

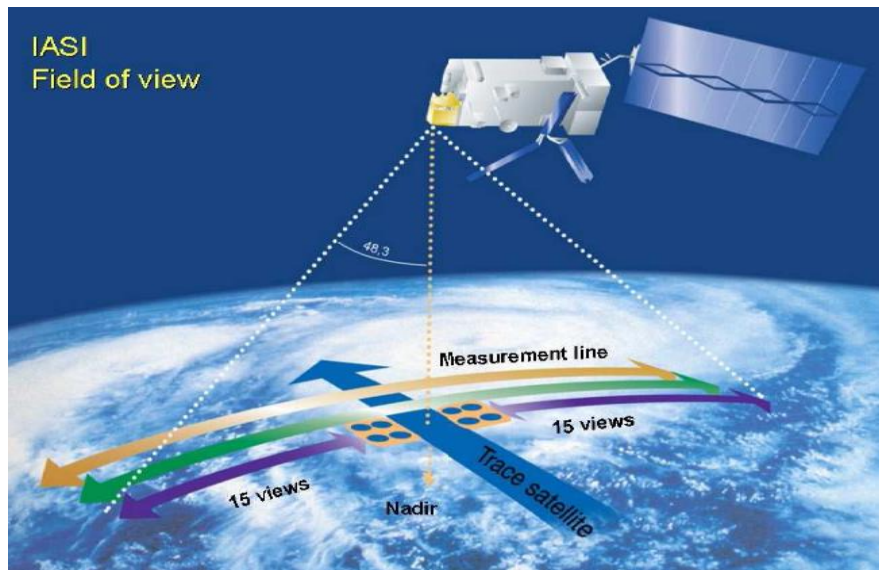
EUMETSAT plans and applications

Presented to CGMS-48 Plenary, Session: HSIR observations,
Agenda item 4.2

by Dorothee Coppens

Current hyperspectral infrared sounding capabilities

IASI (Infrared Atmospheric Sounding Interferometer) is a Michelson Interferometer flying on Metop satellites, part of the LEO (Low Earth Orbit) program at EUMETSAT



Normal Operation Mode

- ✓ Scanning the swath
- ✓ (30 Earth views + 2BB + 2CS) / 8 seconds

IASI	
Spectral characteristics	
Maximum OPD	2 cm
Spectral resolution	0.5 cm ⁻¹
Spectral sampling	0.25 cm ⁻¹
Spectral coverage	645-2760 cm ⁻¹ (3 bands are merged)
Spectral accuracy	< 2 ppm
Radiometric characteristics	
Radiometric noise	0.5 K
Geometric characteristics	
Field of view	12 km
Swath width	2100 km
Detector matrix	2x2 pixels covering 50x50 km ²

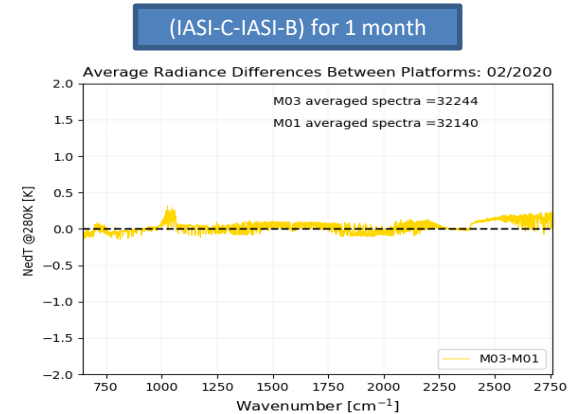
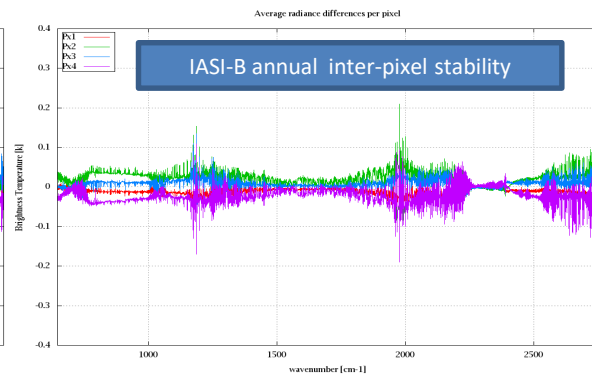
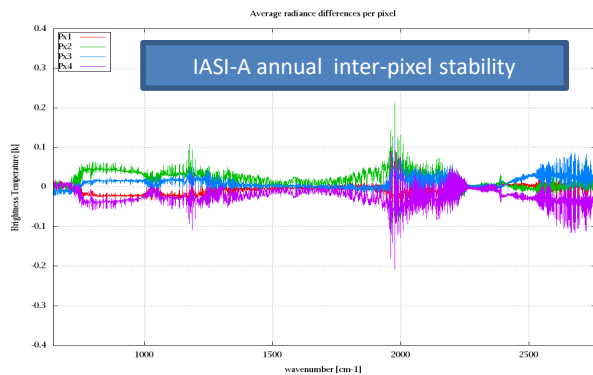
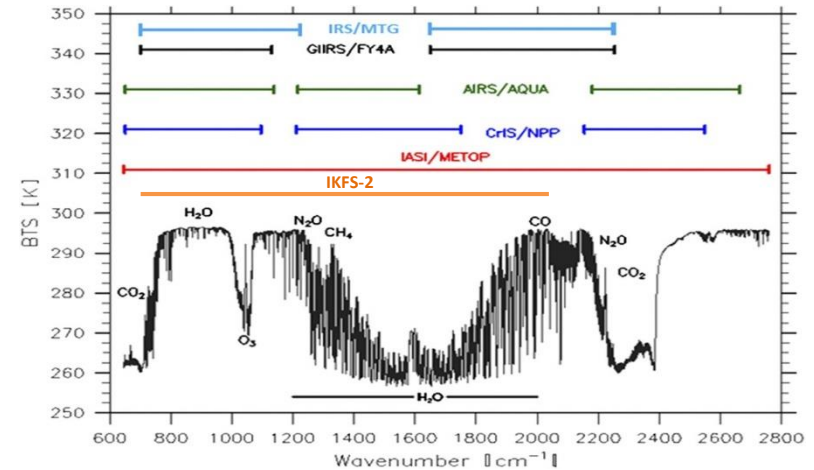
Flying IASI: 3 polar orbiting instruments on:

- ✓ Metop-A since October 19th, 2006
- ✓ Metop-B since September 17th, 2012
- ✓ Metop-C since November 7th, 2018

Current hyperspectral infrared sounding capabilities

IASI main characteristics:

- Provides continuous spectra from 3.62 to 15.5 μm
- Fine spectral sampling of 0.25 cm^{-1}
- Accurate radiometric and spectral calibration
 → Very good stability and accuracy over the 3 Metops

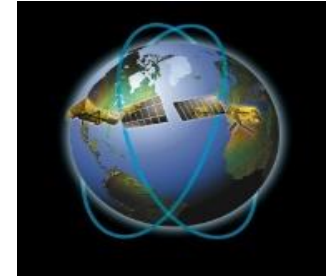


→ IASI is a worldwide GSICS reference for all infrared sounders and imagers

Planned/future hyperspectral infrared sounding capabilities

Future Hyperspectral Infrared instruments operated by EUMETSAT will be flying on two kind of satellites:

On a **Polar orbiting satellite**: The **EPS-SG** (EUMETSAT Polar System - Second Generation) program with the **IASI-NG** (IASI - New Generation) instruments, on three satellites from 2023 onwards, will be a continuation of the EPS program with three flying IASI instruments on the Metop satellites.



On a **Geostationary orbit**: A step forward wrt IASI, with an hyperspectral sounder, the **IRS** (InfraRed Sounder), on-board the Meteosat Third Generation (MTG). MTG will see the launch of six new geostationary satellites from 2021 onwards. The satellite series will be based on 3-axis platforms and comprise:

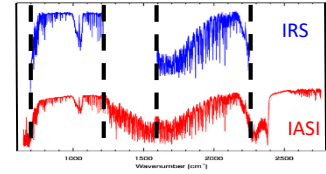
- ✓ Four Imaging Satellites (MTG-I) (20 years of operational services expected)
- ✓ Two Sounding Satellites (MTG-S) (15.5 years of operational services expected)



The **IRS** (InfraRed Sounder) will be flying on MTG-S satellites.

Planned/future hyperspectral infrared sounding capabilities

EUMETSAT is preparing very complementary hyperspectral IR missions:



IASI-NG

is a continuation of the IASI mission: **Michelson interferometer**
+ **Mertz compensation:**

- ✓ Polar orbit at 817 km
- ✓ Better **spectral sampling of 0.125 cm^{-1}** and **resolution of 0.25 cm^{-1}** → Twice better than IASI
- ✓ Detector: 12 km resolution at nadir
- ✓ Spectral coverage: 645 - 2760 cm^{-1}
- ✓ **Half of the IASI radiometric noise**

High spectral resolution and sampling

+

High radiometric accuracy

→ See CNES presentation

**Coordination Group for
Meteorological Satellites**

MTG-IRS

is an imaging FTS, based on a **Michelson interferometer** + **on-board field compensation**

- ✓ **Geostationary orbit**
- ✓ Spectral sampling of $\sim 0.6 \text{ cm}^{-1}$ and resolution of $\sim 0.754 \text{ cm}^{-1}$
- ✓ Detector: **4 km resolution** at nadir
- ✓ Two spectral bands: 700-1210 and 1600-2175 cm^{-1} within IASI spectra

High spatial resolution and sampling

+

High temporal repetition

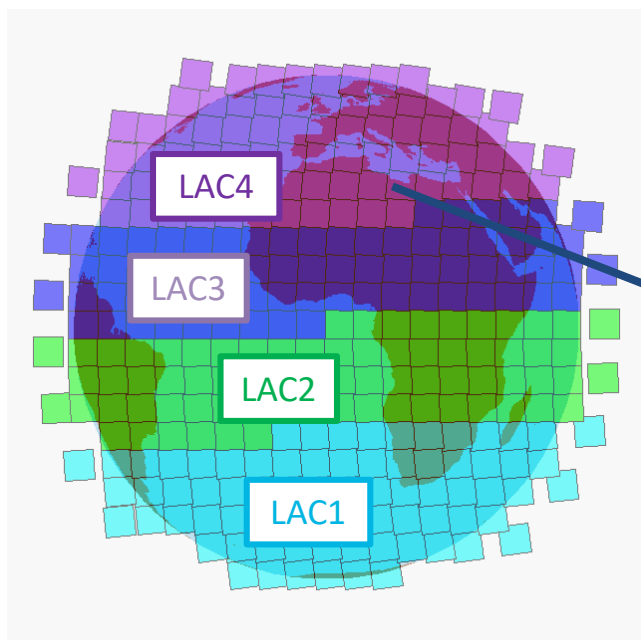


EUMETSAT CGMS

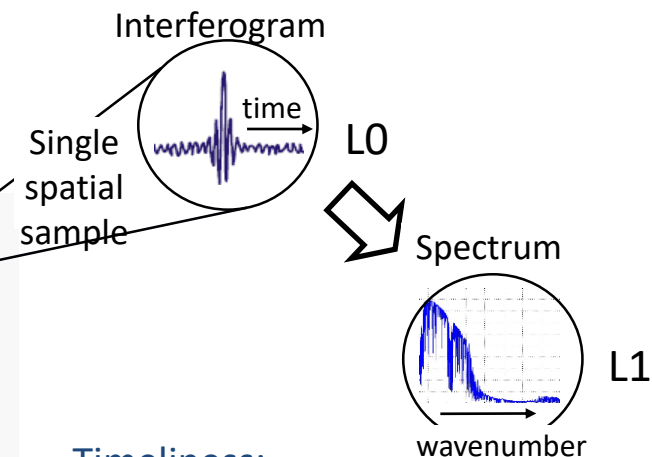
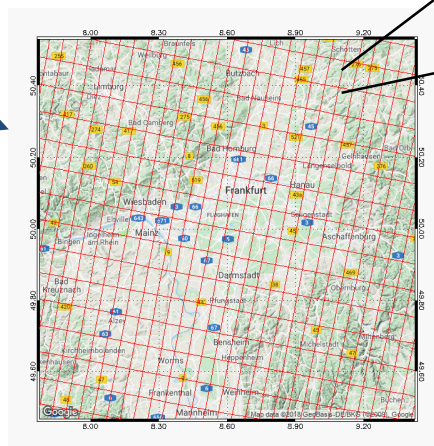
Planned/future hyperspectral infrared sounding capabilities

MTG-IRS

- The Earth disk is split in 4 Local Area Coverage (LAC) zones, each of them covered in 15 min by a succession of “steps and stares” called dwells
- LAC4 (northern mid-latitudes) will be covered every 30 minutes
- LAC1, 2, 3 will be alternatively viewed in-between



Each dwell consists of 160x160 pixels yielding a high spatial sampling



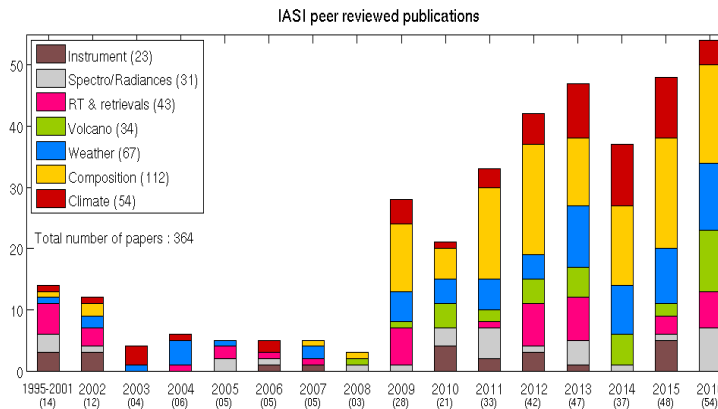
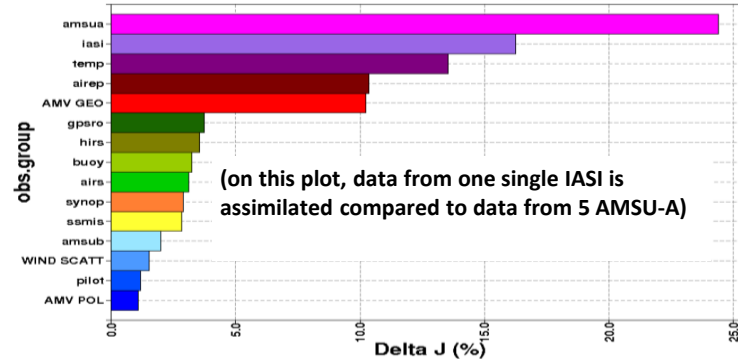
Timeliness:

- 25600 spectra covering 640x640 km² in 15 min!
- Level 2 products in 30 min!

Hyperspectral infrared sounding application areas (NWP and beyond)

- Main IASI applications was originally targeting NWP users:
- But many more applications have been using IASI in reality, and mainly:
 - ➔ Atmospheric composition (AC)
 - ➔ Climate
 (See CNES presentation)

Contribution to the reduction of forecast error
 Courtesy N. Saint-Ramond



Future missions:

- ➔ NWP will benefit of both IASI-NG and MTG-IRS missions
- ➔ IASI-NG will improve the contribution in AC/AQ applications (see CNES presentation)
- ➔ MTG-IRS will complete some applications, like AC/AQ, and will bring new applications using hyperspectral infrared sounders (next 2 slides)

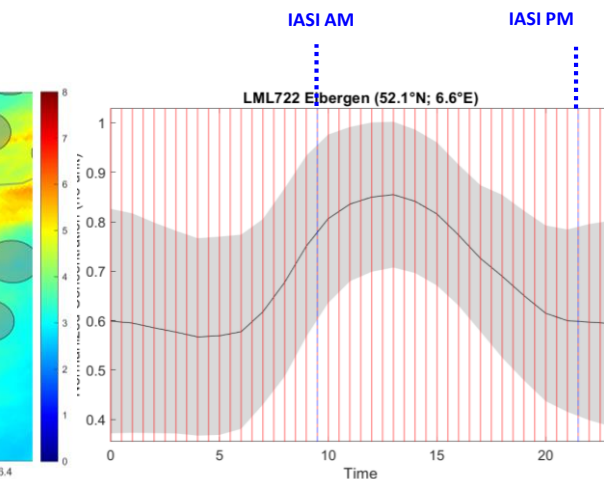
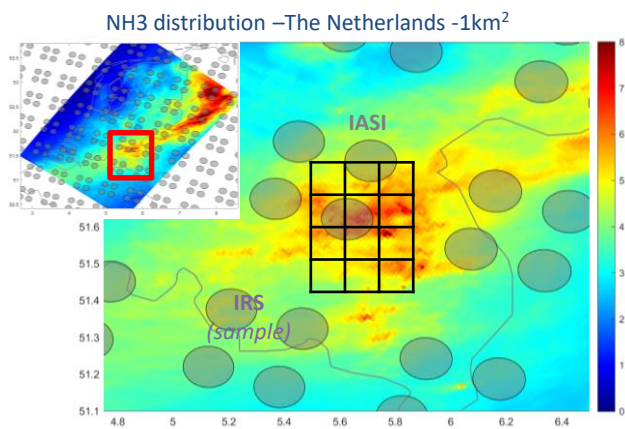
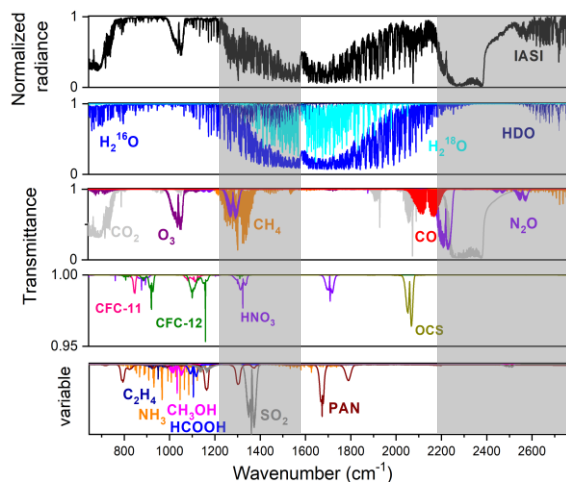
Hyperspectral infrared sounding application areas (NWP and beyond)

MTG-IRS possible contribution to AC

MTG-IRS vs. IASI and IASI-NG

- ✓ Reduced spectral coverage → will miss CH_4 , N_2O , SO_2 , ν_3 , HDO
- ✓ Coarser spectral resolution and larger noise → reduced vertical sensitivity + surface sensitivity

- ✓ Will contain at least O_3 , CO, NH_3
- ✓ Continuous coverage → Better mapping opportunities
- ✓ Higher spatial resolution → improved resolution of sources
- ✓ High temporal sampling → diurnal sampling; rapidly changing chemistry



Credits: Pierre Coheur, IRS-MAG meeting

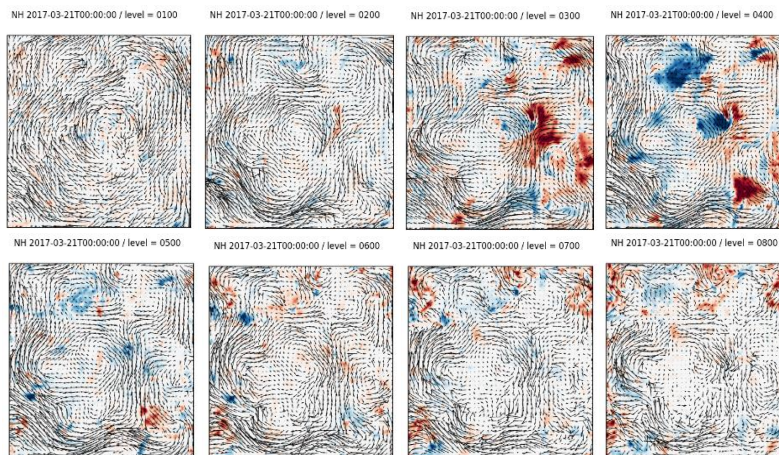
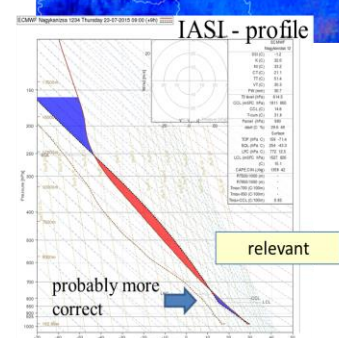
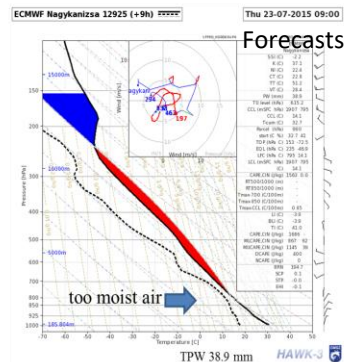
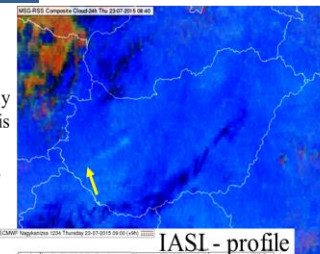
Hyperspectral infrared sounding application areas (NWP and beyond)

And more applications with MTG-IRS:

- Nowcasting:
 - Detection and Monitoring of Instability with IASI
 - Hyperspectral sounding for severe storm forecasting
- 3D winds retrieval using hyperspectral IR sounders:

Evaluation

- IASI profile is less moist at 800 hPa
- The 24h Microphysics RGB indicated relatively dry air (green component: BT10.8-BT8.7), this agrees with IASI profile
- The thunderstorms in this area were short-lived,



To be considered by CGMS/recommendations:

- EUMETSAT will contribute to the Vision 2040 of WIGOS in both GEO and LEO orbits, with two future programs very complementary:
 - Hyperspectral infrared instruments with very high spectral resolution/sampling and high radiometric accuracy in LEO
 - Hyperspectral infrared instruments with high spatial resolution and high temporal repetition in GEO
- IASI has brought an increased contribution to operational weather forecasting and has become a well-established data source for AC/AQ applications and we expect more with IASI-NG and MTG-IRS
- MTG-IRS will bring additional applications with hyperspectral sounders:
 - Nowcasting
 - 3D Winds (expected with IASI) – and should be available with IRS
- Recommendations:
 - To complete the GEO hyperspectral infrared instruments belt
 - To complete the LEO orbits: early morning (CGMS baseline)
 - Optimisation of additional orbits (late morning and afternoon)

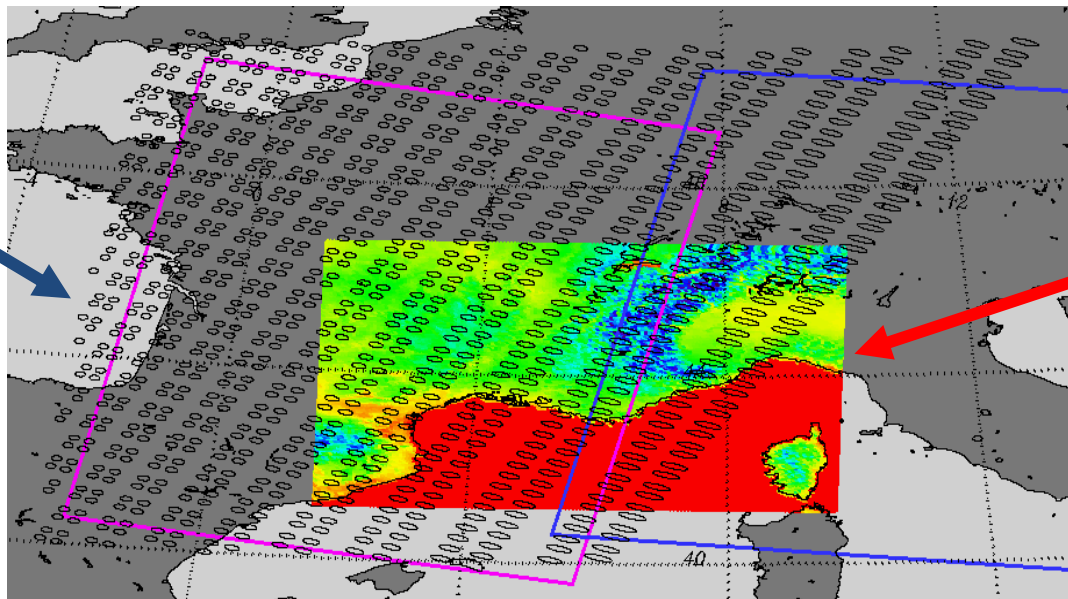


Additional slides

Planned/future hyperspectral infrared sounding capabilities

→ IASI/IASI-NG and MTG-IRS will be very complementary

IASI/IASI-NG
footprints 12-40km
Not-contiguous
2x per day



IRS pixels
~7km
Contiguous
Every 30'

