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Springtime nitrogen oxides and tropospheric ozone in Svalbard: local and long-range transported air pollution

Alena Dekhtyareva[1], Mark Hermanson[2], Anna Nikulina[3], Ove Hermansen[4], Tove Svendby[5], Kim Holmén[6], and Rune Graversen[7]

[1]Geophysical Institute, University of Bergen and Bjerknes Centre for Climate Research, Bergen, Norway (alena.dekhtyareva@uib.no)

[2]Hermanson and Associates LLC, Minneapolis, USA

[3]Department of Research Coordination and Planning, Arctic and Antarctic Research Institute, Russia

[4]Department of Monitoring and Information Technology, NILU - Norwegian Institute for Air Research, Norway

[5]Department of Atmosphere and Climate, NILU - Norwegian Institute for Air Research, Norway

[6]International director, Norwegian Polar Institute, Longyearbyen, Norway

[7]Department of Physics and Technology, UiT The Arctic University of Norway, Tromsø, Norway

Svalbard is a near pristine Arctic environment, where long-range transport from mid-latitudes is an important air pollution source. Thus, several previous studies investigated the background nitrogen oxides (NO_x) and tropospheric ozone (O_3) springtime chemistry in the region. However, there are also local anthropogenic emission sources on the archipelago such as coal power plants, ships and snowmobiles, which may significantly alter in situ atmospheric composition. Measurement results from three independent research projects were combined to identify the effect of emissions from various local sources on the background concentration of NO_x and O_3 in Svalbard. The hourly meteorological and chemical data from the ground-based stations in Adventdalen, Ny-Ålesund and Barentsburg were analysed along with daily radiosonde soundings and weekly data from O_3 sondes. The data from the ERA5 reanalysis were used to evaluate the prevailing synoptic conditions during the fieldwork. Although the correlation between the NO_x concentrations in the three settlements was low due to dominant influence of the local atmospheric circulation, cases with common large-scale meteorological conditions increasing the local pollutant concentration at all sites were identified. In colder and calmer days and days with temperature inversions, the concentrations of NO_x were higher. In contrast to NO_x values, O_3 concentrations in Barentsburg and at the Zeppelin station in Ny-Ålesund correlated strongly, and hence the prevailing synoptic situation and long-range transport of air masses were controlling factors for them. The Lagrangian models HYSPLIT and FLEXPART have been used to investigate air mass transport and transformations during the large scale O_3 depletion and enrichment events. The factors affecting Arctic springtime photochemistry of O_3 have been investigated thoroughly using Lagrangian and Eulerian numerical weather prediction model data and Metop GOME-2 satellite observations.