EO) guidelines.

ET-SAT discussed the possibility to better quantify instrument performances. One option would be to use the performance estimation model of the Dossier Volume 4, but applying it to *actual* instruments instead of future ideal instruments. Such estimation could be provided for a few typical instruments representing the major instrument types and classes. If the performance estimation model was openly documented, this approach, although still based on *theoretical* performances, would provide an objective basis for comparing performances with requirements. Another option would be to document *actual* performances of *actual* instruments if such information was available. It was agreed to proceed stepwise, i.e. to complete and validate the SOCRAT tool with its current functionality, and to investigate at a later stage the feasibility of more precise performance evaluation.

Finally, ET-SAT discussed a roadmap towards the operational phase of SOCRAT. It was agreed that it would be submitted to selected users such as ET-SAT members, with password controlled access, for beta-testing. After successful completion of this beta-testing phase, it would be made openly available with a preoperational status (e.g. for 6 months) to seek feedback from

wider external expert groups (e.g. CGMS and international science working groups), after what it would be publicly advertized. The goal would be to make this tool available early September and introduce it at the forthcoming CBS session.

Action ET-SAT 7.08: The Secretariat to complete the development of the SOCRAT tool, to simplify the granularity of instrument classes, to review the description of instrument "ranking" with reference to "missions", and to implement updates and corrections mentioned at ET-SAT-7.

Action ET-SAT 7.09: Secretariat to consider including a quantitative estimation of instrument performance based on a performance estimator as contained in Volumes 4 and 5 of the Dossier.

Action ET-SAT 7.10: Secretariat to investigate the possibility to base performance assessments on actual instruments instead of theoretical instruments.

Action ET-SAT 7.11: Secretariat to submit SOCRAT to ET-SAT, ET-SUP, and ET-EGOS Members for beta-testing, with password, and subsequently make it openly available on a pre-operational, then operational basis.

6.3 Review of Gap Analysis methodology and outcome

ET-SAT reviewed the Gap Analysis of satellite missions contained in the SOCRAT tool and in the GOS Dossier. Some updates to individual programme information were identified, and particular attention was given to:

- The relevance of the overall methodology used;
- The consistency between the "reference observing strategy" indicated for each "Mission" and the items of the "Vision of the GOS in 2025";
- The accuracy of the assessment of risks and gaps.

This review led to a revised document as contained in Annex 3. In the course of this review, ET-SAT identified the following items for which an update of the Vision was suggested:

- Radio-occultation constellation: while the Vision calls for at least 8 GNSS RO receivers, it would be more appropriate to specify a minimum number of occultations per day;
- Multi-angle, multi-polarization visible/infrared imagery: while the Vision only calls for a "IR dual angle view imager", the potential of multi-angle and multi-polarization sensors should be recognized for proper monitoring of albedo and aerosols;
- Atmospheric composition: the atmospheric composition constellation is not sufficiently detailed in the Vision to provide a useful reference for planning. Distinction should at least be made between nadir and limb sounders, but more detailed requirements should be expressed by the relevant scientific community,
- Geostationary constellation: it had been noted by E-SAT-6 that the maximum interval of 70 degrees longitude between adjacent satellites would be exceeded (See Action 7.04 above).

In reviewing the plans for the coming decade, ET-SAT acknowledged that gaps were anticipated on several areas, and agencies should be urged to develop plans to fill these gaps:

(i) With the termination of the NPOESS programme and the lack of confirmation of a follow-on to the current DMSP, a gap is anticipated for imagery and sounding missions on the early morning orbit. Being aware of CMA's consideration for a possible FY-3 redeployment on such orbit, ET-SAT encouraged such efforts.

(ii) The requirement for hyperspectral infrared sounding from geostationary orbit is not expected to be accommodated for the two GOES and the MTSAT positions in current plans.

Alternative ways to implement such capability should be explored, including through free flyers.

(iii) There is no path towards an operational follow-on of the planned Global Precipitation Measurement (GPM) precipitation radar mission.

(iv) The long-term continuity of upward radiation measurements at the top of atmosphere is not planned on the afternoon orbit after JPSS-1.

(v) There is no long-term plan for limb sounders to monitor stratospheric ozone and greenhouse gases.

Action ET-SAT 7.12: ET-SAT Chair to forward to OPAG-IOS the conclusions of the revised Gap Analysis, raising the attention on anticipated gaps related to early morning orbit imagery and sounding, geostationary sounding, global precipitation measurement, Earth radiation budget, and limb sounding for stratospheric greenhouse gas monitoring, and to recommend urging Members to take initiatives to fill such gaps.

Action ET-SAT 7.13: ET-SAT Chair to forward to OPAG-IOS the suggestions for updating the Vision of the GOS in 2025.

7. ARCHITECTURE FOR CLIMATE MONITORING FROM SPACE

7.1 Update on the development of an architecture

ET-SAT was informed on the near completion of a strategy document by the joint CEOS/CGMS/WMO Writing Team on Architecture for Climate Monitoring from Space. It was noted that the architecture would comprise two aspects:

- A logical view, analyzing the functions to be performed by each agent and their interactions and data streams,
- A physical view, providing a mapping of the actual elements available or remaining to be implemented. This physical view will be initially documented by an inventory of all capabilities for either observation or product processing.

This systematic approach was found appropriate to establish a common ground and a shared understanding of the assets, needs and priorities.

Action ET-SAT 7.14: The Secretariat will circulate the survey to ET-SAT Members, once finalized by the writing team, to enable ET-SAT Members to liaise within their organization and ensure full consistency between the survey process and ET-SAT activities on Gap Analysis.

8. SATELLITE DOCUMENTATION UPDATE

8.1 Updating of the Manual on the GOS

ET-SAT reviewed and finalized the draft update of Part IV, “Space-based Subsystem”, of the Manual on the Global Observing System (GOS), which is part of the regulatory documentation to be approved by the WMO Executive Council. This Manual specifies the main high-level capabilities of satellite systems to be operated in support of WMO Programmes, as a basis for the commitments of WMO Members through their Space Agencies. The objective of this update was to align the future manual with the new baseline agreed by CGMS at its 39th meeting, which is an important step towards fulfilling the Vision of the GOS in 2025. It was recalled that a first version of this update had been presented to ET-SAT-6.

The session approved the new version with a few amendments. The meeting noted that there

are different ways to define the availabilty rate, e.g. including or not the planned outages, and it is normally specified with respect to a period (e.g. over one month). For the purpose of the GOS Manual, however, it was felt sufficient to mention an availability rate of 99% as a target. For geostationary imagery it was recommended replacing "*The availability rate of the imagery mission should be at least 99 per cent*" by *"For the imagery mission the availability rate of rectified and calibrated data should be at least 99 per cent as a target"*. Similarly the following formulation was agreed for LEO missions: *"The constellation should be designed to achieve a high level of robustness allowing the delivery of imagery and sounding data from at least three polar orbiting planes, in a.m., p.m. and early morning orbit, on not less than 99 per cent of occasions. This implies provisions for ground segment, instrument and satellite redundancy, and rapid call up of replacement launches or a.m. and p.m. spares."*

As concerns long-term data preservation, it was recommended to keep *"raw data records and ancillary data required for their calibration"* instead of *"carefully calibrated data records"*,

Action ET-SAT 7.15: ET-SAT Chair to submit the proposed update of the Manual on the GOS to the ICT-IOS with a view of its submission to the CBS Rapporteur on Regulatory Material.

8.2 Draft Implementation Plan for the Evolution of Global Observing Systems

ET-SAT took note of the latest draft (Version 11) of the Implementation Plan for Evolution of Global Observing Systems (EGOS-IP). The EGOS-IP identifies the implementation actions required for incremental improvement of global observing systems towards full realization of the Vision for the GOS in 2025, including surface- and space-based sub-systems, which are central components of the WMO Integrated Global Observing System (WIGOS).

ET-SAT was pleased to note that this latest draft incorporated the inputs provided by the last ET-SAT meeting. The document was further reviewed in light of the evolution of satellite plans and of the Gap Analysis discussed above. Further amendments were discussed as concerns:

- Use of ground-based GNSS receivers for water vapour monitoring and Total Electron Content;
- Action for microwave imagers with low frequency channel for all-weather SST monitoring;
- Performance criteria for radio-occultation ;
- Value of wide-swath altimeters;
- Action for implementing at least a precipitation radar mission and operational follow-on.

ET-SAT also reviewed the input provided by ET-SUP. As concerns Space Weather, it recommended creating a separate chapter as it involves both surface and space-based measurements.

The conclusions of ET-SAT on this item are summarized in : http://www.wmo.int/pages/prog/www/OSY/Meetings/ET-EGOS_Geneva2012/documents/EGOS7-Doc-10.2.2_2-ET-SAT.doc.

Action ET-SAT 7.16: ET-SAT Chair to forward to ET-EGOS the proposed revision to the satellite-related parts (including Chapter 6) of the EGOS-IP.

8.3 Updating of the CIMO Guide

ET-SAT discussed the proposed contribution to the Guide on Instruments and Methods of Observation (CIMO Guide). A first version of this significant document had been communicated and briefly discussed at the previous meeting. The second version had been made available over the preceding months in separate chapters. The team was informed of preliminary feedback from a reviewer of the CIMO Editorial Board, who had commended the author for the considerable amount of work that this draft represented, but had expressed concerns in particular on (i) the style and (ii) the accuracy of the terminology used for physical measurements.

The team expressed its appreciation for the impressive amount of work that had led to this document. The text was found very informative for satellite users and for potential users needing to understand the specific aspects of space-based observation. The team reviewed the whole document chapter by chapter with a view to assess the relevance, correctness, and completeness of the text, and to ensure it was properly structured and balanced. In the course of this review, a number of detailed corrections were elaborated. It was agreed to remove the last two sections of chapter 1, and to redraft part of the last chapter.

Action ET-SAT 7.17: Secretariat to implement the corrections agreed to the draft contribution to the CIMO Guide, ensure an editorial revision, and submit the revised text to the CIMO editorial board.

9. WIGOS/WIS MATTERS

9.1 Information on WIS standards applicable to satellite data

A presentation was given on the WMO Information System (WIS) and related standards. It was recalled that the WIS framework would include the Global Telecommunications System (GTS) as a core component but would offer a lot more flexibility on communication modes (near-real trime dissemination or retrieval), formats and standards, than the GTS. A key element is the description of data in globally interoperable catalogues following ISO catalogue and metadata standards.

As concerns metadata, a distinction could be made between:

- "discovery metadata" which are required for any data set circulating on the WIS and have to be compliant with the WMO core profile of metadata, which is based on ISO 19115, in order to ensure proper visibility in the WIS interconected catalogues.
- "interpretation metadata", which contain all relevant details to not only identify a dataset but actually use it, and are sometimes referred to as "WIGOS metadata" since –for observation datasets - they characterize the source of information rather than its format.

It was confirmed that if data were associated with WIS compliant metadata and registered in the WIS they would be automatically visible in the GEOSS as well, once the GEOSS portal would be fully operational.

9.2 Update on WIGOS in relation with satellite activities

An update was provided on the development and implementation of WIGOS. WIGOS is described as "an integrated, coordinated and comprehensive observing system to satisfy, in a cost-effective and sustained manner, the evolving observing requirements of Members in delivering their weather, climate, water and related environmental services".

The WIGOS Concept of Operations (CONOPS) was submitted as a draft to Cg-XVI who welcomed the proposed approach while requesting to refine the Functional Architecture of WIGOS. A Functional Architecture has been drafted ; it defines structures, processes, tools and core services for WIGOS. Effort is now focused on developing the WIGOS Implementation Plan, which is being reviewed by the Task Team on WIGOS Implementation Plan, in view of submission to the Executive Council (EC-64) in June 2012.

It was recalled that, in April 2010, ET-SAT had considered the implications of WIGOS for the Space Programme (ET-SAT-5 Doc. 9.1(2)) and identified the following areas for further integration efforts:

- Satellite instrument characteristics and inter-calibration
- Satellite data management (incl. metadata)
- Satellite-derived products and composite products,
- Global satellite planning,

- Complementary space and surface-based observations.

ET-SAT was pleased to note that the draft WIGOS Implementation Plan included several actions that ET-SAT was actively contributing to, in particular:

- *Update WMO Regulatory Material:* the GOS Manual is part of the Technical Regulations (Annex V); its update by ET-SAT addresses weather and climate monitoring in a fully integrated way.
- *Develop the Architecture for Climate Monitoring from Space*: ET-SAT member organizations are directly supporting this effort.
- *Develop and maintain RRR databases*: ET-SAT took an active role in reviewing the capabilities database and provided guidance for its completion.
- *Using the RRR process, (…) carry out a design for WIGOS at the global scale:* the Gap Analysis and the development with CGMS of a new baseline provides guidance towards a globally coordinated space-based observing system supporting WMO and co-sponsored programmes; it is the understanding of ET-SAT that this enhanced space-based observing system is the space-based component of WIGOS.
- *Develop WIGOS related guidelines and training materials and other relevant documentation:* the new CIMO Guide volume on satellite observation is expected to contribute to this task.

In addition, ET-SAT suggested three specific actions that would have a practical impact on further integration of satellite observations, that the WIGOS project may wish to support:

- Formalization of GSICS activities as a WIGOS component;
- Definition of requirements for surface observations in support of calibration or validation of satellite observation products;
- Workshops on dual use of observing systems by different application areas (e.g. GNSS RO by atmospheric and space weather communities of practice)

10. SPACE WEATHER ACTIVITIES

ET/SAT was informed on the work pursued by the Inter-Programme Coordination Team on Space Weather (ICTSW) in the area of space weather observing requirements, data management and exchange, and product definition and harmonization. It was recalled that CGMS decided to address Space Weather issues as a regular agenda item. Space Weather activities are addressed by WMO in various fora with a view to advocate for improved observations, to coordinate data exchange and operational products and services, to raise awareness of space weather impacts, to foster partnerships to share responsibilities, and to encourage research to improve these services.

ET-SAT commended ICTSW for the progress made, highlighting in particular the following outcomes:

- Initial set of Space Weather observing requirements
- Initial Statement of Guidance for Space Weather observations
- Prototype web-based Space Weather Product Portal
- Training module on Space Weather basics.

For the near future, work is underway in collaboration with ICAO to review the service specifications of Space Weather to global aviation. It was clarified that ICTSW was working in coordination with ISES, UN-COPUOS, and planned to collaborate with COSPAR.

ET-SAT was pleased to note that ICTSW membership was expanding but, unfortunately, the resources announced by WMO Members had not been confirmed and the sustainability of the work initiated was thus not guaranteed, in spite of the call from Cg-XVI to WMO Members.

11. OUTCOME OF THE WORLD RADIOCOMMUNICATION CONFERENCE

The session recalled the main outcome of the World Radiocommunications Conference 2012 on items of importance for WMO satellte activities. Significant progress was achieved in the negociation for radio-frequency spectrum thanks to a strong mobilization of SG-RFC experts around the Secretariat. The SG-RFC will meet in November 2012 to review the issues to be addressed in the preparation for the next WRC to be held in 2015.

12. FUTURE WORK PLAN AND TERMS OF REFERENCE

ET-SAT members exchanged views on the role of ET-SAT in the WMO system, and its complementarity with other advisory or coordination bodies in the satellite community. It was underscored that this team had provided very significant deliverables – such as the CIMO Guide contribution, the space-based component of the EGOS-IP, the Gap Analysis, and at its last meeting the revised CGMS baseline - that had a major positive impact on WMO and its priority activities. It was also acknowledged that none of these tasks, which are essential for WMO, could be accomplished in an external body.

The team discussed options to achieve greater participation and engagement of space agencies to maximize the efficiency of the meeting. The OPAG-IOS Chairman wondered whether that ET-SAT meetings could be collocated with e.g. CGMS in order to facilitate attendance. All members present expressed the preference to keep the meeting separate, highlighting the advantage of holding ET-SAT several months in advance of CGMS, as the exchange of views within ET-SAT helps to prepare coordinated contribution to CGMS.

It was stressed that the most important was to ensure the maximum outcome of ET-SAT meetings, which was likely to be achieved through a stronger engagement rather than in reducing the scope and duration of the meetings. It was also emphasized that the Terms of Reference and Work Plan of the team should be open enough to accommodate subjects to be discussed upon the initiatives of agencies. Finally, it is important to publicize the outcome of ET-.SAT meetings both internally to WMO –to CBS and EC- and externally – e.g. to CGMS and within the paricipating agencies.

These views will be reported to the ICT-IOS for preparation of a recommendation to CBS.

13. ANY OTHER BUSINESS

No other business was addressed.

14. REVIEW AND ADOPTION OF THE DRAFT REPORT

A draft list of actions agreed at the meeting was reviewed and adopted, subject to finalization after the meeting (See Annex 4). The main outcome of the meeting will be forwarded to the ICT-IOS by the ET-SAT Chairman, and ultimately to the fifteenth session of CBS via the OPAG-IOS Chair.

15. DATE, PLACE AND AGENDA OF NEXT MEETING

No further meeting of this expert team is planned until the CBS session where the mandate and workplan of this team will be reassessed. Web meetings and teleconferences will be held, as necessary, to coordinate the completion of outstanding actions .

The meeting was closed at 16h00 on Thursday 19 April 2012.

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ANNEX 1

Expert Team on Satellite Systems, Seventh Session (ET-SAT-7)

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ANNEX 2

WORLD METEOROLOGICAL ORGANIZATION
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COMMISSION FOR BASIC SYSTEMS
OPEN PROGRAMME AREA GROUP ON INTEGRATED OBSERVING SYSTEMS

EXPERT TEAM ON SATELLITE SYSTEMS

SEVENTH SESSION

GENEVA, SWITZERLAND, 17-19 APRIL 2012

ET-SAT-7/Doc. 1.2(1)
(24.I.2012)
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ITEM: 1.2

Original: ENGLISH

PROVISIONAL AGENDA

1. **OPENING OF THE SESSION**
   - **1.1** Introduction
   - **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**
4. **STATUS OF ACTIONS FROM PREVIOUS ET-SAT MEETINGS**
5. **PROGRAMME UPDATES FROM PARTICIPATING AGENCIES**
6. **GAP ANALYSIS OF SPACE-BASED MISSIONS**
   - **6.1 Information on the 2012 update of the GOS Dossier**
   - **6.2 Conversion of the Dossier to a database: status and open issues**
   - **6.3 Review of Gap Analysis methodology and outcome**
7. **ARCHITECTURE FOR CLIMATE MONITORING FROM SPACE**
   - **7.1 Update on the development of an architecture**
8. **SATELLITE DOCUMENTATION UPDATE**
   - **8.1 Updating of the Manual on the GOS**
   - **8.2 Draft Implementation Plan for the Evolution of Global Observing Systems**
   - **8.3 Updating of the CIMO Guide**
9. **WIGOS MATTERS**
   - **9.1 Information on WIS standards applicable to satellite data**
   - **9.2 Update on WIGOS in relation with satellite activities**
10. **SPACE WEATHER ACTIVITIES**
11. **OUTCOME OF THE WORLD RADIOCOMMUNICATION CONFERENCE**
12. **FUTURE WORK PLAN AND TERMS OF REFERENCE**
13. **ANY OTHER BUSINESS**
14. **REVIEW AND ADOPTION OF THE DRAFT REPORT**
15. **DATE, PLACE AND AGENDA OF NEXT MEETING**

ANNEX 3

DRAFT UPDATE OF THE MANUAL ON THE GOS AGREED BY ET-SAT-7

PART IV: SPACE-BASED SUB-SYSTEM

1 COMPOSITION OF THE SUB-SYSTEM

The main elements of the space-based sub-system are:

a. An Earth observation space segment:
   i) Operational satellites on Geostationary Earth Orbit (GEO);
   ii) Operational satellites on distributed, sun-synchronous, Low Earth Orbits (LEO);
   iii) Other operational/sustained satellites or instruments on appropriate orbits;
   iv) Research and development (R&D) satellites.

b. A space-based intercalibration system.

c. Associated ground segment for data reception, dissemination, and stewardship.

d. A user segment.

NOTES:

1. Information on the detailed characteristics and capabilities of current and planned systems of environmental satellites of the GOS is contained in the Database on Space-based Observation Capabilities, which is available on line: http://www.wmo.int/sat .

(Note: the direct link will be indicated when the database will be officially released. Information is currently available in the Dossier on the Space-based GOS that can be downloaded from the same website, and on the "Satellite Status" pages:http://www.wmo.int/pages/prog/sat/satellitestatus.php "

2. Information on the principles of remote sensing from space and on the derivation of geophysical variables from space-based measurements can be found in the Guide on Instruments and Methods of Observations, Part IV *(being developed).*

2. IMPLEMENTATION OF THE SUB-SYSTEM

2.1 General

2.1.1 Requirements: Operators of environmental satellites should meet, to the extent possible, the uncertainty, timeliness, temporal resolution, spatial resolution, and coverage requirements of the GOS as defined in the Rolling Requirements Review (RRR) process described in Part II of this Manual, and recorded in the requirements database: http://www.wmo-sat.info/db .

2.1.2 Technical coordination: Members operating satellites should ensure the greatest possible compatibility between their different systems, through following recommended Coordination Group for Meteorological Satellites (CGMS) practices, and publish details of the technical characteristics of their instrumentation, data processing and transmissions, as well as the dissemination schedules.

2.1.3 Continuity: A period of overlap of new and old satellite systems should be ensured to determine inter-satellite biases and maintain the homogeneity and consistency of time series observations, unless reliable transfer standards are available.

2.1.4 Contingency arrangements: The satellite operators, working together under the auspices

of the CGMS or otherwise, should ensure the continuity of operation, and the data dissemination and distribution services of the operational satellites within the sub-system.

2.1.5 Data collection platforms:

(i) Members operating satellites with a capability to receive data from Data Collection Platforms (DCP) should maintain technical and operational co-ordination under the auspices of CGMS in order to ensure compatibility.

(ii) A number of “international” DCP channels should be identical on all geostationary satellites to allow movement of mobile platforms across their individual footprints.

(ii) The satellite operators should publish details of the technical characteristics and operational procedures of their data-collection missions, including the admission and certification procedures.

2.2 Operational satellites on Geostationary Earth Orbit

2.2.1 Missions

The following capability should be provided:

a) Multispectral visible and infrared imagery;

b) Infrared sounding;

c) Lightning mapping;

d) Data collection from in-situ observing systems;

e) Space environment monitoring;

f) Other capabilities as appropriate, e.g. Broadband and spectral visible and infrared (for Earth radiation budget estimates), high spectral resolution UV sounding (for atmospheric composition), high-spectral resolution visible and infrared imaging (for ocean colour), solar activity monitoring.

2.2.2 The constellation of satellites in geostationary orbit should provide full disc imagery at least every 15 minutes, throughout a field of view between 60^0 S and 60^0 N. This implies the availability of at least six operational geostationary satellites located at evenly distributed longitudes, with in-orbit redundancy. On-demand rapid-scan capabilities should be implemented where feasible.

2.2.3 For the imagery mission the availability rate of rectified and calibrated data should be at least 99 per cent as a target. 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 in order to achieve continuity.

2.3 Operational spacecraft on distributed sun-synchronous Low Earth Orbits

2.3.1 Missions

The following capability should be provided on several, distributed orbital planes:

a) Multispectral visible and infrared imagery;

b) Infrared sounding;

c) Microwave imagery;

d) Microwave sounding;

e) Scatterometry (for ocean surface winds);

f) Radar altimetry (for ocean surface topography);

g) Radio-occultation sounding;

h) Broadband visible and infrared radiometry for Earth radiation budget measurements;

i) Passive UV sounding (for atmospheric composition monitoring);

j) Space environment monitoring including particle detection and magnetic field measurement;

k) Solar activity monitoring;

l) Data collection from in-situ observing systems;

m) Direct broadcast;

n) Other capabilities as appropriate.

2.3.2 The orbital configuration of satellites in sun-synchronous orbits should enable to provide global coverage for Visible, Infrared and microwave imagery and Infrared and microwave sounding, which represents the core meteorological mission, at least six times per day with a regular temporal sampling. This will require sun-synchronous satellites operated along three orbital planes: one ante-meridian (a.m.) orbit with a descending equatorial crossing around 9:30 Local Solar Time (LST), one post-meridian (p.m.) orbit with an ascending equatorial crossing around 13:30 LST, and one early-morning orbit with an ascending equatorial crossing around 17:30 LST. There should be at least one operational satellite on each of these planes, with redundancy on the am and pm orbits.

2.3.3 At least two of these satellites, one in am and one in pm, should perform Infrared sounding with an hyperspectral sensor.

2.3.4 At least two satellites, one in am and one in pm, should be equipped with radio-occultation receivers;

2.3.5 At least two satellites, on well separated orbits, should be equipped with wind scatterometers;

2.3.6 At least two satellites, one in am and one in pm, should perform broadband Visible/Infrared Earth radiation monitoring;

2.3.7 At least two sun-synchronous satellites, on well separated orbits, should be equipped with altimeter packages for global ocean surface topography monitoring.

2.3.8 Data from these satellites should be acquired on a global basis, without temporal gaps for blind orbits, and delivered to users to meet timeliness requirements.

2.3.9 The constellation should be designed to achieve a high level of robustness allowing the delivery of imagery and sounding data from at least three polar orbiting planes, in a.m., p.m. and early morning orbit, on not less than 99 per cent of occasions. This implies provisions for ground segment, instrument and satellite redundancy, and rapid call up of replacement launches or a.m. and p.m. spares,.

2.4 Other operational/sustained spacecraft on appropriate Low Earth Orbits

2.4.1 Missions

The following capability should be provided:

a) High-precision radar altimetry (for ocean surface topography);

b) Radio-occultation sounding from non sun-synchronous orbits;

c) Total solar irradiance;

d) Dual-angle view infrared imagery (for high-accuracy sea surface temperature measurement);

e) Narrow-band Visible and Near Infrared imagers for ocean colour, vegetation and aerosol monitoring;

f) High-spatial resolution multispectral Visible and Infrared imagery.

2.4.2 An altimetry mission on high-precision, inclined orbit should complement the two altimetry missions in sun-synchronous orbits to build a robust ocean surface topography constellation;

2.4.3 A constellation of dedicated spacecraft with radio-occultation sensors on appropriate orbits should complement the radio-occultation missions on sun-synchronous orbits;

2.4.4 At least one satellite should perform downward solar irradiance monitoring, with provisions for overlap between consecutive missions in order to maintain measurement continuity;

2.4.5 A sun-synchronous spacecraft should be maintained on an a.m. orbit with high-accuracy Infrared imagery to provide reference measurements of sea surface temperature;

2.4.6 Continuity should be provided for at least one narrow-band Visible and Near Infrared imager on a sun-synchronous a.m. orbit to monitor ocean colour, vegetation and aerosols;

2.4.7 Several sun-synchronous satellites in a.m. orbit should be equipped with high-resolution (10-m class) multispectral Visible / Infrared imagers to build a constellation providing sufficient coverage of the land surface.

2.5 Research and Development satellites

2.5.1 Purposes: The main purposes of research and development satellites are:

(i) To support scientific investigations on atmospheric, oceanic, and other environment related processes,

(ii) To test or demonstrate new or improved sensors and satellite systems in preparation for new generations of operational capabilities to meet WMO observational requirements.

2.5.2 Missions: Observing capabilities should be provided to enable for instance the following:

(i) Observation of the parameters necessary to understand and model the water cycle, the carbon cycle, the energy budget and the chemical processes of the atmosphere;

(i) Pathfinders for future operational missions should include for instance: precipitation radars, Doppler lidars, low-frequency microwave radiometers, geostationary microwave imagers and sounders, geostationary narrow-band Visible and Near Infrared imagers, gravimetric sensors, and imagery missions in high-inclination highly elliptical orbits.

2.5.3 Although neither long term continuity of service nor a reliable replacement policy are assured, research and development satellites also provide, in many cases, information of great value for operational use. To this purpose, and in order to promote the early use of new types of data in an operational environment, provisions shall be made when relevant to enable near-real time data availability.

2.6 Inter-calibration system

2.6.1 Operators of environmental satellites should perform rigorous prelaunch instrument characterization and calibration, including radiance confirmation against an international radiance scale provided by a National Metrology Institute.

2.6.2 After launch, all passive instruments should be inter-calibrated on a routine basis against reference instruments or calibration targets, using established and documented methodologies.

2.6.3 Spacecraft with at least one high-quality Hyperspectral Infrared instrument should be maintained in a LEO orbit to provide reference measurements for intercalibration of operational Infrared instruments respectively in geostationary or LEO orbit. Advantage should be taken of satellite collocation to perform instrument intercalibration.

2.6.4 A range of ground-based calibration targets should be maintained, with precise characterization, in order to support routine Visible channel calibration operations.

2.7 Associated ground segments

2.7.1 Members operating environmental observation satellites should make satellite data available to other Members over the WMO Information System (WIS) in accordance with WIS data management practices, and shall inform the Members of the means of obtaining these data through catalogue entries and metadata enabling their meaningful use.

2.7.2 Receiving and processing facilities should provide for the reception of remote-sensing and DCP data from operational satellites and for the processing of quality-controlled environmental observation information, with a view of further near-real time distribution.

2.7.3 Satellite data archives should include Level 1B, together with all relevant metadata pertaining to the location, orbit and calibration procedures used. The archiving system should be capable of providing on-line access to the archive catalogue with a browse facility, and description of data formats, and allowing users to download data.

2.7.4 Data dissemination

All operational environmental observation satellite systems should ensure near-real-time data dissemination of the appropriate data sets, per the requirement of Members, either by direct broadcast or re-broadcast via telecommunication satellites.

2.7.5 In particular, the operational sun-synchronous satellites providing the core meteorological imagery and sounding mission should have Direct Broadcast capability as follows:

(i) Direct broadcast frequencies, modulations, and formats should allow a particular user to acquire data from either satellite by a single antenna and signal processing hardware. To the extent possible, the frequency bands allocated to Meteorological Satellites should be used.

(ii) Direct broadcast should be provided through a high data rate stream, such as the High Resolution Picture Transmission (HRPT) or its evolution, to provide meteorological centres with all the data required for numerical weather prediction (NWP), Nowcasting, and other real-time applications;

(iii) If possible, a low data rate stream should also be provided, such as the Low Rate Picture Transmission (LRPT), to convey an essential volume of data to users with lower connectivity or low-cost receiving stations.

2.7.6 Re-broadcast via telecommunication satellites[1] should complement and supplement direct broadcast services, to facilitate access to integrated data streams including data from different satellites, non-satellite data and geophysical products.

2.7.6 Data stewardship

It is essential to preserve long term, raw data records and ancillary data required for their calibration, reprocessing them as appropriate, with the necessary traceability information to achieve consistent Fundamental Climate Data Records. Operators of environmental satellites should provide full description of all steps taken in the generation of satellite products, including algorithms used, specific satellite datasets used, and characteristics and outcomes of validation activities.

2.8 User Segment

2.8.1 Users' stations

2.8.1.1 All Members should endeavour to install and maintain in their territory at least one system enabling access to digital data from both LEO and geostationary operational satellite constellations,

[1] Formerly referred to as “Advanced dissemination methods” (ADM), this technique generally uses Digital Video Broadcast (DVB) standard or its evolution.

either a receiver of re-broadcast service providing the required information in an integrated way, or a combination of dedicated direct readout stations.

2.8.1.2 Members requiring access to data from research and development satellites will need to download these data from the appropriate servers, or install a relevant re-broadcast service providing the required information, or install an appropriate direct broadcast user station, if the R&D satellite has such direct broadcast capability.

2.8.1.3 Data-collection platforms: In order to extend the GOS by the use of the data-collection and relay capability of the environmental observation satellites, Members should establish fixed or moving DCP systems, in particular to cover data-sparse areas.

2.8.2 Education and Training

2.8.2.1 Centres of Excellence

Support should be provided to education and training of instructors in the use of satellite data and capabilities e.g. at specialized Regional Meteorological Training Centres (RMTCs) or other training institutes designated as Centres of Excellence (CoE) in satellite meteorology, in order to build up expertise and facilities at a number of regional growth points.

2.8.2.2 Training strategy

Individual environmental satellite operators should focus their assistance, to the extent possible, on one or more of these CoEs within their service areas and contribute to the Virtual Laboratory (VLab) for Training and Education in Satellite Meteorology. The aim of the Education and Training strategy implemented through the VLab is to systematically improve the use of satellite data for meteorology, operational hydrology, and climate applications, with a focus on meeting the needs of developing countries.

2.8.2.3 For smooth transition to new satellite capabilities, provisions should be made for appropriate preparation of the users through training, and plans to upgrade receiving equipment and processing software. In addition to working through the VLab, Members should, as appropriate, exploit partnerships with organizations providing education and training in environmental satellite applications, depending on their specific needs.

3 OBSERVATIONS FROM SPACE

3.1 Observed variables

Satellite systems should provide quantitative data and qualitative information enabling, independently, as a constellation, or in conjunction with surface-based observations, the determination of:

(i) Three-dimension fields of atmospheric temperature and humidity;
(ii) Temperature of sea and land surfaces;
(iii) Wind fields at the ocean surface and aloft;
(iv) Cloud properties (amount, type, top height, top temperature, and water content);
(v) Radiation balance;
(vi) Precipitation;
(vii) Lightning detection;
(viii) Ozone concentration (Total column and vertical profile);
(ix) Greenhouse gases;
(ix) Aerosol concentration and properties
(x) Volcanic ash cloud monitoring;
(xi) Vegetation characterization;
(xii) Flood and forest fire monitoring;
(xiii) Snow and ice cover;
(xiv) Ocean colour;

(xv) Wave height, direction and spectra;
(xvi) Sea level and surface currents;
(xvii) Sea ice monitoring;
(xviii) Solar activity;
(xix) Space environment (Electric and magnetic field, particle flows, electron content)

NOTES:

1. Information on the principles of Earth Observation from space and on the different types of space-based instruments can be found in the Guide on Instruments and Methods of Observations, Part IV *(being developed).*
2. The WMO Database on Space-based Observing Capabilities provides an indication of the main instruments that are relevant for each specific variable observable from space, as well as the potential performance of each instrument technique for the relevant variables. *(Being developed)*

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LIST OF RECOMMENDATIONS AND ACTIONS AGREED AT ET-SAT-7

RECOMMENDATIONS

Recommendation 1 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 2 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 3 Sufficient resources should be allocated 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 4 ET-SAT members should keep the Steering Group on Radio Frequency Coordination (SG-RFC) informed of relevant issues from the space community, maintain links with the SG-RFC and the WMO Secretariat on frequency matters, to ensure effective WMO representation of Earth observation satellite providers and users in ITU frequency management processes.

Recommendation 5: Given the pivotal role of the capabilities database in the RRR process and in support of global coordination of satellite planning, and the need to ensure its sustainability and reliability, it is recommended to assign resources with high priority within the Secretariat for technical maintenance, first level contents updating, and - through consultancy - for technical level updating and quality control.

Recommendation 6: Satellite operators, including ET-SAT and CGMS Members, and expert groups, should support the database updating process through submitting inputs and providing reviews and feedback.

NEW ACTIONS

Action	Due Date
Action ET-SAT 7.01: WMO Secretariat to send a letter to the European Commission expressing the interest of the WMO community for GMES missions and the wish that GMES data (in particular from Sentinel 3, 4, 5) will be openly and freely accessible in order to maximize the benefit from these missions that are important European contributions to climate monitoring and applications.	30 June 2012
Action ET-SAT 7.02: Members to review and update the list of web links to data access information and pre-processing software package which is contained in ET-SAT/Inf.4 and provide feedback to the WMO Secretariat (Stephan Bojinski: SBojinski@wmo.int)	30 June 2012
Action ET-SAT 7.03: WMO Secretariat to send a letter to R&D space agencies not represented at ET-SAT-7 in order to express the interest of WMO for R&D missions of particularl relevance for operational users, and to seek update on the plans for near-real time data accessibility.	30 June 2012

Action ET-SAT 7.04: WMO Secretariat to forward to IWWG the recommendation to investigate the impact of the longitude separation between adjacent geostationary satellites over the Pacific for wind field derivation, noting that with current plans the requirement for no more than 70 degrees separation cannot be satisfied over that area.	30 June 2012
Action ET-SAT 7.05: The Secretariat will develop a procedure for the management of the SOCRAT updating process, in order to ensure that the process is efficient and that satellite programme data are consistent with authorized information from agencies.	30 September 2012
Action ET-SAT 7.06: The Secretariat will investigate a mechanism or tool to facilitate provision of inputs and of feedback on the database contents.	End 2012
Action ET-SAT 7.07: The Secretariat will investigate a mechanism for sharing SOCRAT data with e.g.the CEOS MIM.	April 2013
Action ET-SAT 7.08: The Secretariat to complete the development of the SOCRAT tool, to simplify the granularity of instrument classes, to review the description of instrument "ranking" with reference to "missions", and to implement updates and corrections mentioned at ET-SAT-7.	15 June 2012
Action ET-SAT 7.09: Secretariat to consider including a quantitative estimation of instrument performance based on a performance estimator as contained in Volumes 4 and 5 of the Dossier.	May 2013
Action ET-SAT 7.10: Secretariat to investigate the possibility to base performance assessments on actual instruments instead of theoretical instruments.	May 2013
Action ET-SAT 7.11: Secretariat to submit SOCRAT to ET-SAT, ET-SUP, and ET-EGOS Members for beta-testing, with password, and subsequently make it openly available on a pre-operational, then operational basis.	15 June 2012
Action ET-SAT 7.12: ET-SAT Chair to forward to OPAG-IOS the conclusions of the revised Gap Analysis, raising the attention on anticipated gaps related to early morning orbit imagery and sounding, geostationary sounding, global precipitation measurement, Earth radiation budget, and limb sounding for stratospheric greenhouse gas monitoring, and to recommend urging Members to take initiatives to fill such gaps.	1 June 2012
Action ET-SAT 7.13: ET-SAT Chair to forward to OPAG-IOS the suggestions for updating the Vision of the GOS in 2025.	1 June 2012
Action ET-SAT 7.14: The Secretariat will circulate the survey to ET-SAT Members, once finalized by the writing team, to enable ET-SAT Members to liaise within their organization and ensure full consistency between the survey process and ET-SAT activities on Gap Analysis.	1 June 2012 (depending on the writing team)
Action ET-SAT 7.15: ET-SAT Chair to submit the proposed update of the Manual on the GOS to the ICT-IOS with a view of its submission to the CBS Rapporteur on Regulatory Material.	1 June 2012
Action ET-SAT 7.16: ET-SAT Chair to forward to ET-EGOS the proposed revision to the satellite-related parts (including Chapter 6) of the EGOS-IP.	Completed on 30 April 2012 for ET-EGOS-7
Action ET-SAT 7.17: Secretariat to implement the corrections agreed to the draft contribution to the CIMO Guide, ensure an editorial revision, and submit the revised text to the CIMO editorial board.	July 2012

ACTIONS CARRIED OVER FROM PREVIOUS MEETINGS

Nr.	Action	Observation
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. (1 month before ET-SAT 6)	Postponed until completion of the draft contribution to the CIMO Guide. New due date to be defined depending on future ET-SAT work plan.
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 ET-SAT/SUP-4/DOC.18.1, Annex), by December 2010 in consultation with ET-SAT and ET-SUP members.	Related document: http://www.wmo.int/pages/prog/www/OSY/Meetings/ET-AWS6-2010/Doc6.doc New due date: 1 September 2012
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)	CMA has stated its interest at ET-SAT-6, and is encouraged to contact the SCOPE-CM Secretariat (Lothar Schueller, EUMETSAT) to submit a proposal for one or several products, preferably in the terrestrial domain.
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)	Waiting for input from ET-SUP.