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The Evolution of AAOE Observed Constituents with the Polar Vortex

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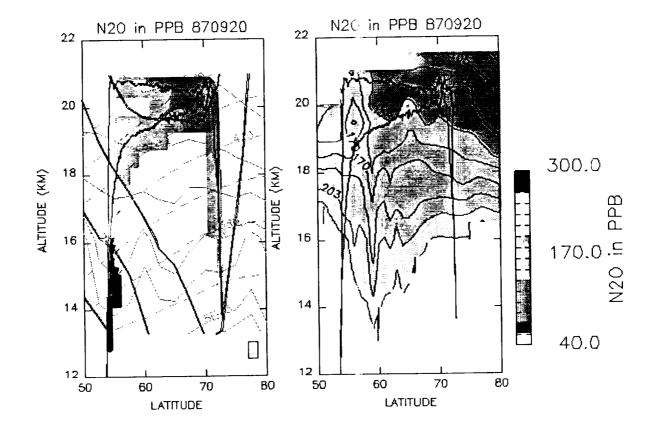J. Anderson[5], and

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One of the difficulties in determining constituent trends from the ER-2 flight data is the large amount of day to day variability generated by the motion of the polar vortex. To reduce this variability, the observations have been transformed into the conservative (Lagrangian) reference frames consisting of the coordinate pairs, potential temperature (PT) and potential vorticity (PV), or PT and N_2O. The requirement of only two independent coordinates rests on the assumption that constituent distributions and their chemical processes are nearly zonal in that coordinate system. Flight data is used everywhere for these transformation except for potential vorticity. Potential vorticity is determined from level flight segments, and NMC PV values during flight dives and takeoffs are combined with flight data in a smooth fashion.
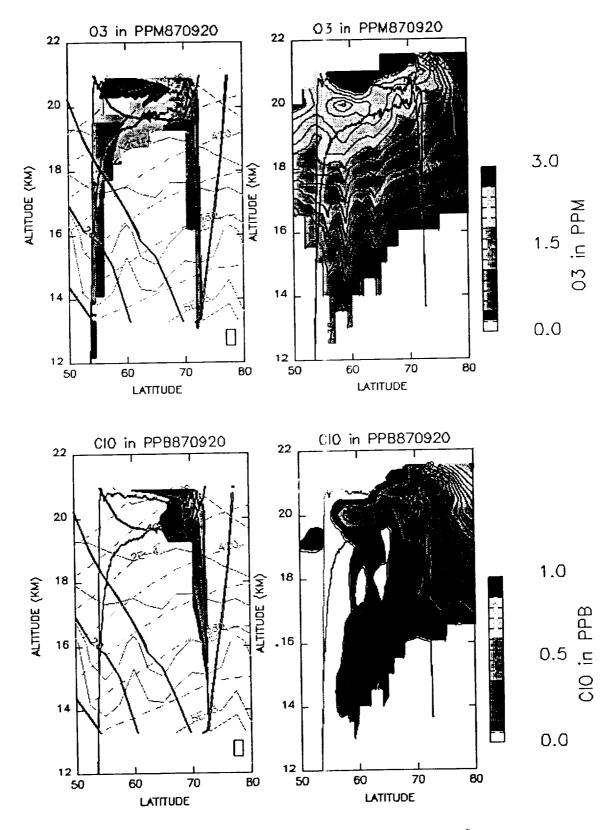
Once the data has been transformed into the conservative reference frames, least square linear fits are used to determine trends. Using the (PT, N_2O) transformation O_3 is shown to decrease on the 440K surface within the polar vortex at a rate of about .06 ppm/day over the mission period. Despite the general reduction in measurement variance this technique produces, a significant degree of variance is still present near the "ClO wall" due to the finite resolution of (PT, N_2O) coordinate transform processes.

Using the (PT, PV) transformations and all of the flight data composited together, constituent distributions over a substantial region can be estimated and then back transformed using the (PT, PV) distribution for any day as derived from global and/or flight meteorological fields. The result is a rather complete picture of the Austral polar vortex chemical structure and its evolution. Sample reconstructions are shown for ClO, O_3 and N_2O on 9/20/87 in the enclosed figure.

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Figure Caption

Reconstruction of the N_2O, ClO, and O_3 distributions using the (PT, PV) compositing method. The left hand figures show the constituent observations using a gray scale. The fluctuating solid line is the flight track. The faint dashed lines show the NMC potential temperature at $65^{\circ}W$ for the day, and the faint solid lines are isopleths of potential vorticity computed from NMC. The heavy solid lines show NMC zonal winds. The right hand figure shows the reconstructed fields using both flight and NMC potential vorticity and flight winds. The reconstructions use all the data from 12 flights. Agreement with the observations is good, but sharper features (e.g. the ClO wall) are washed out to some extent. Reconstructions have been performed for each flight day and the day after the last flight, 9/23/88.

O3 in PPM870920

O3 in PPM870920

ClO in PPB870920

ClO in PPB870920

O3 in PPM

3.0

1.5

0.0

ClO in PPB

1.0

0.5

0.0