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Assimilation of Visible and Near-Infrared Observations in KENDA-COSMO

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Satellite cloud observations contain crucial information about convective activity and are therefore seen as important input parameters for convective scale data assimilation (DA). In current operational DA systems however, only thermal infrared and microwave radiance observations are assimilated and their use is often limited to clear-sky conditions, whereas visible and near-infrared radiances (which mainly deliver cloud information) are neglected due to the lack of suitable forward operators.

To address this shortcoming, a 1D forward operator for visible and near-infrared radiance observations from MSG-SEVIRI is currently developed in the framework of the Data Assimilation Branch of the Hans-Ertel-Centre for Weather Research at LMU München. A first version of the operator that is reasonably fast to perform assimilation studies has been completed and implemented in the pre-operational KM-scale Ensemble Data Assimilation (KENDA) system of DWD. The operator simulates synthetic satellite images from COSMO-DE model output based on the discrete ordinate method to solve the radiative transfer equation.

To assess the operator accuracy, the 1D simulations have been compared to 3D Monte Carlo simulations. After including a suitable parallax correction to account for the slant satellite viewing angle, the difference between 3D and 1D results from 06 to 15 UTC in summer are typically less than 6% and the systematic difference is less than 1%. This is seen to be sufficiently accurate to assimilate such observations. For larger solar zenith angles, e.g. at 18 UTC, the difference becomes larger.

Based on this development, assimilation studies with the regional KENDA-COSMO system are conducted to assess the impact of such visible SEVIRI satellite observations, in particular with respect to clouds. First results show that the assimilation of these observations successfully modifies the cloud water content in the analysis. Besides the direct assimilation, such an operator is potentially also valuable to identify and address shortcomings of the model microphysics that lead to systematic errors in the representation of clouds in the model.