



## THE INTERNATIONAL TOVS WORKING GROUP (ITWG) INTERNATIONAL TOVS STUDY CONFERENCE (ITSC) XVII SUMMARY REPORT

Note: The ITWG did not meet prior to CGMS-39. The next meeting ITSC-XV111 is 21-27, March 2012. Actions for ITWG from CGMS-38 are:

**Action 38.23:** ITWG rapporteur will provide actions related to calibration to GSICS.

**Action 38.24:** ITWG rapporteur will provide actions related to climate to SCOPE-CM.

**Action 38.25:** ITWG rapporteur and ITWG co-chairs to invite IMD and ISRO to consider participation in ITWG.

Below is the ITWG report written for CGMS-38. In bold are the actions related to 38.23 and 38.24. These actions have been reported at GSICS and SCOPE-CM meetings. With respect to Action 38.25, IMD and ISRO scientist have participated in past ITWG meetings and are encourage to attend especially to highlight there new and pending satellites and to discuss GSICS related activities.

**The International TOVS Working Group (ITWG)  
International TOVS Study Conference (ITSC) XVII Summary Report**

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## 1. INTRODUCTION

The Seventeenth International TOVS Study Conference, ITSC-XVII, was held in Asilomar state park conference center, Monterey, 14-20 April 2010. Nearly one hundred and fifty participants attended the Conference and provided scientific contributions. Twenty countries, and three international organizations were represented: Australia, Brazil, Canada, China, Taiwan, Denmark, France, Germany, Hungary, India, Italy, Japan, Norway, Poland, Russia, South Korea, Sweden, Switzerland, United Kingdom, United States, ECMWF, EUMETSAT and WMO. The number of attendees at ITSC-XVII breaks the highest ever record attended at the last ITSC gathering once more. The Working Groups had very productive discussions and it was again encouraging to see a large number of new, younger scientists participating.

ITSC-XVII was sponsored by industry and government agencies and by the University of Wisconsin-Madison's Space Science and Engineering Center. The industry and government agencies included: the World Meteorological Organization (WMO), Meteo France, VCS Engineering, Kongsberg Spacotec, ABB, ITT Industries, the Met Office (UK), CNES, Raytheon, EUMETSAT, NOAA/NESDIS/STAR, NOAA/GOES-R Program Office, Sea Space, Orbital Systems, NASA and IPO. The support of these groups is gratefully acknowledged. The great success of ITSC-XVII can be attributed to the excellent support provided by the local organising committee from the Naval Research Laboratory and the administrative and logistical supports provided by Maria Vasys and Leanne Avila (University Wisconsin) and Carine Previatti (Acquaviva Produções e Promoções).

Most of the meeting was occupied with nine sessions of oral presentations and their associated poster papers. Each poster paper was also allocated a 2-minute quick summary oral overview to highlight the scientific contents. The range of issues covered included the following:

- Generation and validation of meteorological and environmental products from sounder radiances,

- Atmospheric chemistry and air quality,

- Direct broadcast, preprocessing and calibration of sounder radiances (a session dedicated to the memory of Hal Woolf),

A special Hal Woolf Memorial session as a tribute to Hal, a long time ITWG member and a dedicated scientist who has well served the international remote sensing community throughout a distinguished career,

Atmospheric radiative transfer,

Surface property modeling and sensing,

Assimilation of raw measurements and derived products in NWP,

Climate studies,

Agency status report poster presentation,

Future sounders and programs,

Report on action items from ITSC-XVI, and

Working Group Reports.

There were 101 oral presentations, 96 oral poster introductions, 17 working group and technical sub-group presentations, and more than 100 poster presentations during the conference. The conference agenda and all of the talks and many of the posters can be viewed at the ITWG Web site, located at <http://cimss.ssec.wisc.edu/itwg/itsc/itsc17>.

Working Groups were formed to consider six key areas of interest to the ITWG, these including:

Radiative Transfer,

Climate,

NWP,

Advanced Sounders,

International and Future Systems, and

Satellite Sounder Science and Products.

The Working Groups reviewed recent progress in the above areas, made recommendations on key areas of concern and identified items for action. Working Group reviews and recommendations comprise an important part of the ITSC-XVII Working Group Report. A summary of the key points arising from the conference is presented below.

## **2. SUMMARY OF MAJOR CONCLUSIONS**

The ITSC-XVII presentations, posters, Working Group meetings and discussions documented significant issues in many areas and identified areas for future activity. In particular, 65 action items and 70 recommendations were reported by 6 working groups. Below are highlighted actions and recommendations that are directly or indirectly related to CGMS:

1. A few internal action items related to ITWG community:

- 1.1. To obtain response functions for CrIS, FY-3 IR, COMS imager, and other new instruments.
- 1.2. To provide documentation of methodologies used in NWP centres to convert layer atmospheric state variables to level values.
- 1.3. To request Mitch Goldberg to distribute CEOS draft response to the 2010 update of the GCOS Implementation Plan for comment when ready.
- 1.4. European NWP WG members to inform their EUMETSAT OPS WG representatives of changes desired in the scope and format of the notifications sent through the UNS.
- 1.5. NWP WG members involved in regional or limited area data assimilation to share their experience (experiment results, reports, papers, etc...) on bias correction procedures on the regional data assimilation web page.
- 1.6. ITWG Co-chairs to create a section on the NWP WG wiki page which will contain examples of the existing or potential effects of RFI in NWP. Members are invited to add on this web page any relevant impact assessments or evidence found.
2. Recommend ITWG members review Radio Regulations (RR) No. 5.565 and its requirements for use of the spectrum in the band between 275 and 3000 GHz and make their views known to the international community.
3. Recommend space agencies and NWP centers support the use of GIFTS/STORM data for research and development of hyperspectral infrared geostationary sounder products in advance of operational instruments (e.g., MTG-IRS).
4. Recommend space agencies ensure the continuation of capability for conically scanning sounders in the post DMSP era. All future such instruments should be designed with particular attention to calibration accuracy and stability.
5. In concert with the continued development of IR geo sounders, recommend the further advancement of geostationary microwave sounders.
6. Recommend the Russian Federation make the Meteor-M mission a fully contributing component of the GOS by providing the global data sets from this mission in a timely manner with all necessary ancillary information.
7. Recommend satellite agencies operating environmental polar satellites provide or continue to provide a Direct Broadcast capability on their polar environmental satellite systems, and make available in a timely manner the Direct Broadcast data processing (L0 to L1, and/or L1 to L2) software, documentation, and related training.
8. Recommend NOAA and DOD consider the use of the SafetyNet as a joint ground system ensuring timely availability of data from the JPSS and DMSP-Follow-on missions.
9. Noting that the NPOESS program is being restructured into two separate programs, one being run by DoD and the other by NOAA/NASA (known as JPSS,) ITWG recommends that imaging and sounding capabilities should be included on the DoD satellite, ideally including MW and IR. Furthermore, data should be free and readily accessible to the general international user community.
10. ITWG recommends that the constellation of at least three orbits (early morning,

morning, and afternoon), each with full sounding capabilities (IR and MW), is maintained. The WG recommends coordination between agencies of the overpass times of operational satellites with sounding capability (IR and MW) to maximize coverage (including, e.g., China, India).

11. The NWP WG recommends that future microwave sensors maintain sounding capabilities of the upper stratosphere and mesosphere, in addition to tropospheric and stratospheric sounding capabilities, as is the case for SSMIS.
12. The NWP WG continues to support fast delivery initiatives (RARS) with extensions wherever possible, however the WG believes that the system should continue to be low cost. At ITSC-XVII, it was reported that the RARS coverage is now 78%. Further extension towards global coverage is encouraged until the point is reached where further improvements are no longer cost effective.
13. The geostationary and HEO (Molniya) orbit is ideal for observing the rapidly changing component of atmospheric and surface fields. The WG recommends the use of these orbits for high spectral resolution IR and/or microwave sounder/imager instruments. Ideally, if both are possible, the microwave and IR instruments should observe the same portion of the atmosphere at the same time.
14. The NWP WG recommends that EUMETSAT investigates lossless compression methods for the dissemination of the full IASI spectrum in the context of disseminating data from two or more Metop satellites.
15. The WG recommends that all relevant space agencies (i.e. ESA, NASA, NOAA, JMA, EUMETSAT, CMA, KMA, etc...) send information to users, including the NWP WG mailing list, about planned changes in data processing, formats, and other issues related to data as early as possible (preferably at least 6 months).
16. The NWP WG recommends setting up an RTTOV user group, composed of members that do not actively participate in developing RTTOV software, to collect science requirements, and to establish a forum for technical and usage aspects. This group is expected to interact through internet and email.
17. The NWP WG recommends that monitoring web sites be freely accessible on the internet (i.e. not require any password).
18. There is a critical need for a follow on microwave imager/sounder for climate purposes because, although they weren't initially intended for climate studies, they have proven hugely useful. We still look primarily to DMSP to provide such measures because of the need for LECT continuity for climate record continuity purposes. A similar imager/sounder on a post-EPS orbit would also be immensely valuable and EUMETSAT is encouraged to continue planning in this regard. Suitable representation from the climate community in the planning phase of both programs to ensure the continuity of the record is requested.
19. Satellite agencies that are considering changing the frequency or viewing geometry / resolution of heritage measures need to consider the impact on climate monitoring and particularly trend characterization.
20. Recognizing that climate change may have a diurnal cycle component we recommend to CGMS that they explicitly consider the coordinated international phasing of satellites to ensure adequate sampling of diurnal cycle.

21. Recommend EUMETSAT to pro-actively consider the multiple platform issue with consultation with NOAA, who has considerable experience in this regard. Discussions need to recognize the import to climate of the longest term record and that a non-operational platform need not be available in real-time to be useful for climate studies.
22. EUMETSAT and GSICS are urged to look pro-actively at the METOP A/B global SNO measurements opportunity to ascertain the likely validity of the global application of high-latitude-only derived SNOs for other platforms through systematic experimentation and to disseminate in the peer reviewed literature.
23. Reanalysis centers are urged to use suitable satellite Fundamental Climate Data Records (FCDRs) that have had substantial work applied for future reanalysis activities. Quality feedback information, such as data departures from existing reanalyses, should be established for the new FCDRs in order to provide further information on the quality of the observational record. Furthermore, reanalysis centers should consider whether it is more applicable to anchor future reanalyses to these globally complete and consistently processed FCDRs in preference to conventional data sources.
24. Space agencies to recognize the importance of traceability in characterization of the fundamental measurement and to actively engage the meteorologist community throughout the process but particularly in pre-launch characterization building upon the recent BIPM-WMO meeting.
25. ITWG climate working group notes that GPS-RO in and of itself constitutes a valuable climate record. But perhaps of greater value is the cal/val it affords to the operational satellites. It is imperative that a long-term capability be retained.
26. Absolute calibration missions (such as CLARREO) should be planned to continue after CLARREO's expected lifetime and to include other spectral regions including microwave radiances, the latter recognized to be hugely challenging.
27. Recommend agencies provide and sustain high quality in-situ observations through programs such as GRUAN to improve radiative transfer models co-located in space and time. Furthermore, agencies should advertise the existence of such data to their users.
28. GSICS should continue actively reach out to the user community to capture evolving requirements.
29. Recommend SCOPE-CM Exec panel formulate their requirements to GSICS.
30. ITWG climate WG recommend putting up an alternate AWS at DOME-C as back up for AWS8989, the latter having proven invaluable for satellite cal/val. ITWG co-chairs to report this issue to CGMS with the recommendation to encourage the Italian Space Agency to resume the station at DOME-C.
31. Recommend ESA strongly consider clear and unambiguous guidance on data openness and transparency from the outset of the CCI initiative to ensure that datasets created are verifiable and exhibit best practices.
32. Recommend CGMS support multiple analyses of FCDRs and TCDRs, recognising that there are many methodologically uncertain choices required.
33. Recommend CGMS to consider the potential benefits of the NWP and climate



requirements approach adopted by EUMETSAT as part of the post-EPS mission planning.

34. Recommendation to reanalyses centers to provide their diurnal climatologies at hourly resolution for a suite of geophysical and radiance parameters including surface characteristics, this in support of satellite dataset construction efforts.
35. Non-LTE effects should be included/parameterized in fast RT models. Progress on this issue (from the SARTA, RTTOV, and CRTM teams) should be reported when progress is made.
36. Recommend that satellite centers consider upwelling oceanic radiation (water leaving radiance) when designing the next generation of RT models that include the visible part of the spectrum.
37. Recommend NWP centers document the methodologies used to speed up hyperspectral radiance assimilation, specifically with regards to parallelization and load balancing.
38. The SSSP WG recommends expansion in the areas of direct readout observations to areas currently not covered. EUMETSAT should provide a timetable showing the plans for a possible expansion of the Metop-A HRPT services.
39. Recommend to IPO/JPSS that a Level-2 retrieval package for IASI should be funded and made available for IASI DB users.
40. IPO/JPSS should provide timely updates on expected implementation schedules and concerns (including for IPOPP) and a recommendation to NOAA, NASA (or JPSS project management office) on the completion and distribution of the IPOPP software. IPOPP to include a BUFR conversion module.
41. Sounding science WG recommends that EUMETSAT makes calibration datasets available after concurrence with NOAA via the EUMETSAT web site.
42. Product user-groups should study, and have input into, the architecture of such processing systems for hyperspectral and active remote sensing instruments in order to better determine their requirements for issues such as processing, IT infrastructure needs. This extend to methods for data acquisition and/or algorithm development to better assimilate critical data from the large quantities of data that organizations may be unable to process in the timeframes required by operational organizations.
43. The international issues and future systems WG welcomed the plans of CMA and EUMETSAT to implement the planned IR sensors on FY-4 (by 2015) and MTG (2018) missions respectively. The WG also noted that options were being discussed by NOAA regarding a sounding capability to complement the current GOES-R and -S baseline, and strongly encouraged NOAA to pursue these investigations.
44. The WG also noted the following new items of concern:
  - 44.1. The Soil Moisture and Ocean Salinity (SMOS) mission of ESA, which relies on an L-Band 1.4 GHz radiometer, is affected in this band by RFI.
  - 44.2. The Soil Moisture Active Passive (SMAP) mission of NASA, which will also operate an L-Band radiometer, may be affected as well, however it is expected that this will be mitigated on-board through the use of an agile

digital detector for RFI.

- 44.3. The advanced scatterometer (ASCAT) on Metop is facing RFI over land.
45. There are international frequency-spectrum allocations that guide frequency band usage and delineate restrictions placed on such use. It is recognized among the environmental satellite community, however, that there are instances in which emitters are likely to cause the loss of data that is of interest to this community. An international registry of emitters would provide advance notification for future environmental satellite missions. It is proposed that a discussion of such a registry be held within appropriate (WMO, CGMS) entities. Such a registry could contain information on emitter locations, RF characteristics, duty cycles, and anticipated time frame of emitter existence. This would expand a current initiative, a much smaller scale effort named Radiofrequency Interference Survey of the Earth (RISE).
  46. The International Issues and future systems WG recommends that DOD (of USA) operated polar orbiting satellite requirements be stated in terms of Satellite Data Records (SDR) rather than Environmental Data Records (EDR), this in view of the needs of the NWP and climate monitoring communities for the exploitation of radiance measurements. When considering the MW sounder for the early morning orbit mission, particular attention should be paid to the requirements for calibration accuracy and stability, noting existing problems in these areas with current conically scanning MW radiometers. The need for infrared sounding requirements for this early morning orbit mission was reiterated, in accordance with the Vision of the GOS.
  47. Being aware that geostationary microwave sounding was still only envisaged as a technology and scientific demonstration mission in the WMO Vision for the GOS, the WG noted that the NASA GEOSTAR project was responding to the call for such a demonstration mission. It considered that if any trade-off needed to be made between the measurement of precipitation and the vertical temperature and moisture profile, the specific priority for microwave imagery/sounding should be on precipitation.
  48. ITWG requests NOAA, NASA and DOD to confirm and implement Direct Broadcast capabilities on both the JPSS and DMSP follow-on series to ensure that environmental data from these missions are openly and freely available in near-real time and, furthermore, to make the relevant ingest and pre-processing software available to the global community.
  49. ITWG recommends NOAA and DOD consider the use of the SafetyNet as a joint ground system to ensure timely availability of data from the JPSS and DMSP follow-on missions.
  50. ITWG recommends CGMS to consider harmonization of the appropriate layers of the future X-Band Direct Broadcast services, for instance as concerns frequency or transmission protocols based on CCSDS standards.
  51. ITWG recommends JMA to consider a broadcast service to facilitate access to Himawari-8 and -9 data, in particular for users in Pacific islands who have limited Internet connectivity.
  52. ITWG recommends CGMS satellite operators to investigate the potential use of



satellite-to-satellite communication (e.g. Tracking and Data Relay Satellite System, TDRSS) as a mechanism to support timely collection and redistribution of polar-orbiting satellite data in future systems.

### 3. FUTURE PLANS

The ITWG will continue to meet and continue to inform the ATOVS community of the latest news and developments through its Web site (currently maintained by the University of Wisconsin CIMSS) and via the email list (also maintained by CIMSS). The website will continue to evolve to become an even more important tool for ITSC, with many new ideas proposed and endorsed at ITSC-XVI and ITSC-XVII. This could include some interactive elements to the website (e.g. a wiki).

The format of ITSC-XVII was similar to previous meetings, but with a significant increase in attendance resulting in significant time pressure on the agenda. At ITSC-XVII, two-minute poster introductions were followed by the poster viewing session. This format was also applied to the five-minute oral agency status reports. A few technical sub-groups were consolidated into working groups to avoid too many parallel group meetings and too few participants. In addition, as recommended by climate WG in ITSC-XVIII, a session specifically on analyses of overlap requirements for continuity across changes in platform or technology (e.g. HIRS2/3/4, TOVS to ATOVS, AIRS to IASA, SSMI to SSMIS) is to be considered.

The ITSC-XVII Working Group Report, and Proceedings for ITSC-XVII from the papers submitted, will be available on-line. The oral and poster presentations from ITSC-XVII are already available as PDF files that can be downloaded from the ITWG Web site. The next meeting of the ITWG is scheduled to take place in the period between November 2011 and March 2012 and is to be hosted by Meteo France in Toulouse, France. Topics of interest will include initial assessment of NPP, MetOp-B and FY-3B data and the development of new atmospheric chemistry missions directed at trace gas monitoring, air quality research and the advancement of climate studies. More information about ITWG and other ITSCs may be found at: <http://cimss.ssec.wisc.edu/itwg/>.

#### **Acknowledgements**

This paper relied on the active participation of all ITSC attendees and those working group chairs. We acknowledge that writing of this paper is possible only through the collective work of ITWG members. Note that most of the contents presented here are derived from the draft of the executive summary part of the ITSC-XVII working group report, so some of the contents (especially action items and recommendations) are subject to change.

#### **List of Acronyms**

AMSU: Advance Microwave Sounding Unit

ATOVS: Advanced TIROS Operational Vertical Sounders

BUFR: Binary Universal Form for the Representation of meteorological data  
CAL/VAL: Calibration/Validation  
CIMSS: Cooperative Institute for Meteorological Satellite Studies  
CMA: Chinese Meteorological Agency  
COSMIC: Constellation Observing System for Meteorology, Ionosphere and Climate  
CRTM: Community Radiative Transfer Model  
DMSP: Defense Meteorological Satellites Program  
DoD: Department of Defense (US)  
EPS: EUMETSAT Polar Satellite  
EUMETSAT: European Organization for the exploitation of meteorological satellites  
FNMOC: Fleet Numerical Meteorology and Oceanography Center  
FOV: Field of View  
FY-3: LEO satellite from China  
GLONASS: (Russian) Global Navigation Satellite System  
GNSS: Global Navigation Satellite Systems  
GPS: Global Positioning System  
GRAVITE: Government Resource for Algorithm Validation Integrated Testing and Evaluation  
HEO: Highly Elliptical Orbit  
IASI: Infrared Atmospheric Sounding Interferometer  
IASI-NG: IASI- Next Generation  
IR: Infrared  
ITAR: International Traffic in Arms Regulations  
ITSC: International TOVS Study Conference  
IPO: Integrated Program Office  
IROWG: International Radio Occultation Working Group  
ITU: International Telecommunication Union  
ITWG: International TOVS Working Group  
JPSS: Joint Polar Satellite System  
LEO: Low Earth Orbit  
Met.No: Norwegian Meteorological Institute  
MetOp: Meteorological Operational  
MHS: Microwave Humidity Sounder  
MW: Microwave  
NESDIS: National Environmental Satellites, Data, and Information Service  
NPP: NPOESS Preparatory Project  
NRL: Naval Research Laboratory  
NPOESS: National Polar-orbiting Operational Environmental Satellite System  
OPS: Operations  
RARS: Regional ATOVS Retransmission Services  
RFI: Radio Frequency Interference  
RTTOV: Radiative Transfer for TOVS  
SAF: Satellite Application Facility  
SMHI: Sweden's Meteorological and Hydrological Institute  
SSEC: Space Science and Engineering Center  
SSMI: Special Sensor Microwave Imager  
SSMIS: Special Sensor Microwave Imager/Sounder



Met. Office: United Kingdom Met Office  
UPP: Unified Pre-processor (SSMIS)  
WG: Working Group