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Chlorine de-/activation during the Arctic winter 2015/16 POLSTRACC campaign observed with GLORIA

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While the chlorine deactivation into chlorine nitrate ($ClONO_2$) in the Antarctic stratosphere is hindered due to the strong denitrification, the Arctic is characterized by a fast springtime increase of $ClONO_2$ due to the availability of NO_y. Due to climate change, it is expected that temperatures will decrease in the polar lower stratosphere. Thus, conditions for formation of polar stratospheric clouds (PSCs) and activation of ozone depleting substances are expected to occur more frequently and extend to lower altitudes in the Arctic. Furthermore, the budget of reactive NO_y, as a prerequisite for fast chlorine deactivation into $ClONO_2$, is modified and may influence the extent of ozone depletion. It is important to study chlorine deactivation in a changing Arctic stratosphere with observations and simulations.

The Arctic winter 2015/16 was characterized by possibly record-breaking low stratospheric temperatures in December and January, resulting in strong chlorine activation and denitrification of the polar vortex air down to lowest stratospheric altitudes. In this unusual situation, the POLSTRACC (Polar Stratosphere in a Changing Climate) aircraft mission took place from Oberpfaffenhofen (Germany) and Kiruna (northern Sweden) to investigate chemical and dynamical processes in the lower part of the stratospheric vortex during an entire Arctic winter.

Measurements from the Gimballed Limb Observer for Radiance Imaging of the Atmosphere (GLORIA) in high spectral resolution provide two-dimensional trace gas distributions of the critical trace gases $ClONO_2$, nitric acid and ozone during 15 scientific flights, with vertical resolutions as high as ∼400-1000 m. These spatial resolutions are significantly higher than comparable satellite data products in the Arctic Upper Troposphere Lower Stratosphere (UTLS) region. The GLORIA data show extensive chlorine deactivation into $ClONO_2$ and renitrification down to lowest stratospheric levels. The observations are validated at flight altitude with in-situ measurements. Using time series of Aura/MLS (Microwave Limb Sounder) and ACE-FTS (Atmospheric Chemistry Experiment Fourier Transform Spectrometer) observations, the GLORIA observations are brought into a broader context and are used to study lower stratospheric chlorine deactivation in the Arctic winter 2015/16. Furthermore, simulations by the chemistry transport model CLaMS (Chemical Lagrangian Model of the Stratosphere) are used together with the GLORIA data to study the influence of PSCs and denitrification to chlorine de-activation in this particular winter.