

Current and Future EUMETSAT Hyperspectral Infrared Missions: IASI, IASI-NG and IRS

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IASI conference, 2nd of December 2024



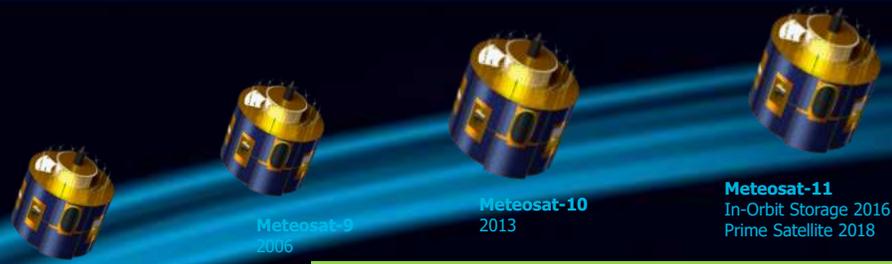
EUMETSAT missions – current and future

Geostationary Programmes

Mandatory Programmes

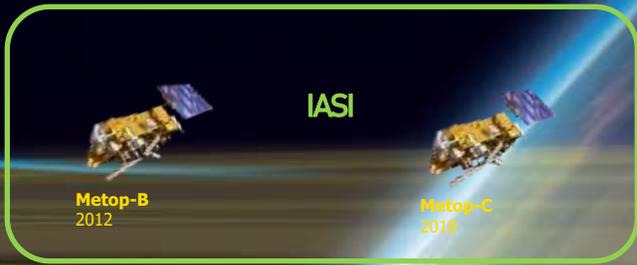
Polar Programmes

Copernicus Programmes



Flying Hyperspectral Infrared sounders

Coming Hyperspectral Infrared sounders





EPS/IASI mission operations

EPS-SG/IASI-NG preparation

MTG/IRS preparation



EPS/IASI mission operations

EPS-SG/IASI-NG preparation

MTG/IRS preparation



The EUMETSAT Polar System (**EPS**) programme comprises a series of three polar-orbiting Metop meteorological satellites which constitute the space segment of the overall EUMETSAT Polar System.



EPS is the **European contribution** to the Initial Joint Polar System Agreement (IJPS), an agreement between EUMETSAT and NOAA. Metop flies in a low Earth orbit (LEO) corresponding to the local "morning", while the United States is responsible for "afternoon" coverage.

EPS-SG will continue to provide morning coverage of LEO satellites under the Joint Polar System (JPS) agreement with NOAA.



IASI (METOP)

Orbit:

Low-Earth orbit (~820km)

Sensors:

2x2

Spatial sampling (Nadir):

12 km

Spectral sampling:

0.25 cm⁻¹

Temporal:

~2x / day

Launch:

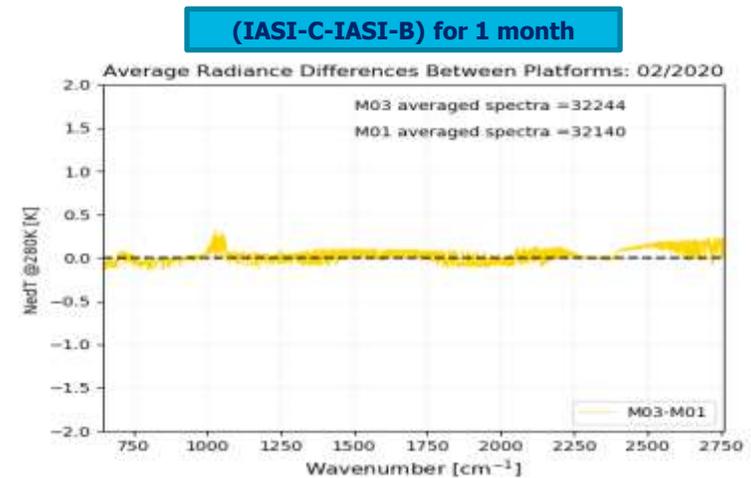
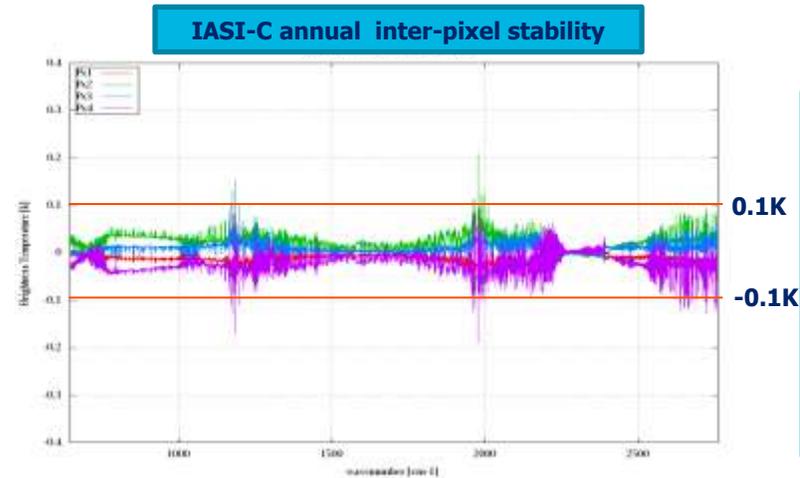
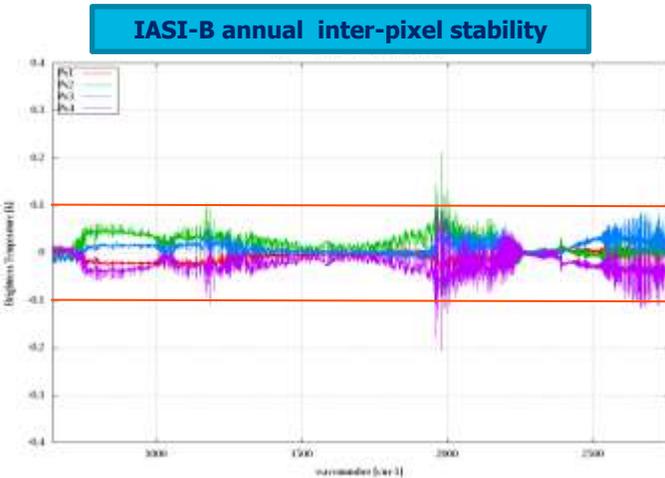
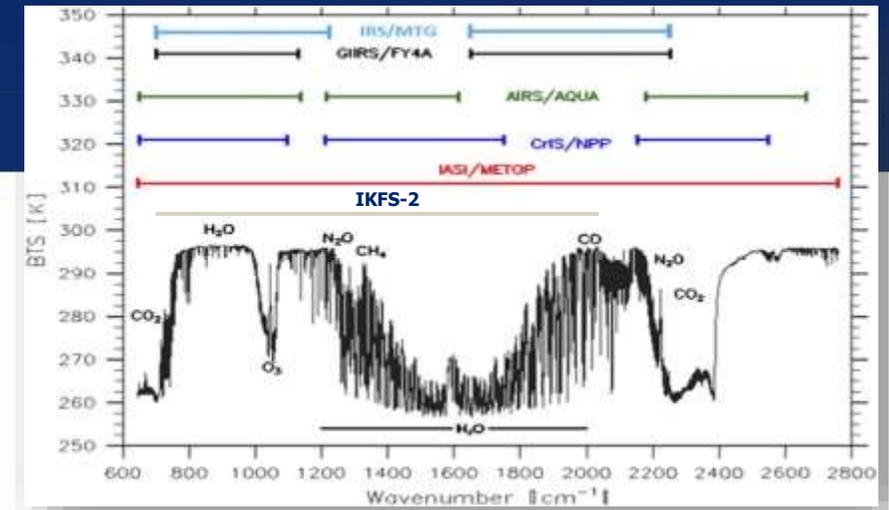
Metop-A 19 October 2006
Metop-B 17 September 2012
Metop-C 06 November 2018



IASI – Very well calibrated

IASI:

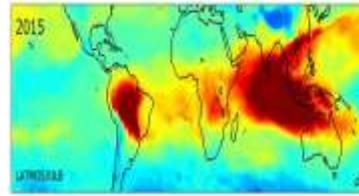
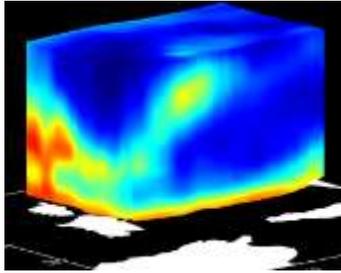
- ✓ Provides continuous spectra from 3.62 to 15.5 μm
- ✓ Fine spectral sampling of 0.25 cm^{-1}
- ✓ Accurate radiometric and spectral calibration
 - Very good stability and accuracy over the 2 Metops



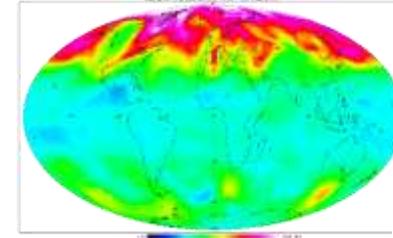


IASI for Atmospheric composition/Air Quality

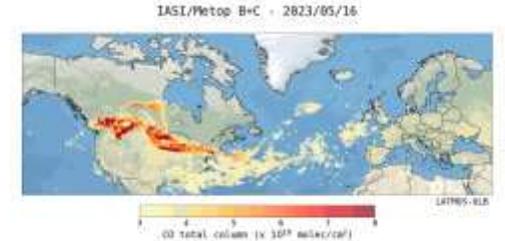
Temperature, humidity Profiles



Carbon monoxide

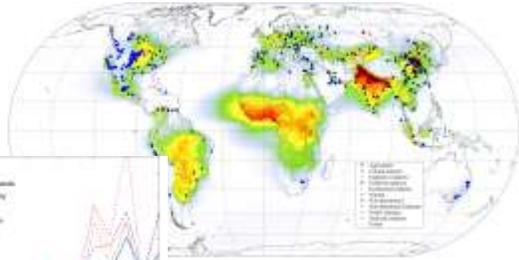


Ozone



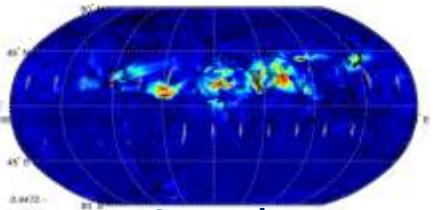
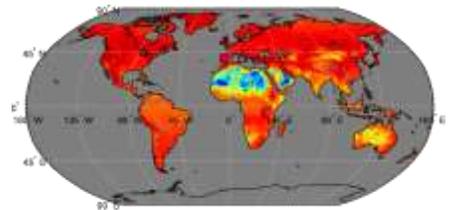
Forest fires detection

IASI,
who was supposed to detect 7
species, detects today **33 species!!**



Ammonia hopt spot detection (NH₃)

Land surface temperature and emissivity

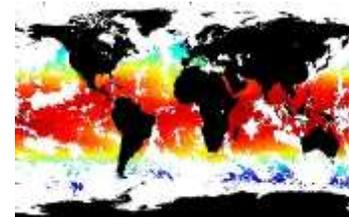


Aerosols

Could mask and height



Sea surface temperature





- Continuous monitoring of IASI-B/IASI-C level 1 products
→ <https://service.eumetsat.int/epsreports/index.php?instrument=IASI&sat=M01>
- Continuous improvement of the IASI PC and L2 processing – Preparation of the version 7
→ *This will be presented by Marc Crapeau (Tuesday at 9h45)*
→ *Interesting latest CO2 profiles development by Jonas Wilzewski – See Poster S8-29*
- Continuous monitoring of the IASI L2 products with in-situ measurements
→ *Example of Ozone profiles monitoring by Stefan Stapelberg (Tuesday at 11h40)*
- Generation of IASI L1 and L2 Climate Data record
→ *See Poster S12-42 by Marie Doutriaux-Boucher*
- Development of innovative techniques to generate a new emissivity atlas based on IASI
→ *See Tim Hultberg's presentation on Thursday at 15h15*



EPS/IASI mission operations

EPS-SG/IASI-NG preparation

MTG/IRS preparation



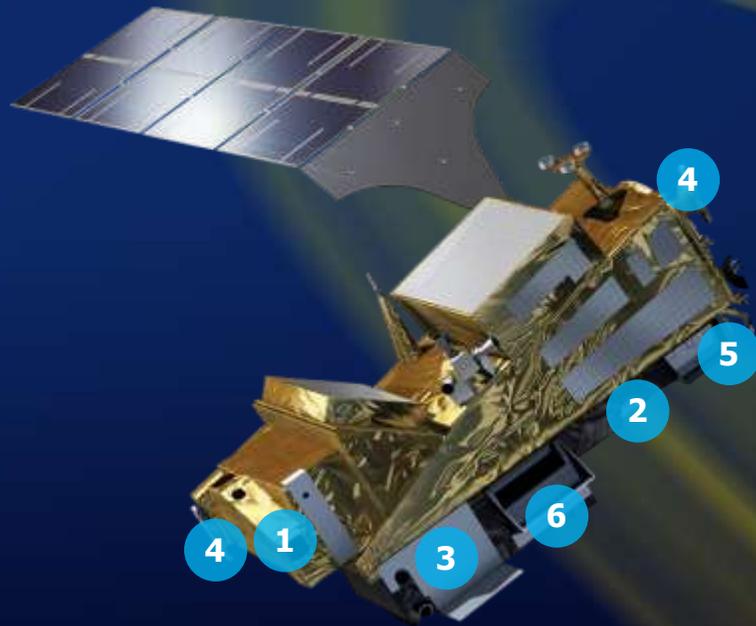
EPS/IASI mission operations

EPS-SG/IASI-NG preparation

MTG/IRS preparation



EPS-SGA Sounding and Imagery Mission



1. **IASI-NG**
Infrared Atmospheric Sounding
2. **MWS**
Microwave Sounding
3. **METImage**
Visible-Infrared Imaging
4. **RO**
Radio Occultation
5. **3MI**
Multi-viewing, -channel, -polarisation
Imaging
6. **Copernicus Sentinel-5**
UN/VIS/NIR/SWIR Sounding

<https://www.eumetsat.int/metop-sg>



EPS-SGB Microwave Imagery Mission

www.eumetsat.int

1. SCA
Scatterometer
2. RO
Radio Occultation
3. MWI
Microwave Imaging for Precipitation
4. ICI
Ice Cloud Imager
5. ARGOS-4
Advanced Data Collection System



<https://www.eumetsat.int/metop-sg>



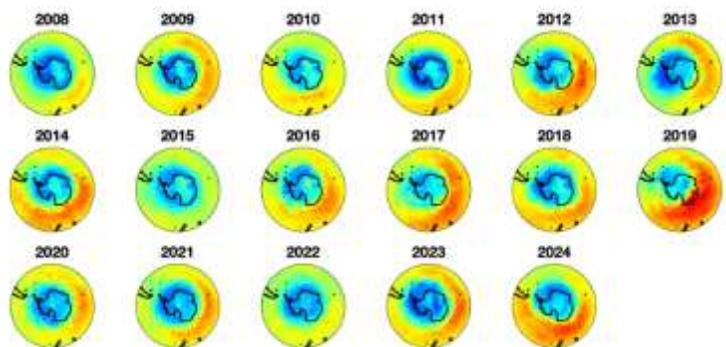
EUMETSAT Hyperspectral sounder missions

	IASI (METOP)	IASI-NG (METOP-SG)
Orbit:	Low-Earth orbit (~820km)	Low-Earth orbit (~820km)
Sensors:	2x2	4x4
Spatial sampling (Nadir):	12 km	12 km
Spectral sampling:	0.25 cm ⁻¹	0.125 cm ⁻¹
Temporal:	~2x / day	~2x /day
Launch:	Metop-A 19 October 2006 Metop-B 17 September 2012 Metop-C 06 November 2018	2025 + Lower noise





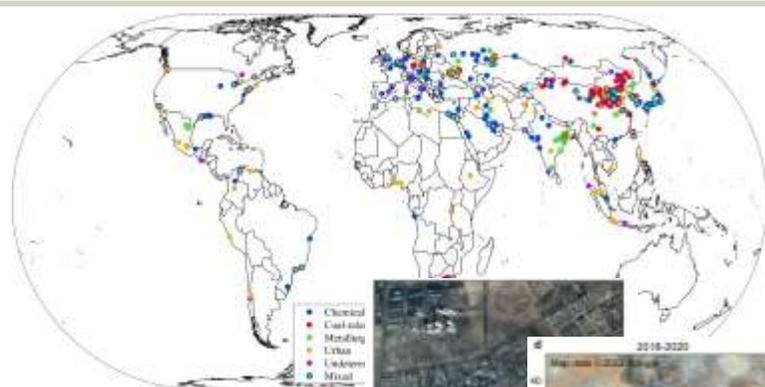
Continuity of the EPS series for weather forecast and climate study purposes



01/09 - 30/09 LATMOS-ULB/AC SAF
IASI Total Ozone Column [DU]

Ozone hole follow up

Detection improvement of the pollution sources, like the detection of Local industrial pollution (Ethyene)

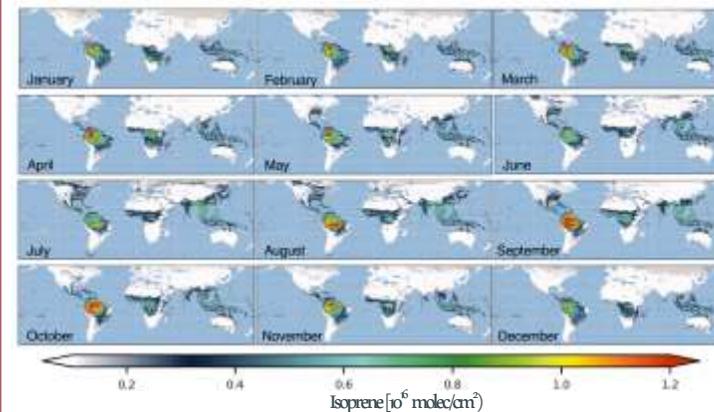


Mega-emition of ethylene (C₂H₄)

Detection threshold of C₂H₄:
IASI : 7.7 10¹⁵ molec.cm⁻²
IASI-NG: 3.4 10¹⁵ molec.cm⁻²

New opportunities

to measure new species, like the detection of organic compounds (Isoprene)



Isoprene: Regulator of the oxidizing capacity of the troposphere; Precursor of ozone and fine particles

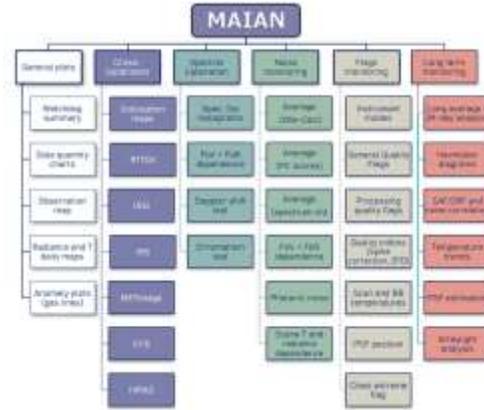
Detection threshold of C₅H₈:
IASI : 5.7 10¹⁵ molec.cm⁻²
IASI-NG: 3.1 10¹⁵ molec.cm⁻²



Preparation of the IASI-NG level-1 and level-2 commissioning

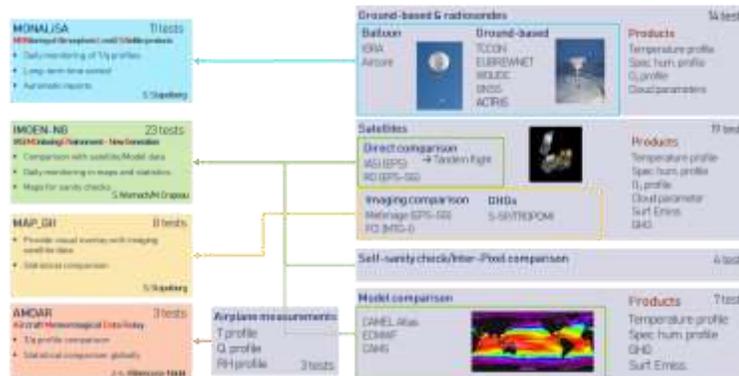
- Preparation of IASI-NG L1 commissioning and routine monitoring:

Monitoring and Analysis of IASI-NG L1C



➔ More details will be presented by Jose-Luis Villaescusa Nadal (Tuesday at 15h15)

- Preparation of IASI-NG L1D/L2 commissioning and routine monitoring:



➔ More details will be presented by Simon Warnach (Tuesday at 11h10)



EPS/IASI mission operations

EPS-SG/IASI-NG preparation

MTG/IRS preparation



EPS/IASI mission operations

EPS-SG/IASI-NG preparation

MTG/IRS preparation



EUMETSAT Hyperspectral sounder missions

www.eumetsat.int

	IASI (METOP)	IASI-NG (METOP-SG)	IRS (MTG-S)
Orbit:	Low-Earth orbit (~820km)	Low-Earth orbit (~820km)	Geostationary (36000km)
Sensors:	2x2	4x4	160x160
Spatial sampling (Nadir):	12 km	12 km	4 km
Spectral sampling:	0.25 cm ⁻¹	0.125 cm ⁻¹	~0.6 cm ⁻¹
Temporal:	~2x / day	~2x / day	Every 30 min Europe
Launch:	Metop-A 19 October 2006 Metop-B 17 September 2012 Metop-C 06 November 2018	2025 + Lower noise	2025



First European Geostationary Fourier Transform Spectrometer

IRS
Hyperspectral
Infrared Sounder



- 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
- Europe (LAC4) will be covered every 30 minutes
- LAC 1, 2, 3 will be alternatively viewed in-between



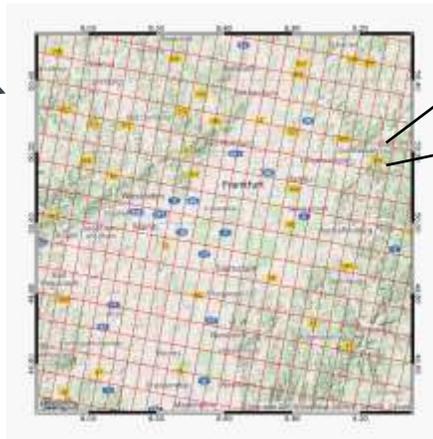
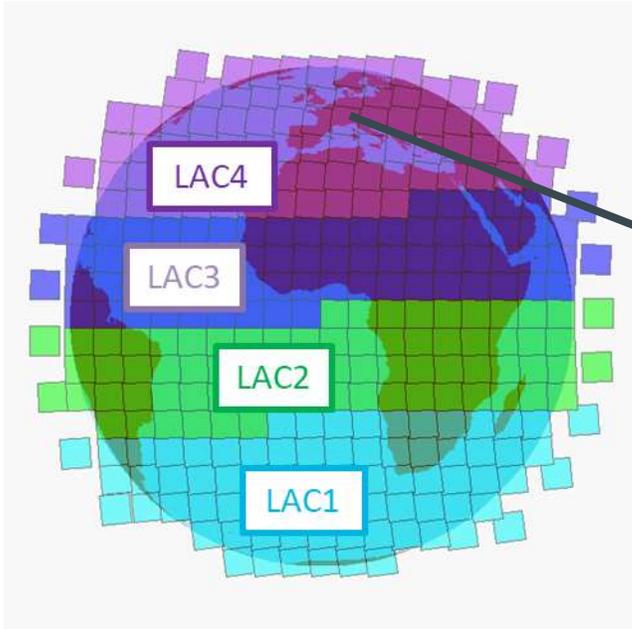
Two spectral bands:

- MWIR: 1600 to 2250cm⁻¹ (4.44–6.25μm)
- LWIR: 680 to 1210cm⁻¹ (8.26–14.70μm)

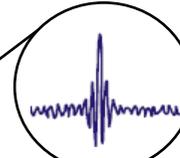
Timeliness:

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

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

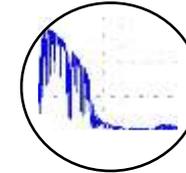


Interferogram



Single spatial sample

Spectrum



- Generation of continuous spectra representative of the atmosphere 3D composition (humidity, clouds, trace gases, ozone...) and thermodynamic state (temperature)
- Applications: Weather forecasting and nowcasting, clouds, trace gas retrievals, winds...



MTG-IRS → New opportunities and applications

A very complementary mission to IASI/IASI-NG:

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: $645 - 2760 \text{ cm}^{-1}$
- ✓ Half of the IASI radiometric noise

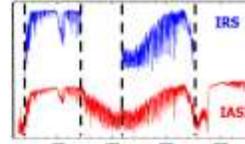
High **spectral** resolution and sampling
+
High **radiometric** accuracy

MTG-IRS

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

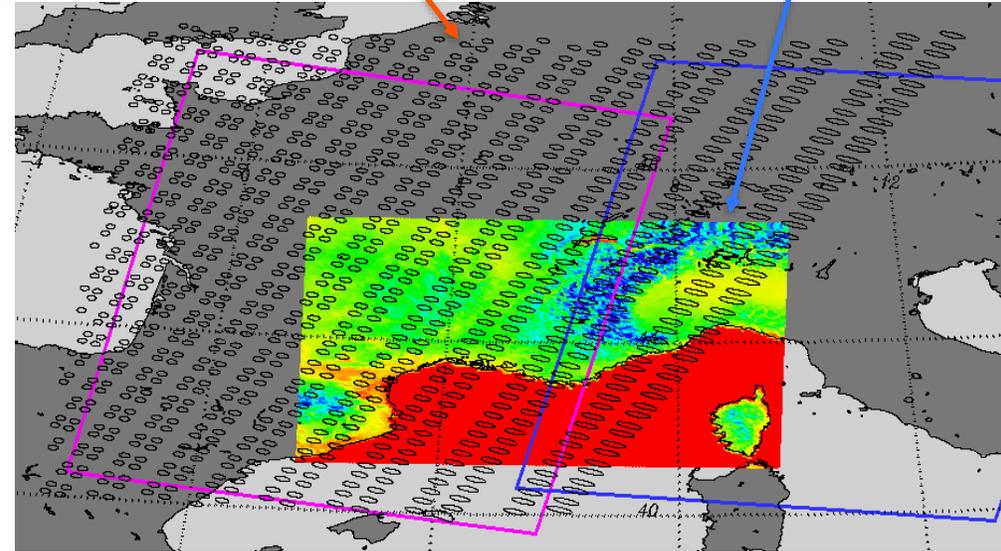
- ✓ Geostationary orbit
- ✓ Spectral sampling of $\sim 0.6 \text{ cm}^{-1}$ and resolution of $\sim 0.754 \text{ cm}^{-1}$
- ✓ Detector: 4 km resolution at nadir
- ✓ Two spectral bands: $700-1210$ and $1600-2175 \text{ cm}^{-1}$ within IASI spectra

High **spatial** resolution and sampling
+
High **temporal** repetition



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

IRS pixels
~7km
Contiguous
Every 30'

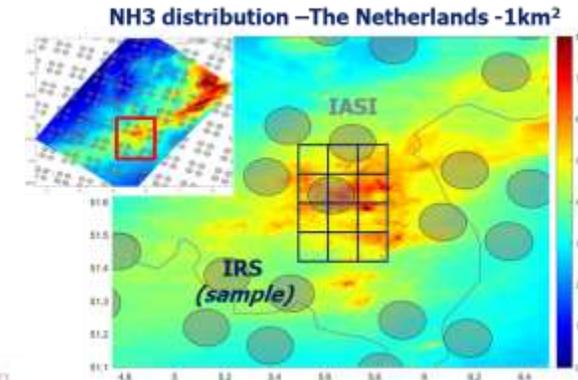


IASI & IASI-NG



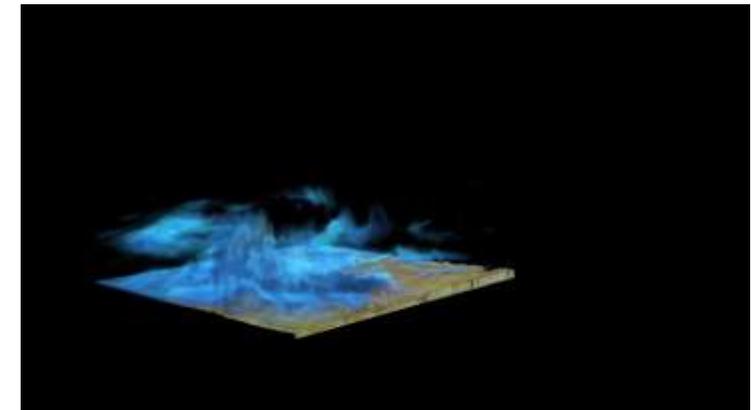
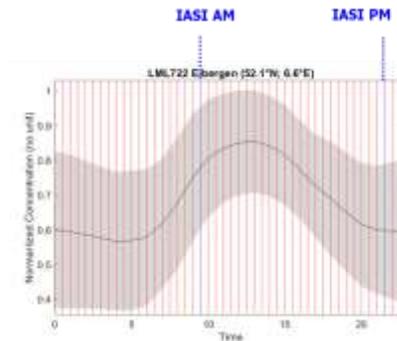
High spatial resolution:

- Atmospheric species at better spatial resolution (4 km)
- Improve resolution of pollution sources
- Improved cloud detection



High temporal resolution:

- Huge asset for nowcasting and severe storm forecasting
- To get the diurnal sampling
- Improved detection of rapid changing chemistry
- Huge asset to derive the 3D winds





- IRS L1 prototype and its monitoring – preparation for the commissioning
→ *See Poster S13-51 by Pierre Dussarrat*
- IRS L2 prototype and support to the operational processing
→ *See Poster S13-50 by Cedric Goukenleuque*
- Preparation to the IRS L2 commissioning:
→ *See Poster S13-502 by Harshitha Bhat*
- 3D winds:
→ *This will be part of Marc Crapeau 's talk (Tuesday at 9h45)*



Thank you!
Questions are welcome.