Geophysical Research Abstracts,
Vol. 10, EGU2008-A-09900, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-09900
EGU General Assembly 2008

Suitability of WRF model for air quality simulations: comparison of two dynamical cores on a yearly basis

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The Weather Research and Forecasting (WRF) Model is a next-generation mesocale numerical weather prediction system designed to serve both operational forecasting and atmospheric research needs. WRF is suitable for a broad spectrum of applications across scales ranging from meters to thousands of kilometres. The current WRF software framework supports two dynamical solvers: the nonhydrostatic Mesoscale Model (NMM) developed by the National Centers for Environmental Prediction and the Advanced Research WRF (ARW) developed and maintained by the Mesoscale and Microscale Meteorology Division of NCAR.

The BSC-CNS is involved in the CALIOPE project, a national initiative that has as main objective to establish an air quality forecasting system for Spain coordinated by the Spanish Ministry of the Environment through funded project 441/2006/3-12.1 and A357/200/2-12.1, delivering air-quality related products with very high resolution (4 km for Spain, 12 km for Europe, 1 hr-temporal resolution) useful to a wide range of users for reducing the impacts of air pollution on human health. The modelling system bases on the WRF (ARW) model as a meteorological driver. As is well known, air quality models are highly dependent on the quality of the meteorological inputs, and any improvement in meteorological fields should be maintained in chemistry models. One major characteristic of WRF model is that it has the possibility to be configured with different dynamical cores. The need to analyse the performance of the system under different configurations is then demanded.

Under this context, the present contribution aims to verify a 2004 year simulation over Europe at 12 km horizontal resolution executed with both dynamical cores of WRF model. The configuration for WRF (ARW) is: ARW dynamical core; Yonsei University PBL scheme; Kain-Fritsch cumulus scheme; single-moment 3-class microphysics' scheme; RRTM for long-wave radiation scheme and Dudhia scheme for short-wave scheme; and the Noah Land Surface. And the model configuration for WRF (NMM) is: NMM dynamical core; Mellor-Yamada-Janjic TKE PBL scheme; Betts-Miller-Janjic cumulus scheme; Ferrier 5-class microphysics' scheme; GFDL (Fels-Schwarzkopf) for long-wave radiation scheme and GFDL (Lacis-Hansen) for short-wave scheme; and the NMM Land Surface Model (very similar to Noah LSM). The yearly simulation consists in 366 daily executions of the models with a 12 hour cold start. The initial and boundary conditions are taken from FNL analysis at 1º of spatial resolution. Several statistics are calculated to compare the performance of both systems at surface level (wind speed, wind direction, temperature, dewpoint temperature). The study specially focuses in stagnant meteorological conditions associated with the development of air pollution episodes.