EASY Project Report

June 2008

PA6.- Implementation of Local Atmospheric models

New Operational Scheme and Model Benchmarks

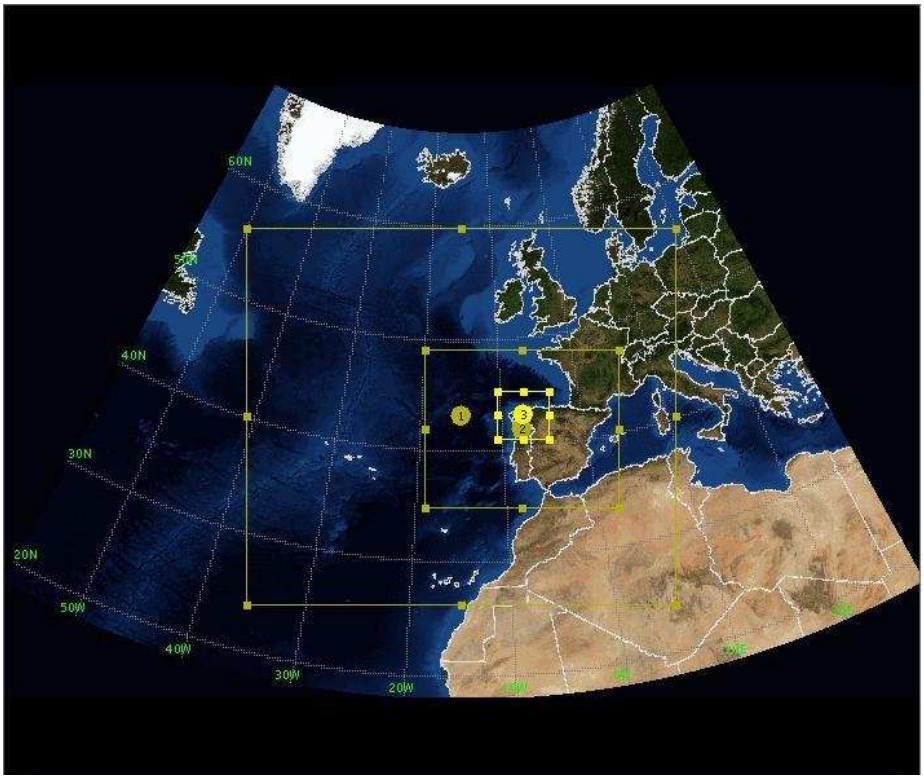
A new operational scheme of the atmospheric models at the University of Santiago de Compostela (from now on USC) in collaboration with MeteoGalicia is under development. WRF model (www.wrf-model.org) has been tested in our environment and it will be used in the near future as the main atmospheric model in the framework of that new operations scheme, which is expected to be released for the end of the project. Moreover, improvements in the facilities of the Galician Supercomputing Center (CESGA), with the acquisition of a new high-performance computing equipment named Finis Terrae, will allow us to significantly increase the resolution of our models.

New computing environment: Finis Terrae

- More than 2.500 cores Intel IA-64 Itanium 2 1600 MHz (± 1.6 TFlops)
    - 142 nodes with 16 cores (128 GB memory)
    - 1 node with 128 cores (1024 GB memory)
    - 1 node with 128 cores (284 GB memory)
- More than 190.000 GB of memory
- Infiniband network
- Storage: more than 390.000 GB (disk) and 1 PB (tape)

New grids configuration

The new operational scheme will implement a finer resolution than current models, covering Southwestern Europe at 36 km of resolution, Iberian Peninsula at 12 km, and Galicia at 4 km, as it can be seen in the next figure:



New grids configuration with WRF model at USC-MeteoGalicia

There are some differences in grid discretization between the two cores of WRF: the Advanced Research WRF (ARW) developed by MMM divison of NCAR, which uses an Arakawa-C grid, and the Nonhydrostatic Mesoscal Model (NMM), developed by NOAA's NCEP that uses an Arakawa-E grid. Due to these differences in horizontal grid point distribution, and in order to assure that both models cover the same area, the number of points in each direction should be adequately chosen. Despite that fact, the total number of horizontal grid points (nx·ny) remains almost equal in both model grids.

	ARW		**NMM**	
	resolution	**grid size (nx·ny·nz)**	**resolution**	**grid size (nx·ny·nz)**
Domain 1	36 km	119x105x28	≈ 36 km	84x150x28
Domain 2	12 km	163x133x28	≈ 12 km	116x190x28
Domain 3	4 km	136x121x28	≈ 4 km	94x172x28

Moreover, additional higher resolution grids would be nested within the inner domain, reaching resolutions about 1 km in Rias Baixas and Artabro Gulf, running once a day. Oceanographic models (waves and currents) would be force by the results of these finer grids.

Benchmarks: CPU times

A simple test to compare CPU time with both WRF dynamical cores was performed, and as it can be seen in the next table, NMM is about 90% faster than ARW solving almost equivalent grids

	domain	resolution	total time	grid size (nx·ny·nz)	Δt	CPU time (1 proc.)
ARW	d01	36 km	24 h	60x60x28	210 s	250.6 s
NMM	d01	≈36 km	24 h	42x86x28	80 s	232.9 s

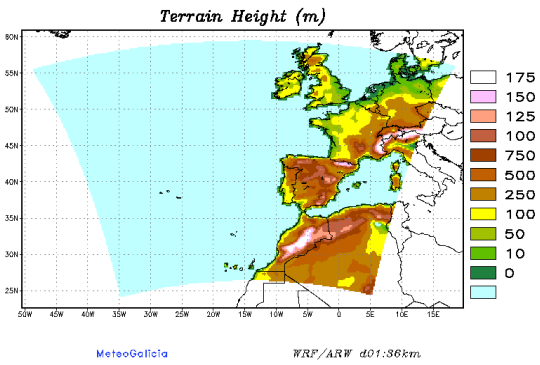
Also some preliminary parallelization benchmarks have been made in this 1-domain configuration, but because of its small size, no significant speed-up has been obtained. A comprehensive parallelization benchmark should be also performed with the complete 3-grid configuration to study speed-ups in order to determine the more convenient computing resources needs.

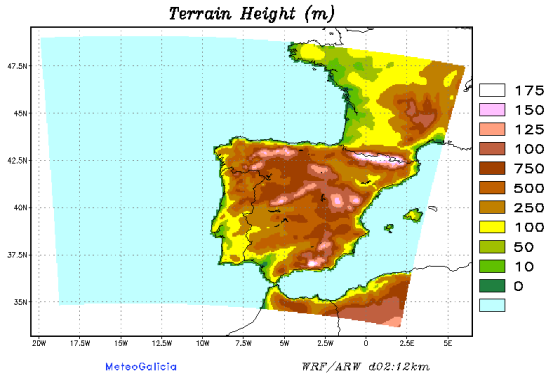
Preliminary CPU time tests with the 3-domains configuration were performed in 4 processors with the next results:

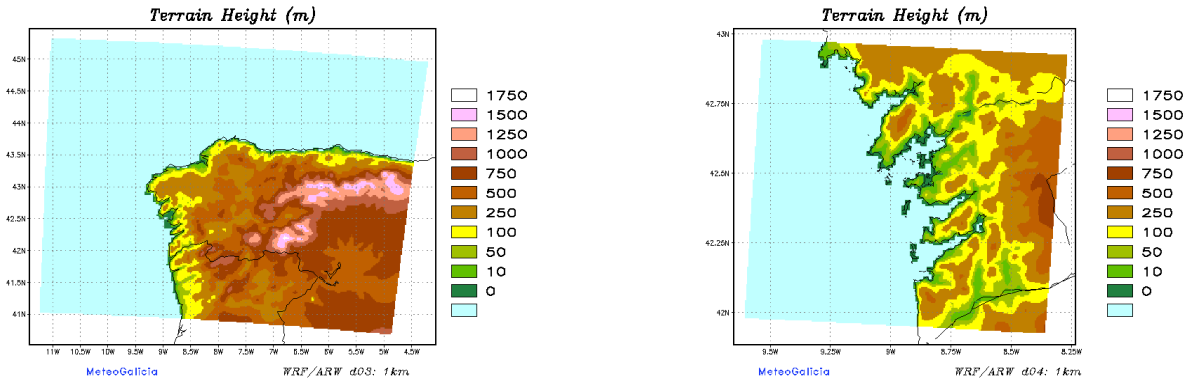
	total simulation time	CPU time (4 proc.)	
ARW	48 h	12397 s	103 min/day
NMM	48 h	14578 s	121 min/day

As it can be seen in the table, NMM seems to be significantly slower than expected (about a 90% of ARW time), this is due to a compilation problem related to optimization of NMM nesting subroutines with Intel fortran compiler. We are currently working in fix that problem, so new tests should be performed to check whether nesting features of both cores consume similar CPU resources or not.

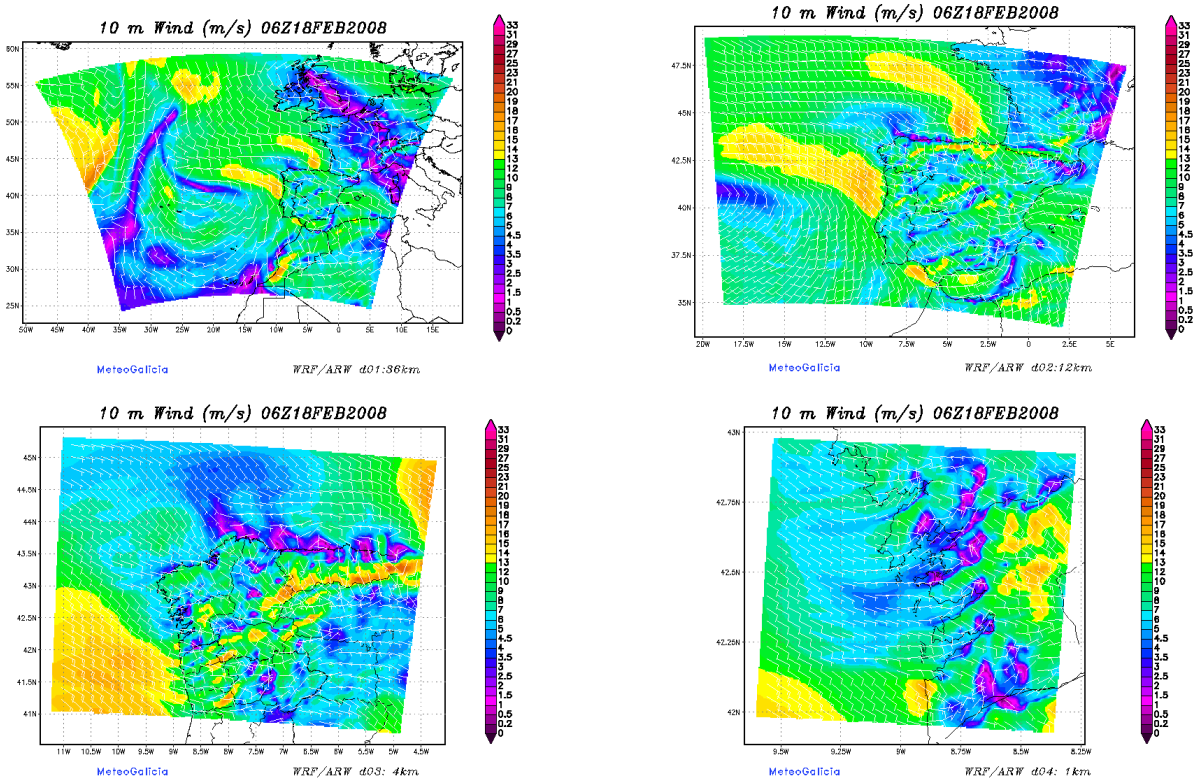
Example results







Modelled terrain height in the four domains (d01 @36km, d02 @12km, d03 @4km and d04 @1km)



Modelled surface wind in the four domains (d01 @36km, d02 @12km, d03 @4km and d04 @1km)

Validation results of the finer domain would be shown in the final report, in order to assure the quality of data. These results will be included in the overall report of all the partners.