SCARBOn: Space CARBon Observatory next step project

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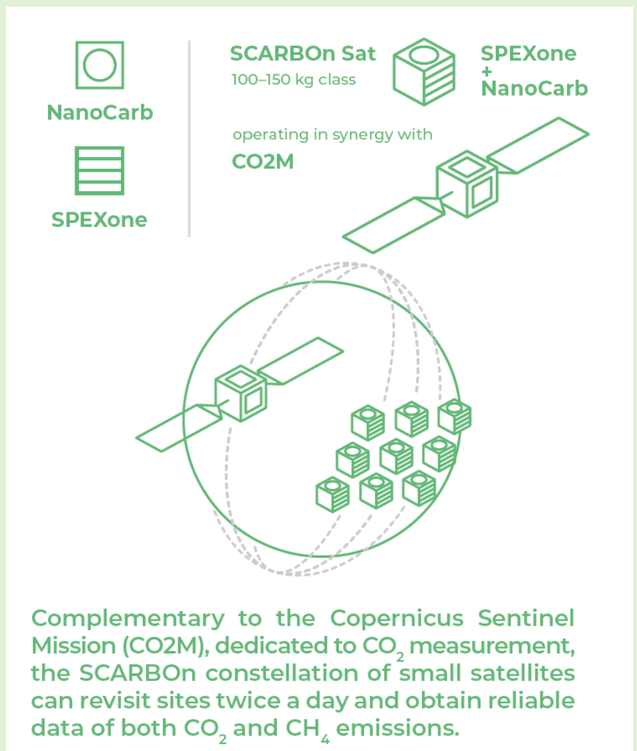
SCARBOn Mission

- A **small satellite constellation**
- **Innovative sensors:**
  - **NanoCarb sensor for CO_2 and CH_4 detection**
  - **SPEXone aerosol detector** for enhanced accuracy
- **Swath**: 200km and **GSD**: 2 x 2 km
- **SSO orbits** on **different orbital planes** allowing for different local times of observation
- **Complementarity with institutional programs** (e.g. CO2M, MicroCarb, TANGO) contributing to a European GHG monitoring system



Complementary to the Copernicus Sentinel Mission (CO2M), dedicated to CO_2 measurement, the SCARBOn constellation of small satellites can revisit sites twice a day and obtain reliable data of both CO_2 and CH_4 emissions.

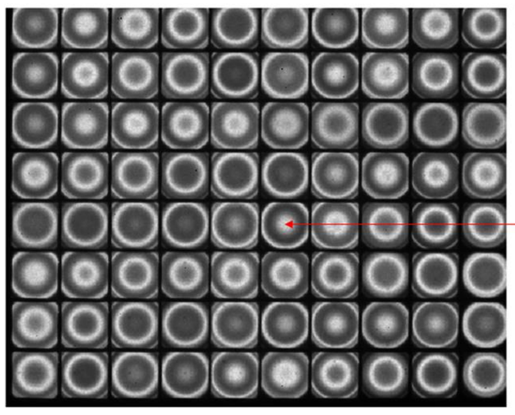
SCARBOn: Space CARBon Observatory next step (2024-2026)

- **EU Horizon Europe-funded project** developing an **innovative satellite system for GHG (Green House Gases) emissions monitoring**
- Successor to the **HE2020 SCARBO project** which laid the technological foundation for SCARBOn
- Coordinated by **Airbus Defence and Space** (with nine EU-based partners)
- Adresses the challenge of GHG emission monitoring from space by **leveraging innovative space-based sensors**, thereby significantly contributing to climate change mitigation through enhanced data accuracy and reliability
- The NanoCarb instrument and the SCARBOn constellation aim to achieve operational system availability by the end of the decade.

NanoCarb: Heart of SCARBOn Mission

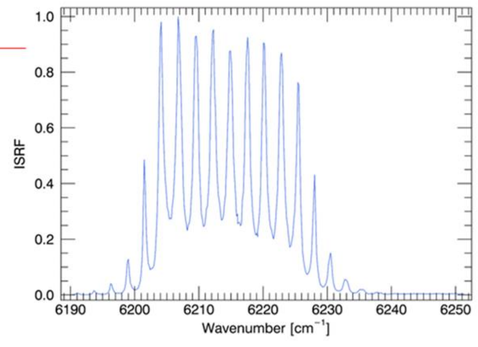
Principle

- Miniaturized (~15x4x4 cm^3) imaging spectrometer
- Full static Fourier Transform Spectrometer
  - Each FP thickness chosen to target a particular **Optical Path Difference (OPD)**
  - **Focal Plan Array (FPA)** intensity modulated by **low finesse** Fabry-Perot array
  - **Snapshot** acquisition mode



Frame acquisition at 1607 nm under uniform and monochromatic illumination, showin Fabry-Perot ring pattern collection corresponding each one to one interferometer at a given tickness

Single pixel spectral response, showing expected interferometric modulation

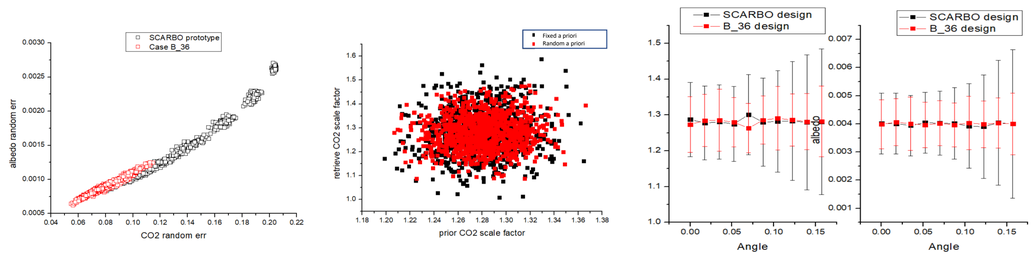


Main SCARBOn Upgrades

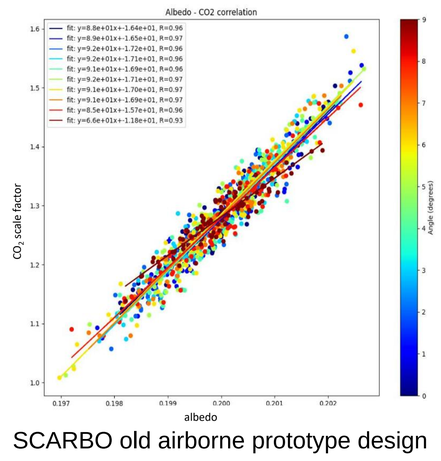
- **Instrument design**: **interferometer array**, narrow-band filter, mecha-thermal housing
- **Up to 2x sensitivity improvement** over the original SCARBO system
- **Stable performance** across varying incidence angles
- **Reduced correlation** between surface albedo and CO_2 retrievals

Improvement of NanoCarb airborne prototype design

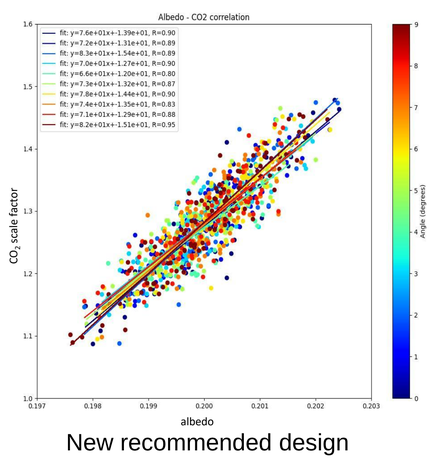
Comparison of the preceding SCARBO design and the new SCARBOn design



- In comparison with old SCARBO design, design B_36 allows to **significantly reduce random error** both on CO_2 scale factor and albedo error
- Performances **are much more stable along the incidence angle variation range**
- Performances slightly better than with λ/5 engravement (old airborne prototype)



SCARBO old airborne prototype design



New recommended design

- In comparison with old design, design B_36 allows to **reduce correlation between CO2 scale factors and albedo**

References

- **L. Brooker Lizon-Tati, S. Val Serra, H. Bovensman, C. Crevoisier, M. Dogniaux, L.Croizé, Y. Ferrec, E. Le Coarer, S. Gousset, B. Sic, M. Smit, and the SCARBO consortium, SCARBO: A constellation of small satellites for the monitoring of anthropogenic greenhouse gases, 73rd International Astronautical Congress (IAC), Paris, France, 18-22 September 2022.**
- **S. Gousset, L. Croizé, E. Le Coarer et al., « NanoCarb hyperspectral sensor: on performance, optimization and analysis for greenhouse gas monitoring from a constellation of small satellites », CEAS Space J., sept. 2019.**
- **M. Dogniaux, C. Crevoisier, S. Gousset, E. Le Coarer, Y. Ferrec, L. Croizé, L. Brooker (2021), The Space CARBon Observatory (SCARBO) concept: Assessment of XCO2 and XCH 4 retrieval performance. Atmospheric Measurement Techniques Discussions, 1-38**

Co-funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Health and Digital Executive Agency (HADEA). Neither the European Union nor the granting authority can be held responsible for them.

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