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The causes of spread in a WRF multi-physics ensemble for wind energy applications

Tija Sile (1), Andrea Hahmann (2), Martin Dörenkämper (3), Yasemin Ezber (4), Elena Garcia-Bustamante (5), Fidel Gonzalez-Rouco (6), Jorge Navarro (5), and Björn Witha (7)

(1) University of Latvia, Department of Physics Riga, Latvia (tija.sile@lu.lv), (2) DTU, Wind Energy Department, Denmark,, (3) Fraunhofer IWES, Germany, (4) Istanbul Technical University, Turkey, (5) Renewable Energy Division, CIEMAT, Spain, (6) Dpto. Física de la Tierra y Astrofísica, IGEO (UCM-CSIC), UCM, Spain, (7) ForWind, Oldenburg University, Germany

In the framework of the New European Wind Atlas (NEWA) project, a wind climate ensemble dataset was created based on different configurations of the Weather Research and Forecast (WRF) model. For two regions in Europe (one covering Denmark, parts of Germany and the Netherlands, the other one covering Greece) a more thorough investigation was carried out with an ensemble consisting of 20 members, while a reduced ensemble for the rest of Europe was created. The base WRF setup used ERA-5 as boundary and initial conditions and weekly initialization with spectral nudging. One full year of calculations was made. Although many options such as different boundary condition sources were explored, the larger spread was found to be created by using different Planetary Boundary Layer (PBL) and Surface Layer (SL) schemes or Land Surface Models (LSM).
Parameters relevant for wind energy, such as wind speed and direction at 100 m height, together with atmospheric stability are analyzed. The methodology is based on comparing the whole distribution of the parameters of interest in each grid-point between two ensemble members using the Earth Mover's Distance (EMD) metric.
Preliminary analysis indicate that there are regions where the spread is significantly larger than in average. The goal of this study is to investigate the physical mechanisms that are represented differently in different PBL/SL schemes and therefore lead to ensemble spread.
One such example is the interaction between large scale flow and orography in coastal regions of the Mediterranean Sea that show large spread in both wind speed and direction.
However, it is interesting to note that large spread in one of the parameters analyzed is not necessarily associated with large spread in other parameters.

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