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Analysis of Transport Regimes during Arctic Spring and Summer based on Airborne in-situ Measurements

Heiko Bozem (1), Daniel Kunkel (1), Oliver Eppers (1,2), Franziska Köllner (1,2), Hans-Christian Clemen (2), Johannes Schneider (2), and Peter Hoor (1)

(1) University Mainz, Institute for Atmospheric Physics, Mainz, Germany (bozemh@uni-mainz.de), (2) Particle Chemistry Department, Max Planck Institute for Chemistry, Mainz, Germany

The polar dome has long been recognized as a transport boundary for mid-latitude air travelling into the high Arctic lower troposphere. A measurement based identification of the polar dome is difficult due to the temporal and spatial variability and a lack of consistent measurements in the lower few kilometers of the Arctic. Particularly the climatological role of the polar dome as a transport boundary for pollution tracers has not yet been fully addressed on the basis of in-situ measurements.
We present aircraft based trace gas measurements in the European and Canadian Arctic with the Polar 6 aircraft of Alfred Wegener Institute Helmholtz Center for Polar and Marine Research (AWI) during six measurement campaigns in spring and summer since 2014 (NETCARE 2014/2015, RACEPAC 2014, PAMARCMiP 2017/2018, ACLOUD 2017). Based on CO and CO_2 measurements and lagrangian analysis tools we characterize the transport regimes of mid-latitude air masses traveling to the high Arctic during spring and summer. In particular, we determine the polar dome boundary using empirical trace gas gradients. We further relate temperature changes of air masses located within and outside the polar dome to diabatic and adiabatic processes that act on the respective air masses during travel. This allows for a more detailed analysis of those air masses that contribute to the observed trace gas composition within the polar dome area.
In spring air masses inside the polar dome experienced diabatic cooling mainly caused by low level transport over cold surfaces. In summer, weak diabatic heating due to insolation dominates the recent transport history of air masses inside the polar dome. Outside the polar dome region air masses in both seasons predominantly experience radiative cooling leading to a continuous descent into the Arctic lower troposphere. The uplift of those air masses to the middle and upper troposphere mostly occured in mid-latitude regions followed by northward motion.