Feature - Forecasting weather on the grid

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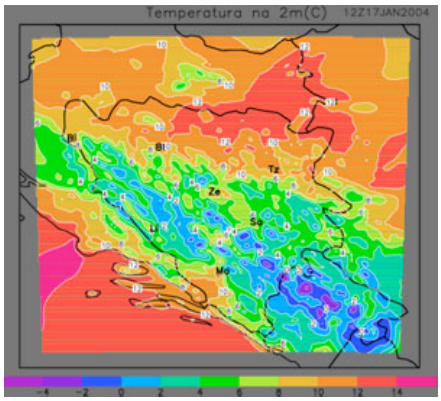
The Weather Research and Forecasting prognostic model (WRF) is an atmospheric simulation system that runs on parallel computing platforms. It is designed with the goal of being flexible, portable, and efficient.

Within the field of meteorology, the Advanced Research WRF (ARW) is one of today's best-known weather research and forecasting models. ARW is suitable for use in a broad range of applications across scales ranging from meters to thousands of kilometers, including:

- Idealized simulations (e.g. Large Eddy Simulations, convection, baroclinic waves)
- Regional and global applications
- Parameterization research
- Data assimilation research
- Forecast research
- Real-time numerical weather prediction
- Coupled-model applications
- Teaching



This image shows the 10 meter wind field on 24 April 2006 at 1300 UTC (1400 h local time). During the early afternoon, a sea breeze flow reached its maximum intensity. Over the land, the wind is rather irregular due to very complex topography. Wind speeds mostly varied in the range of 3.5 m/s to 5 m/s along the Adriatic coast (e. g., Šibenik, Split, Makarska, Dubrovnik). At the land measuring sites, the sea breeze was developing from the southwest direction. The island's measuring sites, however, showed the significant influence of the northwesterly large-scale wind. Image courtesy of Davor Davidovic.

Numerical weather prediction models must use high resolution mesh grids in order to have sufficiently accurate and detailed results. Using high model resolution results in two natural consequences. The first is an increase in the number of computational grid points, necessary to keep the total domain size sufficiently large. The second is the reduction of the integration time step in order to avoid numerical instabilities. Both effects result in larger CPU and memory demands that ordinary computers cannot provide.

The South-East region of Europe presents a particularly big challenge for meteorologists because of the complexity of the reproduction and forecasting of the airflow over complex terrain (e.g. mountain ranges, coastal area), such as the terrain in Croatia, Bosnia, and Herzegovina.

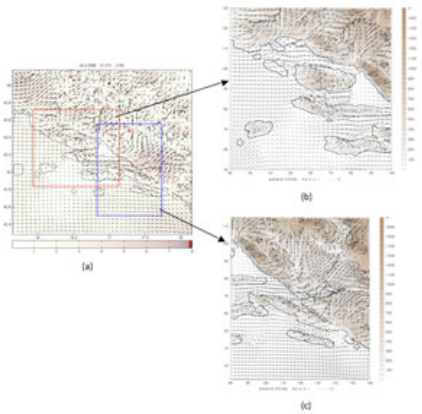


Figure (a) Modeled WRF 10-m wind vectors (m s-1) for 24 April 2006 at 1300 UTC. The wind vectors are given at a horizontal resolution of 3 km. The wind speed is depicted by filled areas (shown by legend) with a 1 m s-1 interval. The thick red and blue rectangles denote the horizontal cross-sections shown in the right panels. A close-up of the flow structure: (b) above the island of Brač and (c) above the wider Neretva area. Image courtesy of Davor Davidovic.

In order to solve these computationally intense high resolution models, the SEE-GRID-SCI grid infrastructure was used. By deploying the model on the grid, we gained access to a large amount of processing power, memory, and storage capacity.

The ARW model was deployed on the grid using generic gLite tools joined together in a few batch submission scripts, while the LHC Computing Grid File Catalogue was used for storing the model data.

The results were quite positive. The gridified ARW has shown great improvements in storage capacity, the ability to run multiple model instances, and model execution speed (up to six times faster on 16 CPUs), running multiple.

Today, the gridified ARW model is used for weather research purposes as well as operational forecasts. Most of the research focuses on wind simulations over coastal areas (e.g. bora winds over the North Adriatic) and inland (e.g. foehn wind effects over the city of Banja Luka). The model is also used regularly for operational weather prediction over Bosnia and Herzegovina.

—*Davor Davidovic*

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