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Testing the data assimilation technique for short-term wind forecast in the PBL: a case study

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In this contribution we show the results of using a data assimilation technique to improve the short-term wind forecast at a site in northern Europe. The assimilation technique is a simple four-dimensional nudging and, for this purpose, we set-up a version of the Regional Atmospheric Modelling System.

The nudging technique consists of adding an extra-tendency term, to the prognostic equations of the zonal and meridional wind components, which forces the variable toward the observations.

$$\frac{\partial \varphi_m}{\partial t} = \frac{(\varphi_{obs} - \varphi_m)}{\tau} f(r) \quad (1)$$

where $\varphi_m$is model variable (zonal or meridional wind component), φ_{obs} is the observation, τ is relaxation time scale (900 s), $f(r)$ is a Gaussian function $f(r) = e_0^{-(r/r)\wedge 2}$, and r_0=*50 km.*

The method was applied in Denmark where suitable observations were available at the Danish National Test Station for Large Wind Turbines, located at Høvsøre (Western Jutland, Denmark), and refer to the measurements of vertical wind profiles; the instrument is the WINDCUBE™ Doppler LIDAR. Data were available every 10 minutes at the following levels: 40 m, 60 m, 80 m, 100 m, 116 m, 130 m, 160 m, 200 m, 250 m and 300 m. The data represent the average of the measurement for the previous 10 minutes. Only data available at the 00 minutes of each hour were considered in this study.

The RAMS model is set-up with four nested grids. The fourth grid has 1 km horizontal resolution and is centred over the site. Model levels do not coincide with the measurement levels, and, to assimilate and to verify the forecast, the observations were linearly interpolated to the model levels. The physical configuration of the model is the one adopted for operational forecast over the Calabria Region in South Italy.

In order to show the potential impact of the nudging technique, we run the model in two different configurations: (a) a simple forecast and (b) an analysis-forecast run. The runs duration is twenty-four hours for both configurations. For each configuration, simulations were performed for a one-month period from 21 April 2010 to 20 May 2010 (one simulation per day, starting at 12 UTC).

In the simple forecast, RAMS uses the ECMWF (European Centre For Medium Weather Range Forecast) gridded analysis and forecast data as initial and dynamic boundary conditions available every 6 hours at 0.25 degrees horizontal resolution.

In the analysis-forecast run, in addition to the ECMWF initial and boundary conditions, measurements at three-hour time interval are nudged into the model for the first 12 h of simulation. For the second half of the period, the model is driven only by the ECMWF forecast, as for the simple forecast run.

To compare the simple forecast and the analysis-forecast runs, we computed the Mean Absolute Error (MAE) and the Root Means Square Error (RMSE) for one, three, and six hours following the end of the nudging time, i.e. after the first 12 h of simulation.

The method was verified we used hourly values at the 00 minutes. So, for each day, one, three, and six model-observation pairs are available for the one, three, and six hours forecast verification.

In this work, we show the results of those statistics. There are days in which the forecast is improved by the nudging technique and days in which the nudging technique does not improve or even worsen the forecast. Work is in progress to characterise each day in terms of synoptical versus local situation in order to associate errors at each run at all heights. Further, we aim to repeat the analyses for very-short term forecasts (up to 1 h).