STUDY OF ATMOSPHERIC CO_2 REGIONAL VARIABILITY OVER EUROPE THROUGH THE ANALYSIS OF INTENSIVE AIRBORNE CAMPAIGNS

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ABSTRACT

We carried out airborne campaigns over Europe in order to analyze atmospheric CO_2 variability at the regional scale. Data reveal a higher standard variation in the planetary boundary layer (PBL) against a lower one in the free troposphere (FT), where the air is more well mixed. Ground data generally agree well with airborne measurements when done in the FT, but not in the PBL where they are exposed to local disturbances. Ground stations located in the FT are shown to be representative of a regional scale while PBL observatories provide only locally representative measurements.

INTRODUCTION

Sources and sinks of CO_2 in Europe at the regional scale (<1000 km) are poorly known yet [*Janssens et al.*, 2003]. Aircraft measurements give access to the quasi-instantaneous repartition of atmospheric CO_2 at such a scale and thus represent a tool of choice for the determination of CO_2 regional fluxes [*Gerbig et al.*, 2003a]. Our goal is to carry out aircraft campaigns to get high resolution CO_2 mesurements at different seasons. Until today, we have done two campaigns in May 2003 and 2004 and one campaign in September 2004 over France and Espagne (Fig.1) via the European sites of the CARBOEUROPE-IP project : Orléans, Puy de Dôme, Pic du Midi, La Muela and Bégur. This work deals with the 2004 campaigns. The instrumentation is presented, followed by an analysis of atmospheric CO_2 within the PBL and the FT. We then compare aircraft and ground stations measurements, and propose an analysis of the spatial footprint of aircraft and observatories measurements.

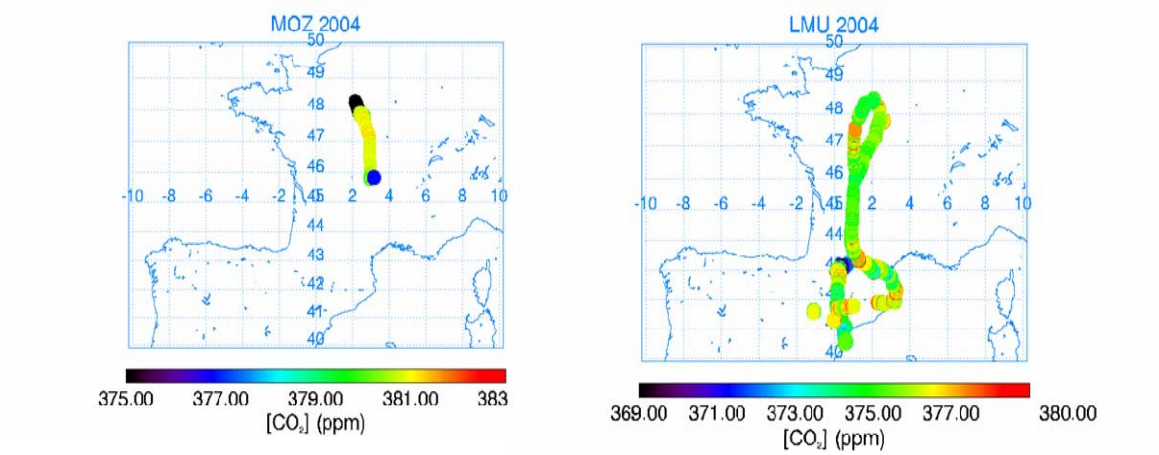

Fig.1. Paths of the 2004 aircraft campaigns over Europe.

INSTRUMENTATION

In 2000/2001, a fast and continous CO_2 analyzer has been built for airborne measurements. This prototype, called CONDOR, is based on an commercial IR spectrometer (Li-Cor 6262) which performances have been improved: first by controlling the pressure, temperature and flows, and second by performing frequent calibrations with two standards that are analyzed on a regular base at LSCE with a precision better than 0.1 part per million (ppm). More information can be found in [*Filippi et al*., 2001]. Data have a precision better than 0.3 ppm and 0.5 ppm for May 2004 and September 2004, respectively, and a frequency of 1 Hz. The instrumentation was installed onboard a Piper Aztec from the AEROSPEED company.

CO_2 VARIABILITY AND SPATIAL REPRESENTATIVITY

To improve the determination of regional carbon fluxes, it is important to understand well atmospheric CO_2 variability, horizontally and vertically. In the PBL, which is in contact with the ground and thus with sources and sinks of CO_2, atmospheric CO_2 shows a higher variability than in the FT, where the air is much better mixed (Table 1).

Table 1.Atmospheric CO_2 variability (ppm) in the PBL and the FT for the 2004 campaigns.

	May 2004	September 2004
Mean in the PBL	378.00	375.10
Standard deviation in the PBL	2.22	1.44
Mean in the FT	380.78	375.78
Standard deviation in the FT	0.32	0.89

AIRBORNE AND GROUND DATA COMPARISON

The comparison between in-situ data and ground stations measurements allows a better understanding of the spatial footprint of these latters. Data analysis show that stations located in the FT match aircraft measurements within a few tenths of ppm, while they differ of a few ppm within the PBL because of the proximity of local CO_2 sources and sinks. We thus conclude that, in general, ground stations are representative of the local scale in the PBl, while they are sensitive to the regional scale in the FT.

CONCLUSION

This work puts in light the usefulness of aircraft campaigns to analyze atmospheric CO_2 variability. Work on the seasonal variation of CO_2 will be undertaken in the next future.

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