VORTEX Icing modeling project

Dr. J. Calbó[1,2], Dr. G. Lizcano[2], Dr. G. Delgado[2] and P. Casso[2]
[1]University of Girona
[2]Vortex FdC.
Marie Curie 8-14, 08042 Barcelona, *german.delgado@vortex.es*

Abstract—VORTEX is a new modeling service designed by and for wind industry professionals (summing more than 15 years of experience in the industry). The technology core of the company is WRF v3.0, a state-of-the-art mesoscale atmospheric model. The company is finishing the last stage of development and during the next months will launch its modeling service. The next challenge of the company is to develop an icing modeling tool using WRF in order to estimate In-cloud icing and precipitation icing (wet snow and freezing rain), taking into account the liquid water content in the atmosphere and the cloud base height.

I. INTRODUCTION

*V*ORTEX is a new modeling service designed by and for wind industry professionals. The technology core of the company is WRF (Weather Research and Forecast model) v3.0, a state-of-the-art mesoscale atmospheric model. VORTEX has developed its own technology focusing on our specialization field, wind energy-oriented atmospheric-modeling, and trying to keep a close link with both industry actors and scientific experts.

WRF is initialized every 6 hours with NCEP-NCAR Analysis (1 x 1 degree resolution) for the European region. In a first stage the model is set up with 2 nested domains with horizontal resolutions of 81 and 27 km. With this, an European wind map has been developed for the year 2007. In a second stage the model is down-scaled from the mesoscale to the microscale resulting in a mean deviation of wind speed between WRF and observations of less than 10%.

One of the main interests of the company is to estimate In-cloud icing and precipitation icing (wet snow and freezing rain), taking into account the liquid water content in the atmosphere and the cloud base height. Annual wind energy production decreases due of icing and rime events in cold climate regions. These losses could be reduced estimating the number of icing and rime days per year.

Some efforts have been done during the recent years regarding icing; for example Vassbø et al. (1998) used HIRLAM (High Resolution Limited Area Model) over Finnish topography to predict icing events. This study was made with coarse horizontal and vertical resolutions. More recently Drague and Hauge (2006), presented a work with a horizontal resolution of 1 km with 17 layers within the lowest kilometer of the atmosphere.

In this contribution we show the technology as it is developed at the present moment, and we show our aim to collaborate with the COST-727 action in order to develop an operative Icing modeling tool.

II. EUROPEAN WIND MAP. FIRST RESULTS

A. Model setup

WRF v3.0 is set up with 2-way nested model domains of 81 and 27 km. The model is initialized with NCEP-NCAR Analysis and run with 40 vertical levels for the year 2007. Figure 1 shows the wind map for the European domain resulting of this modeling effort.

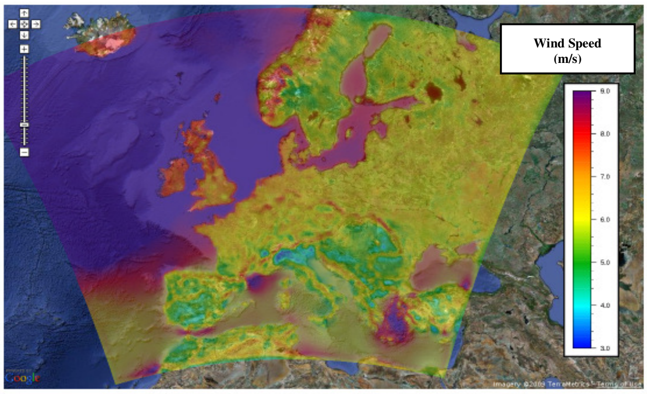

Fig.1: European wind map at a resolution of 27 km.

B. Downscaling

The European mesoscale map is downscaled to the microscale by using Eta turbulence scheme and a height of 5, 20, 40, 60 and 80 m for the lowest vertical levels. Figure 2 shows the nested domains scheme used for the downscaling. At this moment we are starting the validation of the simulation at several sites with data obtained via NCDC web site. Measurements were taken at 10 m above ground level. In this work we show the agreement between the model and the observation for two sites: Tirstrup (Denmark) and Palencia (Spain). Figure 3 shows the wind map for an Italian site after the downscaling. Figure 4 and Figure 5 shows the WRF and the observation histograms and wind roses with the mean values and the deviation in wind speed both for WRF model results and observations.

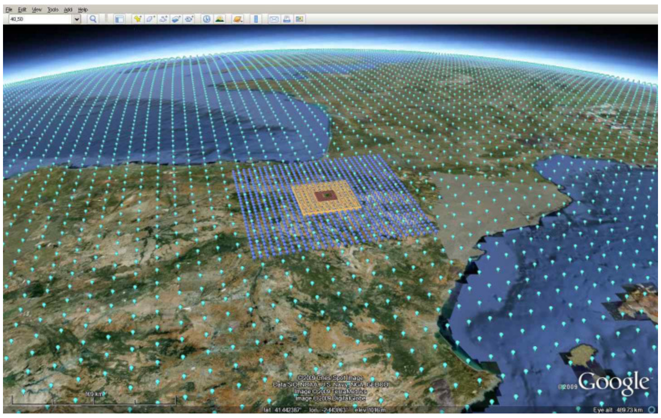

Fig.2 An example of the nested domains used over the European simulation by dowscaling simulation.

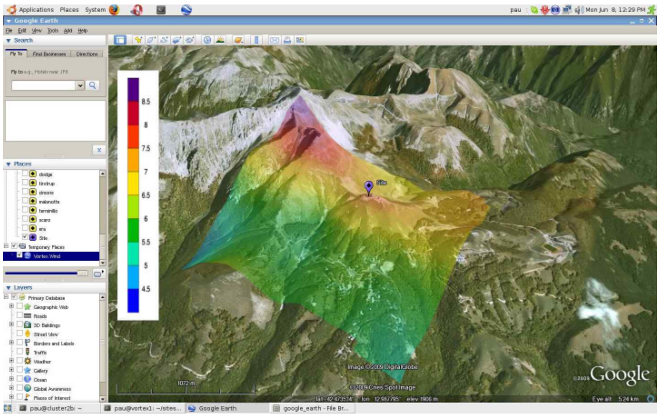

Fig.3 Wind map obtained in Terminillo (Italy) after the downscaling.

III. Icing

According to Drage and Hauge (2006), atmospheric icing has severe economical and technological consequences for human activities. It occurs frequently in sub artic and artic climates as well as other exposed locations at a certain heights above sea level. Telecommunication networks, power transmission lines or aero generators blades suffer the negative effects of the icing events (Poots, 2000). Reliable icing forecasts require meteorological data such as air temperature, relative humidity, wind speed, wind direction and turbulence, in addition to other specific parameters such as typical volume droplet size and liquid water content.

In-cloud icing is considered to occur if the height of cloud base is less than the site elevation and the temperature at the site is below zero. Whereas freezing precipitation occurs when it is raining and wet-bulb temperature lies below zero. Other icing phenomenon like as frost or wet snow may also by simulated by the model. Our aim is to take advantage of the current technology we have design to be able to model icing events.

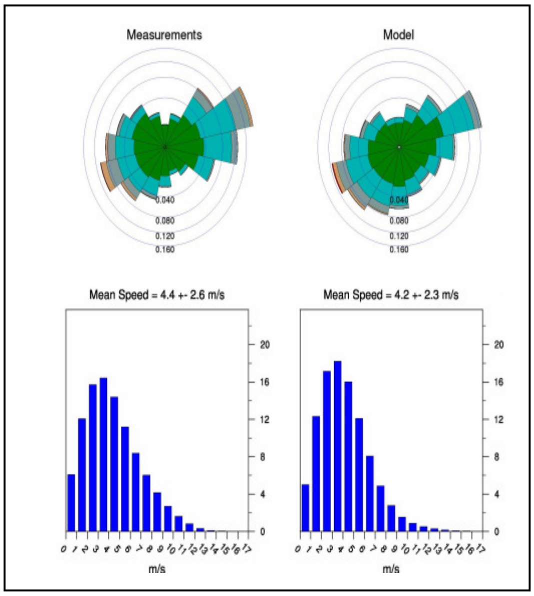

Fig.4 One year (2007) of experimental and simulated data for the site of Palencia.

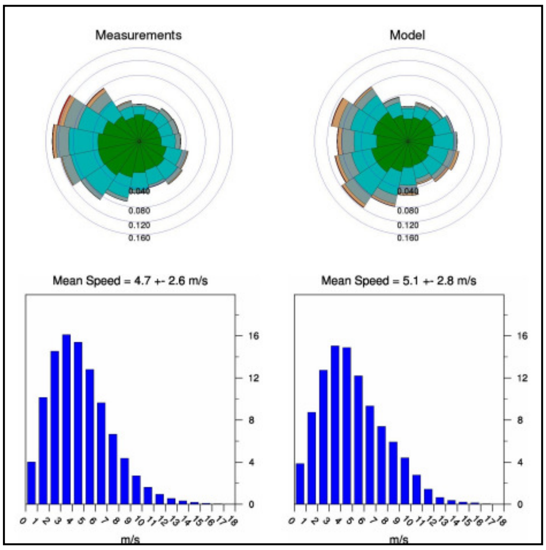

Fig.5 One year (2007) of experimental and simulated data for the site of Tirstrup.

IV. References

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