

WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS
OPEN PROGRAMME AREA GROUP ON INTEGRATED OBSERVING SYSTEMS

EXPERT TEAM ON SATELLITE SYSTEMS

NINTH SESSION

GENEVA, SWITZERLAND

12-14 November 2014

FINAL REPORT





ET-SAT-9 participants:

From left to right: Dohyeong Kim, Alexei Rublev, Guennadi Kroupnik, Jérôme Lafeuille, Riko Oki, Sid Boukabara, Jack Kaye, Jun Yang, Albrecht von Bergen, Yasushi Izumikawa. (Not on this picture: Kenneth Holmlund, Philippe Veyre, Wenjian Zhang, Lars Peter Riishojgaard,.)

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 ninth session of the Expert Team on Satellite Systems (ET-SAT-9) was held from 12 to 14 November 2014 in Geneva.

The main outcome of the session was to deliver preliminary considerations for the vision of the space-based components of the WMO Integrated Global Observing System (WIGOS) in 2040, which are attached as an Annex to this final report.

The meeting also briefly discussed the progress of the WIGOS project as a whole, and the Architecture for Climate Monitoring from Space, including data policy issues that will be addressed by the seventeenth World Meteorological Congress (Cg-17). It was briefed on planned developments of the space module of the Observing System Capability and Analysis and Review tool (OSCAR) that should facilitate its use in support of future gap analysis studies.

FINAL REPORT

1. OPENING OF THE MEETING

1.1 Introduction

The ninth session of the Expert Team on Satellite Systems (ET-SAT-9) opened at 9h00 on Wednesday 12 November 2014, in the WMO Headquarters in Geneva, Switzerland.

The Director of the Observing and Information Systems department, W. Zhang, welcomed the participants (See Annex 1) on behalf of the Secretary-General. In his opening remarks, he stressed that space-based observation was addressed within the WMO Space Programme in the broad perspective of the WMO Integrated Global Observing System (WIGOS). He also highlighted that space-based observation should support the observation and monitoring needs of the Global Framework for Climate Services (GFCS). In this respect he noted that the Intergovernmental Board for Climate Services (IBCS) had recently decided to add “Energy” to the four existing GFCS priority areas (Agriculture and food security, Disaster Risk reduction, Health, Water).

1.2 Adoption of the agenda

The ET-SAT Chairman, J. Kaye introduced the [agenda](#) and the main objective of the session, which was to initiate the development of a Vision of the space-based components of WIGOS in 2040.

1.3 Chairman’s report

The Chairman ([Doc. 1.3](#)) recalled the unique role of ET-SAT to inform the WMO programme areas and the Commission for Basic Systems (CBS) on actual and potential satellite capabilities, and to hear from them their needs and their feedback. He recalled the work done through several on-line meetings since ET-SAT-8 in May 2013, in particular in reviewing a study on potential satellite assets to derive Fundamental Climate Data Records (FCDR) and summarizing a gap analysis as an input to CGMS-42.

The next objectives of ET-SAT in 2015 should be to develop a draft vision of space-based observation in 2040, to update the gap analysis before CGMS-43, and to advise WMO on the Architecture for Climate Monitoring from Space.

1.4 Guidance from OPAG IOS Chair

In an address given remotely ([Doc. 1.4](#)) the Co-Chair of the CBS Open Programme Area Group on Integrated Observing Systems (OPAG-IOS) Anthony Rea (Australia), who is also Chairman of the Inter-programme Expert Team on Satellite Utilization and Products (IPET-SUP) underlined the importance of ET-SAT to WMO and emphasized that formulating a shared vision of the observing system we need is the best way to foster voluntary collaboration and cooperation to progress towards a coordinated system.

He highlighted some outcomes of the CBS Extraordinary session held in Asuncion, Paraguay, two months earlier, providing guidance to the work of ET-SAT. In particular, CBS had adopted updated Terms of Reference for ET-SAT which call for cooperation and information flow with CGMS and CEOS.

The meeting acknowledged the strong link with CGMS, facilitated by some overlap in membership. It recommended strengthening the link with CEOS, e.g. in seeking input from CEOS constellations for future ET-SAT activities and meetings, while noting that some ET-

SAT members who are involved in CEOS activities could help in ensuring smooth communication between ET-SAT and CEOS. It is understood that while CGMS and CEOS have similar membership and share the high-level goal to support coordination of satellite observation, CGMS is focused on an operational perspective while CEOS has a broader scope.

The meeting recalled earlier discussions on the difference between “operational” and “R&D” systems, whereby operational implies a commitment to provide a service responding to the requirements of a user community, generally with continuity and timely data availability. However, in spite of the different mandate of R&D and operational agencies, or different status of R&D and operational programmes, this distinction should not be overstated since there is a continuum of missions which range from early technological demonstrations to proven, recurrent operational missions, with intermediate cases such as “sustained R&D missions”, “operational prototypes” or R&D payload aboard operational satellite series. Moreover, from a user perspective a growing number of missions, whether they are labelled operational or R&D, are used by both operational and research users.

2. OUTCOME OF WMO MEETINGS OF RELEVANCE TO ET-SAT

J. Lafeuille summarized the outcome of major meetings of direct relevance to ET-SAT held over the past year ([Doc. 2.1](#)), including the WMO Executive Council (EC-65), the Consultative Meetings on High-level Policy on Satellite Matters (CM-12), the Commission for Instruments and Methods of Observation (CIMO), and the Commission for Basic Systems (CBS). The meeting noted the agreed publication of the new Guide on Satellite Observation as part of the CIMO Guide, following extensive work conducted with the support of ET-SAT in previous years. It also noted that CBS had assigned to ET-SAT a role to overview the satellite capabilities part of “OSCAR”.

The meeting noted that CM-12 had discussed the socio-economic benefits of satellite programmes and recommended further studies. This was reinforced by CBS.

ET-SAT recommended that ET-SAT and IPET-SUP should join their efforts on future socio-economic benefit studies.

The meeting was also informed of the Draft Resolution on exchange of climate data and products to support GFCS. ([Doc. 2.2](#)). All agencies represented in ET-SAT were invited to consider the Draft Resolution on exchange of climate data and products to support GFCS, and provide feedback to their PR in advance of the next WMO Congress meeting in May 2015.

Action 9.01: The Secretariat to communicate officially the draft resolution on the exchange of climate data and invite ET-SAT member agencies to provide feedback.

Action 9.02: ET-SAT members to ensure that feedback is provided at Cg-17 (May 2015) on the draft resolution on the exchange of climate data, via their Permanent Representative.

The outline of an updated Satellite Data Dissemination Strategy was presented ([Doc. 2.3](#)). CBS recommended refining this strategy in consultation among ET-SAT, IPET-SUP and the expert teams on information systems and services, with a view to submit it for endorsement by CBS in 2016.

G. Carmichaël, Chair of the Global Atmospheric Watch (GAW) Steering Group Scientific Committee, reported on the intermediate outcome of the Task Team on Atmospheric Composition Requirements and Satellite Observations he was chairing. The team was in the process of reviewing observation requirements for three particular applications of atmospheric chemistry: Atmospheric Composition forecasting (at NWP scale, including sand and dust

storm warnings); Assessment of atmospheric monitoring for the implementation of international protocols (including reanalysis); Air quality in megacities (at a scale of a few km) and during high-impact weather situations.

3. REVIEW OF ACTIONS FROM ET-SAT 8

The status of actions from ET-SAT-8 was summarized in [Doc.3](#) which showed that actions N° 2, 3, 4, 7, 9, 12, 13, 14, 16, 17, 18, 19 and 24 were completed. It was agreed that the other actions would be followed up in a web meeting.

4. UPDATE ON WIGOS AND THE ROLLING REVIEW OF REQUIREMENTS

L. P. Riishojgaard briefed the meeting in [Doc.4](#) on the progress of the WMO Integrated Global Observing System (WIGOS), following the Executive Council recommendation made in June 2014 to proceed with the WIGOS Implementation Phase in 2016-2019. The CBS has approved the Manual on WIGOS and the WIGOS Metadata Standards that will be submitted to the Congress in May 2015 for endorsement.

He explained that the WIGOS metadata were describing the observations to support their utilization, unlike the WIS metadata which are only meant to support data discovery and access. WIGOS metadata are assumed to be relevant to Level 2 and above. They are grouped in 10 categories including mandatory and optional elements.

He highlighted the importance of the Rolling Review of Requirements, which is based on the Observing System Capability Analysis and Review tool (OSCAR) with its three components: requirements, space observations, surface observations. The latter is being developed by Meteo-Swiss on behalf of WMO.

The discussion showed that the limit between surface-based high altitude and outer space should be clarified, in order to determine whether for instance stratospheric balloons or suborbital flights are belonging to surface-based or space-based observations. However, networks of surface-based sensors with data collected by satellites are considered as surface-based capabilities.

Action 9.03: WMO Secretariat to investigate the definition of « space » and submit to ET-SAT for review, in order to clarify the limit between the surface-based and space-based components of WIGOS.

5. ARCHITECTURE FOR CLIMATE MONITORING FROM SPACE

J. Lafeuille reported on the on-going activities related to the Architecture for Climate Monitoring from Space ([Doc. 5](#)). ET-SAT noted that the CEOS-CGMS Working Group on Climate was focusing on the inventory of Essential Climate Variables (ECV) data records and would not be in a position to define the space-based component part of the Architecture in the foreseeable future.

The meeting stressed that the Architecture should include the definition of a reference observing system as well as operating principles and processes. The principles should ensure seamless continuity of satellite programmes, comparability of measurements, validation and traceability. Such elements should be incorporated in the Vision of WIGOS Space-based Components in 2040.

6. VISION OF WIGOS SPACE-BASED COMPONENTS IN 2040

6.1 Introduction to the development of a new vision

J. Lafeuille introduced the discussion on the new Vision by [Doc.6](#) which recalled the background and scope of the exercise and suggested different approaches to anticipate future capabilities of relevance to future needs, considering: unfulfilled user needs ([based on Statements of Guidance](#)), lessons learnt from demonstration missions, sensor and satellite system technology, or programmatic framework.

6.2 Inputs from the participating agencies

The participants then presented the views of their respective agencies including:

- [CMA](#)
- [CSA](#)
- [DLR/DWD](#)
- [EUMETSAT](#)
- [JMA](#)
- [KMA](#)
- [NASA](#)
- [NOAA](#)
- [ROSHYDROMET](#)

The meeting noted that R&D agencies, including e.g. CSA, DLR, were increasingly encouraged by their governments to support applications with demonstrated socio-economic benefits. The meeting congratulated Japan for the recent launch of Himawari-8 – first geostationary satellite with a new generation of imagers – and GPM; it also noted that the new space policy of Japan would imply for JAXA a higher priority on Land Observation, and a resulting uncertainty regarding the follow-on of GCOM-W, GCOM-W and GPM missions. The meeting stressed the importance of these missions, confirming that their data were widely used including operationally, and requested WMO to emphasize the operational benefit of these missions in a letter to Japan.

Action 9.04: WMO Secretariat to write to the PR of Japan to express strong support, on behalf of WMO Members, to the GCOM, GPM, programmes, confirm their operational use in NWP, and explain their importance for the weather, hydrology and climate monitoring communities, in response to public enquiry regarding JAXA programmes .

6.3 General discussion on the Vision to 2040

It came out from the discussion that the agencies had to be proactive in describing and showcasing the future achievable capabilities because users were generally not in a position to anticipate the technology that would be available 25 years ahead. WMO has an important role to foster and support the dialogue between providers and representative users to help the providers understand the future user needs.

There is a current trend to diversification of space systems with a high diversity of orbits, and constellations of small satellites, as opposed to big platforms positioned on a limited number of orbital positions, which opens the way to an improved coverage and temporal sampling. This trend raises however the issue of the interoperability of these multiple systems. It would also change the approach to the risk analysis: higher diversity may result in less control on the global long-term planning, but possibly more robustness, provided that minimum standards are complied with. The future global observing system may be considered as a multi-tier system, recognizing also the different programmatic status of operational and R&D systems.

Some agencies are increasingly considering constellations of small satellites as well as e.g. balloons as a complement to classical satellite systems. Management of data from such distributed sources will be facilitated by relying more and more on cloud technology. New business models are also under consideration, with various levels of involvement of the commercial sector: operating a system purchased from industry according to agency's specifications (classical approach); outsourcing the operation; shared investment with a commercial partner (Private-Public-Partnership); data buy to a commercial operator. The meeting noted that such models raised important issues related to data exchange, international coordination, interoperability and traceability.

The outcome of this discussion was captured in a draft document circulated at the end of the meeting, with the understanding that it would be edited by the Secretariat and reviewed by the team by correspondence. The final outcome will be communicated to the Chair of IPET-OSDE. It was recommended to organize a workshop with representative users in the last quarter of 2015, in conjunction with the next ET-SAT meeting, to organize a dialogue on this input to the Vision.

Action 9.05: The Secretariat to circulate the outcome of ET-SAT discussion on the Vision-2040

Action 9.06: The ET-SAT Chairman to communicate the outcome of ET-SAT discussion on the Vision-2040 to the Chair of IPET-OSDE.

Action 9.07: The Chairman and Secretariat to initiate the preparation of a workshop on the draft Vision-2040 with ET-SAT, ET-SUP, application scientists, and representatives of WMO Programmes, tentatively in early November 2015.

7. OBSERVING SYSTEM CAPABILITY ANALYSIS AND REVIEW TOOL (OSCAR) SPACE

J. Lafeuille reported on the status and planned developments of the [OSCAR/Space module](#). He indicated that the Secretariat had analysed the request from ET-SAT-8 to associate to each instrument some information on the instrument status. An update was being made to the data model in order to allow such functionality.

He also presented a concept aiming to replace the current assessment of "instrument relevance for specific variables" by an expert system approach, whereby the assessment would result of a series of rules. An important advantage of this approach would be its transparency allowing an external review of each set of rules by experts in the corresponding field. ET-SAT supported this approach.

Action 9.08: Secretariat to include links in OSCAR/Space to instrument status information from agencies.

Action 9.09: The Secretariat to develop a knowledge-based approach of instrument classification and assessment in OSCAR/Space, as discussed at ET-SAT-9, to ensure transparency, and facilitate collaborative reviewing of the expert assessments.

8. ANY OTHER BUSINESS

No other business was raised.

9. DATE , PLACE AND AGENDA OF NEXT MEETING

The meeting recommended holding a web meeting before CGMS-43 in order to update the gap analysis, and a face-to-face meeting during the last quarter of 2015 in conjunction with the proposed WIGOS-space 2040 workshop.

Action 9.10: Secretariat to prepare a WebEx meeting in advance of CGMS-43 in order to update the gap analysis performed in 2014 (including an evaluation of potential gaps considering the technical and schedule risks) and inform the input from WMO to Working Group III (Operational continuity and contingency planning) of CGMS-43 on this subject.

10. SUMMARY OF ACTIONS AND CONCLUSIONS

The list of actions and other major conclusions was reviewed and adopted, subject to finalization after the meeting (See Annex 3). The main outcome of the meeting will be reported to the CBS by the OPAG IOS Chair.

The meeting was closed at 16h30 on Friday 14 November 2014.

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AGENDA

1. OPENING OF THE MEETING

- Welcome and introduction of participants
- Approval of agenda and working arrangements
- Chairman's report
- Guidance from OPAG IOS Chair/Co-Chair
- New ET-SAT Terms of Reference

2. OUTCOME OF WMO MEETINGS OF RELEVANCE TO ET-SAT

(EC-66, CIMO, CBS-Ext, Expert Team on atmospheric composition observation)

3. REVIEW OF ACTIONS FROM ET-SAT-8

4. UPDATE ON WIGOS AND THE ROLLING REVIEW OF REQUIREMENTS

5. ARCHITECTURE FOR CLIMATE MONITORING FROM SPACE

6. VISION OF WIGOS SPACE-BASED COMPONENTS IN 2040

(Presentations, discussion, drafting in breakout groups, and synthesis)

- 6.1. Objective, overall approach, requirements basis, new and emerging requirements
- 6.2. Presentations by ET-SAT members on their agency's vision
- 6.3. Break out group discussions:
 - Remote-sensing technology advances, opportunities for future satellite systems
 - Data management and telecommunication aspects
 - Assimilation and reanalysis, observation-model linkage, user engagement
 - Satellite programmes and international coordination

7. OBSERVING SYSTEM CAPABILITY ANALYSIS AND REVIEW TOOL (OSCAR) SPACE MODULE

- 7.1. Status, and planned developments, role of ET-SAT in the review process
- 7.2. Roadmap for an updated gap analysis

8. ANY OTHER BUSINESS

9. DATE , PLACE AND AGENDA OF NEXT MEETING

10. SUMMARY OF ACTIONS AND CONCLUSIONS

ACTIONS AND RECOMMENDATIONS FROM ET-SAT-9

Action	Due Date
9.01 The Secretariat to communicate officially the draft resolution on the exchange of climate data and invite ET-SAT member agencies to provide feedback.	Completed letter sent out on 16 Jan 2015
9.02 ET-SAT members to ensure that feedback is provided at Cg-17 (May 2015) on the draft resolution on the exchange of climate data, via their Permanent Representative.	May 2015
9.03 WMO Secretariat to investigate the definition of « space » and submit to ET-SAT for review in order to clarify the limit between the surface-based and space-based components of WIGOS.	ET-SAT-10
9.04 WMO Secretariat to write to the PR of Japan to express strong support, on behalf of WMO Members, to the GCOM, GPM, programmes, confirm their operational use in NWP, and explain their importance for the weather, hydrology and climate monitoring communities, in response to public enquiry regarding JAXA programmes .	Letter completed on 15 Dec 2014 but cancelled in consultation with Japan
9.05 The Secretariat to circulate the outcome of ET-SAT discussion on the Vision-2040	December 2014
9.06 The ET-SAT Chairman to communicate the outcome of ET-SAT discussion on the Vision-2040 to the Chair of IPET-OSDE.	April 2015
9.07 The Chairman and Secretariat to initiate the preparation of a workshop on the draft Vision-2040 with ET-SAT, ET-SUP, application scientists, and representatives of WMO Programmes, tentatively in early November 2015.	June 2015 (First announcement)
9.08 Secretariat to include links in OSCAR/Space to instrument status information from agencies.	Completed on 20 Mar 2015 on OSCAR test version. Planned to be on line by May.
9.09 The Secretariat to develop a knowledge-based approach of instrument classification and assessment in OSCAR/Space, as discussed at ET-SAT-9, to ensure transparency, and facilitate collaborative reviewing of the expert assessments.	Completed as a proof of concept in Mar 2015. The implementation in OSCAR is being developed in 2015.
9.10 Secretariat to prepare a WebEx meeting in advance of CGMS-43 in order to update the gap analysis performed in 2014 (including an evaluation of potential gaps considering the technical and schedule risks) and inform the input from WMO to Working Group III (Operational continuity and contingency planning) of CGMS-43 on this subject.	April 2015

Recommendations

Given the value of OSCAR/Space, which is used by an increasing number of organizations, ET-SAT recommends that adequate staff resources be allocated to ensure the IT maintenance and the evolution of the OSCAR/Space prototype, in response to user feedback, until its migration to Meteo-Suisse, in order to implement e.g. the upgrades discussed by ET-SAT-8 and ET-SAT-9.

ET-SAT and IPET-SUP should join their efforts on future socio-economic benefit studies.

The Architecture for Climate Monitoring from Space should include the definition of a reference observing system as well as operating principles and processes, aiming to ensure seamless continuity of satellite programmes, comparability of measurements, validation and traceability.