Advanced Sounders WG

Co-Chairs:

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Saturday morning, 10 May 2025

AGENDA

- ✓ MTG-S/IRS (EUMETSAT)
  - ✓ MTG-S1 IRS status and impact of IR in GEO on NWP (ASWG-01-Slides)
  - ✓ Direct forecasting from observations in the context of IRS (ASWG-02-Slides)
- ✓ Impact of IR sounders (CrIS/IASI/HIRAS…) on the Forecasts
- ✓ Early morning orbit at 5:30 am, HIRAS-2 on FY-3E – Any impact observed?
- ✓ Smaller footprint for LEO IR orbit missions
- ✓ NEON Program Initial Scope (ASWG-03-Slides) – SMBA/SIRBA - Any feedback of such mission?
- ✓ Advanced Microwave Technology and Data Exploration (ASWG-04-Slides)
- ✓ Considering the ongoing preparation for EPS-Sterna, what about considering also the low inclination orbits in LEO to complement the MW sounding capabilities offered by Sterna?
- ✓ Synergistic importance of both WV and T sounding capabilities (e.g. a small sounder with 50-57 GHz, 89 GHz, 118 GHz +183 GHz)? Any new agency plans?
- ✓ Early feedback from the AWS evaluation workshop (ASWG-05-Slides)
- ✓ First experiences with sub-mm channels from AWS (ASWG-06-Slides)
- ✓ Communication from CGMS/High Level Priority Plan interesting for the ASWG

MTG-S1 IRS status and impact of IR in GEO on NWP

Context: The IRS will be launched in July 2025

Discussion:

- **MTG-IRS status presented by Guillaume Deschamps.**
  - **There was a discussion on the schedule for data availability and it was noted that early dissemination of MTG-IRS data would be available to the MAG and select users; contact EUMETSAT with any early data dissemination requests.**
- **Exercise conducted at ECMWF using GIIRS showed a positive impact of the Temperature and Humidity in the lower troposphere (summary of results presented by Naoto Kusano)**
- **Additional results and work have likely been completed by CMA, but they were not in attendance at ITSC-25 to contribute to the discussion.**
  - **i.e., EGU25-5543, https://doi.org/10.5194/egusphere-egu25-5543**
- **AI Impact on HSIR Sounders**
  - **An overview slide was presented by Guillaume Deschamps. It is estimated that only ~0.06% of the disseminated radiances are used daily in NWP (channel subset selection, spatial thinning, etc.).**
  - **There are valid reasons, considerations, and practical limitations within the current NWP systems for data thinning.**
  - **Recent advances in machine learning (e.g., AIFS) and direct forecasting from observations (e.g. AI-DOP) open new possibilities. It is now conceivable to use all available information (spectral and spatial) in weather forecasting.**
  - **It should be appreciated that redundant channel information is valuable as the use of multiple channels with similar weighting functions and sensitivity effectively increases SNR.**

Outcomes:

- **Action ITSC25-AS-1 to NWP Agencies: To report on the impact of the IRS on NWP at the next ITSC**

Discussion on the impact of having a HS IR sounder in the 5.30 AM orbit

Context: Linked to the High Level Priority Plan from CGMS on work towards ensuring optimised Hyperspectral IR measurements from LEO and GEO orbits to improve time sampling, spatial and spectral resolution and timeliness of observations, including the deployment of HSIR instruments across the GEO ring as per WIGOS vision 2040.

Discussion:

- **Data quality and assimilation impact assessment of the HIRAS-2 on FY-3E is underway at ECMWF. There was a timestamp issue in early assimilation impact testing, which has been resolved, and tests are now being resumed.**
- **Fuzhong Weng mentioned that some work have been done at CMA showing benefits (that answers the action ITSC24-AS-2) - Confirmed by Qifeng Lu in his recorded talk:**
  - **Evaluation of the FY-3E microwave temperature sounding data assimilation on forecasting Typhoon Chanthu, 2021, Yu Huang, Juan Li, Zhengkun Qin**
  - **More recently: Added Benefit of the Early-Morning-Orbit Satellite Fengyun-3E on the Global Microwave Sounding of the Three-Orbit Constellation, 2024, Juan LI, Zhengkun QIN, Guiqing LIU, Jing HUANG**
- **Allen Huang noted that an impact study of the 0530 orbit had been completed recently in the US, and the report would be published in the near future**

Outcomes:

- **Recommendation ITSC25-AS-2 to Space Agencies: to continue considering the early morning orbit in LEO**

Discussion on the impact of smaller footprint for LEO IR orbit missions

Context: Linked to the High Level Priority Plan from CGMS on work towards ensuring optimised Hyperspectral IR measurements from LEO and GEO orbits to improve time sampling, spatial and spectral resolution and timeliness of observations, including the deployment of HSIR instruments across the GEO ring as per WIGOS vision 2040.

Discussion:

- **NWP mentioned that smaller footprint has been a long-standing request. Smaller footprints were considered for JPSS-3/4 CrIS, and studies were completed. These results should be located and distributed if possible.**
- **It was mentioned that we should not forget that the new instruments are also valuable for several applications, not only NWP. These other applications should also be considered during design trade-space evaluation of footprint size, spectral resolution, SNR, etc.**
- **Smaller footprints dramatically increase the probability of a clear sky observation. ECMWF noted that they are developing a full sky assimilation which does not require clear sky only observations but acknowledged that even in this case that cloudy IR footprints do not provide information content below optically opaque clouds.**

Outcomes:

- **Recommendation ITSC25-AS-3 to Space Agencies: to continue improving the new generation of hyperspectral IR sounders, including smaller footprint.**

Discussion on NEON Program Initial Scope and Status

Context: NOAA's NEON (Near Earth Orbit Network) Program will supplement and eventually replace NOAA's Joint Polar Satellite System (JPSS).

Discussion:

- **Summary slides on the current status and initial scope of the NEON program were presented by Joe Taylor. These slides were based on currently publicly available information.**
  - **Quicksounder (ATMS based) scheduled for launch in 2026.**
- **Lihang Zhou to provide a recorded presentation on NOAA program status later in the week at ITSC.**
- **Discussion on disaggregation of observations**
  - **Co-located (spatially and temporally) observations are important for many non-NWP applications.**
  - **Co-located imager information provides sub-FOV information for microwave and IR sounders. A bore-sighted imager should be considered as an important ancillary measurement for disaggregated sounders.**
  - **There is a strong desire and high value of maintaining aggregated measurements for the LEO backbone at 0930, 1330, (and potentially 0530) orbits.**

Outcomes:

- **Recommendation ITSC25-AS-4 to Space Agencies: In the context of de-aggregation of measurements or developing small satellites or CubeSats in a constellation, it is crucial to maintain long-term calibration and stability of the backbone instruments to provide a reliable reference for intercalibration. Furthermore, it should be considered that many Earth System observation applications make use of the combination of sufficiently co-located measurements of different types.**

Discussion on Advanced Microwave Technology and Data Exploration

Context: There are many commercial programs in development, and the NEON program has emphasized coordination with commercial and industry partners. Highly flexible designs are possible, commercial conical scanning passive microwave imagers in development to complement WSF-M, CIMR, AMSR missions.

Discussion:

- **Allen Huang presented a summary of future microwave technology advancement.**
- **Discussion on the importance of accurate and stable calibration.**
  - **There were questions/discussion whether there were new methods or capabilities to provide on-orbit intercalibration of constellations; in general, on-orbit reference measurements are still of high importance.**
  - **Intercalibration will become increasingly important, with the backbone measurements extremely valuable as a reliable reference.**
- **Technology advancements may allow for on-orbit selection of channel sets. While this may be valuable for some applications (to "optimize for expected scene in different geographies and weather events"), non-static channels could have limited for NWP usage**
- **It was emphasized that calibration and stability are key for NWP.**

Outcomes:

- **Recommendation ITSC25-AS-4 to Space Agencies: In the context of de-aggregation of measurements or developing small satellites or CubeSats in a constellation, it is crucial to maintain long-term calibration and stability of the backbone instruments to provide a reliable reference for intercalibration. Furthermore, it should be considered that many Earth System observation applications make use of the combination of sufficiently co-located measurements of different types.**

Discussion on how the low inclination orbits in LEO to complement the MW sounding capabilities offered by Sterna (1/2)

Context: EPS-STERNA will provide new constellation of microsatellites that will each carry a state-of-the-art microwave sounder in a polar orbit. It will provide 19 channels from 50.3 to 325.15 GHz. There was a question to complement the EPS-STERNA program with low inclination orbits. Complimentary low inclination MW coverage by another agency would be of high value.

Discussion:

- **EUMETSAT emphasized that the low inclination orbit satellites could be of very high value to:**
  - **Study fast-evolving mesoscale phenomena such as deep convection, tropical cyclones that require high temporal resolution, thanks to their enhanced temporal sampling**
  - **Monitor diurnal cycle including convection initiation, diurnal warming and precipitation**
  - **Fill the gaps in coverage from polar-orbiting**
  - **Provide the opportunity for direct inter-calibration via co-located measurements with SSO orbit observations at a smaller temporal scale and for a large ensemble of scene temperatures**
- **Low inclination orbits have a well-established importance in the precipitation measurement community**
- **Supplementing the Sterna constellation with low inclination LEO satellites would provide MW observation frequency in line with the potential GEO ring capability for hyperspectral infrared sounders.**

Discussion on how the low inclination orbits in LEO to complement the MW sounding capabilities offered by Sterna (2/2)

Discussion:

- **Currently only TROPICS (Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats) satellite measurements are in a low inclination orbits. It was noted that differences in channels between satellites in the constellation complicate the usage. Calibration biases have also limited the use of the TROPICS data in NWP.**
- **KNMI noted that the low inclination orbits would have limited impact on their current regional models methods due to high variability in the number of observations per cycle.**
- **It was recalled that at the last ITSC-24, the Australian Bureau of Meteorology presented their user survey results and instrument requirements summary, for an Australian MW mission to complete and improve microwave sounding coverage to meet their future NWP and tropical cyclone nowcasting and monitoring needs (ITSC-24, 17p.05).**

Outcomes:

- **Action ITSC25-AS-5 to ASWG: To investigate the impact of low-inclination orbits, or to share with the group any findings already obtained on this topic.**
- **Recommendation ITSC25-AS-6 to Space Agencies: To ensure that microwave coverage is completed in coordination with the hyperspectral infrared coverage. Low inclination orbits could provide Geo-ring-like (temporal refresh and resilience) coverage.**

AWS evaluation workshop and experiences with the sub-mm channels

Context: The Arctic Weather Satellite was launched on 16 August 2024 in a sun-synchronous orbit which has a microwave sounder. There was an AWS workshop recently and AWS data are disseminated since mid-April, ECMWF has looked at the sub-mm channel 325 GHz.

Discussion:

- **It was mentioned that the 325 GHz channel has demonstrated good performance**
- **It is too early to have any impact of 325GHz reported, only a small positive impact on the winds was reported. The EUMETSAT/ESA AWS workshop discussed the overall performances of the instrument and that the initial assimilation results show positive impact in limited runs at Meteo-France and ECMWF.**
- **All-sky assimilation currently adjusts the moisture/winds/etc. but cannot influence cloud concentrations directly. The use of Cloud Control Variable (CCV) could help to get more cloud information into the 4D-Var analysis, and that this might be quite important for cirrus-sensitive radiances like sub-mm or visible**
- **Importance of the Ozone: not using it would impact bias correction**
- **Super cold WV layer could be seen at 325 GHz**
- **AWS mission operations are not funded beyond August 2026**

Outcomes:

- **Recommendation ITSC25-AS-7 to ESA: To extend the AWS mission lifetime beyond August 2026 as currently planned. This could allow an overlap of the initial satellites of EPS-STERNA in 2028/29.**

Discussion on CGMS/High Level Priority Plan

1.2.2 Advance the new generation of GEO satellites, including advanced imaging, lightning mapping and Hyperspectral IR sounding for the whole geostationary ring
Recommendation ITSC25-AS-8 to space agencies: To ensure the completion of the hyperspectral sounder within the GEO ring.

1.2.4 Work towards ensuring optimised Hyperspectral IR measurements from LEO and GEO orbits to improve time sampling, spatial and spectral resolution and timeliness of observations, including the deployment of HSIR instruments across the GEO ring as per WIGOS vision 2040.
Re-iteration of the Recommendation ITSC24-AS-3 (renamed as ITSC25-AS-9) to NOAA: to pursue with the LEO program Recommendation ITSC25-AS-8 to Space Agencies: To ensure the completion of the hyperspectral sounder within the GEO ring.

1.2.9 Work towards operational 3D wind profile observations from space-based lidar.
EUMETSAT mentioned their activity on deriving the 3D winds from hyperspectral infrared sounders.
No action or recommendation noted.

4.1.1 Maintain within GSICS a framework for inter-calibration of hyper-spectral sounders.
4.1.2 Establish within GSICS a consistent inter-calibration for thermal IR channels using hyper-spectral sounders as reference. The implementation will be done successively by the individual satellite operators.
Re-iteration of previous ASWG recommendation (renamed as ITSC25-AS-10) to Satellite agencies: To develop, test and implement an SI-traceable radiometric standard in space as soon as possible, and complete it with a MW instrument.

Discussion on CGMS/High Level Priority Plan

4.3.2 Conduct an intercomparison study between the different methods to derive level 2 data from infrared hyperspectral sounders, recognising that there are several software packages available that utilize AIRS/IASI/CrIS data.
Action ITSC25-AS-11 to all: to conduct such study and communicate to the group as soon as possible.

4.5.1 Report on the progress within the Nowcasting community toward the use of hyperspectral sounders and work toward common products to serve the requirements of the global community
Action ITSC25-AS-12 to all: to report on any study on that topic

4.9 Identify AI/ML technologies for applying to the product processing and data management infrastructure and develop best practices
No action or recommendation noted.

Thank you!

#	Actions/Recommendations from the ITSC-25 ASWG meeting and side discussions to Space Agencies
Action ITSC25-AS-1	To report on the impact of the IRS on NWP at the next ITSC
Recomm ITSC25-AS-2	To continue considering the early morning orbit in LEO
Recomm ITSC25-AS-3	To continue improving the new generation of hyperspectral IR sounders, including smaller footprint
Recomm ITSC25-AS-4	In the context of de-aggregation of measurements or developing small satellites or CubeSats in a constellation, it is crucial to maintain long-term calibration and stability of the backbone instruments to provide a reliable reference for intercalibration. Furthermore, it should be considered that many Earth System observation applications make use of the combination of sufficiently co-located measurements of different types.
Action ITSC25-AS-5	To investigate the impact of low-inclination orbits, or to share with the group any findings already obtained on this topic
Recomm ITSC25-AS-6	To ensure that microwave coverage is completed in coordination with the hyperspectral infrared coverage. Low inclination orbits could provide Geo-ring-like (temporal refresh and resilience) coverage.
Recomm ITSC25-AS-7	To extend the AWS mission lifetime beyond August 2026 as currently planned. This could allow an overlap of the initial satellites of EPS-STERNA in 2028/29.
Recomm ITSC25-AS-8	To ensure the completion of the hyperspectral sounder within the GEO ring
Action ITSC25-AS-11	To conduct studies to address CGMS HLPP 4.3.2 and communicate results to the group as soon as possible
Action ITSC25-AS-12	To conduct studies to address CGMS HLPP 4.5.1 and communicate results to the group as soon as possible

#	Recommendations from previous meetings to Space Agencies
Recomm ITSC25-AS-9	For NOAA to continue to pursue the hyperspectral IR LEO program
Recomm ITSC25-AS-10	To develop, test and implement an SI-traceable radiometric standard in space as soon as possible, and complete it with a MW instrument