REQUEST FOR A SPECIAL PROJECT 2013–2015

MEMBER STATE: …………………… ITALY ……………………...…

Principal Investigator[1]: ………………… Stefano FEDERICO …………………..……

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Other researchers:

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Project Title:

A general-purpose data assimilation and forecasting system

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** ________________	
Starting year: (Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)	2013	
Would you accept support for 1 year only, if necessary?	YES X	NO ☐

Computer resources required for 2013-2015: (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2015.)	**2013**	**2014**	**2015**
High Performance Computing Facility (units)	150000	150000	
Data storage capacity (total archive volume) (gigabytes)	200	200	

An electronic copy of this form ***must be sent*** *via e-mail to:* *special_projects@ecmwf.int*

Electronic copy of the form sent on (please specify date):

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Continue overleaf

[1] The Principal Investigator will act as contact person for this Special Project and, in particular, will be asked to register the project, provide an annual progress report of the project's activities, etc.

Principal Investigator: …………Stefano FEDERICO…………………………

Project Title: ……… A general-purpose data assimilation and forecasting ………system in southern Italy ……………

Extended abstract

The main task of this project is to improve and test a new data assimilation and forecasting system, named CRAMS (Calabria Regional Atmospheric Modelling System), which is developed in southern Italy.

CRAMS is composed by two main components: a univariate analysis package and a forecasting model. Both components are based on the RAMS (Regional Atmospheric Modelling System), which is used since 2005 in southern Italy to produce operational weather forecasting at the mesoscale (Federico, 2011).

The analysis algorithm has several options for solutions: successive approximation, optimal interpolation, 2D-Var, 3D-Var. All components, with the exception of the surface solution for temperature and relative humidity, are univariate.

An important issue in coupling the RAMS model with the data assimilation system is that they use different coordinate systems both in the horizontal and in the vertical. The data assimilation system uses a regularly spaced longitude-latitude grid, while the RAMS model uses a rotated polar stereographic projection, whose pole is rotated near the centre of the domain to minimize the distortion of the projection in the main area of interest.

In the vertical direction, RAMS uses sigma-z terrain following coordinates (Pielke, 2002), while the analysis algorithm uses pressure.

To cope with the differences between the analysis and forecast coordinate systems, two different RAMS settings are used: a "background run" and a "forecast run". The background run will have one domain with 10 km horizontal grid resolution (Table 1, Figure 1) and covers almost all Europe[2]. The background run gives the first-guess fields for the analyses.

Then analyses are performed on the analysis grid, whose domain spans most of Europe (Table 1, Figure 1), and whose horizontal resolution is 0.5°. The analysis grid is contained in the background grid, both horizontally and vertically.

The analyses are used to initialize a new run of the RAMS model, i.e. the forecast run, whose domain is contained inside the analysis domain, both horizontally and vertically (Table 1, Figure 1).

In the vertical, the RAMS model will use thirty-five levels for the background run and thirty-three levels for the forecast run. Levels are not equally spaced: layers within the Planetary Boundary Layer (PBL) are between 50 and 200 m thick, whereas layers in the middle and upper troposphere are 1000 m thick.

The analysis grid uses twenty-eight pressure levels from 1000 hPa to 50 hPa, spaced every 50 hPa between 800 and 300 hPa, and every 25 hPa below 800 hPa and above 300 hPa. Below 800 hPa the

[2] It is important to stress that in this document I give a setting of the system that was already used with success. Nevertheless, the configuration used in this documents may be tuned depending on the computational environment available.

vertical resolution is improved to refine the analyses near the surface. Above 300 hPa the vertical spacing is halved because the vertical resolution of the analysis grid becomes too coarse (≈1500-2000 m) above this level, using a constant layer thickness of 50 hPa.

The data from the GTS (Global Telecomminication System), as archived at ECMWF, will be used both to produce analyses and to verify the RAMS output. The data used will be mainly those from SYNOP data, TEMP, and the European Wind Profiler Network.

The goals of this project are the following two: a) to quantify the performance of the analyses in improving the initial state of the RAMS model; b) to show the impact of the data assimilation system on the short-range forecast of the RAMS model, particularly for surface parameters.

To quantify the impact of the analysis both in the improvement of the initial state and in the short-term forecast, the following strategy is adopted (Figure 2). For each day of a selected period (between one and three months, depending on how fast the model will be on the allocated resources) two background runs lasting 12 h are made at 00 and 12 UTC. Their initial and boundary conditions are derived, every 6 h, from the operational analysis/forecast cycle of ECMWF. These fields are available 0.25° horizontal resolution.

After 6 h of each run, an analysis is made. This corresponds to two analyses per day at 06 and 18 UTC. These hours are chosen because there are several reporting TEMP and wind profiler reports, which can be used to analyse all the parameters considered in this paper (i.e. zonal and meridional wind components, temperature, relative humidity, and geopotential height).

Starting at the analysis times (06 and 18 UTC), two short-term RAMS forecasts, lasting 6 h, are made using the forecast grid. For these runs; a) the initial conditions are given by the analyses produced at 06 and 18 UTC, depending on the simulation; b) the boundary conditions after 6h are taken form the ECMWF operational analysis/forecast cycle and are the same as the background run.

The root means square error (RMSE) is computed between the background fields and observations, and between the forecast fields and observations for the whole period. The comparison of these statistics at the analysis times shows the performance of the data assimilation system (analysis stage); the same comparison for times following the analysis times quantify the impact of the analyses on the short-term forecast (forecast stage).

The 200 GB requested are motivated by the need to manage the numerical experiment. Each simulation (background+analysis+forecast) with the configuration described above requires about 6 GB of disk space. Nevertheless much of the post-processing will be held at local computers in Italy, where there is an enough amount of disk space to manage it, and 200 GB of disk seems appropriate to permit an "easy" upload-download of the data. A sizeable portion of the disk space will be used to store the background matrices of the analysis package and to manage the data downloaded from the MARS archive.

The project will be developed in two years. In the first year, the model will be compiled on the ECMWF resources and the analysis package will be set for the numerical experiment. The dataset from the MARS archive will be managed and a first month of experiment will be performed. Statistics will then be computed and first conclusions will be drawn.

In the second year of the project, simulations will be conducted for a longer period and final statistics will be computed.

TABLE 1: RAMS grid-setting for the background and forecast run. NNXP, NNYP and NNYZ are the number of grid points in the west-east, north-south, and vertical directions. Lx(km), Ly(km), Lz(m) are the domain extension in the west-east, north-south, and vertical directions. DX(km) and DY(km) are the horizontal grid resolutions in the west-east and north-south directions. CENTLON and CENTLAT are the geographical coordinates of the grid centres. The analysis grid (rightmost column) is regularly spaced in longitude and latitude and uses pressure as vertical coordinate.

	RAMS Background-grid	RAMS Forecast-grid	Analysis grid
NNXP	450	230	88
NNYP	450	230	66
NNZP	35	32	29
Lx	5400 km	2520 km	44°
Ly	4200 km	2520 km	33°
Lz	21800 m	18800 m	1000-50 hPa
DX	10 km	10 km	0.5°
DY	10 km	10 km	0.5°
CENTLAT (°)	50.0	50.0	≈ 46.5
CENTLON (°)	8.0	8.0	≈ 8.0

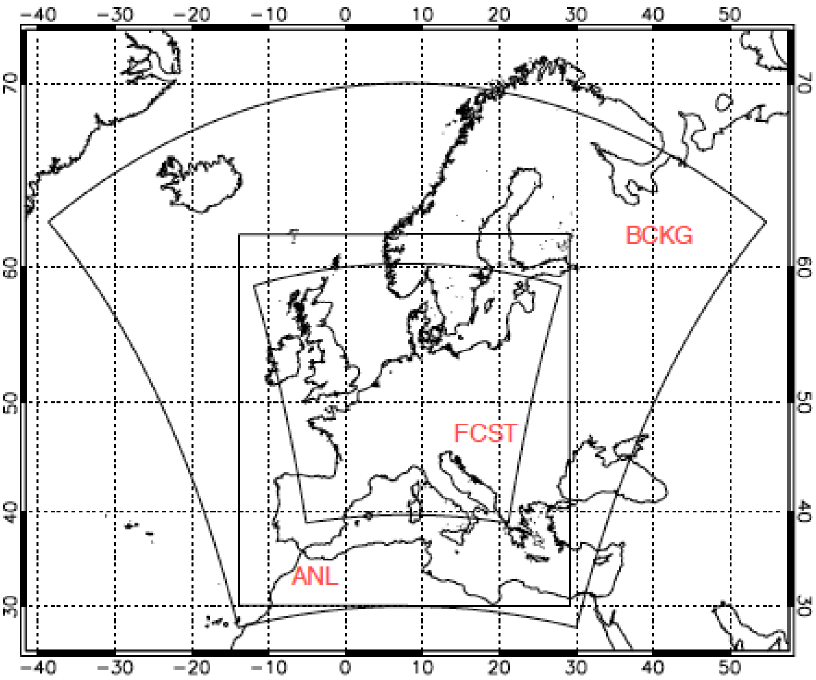

Fig. 1 The three domains: BCKG is the domain of the background run; ANL is the domain of the data assimilation system; FCST is the domain of the forecast run

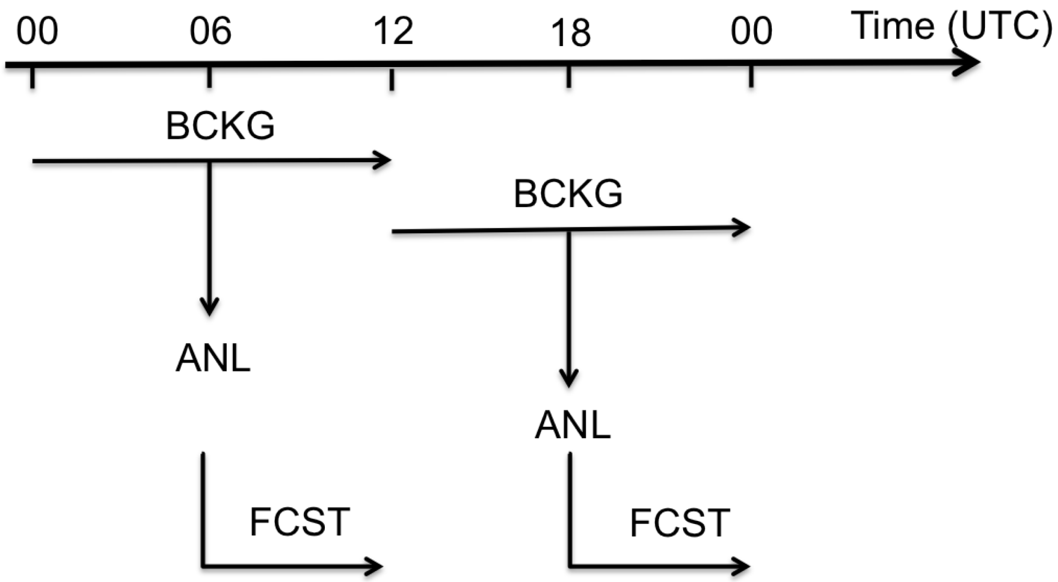

Fig. 2 Synopsis of the simulations. BCKG is the background run and two BCKG runs are performed per day. ANL is the analysis time. Two analyses are produced per day at 06 and 18 UTC. FCST is the forecast run. Two FCST runs are performed per day

REFERENCES

Federico, S.: Verification of surface minimum, mean, and maximum temperature forecasts in Calabria for summer 2008, Nat. Hazards Earth Syst. Sci., 11, 487-500, doi:10.5194/nhess-11-13-487-2011, 2011.

Pielke R. A.: Mesoscale Meteorological Modeling. Academic Press, San Diego, 2002.