FIRST RESULTS FROM A 300 M TOWER ATMOSPHERIC MEASUREMENT STATION FOR GREENHOUSE GASES - BIALYSTOK, POLAND

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ABSTRACT AND INTRODUCTION

CHIOTTO – Continuous HIgh-precisiOn Tall Tower Observations of greenhouse gases – is a European Union-funded project which has as objective to build an infrastructure for the continuous monitoring of greenhouse gas concentrations across Europe above the surface layer using tall towers (~300m height). For this purpose a new analysis system for continuous atmospheric measurements was built and tested at Max Planck Institute for Biogeochemistry, Jena, Germany and was recently installed at a 300 m tower close to Bialystok, Poland (Lat 53°14'N, Long 23°01'E, Alt 180m), as part of the "CHIOTTO" tall tower network. Since July 2005 this system is measuring quasi-continuously the atmospheric concentration of CO_2, CH_4, CO, N_2O, SF_6 and the O_2/N_2 ratio as well as meteorological parameters (atmospheric pressure, temperature, humidity; wind speed and direction) from 5 heights on the tower ranging from 5 to 300 m. The measurement devices are: an Oxzilla O_2 fuel cell analyzer, a LiCor 7000 NDIR CO_2 analyzer, an Agilent gas chromatograph (GC) with flame ionization detector (FID) and electronic capture detector (ECD) for CH_4, CO, N_2O, SF_6. The challenge was to build a reliable automatic system which can run continuously with very little maintenance and to fulfill at the same time the high precision requirements for all the measured species prescribed by the CHIOTTO project goals. The high temporal resolution achieved will capture short term events and diurnal variability. In addition, the system is planned to run for at least several years in order to observe long-term trends as well. We describe the technical setup of the measurement system, the region of influence of the station and present the first months of data if available: correlations between species, observed short term variability patterns and their relation to meteorology and air parcel paths.

TECHNICAL SETUP

The system is designed to measure alternately greenhouse gas air concentrations from five heights of the tower: 5m, 30m, 90m, 180m and 300m. The measurement system is installed inside a temperature controlled container. Before the air composition is analyzed, it is first cryogenically dried to a dewpoint of about -80°C.

CO_2 and O_2/N_2 measurement

CO_2 and O_2 concentrations are measured successively from the same air sample using a LiCor 7000 NDIR analyzer for CO_2 and an Oxzilla O_2 fuel cell analyzer. The O_2/N_2 ratio is then calculated using the measured O_2 concentration taking into account the CO_2 dilution effect. The analyzers are calibrated every 20-30 hours using air from a set of four high pressure cylinders and a "Target" cylinder is measured every few hours to check the stability of the system. The O_2 and CO_2 analyzers are installed inside a thermostated chamber (+/- 0.1°C) to avoid temperature variation influencing the measurement.

CH_4, CO, N_2O and SF_6 measurement

CH_4 and CO are measured by a FID detector with Ni catalyst, using Molsieve 5A and Unibeads 1S columns. For N_2O and SF_6 we use an ECD detector and Hayesep Q columns. The sample air is measured alternately with a reference gas from a high pressure cylinder and the ratio between sample and reference peaks is used to compute the sample concentration. The calibration is made every about 2 weeks with a

set of four high pressure cylinders and a “Target” cylinder is measured every few hours to check the stability.

Meteorological measurement
The meteorological parameters are measured at different heights on the tower; the data are transmitted to computer via CAN-BUS.

Automation
The GC measurement is controlled by Agilent Chemstation software. A custom written Labview program controls overall the measurement sequence: the sample lines selection, valves switching, calibration, data processing and transmission. The data are transferred in MPI database by PCAnywhere via phone line.

RESULTS ABOUT SYSTEM PERFORMANCE

We have a preliminary estimation of the measurement precision expressed in terms of typical standard deviation of concentration for constant gas measurement, compared with CHIOTTO precision targets:

Species	Typical standard deviation	CHIOTTO precision targets
$O2/N_2$	2..5permeg	5permeg
CO_2	0.02..0.07ppm	0.05ppm
CH_4	0.4..0.6ppb	2ppb
CO	0.3..0.6ppb	1ppb
N_2O	0.1..0.2ppb	0.1ppb
SF_6	0.02ppt	0.1ppt

Given the limitations in atmospheric transport modeling the high precision achieved will not be a limiting factor for source and sink calculations using inverse modeling.

PLANNED SCIENTIFIC ANALYSIS OF THE MEASUREMENTS

The data from the first months will give an idea about the short term variability – day/night patterns and particular events and the correlation between the different measured species variability. Using meteorological parameters we will make back-trajectories calculations which give information about the region from which fluxes influence the concentration measurements at the tower. We will also investigate how local meteorology like the stability of the air column influences vertical concentration profiles. At a later stage we will also use the concentration measurements in inverse calculations to help estimate sources and sinks in Central Europe of the trace substances measured.