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Optimizing cloud cover prediction by the Ensemble for Stochastic Integration of Atmospheric Simulations (ESIAS)

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ESIAS is an atmospheric modeling system including the ensemble version of the Weather Forecasting and Research Model (WRF V3.7.1) and the ensemble version of the EURopean Air pollution Dispersion-Inverse Model (EURAD-IM), the latter uses the output of the WRF model to calculate, amongst others, the transportation of aerosols. To capture extreme weather events causing the uncertainty in the solar radiation and wind speed for the renewable energy industry, we employ ESIAS by using stochastic schemes, such as Stochastically Perturbed Parameterization Tendency (SPPT) and Stochastic Kinetic Energy Backscatter (SKEBS) schemes, to generate the random fields for ensembles of up to 4096 members.

Our first goal is to produce 48 hourly weather predictions for the European domain with a 20 KM horizontal resolution to capture extreme weather events affecting wind, solar radiation, and cloud cover forecasts. We use the ensemble capability of ESIAS to optimize the physics configuration of WRF to have a more precise weather prediction. A total of 672 ensemble members are generated to study the effect of different microphysical schemes, cumulus schemes, and planetary boundary layer parameterization schemes. We examine our simulation outputs with 288 simulation hours in 2015 using model input from the Global Ensemble Forecast System (GEFS). Our results are validated by the cloud cover data from EUMETSAT CMSAF. Besides the precision of weather forecasting, we also determine the greatest spread by generating total 768 ensemble members: 16 stochastic members for each different configurations of physical parameterizations (48 combinations). The optimization of WRF will help for improving the air quality prediction by EURAD-IM, which will be demonstrated on a test case basis.

Our results show that for the performed analysis the Community Atmosphere Model (CAM) 5.1, WRF Single-Moment 6-class scheme (WSM6), and the Goddard microphysics outstand the other 11 microphysics parameterizations, where the highest daily average matching rate is 64.2%. The Mellor–Yamada Nakanishi Niino (MYNN) 2 and MYNN3 schemes give better results compared to the other 8 planetary boundary layer schemes, and Grell 3D (Grell-3) works generally well with the above mentioned physical schemes. Overall, the combination of Goddard and MYNN3 produces the greatest spread comparing to the lowest spread (Morrison 2-moment & GFS) by 40%.