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Diagnostics for model error and error compensation in NWP parameterization schemes during an intense cold air outbreak

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Numerical weather prediction (NWP) models generally display comparatively low predictive skill in the Arctic. Particularly, the large impact of sub-grid scale, parameterised processes, such as surface fluxes, radiation or cloud microphysics on weather events pose a large challenge for numerical modelling. These processes are most influential during mesoscale weather events, such as polar lows, often embedded in cold air outbreaks (CAO), some of which cause high impact weather. Uncertainty in Arctic weather forecasts is thus critically dependent on parameterised processes. Furthermore, compensation of errors from different parameterizations limits model improvement.

Here we explore the potential to analyse model output of individual tendencies to investigate single contributions as well as error compensation during Arctic high-impact weather. Individual tendencies describe the contribution of each applied physical parameterization to a respective variable per model time step. Here, the focus is set on atmospheric temperature and humidity. We utilise AROME Arctic, the operational NWP model used by the Norwegian Meteorological Institute for the European Arctic to study a CAO-event taking place during 24 - 27 December 2015. Though being intense, reaching from the Fram Straight to Norway and affecting a particularly large portion of the Nordic seas at a time, this CAO-event is exemplary in its nature.

The individual tendencies enable detailed investigation into situation-dependent contributions of single schemes and act as tool to identify error compensation within the model. Additionally, we explore the use of the ratio between physical and dynamical tendencies as a new measure to pinpoint areas of high model uncertainty due to physical parameterizations.