

Changes in the composition of the upper stratosphere – lower mesosphere at northern high latitudes after a sudden stratospheric warming

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The sudden stratospheric warming (SSW) of January 2009 induced important changes in the chemistry of the upper stratosphere at northern high latitudes. Data from Michelson Interferometer for Passive Atmospheric Sounding (MIPAS) aboard ENVISAT and the Microwave Limb Sounder (MLS) on Aura show record high values of O₃ and ClO and low values of temperature and HCl for the winters of 2005-2012, and a simultaneous enhancement of ClONO₂, in February 2009. The low temperatures favor a more effective ozone production and a greater O₃/O ratio and cause ClO_x to be repartitioned towards ClO. Increases of ClO lead to high ClONO₂ concentrations at high latitudes, where its photodissociation rate is smaller. The altitude and the magnitude of this layer of high ClONO₂ are comparable to those for the ClONO₂ enhancement which occurred after the solar proton event of October–November 2003.

Temperature and O₃ in the polar vortex result to be anti-correlated for long time scales (i.e. months) while the vortex dynamics tends to hide this relationship for shorter time scales. The ingress of air rich in CH₄ and a small reduction of the sum of VMRs of ClONO₂+ClO+HCl characterized the period between the SSW occurrence and early February 2009 when a horizontal air mixing between polar and mid-latitude air occurred. On the other hand, the sum of VMRs is roughly constant and similar to the usual year-to-year variability during the remaining days of February and in March.

The investigated altitudes are not influenced by the descent of mesospheric air rich in NO_x which develops after the SSW. Some limited enhancements in NO_x are detectable at very high latitudes after 20 February but they did not substantially influence O₃ and ClONO₂ in February. Overall, because of the dominant nighttime conditions, the influence from the catalytic cycles on the O₃ variation was limited in February while they are important in explaining the O₃ depletion in middle March.

References

Damiani A., Funke B., López-Puertas M., Gardini A., von Clarmann T., Froidevaux L., Santee M.L., R.R. Cordero, Impact of the sudden stratospheric warming in February 2009 on the composition of the northern polar upper stratosphere, *Journal of Geophysical Research*, DOI: 10.1002/2014JD021698, 2014.