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Potential of accumulated AROME-Arctic parameterisation tendency for stochastic parameterisation perturbation patterns

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Stochastic parameterisations are an important way to represent uncertainty in the deterministic forecasting models underlying ensemble prediction systems. In many of the currently used stochastic parameterisation approaches, random generators produce correlation patterns that induce spatially and temporally coherent perturbations to the parameterisation parameters or tendencies. The patterns that are currently used in the Harmonie ensemble prediction system are therefore unrelated to the atmospheric flow or weather situation. Here we investigate the potential of replacing such random patterns by accumulated tendency fields from parameterized physical processes in the model. The rationale hereby is that by perturbing the parameterisations with a field that reflects where parameterisations are most active, rather than a random pattern, the model obtains a more targeted increase in the degrees-of-freedom to represent forecasting uncertainty.

As an initial test case, we consider a large cold-air outbreak during 23-25 Dec 2015 that affected large parts of Scandinavia. During that time period, strong heat fluxes persisted near the ice edge, while widespread shallow convection dominated in the center of the model domain. For diagnosing the perturbation fields, we utilise an implementation of individual tendency diagnostics implemented in AROME-Arctic within the ALERTNESS project. Total physical tendencies for the horizontal wind components, for air temperature and humidity are accumulated with a time filtering throughout the 66 h forecast period.

The accumulated tendencies from all parameterisations for the different variables show overlapping and differing centers of activity. Wind parameterisations are active near the ice edge, and with smaller scale variability over land areas, in particular at lower model levels. Temperature tendency patterns show activity that is more confined to the ice edge, and a narrow coastal stripe along Northern Scandinavia. These first results show that the approach provides spatially coherent patterns of parameterisation activity, which are meaningfully related to the dominating weather situation. Based on sensitivity tests of cloud parameterisation parameters in a single-column version, we outline the next steps in the path towards diagnostic perturbation patterns for stochastically perturbed perturbations in the Harmonie EPS system.