ABSTRACT

The objective of the CNES/MicroCarb mission is to retrieve the CO₂ dry air mass mole fraction (XCO₂) with a high accuracy, in order to better quantify the sources and sinks of CO₂ through assimilation into atmospheric transport models.

The MicroCarb instrument design has evolved to a more compact design, using a unique telescope, a unique grating and a unique detector on which all the spectral bands are acquired. This evolution gives the opportunity to easily acquire new bands, additionally to the 0.76 µm, 1.61 µm and 2.06 µm bands.

We discuss here the three new bands that have been studied for their scientific interest (especially for a better CO₂ measurement) and their instrumental feasibility: 1.67 µm, 1.27 µm and 2.35 µm. Final choice will be done very soon and any suggestion or comments are welcome.

1 – THE MICROCARB MISSION

- Goal of the Microcarb mission: monitor the global fluxes to better constrain our knowledge of the natural sources and AHVA.
- 4 modes: Nadir, scan, gird and target (ex: TCCON stations)
- The instrument is a compact concept based on a single grating. The spectra are now acquired by a unique 2D detector.

Mission main requirements:

- Calibration
- Level 0 (raw data)
- Level 1 (calibrated spectra in 3 bands)
- Level 2 (dry air mixing ratios in 3 bands)
- Level 3 (CO₂ dry air global maps)
- Radiation transfer model (ICAP linking photometry and radiations)
- Atmospheric transport inversion (LMDz model linking sources, fluxes and circulation)
- Spectroscopy not fully understood

2 – MICROCARB NOMINAL BANDS

- B1: O₃ at 0.76µm
  - Provides O₃ amount to compute XCO₂
  - Provides information on Psurf (with external information from ECMWF) and on the optical path (presence of aerosols).
  - Requires Fraunhofer lines to evaluate the photosynthesis fluorescence contamination

- B2: weak CO₂ at 1.61µm
  - Purest area for CO₂
  - But: No information on the aerosol impact

- B3: strong CO₂ at 2.06 µm
  - Most sensitive band to CO₂
  - Saturated lines provide information on aerosols
  - The aerosols spectral dependence creates a different impact on B2 and B3

- B4: CH₄ at 1.67 µm
  - Improve information on Psurf & aerosols in addition with B1 (O₃ at 0.76 µm)
  - Spectroscopy better known than at 0.76 µm
  - But contaminated by an airglow emission (see 4)

3 – MICROCARB POTENTIAL ADDITIONAL BANDS

- B5: O₂ at 1.27 µm
  - Improve information on Psurf & aerosols in addition with B1 (O₃ at 0.76 µm)
  - Spectroscopy better known than at 0.76 µm
  - But contaminated by an airglow emission (see 4)

- B6: CH₄, CO & H₂O at 2.35 µm
  - The simultaneous measurement of CO₂ and CO gives access to the origin of CO₂ emissions (incomplete combustions come from anthropogenic emissions and biomass burning)
  - Improves information on H₂O to reduce uncertainty on the amount of dry air and XCO₂

4 – SPECIFIC STUDY ON AIRGLOW AT 1.27 µm

- The 1.27 µm O₂ band is known to exhibit strong emission of airglow due to the photodissociation of stratospheric and mesospheric O₂
  - Ignoring airglow in the inversion leads to strong biases on Psurf (~80 hPa)

- Poor literature on this topic

- Dedicated study by LATMOS and ACRI, funded by CNES, to determine the possibility to use it with 0.76 µm band for an improved XCO₂

- Modelling of the phenomenon:
  - Spectroscopy and spatial shape of airglow (impacts centers of O₂ absorption lines)
  - Modelling of airglow emission w.r.t. VER (Volume Emission Ratio)
  - A Chemical Transport Model (REPROBUS by F. Lefevre) can provide estimates of VER
  - Preliminary comparisons to SCIAMACHY limb measurements

- The study concludes in an accurate comprehension of the phenomenon

- Decontamination of MicroCarb spectra
  - Optimal estimation of airglow can efficiently be included in the MicroCarb inversion tool
  - XO₂ residual biases are very low (0.01 hPa)
  - Possibility to remove the most contaminated channels if necessary

5 – OTHER CONSIDERED BANDS

Other spectral bands have also been considered but will not be selected

- H₂O band (0.94 µm, 1.37 µm)
  - Improves information on H₂O to reduce uncertainty on XCO₂
  - Saturated H₂O lines provide a very efficient tool to detect high cirrus

- N₂O (2.1 µm, 2.25 µm)
  - N₂O is the third anthropogenic GHG and its emission processes have large uncertainties