REQUEST FOR A SPECIAL PROJECT 2017–2019

MEMBER STATE: …………FRANCE….……………………………………...…

Principal Investigator[1]**:** …BAZILE ERIC ……………………………………………..……

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Other researchers:

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Project Title:

Regional surface re-analysis with MESCAN at high resolution over Europe
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If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP**__SPFRBAZI________________	
Starting year: (Each project will have a well-defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)	2017	
Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for 2017-2019:
(To make changes to an existing project please submit an amended version of the original form.)

		2017	**2018**	**2019**
High Performance Computing Facility	(SBU)	15,000,000	10,000,000	
Accumulated data storage (total archive volume)[2]	(GB)	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):

28/06/2016………

Continue overleaf

Principal Investigator: …………Eric BAZILE ………………………………………

Project Title: Regional surface re-analysis with MESCAN at high resolution over Europe within the UERRA project

1The 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.[2] If e.g. you archive x GB in year one and y GB in year two and don't delete anything you need to request x + y GB for the second project year.

Extended abstract

It is expected that Special Projects requesting large amounts of computing resources (1,000,000 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 at high resolution over Europe within the UERRA project

This special project aims to continue to create the regional surface re-analysis over Europe in the framework of the UERRA (Uncertainties in Ensembles of Regional Re-Analyses) FP7 project and to investigate the added value of using a cloud resolving model such as Arome (Seity et al, 2011) to downscale the precipitation for the background. 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 2013.

The precipitation analysis will be performed for this period at 5.5Km with MESCAN (Cornel et al 2015) using a downscaled precipitation background from the UERRA-SMHI 3Dvar re-analysis (11km) 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).

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, 2016).
Figure 1 displays the variance spectra of the monthly mean 24-h total accumulated precipitation fields for December 2009. The static downscaling precipitation from ARPEGE at 2.5km (blue and green curve) clearly show a change in the slope corresponding at 4 dx (30km) which is roughly the ARPEGE "effective" resolution. The precipitation analysis (dashed green line) 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 at 2.5km (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 from the so called ALARO physics.
Those experiments are still running.
In addition to this, on a smaller area with orography such as France and/or Scandinavian, precipitation analysis at 2.5km will be done by using a background from the NH model AROME at 2.5km. For this horizontal resolution the deep convection can be considered as resolved explicitly and the uncertainties, especially the one due to the deep convection parameterization should be reduced. This very high precipitation analysis will be compared for several periods with the UERRA product.

An other aspect, is the impact of the density of the observation network especially for precipitation observation. Before the 80's, the precipitation observations available over Europe are very sparse in some areas, the impact on the precipitation trend along the 50 period will be studied by using a poor network (similar to the 60's) for the period 2006-2010. This type of experiment can also be used to estimate the uncertainties.

The SBU estimation for one year of surface analysis at 5.5km (4 time per day + precipitation analysis) and for the static downscaling of the background is about 100 kSBU.
The ALADIN model integration at 5.5km for one year with a 30h forecast from 00UTC and 6h forecast at 6, 12 and 18UTC, the SBU estimation is about 2500 kSBU for one year.

For AROME at 2.5km, with the ALADIN vertical grid, the cost is multiplied by 15, so the experiment with AROME will be limited on short period (maximum week) with extreme events and on a sub domain of Europe.

Working plan:

2017 :

- For the 5 years and the uncertainties:
    - Finalize the 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.

2018 :

- Definition of the configuration (number of vertical level and horizontal resolution) and domain (several ?, if necessary)
- Create the coupling file for the AROME domain using the UERRA re-analysis
- AROME integration on interesting periods : flood events, high precipitation, snow falls etc .. and then surface analysis with MESCAN for precipitation and T2M and comparison with the MESCAN-UERRA product done at 5.5km

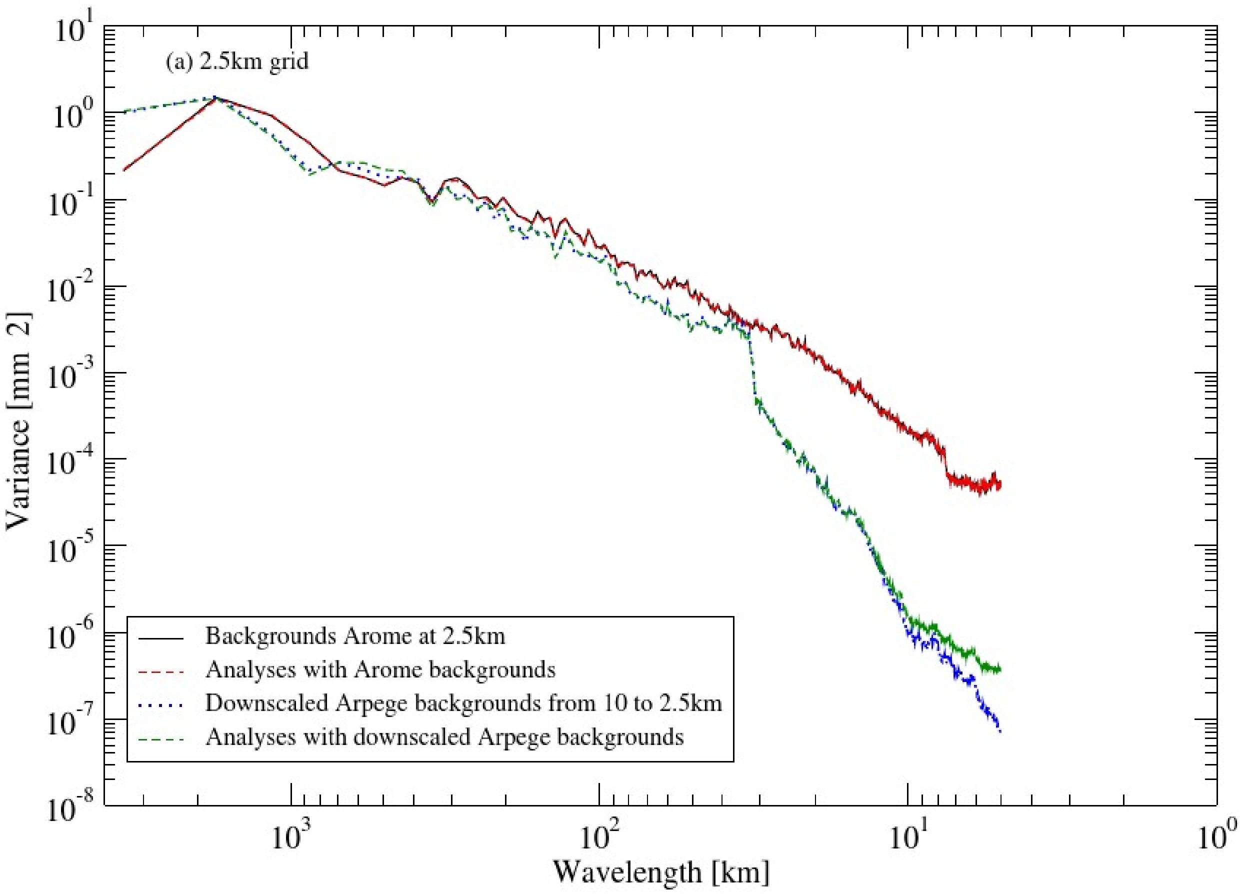

Fig 1: The variance spectra of the monthly mean 24-h total accumulated precipitation as a function of wavelength computed on (a) AROME-France domain at 2.5km grid (for January 2014), The blue dotted lines stand for the downscaled forecast fields, the green dashed lines for the analyses performed with 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.

References :

Cornel Soci , Eric Bazile , François Besson and Tomas Landelius: High-resolution precipitation re-analysis system for climatological purpose. Tellus A 2016, 68, 29879, http://dx.doi.org/10.3402/tellusa.v68.29879

Seity et al. (2011) The AROME-France Convective-Scale Operational Model. Monthly Weather Review http://dx.doi.org/10.1175/2010MWR3425.1