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Development of tracer relations and chemical ozone loss during the setup phase of the polar vortex

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This study investigates the setup phase of the polar vortex. The development of tracer-tracer relations is analyzed at high Southern latitudes during March to June for the winters 1997 and 2003 using ILAS and ILAS-II satellite observations. Chemical changes of ozone, NO_2 and HNO_3 are investigated for the period between March and the first part of April in Antarctica. During late March and April in both winters significant chemical ozone loss occurred between 500 and 650 K. Similar as for the Antarctic winters, Arctic ozone loss was found already during October 2003. Tracer-tracer relations and meteorological analyses indicate consistently a separation of the incipient polar vortex into two parts. The area inside of the edge of the inner vortex is isolated to a certain degree from the outer part that is still influenced by mixing processes. During June, the tracer-tracer correlations within the vortex become uniform through mixing as the internal vortex transport barrier disappears and no further ozone loss occurs because of the lack of sunlight. Box model simulations indicate that ozone loss in the core of the incipient vortex is mainly caused by catalytic cycles involving NO_x. The simulations also explain the conversion from NO_x to HNO_3 during the setup phase of the vortex. However, a possible discrepancy between observed and simulated ozone loss at 530-570 K potential temperature exists that indicates possible deficits in the understanding of polar ozone chemistry in autumn under low sun conditions.