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Monitoring of nitrogen oxides at Svalbard: measurements in Adventdalen

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INTRODUCTION

- Possible impacts of NO_x emissions:
  - ❖ soil and water acidification
  - ❖ nitrates produced from NO_x can act as fertilizers
  - ❖ formation of tropospheric ozone
  - ❖ NO_x are precursors for particle formation
- NO_x emissions from snowmobiles at Svalbard:
  - ❖ almost three times higher than from gasoline cars in 2007
  - ❖ concentrated along the routes as snowmobiles follow one after another forming a motorcade during fieldwork (Fig. 1)
- Other factors affecting NO_x concentration:
  - ❖ other NO_x sources in Longyearbyen: coal power plant, cars and ship traffic
  - ❖ atmospheric conditions promoting accumulation of pollutants in the atmospheric boundary layer
  - ❖ local atmospheric circulation due to complex topography

Main aim of the research project "Monitoring of nitrogen oxides at Svalbard" is to quantify the effect of emissions from snowmobiles, cars and coal power plant on the background concentration of NO_x in Longyearbyen and around the settlement.

Figure 1 Motorcade of snowmobiles during UNIS fieldwork (photo: Richard Hann)

METHODOLOGY

The measurement campaign took place in the Adventdalen valley near Longyearbyen (Fig. 2). Main snowmobile route to the east coast of Spitzbergen from the town goes through the valley along the road, and therefore there is daily snowmobile traffic in spring season lasting from the end of March to the beginning of May. The NO_x monitor was installed in the UNIS CO_2 lab building near UNIS automatic weather station (UNIS AWS) for the period from 23.03.2017 to 15.05.2017.

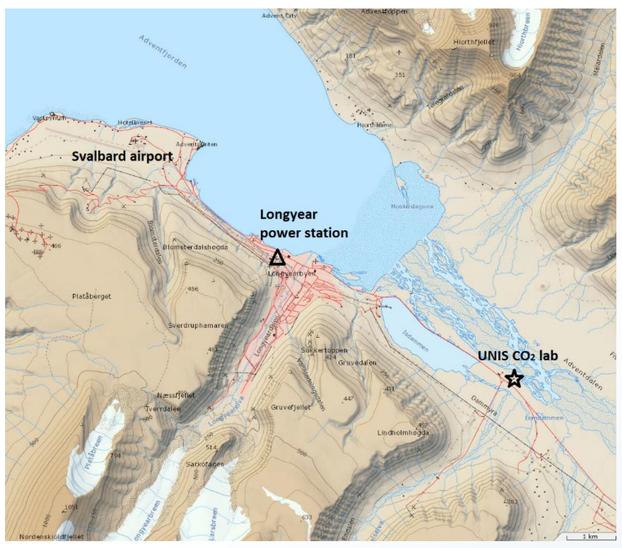

Figure 2 Map of Longyearbyen and Adventdalen

OBSERVATIONAL SET-UP

Figure 3 Chemiluminescence NO/NO_2/NO_x Analyzer (photo: Mark Hermanson)

Figure 4 Equipment for weekly calibration of NO_x monitor: a) zero air generator; b) gas cylinder with NO of known concentration (814 ppb) (photo: Mark Hermanson)

- The NO_x monitor (Fig. 3) was installed inside the building, while the inlet of the sampling hose was secured outside from the window.
- The sensor was calibrated weekly (Fig. 4), and the data were scaled linearly to eliminate zero drift.
- The UNIS AWS is located nearby the UNIS CO_2 lab (Fig. 5), and the data from the station are used to assess local meteorological conditions prevailing during the fieldwork.

Figure 5 UNIS automatic weather station in Adventdalen

RESULTS

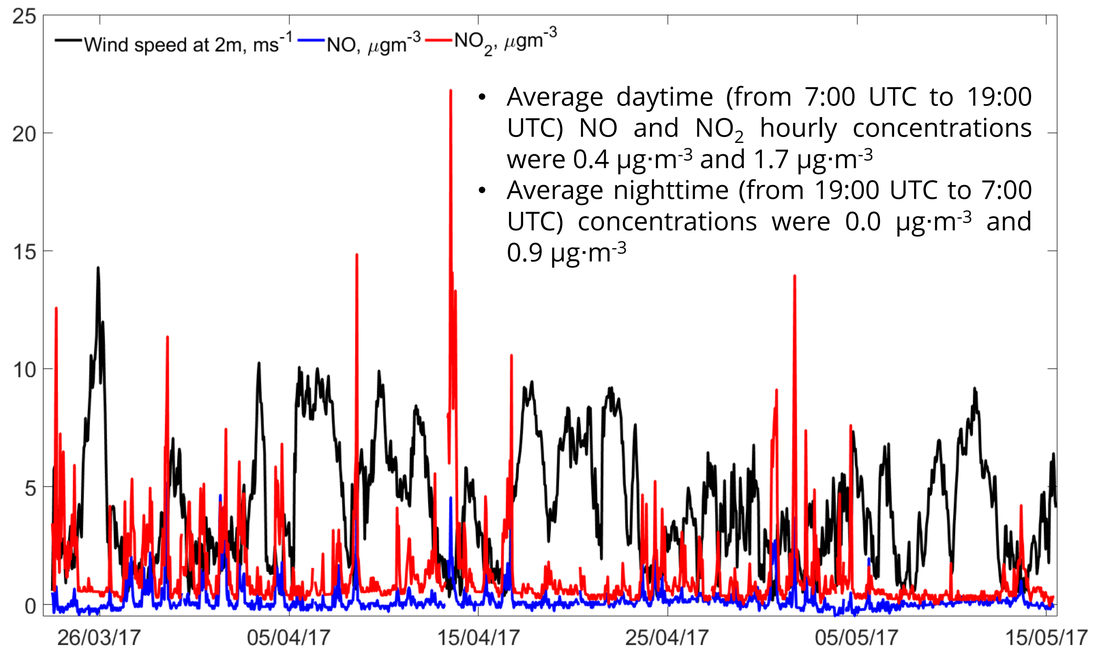

Figure 6 Hourly average wind speed, NO and NO_2 concentrations

- ✓ During daytime local wind speed at 2m height correlates with NO (r =-0.37) and NO_2 (r = -0.38) concentrations. During nighttime, there is no significant correlation with NO, while correlation with NO_2 is weak (r = -0.21).
- ✓ The distribution of average NO and NO_2 concentrations over wind directions during nighttime reveals possible influence of power plant (Fig. 7).
- ✓ Elevated NO_x concentrations were observed during colder days with light winds.
- ✓ Combination of increased recreational traffic and mild weather conditions on Easter holiday, 13.04.2017, led to accumulation of NO_2 concentration 13 times higher than normal.

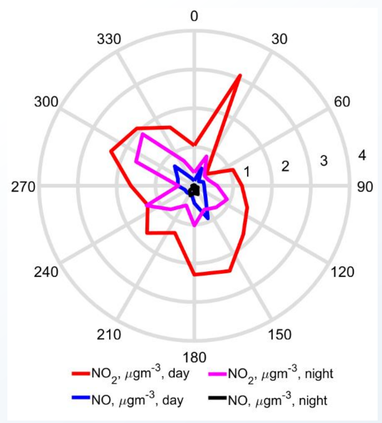

Figure 7 Average concentrations of NO and NO_2 over wind directions

CONCLUSIONS

- ➢ Daytime NO_x concentrations are higher than nighttime ones. This reflects the diurnal pattern of snowmobile traffic intensity.
- ➢ The distribution of average NO_x concentrations over wind directions suggests importance of different emission sources during daytime and nighttime.
- ➢ There is a statistical significant dependence of NO_x concentration on prevailing meteorological conditions.
- ➢ The concentrations observed in this study are under European limit set for health protection (200 μg·m^{-3} NO_2 per hour). However, with further development of tourism activities at Svalbard, there may appear zones where local wind regime and enhanced traffic could lead to concentrations of NO_2 over 30 μg·m^{-3}, which is annual average limit value, defined by the Norwegian legislation for the protection of vegetation.

FUTURE WORK

- Compare NO_x data with measurements in Barentsburg and Ny-Ålesund (Fig. 8) performed by Russian Arctic and Antarctic Research Institute and Norwegian Institute of Air Research, respectively.
- Analyse UV data from UNIS and tropospheric ozone data from Ny-Ålesund and Barentsburg to determine how NO_x emissions in Svalbard affect local O_3 production.
- Future summertime field campaign is needed to assess the effect of emissions from ships on the local air quality in Longyearbyen.

Figure 8 Map of Svalbard with the locations of Longyearbyen, Barentsburg and Ny-Ålesund

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