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Halogen- versus NOx-induced ozone loss in the Arctic stratosphere during the 2002-03 winter and spring

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The NOx-induced ozone loss driven by the so-called summertime NOx chemistry is a well-known photolytical mechanism mainly occurring in the middle and upper stratosphere over polar regions in spring and summer. By transporting ozone with the Chemical Lagrangian Model of the Stratosphere (CLaMS) as a passive tracer, the chemical ozone loss from November 17, 2002 to June 15, 2003 is deduced as the difference between the observed (HALOE, POAM, MIPAS) and simulated ozone profiles. The mean ozone loss that was calculated polewards of 70^0N equivalent latitude and in the potential temperature range 350 to 1400 K shows two characteristic branches which can be attributed to the halogen- and NOx-induced ozone loss. The halogen-induced ozone loss starts mid of December 2002 around 600 K, descents down to 450 K in April and correlates rather well with the occurrence of PSCs. The NOx-related branch starts above 1200 K, descents down to 650 K with an increasing magnitude and highest values of ozone loss of ≈4 ppmv around end of May. Using the IMK-IAA-MIPAS observations, we estimate that the air masses within this branch contain more than 10 ppbv NOy. Whereas until begin of March, the column ozone loss is dominated by the halogen chemistry within the vortex, a significant part of the column loss in March and April can be attributed to NOx chemistry at the top of the decaying and strongly mixed vortex. From the end of April, the contribution of the NOx-branch outweighs the ozone loss in high latitudes. The comparison with the Arctic winter/spring period 1999-2000 and with the evolution of the Antarctic vortex after the major warming in 2002 shows that the NOx-induced ozone loss may be significantly accelerated by major warmings when extra-vortex, ozone-rich air masses are transported polewards and mixed with the vortex air.