Distinction Between Vortex and Midlatitude Air Masses From Tracer-Tracer Correlations, and Lower Stratospheric Halogen Burdens from SOLVE

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In the winter and spring of 2000, the SAGE-III Ozone Loss and Validation Experiment (SOLVE) from Kiruna, Sweden, provided updated information on the trace gas mixing ratios in the midlatitude lower stratosphere and the Arctic vortex. In the vortex, mixing ratios of some chlorofluorocarbons and chlorinated solvents approached zero at altitudes of 16-20 km because of the large-scale descent of the air. Correlations between the mixing ratios of trace gases indicate that there are established relationships between tracers inside the vortex that are significantly different from canonical midlatitude relationships. A simple modeling experiment indicates that in the mature vortex at a given potential temperature level, only 15-25% of the air was at that level originally. Over 75% of the air has descended from higher altitude.

Lack of evidence of anomalous mixing between the midlatitude and vortex air suggests a high degree of isolation of the vortex that allowed unique vortex tracer relationships to be established.

Mean ages of the air parcels were calculated for SOLVE using the ACATS-IV measurements of SF_6 (sulfur hexafluoride). Mean ages over 6 and up to 7 years during spring of 2000 may be attributable to the descent of SF_6-depleted air in the vortex from the mesosphere where a sink of SF_6 possibly exists. Using calculated mean ages and global trends of trace gases from the CMDL ground-based network, present-day stratospheric total Cl is estimated at 3.3-3.6 ppb and is decreasing, and total Br is 18.2-19.7 ppt and is increasing. In air masses older than 3.75 years, 75% of the Br in the stratosphere is present in the inorganic forms, while it takes 5 years for 75% of Cl to be converted from organic into inorganic forms. The comparison of current total Cl with that from 1992-1997 indicates that there is a time lag between the decrease of Cl in the troposphere and its decrease in the stratosphere.