A NEW ATMOSPHERIC MONITORING STATION IN IVITTUUT, SOUTHERN GREENLAND

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The Greenland Automatic Atmospheric Monitoring and Modeling project (GRAAM) is integrated into the framework of the European Carboocean IP, the GRAAM-IPEV and POLARCAT (IPY) projects.

Valuable on-site logistic help is provided by the Danish Naval base of Grønnedal and local authorities of Ivittuut / Sermersooq Kommune

IVIGTUT KOMMUNE

GRØNLANDS KOMMANDO

CO_2 Expert Meeting, Jena, 6-10 September 2009

Scientific objectives and context:

By the way of the Integrated European CarboOcean project, LSCE was given the opportunity to set up a new continuous atmospheric monitoring station in Ivittuut, Southern Greenland. Two high precision automated instruments for CO_2 and O_2 monitoring have been developped at LSCE and installed on site since 2007.

The main scientific objectives of the GRAAM project are:

- To contribute to refine and better constrain the regional and global carbon budget;
- To contribute to a better understanding of the role of the Atlantic Ocean as a carbon sink and to quantify the respective roles of vegetation and Ocean within the region;
- To track the "polluted" air masses coming either from Europe or North America;
- To add a new continuous monitoring station to the global network in an uncovered area.

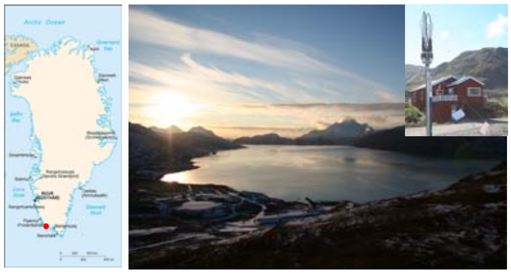
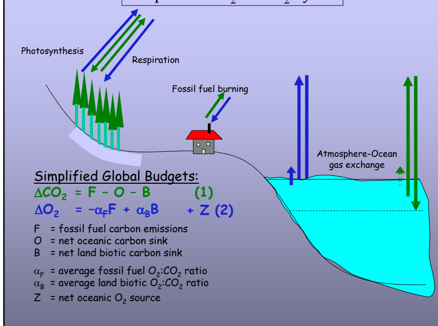


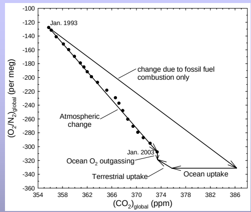
Figure 1: Site location of the GRAAM monitoring station: Ivittuut (61°12' N, 48°10'W) is a former mining city closed in the late 80, close to the danish naval base from Gronnedal which provide us with logistical facilities and assistance for routine maintenance and sampling

Using CO_2 and O_2 measurements to constrain carbon sinks

Simplified CO_2 and O_2 cycles



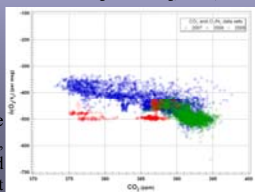
CO_2 and O_2 cycles are closely linked as illustrated in the schematic above. There are three main elements acting, vegetation (source and sink), ocean (source and sink) and fossil fuel emissions resulting from human activities that can be summarized in equations 1 and 2 for CO_2 and O_2.



Manning and Keeling, Tellus, 2006

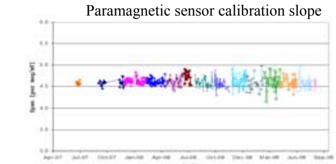
Measuring simultaneously CO_2 and O_2/N_2 ratio in the atmosphere enable us to quantify the role of the vegetation and the ocean as carbon sink following the method of Manning and Keeling or through the calculation of APO:

APO = $(O_2/N_2) + \alpha_b CO_2$

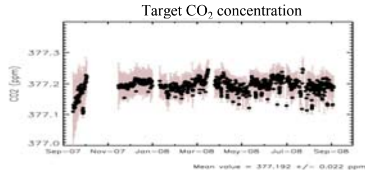


$CO_2 - \delta(O_2/N_2)$ correlation obtained at Ivittuut Station over the 2007-2009 period (hourly mean data). The first 2007 data set are suspicious whereas the 2008 and 2009 data are correlated as expected.

High precision analyzers:



O_2 analyzer based on a paramagnetic sensor



CO_2 analyzer based on dual Cell NDIR detector

Two high precision instruments have been developed at LSCE in collaboration with CEA/IRFU. Both are running continuously and can be remotely controlled. Analytical precision reached are within +/- 5 per meg for O_2/N_2 and better than 0.1 ppm for CO_2 given a precise analytical protocol and regular reference calibration.

Meteorological sensors for temperature, pressure, relative humidity, wind speed and direction are also running on site.

Results : CO_2 and O_2 continuous time series

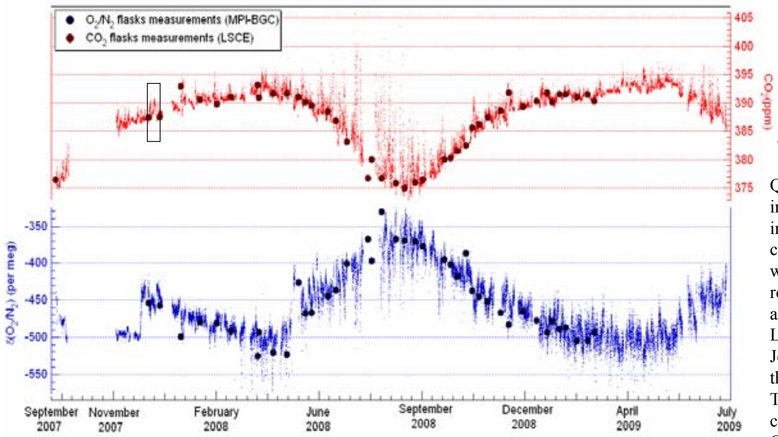


Figure 2: Twenty months of continuous data series for CO_2 and O_2/N_2 ratio (10 mn averages data) and quality control flask data

Figure 2 illustrates the data series obtained at Ivittuut station over the last 20 months for the two instruments. There are two gaps in the data set in October November 2007 and in January 2008 corresponding to serious power failure in Ivittuut. There is another gap during August 2008 corresponding to the maintenance period of the instrumentation.

The main features arising for the data series are the following :

- There is a strong seasonal cycle for both species with a maximum amplitude of 17 ppm for CO_2 and 150 per meg for O_2/N_2 arising at the end of August.
- There is a strong anti-correlation of CO_2 and O_2/N_2 as expected
- There is a larger scattering of the data during the summer season which is linked to the photosynthesis process (including diurnal cycles). Note that there is an unusual large signal variability during the period May 2008 – August 2008 that was related to the burning of local waste in the close surrounding of the station (this has been stopped since that time, and does not show up again in the 2009 summer data).
- The amplitude and range of variability of our data sets are quite similar to those from the Cold Bay station in Alaska and Alert in Canada (not shown).

Quality control and complementary analysis using sample flasks

Quality control of the continuous instruments are done through yearly inter-calibration exercises and also by comparison of the continuous data set with weekly flask samples (blue and red dots on figure 2). The samples are analyzed in the central laboratory at LSCE for additional gases and at MPI-Jena for O_2/N_2 ratio, as illustrated on the figure 3.

This figure shows a clear seasonal cycle in the CO, CH_4, H_2, CO_2 and O_2/N_2 and an increasing tendency for SF_6.

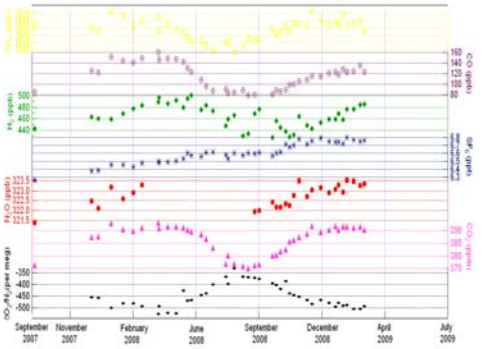
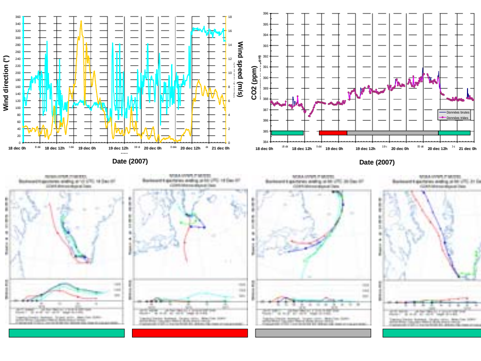


Figure 3: Multi-gas analyses of flasks sampled at Ivittuut monitoring station.

Preliminary data interpretation:



Here a first data filtering and classification has been attempted using meteorological data as selection criteria over a short period (see square in figure 2).

The high frequency variability of the CO_2 signal has been removed and then we have tried to correlate the CO_2 signal level and the air masses origin, using wind speed and direction as criteria and then comparing our results with back trajectories from the Hysplit transport model.

Further refinement of this method is under study to process the full record.