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In-situ observations from HALO during POLSTRACC: Redistribution of total reactive nitrogen in the lowermost stratosphere

Helmut Ziereis (1), Peter Hoor (2), Andreas Zahn (3), Jens-Uwe Grooß (4), Lamont Poole (5), Michael Pitts (6), Greta Stratmann (1), Paul Stock (1), Michael Lichtenstern (1), Tina Jurkat (1), Jens Krause (2), Björn-Martin Sinnhuber (3), and Hermann Oelhaf (3)

(1) Deutsches Zentrum für Luft- und Raumfahrt, Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany (helmut.ziereis@dlr.de), (2) Institute for Atmospheric Physics, University Mainz, Germany, (3) Institute of Meteorology and Climate research, Karlsruhe Institute of Technology, Karlsruhe, Germany, (4) Institute of Energy and Climate Research (IEK-7), Forschungszentrum Jülich, Jülich, Germany, (5) Science Systems and Applications, Incorporated, Hampton, Virginia, USA, (6) NASA Langley Research Center, USA

During winter 2015/2016 the lowermost stratosphere of the Arctic region was characterized by very low temperatures in connection with the occurrence of extensive polar stratospheric clouds.
From beginning of December 2015 until late March 2016 the German research aircraft HALO (High Altitude and Long Range Research Aircraft) was deployed to probe the lowermost stratosphere in the Arctic region within the POLSTRACC mission (Polar Stratosphere in a Changing Climate).More than twenty flights have been conducted out of Kiruna/Sweden and Oberpfaffenhofen/Germany during this time period covering different states of winter.
In-situ observations of total reactive nitrogen, nitrous oxide and ozone from board of HALO were used to study the redistribution of nitric acid, the main component of total reactive nitrogen in the stratosphere. Nitric acid and its partitioning between gas- and particle phase is a key parameter for processes controlling the ozone budget in the winter polar stratosphere.
During several flights, air masses with extensive denitrification and nitrification were observed at typical flight altitudes between 12 and 15 km. The degree of total reactive nitrogen redistribution was evaluated using tracer-tracer correlations. Up to several nmol/mol of total reactive nitrogen were found to be missing during some de-nitrification events in the lowermost stratosphere using the nitrous oxide correlation. On the other hand, sedimentation and subsequent evaporation of nitric acid containing particles led to a nitrification of the lowermost stratosphere. While nitrification events prevailed during the first phase of the POLSTRACC mission, de-nitrified air masses have been probed during the second phase between end of February and middle of March. Along with gas-phase nitrification during the first mission phase, indications for the extensive occurrence of nitric acid containing particles at flight altitude were found during several flights. The present data set is compared to the data obtained during earlier missions in the Arctic and with the results of model simulations.