Visible and Near-Ultraviolet Spectroscopy at Thule AFB (76.5°N) from January 28-February 15, 1988

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Near-ultraviolet and visible spectrographs identical to those employed at McMurdo Station, Antarctica (77.8S) during the austral spring seasons of 1986 and 1987 were used to study the stratosphere above Thule, Greenland (76.5N) during early spring, 1988. Observations were carried out both at night using the direct moon as a light source, and during the day by collecting the scattered light from the zenith sky when solar zenith angles were less than about 94.5 degrees. Excellent meteorological conditions prevailed both in the troposphere and stratosphere during this observing program at Thule. Surface weather was extremely clear over most of the period, facilitating measurements of the direct light from the moon. The lower stratospheric arctic polar vortex was located very near Thule throughout the observing period, and temperatures at the 30 mbar level were typically below -80C above Thule, according to the National Meteorological Center daily analyses. Thus conditions were favorable for polar stratospheric cloud formation above Thule.

Total column ozone abundances were about 350-400 Dobson units, and did not suggest a clear temporal trend over the observing period. Stratospheric nitrogen dioxide measurements were complicated by the presence of a large component of tropospheric pollution on many occasions. Stratospheric nitrogen dioxide could be identified on most days using the absorption in the scattered light from the zenith sky, which greatly enhances the stratospheric airmass while suppressing the tropospheric contribution. These measurements suggest that the total vertical column abundance of nitrogen dioxide present over Thule in February was extremely low, sometimes as low as 3×10^{14} cm^{-2}. The abundance of nitrogen dioxide increased systematically from about 3×10^{14} in late January to 1.0×10^{15} cm^{-2} in mid-February, perhaps because of photolysis of N_2O_5 in the upper part of the stratosphere, near 25-35 km.

Spectra obtained using the moon as a light source on the nights of February 2 through February 7 have been analyzed for OClO. Preliminary results suggest a small but measurable vertical column abundance of OClO, around 3×10^{13} cm^{-2} on the night of February 3, for example. Measurements of OClO in Antarctica during late August, 1987 suggest a much larger value of about 2.3×10^{14} cm^{-2}, while photochemical model calculations employing purely

homogeneous chemistry (no heterogeneous polar stratospheric cloud chemistry) imply a nighttime OClO abundance of only about 5.0×10^{12} cm^{-2}. Thus the observed Antarctic abundances of OClO are about fifty times greater than model calculations neglecting heterogeneous chemistry, while the Thule measurements are about six times greater than such models. This limited series of measurements therefore suggests that significant enhancements of reactive chlorine radicals are present in the Arctic vortex, albeit to a much less extent than in the Antarctic. The possible implications of this suite of measurements for the depletion of Arctic ozone will be explored.