A first step toward the validation of the Merlin and MicroCarb satellite missions: MAGIC campaigns

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2 GHG space missions

<table>
<thead>
<tr>
<th></th>
<th>MERLIN</th>
<th>MicroCarb</th>
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<tbody>
<tr>
<td>Partners</td>
<td>French and German space mission</td>
<td>French, UK, and Eumetsat</td>
</tr>
<tr>
<td>Launch</td>
<td>mid-2024.</td>
<td>2021</td>
</tr>
<tr>
<td>Main product: dry-air</td>
<td>XCH4</td>
<td>XCO2</td>
</tr>
<tr>
<td>Mixing ratio columns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precision</td>
<td>22 ppb</td>
<td>1 ppm</td>
</tr>
<tr>
<td>Systematic error</td>
<td>3 ppb</td>
<td>0.1 ppm</td>
</tr>
</tbody>
</table>

Goals of Validation

- Evaluate the performance of the products in relation to the requirements of the mission before making them available to the scientific community
- Evaluate the quality of the data by comparing the products to the data of other sensors considered as a reference

Performances to be checked
**Objectives:**

- Preparing validation activities for future GHG missions (Merlin, MicroCarb and IASI-NG)
- Multi-instrument campaign for better understanding vertical distribution of GHG and other atmospheric variables
- Establish the merits of various instrumentations to study CH4 and CO2 and other variables
- Compare with current missions (IASI, S5p, GOSAT-2, OCO-2)
- Test of satellite demonstrators: CHARM-F/Merlin
MAGIC 2018

- 2 campaigns have been organised: 23-24 Jan. (rehearsal) and 23-25 May, with a joint flight between SAFIRE Falcon20 and DLR HALO as part of CoMet campaign

- 40 French scientists: 5 Laboratories (LMD, LSCE, LERMA, LOA, GSMA), 3 entities : SAFIRE (scientific fleet), CNES and DLR

- Instruments (1/2)
  - Fourier Transform Spectrometers (XCO2 and XCH4)
    - High resolution TCCON
    - Mid resolution CHRIS (LOA)
    - Low resolution EM27/sun (LSCE, CNES)
  - Atmospheric samplers (CO2 and CH4 profiles)
    - AirCore (LMD) (air sampler)
    - Amulse (GSMA)
    - Radiosounding (P, T, H2O)
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- LOA CHRIS at ASA (TIR+SWIR)

- LSCE EM27/sun at Trainou (SWIR)

- CNES EM27/sun at ASA (SWIR)

GSMA Amulse (CO2 and/or CH4)

LMD AirCore (CO2, CH4, CO, H2O)
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- Instruments (2/2) -> 2 aircrafts
  
  - SAFIRE Falcon 20
    - 2 Picarros CRDS analysers (SAFIRE + NOAA) (CO2, CH4, CO profiles)
    - Dropsouding (T, H2O profiles)
  
  - DLR HALO (as part of CoMet campaign)
    - Picarro CRDS analyser (CO2, CH4 profiles)
    - CHARM-F CH4 lidar (airborne version of Merlin lidar) (XCH4 and XCO2 total columns)
• SAFIRE Falcon 20 and DLR HALO (as part of CoMet campaign) flying together
• Several air-traffic zones controlled by different entities
• Very important work of planning and coordination made by SAFIRE team
MAGIC 2018: Some results

Very good complementarity between aircraft and balloons

Preliminary results for AirCore_ASA2

CH4 (ppm)

CO2 (ppm)
**MAGIC 2019**

- **Dates:** 11-21 June 3 flights planned and deployment over 10 days.
- **7 laboratories:** LMD, LSCE, LERMA, LOA, GSMA, LPC2E, OPGC
- **Funding:** CNES + CNRS/CEA/IPSL/EP/EU + EUMETSAT (IASI) + ESA (S5-P CIP)
- **Instruments:**
  - 6 Fourier Transform Spectrometers (XCO2 and XCH4)
  - 3 balloons sites for atmospheric samplers (CO2 and CH4 profiles)
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  - SAFIRE Falcon 20
    - Picarros and other instruments: 4 sounding sites
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Lessons learnt from MAGIC 2018

- Validation has to be started well before launch:
  - Comparison of the different products (in-situ aircraft profile vs in-situ balloon profile, in-situ aircraft profile vs total columns, weighting functions, etc.)
  - Need of intercomparing instruments on the same place

- Stay on course (bad weather conditions, last minute instrument break down ...)

- Weather condition: campaign period needs to be long enough

- Flight plans which meet scientific goals require important anticipation

- Aircraft availability is an issue (HALO’s schedule very busy, end of life of SAFIRE Falcon20).

- Need to support existing networks of validation (ICOS, TCCON, AirCore, ...)

- Optimize the synergy between the validation of different satellite missions.

...to be continued: MAGIC 2020 Kiruna, Sweden
Many thanks to the team!

GSMA: L. Joly, T. Decarpenterie, J. Cousin, J. Burgala
LERMA: P. Jeseck, Y. Té, C. Janssen
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