

# REQUEST FOR A SPECIAL PROJECT 2012–2014

**MEMBER STATE:** Sweden.....

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Per Källberg, SMHI.....

**Project Title:** European regional re-analysis

for monitoring and observations

If this is a continuation of an existing project, please state the computer project account assigned previously.	SPSEEUR4_____	
Starting year: (Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)	2011	
Would you accept support for 1 year only, if necessary?	YES <input type="checkbox"/>	NO <input type="checkbox"/>

<b>Computer resources required for 2012-2014:</b> (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2014.)	2012	2013	2014
High Performance Computing Facility (units)	2,500,000	2,500,000	
Data storage capacity (total archive volume) (gigabytes)	12,000	15,000	

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): 2011-04-18.....

*Continue overleaf*

<sup>1</sup> 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:** Per Undén.....

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## **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.*

## **European Regional Reanalysis for Monitoring and Observations**

Per Undén

SMHI

SMHI has a long record of analysed meteorological fields over Europe and surrounding areas extending back to the 1960's as produced operationally for the purpose of Numerical Weather Prediction (NWP). The resolution and quality and availability of fields varies over the years with the resolution and quality of the NWP system at the time. The resolution varies from a few 100's of kilometers to a few 10's of kilometers during the last decade. For near surface variables, clouds and precipitation, SMHI developed the Mesoscale Analysis system (MESAN, Häggmark et al, 2000) in the 1990's and this has been used operationally since the mid 1990's and there have also been several re-runs of past periods of several years for specific purposes. MESAN has been run at 22 km or 11 km over the Nordic area. The variables produced varies with the different runs.

It is thus quite obvious that there is no consistent data set of near surface variables or Essential Climate Variables (ECVs) over the recent past, not even for the last decade. There are many demands and applications for long term datasets : climate analysis in general, analysis of extreme events (e.g. winds, precipitation, temperature), quality control observations and other purposes.

Analysis of previous events has e.g. been made for forest damage, wind energy potential, wind production limitation due to strong winds and more. There is more demand for quantifying periods and areas of icing on wind power rotor blades which reduces production of wind energy or completely inhibits it in some cases.

At SMHI there is also a strong need for quality control of Swedish national observations as archived and re-archived. This is a national responsibility for climatic records, validation of climate models and, not the least, for all sorts of future re-analyses. When trying to use existing archives for validation, certain severe errors have surfaced and it is clear that during certain years gross errors have gone through unchecked. A gridded high resolution consistent data set is needed for detecting these errors and correcting the observations (in most cases). Such a project is starting at SMHI but is relying on such a consistent gridded reanalysis data set.

The global reanalysis data sets from ECMWF (ERA-40 and ERA-Interim) have been very valuable for answering at least partly to several of the above questions. Their value lies in the long term record (40 or 20 years) but the resolution is a limiting factor for extreme events and detailed national analyses.

There have been a few approaches to downscaling of the ERA-40 fields. In e.g. EU ENSEMBLES there have been regional downscalings with regional climate models at 25 km, forced on the boundaries from the ECMWF reanalysis. This has mainly been for the purpose of comparing and validating regional climate models. The absence of interior forcing from observations is obviously a limitation for the applicability of the data sets for other purposes. To overcome this, SMHI carried out a European re-analysis with the MESAN system using observations and interpolated background from ERA-40 (ERAMESAN, Jansson et al 2004). These fields, although produced at the limited resolution of (22 km) showed significant improvements over the regional climate model based downscaling.

SMHI has also several years of experience of regional re-analysis. Over the Nordic area and particularly the Baltic sea, SMHI and FMI carried out a regional re-analysis (Fortelius et al, 2002). In EU DAMOCLES SMHI has carried out an Arctic reanalysis for the IPY (2005). This is for a large region over the whole Arctic and northernmost parts of adjacent oceans. Here the regional model and 4D-VAR reanalysis system HIRLAM was employed and, uniquely for this project, a two way intermittent coupling with the HIROMB ocean model was made. HIROMB includes data assimilation and special ice data sets were included.

Based on this background and needs of SMHI and other NMSs as well as many other general users, SMHI has entered the FP7 EURO4M project and has been carrying out both regional re-analyses and high resolution 2D-downscaling together with Météo-France. MESAN and SAFRAN (Durand et al., 1993) have been set up and run and validated with high resolution observational data sets over France. There will be developments of both the regional assimilation system but above all, of the 2D-analysis system which shall combine the best methods applied in MESAN and the MF SAFRAN system.

## Project update

SMHI will carry out a 22 km regional re-analysis for the past 20 years (the ERA-Interim period) and with HIRLAM 3D-VAR based on observations from ECMWF MARS and forced at the boundaries from ERA-Interim. Conventional observations will be used in the data assimilation. Due to the significant extra demands on quantify control and bias correction of satellite radiances and the long period, there are not enough resources to carry out regional radiance assimilation as is done operationally or for the IPY in the case of DAMOCLES. Instead there will be a large scale forcing from either the so called large-scale mixing (re-run of first guess forecasts from ECMWF fields) or, preferably, through a newly developed cost function ( $J_k$ ) which measures the distance of the control variable (analysis effectively) from the ECMWF background in terms of large scales and vorticity. This is based on proper statistics of covariances of such difference fields from historical data. The results are encouraging and significant improvements of large scale fields (like the mean sea level pressure) has been noted (Dahlgren, pers. comm.).

A rather large area covering all the Mediterranean and the Atlantic islands of Canaries and Azores and also Greenland will be run at a resolution of 22 km. The data assimilation system will be 3D-VAR as has a higher quality and is the system used for most operational applications at SMHI as well as the HIRLAM-A member institutes (Gustafsson et. al, 2001)

The HIRLAM data assimilation and modelling system is developed jointly by the National Meteorological Institutes of Norway, Sweden, Finland, Denmark, the Netherlands, Ireland Spain and Estonia. Météo-France is a co-operation member. Latvia and Lithuania are acceding members.

Several months of 2009 have been run and tested, many times, during the past year. The HIRLAM 3D-VAR system including the assimilation HIRLAM forecast model have been evaluated extensively and compared with ERA-Interim. A number of aspects have needed corrections or improvements concerning albedo effects over Sahara, ice boundaries and snow over Greenland ice pack. Furthermore the most recent HIRLAM Reference version (7.3) has some pressure bias problem.

Still, the months that have been run have been demonstrated to perform well and compare well with ERA-Interim and provide additional value due to the much higher regional resolution.

There has been a close cooperation with Météo-France concerning the high resolution downscaling and analysis of near surface or surface variables. The complete station data set from France has been used to test MESAN (SMHI) and SAFRAN and CANARI (MF OI based 2D analysis tool, Taillefer 2002)) for three interesting months 2009-2010. 2m temperature, humidity and precipitation have been analysed using about 2000 stations and comparing the systems with station data and also some independent data.

In general the systems compare well even though they have different strengths. The corrections with respect to orography difference is crucial to the results. A comprehensive report is being written.

## Further plan of the work

There will be a 2-dimensional high resolution 5 km downscaling MESAN analysis over the EEA area with observations additional to those used in the HIRLAM3D-VAR analysis. The MESAN system has been improved in some aspects from the work with MF and the comparisons with SAFRAN.

As a result of the comparisons between MESAN and SAFRAN (and CANARI) a number of strong points from MESAN and SAFRAN will be built together to form an improved system. This will reside within the CANARI (and IFS code) framework.

## Outreach

The European Regional re-analysis will be archived at ECMWF and there will be open access as stipulated in EURO4M and following access methods allowed by ECMWF, if the final data will reside there and most likely also by SMHI using MARS.

Obviously it will be easiest for ECMWF and ECMWF members to access the data at a very early stage. Interactions with ECMWF, other member institutes and of course the partners in EURO4M are expected to be very fruitful.

### References:

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