UERRA Periodic Report Period 2 M13-M30 (20150101-20160630)

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2 Project objectives, work progress and achievements, project management

2.1 Project objectives for the period

Objectives accompanied by a summary of progress towards objectives (in italics).

From the DoW (Annex I, Part B), the following objectives for the **whole** project are defined. The detailed objectives for the reporting period (M13-M30) are listed in 2.1.1 – 2.1.9.

- The overriding objective is to produce long-term high-resolution climate quality datasets over Europe complete with estimations of their quality and uncertainty (WP1, 2, 3 and 4)
- To produce these through 3 and 4-dimensional reanalyses (RA) and 2-dimensional downscaling RA and extended observation gridded datasets (WP2 and WP1)

These areas are actively worked on and there are only partial results. The 3-dimensional RA are in production and the others are in final testing or/and their initial production.

- To estimate the uncertainty of the individual RA through ensemble data assimilation for Europe and produce a high-resolution ensemble RA for as long multi-decadal time period (WP2)

These is being actively worked on and developed but no long-term results yet.

- To provide additional observations to be used for these RAs, other projects and for the community at large (WP1)

Yes, a large number, much more than promised, of the targeted number of observations have been digitised. (See below under WP1 (2.2.1). Roughly half post-1961 and half before. The accessibility of data has been somewhat limited to certain countries and there were not enough post-1961 data available as hoped for. Only some new observations (digitised by the NMSs will be extra observations for the UERRA RRAs though; it is a lengthy procedure to get them all into MARS eventually.

The below objectives apply to the last years of UERRA even though the work has started for several of the below objectives.

- To make the RA data available to a large number of users (WP4)

*This is in active development and the RA data have only been produced for short periods at the time of writing (1-2-5 years, 5*2-3 years and up to 5+5*2-3 years for the different partners. SMHI has almost 25 years but non-contiguous data and not archived in MARS yet)*

- To provide data services and visualisation portals for a large number of RA fields (WP4)

There have been demonstrations of the capability at/after the GA 2016 inter alias so the capacity exists.

- To quantify uncertainties and establish knowledge of the quality of the different RA in many different ways, between datasets and with respect to observation gridded sets and satellite-based datasets and river discharge data (WP3)

The methods and trials on EURO4M data sets and on DWD data sets against observations have been carried out and is ongoing for satellite data. The main work awaits the availability of UERRA data in MARS..

The below objectives apply for the remaining, final, 1.5 year period:

- To get a consistent knowledge for Europe with a common evaluation procedure for ECVs, climate indicators, extremes and scales of variability in space and time and distributions (WP3)
- To document how well extremes and special climate features are reproduced in the RA (WP3)
- To show how the data can be exploited for user-oriented products (WP8 and WP3)
- To provide a unique and useful datasets for a wide range of downstream applications (WP4, WP8)
- To support Climate change services and climate adaptation (WP7)
- To support and aid policy development and monitoring of climate for European wide and European national applications (WP7)
- To establish good user contacts and get early feedback on the user products (WP8)

The first steps have been taken quite successfully through the User WS in Toulouse 2916 and prior as well as subsequent contacts.

- To have a long lasting impact also after the end of the project (WP1, 2, 3, 4, 6, and 7)

2.1.1 Work Package 1

• Assess both the need for synoptic-scale basic observational input for Regional RA and the historical data sources containing surface observations at the sub-daily scale and gain access to their archives

Yes, this was done in the beginning of the year (1) through discussions within the UERRA Project and the Management (MST) team.

• Link and coordinate with existing data rescue initiatives and projects to optimise resources, avoid duplication and enhance data availability and accessibility

Yes, through the extensive knowledge and contacts resting with URV and UEA, this has always been adhered to.

The Data Rescue's coordination has been undertaken in UERRA WP1 by building upon the contacts gathered under EURO4M, which integrates the major players in the international DARE arena (e.g. Meteo-France, ACRE, Justus-Liebig - Universitat Giessen, University of Bern, University of Lisbon, all of them integrated in the ERACLIM project).

In this occasion, special care has been placed in coordinating with ERACLIM2 project activities by using the information held at the I-DARE portal (https://www.idare-portal.org/data/era-clim2-portugal) and by ensuring both the type of data (land surface and upper-air data) and the spatial and temporal targets are different in both projects. While under UERRA the focus has been land surface observations at the synoptic scale and over

European sub-regions (the Mediterranean, Central Europe and the Balkan regions), in ERACLIM2 the focus has been placed at the global scale (e.g. Africa, South America, India, Asia) for land surface data and upper air data for Europe, ensuring that there are none DARE activities duplicated.

• Filling in gaps for available synoptic-scale observations for data-sparse European regions and periods post-1950 and further recovery and digitization of synoptic-scale observations for data-sparse European regions and periods pre-1950

Yes, to a large extent. The number of observations is almost fulfilling the target, but the distribution in space is somewhat limited due to accessibility (see under WP1, 2.2.1).

• Enhance high-quality synoptic-scale data development, including methodological improvements for climate time-series homogenisation at the hourly scale in support of enhanced Regional Reanalysis (RRA) development for Europe

Yes, especially during this reporting period and more extensive work than planned.

• Enhance gridding procedures within E-OBS, particularly for extremes.

Yes, see periodic report I (the first one).

• Improve the uncertainty assessment within E-OBS, taking greater account of the changes in station density in both space and time. These uncertainties should also be more explainable and understandable within and outside the climate science community.

Yes, this has been done at UEA, MS and KNMI and demonstrated in GA 2016 and the Deliverable D 1.9 in particular

• Continue to produce E-OBS in real time

Yes.

2.1.2 Work Package 2

• Development and production of a satellite-era (1978-present) high-resolution European ensemble regional reanalysis dataset, based on ensemble-variational data assimilation.

The development is in good progress even though it is much behind the plan. A regional ensemble 4D-Var data assimilation system has been developed and adapted. The development and final testing took longer than anticipated but is now in its final stage, before production.

• Adaptation and production of a deterministic HARMONIE reanalysis for 1961-present.

The adaptation has largely been done and the first set of 5-year productions started. There are scientific and technical developments for the soil and physiographic coupling planned but not mature or implemented yet. One (vegetation index) has been worked on but the extended Kalman filter for the soil will be worked on during the end of the Project and tested for a period. It will not be ready for the production since this has been running for a such a long time. Therefore it will not impact on the production but it can be used for future reanalyses.

Production is ongoing and satisfactory and is 6 parallel streams of which several years have been done in most of the streams.

• Downscaling of ensemble and deterministic RA to provide km-scale European-wide reanalysis datasets.

Several experiments of both ways of downscaling and early ensembles have been performed. The two physics versions from SMHI have been used and both static and dynamic downscaling have been performed (dynamic by running a high resolution forecast and static by just interpolation to high resolution). Different soil schemes have also been used in the different runs and 6 – 8 ensembles created from these combinations. They have been tested now in order to start production.

• Development of a homogeneous reanalysis system for the pre-satellite-era using a hybrid local ensemble transform Kalman filter/ensemble nudging approach with RA data production of at least 5 years.

The first part of the work involving ensemble nudging has been developed and carried out for a period with promising results. The local ensemble transform Kalman filter (LETKF) was developed but was not completed and is halted until later in the project due to key personnel not available this year.

2.1.3 Work Package 3

• To evaluate deterministic, ensemble reanalyses and downscaled reanalyses through comparison to ECV datasets, that were derived independently

WP3 work progressed with the preliminary data sets from EURO4M and national activities, while awaiting the first UERRA output. Method development, scripting and preparatory work continued thus without any delays. Definitions of variables and evaluation measures were refined and reviewed, incorporating the findings from the user communication of WP8. In this reporting phase, liaising with WP4 (on storage) and WP2 (on production) ensured that the input for WP3 has been prepared for in an optimal manner.

• To establish a consistent knowledge base on the uncertainty of reanalyses across all of Europe, by adopting a common evaluation procedure for ECVs, derived climate indicators, extremes and scales of variability that are of particular interest to users

Preliminary Common evaluation procedures have been agreed on, and are applied to data available up to now (see D3.3). Effort was spend particularly on the ETCCD indices by KNMI, and on the variables of high relevance for renewable energies (wind, solar radiation) by DWD.

• To statistically assess the provided information over Europe by applying the common evaluation procedure to the reanalyses products, gridded datasets and satellite data

Preliminary results have been shared at the GA in Toulouse. A git repository is set up by MI and DWD to share code between the participants and is freely available for users.

• To apply the common evaluation procedure for special climate features of selected sub-regions of Europe, providing feedback on the reliability of measures of uncertainty contained in reanalyses

In this reporting period, method development efforts concentrated on the sub-regions of Scandinavia (MI), the Alps (EDI), and Romania (NMA-RO), with a common focus on precipitation.

The recommendations from the previous review (*Technical Review report from UERRA Year 2*):

Within the *Technical Review report from UERRA Year 2* it is suggested: 1b) “It seems a good idea to delay use of evaluation work resources for analysing any delayed project data output. To be able to do it in the manner as planned. Project results will be more substantiated with good verification reports from large data sets than theoretical deliberations from small test sets. “

All WP3 partners are aware of this, the schedule has been discussed at the GA3 Toulouse and each partner’s plans take this into account when possible.

2.1.4 Work package 4

• To make available the reanalysis data to a large number of users and link in an optimal way to existing data and visualization portals or portals that are being developed in parallel projects, for scientific and policy use

The work is very intensively ongoing to make reanalysis data available and detailed definitions for the new UERRA data in GRIB-2 has been accepted and published. Common test data from EURO4M for two years have been archived in MARS. Data and visualisation services have been demonstrated for UERRA from other projects and work therein.

• To explore how the reanalysis data are best exploited for development of user-oriented products such as derived climate indicators, to use these for assessing the key characteristics of climate change in Europe, and to quantify the uncertainties which are most relevant to the development and assessment of policies

This is linked with Work package 8. Work on derived indices has just started but the tools and scripts are available. Of course, the lack of extended periods of RRA data is a limiting factor.

• To link the activities on reanalysis and observation products with other projects from this call, in particular CLIPC ("Provision of access to simulated and observed climate datasets and climate indicator toolbox")

The partners where CLIPC is actively collaborating, plan and join activities with CLIPC in order for UEREA data to be included. The UERRA ESGF node is being set up.

2.1.5 Work package 5

• Provide the overall legal, ethical, financial and administrative management of the project to ensure aims of the project are efficiently and effectively met, on time and with the resources budgeted

Yes, see further in 3.1. Some re-allocation of resources have been negotiated between the partners due to long delays of some tasks and the realisation that they would be better accomplished by another partner. Data services PM s and Dissemination PM s are being transferred from KNMI to ECMWF and SMHI respectively.

• Coordinate and facilitate effective communication between the consortium and the REA in legal, ethical, financial and administrative issues

There have been communication about practical and technical problems with the previous Periodic report, about correcting how some partner's costs were reported, about use of UERRA funds for overseas travel. Regular progress reports have been written for the REA during the period. Details about subcontracting costs for catering at the meetings in Toulouse 2016 were discussed. The amendments as above were discussed with REA.There have been communication around some of the Deliverables.

• Organize meetings relating to the Consortium Management

Yes, in particular the General Assemblies (2015 and 2016). These have also been review meetings so some rearrangements were necessary. The teleconferences involved both Consortium Management and Scientific coordination.

2.1.6 Work package 6

• Provide effective management to achieve project objectives on time, to cost and at a high quality level

Yes, this has continued with many more Deliverables being completed during this period. There were several delays but most of the delayed ones were caught up on during the spring 2016. The actual production of the four RRAs and their archiving in MARS is still delayed and bars the actual final products to come out based on those archives.

• Ensure that the project prepares all results and deliverables in due time and good quality

There were several delayed Deliverables in the beginning of 2016 and highlighted in the Technical Review Report for year 2. For most of them there were explainable and prior advertised reason, such as coordination and dependencies with and of other scientific work and other projects, like CLIPC. Lately most of these have been caught up on. There are still delays due to the availability of the individual RRAs or lack of results.

• Ensure the scientific interaction with the REA, consultation with the External Scientific Advisory Board (ESAB) and represent the project towards external parties

Yes. However, we never had any success with the involvement of the 3rd member in the ESAB, from DG CLIMA. There seemed mainly to be conflicts with other activities and not enough time available. (Alfonso Guttirrez Teira). Lately a replacement has been found (Muguel-George Paunescu (to be confirmed).

• Manage the scientific progress by ensuring good internal communication and regular meetings with the WP leaders (MST).

Yes, again see 2.3.6. Regular meetings mainly over the phone or in connection with EMS and GA meetings have been held (Every 2 months roughly).

2.1.7 Work package 7

• Ensure the interaction with the EC via REA

Yes, this has continued at regular intervals and when questions have arisen. Therr have been regular status reports and telephone discussions about how to fulfil some of the Deliverables.

• Represent the project towards external parties

Yes (but not much need so far).

• Management of dissemination of the project on regional, national, EU- and International level

Yes. Two Newsletters, presentations, publications and two general Project adverts/information leaflets.

Publications can be seen on http://uerra.eu/publications/pape .rs.html and presentations on http://uerra.eu/publications/conference-contributions.html and in Sect. 2.3 of this document where the ones most from the Rerporting period are listed.

• To connect to the climate change community and the ongoing Copernicus projects and downstream services, to inform them on the developed RA and observation products, and to get relevant feedback for the project

To some extent and especially through the WP9 meetings and exchanges with other projects (some information and questions with ERA-CLIM2 and CLIPC, CORE-CLIMAX).

• To work on capacity development closely with EU candidate countries and developing countries, which will be among the largest potential beneficiaries of international co-operation in climate services

This is delayed but will take place at the end of November (African Workshop) but there is already ongoing work through KNMI contacts and URV has activities in developing countries.

• Prepare high quality dissemination material and organize a final event

2.1.8 Work package 8

- To involve third-party data providers and climate service developers to provide guidance on the use of the ensembles of reanalyses (RA) including the associated uncertainties, to get feedback from these 'early adopters' and to facilitate evaluation of the reanalysis ensemble using independent national observation data

A major pathway for interaction with third-party data providers and climate service developers is 'in-house' within the national meteorological services involved in the UERRA project. In addition to working these obvious connections, the Swiss Centre for Climate Systems Modelling (C2SM) has been visited in May 2016, which serves various users in Switzerland with climate data, and special focus was given on the user requirements of the climate modelling community. Their user feedback on the UERRA archive had been collected and used as input for the Copernicus Regional reanalysis workshop at Reading in May 2016.
More national meteorological or climatological services are informedby UERRA presentations with in the reanalysis session at the European Meteorological Society (EMS) annual meeting, which is

connected with European Conference on Applied Climatology (ECAC) and the European Conference on Applications of Meteorology (ECAM).

- To come up with guidelines on usage or the RA products and their uncertainties

The status of this objective is scientific analysis. Examples of evaluation of reanalyses have been shown to other national meteorological services at the EMS&ECAM conference at Sofia 2015, and are planned for the EMS&ECAC at Trieste, 2016. Guidelines for usage of RA products have been drafted for COSMO-RE6 by DWD, and communicated within DWD, which can be build upon and extended for all UERRA products as soon as the analysis of these (done in WP3) becomes available.

2.1.9 Work package 9

• Coordination activity among the five FP7projects from the 2013 FP7 space call (ERA-CLIM2, UERRA, QA4ECV, CLIPC, EUCLEIA)

Information exchange has taken place on a regular basis, especially through teleconferences.

(15 June 2016, 1 March 2016, before that a long break for 2015).

• Coordinated information exchange between the five FP7 projects and the outside world

• Coordinated approach to relevant Commission DGs

• Joint stakeholder liaison activities

The above three objectives have not been so relevant during this reporting period (2015- June 2016) either and the Overarching activities (WP9) have been limited. The telephone conferences have resumed but not all Project have been represented and not all Projects have made contributions to the Deliverable Lessons learned. It is partially outside UERRA control.

2.2 Work progress and achievements for the period

2.2.1 Work package 1, Data Rescue and development, gridded and observational datasets

During this second reporting period, the work carried out under the UERRA's WP1 in its three different tasks is going well and it is mainly on track. The main tasks include data digitisation and gathering (T1.1 by URV and NMA-RO) of the recovered data and metadata; quality-control (T1.2 by URV and UEA) and the enhancement of methodologies to reduce uncertainties in gridded products, such as E-OBS (T1.3 by KNMI, UEA and EDI).

The progress achieved under WP1's Task1.1 has been remarkable, since this task has not only kept on track, but has also exceeded the digitisation targets as they were planned. A larger number of observations at the synoptic scale than planned have been digitised by URV. This rescue effort includes hourly observations of air pressure (SLP), temperature (TMP), wind speed (WS) and direction (WD), temperature dew point (TDP) and relative humidity (RH), in addition to snow-depth (SD), snowfall (FS) and precipitation (RR) observations at the daily scale. As shown in UERRA agreement, it was agreed that the recovery of about 4M of station values (3.7M by URV and 300K by NMA-RO) would occur during the two first years of UERRA. However, by the end of the month 24, a total of ~8.2M of station-values were digitised by URV (6.5M for the post-1950 period and 1.7M for the pre-1950 period), in addition to 300K station-values recovered by NMA-RO. Therefore, the digitisation tasks in T1.1 have largely exceeded expectations, since the agreed target has been doubled. This exceedance can be explained by the improvements made to the digitisation process, for which several templates emulating data-source formats have been designed to improve the efficiency of the digitisation work. In addition to the data sources listed in D1.1, a number of National Meteorological Services (NMSs) have granted URV access to their un-digitised assets, while other contacted NMSs (e.g. Macedonia, the FYR; Montenegro, Romania, Serbia) could not provide access due to diverse reasons (e.g. internal data policies, lack of resources and impossibility of scanning their data-sources). About 3.5M of station values were digitised by URV over Catalonia (~200K), Germany (730K) and Slovenia (2.5M), increasing dramatically the number of observations available to better support regional reanalysis over these areas. (The potentially available number of data is of course many times larger than the 8M recovered but a more exact number requires inventories by region and time period, but it is likely to be 100s of millions of observed data that have been made and not available digitially (or not at all, there may be lost data too)). At the same time, the URV has been also active contacting European NMSs with open data policies, in order to gather their digitised observations for mainly the post-1950 period for being in use for other UERRA partners through the ECFS and provide them to the relevant international databanks to enhance the input data to support regional reanalysis of high-resolution. In this regard, URV contacts with the NMSs in Norway, Sweden and Catalonia have returned a total of 114M of added observations to be provided to relevant archives, which is a remarkable high amount, not envisaged in Annex 1 that deserves acknowledgement to these NMSs. The two related deliverables, D1.3 on infilling in temporal and spatial gaps for the post-1950 period in Europe and its borders and D1.4 on infilling in European

temporal and spatial gaps for the pre-1950 period were submitted on time by URV to the UERRA coordinator.

The work committed under T1.2 on high-quality synoptic-scale data development has progressed as planned, since a wide number of quality control (QC) tests (e.g. outliers, bivariate outliers, big jumps, sharp spikes, inter-variables inconsistencies checks) have been implemented and applied to the 8M of recovered and digitised observations. In this regard, a battery of QC tests have been designed and programmed by URV to QC the data at the hourly and daily scale. The Universal Quality Control procedure (UQC) has been implemented to QC hourly TMP, WS, WD and RH observations, while the Sea Level Pressure Quality Control procedure (SLPQC) developed to QC SLP observations. RClimDex extraQC has been used to QC RR data at the daily scale and a Simple Snow QC (SSQ) implemented to QC SD and FS observations at the daily scale. From the 8.2M of observations digitised, about 31K observations have been labelled as suspicious and are currently being verified by URV to validate or reject them and substitute them by true observations when possible. This is a very time-consuming task, since it requires human intervention to crosscheck the digitised data against the original values in the data sources. This along with the fact that only one researcher has been contracted with UERRA funds and is working full time on this task makes it highly likely the D1.5 can't be provided on time and a delay of a couple of months in its delivery has been foreseen and communicated well in advance to the UERRA coordinator. This delay is also explained by the extra digitisation effort undertaken by URV, which in return means double the QC verification work. In addition, other actions to minimise its potential impact have been taken by the URV partner, by means of contracting a part time researcher with internal URV funds and adding two more URV researchers to help in the verification work. We think, however, this delay will not have a negative effect on the production and delivery of D1.6. This deliverable is expected for month 36, and the tasks included to test homogeneity and homogenise the data at the monthly scale are fully automated, which require less work and, therefore, no delays are envisaged for it. The same can be stated for producing and delivering on time D1.7 (*all the quality assessed sub-daily data made available to WP2 and publicly available through WP4, including additional datasets of daily and monthly averages and totals as some will likely be of use in this form in Task 1.3 and in WP3*) and D1.8 (*Inclusion of D1.3, D1.4, D1.5, D1.6 data in the ECA&D system and MARS archive*), since no delays are foreseen for these two WP1 deliverables. In addition to the six station for which the team of NMA-RO has rescued the 6-hourly precipitation data and digitised them, they have also performed a QC of their data using an automatic procedure applied in the database to compare the 6-hours amounts with 12-hours sums and with the precipitation in 24 hours. A list of errors has been provided to the digitising operator at NMA-RO who checked again in the original document and made the corrections. The team of NMA-RO has also rescued and digitised hail diameter data and submitted a paper to Monthly Weather Review about the climatology of hail in Romania.

Finally, T1.3 has been correctly handled and although due to staffing problems (maternity leave) some deliverable (e.g. D1.10) was postponed and delivered with a delay. D1.11 and D1.13 are still expected to be completed on time. In this regard, the gamma-transform technique for improving the gridding of precipitation data, particularly in mountainous areas, has continued to be refined and tested by KNMI and UEA against the high-resolution gridded datasets produced by various National Meteorological Services across Europe, as well as against the E-OBS constructed using the existing techniques (Figure 1). To further improve the gridding in the E-OBS dataset a new technique has been developed which provides a much better interpolation of all variables. This technique (regression-kriging) is applied to the monthly resolution data, which serve to constrain the daily

values, and provides a more stable spline over time which is less vulnerable to the changing station data used for the gridding, which is an inherent problem with the E-OBS dataset (see D1.10).

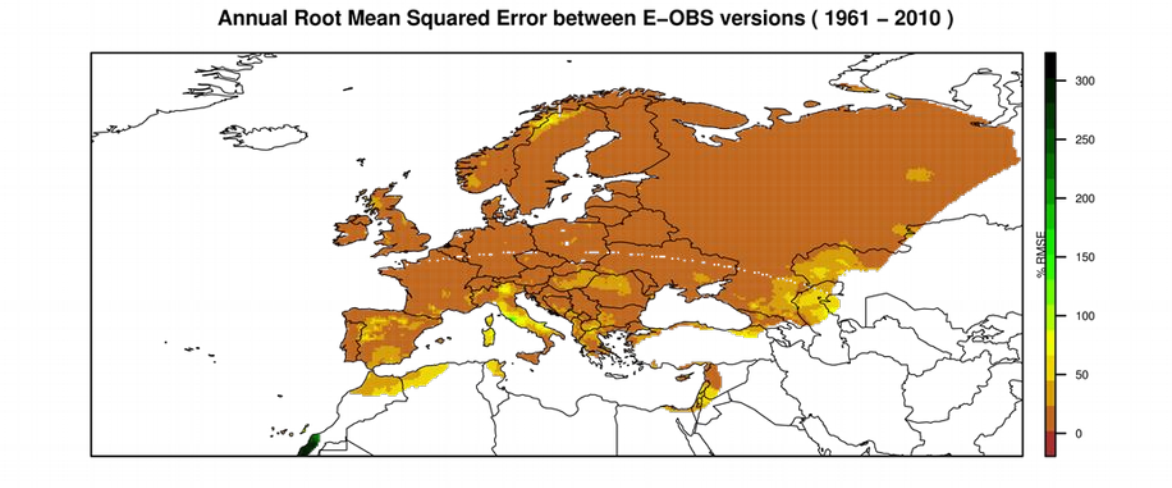


Figure 1. Comparison of the effect of the gamma-transform technique on the gridding of rainfall data across Europe. The annual root mean squared error between the new and old version of E-OBS is plotted, and has been computed over the period 1961-2010. Values are expressed as a proportion of rainfall totals per grid cell.

This new technique also allows for the incorporation of additional topographically-derived parameters to be incorporated into the gridding procedure, which allows for a better interpolation of the station data. Furthermore, this technique forms the basis for the production of an E-OBS dataset consisting of multiple-realizations, which is currently being tested, and will be reported later this year (D1.14). To allow for this development of the E-OBS dataset a new package written in the R computing language has been developed, which also contains extensive user documentation. This software is currently available for use by UERRA project partners. Furthermore, the aforementioned development of the E-OBS dataset using the new R package has been conducted on the ECMWF high-performance computing cluster (see D1.12). This is a significantly higher specification system than has hitherto been used to produce E-OBS and will allow for more computationally demanding techniques to be developed in the future, after the conclusion of the UERRA project. Operational production of the E-OBS dataset will move over to this system in a future version of E-OBS.

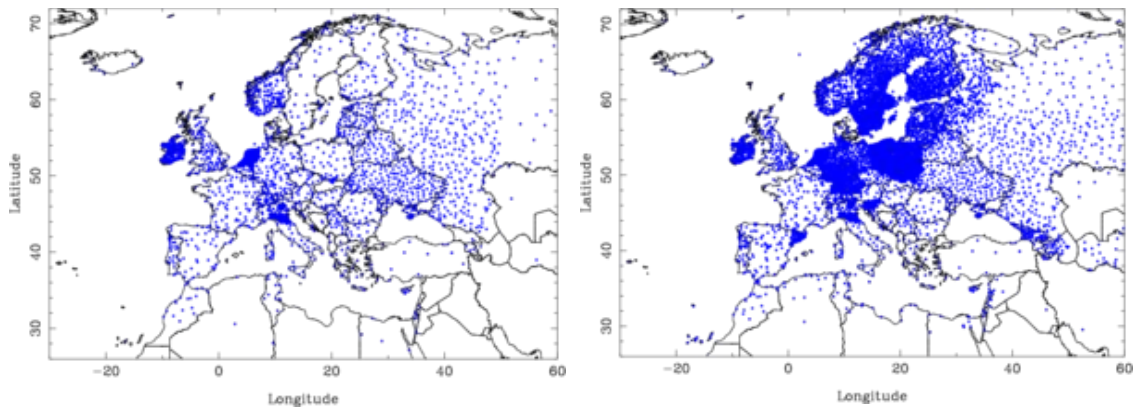


Figure 2a: Station density for daily precipitation amount in E-OBSv2.0

Figure 2b: Station density for daily precipitation amount in E-OBSv12.0

During the reporting period, KNMI has continued to release E-OBS on a monthly basis with full updates twice a year. Work is ongoing to create daily updates of E-OBS. Furthermore, the gridding procedures used to create the current versions of E-OBS are also being applied to the Southeast Asia (Figure 3) and Latin America regions.

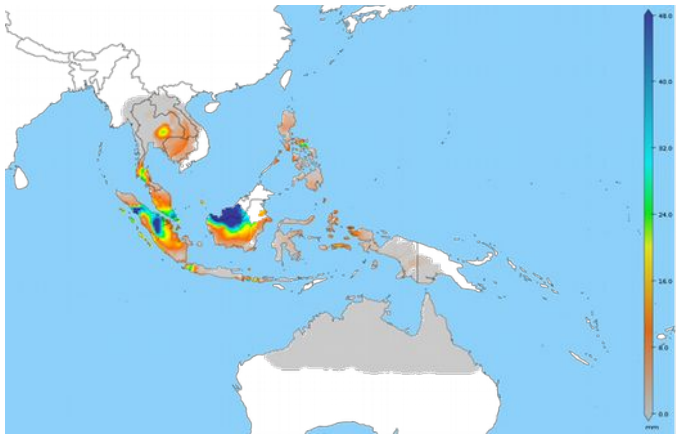


Figure 3: Grid for Southeast Asia for 16 July 2004

Last but not least, EDI has developed a new method to quantify uncertainties in observation-based spatial analyses (grid datasets) of precipitation. The procedure represents analyses in terms of an ensemble of equiprobable realizations, the spread of which informs users about inherent analysis uncertainties, related, for example, to the limited observation density or short-scale variance of precipitation. The method builds on statistical (conditional) simulation and extends it to rectify for several shortcomings. Most notably, the present development takes account of the uncertainty in the statistical parameters. A detailed verification in the Alpine region demonstrates the reliability and consistency of results. The technique is currently employed to derive a new multi-year ensemble dataset of daily precipitation over the entire Alpine region using high-resolution rain gauge data (see Fig. 4 for an example). The new dataset will form a reference for the evaluation of regional re-analyses in WP3. The findings of this work are also relevant for the development of ensemble gridding techniques with other grid datasets.

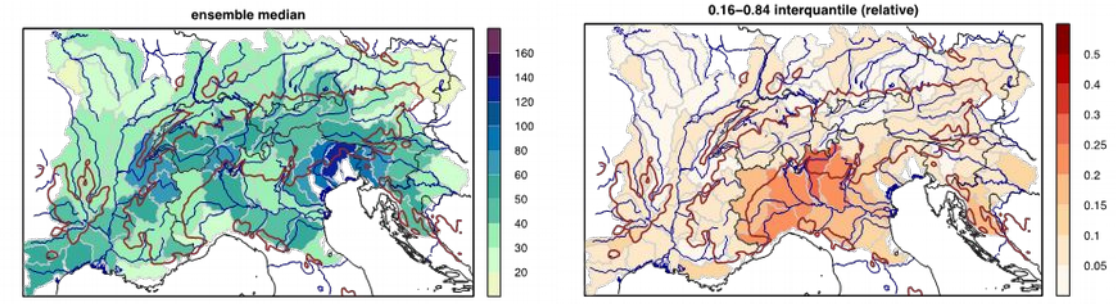


Figure 4: Spatial analysis of the largest one-day precipitation (mm per day) in year 1990 (left) and pertinent relative uncertainty (fraction) for hydrological catchments of size 4’000-14’000 km2. Larger uncertainty in Northern Italy is due to coarser spacing of observation stations. The magnitude of uncertainty increases with smaller catchment size

2.2.1.1 Use of resources in WP1

WP 1 has used almost all the resources planned in the Project except for EDI which still has some PM:s left. This is according to plan as most of the WP1 work was planned to take place the first two years. It can be noted, however, that UEA and particularly NMA-RO have used PM:s above or much above the plan in Annex I part A. It is due to that UEA has done the work and NMA-RO has used lower paid staff than planned.

Please see Table 5 at the end of this document for details.

It is expected that there are still resources to complete the tasks in WP1.

2.2.2 Work package 2 – Ensemble Data Assimilation Regional Reanalysis Dataset

In this period, substantial work has gone into developing and testing technical and scientific aspects of systems ready for production. The ensemble-variational reanalysis T2.1 is currently running an extended test period before production runs start. For the deterministic reanalysis T2.2, two contenders (ALADIN and ALARO) were tested over a 5-year period and ALADIN was found to give the best results. ALADIN is now running for the complete period, 1961 onwards. For the high-resolution 'downscaling reanalysis' T2.3, an ensemble has been tested and production has started, with the 5-year ensemble expected to complete soon.

The cloud fraction reanalysis for 1982-2013, T2.4, has overcome several scientific problems to produce a tuned system that can cope with horizontal inhomogeneities. It was discovered that CM SAF are making available an improved quality METEOSAT cloud product for this period that should result in a better quality reanalysis. Given other delays already, it is planned to wait for the new product before processing the early part of the period. The later part (2004-2013) can be run already using MSG SEVIRI cloud products. The COSMO 5-year ensemble reanalysis T2.5 found problems with the LETKF assimilation system but is now progressing using an ensemble of nudging reanalyses.

There has been contact between WP2 partners and also WP3 (DWD) in agreeing on requirements for fields and products. Also with WP1 (URV) in investigating the scarcity of surface observations during much of the 1960s over several countries in Europe.

All tasks have found that the work to set up the reanalyses was more than anticipated. In each case unexpected problems have come to light. Part of this is due to the complexity of the systems. Small

teams are required to have expertise on a broad range of components (observations, assimilation, model, etc). Complex systems invariably find many ways to go wrong. Another issue is the sheer volume of data and processing. These make strong demands on computer systems, and again provide many opportunities for errors.

Another significant circumstance is that all the regional reanalyses are set up in quite different configurations compared with each partner's operational data assimilation and forecasting systems. There is a sizeable research and development component of WP2 before the production phase, but it has extended more than expected. One cannot lean on and rely on operational developments at the institutes to any high degree.

T2.1 – Ensemble-Variational DA Reanalysis [Months: 1-45] **Met Office**

Summary of progress

Two deliverables D2.1 and D2.2 have been submitted. D2.1 details the ensemble variational approach that has been chosen, an ensemble of 4DVar reanalyses. D2.2 describes the observations and various other inputs prepared for the reanalysis.

The reanalysis will be an ensemble of independent runs, each assimilating observations in a 4DVar analysis system. The spread of the ensemble will come from several sources of perturbations. The observations are perturbed with random noise according to the expected observation error. The Sea Surface Temperatures (SST) come from an ensemble of analyses, HadISST2 (Titchner and Rayner 2014). Model error is accounted for by the method of Piccolo and Cullen (2015) where the model forecast is perturbed by previous analysis increments, taken to be representative of model error.

It was intended also to drive the ensemble with an ensemble of lateral boundary conditions from the ERA5 global reanalysis. Start of ERA5 production is later than was planned and the full ERA5 dataset is not expected until the end of 2017, too late for this project. Therefore we intend to use the deterministic ERA-Interim to provide boundary conditions.

A suite has been assembled to run on the ECMWF HPC implementing the method above. It includes several developments required for a long-period reanalysis. Satellite radiances are bias-corrected with a variational scheme VarBC, following Dee and Uppala (2009). Soil moisture is adjusted according to differences between forecast and observed screen level temperature and humidity, analysed through an Extended Kalman Filter. This is an adaptation of the scheme used for Met Office global NWP. Observation reject lists will be updated monthly based on O-B (observation minus background) differences from the previous month. The suite is currently running a 2-year test period (2007-8) with 20 members which will provide sample data for evaluation work in WP3. Figure 5 shows verification of the ensemble mean for January 2007 against 850hPa radiosonde temperatures, and also the ensemble spread. The ensemble spread is the 'uncertainty'. For a perfect system, the uncertainty should be close to the RMSE of the ensemble mean. It can be seen here that the spread is smaller than the RMSE. This is a common feature of real-world ensembles. It is partly due to the difficulty in representing every source of uncertainty in the ensemble. It is also partly due to errors in the observations. Observation and representivity error (the observation is seeing detail that a 12km model cannot) both contribute to inflating the RMSE.

Status

Work to implement new systems (En-4DVar, VarBC, regional surface EKF, TOVS processing, station reject lists and monitoring for reanalysis) and to build an integrated suite has taken longer and proven more complicated than expected. We had hoped to be running in production mode already but are still in testing. We expect to start production soon but there is a risk that the full reanalysis (1979-) will not complete by month 45. Whether or not this is the case will become apparent once production is started. Then we will be able to assess the speed of multiple parallel runs on the ECMWF HPC and will be able to estimate completion time.

If there is a problem then we can consider mitigation options. One option would be to use fewer than 20 members, but the impact on ensemble statistics would have to be examined.

Deliverables

D2.1 Development of ensemble-variational data assimilation capability and report demonstrating ensemble uncertainty products (month 21, 09/2015). Delivered on time (Sept 2015).

D2.2 Report of observations and datasets assembled for the ensemble-based variational assimilation (month 24, 12/2015). Delivered late (April 2016).

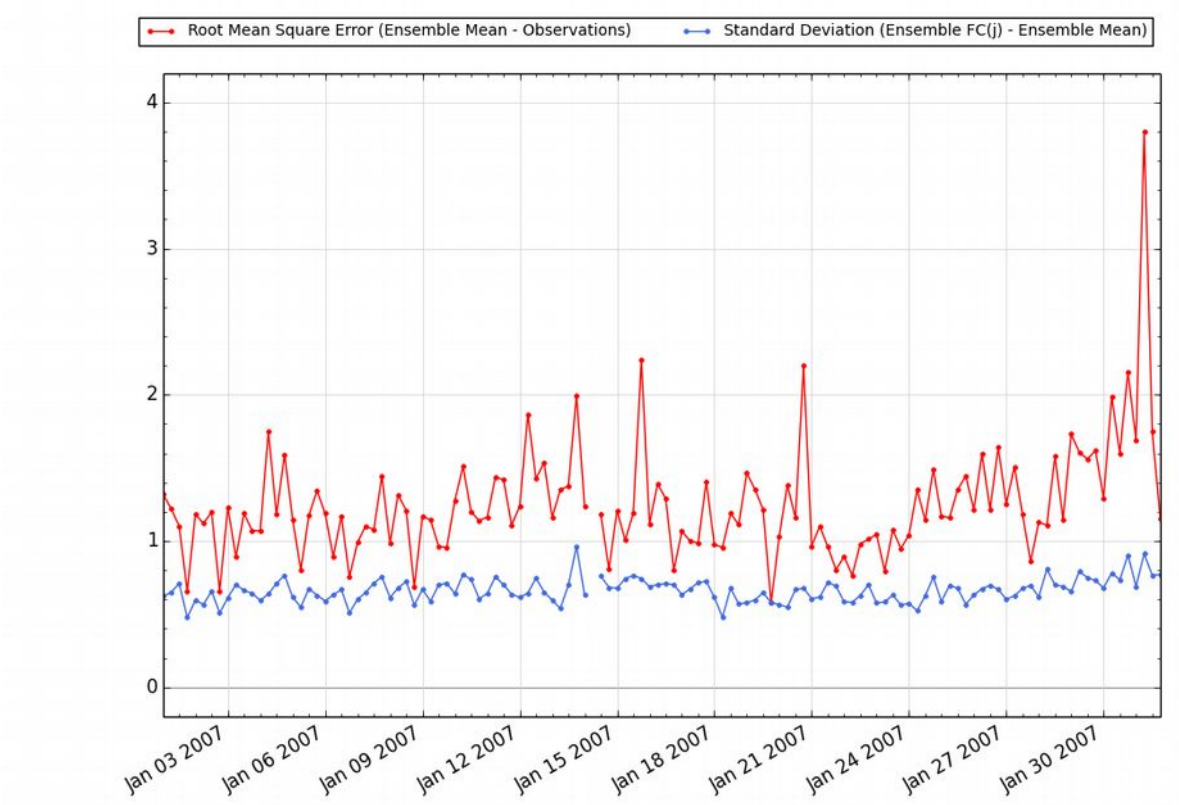
D2.3 Preliminary report with ensemble diagnostics (month 30, 06/2016). Expected Sept 2016.

Use of resources

Use of resources is summarised at the end of this chapter about WP2 (2.2.2.1).

The Met Office has spent a bit over half over their PM:s and is closer to their budget, or slightly below.

Figure 5: January 2007, RMS Error (red) in ensemble mean 850hPa temperature



(K) verified against radiosondes, and ensemble spread (blue)

T2.2 – Deterministic reanalysis [Months: 1-48] **SMHI**, MF

Summary of progress

In preparation for the long reanalysis, two five-year reanalyses were run using two different physics packages: ALADIN which is designed mainly for the synoptic scale and ALARO which is a multi-scale package. The five-year runs were finished and verified against observations and also compared to a corresponding verification of ERA-interim. The verifications showed that the ALADIN package verified better (see examples in figures 6, 7). It was therefore chosen for the long reanalysis ranging from 1961 until present.

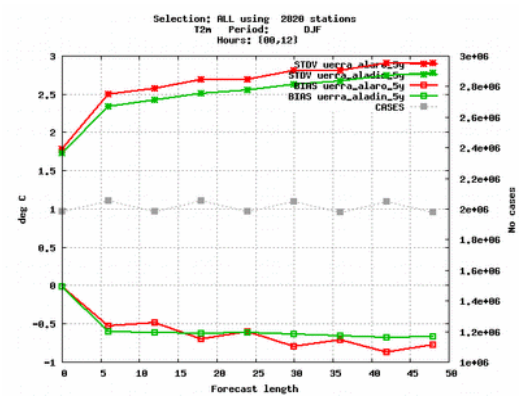


Figure 6: Verification of temperature at 2 metre level. Experiment with ALADIN physics is the green line while the ALARO physics is the red line.

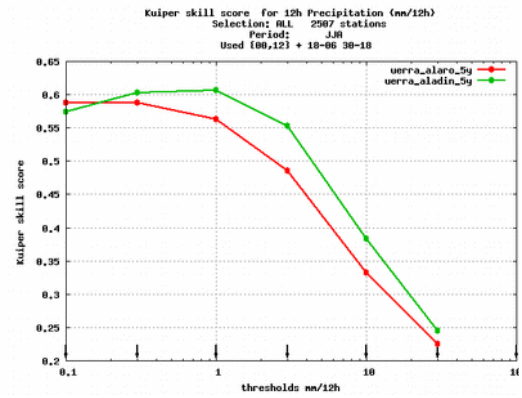


Figure 7: Verification of precipitation using Kuiper skill score. Experiment with ALADIN physics is the green line while the ALARO physics is the red line.

In the experiments a rather serious bug was discovered after production. It was found that there was a bug in the calculations of the large-scale mixing, the so-called Jk-term. This error does not affect the analysis very much in areas with dense observations but in areas without observations, or very few, it has a rather large effect on the resulting analysis and forecasts. Since the model output is verified against observations the conclusions from the verification will not change but the five years need to be rerun in order to have correct fields in all areas.

The output from the five-year mini ensemble will be used for other tasks within UERRA, more specifically in task T2.3 Downscaling [Months: 1-36]. The results from the Downscaling may be affected by the poor analyses and forecasts resulting from the above mentioned error in the Jk calculations. This need to be further investigated, when the new corrected five-year mini ensemble reanalysis is delivered during the second half of 2016.

The long reanalysis was already started when the bug in the Jk calculations was detected. It was restarted after the corrections so the entire period will be run with the corrected large-scale mixing, including the five years already run for the first part. The restart itself did not include any significant delay since only around one year (maximum 1.5) had been run when it was stopped.

To be consistent the ALARO reanalysis is also rerun for the five-year period.

The long reanalysis is run in parallel stream with one decade per stream, except for the five-year period that was started at 2006 in order to finish as soon as possible.

The runs use large amount of computational and storage resources at ECMWF computers. Resources for a special project were granted when the five year runs started but were used up in Spring 2016. An additional 10 million SBUs have been granted but the estimated need for 60-years reanalysis is at least ten times as much. Most of the resources are from the National allocation anyway, and the extra from the Special project only supplements this. There are fresh computer resources in 2017 and enough time to complete the Project. After this Reporting Period, there were some discussion with the Met Office which is positive towards volunteering some of their computer time for the SMHI runs. They have gracefully agreed and an account with 60M SBU (system billing units) will be set up under the GB allocation during the rest of 2016. This is enough to run 20 years and with about 30 years done so far, it is a great resource and will be enough to do most of the production during 2016.

Use of resources in this task for SMHI

In the DOW the amount of work needed for the entire WP2 was estimated to 82 pm by SMHI during the lifetime of the project. So far SMHI has spent just a bit more than 38 pm since project start.. This is slightly below the planned amount.

Reasons for deviations

The person who was supposed to work with this left SMHI for work at ECMWF and the time overlap before a new person was employed was roughly three months. The bug found in the Jk calculations also delayed the start of the reanalysis as well as a new version of the five year mini ensemble. Additionally, we postponed the impact assessment on how a dynamic vegetation index affects the regional reanalysis. The required resources will be used later in the project.

Impact of deviations

The impact of the delay in the long reanalysis in task T2.2 will only result in a delayed delivery to end users. Since the reanalysis is run in several streams the later part of the period will be available much sooner than if it would be run sequentially. This will benefit activities interested in later periods of the reanalysis, e.g. the period 2012-2014 for the Copernicus proof-of-concept activity Urban SIS and others as CLIM4ENERGY.

As a result of the recruitment of a new researcher and of the required rerun of the reanalysis due to the bug, the deliverable D2:6 "Preliminary report of the first period of the RA" cannot be delivered in Month 30 (June 2016). However if the reanalysis will run without too much interruption during Summer 2016 there will be enough material to compile this deliverable in September.

T2.3 Downscaling (Météo-France)

Ensembles of temperature at 2m (T2m) and 24-h precipitation (RR24) reanalyses have been produced on 5.5 km grid for evaluation purposes, for two periods namely December 2009 - January 2010 and June 2010. (These periods have been run in the earlier EURO4M Project so the same months were run for comparison).

The ensemble of T2m analyses has 8 members of which 4 are generated using as backgrounds the downscaled 6-h forecasts from 11km to 5.5 km and the other 4 using native 6-h forecasts performed at 5.5 km grid spacing with 2 physics package ALADIN and ALARO.

Figure 8 shows the ensemble mean standard deviation of T2m re-analysis for January 2010 (left panel) and for June 2010 (right panel), performed at 06 UTC. A comparison between the two maps reveals, for example, that the T2m in winter is estimated with a higher uncertainty than in summer over Iceland and the northern Scandinavia, very likely due to the snow cover. (This should warrant research in a future Project). Furthermore, in Summer the uncertainty increases over the complex topography (Alps, Pyrenees, Carpathians) compared with the winter time due to the temperature inversion which may often occur in the mountain valleys.

The evaluation of the ensemble of T2m reanalyses has been done by using their associated rank histograms. A U-shaped rank histogram (Fig 9) from an 8-member ensemble of re-analyses produced with different backgrounds and the same observation dataset, commonly indicates a lack of variability in the ensemble, but can also be a sign of conditional bias. A reliable ensemble usually generates a flat histogram. Though the rank histogram from the ensemble generated with one background and 8 data sets of perturbed observations illustrated in Figure 5 (right panel) is rather flat, the overpopulation of the middle ranks may still indicate an excess of variability in the ensemble.

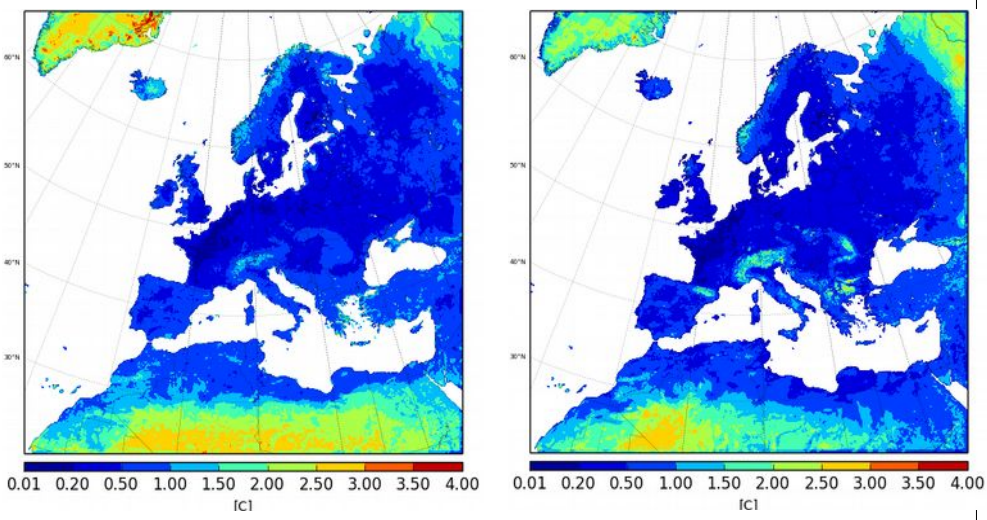


Figure 8: Ensemble mean standard deviation of T2m re-analyses for January 2010 (left panel) and for June 2010 (right panel). Analyses performed at 06 UTC.

Two types of ensemble of RR24 reanalyses have been produced for the test period. Similarly as for the T2m reanalyses, an 8-member ensemble of RR24 reanalyses has been generated using as backgrounds 4 downscaled forecasts and 4 native forecasts respectively. The second RR24 ensemble contains 6 members and has been produced using as background 3 types of downscaled forecast fields from ALADIN and ALARO models with SURFEX to cover the period of 24-hours, respectively: (1) $fc^{06+06}+fc^{12+06}+fc^{18+06}+fc^{00+06}$, (2) $(fc^{00+18}- fc^{00+06}) + (fc^{12+18} - fc^{12+06})$, (3) $fc^{00+30} – fc^{00+06}$,

where the superscripts indicate the hour of model initialization plus the forecast length. The comparison between the two ensemble reveals that the 8-member ensemble has higher variability than the one with 6-member, but still under estimate the dispersion (not shown). The perturbed observation method was also used for the precipitation ensemble analysis but the rank histogram reveals again an under dispersion (not shown).

Figure 9. Rank histogram of T2m re-analyses: Left: ensemble of 8 members with different backgrounds. Right: 8 members with one background and perturbed observations. Re-analyses at 06 UTC for June 2010.

Another important aspect is the evolution of the surface observation network and the availability of the data. This aspect is probably more important for the precipitation analysis than for the temperature (the model error for precipitation are larger), for example in the 60's, ~500 observations are available and 5000, the impact of this large differences will be evaluated through the ensemble analysis for the period 2006-2010 with some members using a low density network (similar to the 60's) for the temperature and precipitation (Fig. 10).

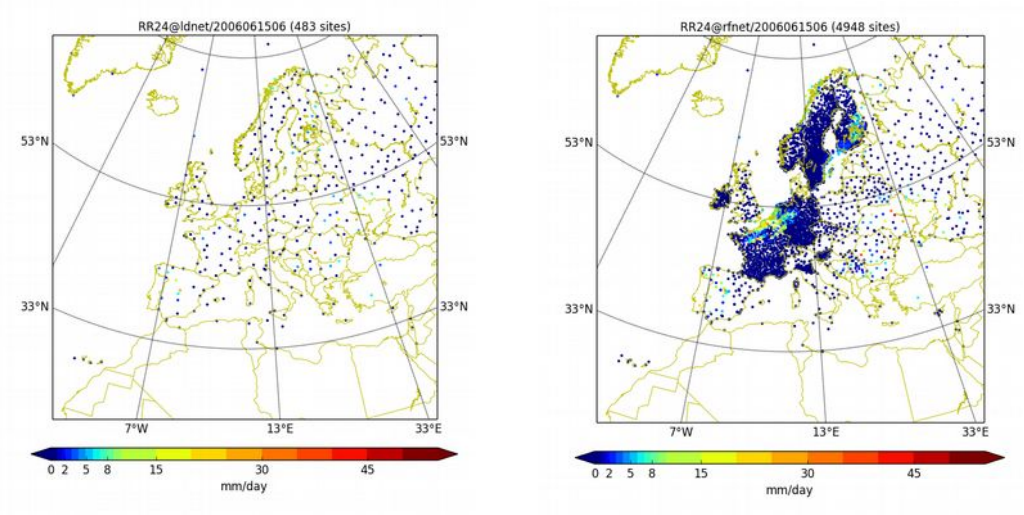


Figure 10: 24h accumulated precipitation observation for the low density network (left) and the reference network (right)

The production of the ensemble re-analysis began at the ECMWF site after some technical work: fetching forecast and analysis files produced by SMHI at 11 km, downscale the fields, perform and monitor the forecasts at 5.5 km. At the same time, we have produced and run the forecasts at 5.5km for the 5 years. The 5 years ensemble analysis would be finished in September 2016.

In parallel, the article of the precipitation analysis developed during the EURO4M and UERRA project has been submitted and accepted in Tellus**.**

Delivarables

D 2.9: There was a substantial delay of the MF work last year since the scientist employed for UERRA could not continue on a temporary contract due to MF internal rules and left for ECMWF. A new scientist was quite quickly recruited with a slightly different profile and there was a learning process but the team functions well again.

Also some delay was caused by delayed SMHI procuction but this has only minor impact.

The scientific methods for ensembles was also more difficult than expected but the production of the 5 years is ongoing and will be complete in September and a report will be done in September too.

Use of resources

MF has used less than planned and again, this is due to their staff replacement and some gap in between.

T2.4 - Cloud Fraction Reanalysis (SMHI)

The objective of this task is to provide a 2D optimal interpolation (OI) analysis of hourly cloud fraction for 30 years (1982-2013) at 5.5 km resolution. The idea is to combine, on a common grid, good quality CM-SAF datasets from geostationary METEOSAT and AVHRR polar platforms and to use NWP reanalysis data for gap-filling.

During the start up of this task it became clear that the CM-SAF is about to start processing a new homogeneous cloud fractional cover product for the entire METEOSAT period (1982 onwards) and that the whole 30+ year period will be finalized by the end of 2016. This will most probably result in a significantly improved cloud product to what is now available for the pre SEVIRI (MSG) era. Because of this it was decided to wait for this dataset to become available and focus on the SEVIRI era, where high quality data is readily available, to begin with.

So far polar CLARA-A1 orbit data and CLAAS-A1 geostationary scenes have been retrieved from the ECFS file archive at ECMWF and transferred to the SMHI HPC system where the analysis is done. NWP cloud cover data from the EURO4M HIRLAM reanalysis at 22 km has been extracted from the SMHI MARS archive at NSC (National Computer Centre, Linköping, Sweden).

Software has been prepared for generation of super observations (SO) with size 5.5 x 5.5, 11 x 11 and 22 x 22 km on a 5.5 km grid. (Super observation is a mean to combine several observations into one by statistical interpolation and use the super observations for the subsequent analysis). An analysis has been carried out for one year (2009) together with a validation against independent SYNOP data. The SO show a bias of +7.3 % compared to CAM-SAF MSG bias of +4.4 % for the European area, more or less regardless of SO size. The reason for the increased bias is now under investigation.

The OI analysis needs estimates of the first guess and observation error. In this case both of these are spatially correlated and the method by Desrozier et. al was used to estimate the error matrices based on forecast difference statistics from the HIRLAM EURO4M cloud cover. The method converges nicely to realistic estimates and by carrying out the OI analysis in Fourier space, where the error matrices are diagonal, the analysis can be done in an efficient way.

In areas with missing satellite data EURO4M HIRLAM data is used as a gap filler since complete fields are needed in order to use the Fourier transform and get diagonal error matrices. This can result in discontinuities in areas with missing data where HIRLAM and the satellites disagree. To reduce these effects we tried to add a weight matrix to the OI formulation and pay less attention to observations in areas where these are actually just NWP data (low weights for NWP). Unfortunately the minimization problem then became much more demanding (non-diagonal matrices). As a remedy a fast adaptive filtering approach is now used where information from neighbouring observations and NWP forecasts is combined according in order to get a smooth transition from the edge to the centre of a missing data region.

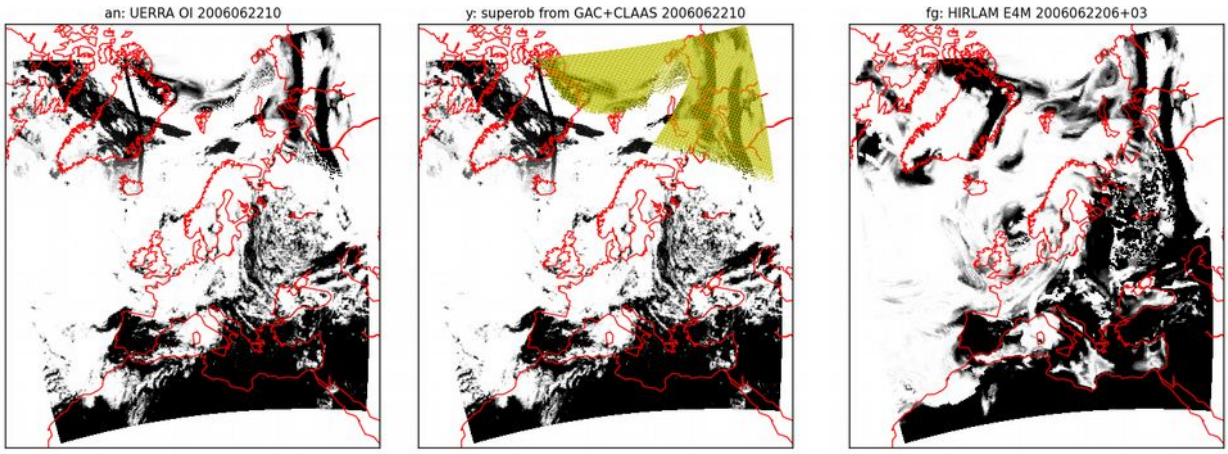


Figure 11. Cloud data and overlap with model data.

Clearly significant results

- Analysis system ready using estimated error covariance matrices.
- Software ready for generation of super observations.
- Analysis test run for one year with geostationary and polar data.

Deliverables

D 2.10 - The work started with a single resource who got responsible for more projects and extra resources waited for a recruitment which took place early 2016. It is not all that bad since we were waiting for more complete satellite processed data and thus get a more complete and higher quality data set. Also the scientific developments and tuning of the grid resolution and fast enough computation have taken more time than expected. The analysis still has to be run in September and the report written in October, thus further delayed from M24.

Reasons for deviations

The work started out with a single resource who then got involved in other work. An extra resource was assigned to the task but had spend much more time than anticipated getting the SMHI reanalysis part of WP2 up and running.

As a result the deliverable D2.10 MESAN cloud analysis (M24) has not been produced. Now this is not all bad since new and better data has or will become available this year: cloud cover for entire METEOSAT era and polar CLARA-A2 that includes also the years 2010-2013. The goal is still to produce an hourly cloud cover analysis on a 5 km grid for the 30 year period within the UERRA project.

Impact of deviations

The output from task 2.4 is intended to be assessed in WP3 and more specifically in task T3.2 [Months: 15-45]; assessing uncertainties over the European domain using the common evaluation procedures comparing against satellite-based ECVs as well as gridded observations.

The impact of the delay in task T2.4 will be reduced by providing task T3.2 with data from the MSG SEVIRI period (2004-2013) as soon as possible. The earlier period will then be processed as soon as the new improved CM-SAF cloud cover product is made available to the UERRA project.

T2.5 – Ensemble Nudging DA Reanalysis [Months: 1-45] **University of Bonn**

Summary of progress

Two deliverables D2.11 and D2.12 have been submitted. One summarises statistical methods developed for generating perturbed observations as well as pseudo observations and the other one shows a feasibility study for the data assimilation method of ensemble nudging which is currently employed in the framework of a reanalysis suite to produce an ensemble reanalysis.

In the following, we give a short overview of the work conducted for the two foregoing deliverables and major conclusions from these. In the second part, we summarise the recent work and status of the reanalysis production.

Work on deliverables D2.11 and D2.12

UB's task as part of WP2 in UERRA is to provide a regional ensemble reanalysis system as well as a proof of concept high-resolution data set for Europe. In D2.11, a technique called ensemble nudging to perturb observations in order to account for observational uncertainty in an ensemble has been introduced. This had been planned to be part of a hybrid technique in combination with a local ensemble transform Kalman filter (LETKF) that is newly developed at Deutscher Wetterdienst. However, due to a couple of reasons that are detailed in D2.12 as well as technical issues that were solved later, but still left inherent problems, the hybrid combination turned out to be of limited usefulness for the production of a comprehensive dataset as an ensemble reanalysis. Moreover, the absence of the PI of the UB work due to parental leave from 2016/01 to 2016/12 led to an agreement with the UERRA management team that the originally intended hybrid system would be replaced by the ensemble nudging component as data assimilation system for the UB reanalysis. The usefulness of this technique is comprehensively shown in D2.12.

Work towards D2.13

In deliverable D2.13 diagnostics of the deterministic and probabilistic capabilities of the reanalysis test data set produced by UB will be shown. The reanalysis denoted COSMO-EN-REA12 will extend from 2006 to 2010. The domain extends over the CORDEX-EUR11 domain at a 12 km grid spacing and comprises 20 ensemble members that represent the uncertainty in the reanalysis given

observation errors in the assimilated conventional observations. The added value of the system as well as its probabilistic capabilities shown in the example of precipitation as Essential Climate Variable, has been shown in terms of two experiments, each of which extends over one month. It can be referred to in D2.12 as well as in Bach et al., 2016, submitted, which gives detailed insight into the set-up of the reanalysis suite.

In the meantime, the reanalysis suite introduced in D2.12 has been fully implemented using ecflow at ECMWF. It is based on a suite that had already been employed by Bollmeyer et. al, 2015 for the production of a high-resolution regional reanalysis for Europe. For UERRA, the system was adapted to a 12km grid resolution. Moreover, a newer model version of COSMO is used and complemented by an ensemble capability using ensemble nudging. The set of output variables has been adapted to the needs of UERRA. The system has been extended by reforecasts. An update of external parameters like the leaf area index, ozone concentration, root depth and similar according to a prescribed annual cycle has been introduced. Details related to surface analyses (snow, SST and soil moisture) have been revised.

The reanalysis production is running since the beginning of April 2016. However, in the meantime different problems have occurred leading to a current revision of the reanalysis suite. This includes the inappropriateness of different variables for archiving in MARS, automated retrieval of ERA-Interim data as lateral boundary conditions, the ingoing observation stream, retrieval of observations for external analyses, i.e. SST and snow as well as automated storage of variables in the ECFS. (The COSMO model output has some features like standard of time step and accumulation time that differ from the other models and what should be in the common UERRA archive in MARS). Moreover, errors occurred related to the absence of observation input which did not lead to a model abort as this is not wanted in operations. Also, it has emerged that feedback observation files are not written under specific circumstances. Probably, due to the lessons learned in the first months of production, the already reprocessed time span will have to be reanalysed at the end of the project to achieve full consistency. However, the revised reanalysis suite promises to result in a much higher quality of the data set, higher production rates and less expenditure of time that is needed to fix problems and restart aborted tasks. Still, note that the work by WP3 which aims at conducting a comparison between the different reanalysis systems by the end of July 2016 will be slowed down or will only have a small data set of 2009 of COSMO-EN-REA12 available (a dataset that might be revised later).

Since the research with the hybrid combination of ensemble nudging and LETKF was abandoned for the time being, there is currently more promising research conducted based on the ensemble nudging reanalysis suite that COSMO-EN-REA12 is produced with. The objective of this research is to identify which source of uncertainty in regional ensemble reanalysis systems (at least in the one employed) is the most important one inducing most ensemble spread and which combination of ensemble generation techniques leads to the most reasonable uncertainty estimation. For that purpose, observation error, model error and errors in the lateral boundary conditions have been chosen to be the most important uncertain components. In a first step, four experiments are performed using ensemble generation techniques that only account for one of the uncertain

components: ensemble nudging (observation error), a perturbed physics ensemble (model error), stochastic perturbation of physical tendencies (model error). Finally, an ensemble of lateral boundary conditions from the newly introduced German model ICON is employed. In a second step, these ensemble generation techniques are combined. Then, the data will be evaluated using spread-skill ratios as well as one- and two-way variance analysis. By that, it is hoped to obtain a first estimate of the relative importance of uncertainties in ensembles of regional reanalyses which might be valuable information for UERRA and future implementation of reanalysis systems.

Concerning the diagnostics of uncertainty estimation capabilities that are scheduled under task T2.5, a range of knowledge and codes have been assembled during the course of the project. Some of these are shown in D2.12 and Bach et. al, 2016, submitted. These will also be useful for task T2.6, a comparative study of the UERRA ensemble reanalyses.

T2.6 – Reanalysis Cross Evaluation [Months: 15-45] **MO**, SMHI, DWD, UB

This task will start once production data is available from all the reanalyses, together with the resources that are currently occupied in developing and producing the reanalyses.

No resources have been expended to date on this task.

2.2.2.1 Use of resources in WP2

Total resources to end of June 2016 are less than budget. In the DOW the amount of work needed for the entire WP2 was estimated to 82 pm by SMHI during the lifetime of the project. So far SMHI has spent just a bit more than 38 PM since project start.. This is slightly below the planned amount. The planned resources are now being used when staff have been replaced as also explained earlier under T 2.2.

The Met Office has spent a bit over half over their PM:s and is closer to their budget, or slightly below.

MF has used less than planned and again, this is due to their staff replacement and some gap in between.

In the DoW the amount of work needed in task T2.4 was estimated to 7 pm during one year. So far SMHI has spent just a bit more than 3 pm on this task. There are several reasons for this as explained above.

Use of resources is as planned and to budget for University of Bonn.

2.2.3 Work package 3 – Assessing uncertainties by evaluation against independent observational datasets

Progress of WP3 (Assessing uncertainties by evaluation against independent observational datasets) towards its objectives was achieved within Task 3.1 and Task 3.2. There were no deviations to task achievements as outlined in Annex I (the DoW).

Below, details of progress to the objectives are summarized for each task.

Coordinated uncertainty evaluation (T3.1)

The resources for T3.1, in the second reporting period, spanning the time from M15 to M30, have been spent on:'

(1) Refining the definition of required input from WP4 and WP2,
(2) incorporating user feedback,
(3) method development (adapting and applying NWP verification skills, and further developing the scale-decomposition approach to spatial verification based on wavelet scale-separation adopted for reanalyses evaluation purposes), and
(4) developing a portable starting set of algorithms in R to support the common evaluation procedure. The starting set of algorithms was developed in close collaboration with MI. It was published on-line, in GitHub, freely available at which is included in project deliverable D3.3. Further ongoing developments include the collaboration of EDI, in addition to the aforementioned institutions.a001857 <heiner.kornich@smhi.se>

By means of the early implementation of the starting set of algorithms and evaluation procedures, experiences were gained which were of interest for the users at the user workshop held at Météo France, Toulouse, France. These users were keen to get a first estimate on uncertainties to judge the potential of regional reanalyses for their applications.

In collaboration with WP8, we managed to maintain a clear user focus in WP3, in line with the WP3 objective ‘common evaluation procedure for ECVs, derived climate indicators, extremes and scales of variability that are of particular interest to users’. The intensive combined effort of WP3 and WP8 together with WP2 and WP4 on the discussion of which parameters to make available was finished constructively by defining a whole set of output levels, parameters, and analysis and forecast times to store. The result of this effort has been handed over to WP4 at the beginning of this reporting period in form of a ten page list.

Assessing uncertainties over the European domain (T3.2)

In line with planned resources, ongoing work focusses on the assessment of uncertainties over the European domain and on special sub-regions of particular interest. Satellite data (radiation products) by CM SAF are being pre-processed in order to be used for further ongoing work. Gridded data sets

are in preparation, with the focus of improving on the representation of precipitation extremes. In addition, uncertainty estimates are developed based on the spread in an ensemble of gridded reconstructions (rather than the single uncertainty estimate).

In T1.3 (WP1), EDI has developed a new method to quantify uncertainties in observation-based grid datasets of precipitation. The results have been verified in detail in the Alpine region demonstrating their reliability and consistency. The method is currently employed to derive a multi-year ensemble dataset of daily precipitation over the entire Alpine region using high-resolution rain gauge data. The dataset will form a reference for the evaluation to assess uncertainties.

A first release of the Nordic Gridded Climate Dataset (NGCD) has been established. It is a high-resolution gridded dataset for daily mean temperature and daily accumulated precipitation based on measurements from weather stations covering Fennoscandia. It will be used as a reference dataset for reanalysis evaluation in that region.

The second reporting period spanning the time from M15 to M30 was spent on:

(5) generating preliminary results, by application of the above mentioned methods and scripts, to preliminary (national and EURO4M) data sets. The so far applied common evaluation procedures are summarized below, with the latest updates (June 2016) included. A preliminary version of this table was published as D3.4 and discussed at the GA3 in Toulouse in January 2016.

Method	Data source	Parameter	Evaluation procedure	Participant, working contact	Application	Code source
B1: independent station measurements	Tower measurements of Lindenberg, Cabauw, FINO, Hamburg of hourly, daily, monthly values	Wind speed	Correlation, bias, RMSE, anomalies, PDF-score, frequency distribution; Extreme event analysis: hit rate, false alarm rate, false alarm ratio, HKS, TS, ETS, frequency bias index, HSS, accuracy, odd ratio, EDI, SEDI;	DWD, Michael Borsche	COSMO-REA6 hourly, daily, monthly from 1995 to 2014	R-package development at
B2: dependent station measurements	DWD station measurements available from	Wind speed		DWD, Michael Borsche	Monthly COSMO-REA6 (1995 to 2014), ERA20C (1901 to 2010), ERA-Interim (1979 to	

					2010)	
C: gridded measurements	E-OBS applying ETCCD indices**500hPa,SLP**	Tmean, Tmin, Tmax, Precipitation, SLP	75 indices as defined by ETCCDI	KNMI, Gerard van der Schrier	European-averaged temperature and trends, percentages of Europe which are 'extremely'/'severly' wet or dry and trends in this (using SPI), and a similar analysis using the HY-INT index (which does not focus on the amount of precipitation as SPI but on the distribution of precipitation). Extreme temperature and trends (using the indices TX90p/TN10p) and extreme precipitation trends (R95p and	R-package will be available at the pcic (Pacific Climate Impact Consortium) in autumn 2016.

					RR1)	
	ROCADA (daily gridded data covering Romania at 0.1 degree resolution) extreme indices; drought indices	Tmin, Tmax, Precipitation	ETCCDI indices of climate extremes; SPI, SPEI drought indices	NMA-RO, Marius Birsan	trend analysis, teleconnections	R-packages from Climdex: and SPEI:
	Nordic Gridded Data Climate Dataset	Precipitation	PDF-score; spatial verification: scale-decomposition approach	MI, Cristian Lussana EDI, Christoph Frei	Theoretical Foundation	R-package development at

Table 1. This table summarizes the common evaluation procedures in UERRA WP3 currently in work.

Clearly significant results of WP3 during the reporting period include:

- All deliverables submitted according to schedule.
  (D 3.3 Programming package and
  D 3.4 Evaluation experiences)
- Scientific WP3 results obtained in this reporting period were presented by various partners at the international conference European Meteorological Society EMS&ECAC 2015 in Sofia, Bulgaria,
- subsequent papers were submitted to Advances in Science and Research:
  - Soci, Cornel, Bazile, E., Besson, F and Landelius, T.: High-resolution precipitation re-analysis system for climatological purposes. Tellus A 2016, 68, 29879,
  - Borsche, M., Kaiser-Weiss, A.K., and Kaspar, F.: Wind speed variability between 10m and 116m height from global and regional reanalyses compared to wind mast measurements over Northern Germany and The Netherlands, Adv. Sci. Res., under review, 2016
- User feedback incorporated from the user workshop at Météo-France, Toulouse, France

2.2.3.1 Use of resources in WP3

The use of resources in WP3 is as planned. After 2.5 years of the project about half of the PM:s have been consumed. The main efforts have been on methods and software development and then early testing on pilot or other reanalysis data. DWD has also spent time on definition of output varaibles. The remaining part of the work is more on the evaluation itself and it relies on data services which are delayed, so the progress of WP3 is very much depending on the actual reanalysis data now. KNMI has only used a small part of their total resources and this is as planned for the same reasons.

UEA and NMA-RO has used a large part of their planned PM:s and this is also as planned.

2.2.4 Work package 4 – Facilitating downstream services (data, derived products and outreach)

T4.1 - Establishing Data services

MARS data:
The work on UERRA data portal and all related tools for data processing and archiving at ECMWF has continued. As agreed at the beginning of the project the data from UERRA predecessor EURO4M was used as a testbed because the UERRA samples had not been available yet. By the end of 2015 four EURO4M data samples, from COSMO, HIRLAM, MESCAN and UM/4DVAR models (Table 1), were archived in MARS for a selected common period 2008-9. Mainly 15 selected parameters (more for UM/4DVAR as that work was already done in the past during EURO4M) were archived in in their original GRIB1 format without any additional post-processing e.g. to a common format which is planned for UERRA datasets only. Because of that the data is varying among the models but it has proved to be still usable for verification purpose in WP3. The EURO4M datasets are available to authorised users only (with ECMWF account) via standard MARS retrieval tools. (The UERRA archives will be put on a special server that is publicly available).

EURO4M

Model	Data status	Next milestone	By when	Progress log
COSMO (DWD)	Data archived		Dec 2015	UER-4 - COSMO (EURO4M) OPEN
HIRLAM (SMHI)	Data archived		Apr 2015	UER-2 - HIRLAM (EURO4M) OPEN
MESCAN (MF)	Data archived		Oct 2015	UER-1 - MESCAN (EURO4M) OPEN
UM/4DVAR (MO)	Data archived		Dec 2012	UER-5 - 4DVAR/UM (EURO4M) OPEN

Table 2. Archiving status of UERRA testbed (EURO4M data) www..ecmwf.int/wiki/display/UER/Progress+status

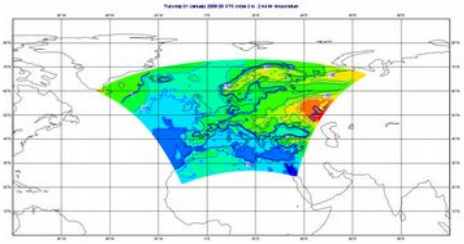


Fig. 12. EURO4M domain (larger than EURO-CORDEX and UERA covering all EEA members).

The main emphasis during the reporting period was put on a finalisation of the GRIB2 WMO compliant definitions of all agreed UERRA parameters and archiving a full UERRA sample dataset in MARS. By June 2016 all new features needed for UERRA proposed to WMO were accepted and officially released in the latest WMO GRIB2 codes and tables (v.1.17). Among those new UERRA features are 5 new parameters and a completely new type of level called soil level which allows to encode a soil level that has not a constant depth across the model domain (each grid cell has soil levels of different depths). The non-constant depth is then encoded as a parameter on this type of level alongside the other parameters like temperature, soil moisture, etc.

By June 2016 the work on ECMWF's grib encoding tool GRIB-API and the related MARS developments was finished too. It means that the full data sample based on some preliminary UERRA test data (derived from HARMONIE model's products) was successfully converted into the final WMO compliant GRIB2 format and archived in the test version of MARS. The exact encoding rules were published in ECMWF's UERRA web portal for providers to be able to apply them on their data and thus to be ready for future production archiving in MARS. The most important next milestone in coming period is to gather full data samples representing each expected dataset correctly encoded by the project partners into the described final GRIB2 format. Once achieved and thoroughly checked that all parameters coming from different models meet fully the set up standards the production archiving of UERRA gridded data can start.

ESGF data:

As stated in the DoW, UERRA will setup an ESGF (Earth System Grid Federation) node for at least one UERRA dataset.

ESGF manages the first-ever decentralized database for handling climate science data, with multiple petabytes of data at dozens of federated sites worldwide. It is recognized as the leading infrastructure for the management and access of large distributed data volumes for climate change research. It

supports the Coupled Model Intercomparison Project (CMIP), whose protocols enable the periodic assessments carried out by the IPCC. Using a system of geographically distributed peer nodes—independently administered yet united by common protocols and interfaces—the ESGF community holds the premier collection of simulations and observational and reanalysis data for climate change research.

Installing an ESGF node is not an easy task. It requires time to get familiar to the code and to get it installed and working. Therefore we started on a local test environment and joined the ESGF administrators mailing lists. We participated to a European ESGF meeting of administrators to get involved and gain knowledge on the system. At KNMI a virtual machine is now available on which the ESGF data node software is running (esgf.knmi.nl). It will require some more effort to get it configured, working and connected to the ESGF network.

Next steps in this task are:

- Finishing the configuration of the ESGF node on the VM (virtual machine) (esgf.knmi.nl)
- Establishing connection to an index node and the ESGF network. We will use the index node of DKRZ
- Testing the data node with (test)data
- Deciding which UERRA set will be published. Note the data will have to pass the requirements of ESGF regarding e.g., file format, file naming, metadata provisioning and content.
- Getting it running the operational setting

T4.2 – User-oriented products

Indices for European area:
The work on the set of derived indices (including uncertainties) has only just started. The tools and scripts to calculate the indices are already available. Initially, these scripts are used on observational data (station-based and gridded) as the RA on which the indices need to be calculated are not yet available. A Climate Indicator Bulletin about 2015 being the joint warmest year on record in Europe has been created in which several derived indices are used (http://cib.knmi.nl/mediawiki/index.php/2015:_joint_warmest_year_on_record_in_Europe).

HYPE-SURFEX-TRIP for European area:
No new results for this reporting period. A general system for coupling the HYPE model to global or regional forcing (Driving), GFD, has been developed at SMHI in preparation for the coming work.

Deliverables:

D4.2: Dataplan

The D4.2 Dataplan was delivered late due to a late start of the team working on the deliverable. The first step was making an inventory of what data will be delivered by UERRA and by whom. Second was to see where the data will be published: MARS archive, climate4impact (indicator data) or on the ESGF node to be set up within UERRA.

Besides publishing the data, we looked at other ways how to connect with the INSPIRE and upcoming C3S data networks. UERRA should not build its own data portal, but connect to existing data portals. The following connections are foreseen:

Data portal at ECMWF providing access to the raw reanalysis and feedback, using the results from the EU EarthServer2 project
Connection with CLIPC through UERRA ESGF data node
Connection whit CLIPC through climate4impact data upload
UERRA wider data dissemination through climate4impact and Climate-ADAPT

The connection with C3S might be out of scope for the project duration of UERRA, as C3S will become operational after the project end. But as it will be the European operational portal for climate data it is very useful to investigate how C3S develops and how UERRA products can be provided. Since UERRA will become the state-of-the-art European Reanalysis by the end of the project, it would be reasonable to expect the C3S to make use of the UERRA dataset to exercise the capabilities of limited area reanalysis.

UERRA wider data dissemination through climate4impact and Climate-ADAPT is beyond the scope of what was promised in the DoW, but should be considered because of the wider impact.

2.2.4.1 Use of resources in WP4

The use of resources has been roughly as planned, with relatively low usage of PM:s during this part of the Project. Particularly for KNMI where the work was planned for the last part of the Project, the use of resources is low. Moreover, the budgeted resources were found to be a bit too much for the relatively limited data services work planned for KNMI compared to the much larger work at ECMWF. Transferring resources to ECMWF has been agreed.

ECMWF has used a large part of their resources and the work is very intense right now (summer 2016) and will continue for the remainder of the Project and with some more resources in (5) PM:s.

SMHI has spent planned resources for hydrological evaluation in the beginning and has still about half left for the second part of the planned work.

MF has started their hydrological modelling work from the MF reanalysis and has started to use PM:s as planned.

2.2.5 Work package 5 – Consortium Management

2.2.5.1 WP 5 activities

See under Management of the Project (chapter 3).

2.2.5.2 Use of resources in WP5

This WP concerns only SMHI and the planned resources have been used, a bit over half of the total. As more resources are really needed, the agreed amendment will help to provide more PM:s for the remainder.

2.2.6 Work package 6 – Scientific Coordination

The management concentrated on coordinating the work between the work packages in close cooperation with the work package leaders to ensure the progress of the project. Particular efforts were spent on coordinating the data service and UERRA archiving between WP2 and WP4 at ECMWF. This has been very intense and technically demanding at times during the period. This issue has taken more resources and much more time than anticipated.

Otherwise the main tasks and achievements during the reporting period were:

2.2.6.1 Scientific reviews and reporting (T 6.1)

The Scientific periodic reporting was started and prepared in early June and partners were asked to send contributions in the latter part of June in order to be able to review the Project for the review meeting at REA in September (7).

Scientific reporting (T6.1)

For a timely and good quality report the coordinator has been working closely together with the allocated scientists in the work packages. The scientific parts of the reporting has been collected and compiled for the 2nd Periodic Report.

Follow up and review of deliverables

The progress and timeliness of deliverables have been monitored by the Project Management including the WP leaders. The Project Management at SMHI have received and scrutinised each deliverable to ensure that it agrees with the DoW and that the quality is high. Once carefully

scrutinized by the Coordinator and the Project Financial and Administrative Officer, the reports are uploaded to the Participant portal and to the UERRA web site.

General management and follow up with REA.

2 project status updates has been communicated and discussed with the PO at REA during 2015 with a long more formal progress report at the end of 2015. This was also directed to the ESAB members and the REA Reviewer, to prepare for the GA in February 2016. The progress report was extensively used by the Evaluator to discuss and advice the Project during and after that GA. In June 2016 a full progress report is made with the partners and the WP leaders to form this Technical Review report.

They concerned the progress in the WPs and particularly the Deliverables. There were quite a few Deliverables that have built up on the waiting list to be completed and this was discussed at the GA. The reasons for that have been communicated and taken up at the GA. The outstanding issues were solved in the months after the GA.

The Project web site had had information added semi-continuously and thus easily communicated to the partners and their institutes as well as other projects and the outside world. (Reports, announcements, table of Deliverables and the deliverables themselves, meeting reports, pictures and presentations, references, newsletters and more) (Please see Table 4 at the end for a detailed account).

There has also been communication and discussion with the PO during the period, via telephone and mail.

2.2.6.2 Scientific management and internal communication (T 6.2)

MST activities
The project internal communication structures are implemented with mailing lists as well as the establishment of schedules for a regular communication e.g. via teleconferences to ensure a smooth communication.

Regular MST (Management Support Team consisting of the Coordinator and the WP leaders) meetings have also taken place during the period.

MST meeting 5: In connection with the GA in Tortosa, 28 January 2015.

MST meeting 6: Telephone conference 10 March.

MST meeting 7: Telephone conference 28 April.

MST meeting 8: Telephone conference 23 June.

MST meeting 9: Telephone conference 2 September.

MST meeting 10: Telephone conference 18 November.

MST meeting 11: Telephone conference 29 February 2016.

MST meeting 12: Telephone conference 9 May 2016.

The MST meetings have dealt with issues in the WPs and communication between the WPs as well as organisation of meetings and reporting. On one occasion also one or two partner's representatives have been invited in connection with Project or other meetings. This has added strength in the discussions of the progress in the relevant WPs.

Deliverables and the work in the WPs have been followed up. Communication with REA and adjoining project as well as external communications and exchanges were also brought up. A list of action points is made at every meeting and followed up afterwards.

Follow up of the progress in the WPs

The Coordinator followed up the progress closely. The tasks in the WPs and the associated Deliverables and Milestones were followed up both by the Management and the responsible partners themselves. Also long term developments with Deliverables far away have been followed up where there is significant work and problems can be foreseen later on if the early work is not started on time or not allocated enough resources.

The Coordinator is and has been aware of the delays and they are inter alias reported in the MST minutes on the web (http://uerra.eu/project-meetings/mst.html).

Communication has taken place via emails and personal discussions via telephone or at meetings. In addition the MST meetings and sometimes dedicated telephone conferences have been useful to follow up the work and agree on actions.

Delays have been followed by mail communication and in some cases through telephone calls to the responsible institutes.

The follow up of the progress comprised the continuous monitoring of the project using the DoW, part A as well as part B and the connection with the list of deliverables and milestones. When difficulties or delays have been identified discussions with the partners as well as in the MST took place. In some cases the delays were only minor or of little consequence (most of the WP1 Deliverables) and no corrective actions was needed as the work was in progress. In other cases (in WP7 and WP4) corrective measures in terms of resource allocation were discussed between the Project management and the partner(s). (Such a resource transfer between 3 of the partners has been agreed to take place now). Some or the reanalysis and data services tasks involve a lot of technical work and subsequent data processing and computing and in a few cases the difficulties have been

larger then foreseen in the DoW. Some of the Deliverables are delayed or are already foreseen to be delayed. The progress as well as the foreseen or actual delays were discussed with REA.

2.2.6.3 ESAB (T 6.3)

The ESAB is constituted by 3 persons with extensive experience from EEA, ECMWF and DG CLIMA. The DG-CLIMA representative has not been able to make it to any of the meetings and only some mail communication took place. Since he has now left for another position, there will be a new representative from DG CLIMA. The ECMWF (reanalysis) and EEA ones have been actively participating in the GA/Review meetings January 2015 and February6 2016.

Meetings.

The following meetings have been organised and followed up by the project management. The Coordinator and the WP leaders attended these meetings (except one WP leader did not attend the EMS meeting). The Coordinator took active part in the WP3 meeting and also presented UERRA to DWD staff.

Meeting	Date	Venue
2nd General Assembly	26-27th March 2015	Tortosa (Spain)
EMS/ECAM conference (external meeting but involving several of the Project staff)	7-11 September 2015	Sofia (Bulgaria)
3rd General Assembly	1-3 February 2016	Toulouse (France)
WP8 User Workshop	3-4 February 2016	Toulouse (France)

Table 5: List of larger Project meetings (meetings involving international travel)

Problems encountered and corrective actions

There are accrued or anticipated delays for all of the partners in WP2, SMHI and UB, Met Office and MF. There have been many technical and model specific problems to sort out and also scientifical in terms of getting a good ensemble. The matters have been dealt with and the ones not yet in production will start imminently now (end of Summer 2016). It means that the complete production and data sets will be rather late during the project period (2017) and that all reports and comparisons may not have used the full periods in the RA s (but still there is hope for this).

In WP4 there are some delays of Data services and visualisation. It is important for WP3 to build their evaluation software on MARS data access and for SMHI in WP2 to have the efficiency of the MARS archives. The work is receiving full attention and every effort is made to complete the implementation of the services as soon as possible, during the summer of 2016. A plan how to cope with the delay, first knowing the more precise and realistic plan and then when to do the work including some alternative data that can be used (i.e. existing reanalyses).

WP3 is waiting for its data even though there are back-up options to work on e.g. existing DWD reanalysis but a full plan for UERRA production and archiving availability is urgently being prepared (mid September 2016).

2.2.6.4 Use of resources in WP6

WP 6 only involves the Coordinator and the use of resources is as planned, a little above half of the total has been used. The rest will be used for the increased activities expected when results become available and more workshops take place.

2.2.7 Work package 7 – Dissemination & Outreach

2.2.7.1 Dissemination (T 7.1)

UERRA Web portal

Project information, notices, reports and presentations have been added throughout the Project.

A log of all changes and uploads is shown in Table 4, appended at the end of this document.

2.2.7.2 Outreach and capacity development (T 7.2)

UERRA has had contacts and exchange with CORE-CLIMAX participated in a User oriented Workshop and prepared for the Colocation Workshop. Other more specific policy briefs and GFCS activities have not taken place yet.

There have been general outreach activities via the web site, conferences and national contacts with users of climate and climate change data.

Two Newsletters have been published on the web and linked information has been sent to contacts.

Information / Project Profile leaflets have been prepared with two Magazines targeting policy makers and the EU commission and bodies. Parliament and Adjacent Government. The first was published in March (see)

The second one is in http://www.adjacentgovernment.co.uk/wp-content/uploads/2016/08/AG11-web-smaller-final.pdf#page=210&zoom=auto,-12,365

The Deliverable D7.3, EU-brief I which was hard to define, was linked with the work on this publication and counted as that. At the same time the responsibility for the EU-briefs was taken over from KNMI to the Coordinator at SMHI since there had been no prior activity and lengthy delay.

The Project has been presented at several conferences by scientists in the project, Work package leaders and the Coordinator.

In particular at the European Meteorological Society/European Conference on applied Climatology/Meteorology in Sofia, September 2015, where two talks about UERRA in the context of Climate Services and of Reanalysis were given by the Coordinator jointly with the UERRA WP leaders.

See also a list of Conference presentations below, after the References (NB a selected list and it cannot claim to be complete as more UERRA scientists have given presentations in other forums and with some UERRA material included.

2.2.7.3 Use of resources in WP7

The use of PM:s in WP7 is less than half of the total and is because more of the work is during the coming Period (African WS e.g.) and that SMHI is taking over some tasks from KNMI. It is mainly that KNMI has not used resources at all yet, whereas SMHI and DWD have as planned.

2.2.8 Work package 8 – User feedback - Third party evaluation of reanalyses and products

D8.1 The initial review of existing user consultation reports

Results from user consultation from other projects and activities were collected and analyzed providing useful background information for user feedback activities within UERRA.

As sources we used documents
-from EURO4M
"*Meta user requirements document for the user needs across the range of user communities*", and "*Two workshops to support user feedback and dissemination of EURO4M products and services*"
-from CLIPC
'*User requirements, part 1: Strategies for user consultation and engagement and user requirements: Synthesis from past efforts'*
-from CORE-CLIMAX
The extensive user survey (2500 users responded) and the project workshops on the development of a Maturity Index for climatological datasets
-from UERRA
Workshop on the definition of a common evaluation procedure (UERRA D3.1)

The review that was produced also benefited from the output from the German national reanalysis project, and from the experience of existing networks. After the end of this reporting period, the focus will shift more to the UERRA generated products, and user feedback after publication of UERRA products.

The deliverable D8.1 contained an initial plan for the first UERRA user Workshop, specifying the target audience, topic list, and an outline for the workshop programme.

D8.2 First Workshop involving external climate service providers

As part of Workpackage 8 (User Feedback) of UERRA two user workshops are planned: one half way, and one at the end of the project. Goals and set-up of both workshops differ, since at the time of the first workshop the UERRA data products will not yet be delivered, while at the second the final products and services will be presented to the users.

The 1st workshop which was held after the 3rd General Assembly of the project in Toulouse, France.

For the workshop 48 participants from 12 countries (18 from France) were registered. Of this group, 19 were working on applications of re-analyses data and 10 were not related to UERRA.

Participants came from a wide range of sectors. Applications (potentially) using re-analysis data that were presented at the workshop were: Energy (wind, solar, demand), Insurance, Transport, Agriculture, Defense, Hydrology, Climate Impacts, Model evaluation, and Atmospheric Physics. The participants were asked to very briefly present their interest in re-analyses, examples of use, requirements, etcetera. This was done in the first part of the meeting.

A significant amount of time was allocated to discuss user requirements for data as well as for scientific and technological support. Although a wide range of sectors were represented in the meeting, it was a clear advantage that all users either already worked with re-analyses data, or were

interested to do so in the near future. About half of the participating users worked with re-analyses data before. Several examples were shown of the use of ERA-40, ERA-Interim, or analyses made for operational weather forecasts. Because of the need for very detailed information (often related to extreme situations) several participants used some form of statistical downscaling to get to the scale relevant for their specific applications. Although it is clear that not all requirements can be met with the UERRA products, the discussion on the future data products did not lead to significant changes in the list of products to be produced by UERRA. Items not on this list, but considered useful by some participants were wind gusts at 100m height and CAPE (Convective Available Potential Energy) .

A short summary of the findings of the user presentations are listed in a table in the Workshop Report (D8.2). The agenda containing links to the presentations can be found at:

In summary, user contact has been successfully established, and interest in UERRA output had been evoked. Results from WP2 and WP3 had been used to do so. Some of the participants (in the Workshop are or were to be, involved in the Energy SIS projects, so there are links through personal contacts but not more than that during the reporting period). Results from WP2 are critical, as users want the data, and results from WP4 are important, as users need a convenient access to the data. Findings from WP8 user workshops were satisfactorily communicated within the UERRA project, as the data producers were involved in the workshop.

2.2.8.1 Use of resources in WP8

Again the resources spent are close to a half of the total and it is because most of the activity was planned from late 2015 and for 2016-2017. Thus more fall in the coming reporting period. Both KNMI and DWD have used as expected.

2.2.9 Work package 9 – Overarching FP7 Coordination Copernicus climate change projects

2.2.9.1 Information exchange and ideas among the five projects (T 9.1)

The coordination plan was delayed in 2015, because of the staffing situation and internal reorganization at KNMI. It is no longer meaningful and the Deliverable D9.1 will be removed with a notice thereof.

2.2.9.2 Coordination meetings organization (T 9.2)

Coordination meetings (telecons) have been resumed and two of them have been held in 2016. Not all the 5 projects have been participating. The ECMWF coordinator for C3S (Jean-Nöel Thépaut) or Dick Dee have attended the telecons and will participate in future telecons.

2.2.9.3 Common web page (T 9.3)

A preliminary version produced by CLIPC has been considered to be the Deliverable and it is satisfactory.

Deliverables

The deliverable 9.3, Lessons learned, has not been completed due to missing contributions from some of the adjoining SPACE Projects. It is beyond the control of UERRA and apparently one of the Projects does not even have it in their own list of Deliverables. However, a draft version was uploaded earlier with the existing contributions.

2.2.9.4 Use of resources in WP9

The use of resources in WP9 has been much less than planned due to the relatively limited activity from the WP9 leader at KNMI. Thus KNMI has used little, but the activity has resumed in 2016 so more is espected to be used. SMHI has been more involved in overarching activities with general communication to and with other project as well as working with KNMI to help with the WP9 work.

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Undén, Per, M. Brunet, D. Barker, A. Kaiser-Weiss, A. Klein Tank and P.D. Jones, 2015: The regional reanalysis activities in UERRA to support Copernicus Climate Change Services, 15th EMS Annual Meeting & 12th ECAM Conference, 9 September 2015, Sofia, Bulgaria

Undén, Per, M. Brunet, D. Barker, A. Kaiser-Weiss, A. Klein Tank and P.D. Jones, 2015: Development of the regional UERRA reanalysis systems and the output validation. Oral presentation at the 15th EMS Annual Meeting & 12th European Conference on Applications of Meteorology (ECAM) | 9 September 2015 | Sofia, Bulgaria.

Undén, Per, M. Brunet, D. Barker, A. Kaiser-Weiss, A. Klein Tank and P.D. Jones, 2016: UERRA regional reanalyses and uncertainties, poster presentation at the 26th ALADIN/HIRLAM Workshop/All Staff Meeting, Lisbon, 4-7 April 2016 -

3 Project management during the period

3.1 Work package 5 – Consortium management

The management structure and procedures of UERRA are described in WP5 description of the DoW and will not be repeated here.

3.1.1 Management (T5.1)

The management of UERRA has been maintained during the period following the stuctures set up at the start of the Project and following the DoW. The main tasks performed and the achievements are briefly described in the following.

Consortium Agreement

The maintenance of the Consortium Agreement (CA) is an ongoing task for the Consortium Management. No changes have been needed. (The budget changes between partners do not affect the CA.

Communication - internal

Internal communication structures have been maintained and updated due to changes at partner institutes, mainly. several mailing lists consisting of all beneficiary contacts. These are used frequently for all kind of communication from the Coordinator to beneficiaries.

Reporting and financial management

A project specific database has been maintained for the reporting and financial management. The structures of periodic reporting have been set up accordingly to deliver the 2nd Periodic report in time.

General management and follow up

There have only been a few questions discussed with some partners in connection with the WP4 distribution of work between ECMWF and KNMI and this has been resolved resulting in re-allocation of some 5 person-months.

Communication with EU and REA

Communications took place between the Coordinator and the PO in the REA to resolve the above and other minor questions. (See chapter 2.1.5 for more details).

Status updates has been communicated REA as mentioned under WP6.

GA meetings

The 2nd GA at URV in Tortosa was held in January 2015 and the 3rd in Toulouse 1-3 February 2016 and they both entailed a lot of organisation and very much supperted by the local organisations.

Changes in the consortium

There were no changes to the consortium.

3.1.2 Financial reporting, Communication and interfacing with REA (T 5.2)

Budget & distribution of funds

The distributions of any payments was without delay.

Communication - internal

Internal communication structures have been maintained to be up to date and are used frequently for all kind of communication from the Coordinator to beneficiaries. The Financial Officer maintains regular contacts and communication with the partner’s financial administrators.

Communication with EU and REA

There have been regular communications with the PO at REA as well as some communication about technical issues with the Participant Portal during the period. The issues were resolved.

3.2 Deliverables and milestones tables

3.2.1 Deliverables

There is a continuously maintained cumulative table from the beginning of the project on the UERRA web site:

Below is the table for the reporting period, M13-30 of the Project.

Table 3. Deliverables								
Del. no.	**Deliverable name**	**WP no.**	**Lead beneficiary**	***Nature***	**Dissemination level[1]**	**Delivery date from Annex I (proj month)**	**Actual / Forecast delivery date**	**Status Not submitted/ Submitted**
D1.3	DARE gaps post 1950	WP1	URV	R	PU	M18	30/06/2015	Submitted
D1.4	DARE gaps pre 1950	WP1	URV	R	PU	M24	28/12/2016	Submitted
D1.5	DARE quality control	WP1	URV	R	PU	M30	September 28	Submitted late see 2.2.1 and below.
D1.9	E-OBS impact of data	WP1	KNMI	R	PU	M15	11/01/2016	Submitted
D1.10	Gridding improvements	WP1	UEA	R	PU	M24	06/05/2016	Submitted
D1.11	Gridding resolution assessments	WP1	KNMI	R	PU	M30	Imminently	Not subm see 2.2.1
D1.12	Gridding resolution enhancements	WP1	KNMI	R	PU	M24	16/05/2016	Submitted
D2.1	Ensemble variational DA developments	WP2	MO	R	PU	M21	29/09/2015	Submitted
D2.2	Ensemble variational observations	WP2	MO	R	PU	M24	05/04/2016	Submitted
D2.3	Ensemble variational diagnostics	WP2	MO	R	PU	M30	October	Not subm see 2.2.2
D2.5	Harmonie physics ensemble	WP2	SMHI	R	PU	M12 [2]	16/02/2016	Submitted
D2.6	Harmonie initial production	WP2	SMHI	R	PU	M30	September 29	Submitted late See 2.2.2
D2.9	MESCAN ensemble	WP2	MF	R	PU	M30	October	Not subm See 2.2.2
D2.10	MESAN cloud analysis	WP2	SMHI	R	PU	M24	October	Not subm See 2.2.2
D2.11	Kalman filter ensemble DA observations	WP2	UB	R	PU	M15	03/11/2014	Submitted

[1] **PU** = Public **PP** = Restricted to other programme participants (including the Commission Services). **RE** = Restricted to a group specified by the consortium (including the Commission Services). **CO** = Confidential, only for members of the consortium (including the Commission Services). **Make sure that you are using the correct following label when your project has classified deliverables.** **EU restricted** = Classified with the mention of the classification level restricted "EU Restricted" **EU confidential** = Classified with the mention of the classification level confidential " EU Confidential " **EU secret** = Classified with the mention of the classification level secret "EU Secret "

[2] D 2.5 delayed from reporting period 1

D2.12	Kalman filter ensemble DA development	WP2	UB	R	PU	M21	28/09/2015	Submitted
D3.3	Programming package	WP3	DWD	R	PU	M15	19/062015	Submitted
D3.4	Evaluation experience	WP3	DWD	R	PU	M24	22/12/2015	Submitted
D4.2	Data plan	WP4	KNMI	R	PU	M12[3]	15/03/2015	Submitted
D4.3	Data services and visualisation	WP4	ECMWF	R	PU	M10[4]	27/02/2015	Submitted
D7.3	EU brief I	WP7	KNMI[5]	R	PU	M18	29/04/2016	Submitted
D7.6	Website	WP7	SMHI	R	PU	M15	24/03/2015	Submitted
D7.9	African Workshop	WP7	KMNI	O	PU	M24	November	Not subm See below
D8.2	User Workshop	WP8	KNMI	R	PU	M24	14/03/2016	Submitted
D9.2	Web portal	WP9	SMHI	O	PU	M6	28/04/2016	Submitted
D9.3	Lessons learned	WP9	KNMI	O	PU	M24	Imminently uncertain	Submitted See below

3.2.2 Milestones

Table 7. Milestones

Milestone no.	Milestone name	WP no	Lead beneficiary	Delivery date from Annex I dd/mm/yyyy	Achieved Yes/No	Actual / Forecast achievement date	Comments
MS1	Completion of D1.5	WP1	URV	M30	No	September	Staffing
MS4	Prel EVDA dataset available	WP2	MO	M24	No	September	Delayed start of production and GRIB conversion
MS7	KFENDA Observation data set	WP2	UB	M24	Yes	03/11/2014	
MS10	First experiences from EVAL shared between partners	WP3	DWD	M24	Yes	15/12/2015	

[3]Delayed from Reporting period 1

[4]Delayed from Reporting period 1

[5]Actually taken over and handled by SMHI

3.2.3 Individual comments on delayed Deliverables

D1.5:

As explained in sect. 2.2.1 in the Technical Periodic Report, the quality control has been very extensive and ambitious taking more than double the amount of planned recovered data (8.2 M) and the availability of only one (but very competent) researcher has meant that the quality control has taken a few months more than planned. Moreover the quality control has been extended and coded for more variables and particularly to cope with the daily and hourly time scale. It is very important that this is done properly and completely for the data to be fully beneficial for reanalyses.

The D1.5 was delivered on 28 September. It was agreed earlier that it would be delivered with a small remaining point: 8% of the **rejected** data are left to be checked manually and this will be done during the next months and everything submitted to the international data bases before the end of 2016.

The later following Deliverables, D1.6 and 1.7 will not be delayed because of D1.5 since the coming ones are fully automatic and can be executed quite quickly once all the quality control (D1.5) is done.

D 1.11

There was a general delay in task T1.3 due to staffing (maternity leave 2015) but the postponed work has been caught up on and the Deliverable D1.11 was worked on intensively in July but after holidays it was found that more work is needed and the researcher is looking at more national data sets for a more complete evaluation The Deliverable is worked on and expected by mid September and certainly before the end of the month. The later coming work and Deliverables are not dependent on this Deliverable and there are no negative consequences (apart from waiting for the results and increased knowledge for the project and other scientists).

D 2.3

There has been a general delay in the Met Office development of the Ensemble Variational assimilation due to new scientific and technical components and quite a lot of computational time needed for testing and correcting the system. The system has still been in testing mode and production was not started, thus not providing long enough data series for meaningful diagnostics. Also the same researchers as were doing the developments are working with the report. In order not to distract the final testing it was decided to leave the report for a few months.

The report will be done and finished in October.

The Deliverable in itself has no impact on later work but the fact that the running and production of reanalyses is delayed has consequences for the use of the reanalyses for evaluation and users and the eventual ability to finish the whole period before the end of UERRA. Mitigation options are considered in 2.2.2, e.g. to use fewer member than planned. Still, once production is started, several parallel streams will be run and one can proceed quite quickly and certainly get a good estimate of the time needed to complete.

D 2.6

There have been changes and gaps in the staffing of the Project due to two researchers that left for joining ECMWF but replacements have taken place. An important bug affecting the reanalyses and they had to be re-run, thus delaying the production and the material available for evaluation of the reanalyses.

The work on the report started in the summer and great part has been done. It will be finalised before end of September (and was submitted then.

There is no impact on any later work since it is a report of the quality, but of course the results are important for the Project to know.

D 2.9

There was a substantial delay of the MF work last year since the scientist employed for UERRA could not continue on a temporary contract due to MF internal rules and left for ECMWF. A new scientist was quite quickly recruited with a slightly different profile and there was a learning process but the team functions well again.

Also some delay was caused by delayed SMHI procuction but this has only minor impact.

The scientific methods for ensembles was also more difficult than expected but the production of the 5 years is ongoing and will be complete in September and a report will be done in September too.

The impact of the delay is for WP3 that want to evaluate the uncertainties. Moreover, the archiving in MARS of these data as well as all the other reanalyses has been delayed and required much more work and this is crucial for WP3.

D 2.10

The work started with a single resource who got responsible for more projects and extra resources waited for a recruitment which took place early 2016. It is not all that bad since we were waiting for more complete satellite processed data and thus get a more complete and higher quality data set. Also the scientific developments and tuning of the grid resolution and fast enough computation have taken more time than expected.

It was agreed to delay the report from M24, even though a temporary report could have been done, for the complete report expected in the summer of 2016.

Since then the start of the production with the final choices took even more time than expected there will first be a final test of one year or reanalysis before final production. This is expected to take 1-2 months and the report will be produced after this, so October - November.

The impact is small even if it would have been nice for WP3 to use the data, but they have never considered this to be any their main reference data sets.

D 7.9

This African Workshop would take place in Angola 28 November to 9 December 2016 in the context of GFCS and ETCCDI. Now (September 2016) it is transpired that it cannot be in November and Angola, but it will be in spring 2017 in Botswana. It is in the same context, but it is nothing that UERRA or KNMI can control.

This deliverable has always been depending on the colocation with a more major meeting as above and it has not been possible to predict the timing so long in advance.

D 9.3

The UERRA part as well as ERA-CLIM2 and one or two of the other projects have provided the input for Dr. Albert Klein Tank to compile and make available as a deliverable. This was agreed with Dr. Klein Tank around March. He is coordinating the Overarching activities for all the 5 adjoining Space projects and the issue has been discussed in telephone conferences. One contribution is still missing and it seems that one of the projects does not even have it in its list of deliverables, so it has now been agreed to submit it with 4 of the 5 projects included.

Appendix 1. Plan for producion in WP2 and impact on WP3, 4

The Plan for the production and archiving in WP2 and how it impacts on WP3 and WP4

The WP2 partners' status and plans have been surveyed during the last two weeks and the consolidated picture is compiled in the GANTT diagram also uploaded on the Participant portal (and Fig. 13 below but it is hard to read inside this document)..

It was taken from the DoW first but then much elaborated and focusing in on the more precise tasks in WP2 and WP4 and more precise in time with week numbers and quarters indicated at the top. It goes down to the data years that are and will be produced and then archived. By focussing in on WP2 and WP3 and WP4 to some extent, the diagram does not go all the way to the end of 2017, but some tasks extend to the end as indicated in the diagram and in the text on the rows.

WP4 have some tasks that depend on WP2, foremost the hydrological modelling SURFEX/TRIP strongly coupled to the ongoing production at MF and SMHI HYPE modelling with is only going to start in 2017 when data are available.

For SMHI / HARMONIE a great portion has been run – more than 25 years of reanalyses plus runs with the two physics versions for 5 years. MF has done most of the ensembles from the 5 years (2006-2010) and is soon completing that.

Univ. of Bonn has run most of 2008 and Met Office part of it.

The data so far exists only on file storage at ECMWF and in the producer's native GRIB1 format and in files of specific naming conventions and stored chronologically as the reanalyses were produced. These data are slow to retrieve and different extractions needed from each model. Some work has already been done using these files directly and it will still be possible to continue and extend this work for more models and variables for the selected year of 2008.

In the mean time intensive work by ECMWF and the WP2 producers has taken place to check and correct and adjust their outputs to agree with the common UERRA table of data and the Data Plan (D4.2) and just now data from MF, SMHI and Univ. Bonn is being archived in MARS with some additional correction needed for the MO case.

This means that during all the 4 weeks in October there will be intense archiving of produced data from SMHI and MF while the others continue or start their archiving. The Common software package developed and used within WP3 interfaces GRIB via the grib_api software library which new version handles also the UERRA data in GRIB2. The interface for the UERRA data needs will be implemented (by switching to the new library) and the parameters that are to be used will be checked and any necessary adaptations made. Gradually the evaluation and uncertainty work will be switched to the MARS GRIB2 archive but in the month of October and before the UERRA General Assembly and Showcase WS 21-23 and 23-24 November resp.) a mixed access methods to the data will have to be used, some using MARS depending on the rapid availability and that all models will not be there in time, and some using file based data.

As more years are produced and archived, the work will be extended to those during the last month of 2016 and early 2017. The somewhat long bars over months does not necessarily mean that each task takes that long, but merely that the work will be carried out in the period. Some partners do not have enough person months for the long periods indicated but they will do their planned work during the indicated periods.

WP2 Details:

Met Office as in the GANTT

SMHI HARMONIE detailed schedule:

Already produced (E.o. September 2016):

1961-1964

1970-1972

1979-1982

1990-1993

2000-2001

2005-2008

2011-2014

Oct 2016 2009-2010,

2015 produced and archived

2007-2008 archived

Nov 2016 1965-1966,
1973-1974,
1983-1984,
1994-1995,
2002-2003 produced, and archived

1961-1962,
1970-1971,
2005-2006,
2011-2012 archived

Dec 2016 1967,
1975,
1985,
1996,
2004 produced and archived

1963-1964,
1972,
1979-1980 archived

Jan 2017 1968,
1976,
1986,
1997,
2005 produced and archived

1981-1982,
1990-1991 archived

Feb 2017 1969,
1977,
1987,
1998 produced and archived

1992-1993,
2000-2001 archived

Mar 2017 1978,
1988,
1999 produced and archived

Apr 2017 1989 produced and archived

UB Bonn COSMO as in the GANTT

MF MESCAN details:

Sept 2015: only downscaling from SMHI (without the MESCAN analysis)
1961-1964 done we are waiting and preparing observation files
1970-1971 done
1990-1993 done
2006-2010 done

Oct 2015: ensemble MESCAN produced for 2006-2010
only 2008 will be archived on MARS for GA

Starts the downscaling for 2000-2001

After we will follow as much as possible the SMHI production for the downscaling

We will run the full MESCAN-SURFEX for 2000-2010 for the end of January 2017.

After MESCAN can run in parallel following the SMHI product but for

SURFEX will have at least 10 years for one stream (for soil moisture it should be better) so it means we will start MESCAN-SURFEX for the period

61-70 March 2017

71 -79 April 2017

80-89 May 2017

90-99 May 2017

WP 3 details:

Both Task 3.1 (coordination and communication) month 1- 48 and

Task 3.2 (evaluation) months 15-45, have started as planned in the DoW.

Up to now the focus was on method development. Application to WP2 output was planned to begin June 2016. Due to the delay in the WP2 production, application has started in September only with first WP2 results. Of course, WP3 results obtained from limited samples of WP2 output are of less value than results obtained from the complete WP2 data set. For the latter, we depend on the timing of the end of production. Thus, the end of Task 3.2 is expected to shift to the end of the project. In the meantime, WP3 can deal with scientific and expected user questions which do not require full data coverage (e.g., characteristics of diurnal cycle), while taking into consideration the production schedules of the various producers (e.g., ensemble methods require a statistically meaningful data coverage).

Thus the WP3 partners start analysing a common year (2008) with methods and software we have, using the most pragmatic ways to access the 2008 data of the various WP2 producers (Q4 2016).

During 2017, we will switch data access to the UERRA archive, and will extend the WP3 analysis to longer periods, responding to data availability of the different producers. This approach is valid for all 3 activities:

UERRA-EVAL-PREP (method and software development) had started as planned and will go on during the first quarter of 2017. Next steps are to adapt the WP3 software to the archive, and testing of performance (from 4th October to Christmas).

UERRA-EVAL-SYNTH (analysing multi-model data for 2008)had been delayed for 4 months, had started in September and will go on during 2017. It comprises comparisons against: precipitation, wind, temperature and climate indices, concentrating on high resolution data sets over subregions.

UERRA-EVAL-EUROPE (covering the whole of the European region) had started in September with a first comparison of selected global radiation reanalysis data against CM-SAF data. Starting Q4 2016, analysis extends to ECA&D and EOBS data sets.

WP3 partners will share their output, and scientifically describe and explain results to users during Q2-Q4 2017, as planned.

Figure 13. GANTT diagram for the Project for the year from 1 October 2016

Table 4. New articles (any material) added in to the uerra.eu website. (not including changing and editing material)

Some leaflets (Alias: some-leaflets) Public	01/06/2016
MST Meeting 12 (Alias: mst-12) Public	01/06/2016
Newsletter No 2 April 2016 (Alias: newsletter-no-2-april-2016) Guest	01/04/2016
User oriented products, contacts, outreach and dissemination (Alias: user-oriented-products-contacts-outreach-and-dissemination) Public	01/04/2016
Data services and visualisation (Alias: data-services-and-visualisation) Public	01/04/2016
Uncertainty and quality evaluation and validation (Alias: uncertainty-and-quality-evaluation-and-validation) Public	01/04/2016
NWP based reanalyses (Alias: nwp-based-reanalyses) Public	01/04/2016
Reanalysis systems (Alias: reanalysis-systems) Public	01/04/2016
Newsletters (Alias: newsletter-all) Public	01/04/2016
Observation rescue year 2 (Alias: observation-rescue-year-2) Public	31/03/2016
Newsletter 2 (Alias: newsletter-2) Public	31/03/2016
MST Meeting 11 (Alias: mst-meeting-11) Public	03/03/2016
Next General Assembly in November and UERRA Event (Alias: next-general-assembly-in-november-and-uerra-event) Public	10/02/2016
Report from the GA3 (Alias: report-from-the-ga3) Public	10/02/2016
Wednesday_AM (Alias: wednesday-am) Public	08/02/2016
Tuesday_PM (Alias: tuesday-pm) Public	08/02/2016
Tuesday_AM (Alias: tue-am) Public	08/02/2016
Monday PM (Alias: monday-pm) Public	08/02/2016
MST Meeting 10 (Alias: mst-meeting-10) Public	09/12/2015
Agenda with presentations (Alias: agenda-skeleton) Public	27/10/2015
MARS conventional observations (Alias: mars-conventional-observations) Public	21/10/2015
Conference contributions (Alias: conference-contributions) Public	17/09/2015
Papers (Alias: papers) Public	17/09/2015
MST Meeting 9 (Alias: mst-meeting-9) Public	17/09/2015
General information (Alias: general-information) Public	03/09/2015
The User Workshop in February was well attended (Alias: user-workshop-announcement) Public	03/09/2015
Newsletter No 1 available (Alias: newsletter-no-1-available) Public	01/09/2015
MST Meeting 8 (Alias: mst-meeting-8) Public	01/07/2015
Old news archive (Alias: old-news-archive) Public	09/06/2015
New Deliverable reports (Alias: new-deliverables) Public	27/05/2015
User Workshop and General Assembly 2016 (Alias: user-workshop-and-general-assembly-2016) Public	26/05/2015
Use oriented products and climate information (Alias: use-oriented-products-and-climate-information) Public	26/05/2015
Data services and evaluation procedures (Alias: data-services-and-evaluation-procedures) Public	26/05/2015
Development of COSMO Ensemble reanalysis (Alias: development-of-cosmo-ensemble-reanalysis) Public	26/05/2015
Large ensemble 4DVar at the Met Office (Alias: large-ensemble-4dvar-at-the-met-office) Public	26/05/2015
Near surface ensemble reanalysis (Alias: near-surface-ensemble-reanalysis) Public	26/05/2015
HARMONIE 3-dimensional reanalyses (Alias: harmonie-3-dimensional-reanalyses) Public	26/05/2015
Over 5 M data rescued (Alias: nl1-dare) Public	26/05/2015
UERRA GA in Tortosa (Alias: nl1-uerra-ga) Public	25/05/2015
Newsletter 1 (Alias: newsletters) Public	25/05/2015
MST Meeting 7 (Alias: mst-meeting-7) Public	13/05/2015
MST Meeting 6 (Alias: mst-meeting-6) Public	20/04/2015
CLIMATE-ES 2015 (Alias: climate-es-2015) Public	16/03/2015
MST Meeting 4 (Alias: mst-meeting-4) Public	05/03/2015
MST Meeting 5 (Alias: mst-meeting-5) Public	05/03/2015
Practical details (Alias: practical-details) Public	04/03/2015
General Assembly 2016 (Alias: ga-3) Public	04/03/2015
Minutes from UERRA General Assembly No2 January 2015 (Alias: minutes-from-uerra-general-assembly-no2-january-2015) Public	01/02/2015
Presentations_Wednesday_afternoon (Alias: presentations-wednesday-afternoon) Public	30/01/2015
Presentations_Wednesday_morning (Alias: presentations-wednesday-morning) Public	30/01/2015
Presentations_Tuesday_afternoon (Alias: presentations-tuesday-afternoon) Public	30/01/2015
Presentations_Tuesday_morning (Alias: presentations-tuesday-morning) Public	30/01/2015
Project Reports (Alias: project-reports) Public	12/01/2015

Table 5. Used resources for 2014-30 June 2016 in PMs.

Summary table - Do not touch cells!

budget figures for total project period!

	budget WP1	consumed WP1	budget WP2	consumed WP2	budget WP3	consumed WP3	budget WP4	consumed WP4	budget WP5	consumed WP5	budget WP6	consumed WP6	budget WP7	consumed WP7	budget WP8	consumed WP8	budget WP9	consumed WP9	**budget TOT**	consumed TOT	%
SMHI		0.00	82	38.98		0.00	8	3.81	8	5.00	9	4.70	4	2.72		0.00	4	2.13	**115**	**57.34**	50%
MF		0.00	52	20.72		0.00	14	6.00		0.00		0.00		0.00		0.00		0.00	**66**	**26.72**	40%
KNMI	12	25.42		0.00	21	1.93	20	6.50		0.00		0.00	5	0.00	8	3.56	4	0.20	**70**	**37.61**	54%
MO		0.00	164	92.00	2	0.00		0.00		0.00		0.00		0.00		0.00		0.00	**166**	**92.00**	55%
UEA	25	28.14		0.00	5	2.75		0.00		0.00		0.00		0.00		0.00		0.00	**30**	**30.89**	103%
EDI/MeteoSwiss	3	2.07		0.00	7	2.90		0.00		0.00		0.00		0.00		0.00		0.00	**10**	**4.97**	50%
URV	54	49.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00	**54**	**49.00**	91%
NMA-RO	3	11.00		0.00	4	0.00		0.00		0.00		0.00		0.00		0.00		0.00	**7**	**11.00**	157%
ECMWF		0.00		0.00		0.00	22	14.94		0.00		0.00		0.00		0.00		0.00	**22**	**14.94**	68%
DWD		0.00	3	1.48	37	27.30		0.00		0.00		0.00	4	3.40	4	2.50		0.00	**48**	**34.68**	72%
MetNo		0.00		0.00	9	8.10		0.00		0.00		0.00		0.00		0.00		0.00	**9**	**8.10**	90%
UB		0.00	47	27.80		0.00		0.00		0.00		0.00		0.00		0.00		0.00	**47**	**27.80**	59%
	97	**115.63**	**348**	**180.98**	**85**	**42.98**	**64**	**31.25**	**8**	**5.00**	**9**	**4.70**	**13**	**6.12**	**12**	**6.06**	**8**	**2.33**	**644**	**395.05**	**61%**
Consumed WP level		119%		52%		51%		49%		63%		52%		47%		51%		29%			