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Evolution of temperature and ozone in the Arctic stratosphere during the winters 2001-2002 and 2002-2003

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The data used in this study were acquired during the Arctic winters 2001-2002 and 2002-2003. Measurements were made at Thule, Greenland (76.5˚ N, 68.8˚ W) with a Rayleigh lidar and a Ground Based Millimeter Spectrometer (GBMS). The lidar transmitter is a two stage Nd-YAG laser emitting at 532 nm, while the receiver comprises a 800 mm diameter Cassegrain telescope and two detection channels, for two polarizations. The temperature profiles are derived from the Rayleigh signal in the altitude range 25-70 km. The GBMS observes rotational emission lines of O_3 and other stratospheric species with a millimeter-wave receiver and two back-end spectrometers. The combination of the two spectrometers allows retrievals of O_3 vertical profiles from 20 to 70 km altitude with an uncertainty of approximately $\pm$10%.

The evolution of temperature and ozone has been related to the stratospheric potential vorticity. Temperature and ozone are largely affected by the polar vortex behavior, which is modulated by planetary waves. The temperature and ozone variations associated with planetary waves are of the order of 10 K and 2 ppm, respectively. Stratospheric warmings produce the largest impact on the thermal structure and ozone content over Thule, with temperature variations as large as 30 K and ozone changes as large as 3 ppm.

The strongest warming took place in mid-January 2003, leading to a significant increase in the temperature (from 238 K to 260 K at 37.5 km in about 24 hours), and a 40% ozone reduction in the lower stratosphere.