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Sensitivity of near surface forecasts to the WRF initialization versus domain configuration

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Mesoscale models are used in numerical weather prediction (NWP) to detail weather forecasts produced by global-scale models. Initial and boundary conditions from the global-scale models are used by the regional-scale models to produce higher resolution weather forecasts. Usually, the process requires an adjustment warming period of the mesoscale model, which can be dealt with by neglecting the early hours of simulations. If the global-scale forecasts are timely available it will be useful to have initialization methodologies which reduce the warming period of the mesoscale model. Here we explore three possible initialization schemes.
Several experiments with the WRF-ARW v3.4.1 model driven by 0.5ºx0.5º GFS forecasts were performed. In the experiments, two WRF domain configurations were applied to Portugal Mainland, both consisting in a parent domain with 25 km horizontal resolutions and a nested domain with 5 km resolution. One of the configurations has a larger parent domain but maintaining the same nested domain.
The WRF was initialized using three different methodologies: (1) the model is initialized using the initial and boundary conditions from the most recent GFS forecast, performing a cold start; (2) the model is restarted using the most recent state produced by a continuous WRF simulation which is forced by all previous GFS analysis and 3-hour forecasts, including the most recent analysis, with Newtonian relaxation; (3) the model is initialized with the previous 6 hours GFS analysis, the lateral boundary conditions are given by the previous 3-hour GFS forecast, the most recent available GFS analysis and the corresponding forecast. The main difference between methods (2) and (3) is that in (2) the model is restarted from a previous continuous WRF run in which the analyses and 3-hour forecast were assimilated through grid-nudging whereas in method (3) the model starts from a cold initialization from a previous GFS analysis, using the most recent GFS analysis only as BLC, without grid-nudging.
Experimental tests were conducted for 15 days in August and December 2010. The skill of the three forecast's methods was assessed by comparing the 10 m wind and 2 m temperature forecast fields with observations from a network of weather stations.
The influence of domain configuration (size) was assessed by comparing the simulations in the nested domain forced by two parent domains of different sizes. Results show that after the early hours of simulation the error is little sensitive to the initial conditions. The magnitude of the error is comparable with the uncertainty resulting from the choice of the parent domain, suggesting that after the early hours of simulation the weather forecasts by mesoscale models are essentially a boundary problem.