Arome, a new operational mesoscale NWP system for Météo-France

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In an effort to improve early warnings of severe convection events, Météo-France is developing a convection-resolving data assimilation and limited area forecast model (LAM) called Arome (Applications of Research to Operations at Mesoscale). This will be used at 2 to 3km horizontal resolution over domains the size of mainland France (approx. 2000km wide) for short range predictions in replacement of the current Aladin local adaptation model (9.5km resolution today). The deadline for operational implementation is 2008. The Arome model will be coupled with Arpège, a variable-resolution global model.

Arome will reuse available software as much as possible. The software basis will be the IFS/Arpège/Aladin system developed jointly by Météo-France, ECMWF and Aladin partner countries. The dynamical core will be the so-called Aladin-NH spectral semi-implicit, semi-Lagrangian, non-hydrostatic mass-coordinate compressible model in a recent, very stable version that allows timesteps in excess of 1 minute at 2km resolution when minimal physics are used. Most of the physical parameterizations will be imported from the Méso-NH mesoscale research, and they will be different from the ones in the French global Arpège model. They will comprise: ICE3 cloud microphysics with 6 cloud and precipitation prognostic species, a version of the ECMWF FM radiation scheme, 1-D and 3-D turbulent mixing schemes with prognostic TKE, Kain-Fritsch-Bechtold subgrid-scale convection, and a PRISM/ALMA-compliant interface with externalized versions of the ISBA land surface scheme allowing e.g. CO2 flux management, variational soil moisture initialization and runoff routing for hydrological models. Advection of arbitrary passive scalar fields is provided for chemicals and aerosols, and later the Méso-NH chemical equation compiler will be included into the software. This should provide a state-of-the-art model for resolutions between 800m and 10km, with good scope for future interaction with the mesoscale research community on physics development and cloud-resolving model studies.

The main novelty will be in the data assimilation shceme. Arome being for short-range forecasting (3 to 36 hours) will run analyses using the Aladin 3D-Var-FGAT system, which is closely related with the ECMWF operational 4D-Var and 3D-Var-FGAT used in ERA-40. The obs processing will encompass all types already used in the global ECMWF and Arpège systems, with an emphasis on IR polar-orbiting sounders borne on the EOS, NPP, NPOESS and Metop platforms. Currently, ATOVS level 1C AMSU-A radiances are assimilated, with good progress being made on HIRS,

AMSU-B and AIRS. Arome will also assimilate rain radar reflectivities, conventional data with high density near the ground, and geostationary MSG/SEVIRI as radiances for clear-air humidity analysis, and as cloud analysis using pixel classification.

Current algorithmic developments include: downscaling of background error covariances, with flow-dependent vertical humidity structure functions and enhanced resolution at low level; blending of the latest large-scale 4D-Var analyses into the mesoscale 3D-Var assimilation; an accelerated version of the analysis for use in nowcasting; automated tracking of precipitation fields on radar imagery for data quality control and verification of precipitation forecasts; studies of initialization using digital filters at high resolution; optimization of the coupling between the global and mesoscale NWP systems.

Preliminary testing using data assimilation and breeding experiments suggest good potential for improving over the global-model forecasts. This is well known in cases of slow-moving convective systems. In most weather situations, the whole interior of a 2000km-wide LAM forecast will be affected by the large-scale boundary conditions within 48 hours. On the other hand, there is evidence that perturbations to the LAM initial state do affect the LAM forecast over the same range. It means that although one cannot ignore large-scale forecast errors when developing a LAM NWP system, one can still obtain good added value in the regional forecast products by investing into a sophisticated LAM model and data assimilation.