HPC challenges of running large ensemble simulations in a Tier-0 machine to model atmospheric desert dust

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In this contribution, we will present the work done towards the production of a desert dust reanalysis over the domain of Northern Africa, the Middle East, and Europe at an unprecedented high spatial resolution and using computational resources granted by PRACE HPC access.

Over the last decade, there has been a growing recognition of the crucial role of sand and dust storms on weather, climate, and ecosystems, along with their substantial adverse impacts upon life, health, property, economy, and other strategic sectors. Understanding desert dust impacts requires fundamental and cross-disciplinary knowledge underpinned by state-of-the-art scientific research, the availability of reliable information on past trends and current conditions. A major obstacle to reconstructing comprehensive dust information of the past is **the scarcity of historical and routine in-situ dust observations, particularly in the countries most affected by desert dust**. Model simulations can be used to “fill in the blanks” and overcome the sparse coverage, low temporal resolution, and partial information provided by measurements. By objectively combining model simulations with satellite observations, the present work aims to produce an advanced and thoroughly evaluated high-resolution dust regional reanalysis using the Multiscale Online Non-hydrostatic AtmospheRe CHemistry model (MONARCH) coupled to a Local Ensemble Transform Kalman Filter (LETKF) data assimilation scheme [1] developed at the Barcelona Supercomputing Center (BSC), and assimilating satellite observations of dust optical depth from MODIS Deep Blue retrievals at 10 km resolution [2].

The simulations were performed on 1-day chunks, composed of a forecast step (12 ensemble member of MONARCH forward simulations), a state estimation step (LETKF data assimilation), and two post-processing steps needed to compress the original model output and to calculate ensemble statistics. The submission of the jobs was automatically handled by Autosubmit, a python-based workflow manager that allows creating, managing, and monitoring experiments remotely [3]. Autosubmit put all these steps together in a unique wrapper and allowed us to process 30 consecutive days with a single job submission requiring 10320 cores for ~24 hours. Different experiments were created, each of them performing a 2-month spinup and 1-year reanalysis. The web app Autosubmit GUI was used to easily monitor the experiments.

With the selected configuration, we produced 10 years (2007-2016) of 3-hourly output, which means more than 500T of data currently being evaluated with various observations from ground-based and satellite observations.

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