Atmospheric concentrations of methane and carbon dioxide

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Outline:

Measurement system

Calibrations

Seasonal cycle of concentrations

Possible marine emissions

Future plans
To be useful atmospheric observations must be accurate
WMO – Global Atmosphere Watch expert group recommendations

$\text{CO}_2$ measurement compatibility better than $\pm 0.1 \text{ ppm}$

$\text{CH}_4$ measurement compatibility better than $\pm 2 \text{ ppb}$

Calibration gases directly traceable to
WMO – Central Calibration Laboratory (CCL) primary standards
at NOAA, Boulder
Measurements in Tiksi started in July 2010

Researchers from Voeikov Main Geophysical Observatory and Finnish Meteorological Institute

Aerosols

$\text{CO}_2, \text{CH}_4$
Measurement system

TCCCMS (Tiksi CH4/CO2 Concentration Measurement System) Flow Diagram

Concentrations are measured in the Clean Air Facility using new laser technology by Los Gatos Research, Inc (DLT-100).

Air is sampled from the 10 m tower.

1. Sampling line
2. Cryo cooling drier
3. Sampling pump
4. Sample Air Control Unit
5. Working standards
6. Primary calibration standards
7. Concentration analyzer DLT-100
8. Vacuum pump
9. Control and data collection computer
In Tiksi, we have 6 cylinders prepared in CCL for calibration and 2 cylinders for target gases prepared in MGO.

Calibration gases are used for calibration. Target gases are ‘unknowns’ for checking that system produces stable results.

We measured every third day 3 CCL prepared cylinders and MGO target for 7 minutes. Additionally, MGO target was measured every 16 hour for 5 minutes.

I used 2 CCL cylinder measurements for calibration and 1 CCL and 1 MGO cylinder as targets for checking performance.

Calibration was done on monthly basis.
Methane calibration performance

In Tiksi, we have 6 cylinders prepared in CCL for calibration and CCL target cylinder, deviated 0.15ppb from the assigned value if we compare the average of all 16 about monthly periods. SD of these about monthly values was 0.7ppb
The maximum and minimum deviations (of individual monthly periods) were 1.5 and -1.2ppb.
MGO cylinder which was measured every 16 hour, the average deviation (over 16 periods) was -0.12ppb, the max and min deviations of the individual months were 1.7 and -1.9 ppb.
Methane calibration performance

Individual calibration measurements have higher variability. Within a month standard deviation of calibration and target gas concentrations were close to 2 ppb. MGO 16 hour target has on the average standard deviation of 2.0 ppb as an average over 16 about monthly periods. The highest monthly SD was 3.7 and lowest 1.2ppb. The highest variability is usually in winter and lowest (luckily) in the late summer and early autumn. August 2011 is very interesting. Then, MGO target deviated -0.05 ppb and SD of the target measurements was 1.2ppb. For the NOAA cylinder, which was used as a target in the calibration cycle, the average deviation was -0.3ppb, SD 2.0ppb.
Local terrestrial and marine sources

Long-range transport episodes from southern Siberia and Russia
CH4 and wind in August 2011
Conclusions:
- Methane concentration measurements by Los Gatos DLT100 roughly meets the GAW compatibility target
- Carbon dioxide measurements does not meet the target
- We observed interesting marine and terrestrial emissions

Future:
- Picarro G2301
  - improvement of CH4 precision,
  - CO2 will meet the GAW target
  - We are running out of the MGO target gas
  - New target gas cylinder from FMI
Ambient air monitoring