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Radiation fog modelling: Unravelling physics sensitivity in a process diagram approach.

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Fog forecasting is a challenging task for numerical models, since many physical processes are involved, i.e. radiation, turbulence, microphysics and coupling to the land surface. This means that multiple parameterization schemes are involved. We address the question which parameterization scheme is most critical to the model skill in different parts of the fog life cycle.

The 1D WRF model is evaluated for a radiation fog event at the Cabauw tower (the Netherlands) for multiple combination of physics parameterizations. Next, we aim to explain model variation is explained by a process diagram approach (Sterk et al 2013) by varying the process strength in each of the parameterization schemes in a reference run.

We evaluate the 1D WRF model for a diurnal cycle of the radiation fog at the Cabauw research tower (the Netherlands). We focus on the timing of the fog onset and dissipation, as well as liquid water content and fog vertical extent. To mimic a model intercomparison, multiple combinations of parameterization schemes for turbulence, longwave radiation, microphysics and land-surface coupling are permutated. Since the formulation of physics parameterizations is known to be subject to uncertainties, the ensemble of model intercomparison results is subsequently studied in order to unravel whether the model spread is dominated along one or more of the four physical processes. This is achieved by defining a reference model setup, in which the process strength of each of the processes is varied by a factor 2 and 4 to represent the parameterization uncertainty. Results are plotted in a so-called diagram. The resulting spread due to varying parameterization strength is compared to the model ensemble spread and observations to study physical consistency.

The 1D WRF model is able to represent the selected fog case study. It appears the model most sensitive to the selected boundary layer scheme for the fog onset, while the model results for the fog dissipation are most sensitive to the microphysics scheme. The strongest model sensitivity is found for mixing strength and land-surface coupling. The 1D WRF model is able to forecast the selected fog case at Cabauw, and the processes diagram approach is a suitable method to study model sensitivity.