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Observations of surface radiation and stratospheric processes at Thule Air Base, Greenland, during the IPY

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Abstract

Ground-based measurements of atmospheric parameters have been carried out for more than 20 years at the Network for the Detection of Atmospheric Composition Change (NDACC) station at Thule Air Base (76.5°N, 68.8°W), on the north-western coast of Greenland. Various instruments dedicated to the study of the lower and middle polar atmosphere are installed at Thule in the framework of a long standing collaboration among Danish, Italian, and US research institutes and universities. This effort aims at monitoring the composition, structure and dynamics of the polar stratosphere, and at studying the Arctic energy budget and the role played by different factors, such as aerosols, water vapour, and surface albedo. During the International Polar Year (IPY), in winter 2008-2009, an intensive measurement campaign was conducted at Thule within the framework of the IPY project "Ozone layer and UV radiation in a changing climate evaluated during IPY" (ORACLE-O3) which sought to improve our understanding of the complex mechanisms that lead to the Arctic stratospheric O_3 depletion. The campaign involved a lidar system, measuring aerosol backscatter and depolarization ratios up to 35 km and atmospheric temperature profiles from 25 to 70 km altitude, a ground-based millimeter-wave spectrometer (GBMS) used to derive stratospheric mixing ratio profiles of different chemical species involved in the stratospheric ozone depletion cycle, and then ground-based radiometers and a Cimel sunphotometer to study the Arctic radiative budget at the surface. The observations show that the surface radiation budget is mainly regulated by the longwave component throughout most of the year. Clouds have a significant impact contributing to enhance the role of longwave radiation. Besides clouds, water vapour seasonal changes produce the largest modification in the shortwave component at the surface, followed by changes in surface albedo and in aerosol amounts. For what concerns the middle atmosphere, during the first part of winter 2008-2009 the cold polar vortex allowed for the formation of polar stratospheric clouds (PSCs) which were observed above Thule by means of the lidar. This period was also characterized by GBMS measurements of low values of O_3 due to the catalytic reactions prompted by the PSCs. In mid-January, as the most intense Sudden Stratospheric Warming event ever observed in the Arctic occurred, GBMS and lidar measurements of O_3, N_2O, CO and temperature described its evolution as it propagated from the upper atmosphere to the lower stratosphere.

Keywords

Polar atmosphere; NDACC; Radiative budget; Stratospheric ozone

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References

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