

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

Dorothee Coppens
Hyperspectral IR Competence Area Manager

IASI conference, 2nd of December 2024



EUMETSAT missions – current and future





EPS/IASI mission operations

EPS-SG/IASI-NG preparation

MTG/IRS preparation



EPS/IASI mission operations

EPS-SG/IASI-NG preparation

MTG/IRS preparation



Joint Polar System agreement

www.eumetsat.int



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:

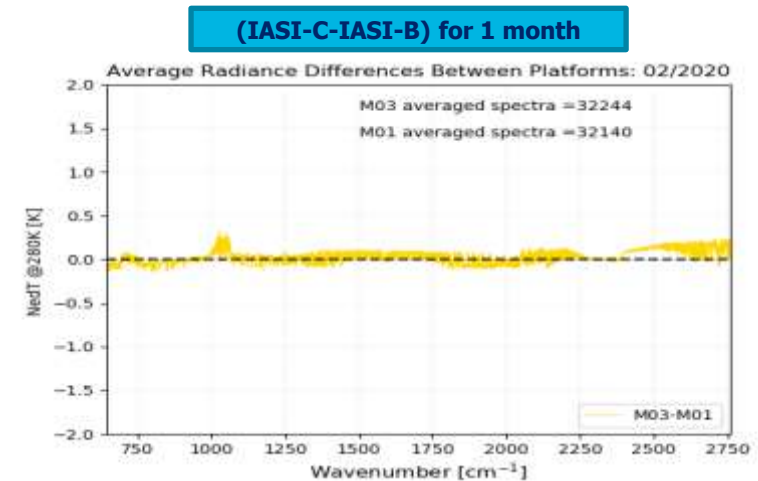
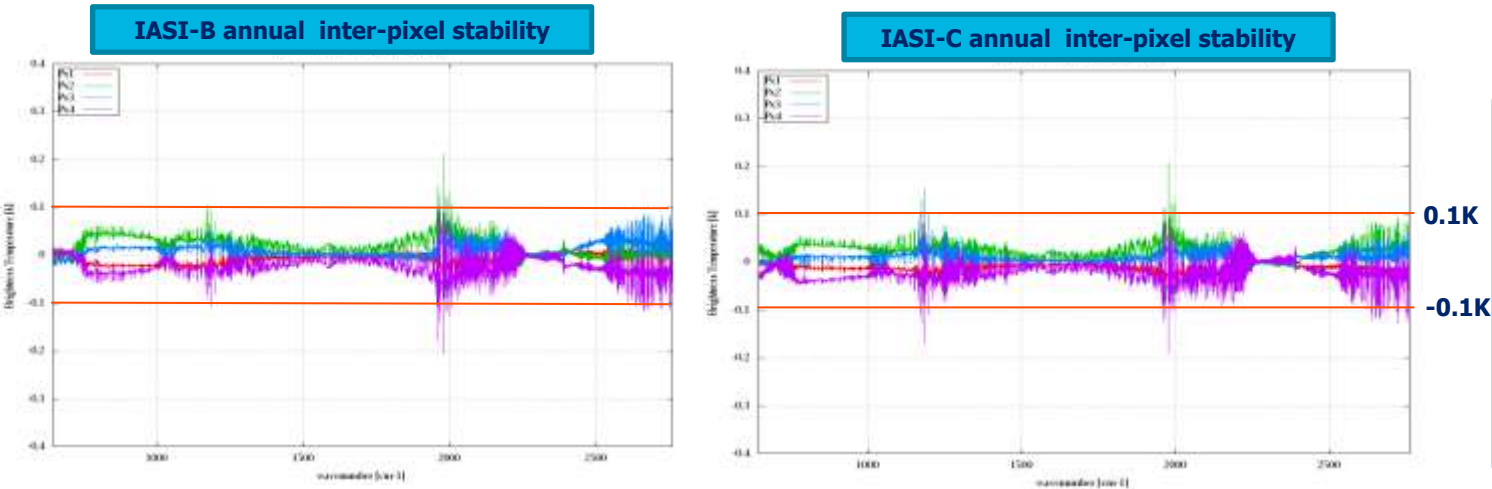
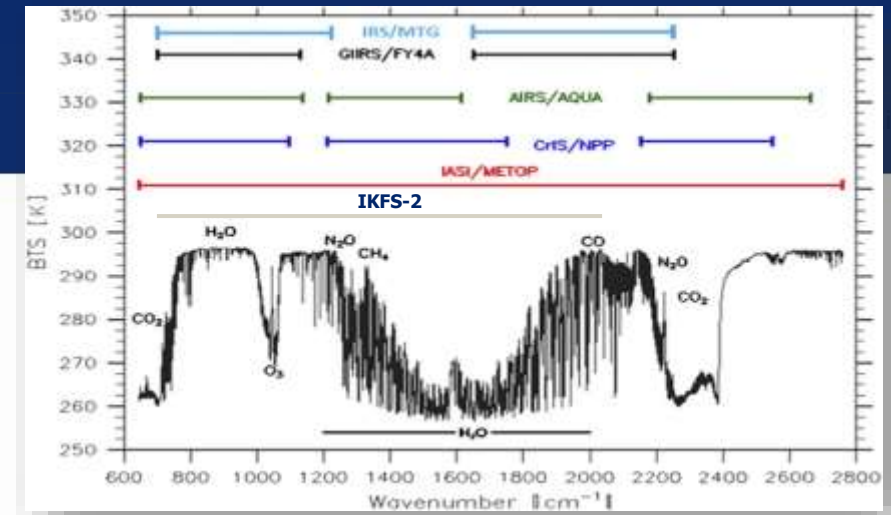
Metop-A 19 October 2006
Metop-B 17 September 2012
Metop-C 06 November 2018



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

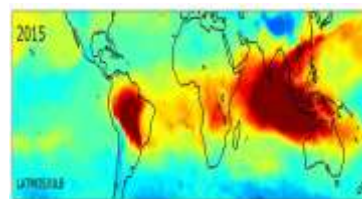
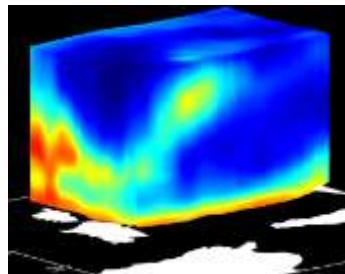




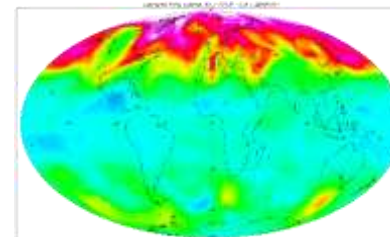
IASI for Atmospheric composition/Air Quality

www.eumetsat.int

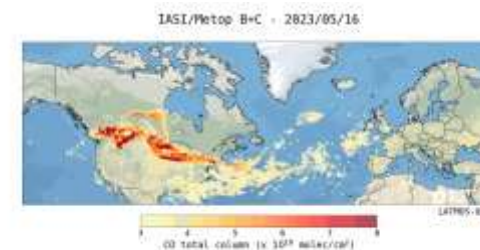
Temperature,
humidity Profiles



Carbon monoxide



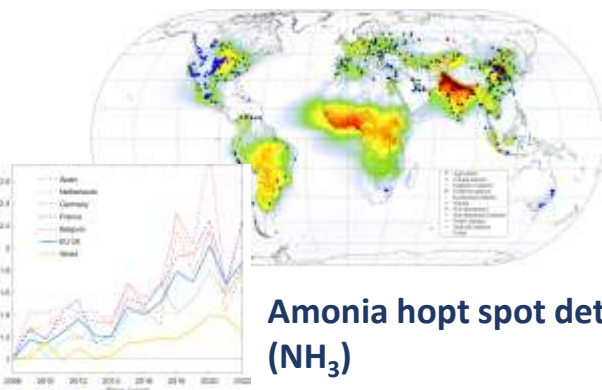
Ozone



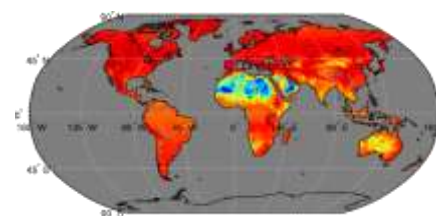
Forest fires detection

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

Amonia hopt spot detection
(NH₃)



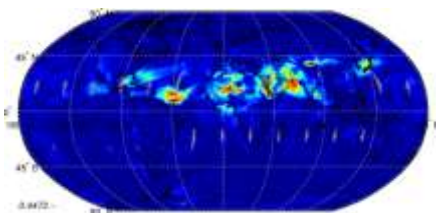
Land surface
temperature and
emissivity



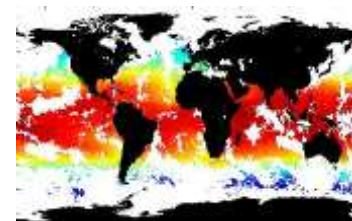
Could mask and
height



Aerosols



Sea surface
temperature



Credit: Pierre Coheur, ULB



- 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

www.eumetsat.int



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



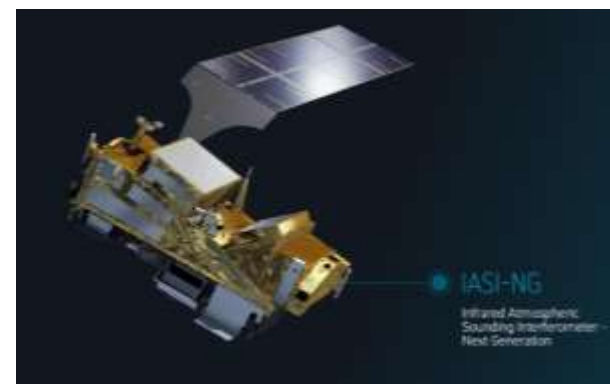
<https://www.eumetsat.int/metop-sg>



EUMETSAT Hyperspectral sounder missions

www.eumetsat.int

	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



[illegible]

Of all types of observation, IASI is one of the most important instruments to provide atmospheric measurements for 12-hour to 10-day weather forecasting.

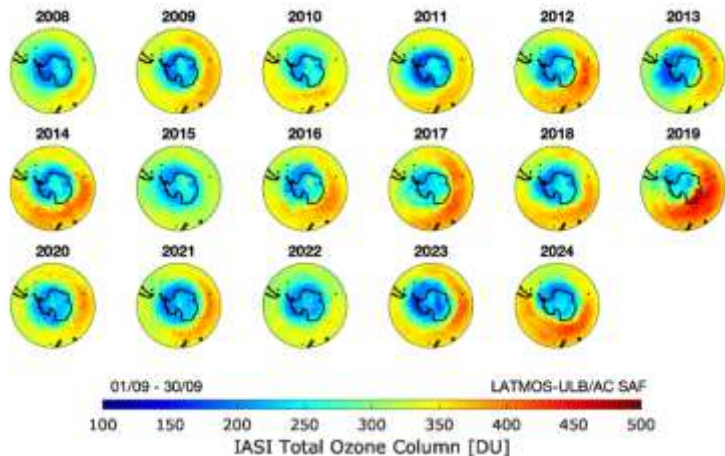
EPS-SG and its new generation of instruments will ensure the continuity and significantly improve all the atmospheric observations we currently have.

This is essential for weather forecasting and climate

This is essential for weather forecasting and climate



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



Ozone hole follow up

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

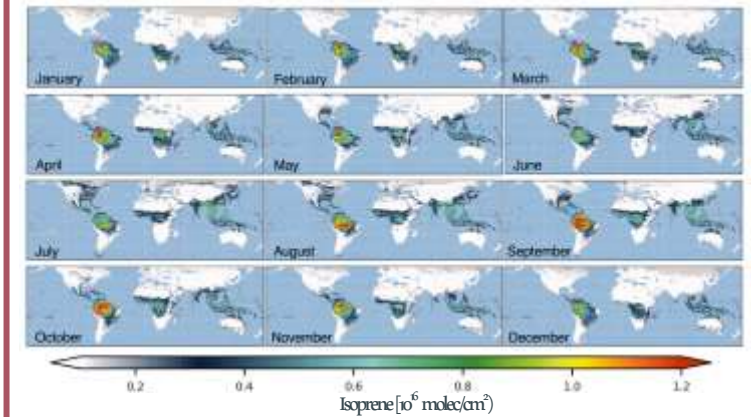


Mega-emition of ethylene (C_2H_4)

Detection threshold of C_2H_4 :
IASI : $7.7 \cdot 10^{15} \text{ molec.cm}^{-2}$
IASI-NG: $3.4 \cdot 10^{15} \text{ molec.cm}^{-2}$

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 C_5H_8 :
IASI : $5.7 \cdot 10^{15} \text{ molec.cm}^{-2}$
IASI-NG: $3.1 \cdot 10^{15} \text{ molec.cm}^{-2}$



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

www.eumetsat.int

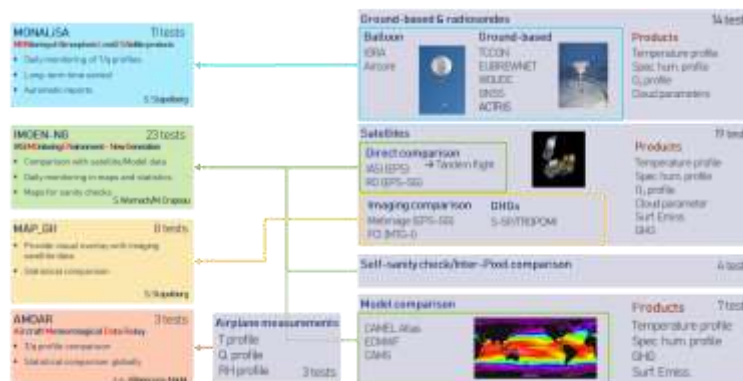
- Preparation of IASI-NG L1 commissioning and routine monitoring:

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


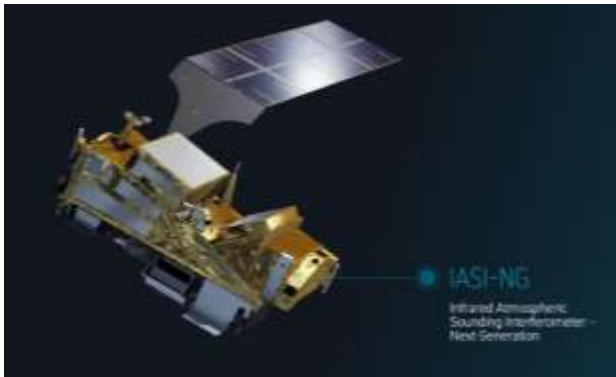

EPS-SG/IASI-NG preparation

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

IASI-NG

Infrared Atmospheric
Sounding Interferometer -
Next Generation

IRS

Hyperspectral
Infrared Sounder



IRS Mission

www.eumetsat.int

- 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

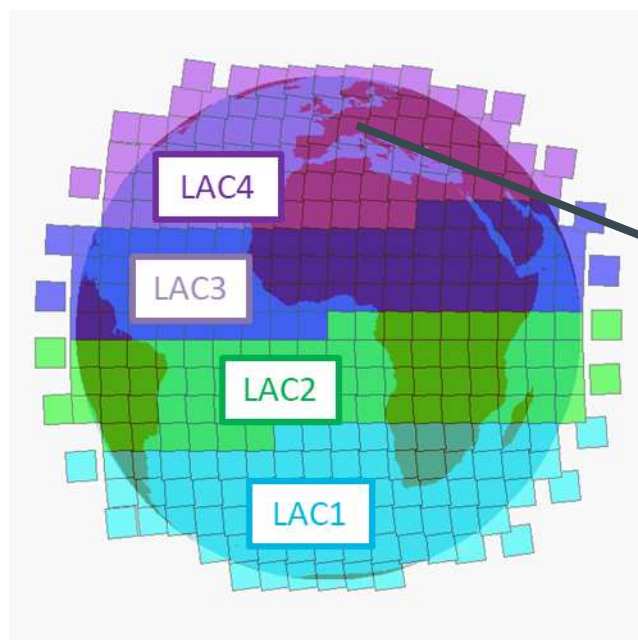


Two spectral bands:

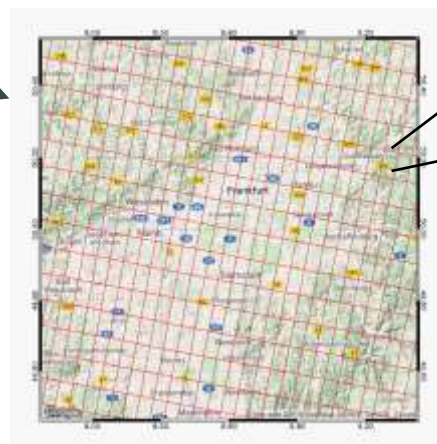
- MWIR: 1600 to 2250cm⁻¹ (4.44–6.25μm)
- LWIR: 680 to 1210cm⁻¹ (8.26–14.70μm)

Timeliness:

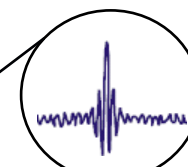
- 25600 spectra covering 640x640 km² **in 15 min!**
- Level 2 products **in 30 min!**



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

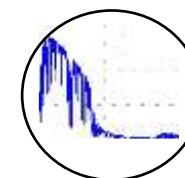


Interferogram



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...

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

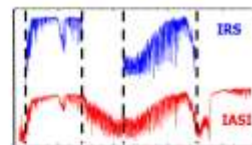
High **spectral** resolution and sampling
+
High **radiometric** accuracy

MTG-IRS

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

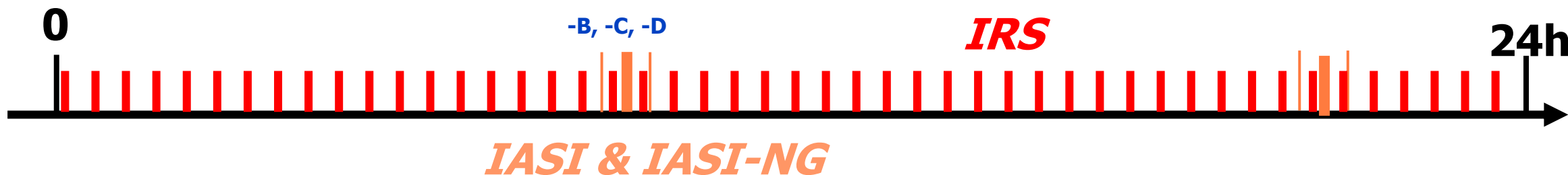
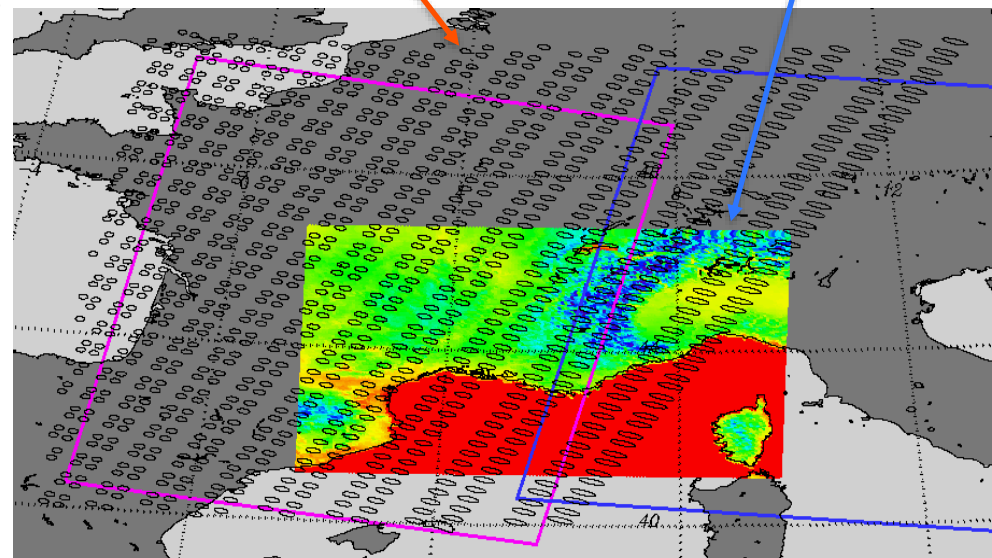
- ✓ Geostationary orbit
- ✓ Spectral sampling of $\sim 0.6 \text{ cm}^{-1}$ and resolution of $\sim 0.754 \text{ cm}^{-1}$
- ✓ Detector: 4 km resolution at nadir
- ✓ Two spectral bands: $700\text{-}1210$ and $1600\text{-}2175 \text{ cm}^{-1}$ within IASI spectra

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



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

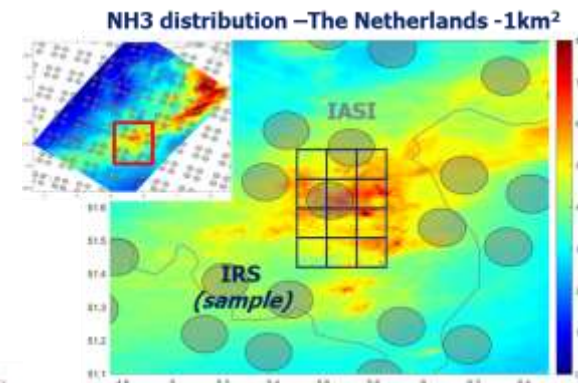
IRS pixels
 $\sim 7\text{km}$
Contiguous
Every 30'





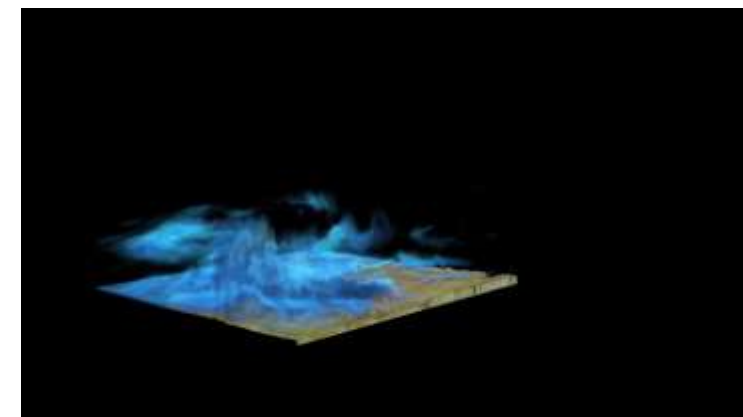
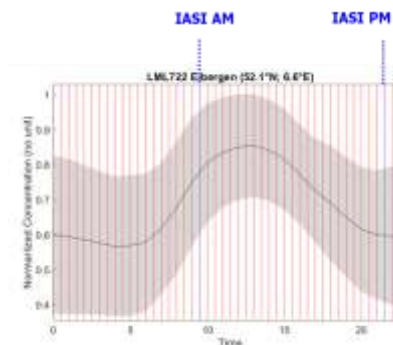
High spatial resolution:

- 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.