IASI AND IASI NG, MERLIN, MICROCARB FOR CH₄ AND CO₂ 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

**Microcarb**
- Passive spectrometer SWIR
- Context COP21
- Phase A completed
- Demonstrator
- Climate sentinel

Cathy Clerbaux
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
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.

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: CO₂ with IASI

Mid-tropospheric CO₂ from IASI/Metop-A
Monthly evolution over July 2007-December 2014
Seasonal maps of mid-tropospheric IASI CH$_4$
Average over July 2007-June 2015

Near-real time (D+1) delivery to Copernicus Atmospheric Service
Greenhouse gases: CH$_4$ with IASI

CH$_4$ flying carpet
### Long-term variations of CH₄

<table>
<thead>
<tr>
<th>Latitude band</th>
<th>Averaged growth rate (ppbv.year⁻¹)</th>
<th>Increase of CH₄ (ppbv) (Jul 2007-Dec 2014)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[60N:30N]</td>
<td>4.54 +/- 7.15</td>
<td>~ 33</td>
</tr>
<tr>
<td>[30N:Eq]</td>
<td>5.49 +/- 8.46</td>
<td>~ 41</td>
</tr>
<tr>
<td>[30S:Eq]</td>
<td>5.31 +/- 5.92</td>
<td>~ 39</td>
</tr>
<tr>
<td>[60S:30S]</td>
<td>3.12 +/- 2.42</td>
<td>~ 23</td>
</tr>
</tbody>
</table>
IASI-NG on MetOp-SG
The IASI-NG mission

- 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.
### Carbon dioxide

<table>
<thead>
<tr>
<th>Spectral bands for IASI-NG</th>
<th>Improvement of the CO₂ precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 µm</td>
<td>30 %</td>
</tr>
<tr>
<td>4.3 µm</td>
<td>0 %</td>
</tr>
<tr>
<td>15 + 4.3 µm</td>
<td>45 %</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Spectral bands for IASI-NG</th>
<th>Improvement of the CO₂ precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.7 µm</td>
<td>44 %</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Nadir</th>
<th>Glint</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over lands</td>
<td>Over oceans</td>
<td>For calibration (TCCON)</td>
</tr>
</tbody>
</table>

### 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**

<table>
<thead>
<tr>
<th>Spectral performances</th>
<th>B1</th>
<th>B1’ (=B5)</th>
<th>B2</th>
<th>B3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range (nm)</td>
<td>758-769</td>
<td>1264-1282</td>
<td>1596-1619</td>
<td>2023-2051</td>
</tr>
<tr>
<td>Detection</td>
<td>O2. Surface pressure + properties of aerosol</td>
<td>Idem B1. Aerosols properties at λ close to B2-B3</td>
<td>CO₂</td>
<td>CO₂</td>
</tr>
</tbody>
</table>

**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

**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
Sat. chimie/climat & contexte EU

Copernicus services :
Intégration des différentes composantes :
Mesures sol,
+ Satellites,
+ modèles

Composante satellite
Atmosphère S4 et S5
Climat S6-S7

http://www.esa.int/spaceinimages/Images/2014/02/The_Sentinel_family
Copernicus Atmosphere Monitoring Service

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 Climate Change 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...