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Stratospheric ozone chemistry at very low ozone concentrations in the Antarctic

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Observations of ozone sondes in the Antarctic have shown mixing ratios decrease from several ppmv to close to the detection limit of a few ppbv in the ozone hole period. Plotted on a logarithmic scale, the range of ozone observations is similar from year to year. By the end of September the minimum ozone mixing ratio decreases to values close to the detection limit of the ozone sondes in nearly all years. Later, in the months of October and November, an increase of the minimum ozone values is also observed. For all times, also observations above the lower envelope of the range of ozone observations are frequently found.

Until now, it is not well understood under which conditions catalytic ozone loss stops in the range of ozone mixing ratios of a few to about 100 ppbv. It is also unclear, whether in-situ ozone production or mixing with ozone richer air masses dominates the later increase of the lower envelope.

Using the Chemical Lagrangian Model of the Stratosphere (CLaMS) we examine in detail both the circumstances under which catalytic ozone depletion stops at low ozone mixing ratios and the reasons for the later ozone increase. We use both box-trajectory model simulations for selected air parcels and a hemispheric CTM simulation.

A very rapid and complete deactivation of active chlorine compounds into HCl is triggered by the low ozone mixing ratios, even in the presence of PSCs. The timing of this deactivation and the minimum ozone mixing ratio reached depend very sensitively on factors like the temperature history or the ozone initialization. Therefore it is nearly impossible to exactly predict time and mixing ratio of the ozone minimum for a single air mass. The increase of the lower ozone mixing ratios in October may be explained by in-situ ozone production while in November mixing is most likely involved.