Representativeness analysis of airborne and tall tower CO_2 measurements in Bialystok

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AGL

2500m

a & b. Aircraft profiling (100m - 2500m)

Regular measurements at three different locations:

1. Aircraft ascent profiling (100m → 2500m)
2. Aircraft descent profiling (2500m → 100m)
3. BIK tower measurements (4m → 300m)

Aircraft

– In-situ: CO_2
– Flasks: CO_2, CO, CH_4, N_2O, H_2, SF_6

Tower

– In-situ: CO_2, CO, CH_4, N_2O, SF_6 and O_2/N_2

300m

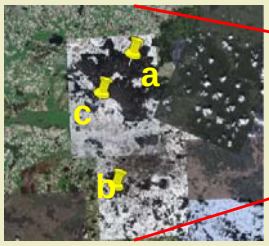
c. BIK tower

100m

5m

1. Introduction

Airborne measurements have been made aboard a rental aircraft near the Bialystok tall tower (BIK) over northeast Poland since 2006 on a weekly basis. These measurements provide important information on the spatial variability of atmospheric CO_2 near the tower and enable us to analyze the representativeness of the tall tower. Combined with high resolution transport model analysis, they can e.g. help to improve tools to filter out data of the continuous tower record that are non-representative for e.g. inverse modeling purposes.



Aircraft profiles near BIK (53° 14′N, 23° 01′E), Poland

2. Flight protocol

Ascending profiles near BIK tower around mid-day had been made since 2006 using a modified Li-Cor system. Seven pairs of flasks were taken at altitudes of 100m, 300m, 500m, 1000m, 1500m, 2000m and 2500m above ground level, while the Li-Cor was doing calibrations. Since August 2008, two profiles have been made during one flight using a modified AOS analyzer system: one ascending profile near the BIK tall tower and another descending profile that is 20 km apart, southwest of the city of Bialystok. The flasks were analyzed by the GasLab at MPI-Jena for CO_2, CH_4, CO, N_2O, SF_6 and H_2 concentrations. The aircraft climbs at the speed of ~1.5 m/s and descends ~ 5.5 m/s, corresponding to vertical resolutions of 7 m and 26m, respectively.

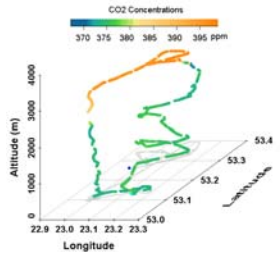


Fig 1. The flight track colored by CO_2 concentrations: the grey lines show the projected flight track on the ground level and the bule dot indicates the location of the tower.

3. Spatial variability

3.1 mixed layer average variability

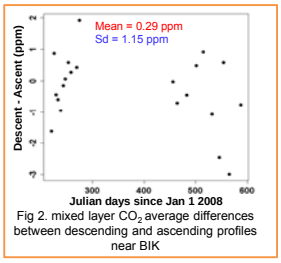


Fig 2. mixed layer CO_2 average differences between descending and ascending profiles near BIK

3.2 spatial variability at 300 m level

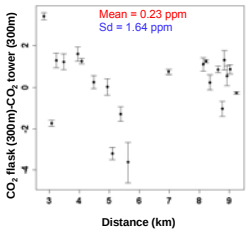


Fig 3. Differences of 300 m flight flasks and 300 m tower measurements as a function of distances (3 -10 km)

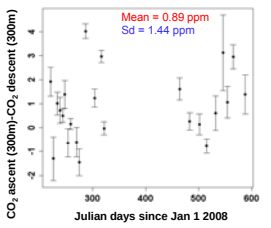
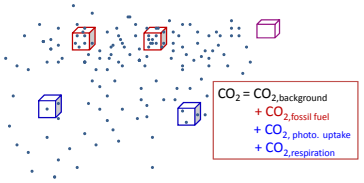


Fig 4. Differences of 300 m aircraft in-situ measurements from ascending and descending profiles that are 20 km apart

4. Model simulations

4.1 Stochastic Time-Inverted Lagrangian Transport (STILT) model



Background: from TM3
Fossil fuel: IER_Stuttgart 2000
Photosynthetic uptake, respiration: VPRM model

4.2 Representativeness analysis

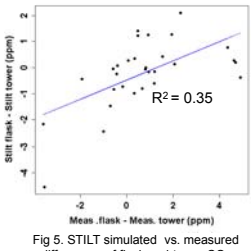


Fig 5. STILT simulated vs. measured differences of flask and tower CO_2 concentrations at 300 m level

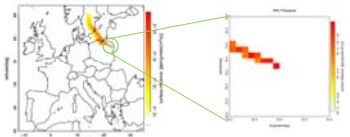


Fig 6. Footprint for one flask measurement

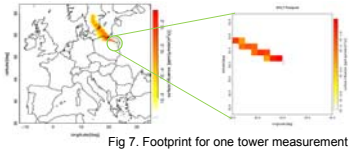


Fig 7. Footprint for one tower measurement

5. ACKNOWLEDGEMENTS

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