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Southern Hemispheric Nitrous Oxide measurements obtained during the 1987 Airborne Antarctic Ozone Experiment

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Nitrous Oxide (N2O) is a valuable tool for detecting air motions in the lower stratosphere. It is well mixed in the troposphere, and falls off with altitude in the stratosphere due to photolysis and reaction with O(1D). N2O vertical profiles have been measured over the last decade by aircraft and balloon instruments, and its global distribution is fairly well characterized. The chemical lifetime of N2O is about 150 years, which makes it an excellent dynamical tracer of air motion on the time scale of the ozone depletion event. For these reasons its was chosen to help test whether dynamical theories of ozone loss over Antarctica were plausible, particularly the theory that upwelling ozone-poor air from the troposhere was replacing ozone-rich stratospheric air.

The N2O measurements were made with the Airborne Tunable Laser Absorption Spectrometer (ATLAS) aboard the NASA ER-2 aircraft. The detection technique involves measuring the differential absorption of the IR laser radiation as it is rapidly scanned over an N2O absorption feature. Originally designed to measure CO, ATLAS was modified to measure N2O for this project. For the AAOE mission, the instrument was capable of making measurements with a 1 ppb sensitivity, 1 second response time, over an altitude range of 10 to 20 kilometers.

The AAOE mission consisted of a series of 12 flights from Punta Arenas (53S) into the polar vortex (approximately 72S) at which time a vertical profile from 65 to 45 km and back was performed. In addition a series of transit flights between 38N to 53S were made to get broader latitudinal coverage.

Comparison of the observed profiles inside the vortex with N2O profiles obtained by balloon flights during the austral summer showed that an overall subsidence had occurred during the winter of about 5-6km. Also, over the course of the mission (mid-August to late September), no trend in the N2O vertical profile, either upward or downward, was discernable, eliminating the possibility that upwelling was the cause of the observed ozone decrease. Throughout the mission, significant latitudinal gradients of N2O on isentropic surfaces were observed. These will prove useful in understanding the extent of lateral mixing air into and out of the vortex. An average N2O distribution for austral winter-spring will be presented.