

Advanced Sounders Working Group

co-chairs: Dave Tobin and Dorothee Coppens

ITSC-23

16 June 2021

Virtual WG meeting

- ***ASWG Introduction and Scope***
- ***WG Goals and Process***
- ***Review of the Agenda***

ITSC-23 ASWG Meeting Agenda

ASWG Introduction / Goals / Review of the Agenda	5 min	Co-chairs
Review of progress of action items and recommendations from the last meeting	20 min	Co-chairs/all
WMO Coordination Group for Meteorological Satellites (CGMS) High Level Priority Plan Items	5 min	Co-chairs/all
Hybrid PC approach for the hyperspectral sounder radiances Current status at EUMETSAT (dissemination and ongoing studies) Current status for CrIS	20 min	Tim Hultberg D.Tobin
Latest status of FY-3D/3E and FY-4A/4B	20 min	Chengli Qi
Presentation of the FORUM mission	20 min	Luca Palchetti
User readiness for ICI	15 min	Alan Geer
Information on NOAA future missions	30 min	Mitch Goldberg
Coming End Of Life activities IASI EOL AIRS EOL	20 min <i>(if time permits)</i>	Dorothee Coppens D.Tobin for S.Broberg
Open discussion, Candidate recommendations/actions	20-30 min	All
ASWG Website	5 min	
AOB		

Actions and recommendations from the ITSC-22

Planned sensors and data

There was discussion of the upcoming FY-3E and FY-4B launches in the next year. FY-3E will be in the early morning orbit and include an improved HIRAS with a 3x3 versus 2x2 FOV array and also possible removal of the FY-3E HIRAS spectral gaps. There was a request to have full spectral resolution (FSR) version of the HIRAS data available from the start of the operational mission. FY-4B will include an improved GIIRS, as compared to the research GIIRS on FY-4A. For both platforms, commissioning is expected to take 6 months and data available afterwards.

Recommendation ITSC22-AS-1 to Space Agencies (CMA)

Disseminate the HIRAS and GIIRS data 6 months after launch if possible, and not only via EUMETCAST but also to the Global User Community.

Recommendation ITSC22-AS-2 to Space Agencies (CMA)

Consider to make available as soon as possible the HIRAS spectra at full spectral resolution for all bands. This also applies to all future hyperspectral sounders.

Recommendation ITSC22-AS-3 to Space Agencies (CMA)

FY-4B GIIRS data has good noise performance below the current longwave cutoff of 700 $1/\text{cm}$; CMA to investigate and consider extending the output range of FY-4B GIIRS spectra to ~ 680 $1/\text{cm}$.

Action ITSC22-AS-1 to ITWG Co-chairs: Bring these recommendations to the attention of Space Agencies at CGMS

Reported at the CGMS-48

Planned sensors and data

Discussion on IKFS-2 data and the possibility to have a direct broadcast. Only for the one from 2025 on, we could have direct broadcast.

→ We will keep the recommendation from ITSC-21

Recommendation ITSC22-AS-4 to Space Agencies (Roshydromet and Roscosmos)

ASWG recommends establishing a Direct Broadcast capability for the data on the Meteor-M satellite, in particular for the hyperspectral IKFS-2 data.

Action ITSC22-AS-2 to ITWG Co-chairs: Bring this recommendation to the attention of Space Agencies at CGMS.

Reported at the CGMS-48

Discussion on Meteor-M N2-2 launched in July 2019 → data will be released in 2 or 3 months (probably in January 2020).

Action ITSC22-AS-3 to ASWG co-chairs to follow the data release date and circulate the information at ASWG.

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Planned sensors and data

Presentation on MTG-IRS, showing the interest of such mission. GEO hyperspectral sounders are providing high spatial and temporal resolution and coverage, an unique dynamic view of the atmosphere, 3D winds, important for NWC and NWP. It supplements the forecasts, independent observations, gain precision and lead-time in issuing warnings.

Discussion on the amount of data it implies in terms of downlink and dissemination. The dissemination will be done in Principal Component with a new methodology discussed later during the meeting.

Action ITSC22-AS-4 to ASWG co-chairs:

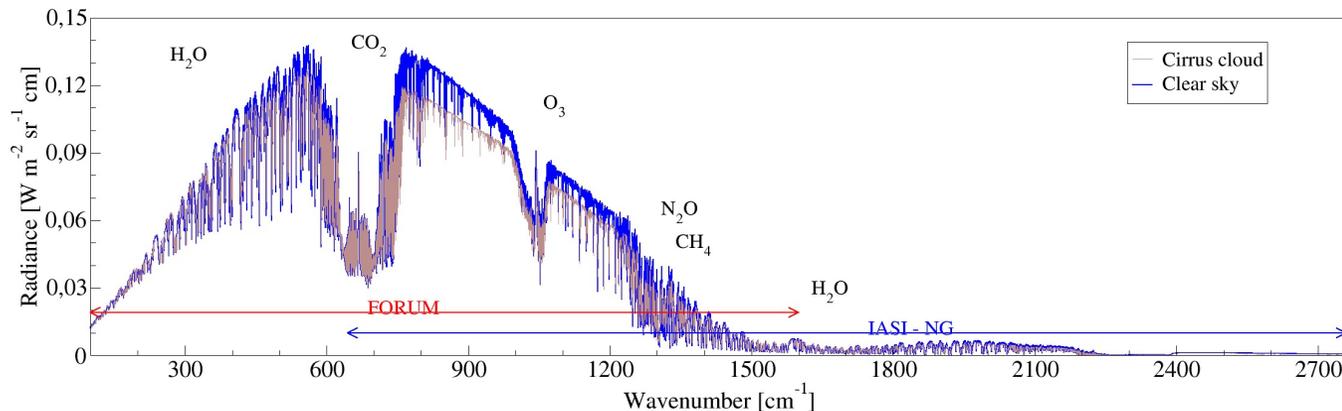
To circulate to ASWG the information to the bandwidth for the MTG IRS L1 PC dissemination as soon as it is available.

Will be discussed at the meeting

Planned sensors and data

The future mission FORUM (Far-infrared Outgoing Radiation Understanding and Monitoring) was presented and discussed.

- ✓ ESA Earth Explorer 9 – 3-year lifetime mission
- ✓ 100-1600 cm^{-1} : highly sensitive to upper tropospheric water vapour and to cirrus cloud
- ✓ Nadir viewing only
- ✓ sun-synchronous orbit at an altitude of about 817 km, flying in tandem with IASI-NG
- ✓ Ground footprint is a single pixel of about 15 km



No specific action or recommendation

Updated status to be presented in future ITSC

Will be presented at the meeting

Next generation sensors and data

NOAA is moving forward with the pre-phase A for new missions. Dedicated study on what NOAA could have with LEO/GEO orbits, trying to identify mixed-capabilities and Tundra orbit.

Presentation from NOAA on their view: constellation with mission in Tundra orbit, GEO ring, NOAA imagers. GOES-R series and JPSS: same instruments until 2035. No evolution in terms of instrument improvement.

GEO-LEO trade-off. NOAA is looking at the minimum of importance for the applications to decide what to do. Currently the "reference constellation" includes East and West GEO platforms with Imagers, and LEO "Sounder Sats" (IR + MW). The US is thinking of quantity (Several small LEO instruments), versus Quality. This is mainly for NWP applications. The typical useful lifetime of small satellites is based on 3 years of design life.

A particular attention has been put on having IR+MW sounders on the same platform, the imagers could be on another one.

Inter-satellite calibration and consistency are very important for both IR and MW

Next generation sensors and data

Action ITSC22-AS-5 to Karen St Germain to provide information on the new NOAA trade study mission

Action ITSC22-AS-6 to ASWG Co-chairs to organize ASWG members and provide feedback to NOAA on all aspects of the proposed mission(s)

Will be presented at the meeting

Recommendation ITSC22-AS-5 to space agencies to keep IR and MW sounders together on the same platform.

Recommendation ITSC22-AS-6 to space agencies to study whether to have or not the imager on the same platform

Recommendation ITSC22-AS-7 to space agencies to keep inter-satellite good calibration and consistency for both IR and MW.

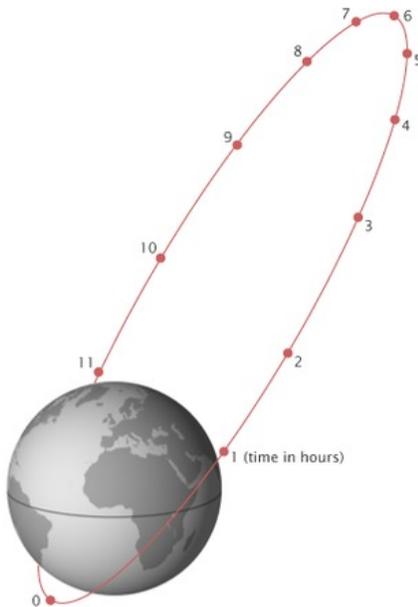
Action ITSC22-AS-7 to ITWG Co-chairs:

Bring these recommendations to the attention of Space Agencies at CGMS.

Reported at the CGMS-48

Next generation sensors and data

For the Tundra orbits, ECCC has studied largely those orbits, and they are considered as a good option but they are not the preferred option.



Combination of LEO/GEO

- ➔ With 2 satellites, it covers down to 58 degrees latitude
- ➔ With 3 satellites, it covers down to 40 degrees latitude.

Action ITSC22-AS-8 to Louis Garand to send documentation on those studies to ASWG

Document circulated

Efficient dissemination of Hyperspectral IR data

From CGMS: Develop efficient standardized data handling for high-resolution imaging and hyperspectral instruments, employing novel methods like dissemination of hyperspectral infrared data based on Principal Component Analysis

Presentation from EUMETSAT on the new hybrid PC methodology for MTG-IRS L1 products to address all user needs (including Atmospheric Composition). EUMETSAT reported that they have initiated several studies with NWP centers to assimilate PC. DWD and Meteo-France have observed no difference when using PC in comparison with original radiances. More study results are expected from the Atmospheric Composition user community.

The hybrid method of EUMETSAT has already been endorsed by NWP WG at ITSC-21

Discussion on noise when using PC: Observation error matrices can and should be constructed in the same way as done empirically when using original radiances. i.e. to include error correlations coming at least from the forward modelling.

Recommendation ITSC22-AS-8 to ASWG to look at available PC and give feedbacks to ASWG co-chairs.

Recommendation ITSC22-AS-9 The hybrid method of EUMETSAT should be taken as the best practice to establish PC for IRS on MTG

Additionally, as opposed to using a relatively small subset of spectral channels that are used in some applications, PCs enable the full information and Signal-to-noise advantage of high spectral resolution spectra to be conveyed to the users. Refer to appendix A for more information on this topic.

Recommendation ITSC22-AS-10 to NWP centers to investigate the use of theoretical PC reconstructed radiances, for a representative set of spectral channels, to be used in the radiance assimilation process.

To be discussed

ASWG webpage

Action ITSC22-AS-9 to ASWG Co-chairs: to update the webpage and redesign it to include a forum for discussion and exchange.

On-going, to be discussed

Re-iterating previous high priority ASWG recommendations:

Recommendation to Satellite Agencies (NOAA, JAXA): Consistent with numerous previous ITWG and ASWG recommendations, and consistent with the WMO Integrated Global Observing System (WIGOS) Vision for the Global Observing System in 2025 and 2040, the ASWG strongly recommends that space agencies develop and implement plans to fill the gaps in IR hyper-spectral sounding within the Geostationary constellation.

Recommendation to Satellite Agencies: The constellation of at least three polar orbits (early morning, morning, and afternoon), each with full sounding capabilities (IR and MW), should be maintained. The overpass times of operational satellites with sounding capability (IR and MW) should be coordinated between agencies to maximize their value.

Recommendation to Satellite Agencies: Implement high spatial resolution and contiguous sampling detector arrays in future hyperspectral infrared sounding instruments.

Recommendation to Satellite Agencies: To develop, test, and implement an SI-traceable radiometric standard in space as soon as feasible.

Action to ITWG Co-chairs: To re-iterate these recommendations to Space Agencies via CGMS.

Reported at the CGMS-48

***CGMS High-Level Priority Plan (HLPP) for the
period 2021-2025***

- **Ref 4.2.7:** To establish together with the user community a commonly agreed approach for retrieval of Principal Component scores and associated parameters from hyperspectral infrared data, minimizing information loss including the mutually acceptable update strategy for the principal component basis and to implement such an approach in a coordinated manner.
- **Ref 4.3.3:** Conduct an inter-comparison study between the different methods to derive level 2 data from infrared hyperspectral sounders, recognising that there are several software packages available utilizing AIRS/IASI/CrIS data.
- **Ref 4.4.1:** Establish a common vocabulary and methodology with appropriate error propagation to include the errors associated with validation data (e.g. radiosonde temperature, water vapour, precipitation and winds).
- **Ref 4.4.2.:** Agree on standardized procedures to derive NedT estimates for microwave sounders, and include such estimates in the disseminated BUFR data.
- **Ref 4.6.1:** Continue support for line-by-line (LBL) reference model development and enhanced characterization of spectroscopy to ensure that product development teams and users of level 1 data have access to the latest updates in LBL forward modelling and the uncertainties involved.
- **Ref 4.6.2:** Perform validation and intercomparison of LBL models/spectroscopy to assess the impact of spectroscopic uncertainties and the differences between line-by-line and fast radiative transfer models

Ref	HLPP item	Summary/highlights of progress as reported for CGMS-48	Overall Status
4.2.7	To establish together with the user community a commonly agreed approach for retrieval of Principal Component scores and associated parameters from hyperspectral infrared data, minimizing information loss including the mutually acceptable update strategy for the principal component basis and to implement such an approach in a coordinated manner.	EUMETSAT has previously presented their hybrid PC methodology for disseminating MTG-IRS radiances, and this approach was endorsed by ITWG at ITSC-21. In order to help prepare for MTG-IRS, EUMETSAT reported at ITSC-22 that the IASI PCs will be updated in 2020 to use the full noise covariance matrix, a training data set with updated trace gas events, and an additional five vectors derived from the granule (Hybrid PCA). ITWG encouraged NWP centers to use the IASI Hybrid PC-compressed dataset to ensure they are prepared for MTG-IRS. NWP centers are requested to provide feedback to EUMETSAT on the use of these data.	
		ECMWF presented recent results at ITSC-22 on assimilation of IASI radiances reconstructed from PC scores (instead of assimilating the PC scores themselves). The method offers the advantages that a NWP center can decide which reconstructed channels to use (rather than a subset determined by the data provider), and existing infrastructure for radiance-based cloud and aerosol screening can be used. Significant positive impact was demonstrated.	
4.3.3	Conduct an inter-comparison study between the different methods to derive level 2 data from infrared hyperspectral sounders, recognising that there are several software packages available utilizing AIRS/IASI/CrIS data.	At ITSC-22 CIMSS/SSEC presented a review of the applications of Level 2 sounding products from the NUCAPS and HSRTV direct readout packages, which both support CrIS and IASI-based retrievals (HSRTV also supports AIRS retrievals). Applications in air quality monitoring and detection of cold air aloft were presented. In the case of NUCAPS and HSRTV, the same retrieval software package can support sensors on multiple satellites (e.g., NUCAPS supports SNPP, NOAA-20, Metop-A, and Metop-B). This facilitates much better temporal coverage of morning and afternoon overpasses with a consistent retrieval algorithm and product quality.	
4.4.1	Establish a common vocabulary and methodology with appropriate error propagation to include the errors associated with validation data (e.g. radiosonde temperature, water vapour, precipitation and winds).	At ITSC-22 EUMETSAT presented the status of microwave humidity sounding FCDRs generated using a common algorithm for all sensors, based on principles developed in the EU Horizon-2020 FIDelity and Uncertainty in Climate data records from Earth Observations (FIDUCEO) project. A thorough analysis of the physical effects in the measurement equation (which could introduce uncertainties to the measurements) is performed and thus the dataset provides not only the radiances (brightness temperatures) but also the independent, structured, and common uncertainties which are associated with individual sensor measurements.	
4.4.2	Agree on standardized procedures to derive NedT estimates for microwave sounders, and include such estimates in the disseminated BUFR data.	Since ITSC-21, NEDT estimates have been added to the ATOVS BUFR data distributed by EUMETSAT. However, it remains an issue that the calculation of the NEDT differs between NOAA, EUMETSAT and the Met Office. Jörg Ackermann (EUMETSAT) distributed a report detailing the differences between these approaches. For further progress, working group members will review these approaches and make suggestions as to the preferred method for calculating NEDT. Satellite data providers were encouraged to agree on a standardized procedure for calculation of NEDT estimates for inclusion within BUFR for microwave data. An action was assigned to NOAA to report on the status of the provision of NEDT estimates in BUFR files for microwave data from NOAA/NESDIS.	
4.6.1	Continue support for line-by-line (LBL) reference model development and enhanced characterization of spectroscopy to ensure that product development teams and users of level 1 data have access to the latest updates in LBL forward modelling and the uncertainties involved.	At ITSC-22 LMD/CNRS reported on the status of the new GEISA-2019 spectroscopic database. GEISA and associated management software facilities are implemented and freely accessible online. The next release is planned for the mid 2019. Examples of validation studies for molecules such as H ₂ O, CO ₂ and CH ₄ were presented. At ITSC-22 an action was assigned to Marco Matricardi (ESMWF) to communicate to the ITWG on the CO ₂ perturbation impact on LBL radiances, and to provide a report on the perturbation of the line mixing model.	
4.6.2	Perform validation and intercomparison of LBL models/spectroscopy to assess the impact of spectroscopic uncertainties and the differences between line-by-line and fast radiative transfer models.	As above	