SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year	2015
Project Title:	Regional European re-analysis with HARMONIE for UERRA (RERA)
Computer Project Account:	spserera
Principal Investigator(s):	Heiner Körnich Per Undén
Affiliation:	SMHI
Name of ECMWF scientist(s) collaborating to the project (if applicable)	Richard Mladek …………………………………………………………….……
Start date of the project:	1/1/2014
Expected end date:	31/12/2017

Computer resources allocated/used for the current year and the previous one

(if applicable)

Please answer for all project resources

		Previous year		**Current year**	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	30,000,000	3,093,230	30,000,000	4,349,074
Data storage capacity	(Gbytes)	40,000	?	80,000	~75,000

Summary of project objectives
(10 lines max)

This project will create a regional European re-analysis data set from 1961 to present-day with the HARMONIE (Hirlam Aladin Regional / Mesoscale Operational NWP in Europe) modelling system. The resolution will be 11 km horizontally and 65 levels vertically. A 3-dimensional variational data assimilation will be employed. Over a shorter time span of 5 years, a multi-physics mini-ensemble will be run with different physical parameterisations. The results from the proposed project will contribute directly to the European FP7 project UERRA - Uncertainties in Ensembles of Regional Re-Analyses with 12 institutes from 7 EU countries, Switzerland and an international organisation (ECMWF), coordinated by Per Undén. UERRA will provide long-term datasets of Essential Climate Variables (ECVs) on the European regional scale in order to support adaptation action and policy development. The datasets will contribute to Climate services for Copernicus, climate monitoring and research.

Summary of problems encountered (if any)
(20 lines max)

A large part of the 5-year runs were not used with the correct HPC account and were registered on the Swedish national resources instead. The total amount for this part could be as much as 35 Million SBUs.
We were running into problems with the inode limit on $PERM@cca, since HARMONIE generates a lot of files even after having optimized the usage on SCRATCH and PERM for the experiments. On request, Carsten Maass (ECMWF) has increased the allowed number of inodes on $PERM@cca that provided a more stable production environment for us.The runtime of the HARMONIE setup was optimized in order to finish the multi-year runs in reasonable time. To this end, the long forecasts and the analysis are performed in parallel. Further code optimization was implemented concerning retrieving the boundary data, usage of pools during preprocessing, number of threads and nodes in parallelisation, parallel production streams.
Due to the slower than expected performance of the model, the 5-year multi-physics mini-ensemble is delayed. The experiments are expected to be finished during June 2015.
For archiving on MARS, most HARMONIE parameters are now defined in GRIB2. The definitions were sent to ECMWF and accepted. However, the conversion from GRIB1 to GRIB2 and the archiving in MARS is not tested. So far, we will continue to store the data on ECFS.

Summary of results of the current year

For the FP7-projekt UERRA, SMHI continued its contribution to WP2 task T2.2, Deterministic Reanalysis. A first production run has been started. The 5-year multi-physics mini-ensemble is expected to be finished during June 2015. Based on the results of these experiments, the model configuration for the long 50-year production will be determined.

Preliminary results of the 5-year multi-physics mini-ensemble

The five year mini ensemble runs are performed using the HARMONIE model system cycle 38h1.1. HARMONIE allows for different physics packages and surface schemes. Here, two different physics schemes are used, ALADIN synoptic scale scheme and the multi-scale ALARO scheme. For the surface the scheme SURFEX is used. Both models are run with upper air data assimilation using a 3D-Var scheme and only conventional observations, and with surface assimilation using optimal interpolation. The selected period is 2006 to 2010.

Preliminary verification is available for the first 3 years (2006-2008) using available conventional observation over the entire model domain. Figure 1 shows the verification of the DJF 2m-temperature. For both bias and standard deviation, ALADIN outperforms ALARO. In almost all seasons, ALADIN shows also better verification for 10m-winds, 2m-relative humidity and for surface pressure. Also in the free troposphere, ALADIN shows better verification than ALARO, e.g. for the 500hPa-wind speed during autumn (SON; Fig. 2).
For the precipitation, the comparison between the different physics package is more mixed. Figure 3 shows the Kuiper skill score for the 12h-precipitation during summer (JJA). For precipitation classes less than 3 mm/day, ALARO shows slightly higher scores than ALADIN. This situation is reversed for classes higher than 3mm/day, with higher scores for ALADIN than ALARO.
A thorough analysis of the two 5-year reanalysis will be performed when the runs are finished. However, at the current stage and with the given set-up, ALADIN shows clearly better meteorological performance than ALARO.

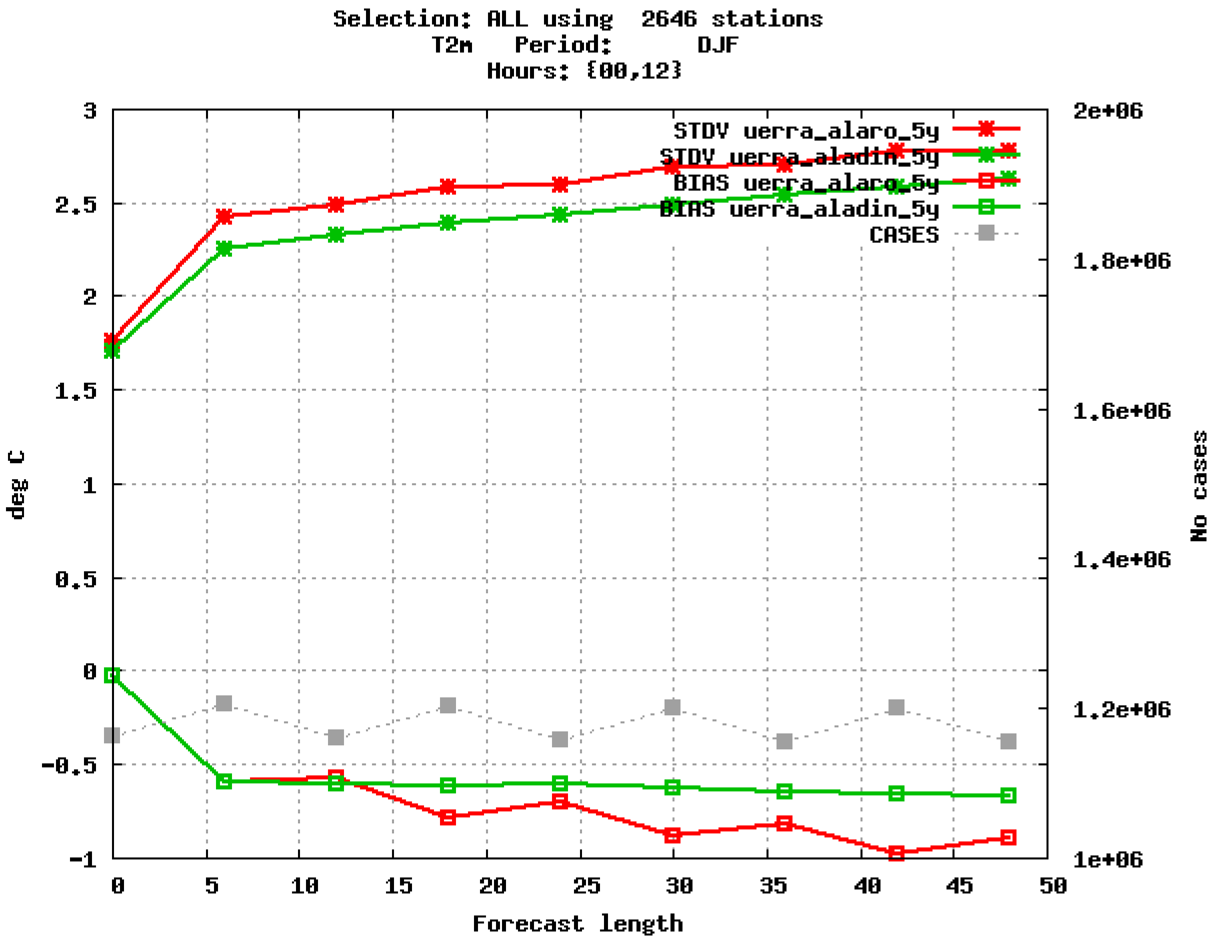

Figure 1: Verification of the DJF 2m-temperature for the UERRA mini-ensemble for the years 2006-2008.

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http://www.ecmwf.int/about/computer_access_registration/forms/

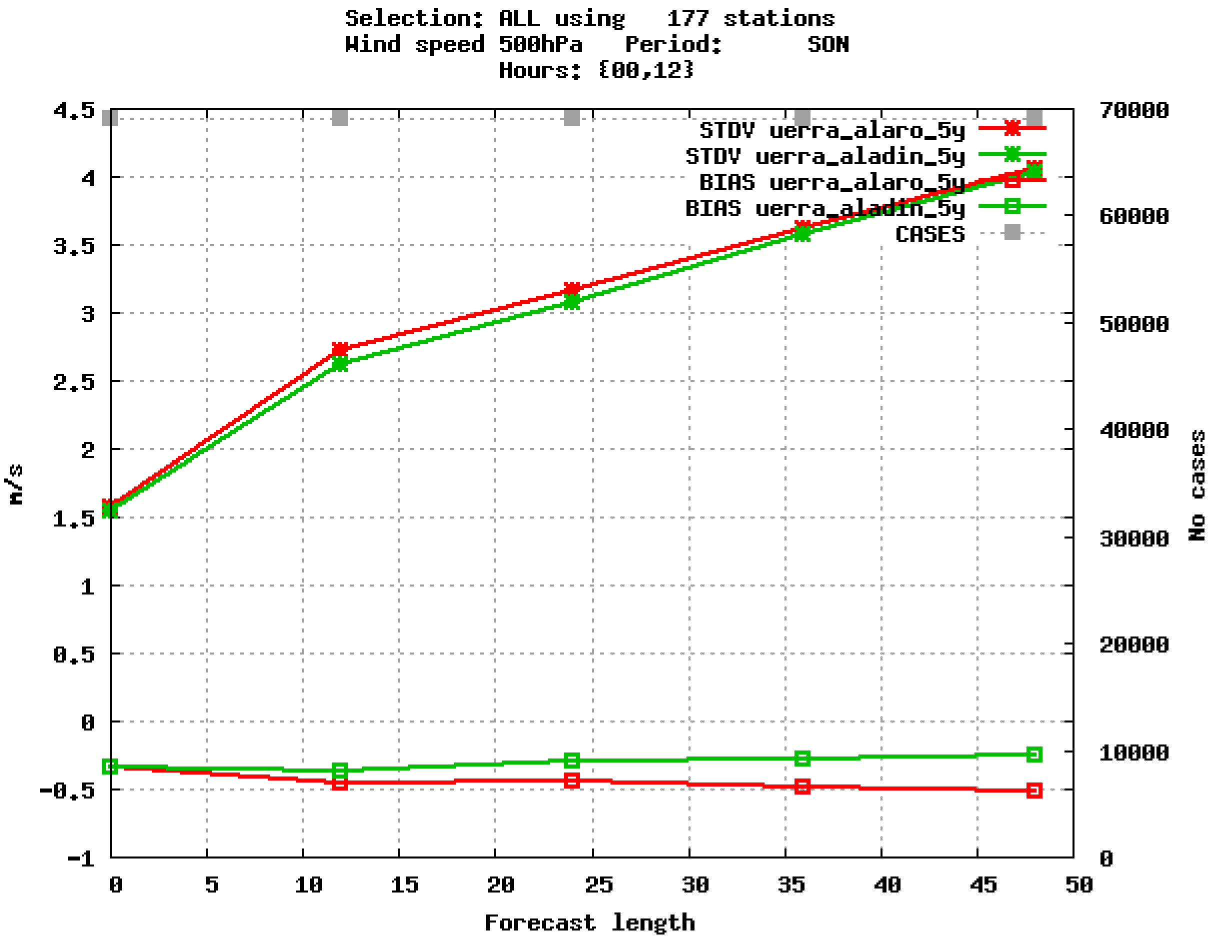

Figure 2: Verification of the SON 500hPa-wind speed for the UERRA mini-ensemble for the years 2006-2008.

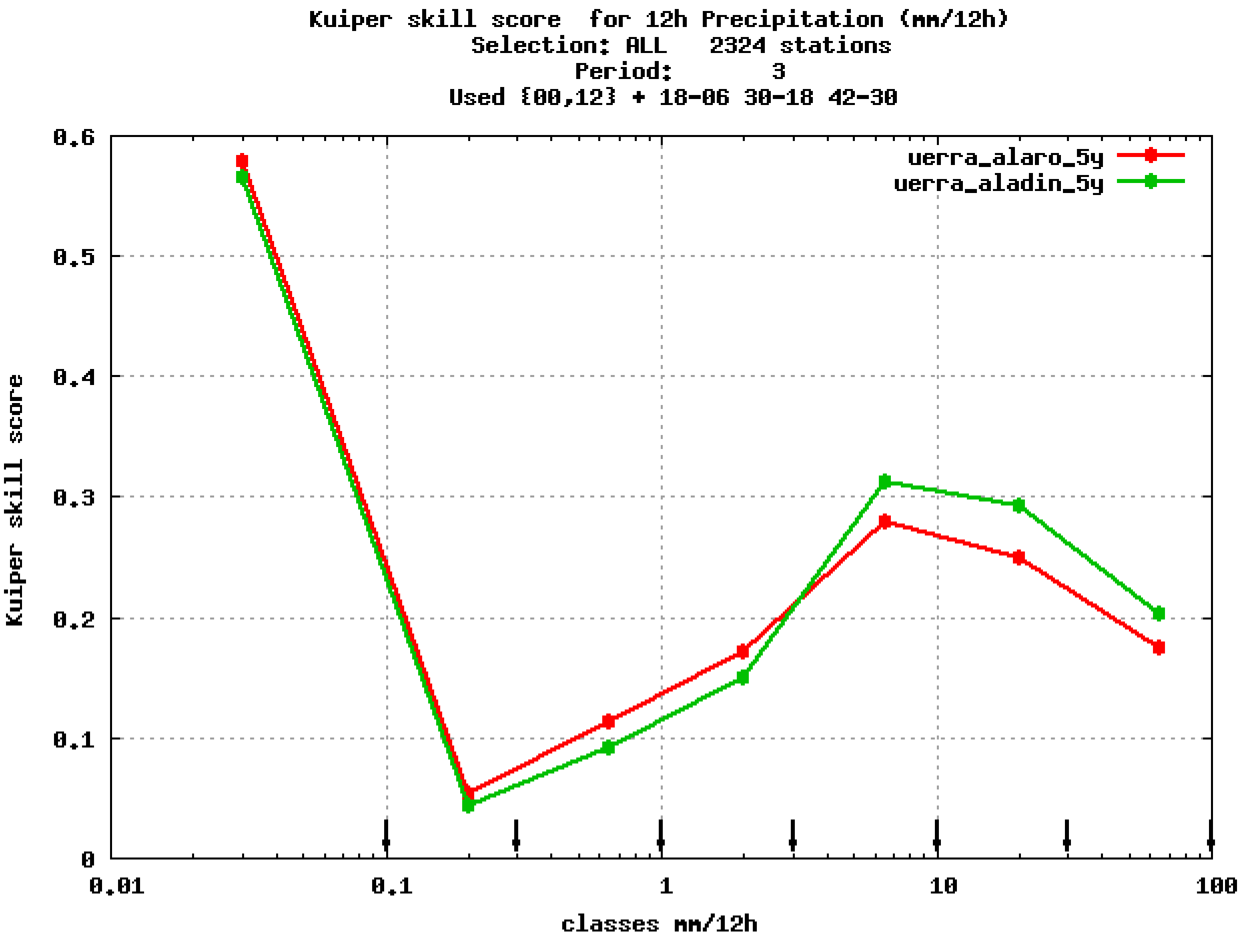

Figure 3: Kuiper skill score of the JJA 12h-precipitation for the UERRA mini-ensemble for the years 2006-2008.

Results for large-scale mixing

NWP on a regional domain requires a coupling system that provides lateral boundary information during the time integration step. The coupling system is often a global NWP model run on a coarser grid mesh than the regional model. Global models are generally better at representing large scale features, e.g. Rossby waves with a length scale of 1000-3000 km, which is essential to get the position of the synoptic high- and low pressure systems right. Blending, or large scale mixing, refers to the methodology of introducing the large scale features of the host model into the initial condition of a regional model.

There are different ways to do this and in the HARMONIE framework two methods are implemented. The first method, LSMIXBC, combines the large scale spectral components from the first boundary file with the small scale components from HARMONIE into a modified field used as first guess in the 3DVAR analysis. The second method adds a penalty term, Jk, to the cost function in 3D-Var that measures the distance between the model state and the large scales from the host model. It has been shown by Dahlgren (2013) that the latter method gives somewhat better results so in this study this will be the choice.

In the 5-year mini-ensemble run, large scales from ERA interim are mixed in via a Jk-term in the 3D-Var minimisation. This means that the large scale mix will be added as an extra constraint in the 3D-Var.

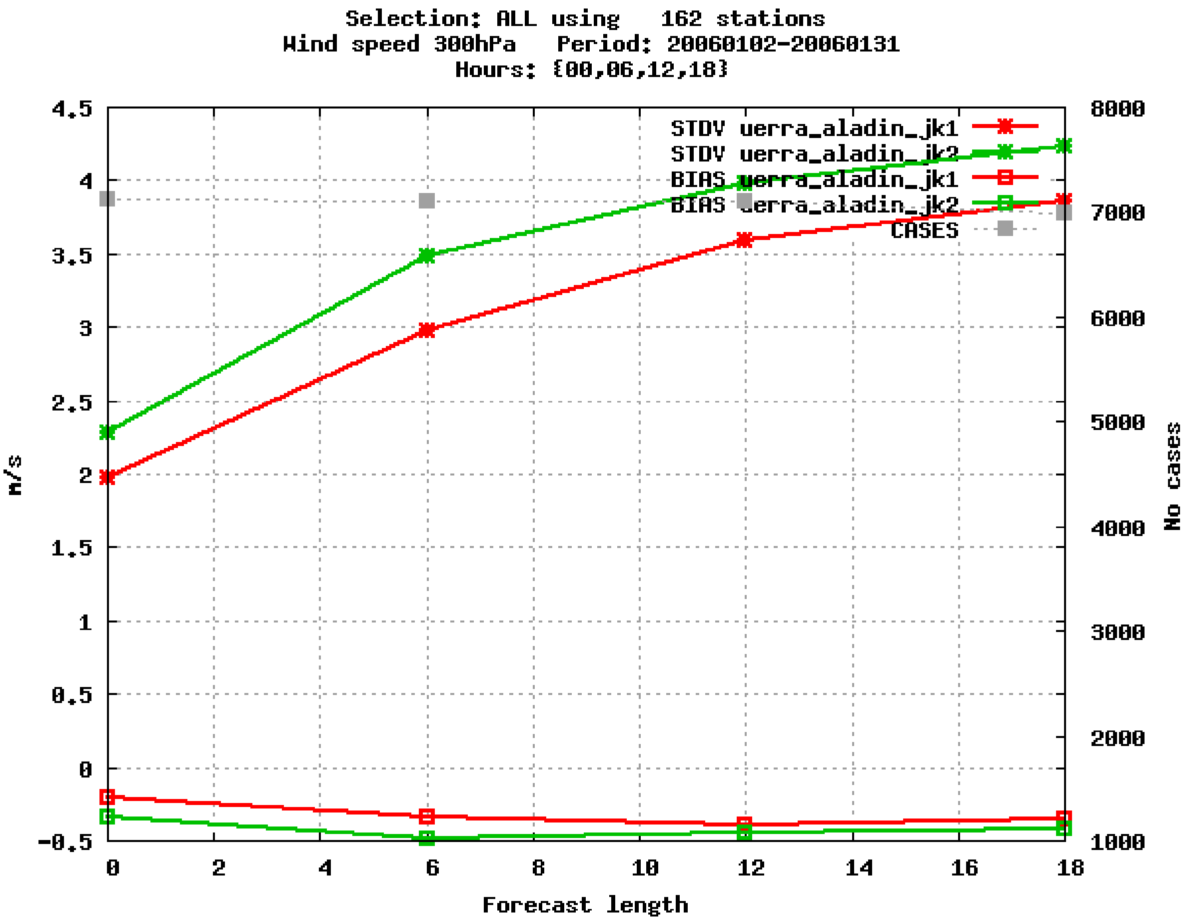

Figure 4. Comparison between two ALADIN experiments using Jk with ERA-interim forecasts (green) and ERA-interim analyses (red)

From ERA interim the analyses are used. This implies that there is a risk of using the same observations twice, however, the verification of the experiments run with analyses instead of forecasts verified much better. An example from January 2006 with ALADIN is shown in Figure 4. The green line represents the experiment using ERA-interim forecasts (jk1) while the red line is the

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same experiment but using ERA-interim analyses for the Jk-term. The upper lines show the model error (standard deviation) and the lower ones show the bias of wind speed at 300 hPa.

References

Dahlgren, P. and N. Gustafsson, 2012: Assimilating host model information into a limited area model, Tellus A, 64, 15836, doi: 10.3402/tellusa.v64i0.15836.

Dahlgren, P., 2013: A Comparison Of Two Large Scale Blending Methods; Jk and LSMIXBC. MetCoOp Technical Memorandum. Available at http://metcoop.org/memo/

Guidard V. and Fischer C., 2008: Introducing the coupling information in a limited-area variational assimilation, Q. J. R. Meteorol. Soc., 134, 723-736.

Masson, V. et al., 2013: The SURFEXv7.2 land and ocean surface platform for coupled or offline simulation of earth surface variables and fluxes, Geosci. Model Dev., 6, 929-960, doi:10.5194/gmd-6-929-2013.

List of publications/reports from the project with complete references

The reports of the FP7-project UERRA can be found on the following webpage:
http://www.uerra.eu/publications/deliverable-reports.html
No specific report related to the new reanalysis that will be produced in this special project has yet been produced.

Summary of plans for the continuation of the project

(10 lines max)

The earlier project EURO4M generated regional European reanalysis for the years 1989 to 2010 with the HIRLAM modelling system. Currently we are working on a continuation of that reanalysis.
The project UERRA will finish in the end of 2017, covering the years 1961 to present-day. It is desirable that this regional reanalysis will continuously be produced, downscaling the global reanalysis of ECMWF. No concrete plans for this continuation have been made so far.