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Evaluating the improvements of the BOLAM meteorological model operational at ISPRA: A case study approach – preliminary results

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The Institute for Environmental Protection and Research – ISPRA (former Agency for Environmental Protection and Technical Services – APAT) runs operationally since 2000 an integrated meteo-marine forecasting chain, named the Hydro-Meteo-Marine Forecasting System (Sistema Idro-Meteo-Mare – SIMM), formed by a cascade of four numerical models, telescoping from the Mediterranean basin to the Venice Lagoon, and initialized by means of analyses and forecasts from the European Centre for Medium-Range Weather Forecasts (ECMWF). The operational integrated system consists of a meteorological model, the parallel verision of BOlogna Limited Area Model (BOLAM), coupled over the Mediterranean sea with a WAve Model (WAM), a high-resolution shallow-water model of the Adriatic and Ionian Sea, namely the Princeton Ocean Model (POM), and a finite-element version of the same model (VL-FEM) on the Venice Lagoon, aimed to forecast the acqua alta events. Recently, the physically based, fully distributed, rainfall-runoff TOPographic Kinematic APproximation and Integration (TOPKAPI) model has been integrated into the system, coupled to BOLAM, over two river basins, located in the central and northeastern part of Italy, respectively. However, at the present time, this latter part of the forecasting chain is not operational and it is used in a research configuration.

BOLAM was originally implemented in 2000 onto the Quadrics parallel supercomputer (and for this reason referred to as QBOLAM, as well) and only at the end of 2006 it was ported (together with the other operational marine models of the forecasting chain) onto the Silicon Graphics Inc. (SGI) Altix 8-processor machine. In particular, due to the Quadrics implementation, the Kuo scheme was formerly implemented into QBOLAM for the cumulus convection parameterization. On the contrary, when porting SIMM onto the Altix Linux cluster, it was achievable to implement into QBOLAM the more advanced convection parameterization by Kain and Fritsch.

A fully updated serial version of the BOLAM code has been recently acquired. Code improvements include a more precise advection scheme (Weighted Average Flux); explicit advection of five hydrometeors, and state-of-the-art parameterization schemes for radiation, convection, boundary layer turbulence and soil processes (also with possible choice among different available schemes). The operational implementation of the new code into the SIMM model chain, which requires the development of a parallel version, will be achieved during 2009.

In view of this goal, the comparative verification of the different model versions' skill represents a fundamental task. On this purpose, it has been decided to evaluate the performance improvement of the new BOLAM code (in the available serial version, hereinafter BOLAM 2007) with respect to the version with the Kain-Fritsch scheme (hereinafter KF version) and to the older one employing the Kuo scheme (hereinafter Kuo version).

In the present work, verification of precipitation forecasts from the three BOLAM versions is carried on in a case study approach. The intense rainfall episode occurred on 10th – 17th December 2008 over Italy has been considered. This event produced indeed severe damages in Rome and its surrounding areas.

Objective and subjective verification methods have been employed in order to evaluate model performance against an observational dataset including rain gauge observations and satellite imagery. Subjective comparison of observed and forecast precipitation fields is suitable to give an overall description of the forecast quality. Spatial errors (e.g., shifting and pattern errors) and rainfall volume error can be assessed quantitatively by means of object-oriented methods. By comparing satellite images with model forecast fields, it is possible to investigate the differences between the evolution of the observed weather system and the predicted ones, and its sensitivity to the improvements in the model code. Finally, the error in forecasting the cyclone evolution can be tentatively related with the precipitation forecast error.