REQUEST FOR A SPECIAL PROJECT 2016–2018

MEMBER STATE: ……FRANCE…….
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Project Title: Regional surface re-analysis with MESCAN for the UERRA project

……..……

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.)	2016	
Would you accept support for 1 year only, if necessary?	YES ☐	NO ☒

Computer resources required for 2016-2018: (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2018.)		**2016**	**2017**	**2018**
High Performance Computing Facility	(units)	15,000,000	15,000,000	
Data storage capacity (total archive volume)	(gigabytes)	25,000	50,000	

*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):
……2015-10-29…

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: Eric BAZILE……

Project Title: Regional surface re-analysis with MESCAN for the UERRA project……

Extended abstract

It is expected that Special Projects requesting large amounts of computing resources (500,000 SBU or more) should provide a more detailed abstract/project description (3-5 pages) including a scientific plan, a justification of the computer resources requested and the technical characteristics of the code to be used. The Scientific Advisory Committee and the Technical Advisory Committee review the scientific and technical aspects of each Special Project application. The review process takes into account the resources available, the quality of the scientific and technical proposals, the use of ECMWF software and data infrastructure, and their relevance to ECMWF's objectives. - Descriptions of all accepted projects will be published on the ECMWF website.

Regional surface re-analysis with MESCAN for the UERRA project

Eric Bazile (Météo-France)

This special project aims to create a regional surface re-analysis over Europe in the framework of the UERRA (Uncertainties in Ensembles of Regional Re-Analyses) FP7 project. The surface analysis system used is MESCAN: a 2-dimensional univariate analysis system based on the optimal interpolation method and developed during the EUROM project with SMHI (more details of MESCAN in the EURO4M report D2.6).
12 institutes from 7 EU countries, Switzerland and an international organisation (ECMWF) involve in the UERRA project coordinated by Per Undén (SMHI).

The surface analysis, done at 5.5km over Europe, will provide some of the Essential Climate Variables (ECVs) on the European regional scale such as 2m temperature, relative humidity, 10m wind and precipitation. The reanalysis will start in 1961 and go to 2010.

The precipitation analysis will be performed for this period (50 years) at 5.5Km with MESCAN (Cornel et al 2015, submitted to Tellus) using a downscaled precipitation background from the UERRA-SMHI 3Dvar re-analysis and 24h-accumulated observed precipitation. This approach has been validated and used in the EURO4M project to create a precipitation analysis at 5.5km for the period 2006-2010 (Fig 1)

The uncertainties of the surface re-analysis will be assessed by an ensemble (6-10 members) of surface analysis on a shorter period 2006-2010. The question of the observation network density and its impact will also be addressed.

The MESCAN re-analysis will be used to drive the surface module (SURFEX) which computes soil variables such as surface and deep soil temperature, soil moisture and snow characteristics (density, albedo) etc … The drainage and run-off computed by SURFEX will be used to force the hydrological model TRIP (Total Run-off Integrating Pathway) over Europe to compute river discharge.

Scientific plan:
The question of the downscaling method for the surface background field, provided by the regional re-analysis done by SMHI in this project, will be studied. The 2m-temperature adaptation from an orography at 11Km to 5.5km must be accurate to use in an optimum way all the surface observations in particular over mountain area (Alps and Scandinavia).

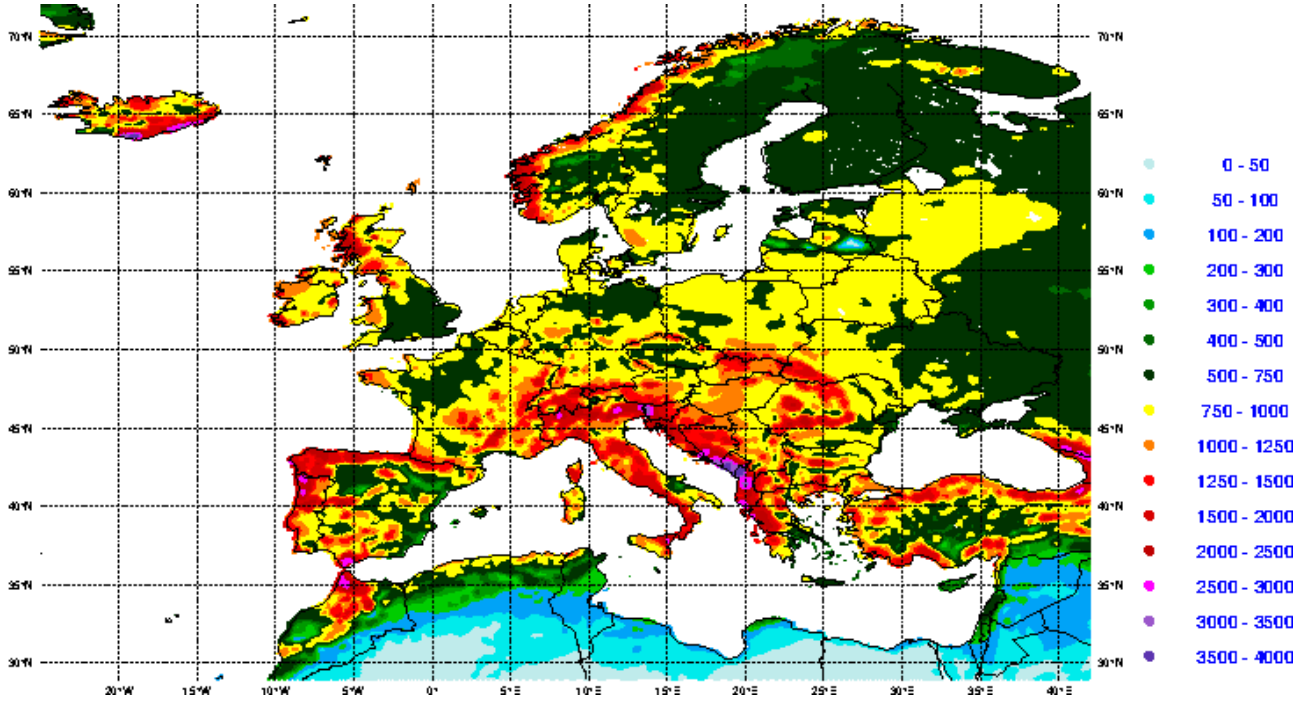

Fig1: Map of annual precipitation re-analysis at 5.5km for the year 2010 (mm/year)

For the analysis of the 24h-accumulated precipitation at 5.5km, the presence of detailed small-scale spatial patterns is an important feature in high-resolution regional re-analyses compared with global re-analyses, which make them more suitable for example in hydrology and climate applications. Fine scales are developed by time integrating a high-resolution numerical forecast model. When employing a spatial interpolation method to downscale a prior atmospheric field from a coarse to a higher horizontal grid, spurious noise is introduced. This noise has been quantified by computing the variance spectra of the monthly mean 24-h total accumulated precipitation (Soci et al, Submitted).

Figure 2 displays the variance spectra of the monthly mean 24-h total accumulated precipitation fields for December 2009. In both panels, it can be noticed that at the shortest wavelength represented in the model, i.e. 2x, the variance of the downscaled forecasts is significantly lower than the variance of the native forecasts. There is also a steep decrease of the variance at the wavelength corresponding to 3x for native forecasts. As explained in Ricard et al. (2013), the reduction in the spatial variability comes from the quadratic truncation applied to the model orography. Furthermore, Figure 8a shows that such a decrease is also triggered in the downscaled fields at about 12x, corresponding to 3 times the value of the coarser ARPEGE grid, that is the decrease of the variability begins below 3x of the input grid. This finding may indicate that the decrease of the variability is triggered at the wavelength corresponding to the quadratic truncation applied to the input model orography. The precipitation analysis increases the variance at short wavelengths when the background is a downscaled forecast (dashed green line) and has a rather neutral impact when it is performed with background from a native forecast (dashed red line).

These findings show that for applications in which the small-scale spatial variability is important (e.g. in hydrology), it is more desirable to run a high resolution model than to downscale fields employing the 12-point cubic interpolation technique, particularly when there is a large difference between the initial and the final grid resolutions.

As a consequence, for the 5 years period (2006-2010), the limited area model (LAM) ALADIN will be used to generate the background field at 5.5km. In order to estimate the

uncertainties, two background fields will be provided with two physics package: one from the global model ARPEGE and one frm the so called ALARO physics.

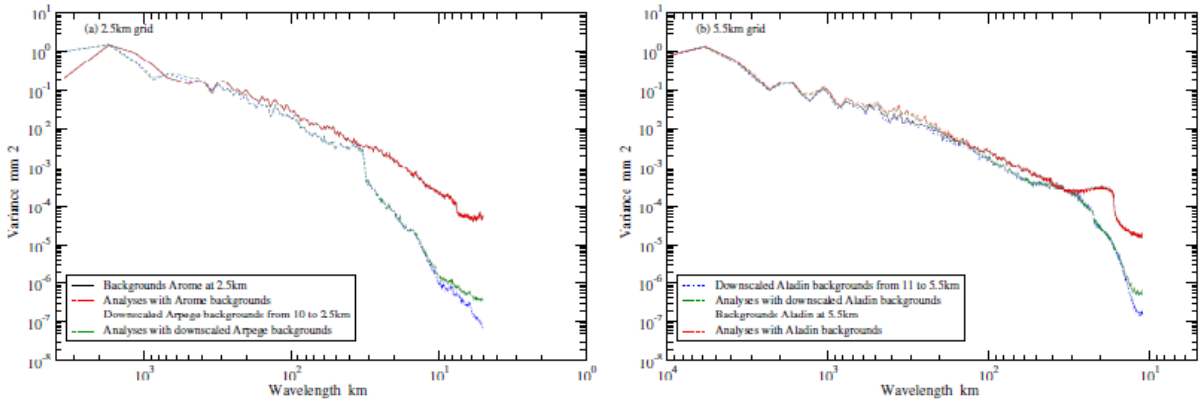

Fig 2: The variance spectra of the monthly mean 24-h total accumulated precipitation as a function of wavelength computed on (a) AROME-France domain at 2.5km grid (for January 2014), and (b) a domain for running ALADIN model at 5.5km grid covering Europe (for December 2009). The blue dotted lines stand for the downscaled forecast fields, the green dashed lines for the analyses performed with downscaled fields, the black solid lines for native forecasts at 2.5km(5.5km) grid and the red dashed lines correspond to the analyses performed with backgrounds from native forecasts. Note that the scales of the abscissa differ in (a) and (b).

Working plan:

2016 :

- For the 5 years and the uncertainties:
  - ALADIN model integration at 5.5km over Europe up to 30h with 2 physics package.for the 5 years period.
  - finalize the configuration of the ensemble surface re-analysis for the 5years period: numbers of members, perturbed observation etc ..
- Starts the 50 years MESCAN surface re-analysis with the static downscaling from the SMHI background. (plan to run 15years)
- The output data will be archived in MARS at ECMWF.

2017 : Finalize the 50 years production (35 years) and the ensemble period (5years)

References :

Cornel Soci , Eric Bazile , François Besson and Tomas Landelius: High-resolution precipitation re-analysis system for climatological purpose. Submitted to Tellus September 2015

Ricard, D., Lac, C., Riette, S., Legrand, R. and Mary, A. 2013. Kinetic energy spectra characteristics of two convection-permitting limited area models AROME and Meso-NH. Quart. J. Roy. Meteor. Soc. 139, 1327–1341.