Abstract

In the present work, a short-term wind power forecasting system, namely PROGNOSIS is presented and evaluated. The two main components of the system are: i) a COAMPS model and ii) a Numerical Weather Prediction (NWP) model for atmospheric parameter forecasts which provides the basic input for wind power forecasts. The COAMPS model is applied in the Coupled Ocean/Atmosphere Meso-scale Prediction System (COAMPS) developed at the US Naval Research Laboratory. COAMPS runs operationally on a daily basis at InFlow ensuring an independence from external meteorological services. Systematic application of the model since the end of 2005 together with wind predictions from operational weather forecast models used by National Weather Service Organizations and wind measurements from meteorological masts resulted in a wind database development continuously updated and enriched. To evaluate the system, mesoscale time series from the NWP database are extracted and directly compared with wind mast data from four sites in Greece where measurements are available. Next, reproduced wind roses from mesoscale forecasts are evaluated against the mast data. The results seem very promising regarding the procedure verification and encouraging conclusions are drawn.

Objectives

Completed research efforts over complex terrain applications are still at a premature stage and very few completed operational forecasting tools are in operation. Development and improvement of the forecasting systems in countries of already high levels of wind power penetration like US, Denmark, Germany and Spain. Consequently, completed research efforts over complex terrain applications (as in Greece) are still at a premature stage and very few completed operational forecasting tools are in operation.

The forecasting system PROGNOSIS has been developed by InFlow as the outcome of a research project [5] funded by the Greek Secretariat for Research and Technology (GSRT) and the EU.

- Comprises physics-based models in combination with specific statistical techniques
- The first such system at a National level and the only physics-based system
- Fully operated by Greek parties
- It has been assessed thoroughly and corresponding research efforts have been undertaken

The nationwide assessment of NWP model which constitutes the basic input for wind power forecasts leads to the integration of this operational short-term forecasting tool for wind farm power production in complex terrain areas (as in Greece) to be used for efficient integration of wind energy production into the overall power supply system.

Method

The NWP model applied is the Coupled Ocean/Atmosphere Meso-scale Prediction System (COAMPS) developed at the US Naval Research Laboratory. COAMPS is a three-dimensional non-hydrostatic model driven by the US Navy Operational Global Atmospheric Prediction System (NOGAPS) (cold start) or the most recent COAMPS forecast as the first guess (warm start). Observations from aircraft, rawinsondes, ships and satellites are blended with the first guess fields to generate the current analysis fields (initial conditions). Then, the forecast numerical model performs time integration of model numerics and physics. Lateral boundary conditions are taken from NOGAPS. The atmospheric model uses nested grid techniques to achieve high resolution for a given area.

- It runs operationally on a daily basis at InFlow (Registered User) ensuring an independence from external meteorological services
- It is applied every 24 hours at a high resolution of up to 3 km to simulate the wind field over the area of interest from a forecast window length of 168 hours.
- Two independent grid layouts are adopted to cover Greece and Europe respectively focusing on specific areas where wind farms are installed.
- The model output is stored hour-by-hour and the parameters related to wind energy applications (temperature, wind velocity components, pressure) are analyzed and processed.
- Database for wind resource assessment in flat terrain (Meso-scale Aerological Charts (MACh)) of the wind energy potential can effectively be generated for every time period and wind roses can be reproduced for any specific site.

In this paper, mesoscale time series from the database are extracted and directly compared with wind mast data from four sites in Greece where measurements are available for a period of 15 consecutive days. Reproduced wind roses from mesoscale forecasts are evaluated against the mast data.

Results

An appropriate grid for operational use in Greece is adopted and COAMPS is applied at high resolution to simulate the wind field over the Hellenic territory. Five nested grids are adopted at horizontal resolutions of 27km, 9km, 3km, 9km and 3km respectively (scale ratio of 3:1). In the vertical, 36 sigma levels covering a total depth of 300m of the atmosphere are imposed with approximately 20 levels in the boundary layer. A total of 1.8 million grid points are used in the outer, middle and inner meshes. Although COAMPS provides atmospheric forecasts up to 7 days ahead every 24 hours, only the first day results are extracted from the time series database, since these are characterized by higher accuracy while data overlapping is avoided.

Details about the sites considered and the available measurements carried out according to IEC 61400 standards are summarized in the following Table.

Conclusions

The present paper includes a brief description and preliminary evaluation of a short-term wind power forecasting system. As far as wind power penetration is concerned for a specific power transmission grid, a number of technological issues (e.g. capacity credit estimation) should be addressed. First of all, simultaneous information on wind statistics over every potential area is required. Even if a large volume of wind measurements is available, it is practically very difficult to be simultaneous while covering every potential area. Installation of a wide measuring network is imposed to rather prohibitive technical and economic restrictions. Although existing wind monitoring networks can provide large spatial coverage, these are not necessarily at high resolution. On the other hand, use of wind atlases is not a solution since they only provide an estimate of the spatial distribution of the mean wind speed without any information on its temporal variation.

References


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Wind Resource Assessment Using an Advanced Meso-scale Atmospheric Prediction System: Implementation at Four Sites in Hellenic Territory

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