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IASI AND IASI NG, MERLIN, MICROCARB FOR CH_4 AND CO_2 OBS. IN THE TROPOSPHERE

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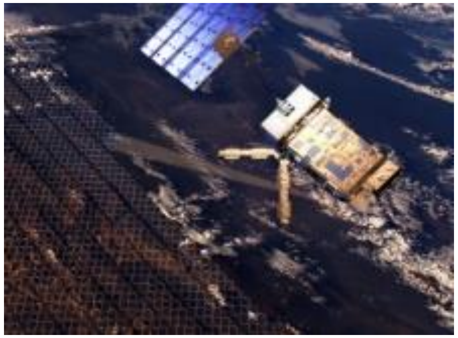
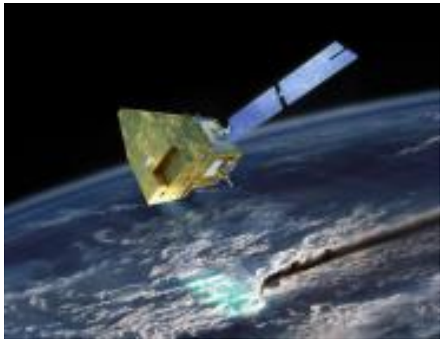
&
Presented by C. Clerbaux, LATMOS/CNRS, France

French contribution to GG observation





IASI
IASI-NG

Passive FTIR
IASI-A, IASI-B
IASI-C 2018

IASI-NG Phase C/D
Operational mission
(NRT + continuity)
S5 component

Merlin

Lidar
DLR-CNES collaboration
Phase B completed
Demonstrator

CNES in charge of platform, system, launcher, and part of ground segment
DLR in charge of payload, and part of ground segment

Microcarb

Passive spectrometer SWIR
Context COP21
Phase A completed
Demontrator
Climate sentinel

ECMWF CO_2 forecast

CO_2 SURFACE FLUXES:

Vegetation (CTESSEL)
Fires (GFAS)
Ocean (inventory)
Anthropogenic (inventory)

IFS TRANSPORT

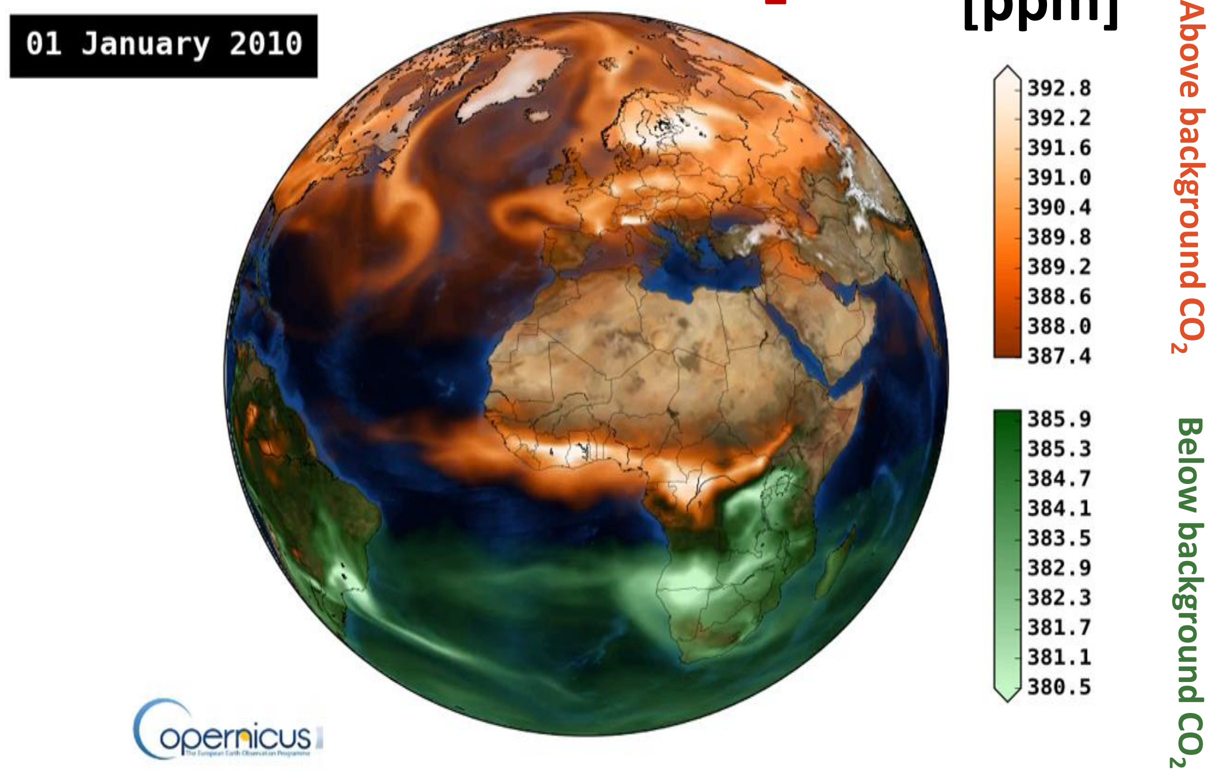
PBL mixing
Advection
Convection

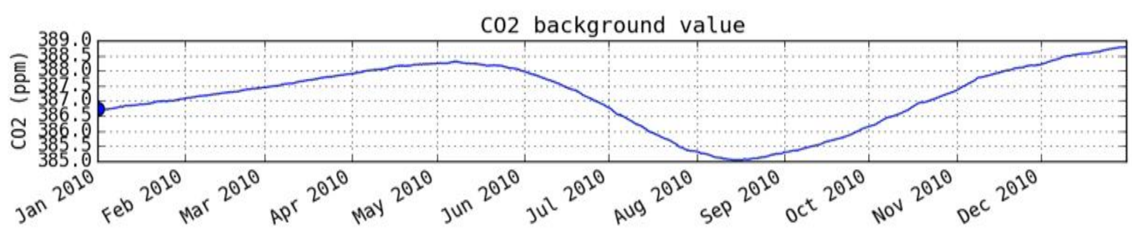
CHEMISTRY

Oxidation of CO
(not yet represented in model)

Total column average atmospheric CO_2

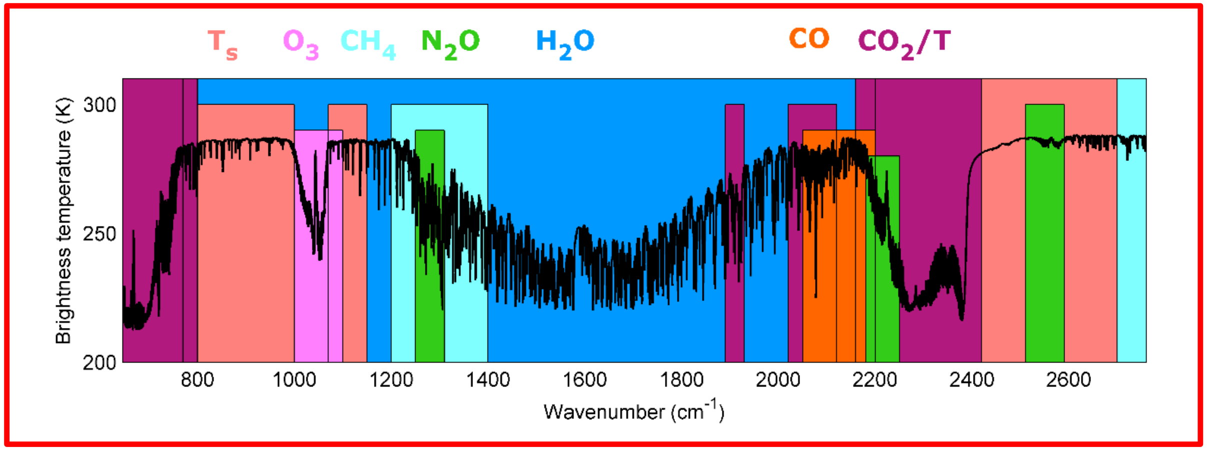
[ppm]

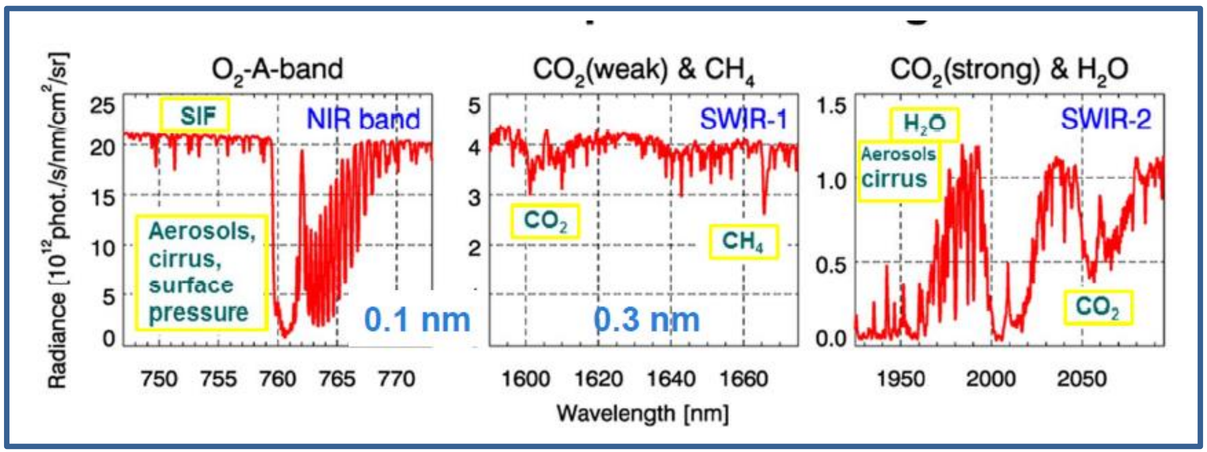


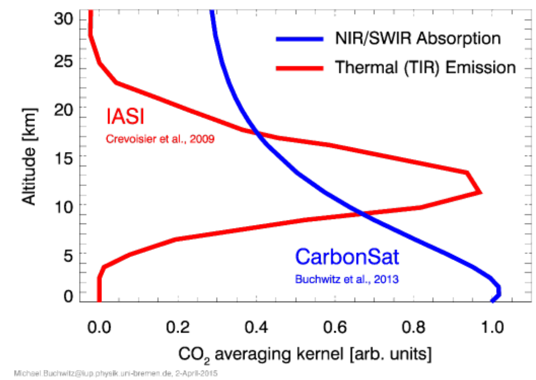


Credit: S. Massart/A. Agusti-Panareda, JN Thépaut

TIR vs NIR/SWIR







Cathy Clerbaux

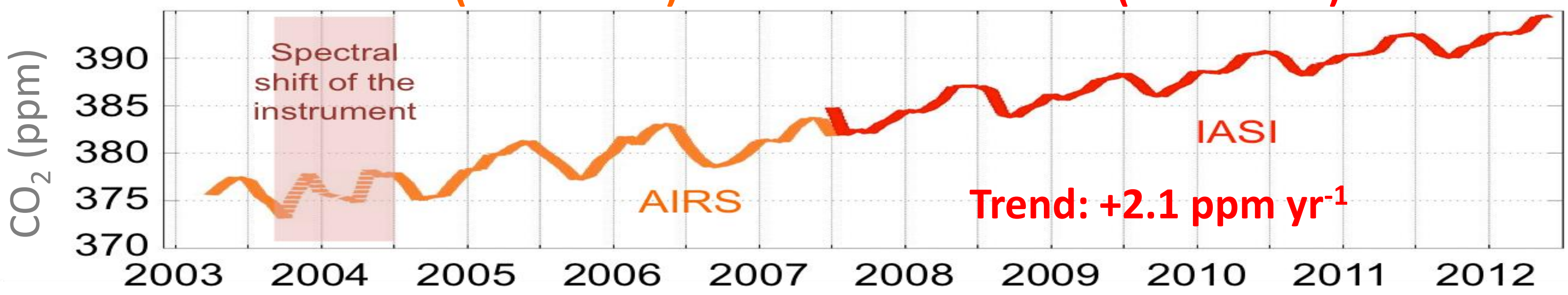
IASI on MetOp

Greenhouse gases: CO_2 and CH_4 with IASI

Objective: to better understand surface sources and sinks of greenhouse gases and the related processes (transport, flux).

IASI contribution: mid-tropospheric columns of CO_2, CH_4 over both land and sea, day and night.

AIRS (2003-2007) IASI (2007-2012)

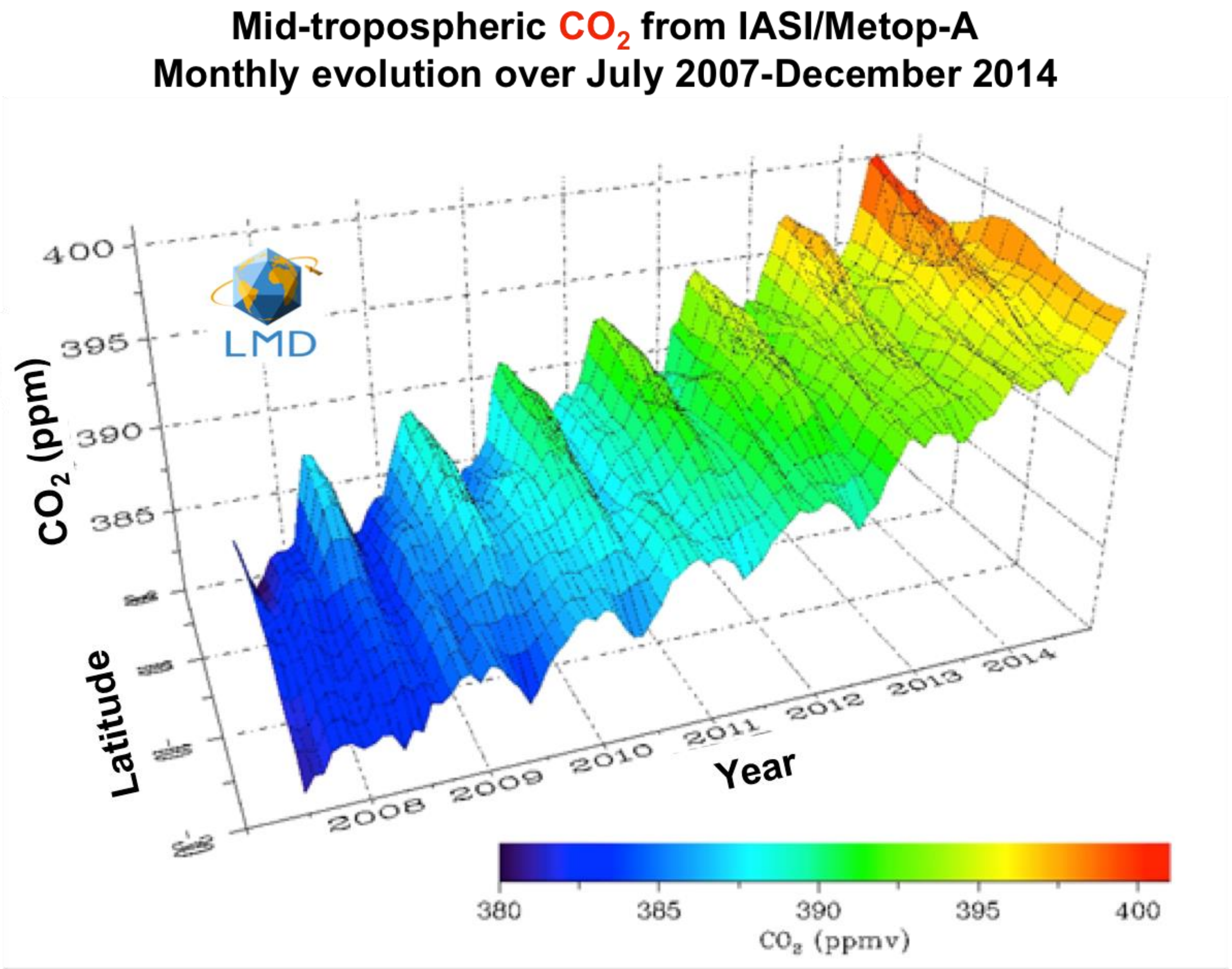


AIRS (2003-2007) IASI (2007-2012)

Methods: non linear inference scheme for CO_2 and CH_4

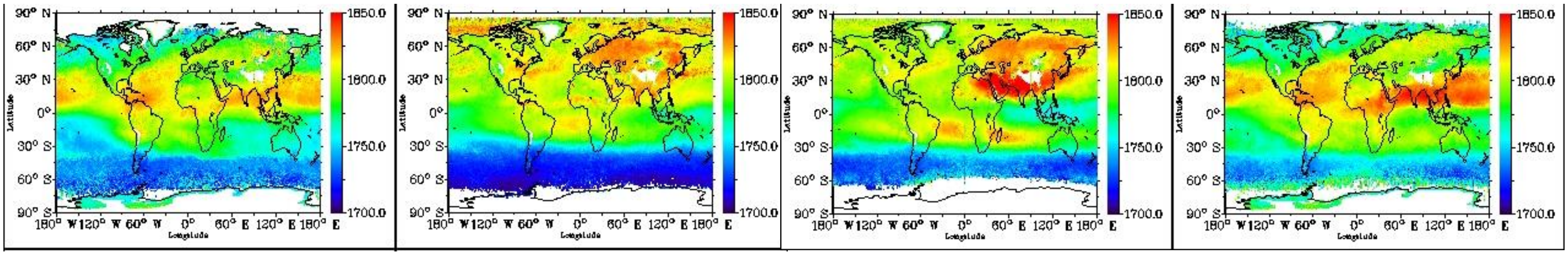
Chédin et al., 2003; Crevoisier et al., GRL, 2004; ACP 2009; ACP 2012.

Greenhouse gases: CO_2 with IASI

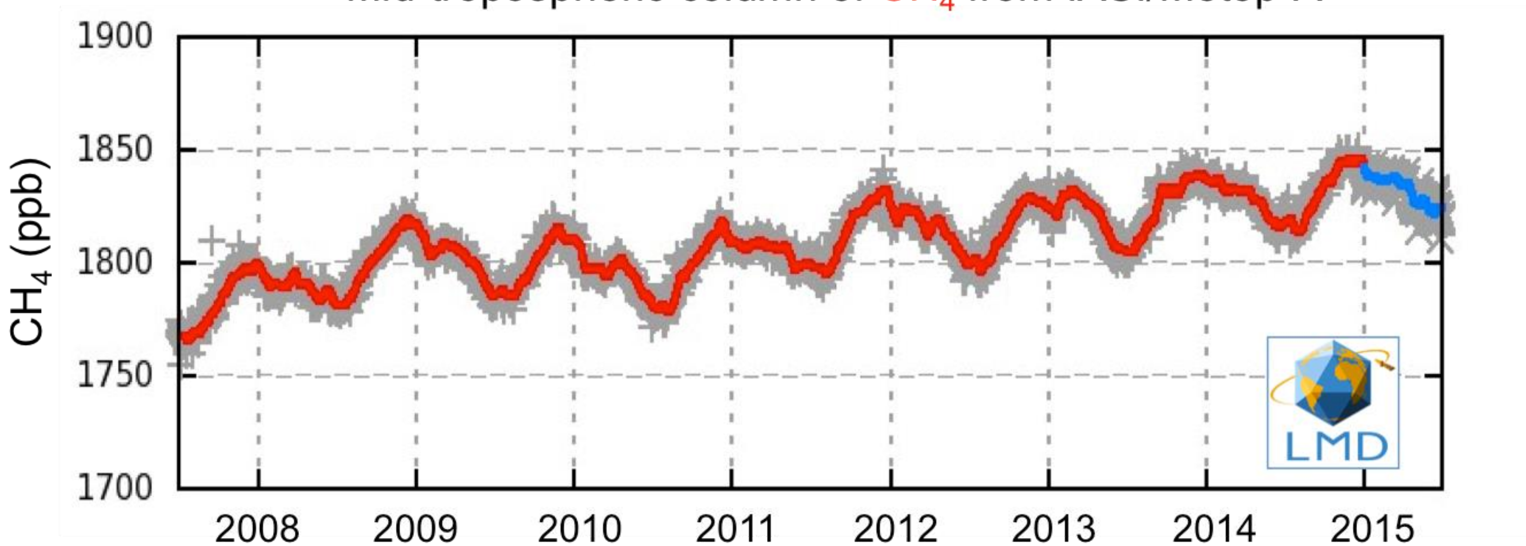


Seasonal maps of mid-tropospheric IASI CH_4 Average over July 2007-June 2015

Jan-Feb-Mar | Apr-May-Jun | Jul-Aug-Sep | Oct-Nov-Dec



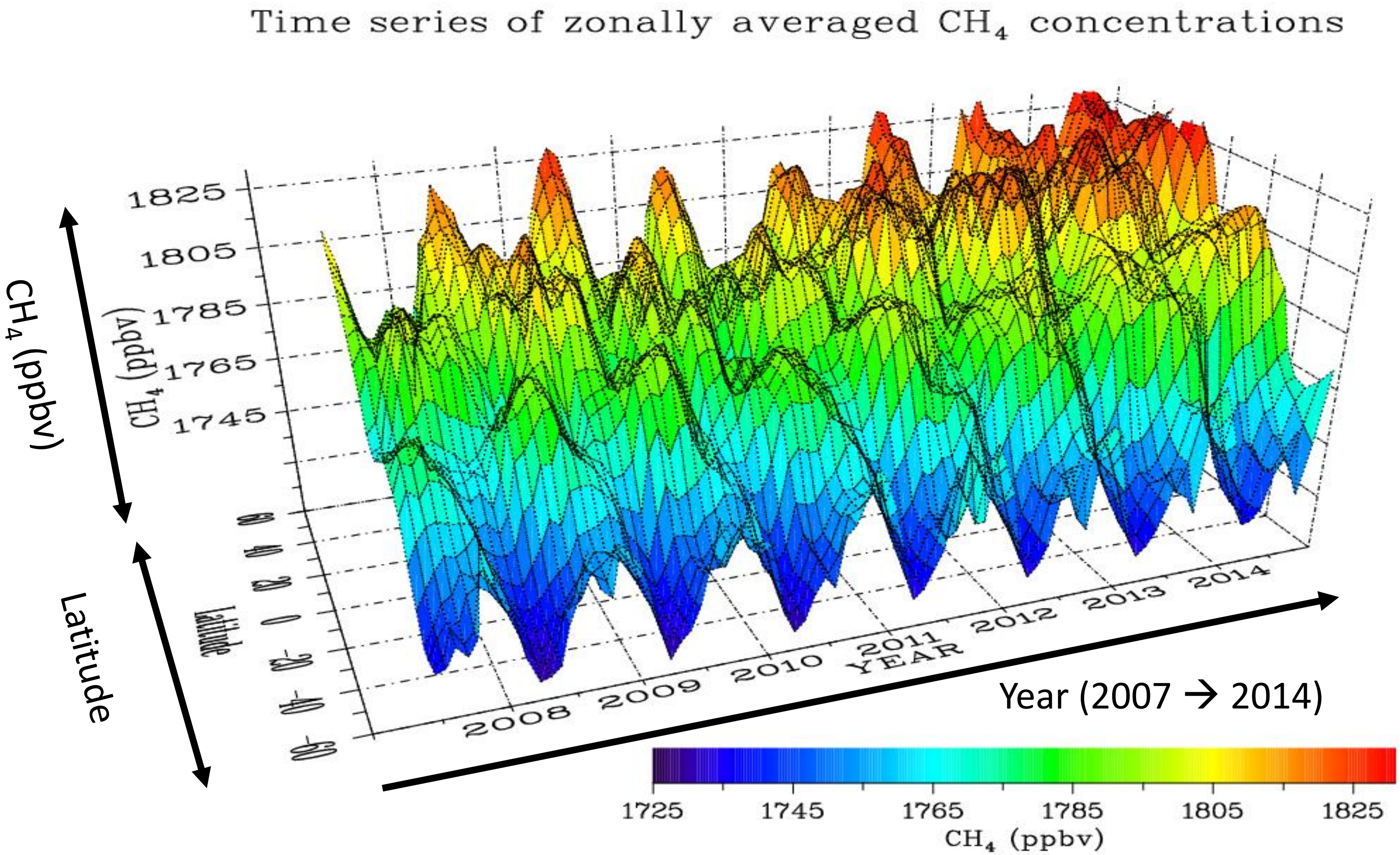
Mid-tropospheric column of CH_4 from IASI/Metop-A



Near-real time (D+1) delivery to Copernicus Atmospheric Service

Greenhouse gases: CH_4 with IASI

CH_4 flying carpet



Greenhouse gases: CO_2 and CH_4 and CO

Long-term variations of CH_4

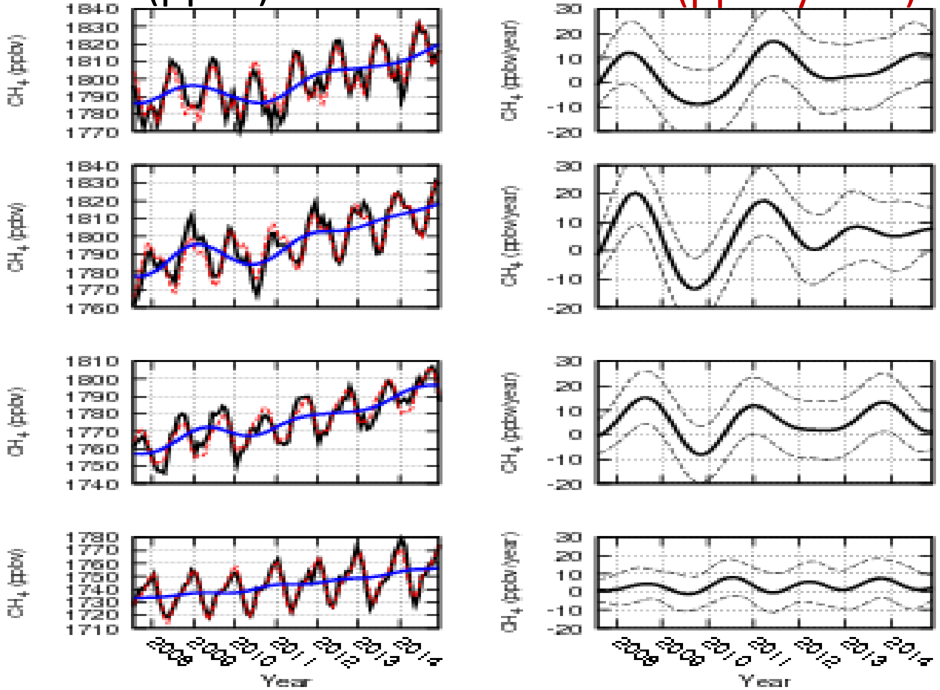
Time series & Trend (ppbv) → Growth rate (ppbv.year^{-1})

[30N:60N]

[30N:Eq]

[30S:Eq]

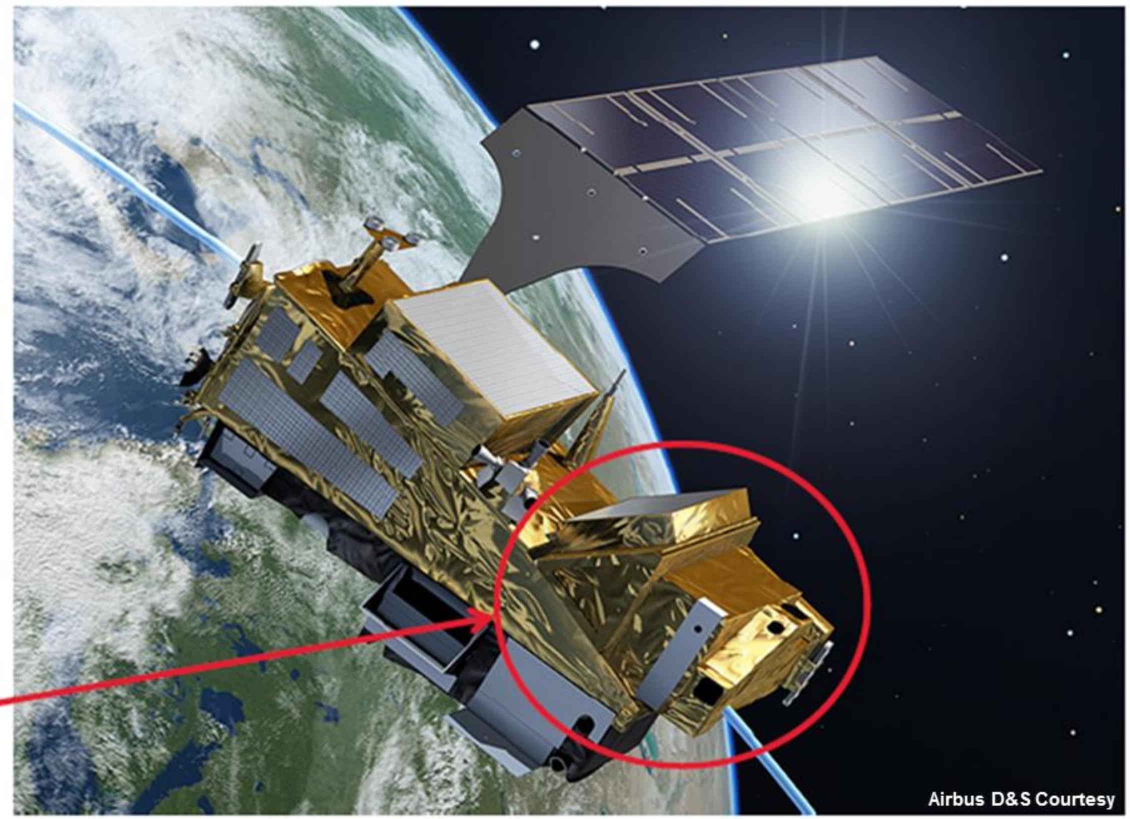
[60S:30S]



Latitude band	Averaged growth rate (ppbv.year-1) IASI	Averaged growth rate (ppbv.year-1) surface stations	increase of CH_4 (ppbv) (Jul 2007-Dec 2014)
[60N:30N]	4.54 +/- 7.15	4.90 +/- 3.96	~ 33
[30N:Eq]	5.49 +/- 8.46	6.52 +/ 2.90	~ 41
[30S:Eq]	5.31 +/- 5.92	5.53 +/ 4.25	~ 39
[60S:30S]	3.12 +/- 2.42	5.37+/- 2.28	~ 23

IASI-NG on MetOp-SG

IASI-NG on METOP SG



The IASI-NG mission

2006	2012	2018	2021	2028	2035
IASI-A	IASI-B	IASI-C	IASI-NG-A	IASI-NG-B	IASI-NG-C

- **Objectives of the mission:**
  - To assure the continuity of IASI for NWP, atmospheric chemistry and climate applications.
  - To improve the characterization of the lower part of the troposphere, the UT/LS region and, more generally, of the full atmospheric column.
  - To improve the precision of the retrievals and to allow the detection of new species.

➡ Improvement of spectral resolution and radiometric noise.

- **IASI-NG Characteristics**:

-spectral coverage: 645 - 2760 cm^{-1} (*similar to IASI*).

-spectral resolution: 0.25 cm^{-1} after apodisation (*0.50 cm^{-1} for IASI*)

-spectral sampling: 0.125 cm^{-1} (*0.25 cm^{-1} for IASI*).

-reduction of the radiometric noise by at least a factor of ~2 as compared to IASI.

-spatial sampling: 12km FOV.

IASI-NG: Mid-tropospheric columns of CO_2 and CH_4

Carbon dioxide

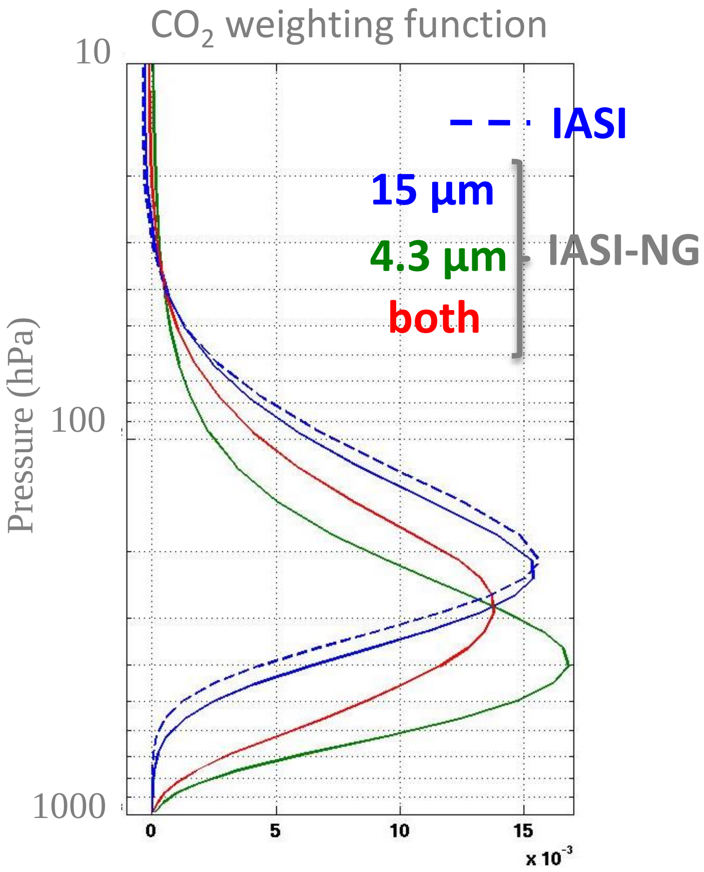
Spectral bands for IASI-NG	Improvement of the CO_2 precision
15 µm	30 %
4.3 µm	0 %
15 + 4.3 µm	45 %

IASI-NG will enable the use of 4.3 µm channels, giving access to a lower part of the atmosphere, with a much improved precision.

Methane

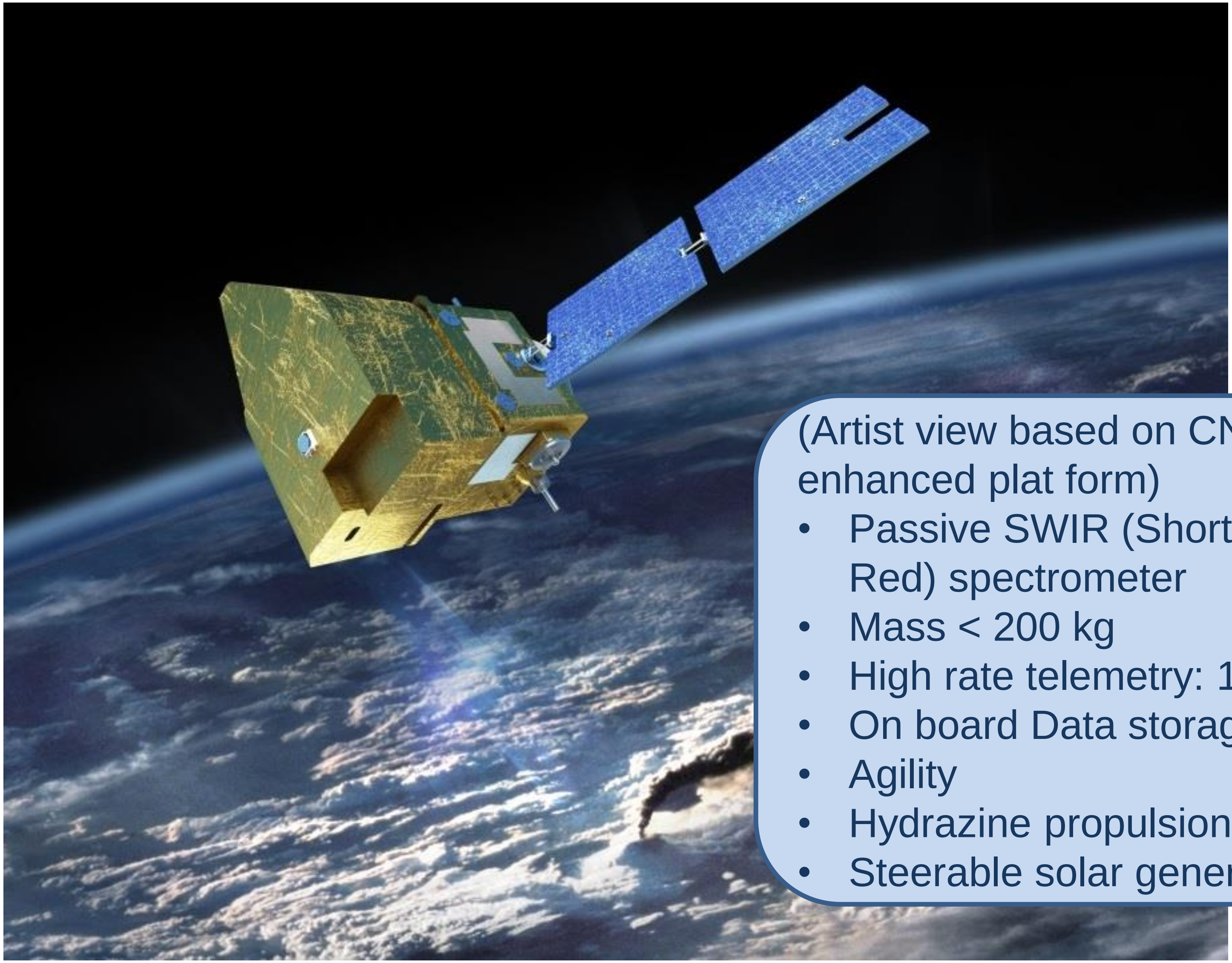
Spectral bands for IASI-NG	Improvement of the CO_2 precision
7.7 µm	44 %

Less interference with water vapor lines.



•Strong and needed complementarity with SWIR obs. (UVNS/Sentinel5).

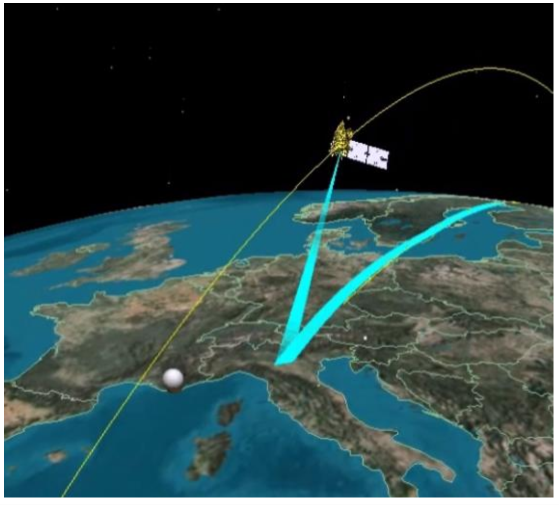
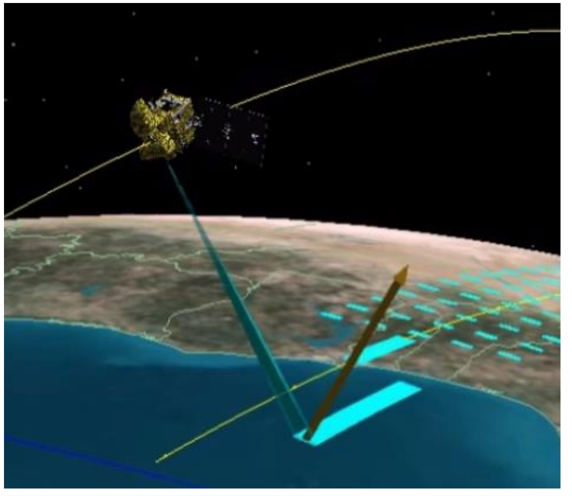
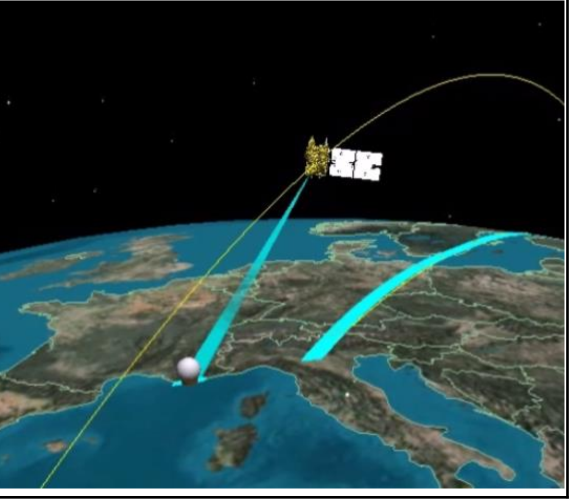
MICROCARB: CO_2

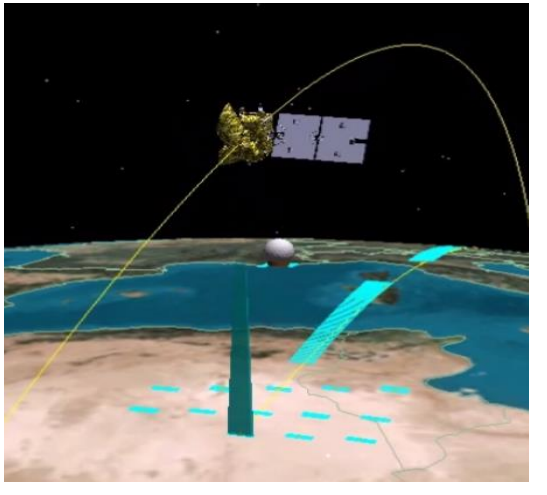


(Artist view based on CNES Myriade enhanced plat form)

- Passive SWIR (Short Wave Infra Red) spectrometer
- Mass < 200 kg
- High rate telemetry: 156 Mbits/s
- On board Data storage: 800 Gbits
- Agility
- Hydrazine propulsion
- Steerable solar generator

MICROCARB : Operating modes

Nadir	Glint	Target
Over lands	Over oceans	For calibration (TCCON)
		



- **Scan capacity**
  - ✓ Mechanism integrated in the instrument (rotating mirror. One axis)
  - ✓ Across the track: ± 200 km
  - ✓ Permits to acquire non correlated data
  - ✓ Sampling distance: 100 km ALT and ACT

MICROCARB: Spectral bands

- **Spectrometer**

Spectral performances	B1	B1' (=B5)	B2	B3
Range (nm)	758-769	1264-1282	1596-1619	2023-2051
Detection	O2. Surface pressure + properties of aerosol	Idem B1. Aerosols properties at λ close to B2-B3	CO_2	CO_2

Cloud imager

- ✓ Cloud detection
- ✓ 0,625 µm
- ✓ Ground sampling distance: 100 m

MICROCARB: scanning modes

Standard Sounding geometry

Ground footprint:

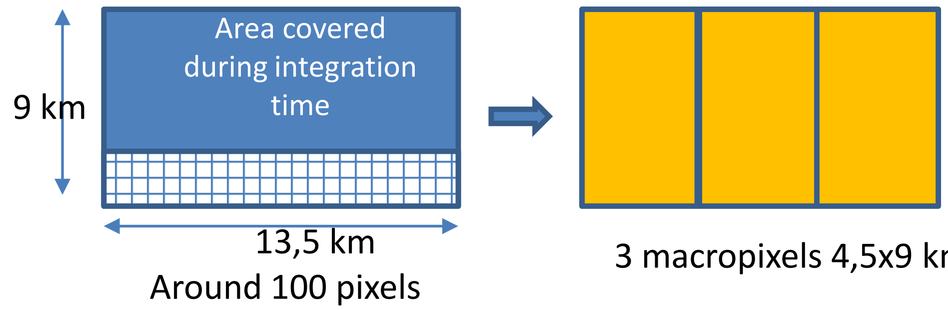
13 km (ACT) x 9 km (ALT)

Data combined on ground =>

3 simultaneous samples

with size 4,5 km x 9km

Normal mode



Improved resolution or « City « mode (exploratory)

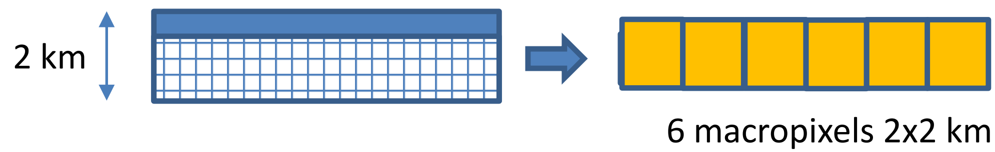
Goal: experiment capacity to characterize local emissions + Support for vicarious validation locally improvement of the spatial resolution

Obtained by slowing down the satellite scrolling + scan + binning tuning

Typical footprint: 2x2 km

Typical area surface: 40 x 40 km²

Exploratory mode



Sat. chimie/climat & contexte EU

http://www.esa.int/spaceinimages/Images/2014/02/The_Sentinel_family

Sat. chimie/climat & contexte EU

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CAMS

Copernicus Atmosphere Monitoring Service

About homepage

Who we are

What we do

- Numerical weather forecasts
- Severe weather prediction
- Air quality analysis
- Climate monitoring

As part of the delegation agreement with the European Union, ECMWF is managing the Copernicus Atmosphere Monitoring Service.

Why do we need to monitor the atmosphere?

Some of today's most important environmental concerns relate to the composition of the atmosphere. The increasing concentration of the greenhouse gases and the cooling effect of aerosol are prominent drivers of a changing climate, but the extent of their impact is often still uncertain.

At the Earth's surface, aerosols, ozone and other reactive gases such as nitrogen dioxide determine

Copernicus

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C3S

Copernicus Climate Change Service

About homepage

Who we are

What we do

- Numerical weather forecasts
- Severe weather prediction
- Air quality analysis
- Climate monitoring
- Supercomputer centre
- Copernicus
  - **Copernicus Climate Change Service**
  - Copernicus Atmosphere Monitoring Service

As part of the delegation agreement with the European Union, ECMWF is managing the Copernicus Climate Change Service.

Why do we need climate information?

This Service, which cuts across all other Copernicus Services, will deliver substantial economic value to Europe by:

- informing policy development to protect citizens from climate-related hazards such as high-impact weather events;
- improving planning of mitigation and adaptation practices for key human and societal activities;
- promoting the development of new services for the benefit of society.

How will the information be produced?

The Climate Change Service will combine observations of the climate system with the latest science to develop authoritative, quality-assured information about the past, current and future states of

Copernicus