

# Advanced Sounder Working Group

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*Colour Key:*

**Existing Text** **New Text** **New Recommendations** **Action Items**

# Advanced IR Sounders in Geostationary Orbit

**Recommendation to the space agencies:**

It is recognised that high spectral resolution imaging radiometers on geostationary platforms would be an important part of the future global observing system. **It is recommended that an operational mission be conducted, preferably preceded by a demonstration mission for risk reduction purposes.** GIFTS is the best current option for a **demonstration mission.**

**Action on Steve English: Invite the NWP working group to review the need for geostationary high-spectral resolution ir sounders with view to recommending an operational mission (and a demonstration mission for risk reduction).**

**Action on ITWG co-chairs: Co-ordinate recommendations from this conference with those from the with Winds Workshop and communicate to Space Agencies.**

# IGeoLab

The IGeoLab initiative to promote international cooperation to place and test advanced sounders (e.g., GIFTS and MW) in geostationary orbit was also noted. This initiative should be supported. **A new IGeolab mission has been proposed by Russia, Canada and Finland for 2012. A Molnya orbit is proposed giving the benefits of a geostationary platform to high latitudes.**

**Recommendation to WMO: GIFTS should be considered as a candidate hyperspectral imager for this mission.**

**Recommendation to the space Agencies**

**The WMO IGEOLAB concept should be supported.**

# Calibration and Validation of Advanced Sounder Data (1)

## Recommendation to data users

The group encourages pre- and post-launch instrument characterisation and traceable calibration. Requirements for the parameters to be characterised and their required accuracy **and stability** should be communicated from the users (i.e., NWP, RT modellers, climate researchers) to the data providers. **To aid in early calibration and characterisation of new instruments data should be released as early as possible to NWP centres.**

## Recommendation to the space agencies **and NWP centres**

Cal/Val for advanced sounders needs to be an activity which receives sufficient resources. High-altitude airborne sensors, such as those associated with the NAST and ARIES airborne sensors, and upper air reference networks need to be added to complementary data sources, such as NWP, in order to validate the radiances and derived products to the very high accuracy and precision specified by the users. **These campaigns should be co-ordinated with new satellite launches.**

# Calibration and Validation of Advanced Sounder Data (2)

**Recommendation to Agencies and Scientists doing validation campaigns:**  
Case study data sets should be prepared and made freely available from these campaigns and the scientific community is encouraged to use these data to determine instrument spectral and model error, with a workshop taking place after a couple of years.

**Action on Jonathan Taylor:**  
E-mail details of Jaivex data to the ITSC conference

# Calibration and Validation of Advanced Sounder Data (3)

*The Working Group report from the previous meeting recommended that lessons learnt from establishing the in-orbit performance of IASI be used in pre-flight testing of future instruments. IASI underwent very careful ground calibration and the in-flight performance was very similar (if not slightly better). Calibration with different scene temperatures is important. Footprint shape determination, while costly to perform, is much more accurate when done on the ground.*

*Recommendation AS-5 to Space Agencies: Future instruments should be carefully calibrated before launch. In particular, care must be taken to accurately establish the instrument field of view as this procedure is far more accurate on the ground than in orbit.*

# Calibration and Validation of Advanced Sounder Data (4)

**Recommendation to the science community:**

**The utility of applying the SNO (Simultaneous Nadir Observation) technique for an equatorial (inclination  $< 20^\circ$ ) LEO platform for the purpose of radiometric cross-calibration should be examined. Optimal orbital parameters (attitude and inclination), as well as sensor(s) type, should be determined so that recommendations for possible sensors on future equatorial satellites can be put forward. The **CLARREO mission (which is primarily concerned with climate change and is in a 90 degree inclination orbit) partially fulfills these criteria and is a good first step.****

# Calibration and Validation of Advanced Sounder Data (5)

Spectrally correlated noise is fundamental to satellite observation systems and is a particularly important consideration for advanced sounders. This noise may be intrinsic to the instrument; may be introduced in post-processing; or may be caused by the forward model. Correlated instrument noise are best characterised through both ground-based measurements and in-flight measurements. Correlated forward model noise (which may include noise due to the effects of spectroscopic errors, cloud, aerosol and surface emissivity not being properly modelled) is best determined through inspection of the observations using the resources of NWP and dedicated validation campaigns.

**Recommendation to Space Agencies and NWP Centres: Encourage studies to evaluate the full error covariance matrix of forward models.**

**Action on members of ITSC: Use the information from dedicated validation campaigns to better understand the full error covariance matrix of forward models.**

# Advanced Sounder Fields of View

**It was noted that the current field-of-view size for advanced infrared sounders are larger than optimal to avoid cloud contamination. It is further noted that the optimal requirement for sounder fields-of-view may evolve with future advances in sounding techniques for cloudy regions.**

**Recommendation to the scientific community:  
Further studies on optimisation of the size of advanced sounder fields-of-view and spatial contiguity need to be pursued, taking into account probable future advances in sounding techniques.**

# Objectives and Desirable System Requirements of Advanced Sounders

**Action on Bill Smith: Review and re-create the advanced IR sounders requirements table with particular emphasis on establishing a link between instrument and geophysical measurement criteria (particularly WMO requirements).**

**Action on Bjorn Lambrigsten and Bill Blackwell:**  
**Prepare a draft table summarising the requirements for microwave sounding systems with particular emphasis on establishing a link between instrument and geophysical measurement criteria (particularly WMO requirements). This should be communicated to the frequency-protection community (Jean Pla).**

**Action on the Advanced Sounders Working Group: Review the tables produced above.**

# **Distribution and Optimal Use of Advanced Sounder Radiance Data in NWP (1)**

## **Recommendation to NWP Centres**

**It is recognised that more efficient use of the full advanced IR sounder spectrum is desirable within NWP data assimilation. NWP centres are encouraged to consider research into the direct use of principal components and/or retrievals from advanced IR sounders in assimilation systems.**

## **Recommendation to retrieval providers:**

**Provide full characterisation of retrieval schemes including observation error covariance matrix, averaging kernels, quality control, cloud detection. This characterisation should be both theoretically derived and independently validated. Data should be available in suitable and timely format.**

**Action on ITSC: Where possible, retrieval studies should be presented with averaging kernel and full error covariance estimates and validation.**

# Distribution and Optimal Use of Advanced Sounder Radiance Data in NWP (2)

**Recommendation to data providers:**

**It is noted that the use of principal components to represent advanced sounder spectra carries the danger of the loss of signals that are not properly represented in the training set. Care must be taken to ensure that data compression methods used for archiving of satellite data be lossless. Lossy compression of advanced sounder data for transmission may be acceptable for certain users. This question has become particularly pertinent in the context of continued distribution of IASI data in near real time.**

**Action on Ken Holmlund and the ASWG co-chairs:**

**Produce a table documenting the timeliness required (i.e., type of distribution) and the required fidelity of advanced sounder data as a function of user type (e.g., NWP, trace gas retrieval, climate applications) as a guide to space agencies on the most efficient strategy for data dissemination.**

**Action on ASWG and other working groups:**

**Critically review the table produced above.**

# **Distribution and Optimal Use of Advanced Sounder Radiance Data in NWP (3)**

**Recommendation to researchers:**

**Consider possibilities for spatial compression at data source.**

**Recommendation to Space Agencies:**

**Encourage further investigation of truly lossless data compression techniques.**

# Optimal use of community state-of-art algorithms and systems within prime contractor operational processing for satellite programs

Environmental satellite systems have historically been developed by a partnership of government (NASA, NOAA, and EUMESAT, for example), industry and university science communities. While the technological expertise of industry is a key part of the entire system, industry is not well-suited to supplying the broad perspective on the use of these future systems nor is it well suited to developing the necessary pre-launch simulations, ground data processing science algorithms, and associated data application approaches. The ITWG believes that approaches which require prime contractors to implement operational systems without making full use of community advances in algorithm and data processing system development, decrease overall quality and usage of final data products and increase program risk.

This includes activities associated with pre-launch instrument simulations, proxy data generation, and processing algorithm development and testing, through post-launch infusion of algorithm advancements to enhance operational processing data product quality and utility.

*Not ensuring infusion of latest community advancements also inhibits the science community from acting as an objective, commercially-neutral, body in the development and implementation of future satellite systems.*

**Recommendation to Space Agencies: Environmental satellite systems should be developed by a partnership of government, industry and university science communities under the leadership of government agencies.**

# On the continuation of the global GPS RO constellation

GPS radio occultation (GPS RO) measurements are an important source of temperature information in the upper troposphere and lower stratosphere, with applications in NWP and climate studies. The GPS RO measurements can be assimilated without bias correction, so they provide an important “anchor” for the bias correction of satellite radiance measurements. It is important that the global observing system includes observations that can be actively assimilated without bias correction. The COSMIC constellation is comprised of six LEO satellites, providing ~2000 globally distributed measurements per-day in near-real-time. COSMIC is the only dedicated GPS RO constellation and the mission will end in 2011. It is desirable that there is a fully operational follow up mission (e.g., COSMIC-2).

**Recommendation AS-17 to Space Agencies: A fully operational constellation of GPS radio-occultation receivers should be flown to follow-on the current COSMIC constellation.**

# Spacing of satellites when during MetOp overlap periods

MetOp-A and -B will be flying in parallel with the same equator-crossing time for up to five years after the launch of MetOp-B. As they will be using the same ground-based antenna their orbits need to be separated by a minimum of 20 minutes and a maximum of 50 minutes. The exact separation between the satellites should be determined by the NWP centres.

**Recommendation to EUMETSAT:** All MetOp level-1 and level-2 data should be distributed in near-real time from both satellites.

**Recommendation to NWP centres:** Preferences for separation between the two satellite should be communicated to EUMETSAT.

**Recommendation to ITSC:** Investigate the implications on developing innovative products from this configuration.

# Communication of the full CrIS spectrum

In order to retain consistency with with the full IASI capabilities (e.g., the ability to retrieve CO, low altitude H<sub>2</sub>O) as much of the measured CrIS spectrum as possible should be communicated to the ground.

**Recommend to IPO: that CrIS measurements are communicated at full (as measured) spectral resolution**

**Recommend to IPO: further investigation into communication of the full spectrum**

# **Cross-track vs conical scanner microwave sounders for future sounding missions**

**Recommend to Space Agencies/IPO: Further study of the ability of conical sounders to deliver sufficiently accurate observations for NWP in the light of the most recent results.**

# Land Surface Infrared Emissivity

The accurate determination of land surface infrared emissivity is crucial to the determination of the near-surface atmospheric state from these data. Derivation of the land surface emissivity relies on the combination of a realistic first guess and an accurate retrieval algorithm. The presence of cloud in the field of view can affect the accuracy of the emissivity retrieval algorithm.

**Recommend to researchers: Continued work on land surface emissivity databases including intercomparison between techniques.**

**Recommend to researchers: Continued work on land surface emissivity retrieval algorithms including intercomparison between techniques and investigation of robustness to cloud.**

**Recommend to researchers: Databases of global land surface emissivities should be given in terms of EOFs. Ideally, these EOFs should be universal between RT codes and users.**

# 4<sup>th</sup> Hyperspectral Sounding Conference

**4<sup>th</sup> Hyperspectral Workshop. EUMETSAT. 15<sup>th</sup>-17<sup>th</sup> September 2008.**

**Recommend to the relevant chairpersons: Co-ordination between the Advanced Sounders Working Group, the Hyperspectral Workshop, the IASI Conference and the AIRS science team.**

**Action on ASWG co-chairs: Co-ordinate with the IASI conference chairs, the AIRS science team and Paolo Antonelli to suggest possible topics that should be covered at future workshops and conferences.**

# Principle vs Principal Components

**And Finally....**

**Action on ITWG members: Check your presentations to ensure that you are using Principal (adjective) and not Principle (noun) Components.**

**Questions?**