

## 2.4 ADVANCED SOUNDERS

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### 2.4.1 Introduction

This working group focuses on scientific issues affecting the optimal performance of advanced satellite sounder systems. The working group reviews the status of the development of advanced sounder systems and recommends changes pertaining to instrument specification, performance, data processing, and utilisation. For the purpose of this group, “Advanced Sounders” are defined as instruments that present significant new scientific and technological challenges and which require new methods for data processing and utilization. Thus, Advanced Sounders currently include high spectral/spatial resolution passive infrared and microwave sounders and active sensors.

### 2.4.2 Potential Observation Gaps in Geostationary IR Sounding

The WMO vision of the GOS in 2025 asks for a complete coverage of infrared sounders in geostationary orbit; current implementation plans of space agencies only partially consider an implementation. The group recognises a growing concern of potential observation gaps, particularly over America and the Pacific Ocean.

#### **Recommendation AS-1 to space agencies (e.g., NOAA, JAXA)**

**Devise plans to fill gaps in geostationary coverage with infrared soundings.**

#### **Action AS-1**

**ITWG Co-Chairs to present the concern of this group to CGMS.**

### 2.4.3 High Spectral Resolution MW Sounding

Vertical resolution of temperature and water vapour soundings in the microwave region has been limited through noisy receivers. Recent advancements in microwave receiver technology enable high spectral resolution measurements in the microwave regions between 118 and 183 GHz with low noise.

#### **Recommendation AS-2 to space agencies**

- 3. Pursue the development of advanced microwave sounders with high spectral resolution and reduced noise in order to enhance vertical resolution of temperature and moisture soundings under partial and non-precipitating cloud conditions.**
- 4. Extend developments of microwave receiver technology to enable high spectral resolution measurements with lower noise in the 50-60 GHz region.**

#### **Action AS-2**

**ITWG Co-Chairs to present the recommendation of this group to relevant space agencies (e.g., NASA, ESA, JAXA).**

#### **2.4.4 Infrared FOV Size**

Along with high radiometric and spectral resolution, the user communities need infrared sounders with higher spatial resolution and denser spatial sampling to increase the likelihood of clear soundings, commensurate with finer grid size of future NWP models. With new technological developments the employment of infrared detector arrays, which allow for higher spatial resolution at reasonable noise increase, seems feasible. Increasing horizontal resolution will also demand an increase in vertical resolution. Significantly higher vertical resolution can only be obtained by utilising active techniques such as lidar, radar, and GPS.

##### **Recommendation AS-3 to space agencies**

- 3. Conduct studies to trade off benefits of spectral, radiometric, and spatial resolutions of infrared sounders.**
- 4. Consider the development of active techniques for future systems (lidar, radar, GPS).**

##### **Action AS-3**

**ITWG Co-Chairs to present the concerns of this group to space agencies.**

##### **Recommendation AS-4 to NOAA**

- 3. Develop plans for the next generation infrared sounders (evolution of CrIS) for the JPSS-2 and follow-on satellites.**
- 4. Pursue the development of next generation sounders, which support higher spatial resolution and denser spatial sampling, complementary to the high spectral and high radiometric resolution of IASI-NG; this includes the highest spectral resolution being maintained in all bands and the elimination of band gaps.**

##### **Action AS-4**

**ITWG Co-Chairs to present the recommendation of this group to NOAA.**

#### **2.4.5 Apodisation of CrIS Data**

While CrIS provides a spectral resolution that is closely adapted to the CO<sub>2</sub> line spacing, the apodisation of the spectra reduces the resolution to an extent that information is lost in radiances of single spectral samples which in turn has a damaging effect on the vertical resolution. Most NWP users today make use of a sub-set of spectral samples and therefore will suffer from lost vertical resolution if they select apodised radiances. Users must be enabled to access the full hyperspectral resolution information content of the CrIS data.

##### **Recommendation AS-5 to users**

- 4. Preserve hyperspectral information in CrIS data by utilising either full CrIS spectra or unapodised radiances if a sub-set of spectral samples is utilised.**
  - 5. Develop radiative transfer codes for the use with unapodised radiances.**
  - 6. Develop radiative transfer codes in PC space and educate users to make use of these in data assimilation (and retrieval).**
- Or 4. Ensure apodised radiance channel sub-set is representative, i.e. channel subset sufficiently covers spectral band(s) of interest and noise representation includes apodisation and inter-channel correlations.**

**Recommendation AS-6 to EUMETSAT**

**Preserve hyperspectral resolution information in CrIS data from EARS by either distributing full CrIS spectra or disseminating unapodised spectral samples if a sub-set needs to be distributed.**

**Action AS-5**

**ITWG Co-Chairs to present the concern of this group to EUMETSAT.**

**2.4.6 Full Resolution CrIS Data**

While CrIS data are measured at high spectral resolution only spectrally sub-sampled data in mid and short-wave bands are down-linked from the Suomi NPP satellite and distributed to users. The users desire full-resolution spectra in all three bands to fully exploit the data.

**Recommendation AS-7 to NOAA**

**Down-link full resolution data from the CrIS instrument and distribute it to users.**

**Action AS-6**

**ITWG Co-Chairs to present the concern of this group to NOAA.**

**2.4.7 Data compression**

Future high-resolution sounders will provide data volumes that demand data compression for space-to-ground links as well as for ground transportation. Compression techniques must be exploited to reduce data transmission costs.

**Action AS-7 to ITWG**

**Report current state of compression techniques.**

**Recommendation AS-8 to space agencies**

**Pursue advancement of loss-less compression techniques for hyperspectral sounders.**