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High resolution topography and land cover databases for wind resource assessment using mesoscale models

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In wind resource assessment, mesoscale models can provide wind flow characteristics without the use of mast measurements. In complex terrain, local orography and land cover data assimilation are essential parameters to accurately simulate the wind flow pattern within the atmospheric boundary layer. State-of-the-art Mesoscale Models such as RAMS usually provides orography and landuse data with of resolution of 30s (about 1km). This resolution is necessary for solving mesocale phenomena accurately but not sufficient when the aim is to quantitatively estimate the wind flow characteristics passing over sharp hills or ridges. Furthermore, the abrupt change in land cover characterization is nor always taken into account in the model with a low resolution land use database. When land cover characteristics changes dramatically, parameters such as roughness, albedo or soil moisture that can highly influence the Atmospheric Boundary Layer meteorological characteristics. Therefore they require to be accurately assimilated into the model.

Since few years, high resolution databases derived from satellite imagery (Modis, SRTM, LandSat, SPOT) are available online. Being converted to RAMS requirements inputs, an evaluation of the model requires to be achieved. For this purpose, three new high resolution land cover and two topographical databases are implemented and tested in RAMS. The analysis of terrain variability is performed using basis functions of space frequency and amplitude. Practically, one and two dimension Fast Fourier Transform is applied to terrain height to reveal the main characteristics of local orography according to the obtained wave spectrum. By this way, a comparison between different topographic data sets is performed, based on the terrain power spectrum entailed in the terrain height input. Furthermore, this analysis is a powerful tool in the determination of the proper horizontal grid resolution required to resolve most of the energy containing spectrum.

Following, the implementation of all databases, a high resolution simulation is performed over the complex terrain area of Northern Spain. The results are compared with meteorological station in the Navarra region and tall masts available on site. Using two way nesting techniques, the model is simultaneously resolving the synoptic forcing over Spanish Peninsula, mesoscale features over Navarra Region and microscale flow pattern passing around the Alaiz Mountain. To do so, multiple grids nests are set up in which the resolution varies gradually from the order of 10km to 100m. The time step decreases from twenty seconds to tens of milliseconds according to the Courant Friedrichs Lewy condition. The model that features Message Passing Interface is run using 64 cores. For high resolution grids (less than 500m), local convection is resolved using Large eddy simulation (LES) turbulent closure schemes. The LES technique provides a more detailed characterization of microscale turbulent flows using the complete Reynolds stress tensor for the sub filter scale parameterization.