Polar stratospheric clouds (PSCs), stratospheric temperatures, denitrification, and ozone depletion

Place:
Svalbard

Disciplines:
Atmospheric chemistry

Motivation:
In addition to being a strong greenhouse gas, water vapor controls the formation of polar stratospheric clouds (PSCs), which are known to initiate ozone depletion through heterogeneous reactions and through removal of nitric acid (denitrification) via sedimentation. Ubiquitous stratospheric sulphate aerosols serve as nucleation sites for PSCs that form by co-condensation of nitric acid and water vapor when temperatures drop (< 195 K). Only solid-phase particles can be responsible for denitrification. Although solid phase PSC particles are frequently observed in the Arctic stratosphere, current theories for solid phase particle formation require much lower temperatures than usually occur in the Arctic stratosphere. This apparent paradox should be pursued experimentally through an international polar balloon campaign from Spitsbergen, as well as theoretically through global scale, microphysical, and microchemical simulations.

Research:
The main objective is a comprehensive investigation of synoptic-scale polar strato-spheric clouds inside the cold polar vortex. Spitsbergen offers the unique opportunity for a European/US campaign to launch balloon-borne instruments at a very high latitude (~80N). Here the vortex contains the coldest air and largest PSC fields in the Arctic. In a combination of balloon-borne experiments with ground- and satellite-based atmospheric observations, substantial progress can be made to quantify physical properties of synoptic PSCs, formation of large solid particles, and denitrification. The experimental data will be used to improve microphysical modelling capabilities. A campaign in the IPY from Spitsbergen will open the opportunity to establish polar research, providing the necessary information to make reliable predictions of the future ozone layer. Balloon-borne experiments, ground-based observations, and data retrieved from the ENVISAT satellite will be used to characterise both the particles and the gas-phase of the lower stratosphere that is enclosed by the large, cold polar vortex. The major focus of this research will be on synoptic-scale PSCs. Detailed objectives include precise measurements of size and phase of PSC particles, a detailed characterisation of the gases interacting with the particles, especially H2O and HNO3, and a search for large solid particles and processes leading to denitrification and dehydration. Balloon-borne experiments are proposed to be launched into the polar vortex to analyse PSCs and the atmospheric environment in combination with ground- and satellite-based observations and model development and applications. ENVISAT data will play a critical role especially in the distribution of HNO3 and of other trace gases. From the research station at Ny Ålesund, ground-based lidar measurements of PSCs may be obtained before, during, and after the campaign in IPY to provide support to the balloon flights.
Most of the experiments have been tested and flown in campaigns from Kiruna. Microphysical and atmospheric modelling work will focus on the conditions within the polar vortex and will use the data obtained to predict the influence of denitrification, particle formation, and their existent temperatures. Transportation to and from Spitsbergen as well as preparation of the actual campaign and launching of balloons will be well within the capabilities of the participating scientists. Approximately 2 years of preparation are required, the balloon campaign may last 4 weeks and about a year thereafter the data and model applications will be completed. Efforts will be made to recover the payloads outside from Spitsbergen.