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Diagnosing factors in parameterised and resolved convection with physical tendency output in AROME-Arctic during a Cold-Air Outbreak event

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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 during high-latitude weather events pose a substantial challenge for numerical modelling. Such 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. The strong influence from several parameterised processes also makes model forecasts particularly susceptible to compensation of errors from different parameterisations, which potentially limits model improvement.
Here we analyse model output of individual parameterised tendencies of wind, temperature and humidity during Arctic high-impact weather in AROME-Arctic, the operational NWP model used by the Norwegian Meteorological Institute Norway for the European Arctic. Individual tendencies describe the contribution of each applied physical parameterisation to a respective variable per model time step. We study a CAO-event taking place during 24 - 27 December 2015. This intense and widespread CAO event, reaching from the Fram Straight to Norway and affecting a particularly large portion of the Nordic seas at a time, was characterised by strong heat fluxes along the sea ice edge.
Model intern definitions for boundary layer type become apparent as a decisive factor in tendency contributions. Especially the interplay between the dual mass flux and the turbulence scheme is of essence here. Furthermore, sensitivity experiments, featuring a run without shallow convection and a run with a new statistical cloud scheme, show how a physically similar result is obtained by substantially different tendencies in the model.