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# Optimizing WRF for Realistic Large Eddy Simulations

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Land-Atmosphere coupling depends both on very small scale processes like turbulence ranging at the lower end of the spectra on a spatial scale of millimetres up to very large processes determining the synoptic weather situation like Rossby-Waves on a scale of several hundred kilometres. Numerical Models covering both ends of the range of processes require both a large domain and a fine spatiotemporal resolution, increasing the necessary computation time massively. A solution is the nesting of several domains inside each other. The Weather Research and Forercast (WRF) model can be operated over a large range of scales. Therefore it gives the opportunity to perform Large-Eddy-Simulations (LES) at a spatial resolution of 100 m and finer, where the turbulent flow inside the Planetary Boundary Layer (PBL) is partly resolved, nested inside larger scale domains, which are able to cover the synoptic situation. Thus it is possible to execute LES runs under realistic weather situations with WRF. Furthermore, a finer resolution gives the opportunity to make use of fine scale land use, orographic and soil maps. Such simulations promise to give new insights into the behaviour of Land-Atmosphere coupling.
Nevertheless, nesting over a range of scales comes along with some challenges. First of all, nesting constrains determine that at least one of the domains must lie in the so called grey zone between spatial resolutions of 1000 m to 100 m, where it is unclear, if a PBL parametrisation is still necessary. Related to that problem is the question at which resolution it is reasonable to perform WRF in LES-Mode for a particular PBL flow. Additionally, at fine resolutions it becomes necessary to account for the lateral flow of water on the land surface and in the ground. Another point are the boundary conditions for the nested domains. They should be as close as possible to the real weather situations, what brings Data Assimilation (DA) in the outermost domain into play. Most DA techniques used today for Numerical Weather Prediction are still intermittent. Thus it is not clear if the update of the boundary conditions according to observations is improving the simulation in the nested domains, or if smooth boundary conditions are favourable.
Different set ups of a chain of nested WRF domains at a resolution starting at 2500 m over 500 m, 100 m down to 20 m have been tested for the impact of different PBL schemes in the 2500 m and 500 m domain and the usage of a 3DVAR Rapid Update Cycle in the 2500 m domain. Furthermore, an online calculation method for turbulent fluxes and moments up to the fourth moment has been implemented in WRF. HYDRO was used in some of the realisations to account for lateral fluxes of water on the land surface. The model has been tested with respect to the boundary layer flow characteristics and the Land-Atmosphere coupling.