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Understanding large scale transport: ICON-ART N_2O satellite data assimilation with an independent POLSTRACC validation

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The ICOsahedral Nonhydrostatic model with Aerosols and Reactive Trace gases (ICON-ART [1]) is a state-of-the-art modelling system that can be used across a wide variety of spatial and temporal scales, e.g. from weather to climate time scales. Here, we will focus on large scale descending motions in polar regions and how those are represented in a particular configuration of ICON-ART. We will focus on a case study during the NH winter of 2015/16. The anthropogenic greenhouse gas nitrous oxide (N_2O) is a long-lived species, with an approximate lifetime of 120 years. For composition studies, N_2O is a widely used tracer for the characterisation of transport processes. A succession of N_2O profiles was measured during the aircraft campaign POLSTRACC, in the Winter of 2015/2016. Due to the subsidence of (high latitude) air masses in the polar vortex, low N_2O concentrations have been observed.

We use this measurement as an independent validation to demonstrate the benefit of a new assimilation module for ICON-ART. The Parallel Data Assimilation Framework (PDAF) [2] has been included into the ICON-ART infrastructure. We use PDAF to assimilate satellite data (namely MLS) to demonstrate the interplay between different initialisations and model components, here chemistry and transport, and how modelled distributions of N_2O are affected. We use a tailor made setup to distinguish between the contributions of the different components. We assimilate the MLS satellite observations before and during the POLSTRACC campaign and compare the resulting N_2O model distributions with the POLSTRACC measurements. This allows us to characterise the modelled large-scale transport, including the air mass descend in the polar vortex. We discuss the importance of a well-defined initialisation (including an assimilation period prior to the campaign) and the benefit an independent validation with in-situ data.

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(2) Lars Nerger, Wolfgang Hiller: Software for ensemble-based data assimilation systems - Implementation strategies and scalability, Computers Geosciences, Volume 55, 2013