Vertical profiles of CO2 and CH4 measured using AirCores to complete the observing system of Greenhouse Gases

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Résumé

Monitoring and understanding the evolution of the two most important anthropogenic greenhouse gases (carbon dioxide (CO2) and methane (CH4)) is one of the major challenges in climate science. Over the past decades, the increased availability and diversity of observations (surface networks, aircraft campaigns, satellite observations) and the improvement of atmospheric transport models has allowed developing our understanding of biogeochemical cycles of CO2 and CH4. Nevertheless, precise vertical observations are still very rare, although these become crucial to both properly characterize the vertical transport of the gases, as well as to fully evaluate total or partial columns of gases retrieved from space observations or simulated by atmospheric transport models.
AirCores are innovative instruments that could complete the observing system. Flown under a stratospheric balloon, an AirCore collects a continuous air sample along the atmospheric column while descending from high altitude. The analysis of CO2 and CH4 mole fractions in the collected sample allows retrieving vertical profiles from the surface to 30 km, with a vertical resolution typically varying between 300 m at the surface and 3 km at 30 km for light AirCores flown under meteorological balloons.

Using a dataset of AirCore profiles collected by LMD during CNES annual campaigns in various locations and by University of Groningen in Sodankyla (in collaboration with the Finnish Meteorological Institute), we will show how the measured vertical profiles allow a full evaluation of integrated columns retrieved from space missions, using methane columns from IASI as a test bed. In particular, we will highlight the importance of a proper measurement of the upper-tropospheric and stratospheric parts of the gas profile and show how they can be used to interpret potential biases in the simulations of the stratosphere in atmospheric transport models.
Finally, we will use the results to suggest strategies for future validation campaigns of science products.

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