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

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1 cnes CENTRE NATIONAL D'ÉTUDES SPATIALES

2 LMD

3 LSCE

4 LERMA

5 GSMA

6 LA

7 SAFIRE

8 DLR

2 GHG space missions

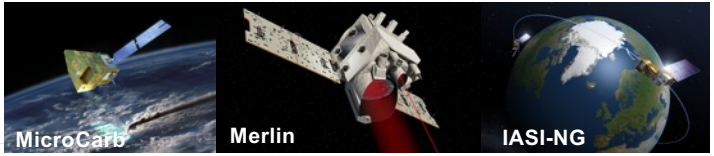
	MERLIN	MicroCarb
Partners	French and German space mission	French, UK, and Eumetsat
Launch	mid-2024.	2021
Main product: dry-air mixing ratio columns	XCH4	XCO2
Precision	22 ppb	1 ppm
Systematic error	3 ppb	0.1 ppm

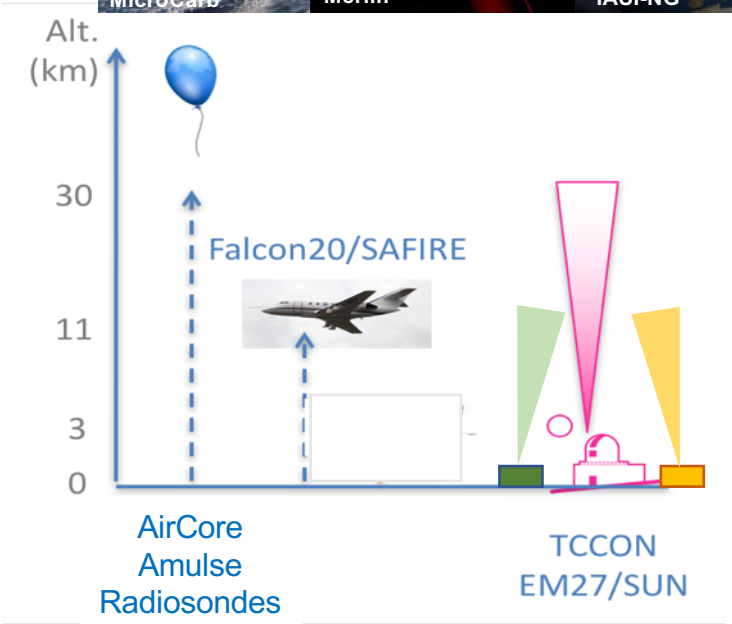
Performances to be checked

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

MAGIC: Monitoring of Atmospheric composition and Greenhouse gases through multi-Instruments Campaign





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

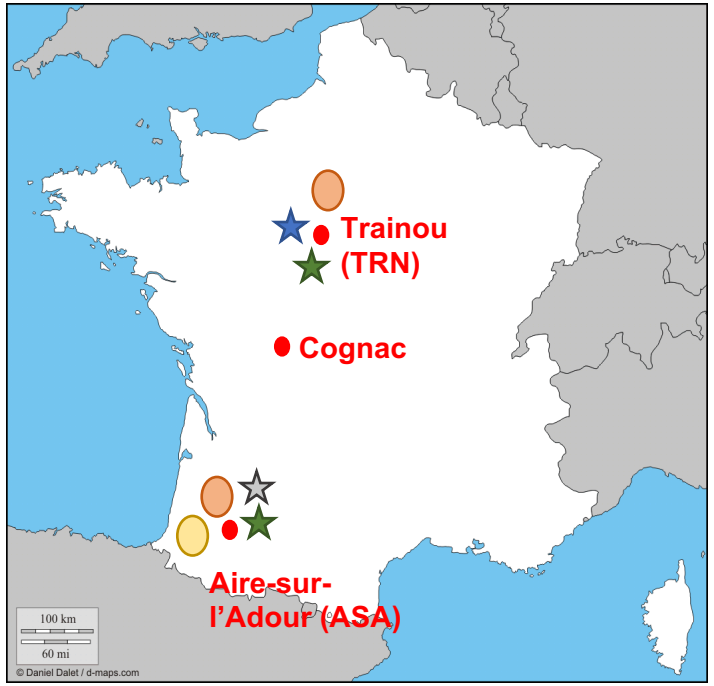
- 2 campaigns have been organised: 23-24 Jan. (rehearsal) and 23-25 May, with a joint flight between SAFIRE Falcon20 and DLR HALO as part of CoMet campaign

- 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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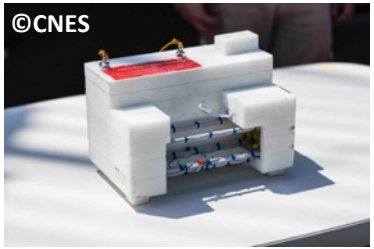
LOA CHRIS at ASA (TIR+SWIR)

LSCE EM27/sun at Trainou (SWIR)

CNES EM27/sun at ASA (SWIR)

GSMA Amulse (CO_2 and/or CH_4)



LMD AirCore (CO_2, CH_4, CO, H_2O)

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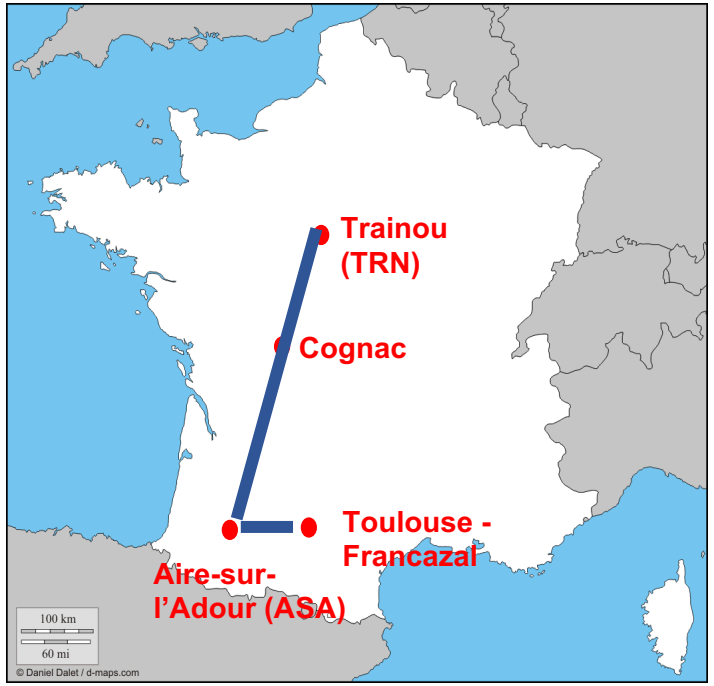
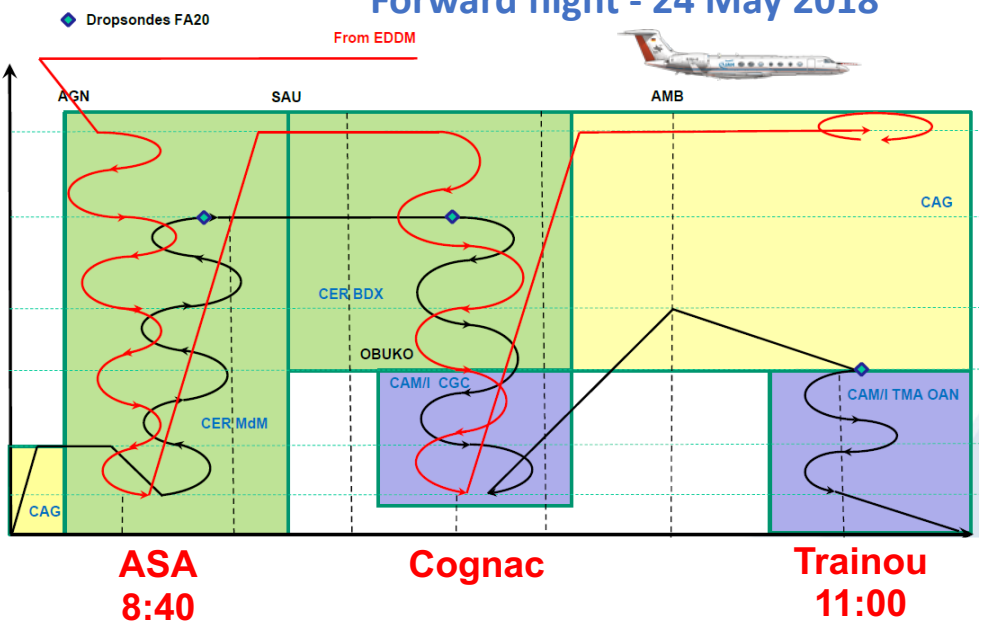
- 40 French scientists: 5 Laboratories (LMD, LSCE, LERMA, LOA, GSMA), 3 entities : SAFIRE (scientific fleet), CNES and DLR
- **Instruments (2/2) -> 2 aircrafts**
  - SAFIRE Falcon 20
    - 2 Picarros CRDS analysers (SAFIRE + NOAA) (CO2, CH4, CO profiles)
    - Dropsouding (T, H2O profiles)
  - DLR HALO (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)



MAGIC 2018: flight plan

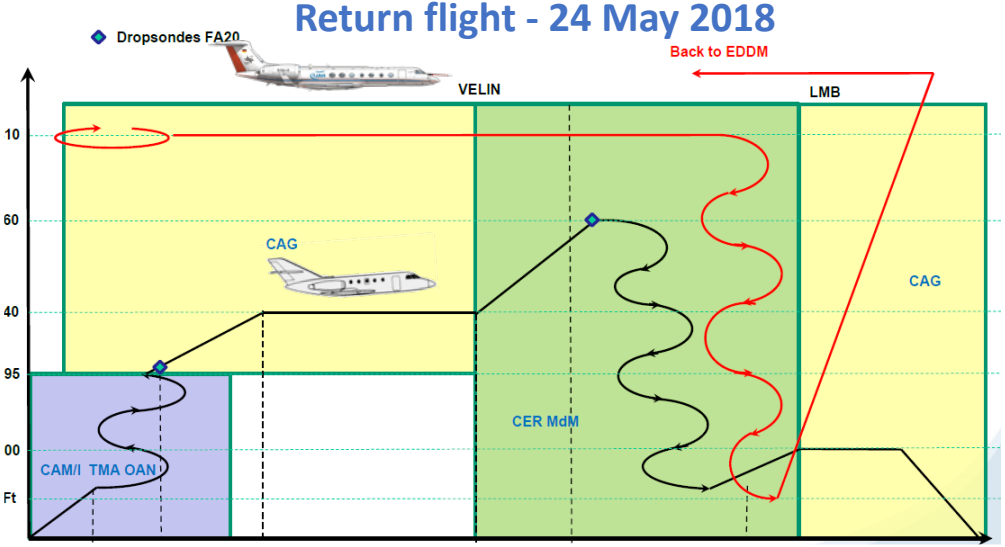
Forward flight - 24 May 2018



ASA 8:40 — Cognac — Trainou 11:00

FL410 (10) FL360 (60) FL240 (40) FL195 (95) FL100 (00) Ft

Return flight - 24 May 2018

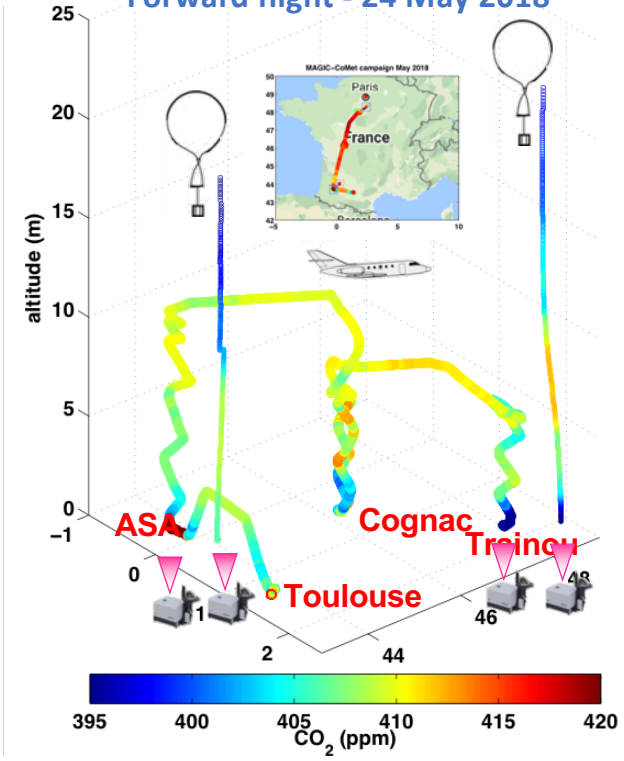


Trainou 12:00 — ASA 14:00

- 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

Forward flight - 24 May 2018



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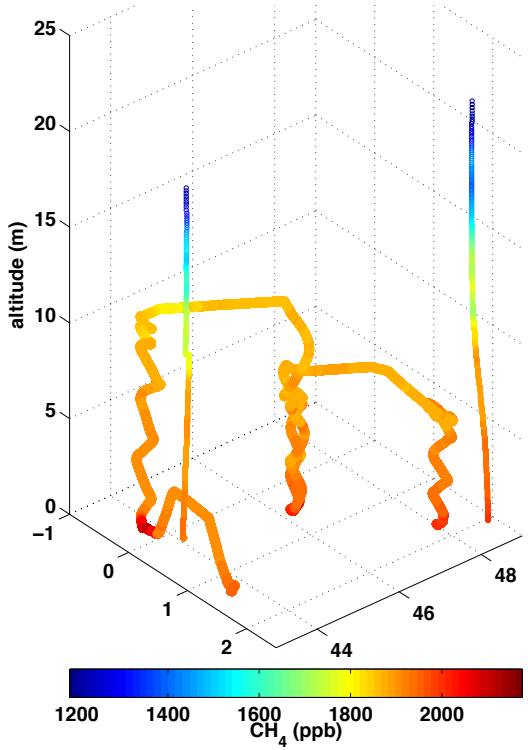
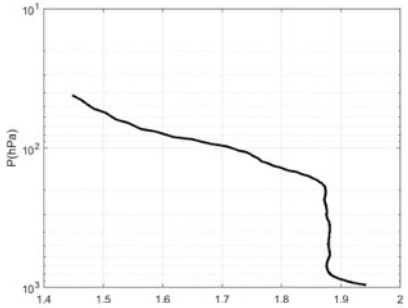
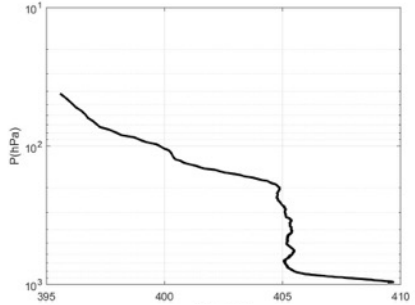


Very good complementarity between aircraft and balloons

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)
    - AirCore (LMD) (air sampler)
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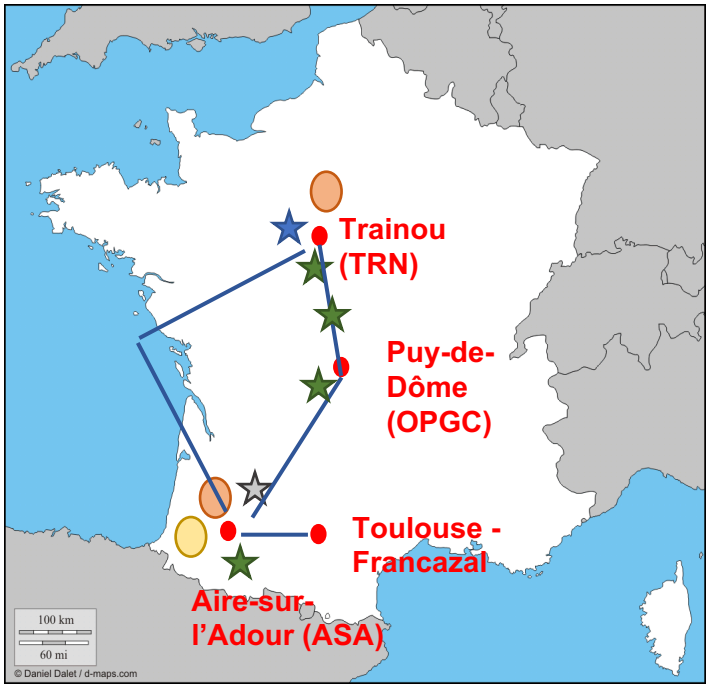
  - SAFIRE Falcon 20
    - Picarros and other instruments : 4 sounding sites



TCCON CHRIS EM27
AirCore Amulse Flight plan

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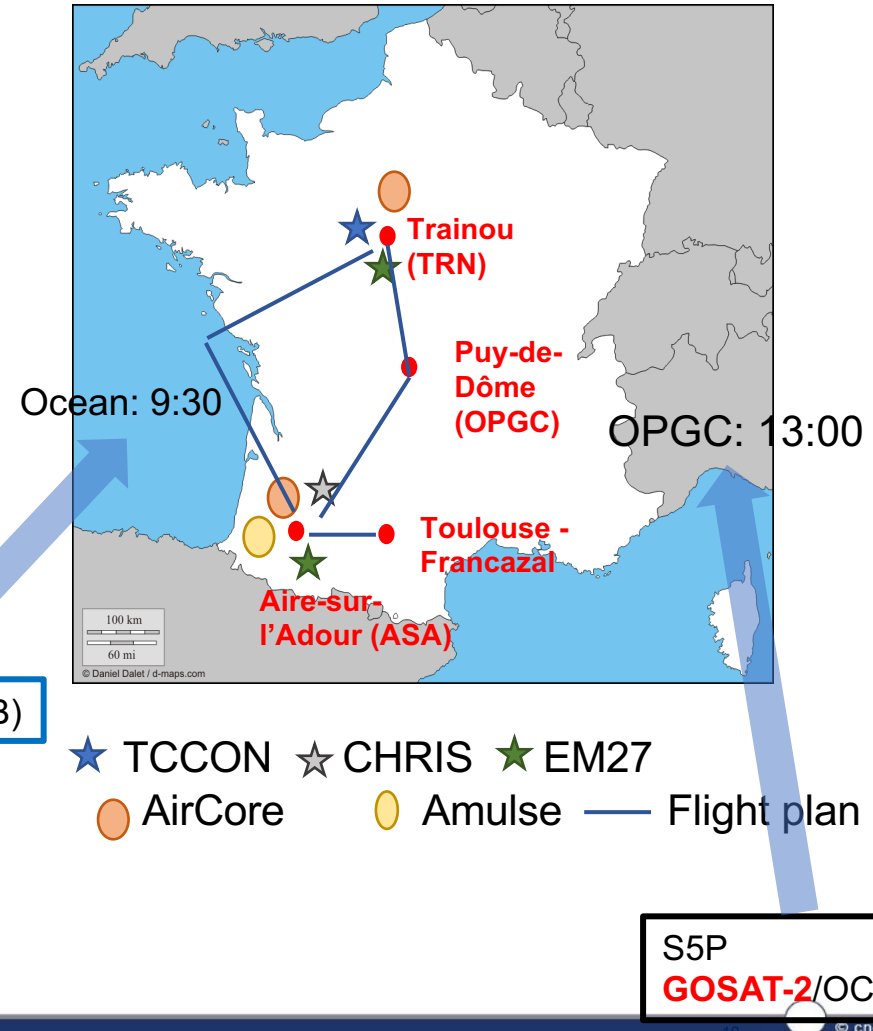

Lessons learnt from MAGIC 2018

- **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

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