UERRA Periodic Report Period 1 M1-M12 (20140101-20141231)

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2 Project objectives, work progress and achievements, project management

2.1 Project objectives for the period

From the DoW (Annex I, Part B), the following objectives for the **whole** project are defined. The detailed objectives for the reporting period (M1-M12) 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 early results. Only some (3-dimensional RA) has started but most of the production was not planned to start yet.

- 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 results yet and this was not planned for Y1.

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

Yes, most, or almost all, 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.

The below objectives apply to the following 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)
- To provide data services and visualisation portals for a large number of RA fields (WP4)
- 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)
- 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)
- 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 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.

• 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, this has been done.

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

Yes, see below.

• 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, some early work done.

• 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 and according to plan. A regional ensemble 4D-Var data assimilation system is being developed and adapted.

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

The adaption 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 later.

• 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.

• 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.

• Ensemble reanalysis uncertainty estimates derived from comparison of the UERRA reanalyses against each other, global (ERA) and regional (HErZ) RA.

(The light faint colour above and in the following sub-sections indicate objectives from the DoW (part A) which do not apply for the reporting period and are thus not commented on).

2.1.3 Work package 3

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

Extensive work has been done on the definitions of variables, comparison data sources and evaluation measures has been done. There was much involvement with WP2 (the main data set producers) but also WP1 (gridded datasets and their uncertainties) and with WP4 (data services) and WP8 (user aspects).

• 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

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

• 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

• To synthesize the results of the evaluation into a general assessment of the reliability and uncertainty of regional reanalysis that guides users in the state-of-the-art application of the datasets produced in WP2

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 has started to make reanalysis data available and in depth planning for the new UERRA data is taking place. It is built on and extending existing systems for data and visualisation.

• 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 really Work package 8)

• 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") (This is really Work package 9)

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 on, (3.1)

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

Yes.

• Organize meetings relating to the Consortium Management

Yes, in particular the General Assemblies.

2.1.6 Work package 6

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

Yes, for the objectives due during this initial year of UERRA:

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

Yes, except for a few Deliverables that are delayed and which is explained in 2.2.6.

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

Yes.

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

Yes, again see 2.3.6.

2.1.7 Work package 7

• Ensure the interaction with the EC via REA

• 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.

• 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.

• 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

• 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 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

Only preparations planned and started during this first year of UERRA.

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

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.

• 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 do only partially apply for this period and there has not been much reason for those activities yet.

2.2 Work progress and achievements for the period

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

UERRA WP1 workload for Y1 included activities in all of its three tasks, from progress in data rescue (DARE) of climatic observations for those variables that have the highest impact for the enhancement of high-resolution Regional Reanalysis (RRA) products (for T1.1 by URV and NMA-RO) to high-quality synoptic-scale data development (for T1.2 by URV and UEA) and enhancing methodologies that might reduce the uncertainties of gridded products, such as E-OBS (for T1.3 by KNMI, UEA and EDI).

Remarkable progress has been achieved in all the committed tasks for Y1, highlighting the digitisation of about 3.5M station-values of hourly air pressure (SLP), temperature (TMP), wind speed (WS) and direction (WD), temperature dew point (TDP), relative humidity (RH) and snow-depth (SD), snowfall (FS) and precipitation (RR) observations at the daily scale for the post-1961 (more than 1.8M) and pre-1961 (more than 1.6M) periods by URV. The total value is close to the digitisation target committed in the DoW (3.7M station-values) and also points to a potential exceedance of this target during Y2, a second UERRA year that is still focused on digitisation in T1.1. The UEA contribution to the assessment of the spatial coverage of ECMWF observations in setting the digitisation targets has been vital in identifying the relevant observations to be digitised. NMA-RO has also digitised 3 out of 6 Romanian stations with 6-hourly RR observations for the period ~1979-2002. Finally, the two Deliverables (D1.1: A comprehensive list of possible additional sources that can be accessed for digitisation and encoding and D1.2: Report on the locations of the station data: digitised and to be digitised) committed in the DoW for Y1 were provided on time by URV, UEA and NMA-RO to the UERRA Coordinator.

Similarly, the progress achieved under T1.2 has also been good, since UEA has been an active contributor to a number of committed tasks, such as the conversion to ODB of the SLP hourly data recovered under the EURO4M DARE effort (about 0.5M station-values) that were provided to the MARS Archive. UEA has also updated the CRU TS dataset to 2013 (v3.22) and updated and improved the CRUTEM4 station network, particularly over Europe (mostly using E-OBS data). URV has additionally devoted time in Y1 to defining and implementing new automatic quality controls (QC) at the hourly scale and for the specific climate variables to be passed onto the digitised data to ensure their quality and consistency. Automatic quality control has been conducted along with visual cross-checking (digitised values against data sources figures) to ensure both the quality of the data-sources in use and the digitisation output.

Finally, for T1.3 UEA has worked on improving the gridding of precipitation in the E-OBS Dataset by using a gamma distribution fitted to the data over a base-period. In addition, KNMI has progressed on releasing monthly updates of the daily gridded station data set for Europe (E-OBS), which includes additional data for a number of European countries from the ECA&D archive. Also preliminary work has been carried out by KNMI to accomplish D1.9 (Assessment of the impact of changes in station density on the E-OBS dataset). During Y1, EDI has advanced its efforts towards quantifying interpolation uncertainty via stochastic simulation with the final goal being to derive an ensemble of quasi-realistic grids of precipitation, already tested over the Alpine region, which are conditioned on rain-gauge observations and the representation of the uncertainty inherent due to the limited station density.

2.2.1.1 Data coordination, inventory and access to national archives (T1.1)

University Rovira i Virgili (URV), in charge of leading WP1 on Data Rescue (DARE) and development, gridded and observational datasets, has largely accomplished all the activities planned for Y1 under both tasks: T1.1 Data coordination, inventory and access to national archives and T1.2 High-quality synoptic-scale data development, which are also lead by URV and include the on-time provision of two deliverables (D1.1: DARE list of sources and D1.2: DARE station locations). Both tasks are intended to:

- Assess the needs for synoptic-scale basic observational input to enhance Regional Reanalysis (RRA), exploring historical and recent data-sources containing surface observations at the sub-daily scale and gaining access to the suitable data sources
- Link to and coordinating with existing DARE initiatives and projects to optimise resources, avoid duplication and enhance data availability and accessibility
- Fill in gaps from available synoptic-scale observations over data-sparse European regions and periods (e.g. post-1950) and further recovery and digitisation of synoptic-scale observations for data-sparse European regions and periods pre-1950

Enhancing high-quality synoptic-scale data development (e.g. developing new quality controls –QC- at the hourly scale and ensuring time-series homogeneity through homogenisation, if required)

First, URV in cooperation with the University of East Anglia (UEA) has assessed current availability of digitised data maintained at the Meteorological Archival and Retrieval System (MARS) Archive of the European Centre for Medium Weather Forecast (ECMWF), observations that are the basic input for the European Reanalysis, but for which there isn’t any catalogue currently available.

Second, URV has identified the relevant data sources containing un-digitised synoptic observations for Europe in scanned and other formats, either building upon the EURO4M DARE effort or exploring new on-line and physical data sources and holders, to produce a comprehensive list of historical climate data holders and sources with relevant un-digitised, but imaged data over Europe, as a first step to carry out additional DARE activities.

Third, URV thanks to the former activities identified the data-sparse European sub-regions and sub-periods of the 20th century, gained knowledge on the data holders located and accessed from which relevant imaged data will be digitised to enhance European RRA (in WP2) and set the DARE targets for digitisation.

Fourth, URV has coordinated with other existing DARE initiatives worldwide as a way to avoid duplication and optimise resources,

Fifth, the digitisation plan was set up and digitisation started on early 2014 after contracting 10 URV students steered by URV personnel. A remarkable outcome from this activity might be highlighted, since even without finalising the first year of digitisation, it has already been digitised about 90% of the committed station-values to be provided, which point to a clear exceedance of the committed value by the end of the 2nd year.

And sixth, URV has been working on defining a wide set of quality controls (QC) and developed the corresponding software to identify either errors derived of the digitisation or non-systematic errors existing in the data-sources used.

All these activities are explained more in detail in the next sub-sections.

2.2.1.2 Assessing the needs for DARE, locating/accessing to relevant data-sources and holders to set the targets for digitisation and data coordination (T1.1, Data coordination, inventory and access to national archives)

In coordination with UEA, whom were in charge of decoding the ECMWF MARS observations acquired under EURO4M to assess currently available data for Reanalysis as described below by UEA, the URV also explored other on-line (e.g. International Surface Pressure Databank v2 –ISPDv2-, European Climate Assessment and Dataset –ECA&D-) and physical (e.g. National Climate Data Systems of the Western Balkans NMS of Albania, Bosnia & Herzegovina, Macedonia the FYR, Montenegro and Republika Srspka, and those in Catalonia, France, Germany and Slovenia) data sources containing digital data to avoid duplicating the digitisation effort under UERRA. In addition, URV built upon the scanned data-sources gathered under EURO4M and further explored those and other on-line repositories (e.g. NOAA/NCDC Climate Data Modernization Project -CDMP-, National Climate Data Center –NCDC- new holdings, the Hydro-meteorological Service of Serbia repository, ACRE/BADC repository, the MEDARE metadata base) and physical (e.g. Ebro's Observatory Library, , Météo-France archives, National Climate Data Systems of the Western Balkans NMS of Albania, Bosnia & Herzegovina, Macedonia the FYR, Montenegro and Republika Srspka, and those in Catalonia, France, Germany and Slovenia) to identify new relevant and un-digitised data-sources and set the targets for digitisation, as reported and documented in detail in D1.1. From these outcomes and in consultation with UERRA partners, two 20th century sub-periods (pre- and post-1961 periods) and three data-sparse European sub-regions were identified and set as targets for enhancing the basic input in support of high-resolution regional reanalysis. The data-sparse European sub-regions are: Eastern Europe (45°N-55°N,15°E-25°E), the Mediterranean region, including Middle East countries (29°N-45°N,10°W-40°E) and Northern Europe (55°N-71°N,5°E-25°E).

As all the data-sources gathered and explored mainly contain hourly data for the pre-1961 period, URV undertook contacts with relevant National Meteorological Services (NMS) using WMO channels to getting access to post-1961 observations by proposing to the NMS Permanent Representatives (PR) within WMO an exchange exercise consisting in accessing to their imaged, but un-digitised data, and digitising for them some of the identified station records. Such exercise was proposed to the NMS of Catalonia, Egypt, Jordan, Libya, Germany, Macedonia the FYR, Montenegro, Romania, Serbia, Slovenia and Sweden. Despite of initial positive responses from most of them (e.g. Jordan, Libya, Macedonia the FYR, Montenegro, Serbia) and the negative of others (e.g Romania and Sweden), only the proposals to Catalonia, Germany and Slovenia had succeed. This can be explained in many cases due to the fact that the SMN has not duplicated (imaged) their original logbooks, making the exchange exercise unviable (e.g. Macedonia the FYR, Montenegro, Serbia). In other cases, this was related to internal policies for digitisation that preclude the exchange (Romania and Sweden). Therefore, the high chance of having to mainly digitise pre-1961 observations, as noted in D1.2 and in the Minutes #3 of the UERRA Support Steering Team (MST), was overcome by gaining access to the accessible data-sources, although in some cases it meant to include stations not strictly located in the 3 data-sparse regions targeted (e.g. eastern Germany).

Before setting the plan for digitisation, coordination activities were envisaged to avoid duplication and optimise resources. This was done by taking advantage of URV contacts and involvement in different DARE activities worldwide. Among others, the UERRA WP1 leader involvement in the International Surface Temperature Initiative (ISTI) DARE team resulted in a good coordination not only within ISTI, but also with other relevant DARE projects worldwide. Among them to highlight the Atmospheric Circulation Reconstructions over the Earth (ACRE) and their parent projects, the

WMO MEditerranean DAta REscue (MEDARE) Initiative and the WMO International-DARE (I-DARE) group under deployment. This coordination ensured and avoided duplicating efforts.

As in detail reported in D1.2, the targets for digitisation were set up, which involved the digitisation of the following climate variables at the hourly scale: sea level pressure (SLP), temperature (TMP), wind direction (WD), wind speed (WS), temperature dew point (TDP) and relative humidity (RH), while at the daily scale these other variables were also targeted: rainfall (RR), snow-depth (SD) and fresh snow (FS). A total of about 120 meteorological stations with a number of hourly observations per day (e.g. from one to 24, being three times per day the most frequent observing times) have been recorded, in addition to those other stations pending to identify from the agreements reached with a few NMS for scanned data-sources access, as stated in D1.2. These stations are distributed across the three European sub-regions that have been set as an initial target for data recovery and development (primarily for the use in the RRA in WP2).

2.2.1.3 Assessment of spatial coverage of ECMWF observations (T 1.2)

To allow URV to explore areas of greatest need, the ECMWF observations acquired for the EURO4M project were 'mined' for coverage information. This was distilled for three selected areas:

- Eastern Europe (45°N-55°N,15°E-25°E)
- Mediterranean (29°N-45°N,10°W-40°E)
- Northern Europe (55°N-71°N,5°E-25°E)

The first few lines of the coverage report for the Mediterranean region are in Table 1. An accompanying graphic (Figure 1) shows spatial coverage and indicates degrees of temporal cover for Sea-Level Pressure. Similar plots of the other two European regions are shown in Figures 2 and 3.

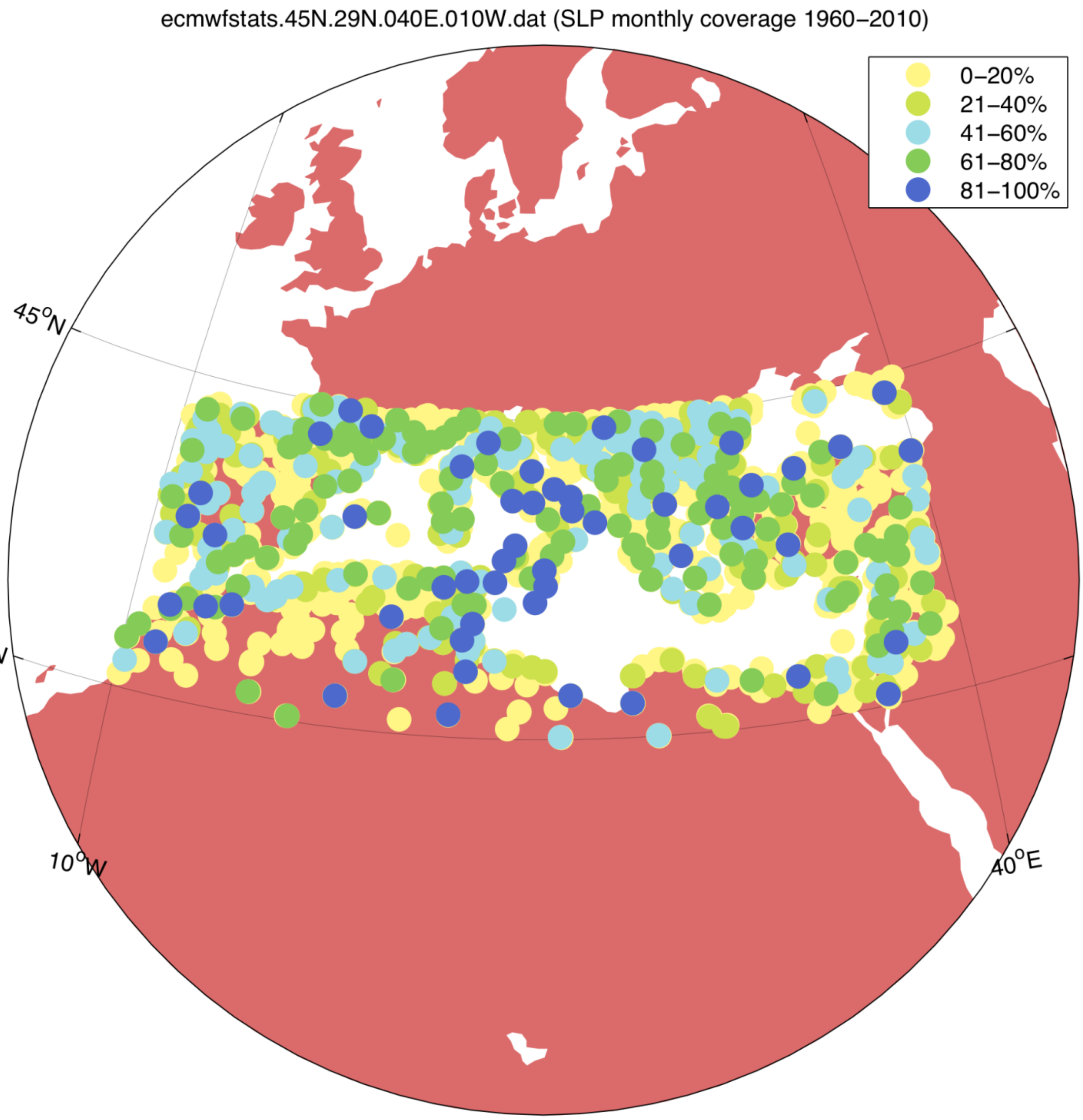

Figure 1. Spatial and temporal coverage for sea-level pressure observations in the Mediterranean region. Percentage cover is overplotted from low to high; so areas with low temporal cover are yellow or light green (no cover being red).

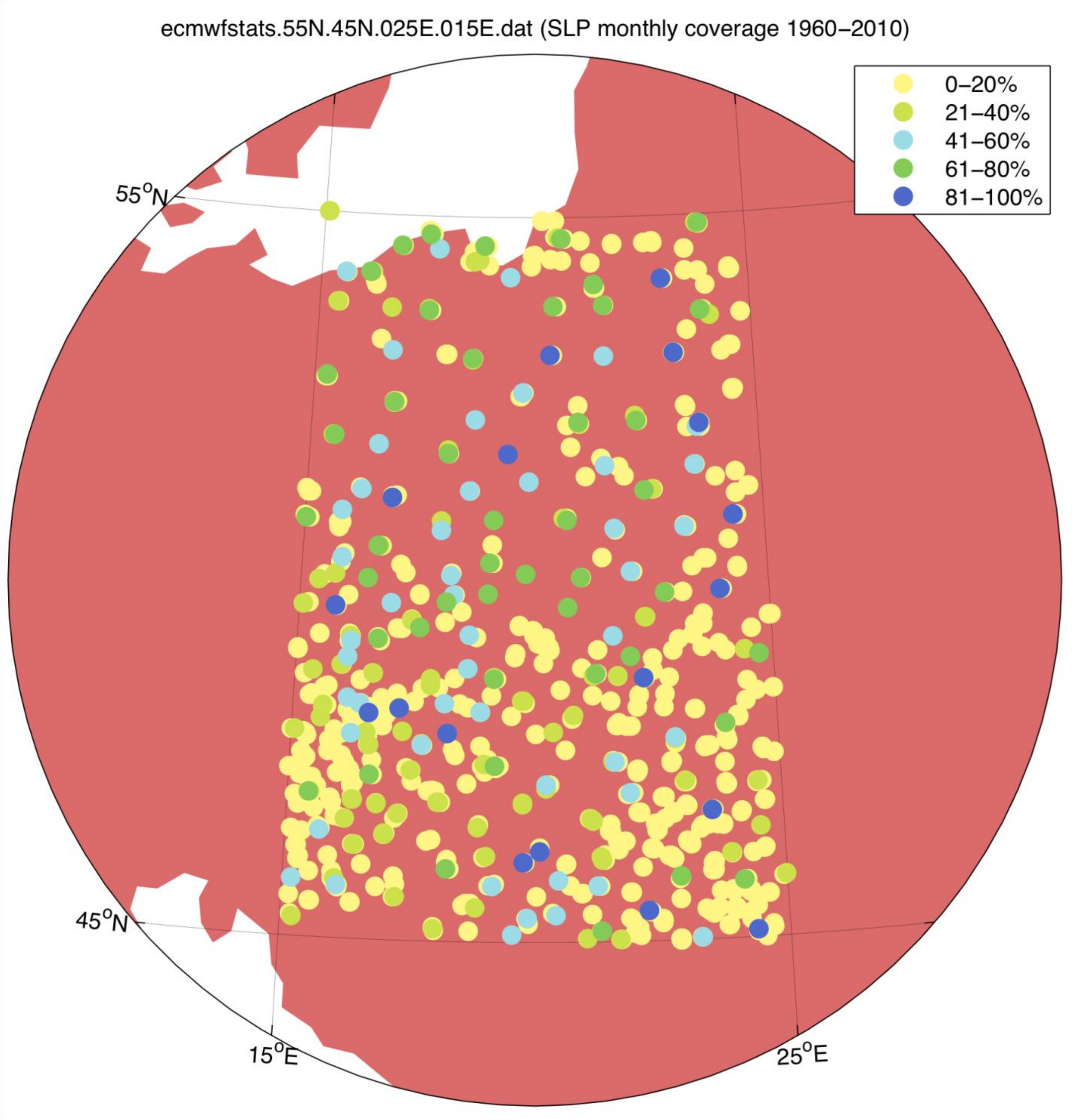

Figure 2. Spatial and temporal coverage for sea-level pressure observations in the Eastern European region. See Figure 1.

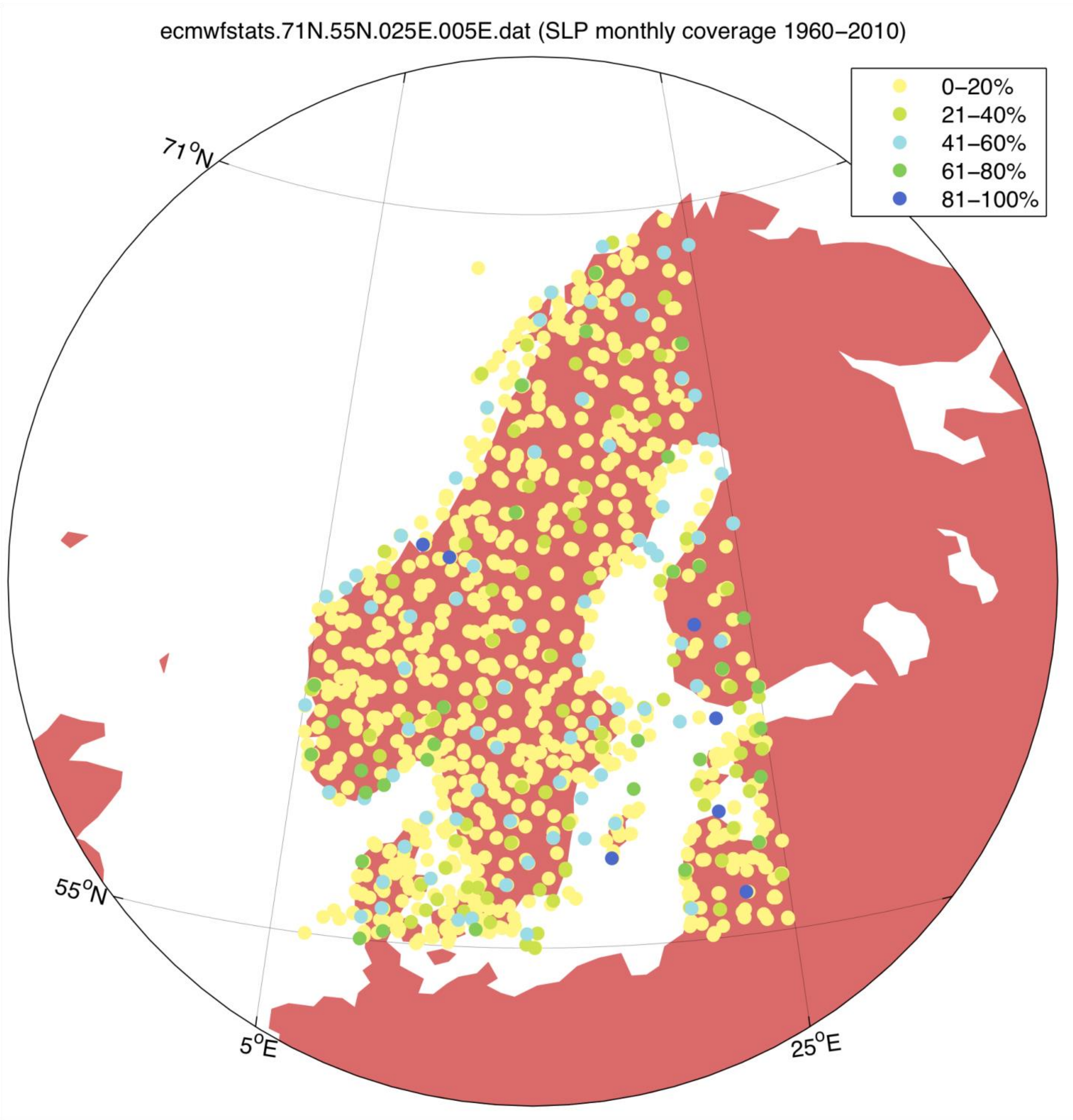

Figure 3. Spatial and temporal coverage for sea-level pressure observations in the Northern European region. See Figure 1.

2.2.1.4 Conversion of URV rescued data into ECMWF-compliant format (T1.2)

For incorporation into the ECMWF MARS archive, the digitised observations from URV needed to be converted into ODB-compliant database files. This was accomplished in an iterative process owing to a (shared) unfamiliarity with the conversion rules and limitations.

The data from URV consisted of sub-daily observations from 33 stations in Morocco, Spain, Algeria, Tunisia, Egypt, Cyprus and Lebanon. The temporal span was 1852-2008, with over 600,000 observations in approximately 57,000 lines. The data as presented required considerable reformatting (tripling the line count) before conversion to ODB was possible.

WMO	LAT	LON	ALT	FRQ	PSL	WDR	WSP	TMP	TDP	PRE	RHM	BEST
8159	41.67	-1.02	257	8	50	50	50	50	50	41	0	50
8222	40.50	-3.45	610	6	5	5	5	5	5	0	0	5
8397	37.17	-5.57	104	2	5	5	5	5	5	0	0	5
8495	36.15	-5.35	2	24	77	77	77	77	77	55	0	77
13208	44.87	13.85	32	8	25	25	25	25	25	0	0	25

Table 1: Extract from ECMWF observations coverage report for the Mediterranean region, with header added. WMO is the World Meteorological Organization Code of station, LAT/LON/ALT give station location details, FRQ indicates temporal resolution of observations (8 indicates every 8 hours, etc.), PSL sea-level pressure, WDR/WSP wind direction/speed, TMP mean temperature, TDP dewpoint temperature, PRE precipitation, RHM relative humidity, BEST highest score. Scores for PSL to RHM are percentage coverage over 1960-2010.

2.2.1.5 Progress on digitisation and quality control (QC) of the climate observations set as DARE targets (T1.1, Data coordination, inventory and access to national archives and T1.2, High-quality synoptic-scale data development)

After contracting 10 URV students to digitise relevant data from the gathered data-sources, the digitisation process started, which has been mainly carried out by manual key-entering, since although URV has purchased and applied to the scanned data an Optical Character Recogniser (OCR), most of the data-sources gathered, except a few of them, haven't enough quality and readability to enable an efficient usage of the OCR for digitisation. In addition and in parallel to data digitisation, URV researchers worked on the definition and implementation of a battery of new QCs and their corresponding software to be passed onto the digitised hourly data to identify potential non-systematic errors remaining in the digitised data-series, either derived of mistakes when digitising or in the data-sources used. This will allow us to assess both data-sources quality and reliability of the digitisation product.

A summary of the amount of data digitised during Y1 is provided in Figure 1, which shows a) percentage of digitised values by variable for both the pre- and post-1961 periods and b) percentage of the digitised station-values by observing times for both sub-periods of the 20th century.

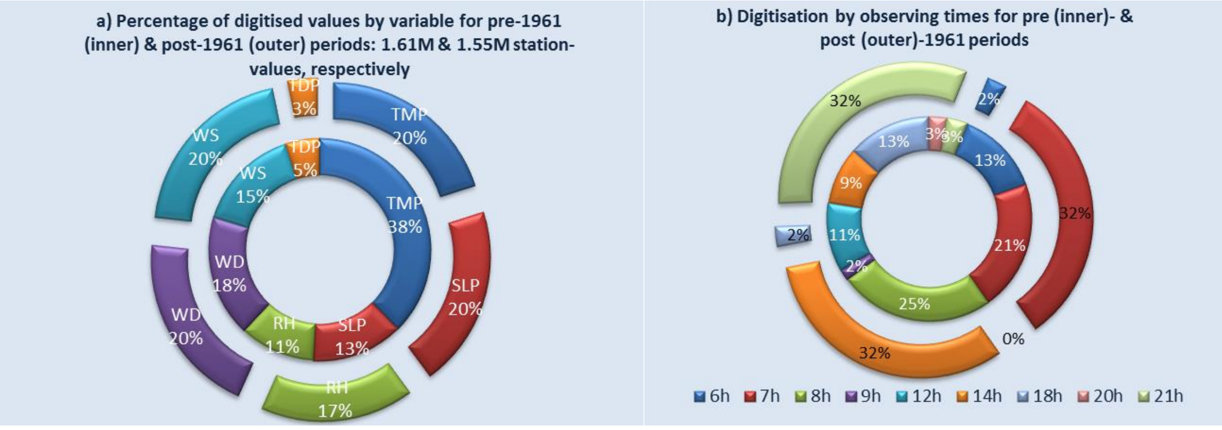

Figure 4. Percentage of hourly values digitised during Y1 by URV according to a) type of variables and b) by observing times. In both cases there is distinction between the two targeted sub-periods (pre- and post-1961). The total number of digitised values is provided in Fig. 4a.

As it is shown in Fig. 1, the digitised hourly station-values largely exceed the total data amount committed in the DoW to be digitised (3.7M station-values), since during Y1 it has been already digitised more than 3M station-values (about a 90% of the committed target), which points to a clear exceedance in the number of new hourly observations to be provided as basic input for enhancing ERRAs to being still pending another year of digitisation (Y2).

URV's strategy to QC the digitised data follows a two-pronged approach: first, a visual cross-checking (VQC) involving random comparison of data-sources and digitised-data has been adopted. Second, a battery of automatic tests (A-QC) has been defined and the corresponding software developed to identify potential errors in the digitised data. The VQC has been useful to identify both data-sources errors and the digitisation errors, which will help assessing both the reliability and accuracy of the scanned data-sources used and the data digitised by labelling and correcting after examination the suspicious values of being not truly climate measurements. Different kind of errors associated with a not-perfect scanning of the data-sources in use have been identified, most of them being related to missing and duplicated scanned pages, days, months and annual images, as well as fade and damaged pages. The identification of data-sources mistakes will help the data-sources owners and holders to improve their scanned products and it will also warn other potentially interested digitisation projects about the data-source quality. In addition, the VQC has been also useful to identify digitisation errors, which have been corrected by revisiting the scanned data to fix those labelled values as suspicious and substituting them by the correct values or set to missing those identified wrong values.
Finally, as currently available and accessible software to QC climate observations is mainly restricted to temperatures and precipitation data at the daily scale, URV has defined and developed new tests to QC the targeted climate variables at the hourly scale and implemented the corresponding software. A number of new QCs have been developed aimed at identifying, among others, dates-order errors, chain of repeated similar values, physically impossible outliers, flat lines, monthly means and absolute differences between consecutive values, data PDF, secondary peaks in the frequency of data distribution, big jumps among consecutive hourly observations or cross-checking consistency among related variable values.

2.2.1.6 NMA-RO Data Rescue effort (T1.1)

The NMA-RO DARE effort has been set with the target on digitizing Romanian stations with 6-hourly precipitation data. The Romanian stations which are set for digitization are listed in Table 2 and illustrated in Figure 5. Three of them are situated in mountain regions. NMA-RO team has digitized up to now the 6-hourly precipitation data from the stations of Bâlea Lac, Bucuin and Stâna de Vale.

Nr.	Name	ID	Latitude (°)	Longitude (°)	Altitude (m)	Period
1	Bâlea Lac	15279	45.60388889	24.61472222	2070	1979 - 2002
2	Bucin	15148	46.64888889	25.29638889	1282	1978 - 2002
3	Dej	15083	47.12805556	23.89888889	232	1974 - 2002
4	Reșita	15314	45.31444444	21.88694444	279	1979 - 2002
5	Slatina	15434	44.44222222	24.35444444	172	1977 - 2002
6	Stâna de Vale	15118	46.68972222	22.62333333	1108	1979 - 2002

Table 2. List of Romanian stations with 6-hourly precipitation set for digitisation

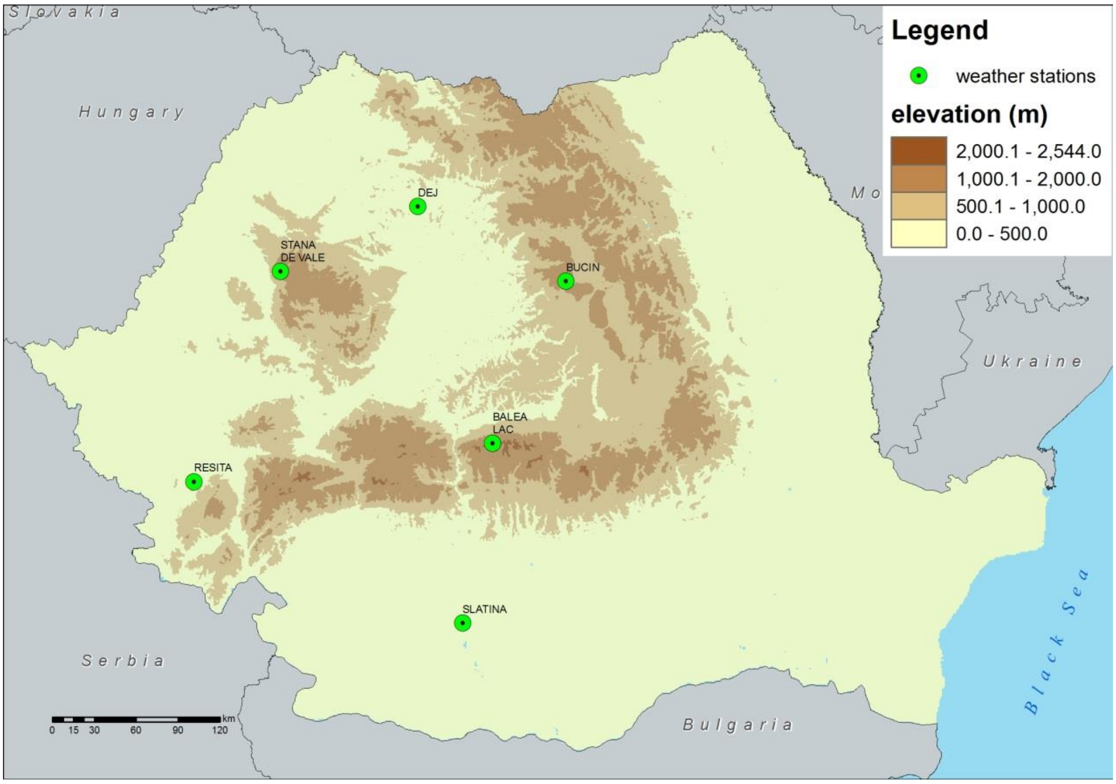

Figure 5. The locations of Romanian stations with 6-hourly precipitation set for digitization.

2.2.1.7 The acquisition and addition of data for the monthly CRUTEM global temperature archive, with a view to the improvement of both areal and temporal station density over an extended European window (T1.1)

For more information concerning CRUTEM (the Climatic Research/UK Hadley Centre monthly temperature archive), see http://www.cru.uea.ac.uk/cru/data/temperature/.
Regions of recent focus have been/are:

- Spain- homogenized long climate series
- Russia -Russian Federation updates
- Norway – additions to the homogenized climate series
- Europe – the ECA&D extended European window

Spain

There are 22 homogenized climate series (Tmax and Tmin) in the SDATS archive which was acquired through personal communication with Manola Brunet and Javier Sigro at the Centre for Climate Change, C3 Universitat Rovira I Virgili (http://www.c3.urv.cat/). The series start between 1850 and 1903 and currently run to the end of 2012. After initial processing and the production of Tmean from (Tmax+Tmin)/2), the 22 series were added to CRUTEM, using blanket overwrite of any existing matches in CRUTEM. This resulted in a gain of ten Spanish series for the archive.

For two of the series (Soria and Salamanca), the Tmean series were further extended using data from Climatic Research Unit (CRU) existing monthly archives which started at an earlier date than the Tmax and Tmin series from SDATS. Homogeneity adjustments for the new additions to the two series were taken from the homogeneity adjustments used in the SDATS homogenizing processes run by Brunet *et al*. (2006). The result was that both series were extended back to 1866. However, on the application of a new homogeneity test, the first reliable year (FRY) flag was retained as 1893 for Soria.

Russian Federation

Updates to and including October 2013, for most of the 518 series (the same stations as in the previous such exercise in January 2012), were obtained from http://meteo.ru/english/climate/d_temp.php . No new station series were added by the merger with CRUTEM.

Norway

The holdings of homogenized series at the eKlima portal (http://sharki.oslo.dnmi.no/portal/page?_pageid=73,39035,73_39049&_dad=portal&_schema=PORTAL were checked as a follow up to the initial exercise in July 2012, when all available series having sufficient length were incorporated into the CRUTEM archive. This effectively added 132 new series to the archive and modified the data holdings in 39 series. This time, it was found that no routine updates had been made but five new or extended/modified series were downloaded and processed. In the final (blanket overwrite) merger, no new stations were added to CRUTEM since the series new to eKlima were already present following the earlier exercise. The most significant gain in terms of length of series was for the high Arctic station Svalbard Airport which has been extended back in time to 1898 (see http://www.polarresearch.net/index.php/polar/article/view/21349).

Greater Europe

ECA&D series for an extended Europe window are archived through the ECA&D Project (http://eca.knmi.nl/), which is run by KNMI (Royal Netherlands Meteorological Institute). This dataset is also referred to as E-OBS. This very large archive of daily meteorological data has outputs in various formats and forms. In the case of the current work towards UERRA, daily series have been averaged to monthly series. Work is ongoing towards the maximum possible gains for CRUTEM from ECA monthly series. A significant number of CRUTEM series are the product of different homogenization exercises (see Jones *et al*., 2012, for relevant references). The use of ECA&D non-homogenized data has some implications for the merging [with CRUTEM] process described below.

The ECA&D downloads of daily or average/aggregate monthly data can be requested as blended or unblended series. The blending option allows for the amalgamation of nearby station records to maximize the length and degree of completeness of a large number of station series, over the extended European window. This includes a longitude band from western Greenland to the eastern extremity of the Russian Federation and latitudes north from North Africa. For more details including the geographical extent of ECA and rules for blending of station data, see http://eca.knmi.nl/dailydata/datadictionary.php and http://eca.knmi.nl/FAQ/index.php#3, respectively.

ECA&D series are indexed but the index system used does not coincide with that of CRUTEM which uses WMO ID codes or pseudo-WMO ID codes. We note that a significant percentage of ECA&D series do not coincide with WMO stations. This makes the job of blending any records taken from ECA&D with CRUTEM more difficult as WMO codes have to be allocated to ECA&D series wherever possible and pseudo-WMO ID codes have to be generated where ID codes have not been firmly identified (via station metadata - however, ECA&D have supplied WMO ID codes where they are known to ECA&D records).

After consultation with the ECA&D project personnel, a special extraction of non-blended monthly mean temperature series was offered [van der Schrier, pers. Comm.]. This is similar to their Indices products that are available at http://eca.knmi.nl/download/millennium/millennium.php . The output received holds monthly values for maximum, mean and minimum temperature. An advantage of the use of monthly data at this point is the loss on restrictions imposed by some national meteorological agencies (NMAs) that do not permit ECA&D to make their daily data publicly available. In addition, the receipt of monthly mean-temperature data, as produced by NMAs, ensures that the series have been produced *via* the algorithm used by the NMA to determine mean temperature. The latter is important for the maintenance of homogeneity in temperature series in the sense that different derivation algorithms produce different results and consistency is required to maintain homogeneity – particularly where data may be blended from different sources to maximize the length and completeness of individual series.

Processing and merger

For a merger of the monthly temperature series from ECA&D with CRUTEM, all ECA&D series have to be matched to a WMO ID code, where possible. After processing the metadata received from ECA&D for each station series and matching these with databases of metadata relating to WMO listed stations, two distinct categories of series emerge: those that match and those that do not. While the use of coordinates, elevation and station name can provide a high degree of confidence in the matching process, the final proof of match ideally relies on a comparison of overlapping station data. Trial mergers using the merger software provide comparison matrices that are used extensively in the decision making process regarding good matches for WMO ID codes. However, not all series available from ECA&D have a presence in CRUTEM. In these instances, confident matches are treated as new series [to CRUTEM].

For the ECA&D series that have been rejected by the matching process, these have been put through a further matching process with the CRUTEM archive series. This is due to the presence of series in CRUTEM that have pseudo-WMO ID codes that, by definition, do not appear in WMO station listings. There is a small number (see below) of series that have shown a positive match with CRUTEM and these have been given the same ID codes to enable series merger and to provide differences matrices (where overlaps exist to add further confidence to the matching process).

Finally, the non-matching series (after WMO and CRUTEM matching exercises) have been filtered so that only stations that are a minimum distance (currently *ca*. 40 km) from matched series are accepted for new pseudo-ID code allocation and inclusion in CRUTEM. This is to add new series that are going to have a positive effect on CRUTEM station areal density. Any series close to existing station series are not going to greatly affect areal density and there is a risk of duplication in that the nearby series may be subsets of existing series under slightly different coordinates or different names.

Current status of the incorporation of ECA&D series to CRUTEM

The work is ongoing and subject to further fine-tuning which will relate to:

- The length and degree of completeness of any new series added – short or very incomplete series will not benefit the function of CRUTEM
- The avoidance of the addition of non-homogenized values to a series that has been subjected to a homogeneity adjustment process

Of the 2900 monthly mean temperature series received from ECA:

- After matching attempts with two separate WMO station metadata reference files, 1630 series emerged with WMO ID codes (confident matches). After some internal mergers due to there being two subsets of data for the same location, which is a result of the requirement for non-blended series in the data request to ECA&D (as described above), the number of series with confident WMO-ID matches currently stands at 1552.
- The number of matched series coming out of the matching operation with CRUTEM existing series is 88. However, these will be assessed in terms of whether there are any potential gains from their merger with CRUTEM.
- The subset of series that have failed all matching attempts and are sufficiently distant (~40 km) from existing stations to offer positive gains in future CRUTEM station areal density, currently number 246.

Future updates to any series gained form ECA&D

While the general sources of routine update to CRUTEM are the monthly global compilations of climate data held in CLIMAT and MCDW (for CLIMAT see http://en.wikipedia.org/wiki/CLIMAT and for MCDW [Monthly Climate Data of the World], see https://catalog.data.gov/dataset/monthly-climatic-data-of-the-world), it will be possible to update any of the ECA&D series from their updates since ECA&D ID codes will be included in CRUTEM station headers. In addition, a selection of and ECA&D series will be carried by CLIMAT and MCDW.

2.2.1.8 Gridded and observational Datasets (T 1.3)

2.2.1.9 Updating of the CRUTS dataset to 2013 (v3.22)

The CRUTS dataset was updated to v3.22, covering 1901-2013. The CRUCY country averages dataset was in turn updated. In addition to adding twelve months of data, the update corrected a problem in East Africa. 2014 Also saw the publication of a paper describing the dataset (Harris et al., 2014).This paper already has over 70 citations on ResearcherID as of Nov 30, 2014.

2.2.1.10 Updating of the E-OBS dataset

As a continuation of the work in EURO4M, KNMI has released monthly updates of the daily gridded station data set for Europe called E-OBS. These updates include additional data for a number of European countries from the ECA&D archive. As in the EURO4M project, the gridded E-OBS products are available at a variety of spatial resolutions and cover the period since 1950. The E-OBS products will be used for the evaluation of the ensemble of reanalysis data sets and for developing the Climate Information Bulletins (CIBs). Preliminary work has started towards deliverable D1.9: Assessment of the impact of changes in station density on the E-OBS dataset.

2.2.1.11 Improving the Gridding of Precipitation in the E-OBS Dataset

Overview

Work was conducted that aimed to improve the gridding of monthly totals of precipitation in the E-OBS dataset (the gridded version of the ECA&D dataset referred to also referred to above). The stages in the gridding procedure were essentially the same as in the original E-OBS dataset (Haylock et al. 2008), with the main difference being that the monthly totals were derived from a transformation of the data with respect to a Gamma distribution calculated over a common base-period. The transformation related to the first part of the gridding procedure, whereby the monthly precipitation totals (in practice bi-monthly totals) from each station were gridded using a thin-plate spline. The aim of this additional procedure was to provide a better representation of the monthly totals, and hence the daily values since these are calculated as proportions of their monthly totals. The method of gridding the daily values, however, remained the same.

At each station bi-monthly rainfall totals (January and February, March and April, etc.) were converted to probability estimates from a gamma distribution fitted to data over a base-period, with the shape and scale parameters at each station being retained. Both the monthly probabilities and shape/scale parameters were gridded using a modified thin-plate spline technique. To form bi-monthly rainfall totals at the high-resolution grid, the probabilities were then converted back to absolute units using the gridded shape and scale parameters. The gridding process then proceeded using these gridded monthly totals in the usual manner for the E-OBS dataset.

The reasoning behind this gamma-transformation follows that described by Bradley et al. (1987), in that small-scale spatial variations that typically occur in the rainfall field can prevent successful gridding of rainfall totals: the probabilities have a much smoother field that can be gridded more easily. As a reflection of this, a bi-variate spline is used for gridding the probabilities, whereas a tri-variate spline is more appropriate for rainfall totals. The gamma distribution was chosen since the positive skewness that often occurs in rainfall data can be adequately captured by this flexible probability distribution but also because this distribution provides a better representation of very high rainfall extremes.

Gridded Results

To provide an indication of the differences that are produced by this new gridding technique, we compared indices of extremes calculated from the E-OBS (v10) daily dataset to similar indices calculated from a dataset where the daily rainfall proportions are gridded relative to the gamma-transformed bi-monthly totals. We have also compared this latter dataset to indices calculated from three high-resolution rainfall datasets: the Spain02 data, and the high-resolution Alps and Norwegian datasets. A sample of results is provided below. Although these datasets contain the same stations as used in the E-OBS gridding, they also include many more stations, and are as such more likely to give a closer replication of "true" rainfall conditions, following the reasoning given by Hoftra et al. (2008).

In Figure 6 results from the R95Ptot climdex extremes index (annual total rainfall [RR] on days when RR > 95th percentile of daily precipitation amounts) are compared. Across the domain the results are broadly comparable, although the gamma-transform dataset shows a wider range of extremes, with for example more extensive high rainfall across Europe and lower extremes around the Caspian Sea area. Also evident is more spatial variation in the gamma-transformed data, for example an enhanced rain-shadow over Scandinavia. This greater speckling in the gamma-transformed data may indicate problematic station values, and that this technique is more susceptible to such erroneous values. It should be noted in this comparison that as well as the different technique used to calculate reference totals for the daily data (bi-monthly gamma transformed values compared to monthly totals in E-OBS), different software was used to krige the daily anomalies although this difference has only a minor influence on the results.

Comparing the results of the R95PTOT index from the E-OBS datasets with the high-resolution Alps dataset (Figure 7) certain differences are evident. Notably the spatial pattern of extreme rainfall totals measured by the index is slightly better reproduced in the gamma-transform data, although there is still an under-estimation in the extremes compared to the high-resolution dataset.

The comparison with the Norwegian high-resolution dataset (Figure 8) indicates much the same feature as for the high-resolution Alps dataset in that both versions of the E-OBS data underestimate the highest extremes. There is an indication, however, that the higher extremes extending south along the southern Norwegian coast in the gamma-transformed data are a true feature that is not reproduced so well in the E-OBS V.10 data.

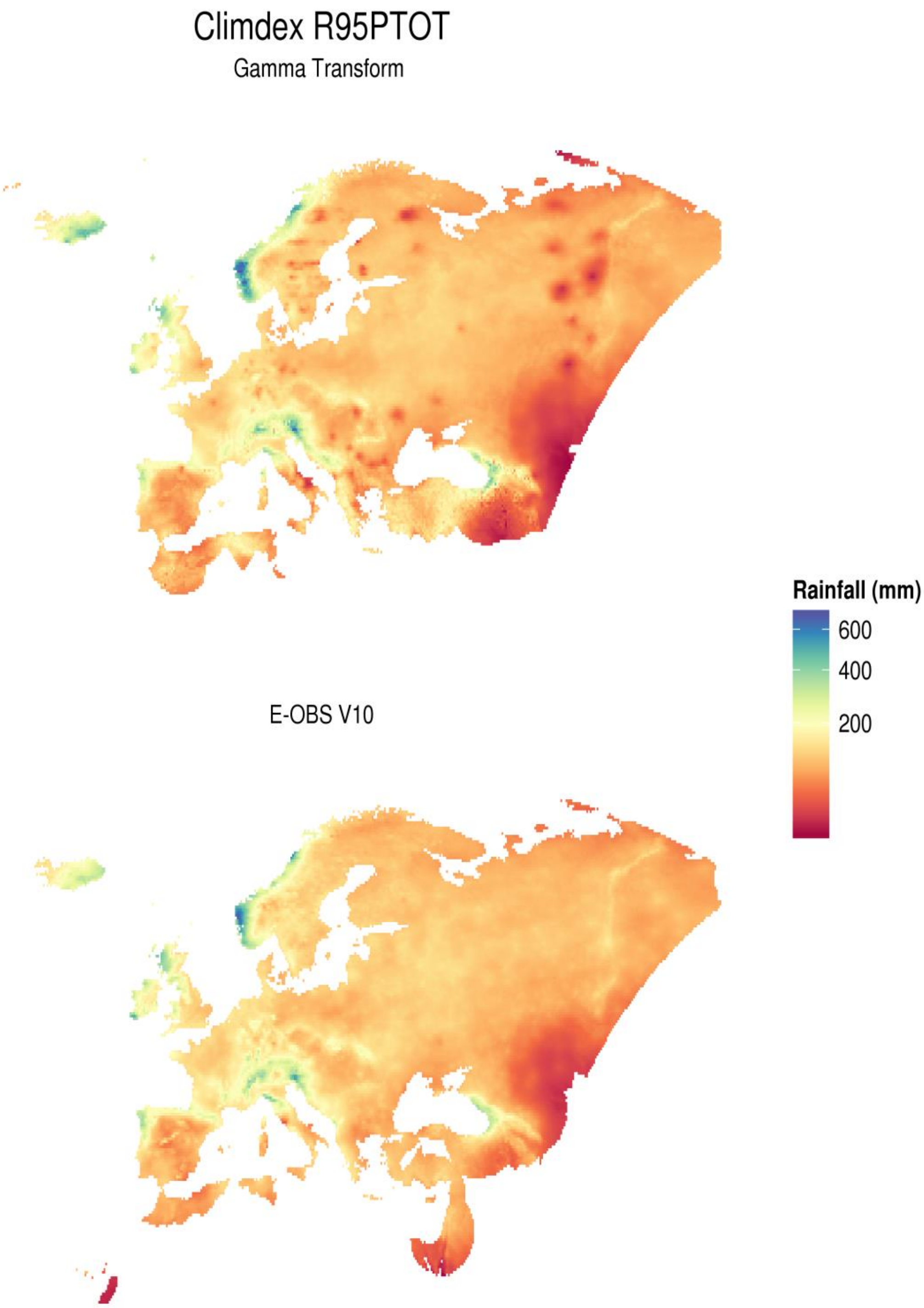

Figure 6. Comparison of the R95pTOT index calculated from the E-OBS data and gamma-transformed data. Note the square-root transformed scale. The data are at the 0.25 degree resolution.

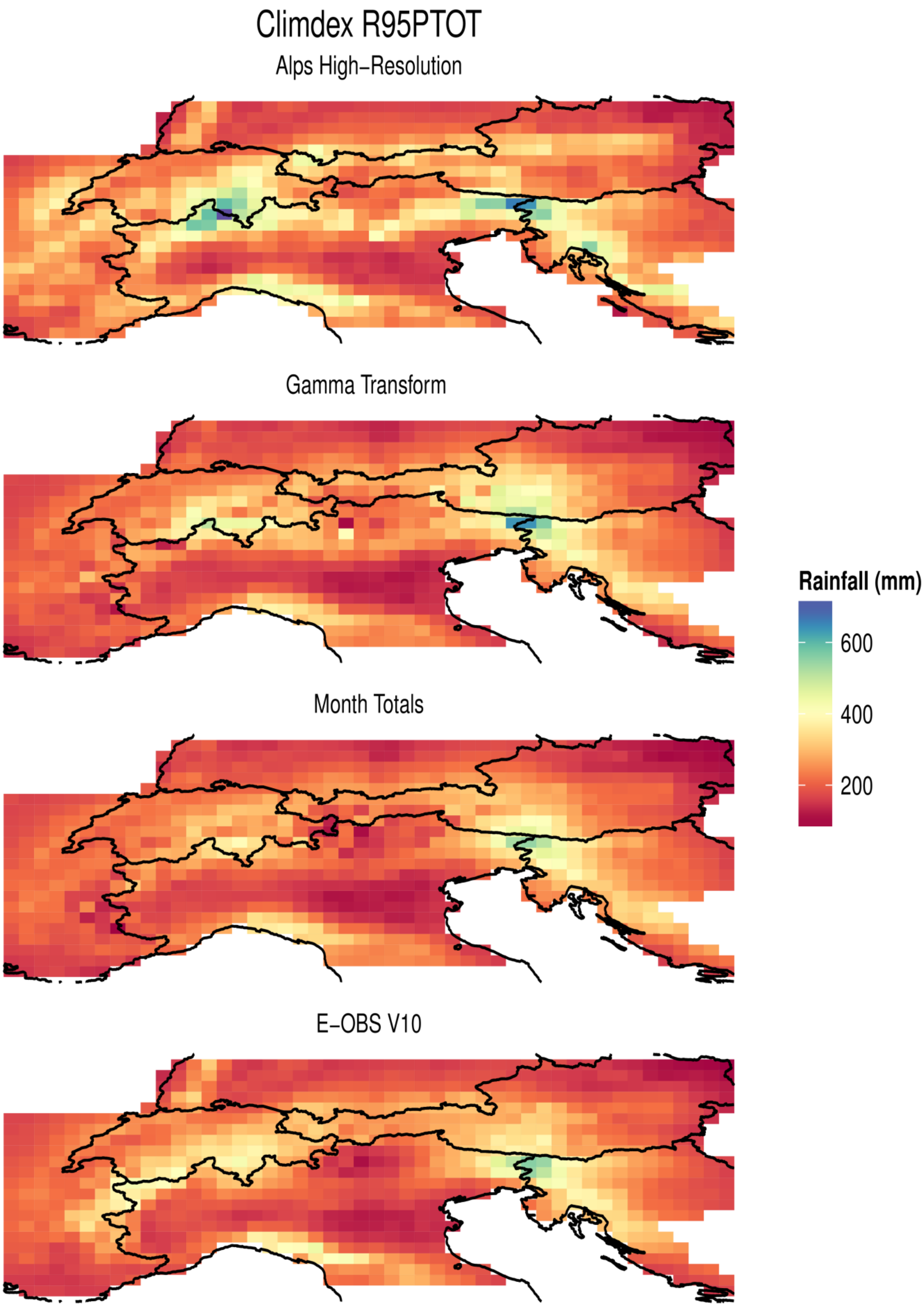

Figure 7. Comparison of the R95pTOT index calculated from the E-OBS data, gamma-transformed data, bi-monthly total data and the high-resolution Alps dataset. The Alps data have been regridded to the 0.25 resolution to match the E-OBS data. Note the square-root transformed scale.

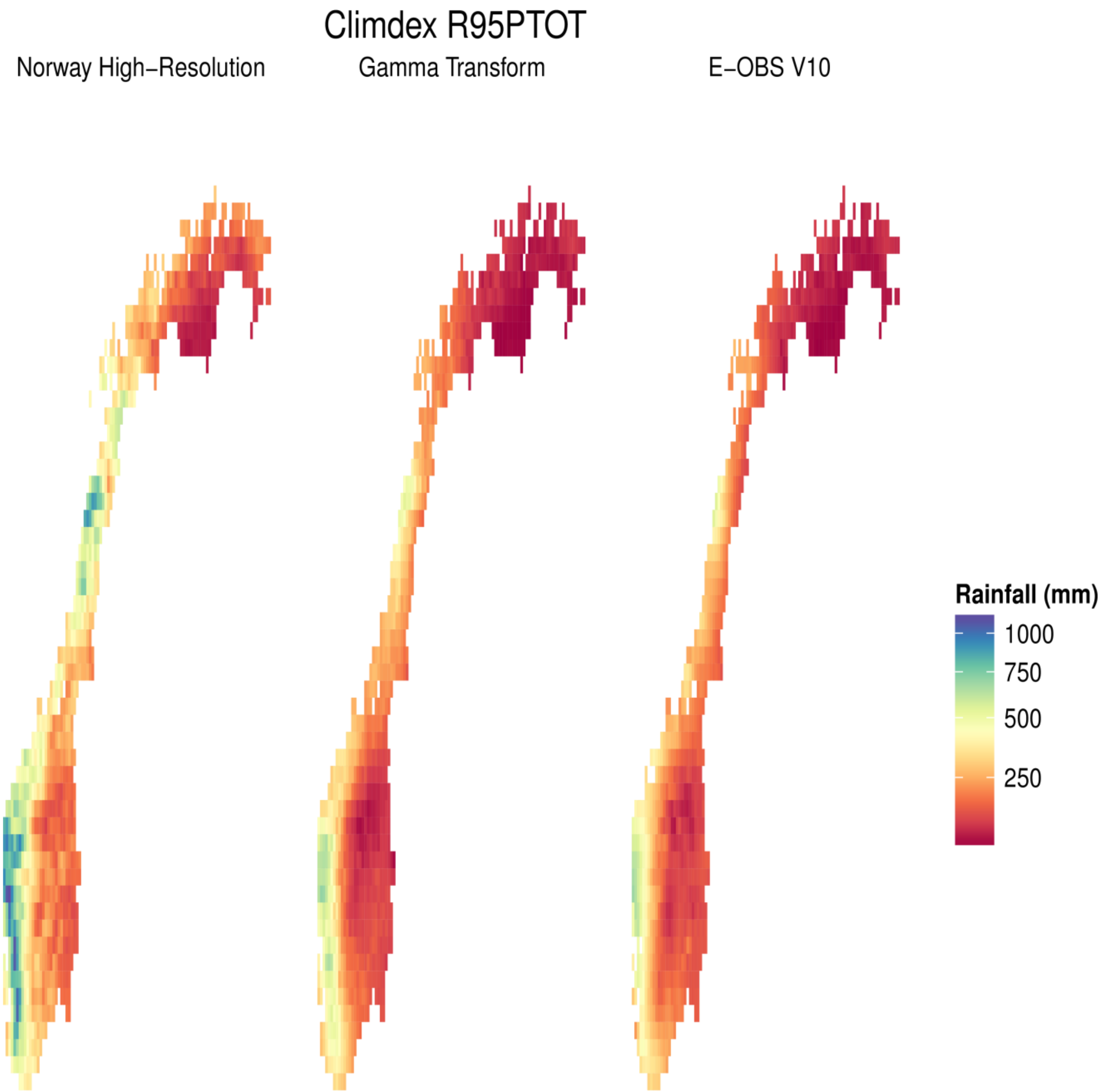

Figure 8. As Figure 7, but for the high-resolution Norwegian dataset.

2.2.1.12 Quantifying uncertainties in interpolation (T 1.3)

Knowledge about and quantification of uncertainties in grid data products is an important pre-requisite for their use in evaluating ensemble regional reanalyses from UERRA. Reanalysis datasets will have resolutions near the spacing of in-situ surface observations, so that uncertainties in their interpolation will become relevant. During the reporting period EDI has advanced its efforts towards quantifying interpolation uncertainty via stochastic simulation. These efforts are building on a pilot study (Vogel 2013). The ultimate goal is to derive an ensemble of quasi-realistic grids of precipitation conditioned on rain-gauge observations and representative for the uncertainty inherent to the limited station density (see Fig. 1 for an example). The procedure was further investigated in terms of the variation of ensemble spread as a function of weather situation (convective versus stratiform), spatial scale considered (e.g. size of river catchments), and density of station network. The results indicate plausible dependencies of ensemble spread, which corroborates the underlying concept. Yet, difficulties are anticipated with the applicability of the current implementation over large regions (e.g. the entire Alpine region). Further technical developments (moving window techniques) are necessary to overcome this limitation.

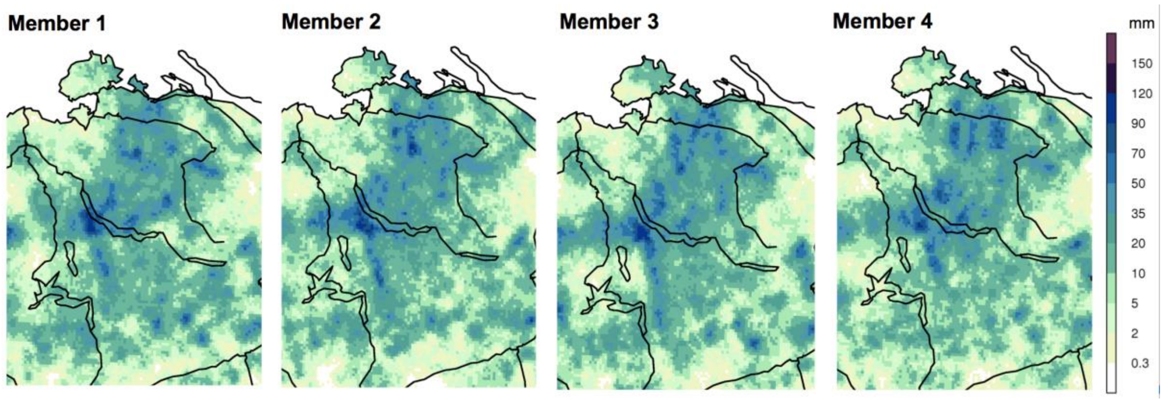

Figure 9. Members of a conditional stochastic simulation of rainfall fields for precipitation in northern Switzerland (10. 6. 2008, Vogel 2013). Such simulations shall be used to account for uncertainties in reference datasets during the evaluation of ensemble regional reanalyses in UERRA.

2.2.2 Work package 2 - Ensemble Data Assimilation Regional Reanalysis Dataset

The first year of the UERRA project has seen good progress in WP2 to setup and further develop the data assimilation systems to be used in the production runs in subsequent years of the project. The various groups in WP2 (Met Office, SMHI, Météo-France, University of Bonn) have collaborated proactively to define common grids and output fields (e.g. as requested/agreed by users in WP3). UERRA WP2 efforts are converging on a common domain, namely the CORDEX EU domain chosen specifically to foster the use of UERRA data by the European Climate Community.

Fruitful scientific interactions have helped define the choice of ensemble data assimilation techniques used within this world's first ensemble regional reanalysis project. The Met Office has written a project report on their choice of an ensemble of (hybrid) 4DVars – this represents a compromise between the Met Office's currently operational (ETKF-based) hybrid 4DVar and ECMWF's ensemble of (standard, non-hybrid) 4DVars. The University of Bonn has chosen an ensemble nudging technique, which will provide a useful benchmark dataset, and additional members, for the more traditional ensemble data assimilation outputs. An initial reanalysis for a 2011 period has been produced. SMHI efforts to ensure an optimal blend of global (ERA-Interim) large-scale and regional (HARMONIE) small-scale reanalyses have resulted in the choice of the 'Jk' method to provide this coupling.

Significant technical work has been undertaken this year. Building on earlier work in the EURO4M project, the Met Office has updated the version of the Unified Model (UM) to include latest science, suites and to ensure the UM runs efficiently on ECMWF's new Cray HPC. Work is ongoing in 2015 to enable production runs can start as planned in 2016. The SMHI deterministic reanalysis leverages a decade of Europe-wide collaborations to bring in the HARMONIE modelling system to UERRA, replacing the HIRLAM system used previously in the EURO4M project. SMHI and Météo-France have undertaken summer and winter comparisons of the ALADIN and ALARO physics packages over a 5-year period (2006-2010) to understand their relative performance in UERRA's ensemble reanalysis framework – a slightly delayed report will be provided early in year 2. Météo-France have worked with SMHI to combine HARMONIE reanalysis members with statistical downscaled members from the MESCAN system to produce a demonstration 6-member, high-resolution ensemble surface precipitation reanalysis. Efforts are also underway at SMHI to combine the HARMONIE reanalysis with European cloud observations to provide a 5km resolution cloud analysis.

WP2 partners continue to work with each other (and WP3, WP4) to agree common output fields for the production runs. Technical work remains to agree and complete the interface with the UERRA models and the ECMWF MARS archive, but we are confident a solution will be reached in coming months to allow the production runs to begin as planned in 2016.

WP1 has consulted WP2 and the UERRA Management team (MST) and there were discussions on the priorities for observational data rescue, in terms of areas, parameters and time period. WP1 has taken into consideration the needs and benefits of additional observations that can be used in the regional reanalyses in WP2 from 1961 onwards.

2.2.2.1 Ensemble Variational Data Assimilation reanalysis (T 2.1).

Work at the Met Office has focused on building the capability for the reanalysis system that will be run. This year there has been progress in three areas. Different options have been considered for an ensemble-variational data assimilation system, and one of these is considered the preferred option as being both affordable and reliable. Code to assimilate satellite radiances has been extended to assimilate data from TOVS, which adds the ability to assimilate satellite radiances from 1979 onwards. A new system to monitor observation quality, produce reject lists and bias corrections, is being written.

Ensemble-Variational Data Assimilation
The Met Office is committed to running an ensemble-variational data assimilation system for a regional reanalysis. For the global model, the Met Office already has an ETKF (Ensemble Transform Kalman Filter) and is developing a global "4DEnVar" (4D-Var using an ensemble instead of a perturbation-forecast model to transform the error covariances in time). These aren't suitable for a regional reanalysis. The ETKF needs artificial inflation to maintain the ensemble spread, and is not coded for a regional model. 4DEnVar is likely to need a large number of members to match the

quality of deterministic 4DVar. For these reasons, the preferred option is an ensemble of 4DVars. It will be driven by lateral boundary conditions from the ECMWF ERA5 global reanalysis. Surface fields, observations, and model will all be perturbed so that the spread in the ensemble will reflect, as best as is possible, all uncertainties in the system.

A report has been written providing more detail: "Met Office Ensemble Data Assimilation Configuration", available from the UERRA website (http://www.uerra.eu/publications/project-reports.html). This system will be tested and evaluated in 2015.

Use of TOVS radiances

TOVS processing uses AAPP (ATOVS and AVHRR Pre-processing Package) to convert level 1b counts to radiances, and to map the low-resolution MSU (Microwave Sounding Unit) pixels to HIRS (High-resolution Infra-red Radiation Sounder) pixels. Met Office DA code has been adapted to assimilate these observations. They are processed in 1DVar, which applies quality control to the data, and assimilated in 4DVar. Bias correction will be by a VarBC (Variational Bias Correction) scheme. Similar schemes are already used elsewhere for global models. VarBC at the Met Office is coded and will be tested to see whether it will work in a regional system. Biases in a regional model are more likely to show day-to-day variation and it will be a challenge to correct for temporal changes in instrument bias while not wanting to correct for daily changes in the weather. One possibility is to modify the adjustment timescales to allow for rapid change whenever such changes were seen in ERA-Interim, and slow change otherwise.

Observation monitoring

Met Office operational models reject stations that have been consistently poor quality over the previous month. The lists of stations to reject is compiled by proprietary systems that are neither portable nor easily run outside of the operational system. For reanalysis, a more flexible method is needed. Such a system is being written. It is in python and uses ODB format (ECMWF Observation DataBase). This will make it both portable and flexible. It also gives an enhanced capability for observation monitoring, for instance plots of O-B as below.

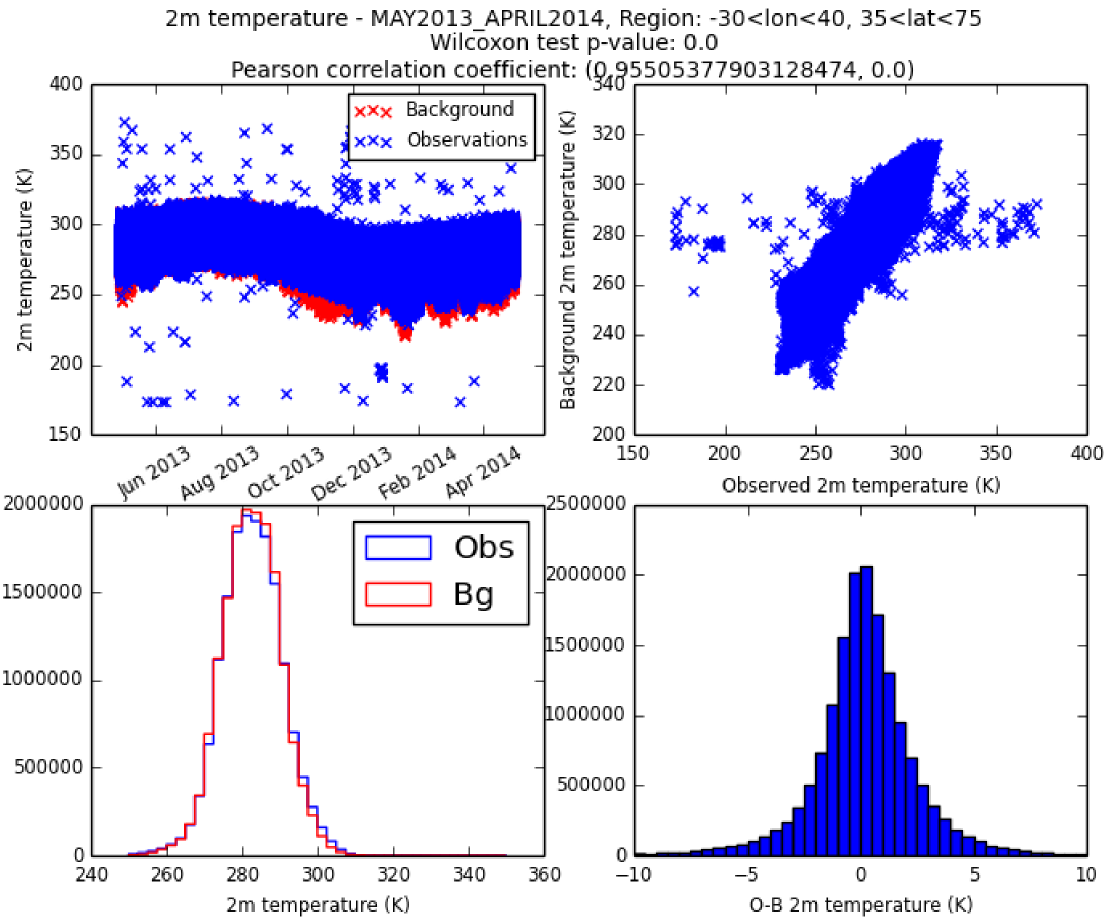

Figure 10. Statistics of screen-level temperature observations and equivalent model background values for European stations, May 2013 to April 2014

Such plots will allow for close monitoring of reanalysis quality during the production runs, so that errors and problems can be spotted quickly. This system is currently able to process surface observations. Code for other in situ types (upper air and aircraft) will be added in 2015.

Cooperation with other partners

The Met Office has been involved in discussion with ECMWF for archiving, and with attendance at a workshop in Offenbach (June 2014) to consider evaluation of uncertainty for WP3. This has included proposing and agreeing, with partners, products to be archived from the reanalyses.

The Met Office was also represented at an observation feedback meeting at ECMWF (November 2014) organised for CORE-CLIMAX. The meeting was a chance for reanalysis producers to consult on how they select, or reject, observations for assimilation, and on how to make available the vast quantities of information that reanalyses can provide on individual observation quality.

There were no Met Office milestones listed in WP2 for 2014, and no deviations from schedule. Commitment of staff time in 2014 has been as per budget.

2.2.2.2 Deterministic Reanalysis (T 2.2)

The HARMONIE reanalysis system and its environment.

HARMONIE is the ALADIN (Bubnova et al., 1995) based modelling system used by SMHI for NWP and climate modelling and now also for reanalysis. It has different physical parameterisation options, ALADIN/ARPEGE for global and limited area applications, ALARO for limited area and medium- high resolution applications (around 10 – 2 km grid resolution) and AROME for high resolution (convective permitting scales of around 2 km or better).

The ALADIN and ALARO versions are the ones suited for the 11 km grid resolution chosen for the Project. The two physics options will also provide differences and can provide input to ensemble estimations and in particular for the MESCAN near surface analysis at Météo-France. A large European-Atlantic domain has been defined and is as similar as possible to the EU-CORDEX domain (Fig. 11). The horizontal projection is Lambert rather than rotated latitude-longitude so exact correspondence of the grid points is not possible.

The two physics options have been set up and tested together, both at Météo-France and at SMHI. SMHI uses the HPC resources including file storage at ECMWF. The two physics options and the underlying climate (constant) file base have been checked extensively, as there are many options and settings for the different parts of the physics.

The reanalysis runs generate a lot of data and some choices to limit the amounts have been made, in terms of time steps of the forecast model and variables and levels. These choices have been made so that it is possible to re-start the reanalysis and to provide all the outputs that comply with evaluation in UERRA (WP3) and to provide additional variables for general usage for climate monitoring and research. Data has been prepared for a common archiving for data services at ECMWF (WP4) which will be in GRIB-2 format.

The trial reanalyses have been run for one summer month, June 2010, and one winter month, January 2006. The summer month was run with surface data assimilation only just to test the two model configurations. The upper air data assimilation was developed in parallel to this work and the winter runs were later performed with the full 3D-Var analysis system. Here follow some verification figures of these two test months. The verification is done against observations. The forecasts were run up to 18 hours during the winter month and 24 hours during the summer month.

There were better standard deviation scores of Mean Sea Level (MSL) pressure for ALADIN for the winter month, but both models very close during the summer month. (Figures 12 and 13). ALADIN shows a little bit bigger negative bias for the summer

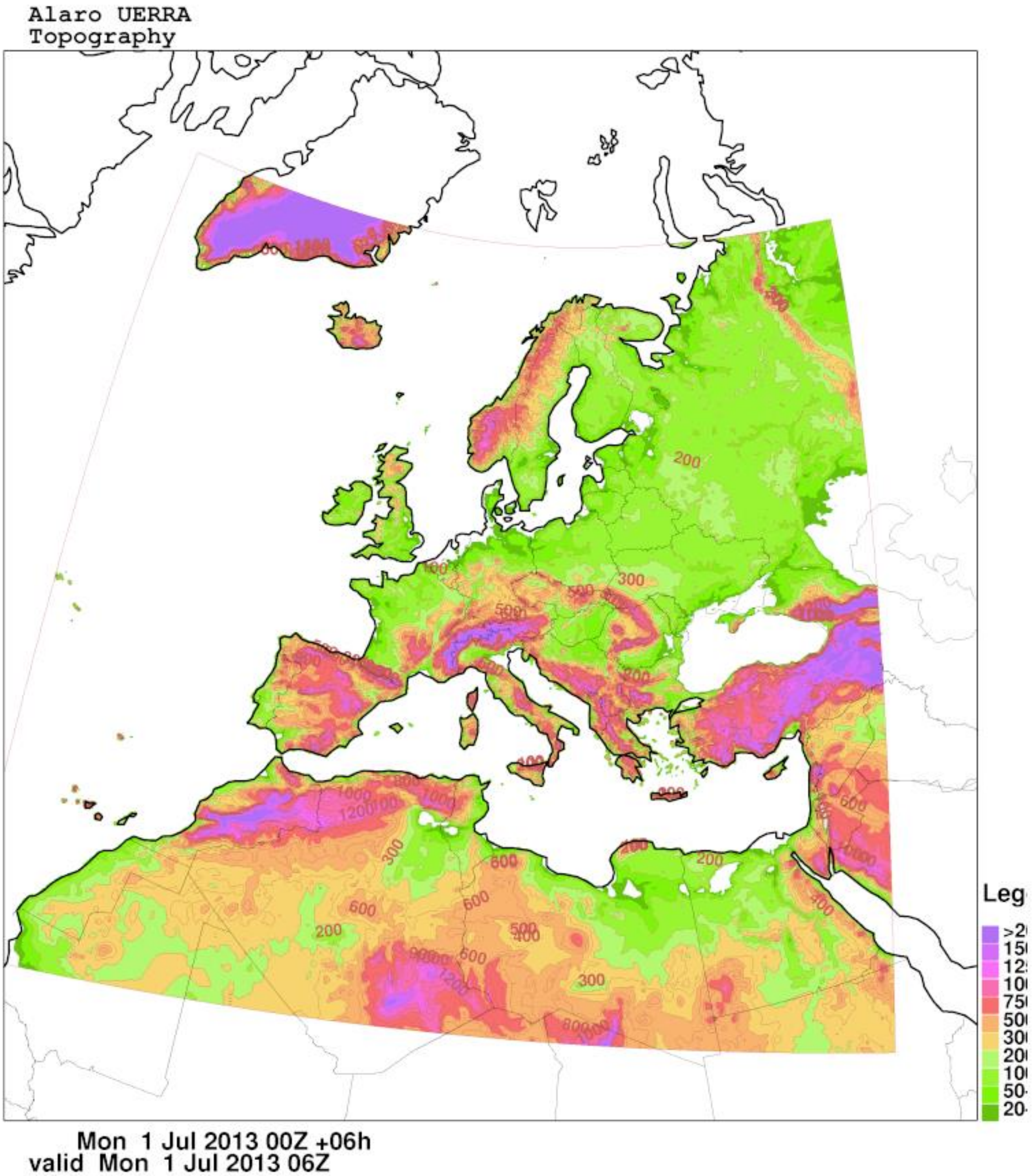

Figure 11. The SMHI UERRA domain and the topography used.

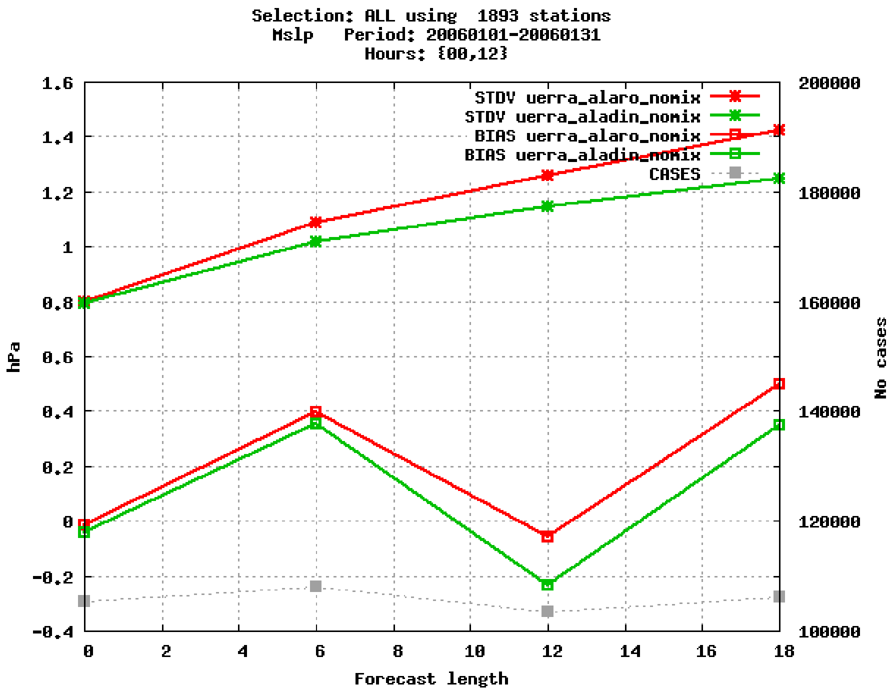

Figure 12. Verification of MSLP January 2006, standard deviation and bias for ALADIN in green and ALARO in red.

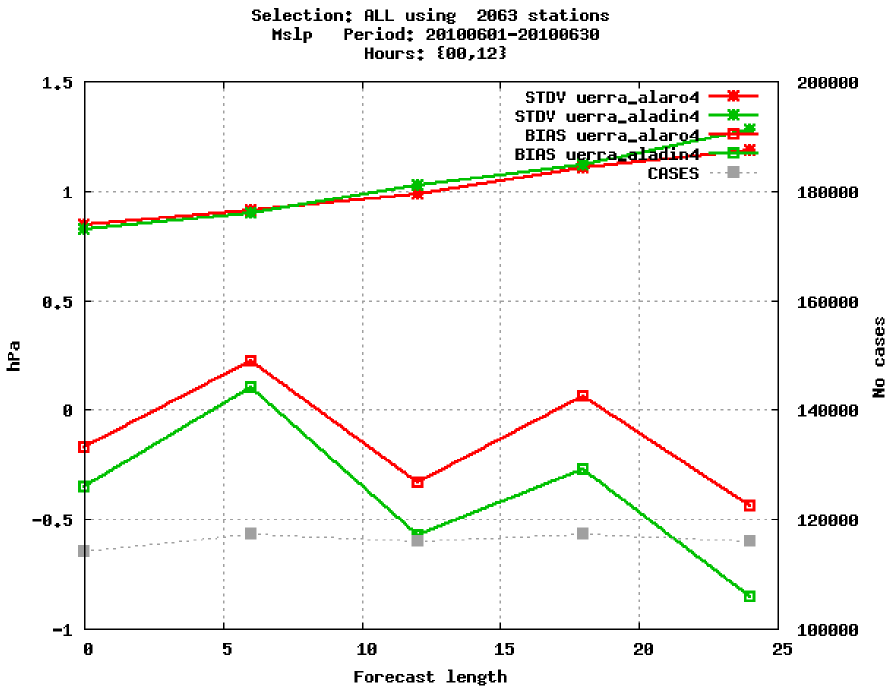

Figure 13, Verification of MSLP June 2010, standard deviation and bias for ALADIN in green and ALARO in red.

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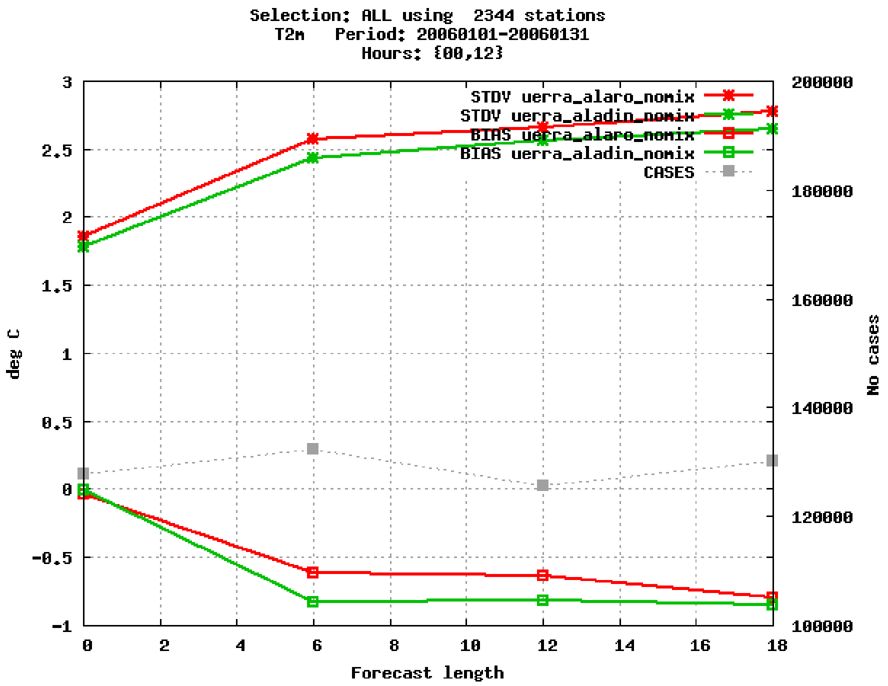

Figure 14. Verification of 2-m temp January 2006, standard deviation and bias for ALADIN in green and ALARO in red.

The standard deviation scores for 2 m temperature are slightly better for ALADIN both for summer and winter (Fig. 14 for winter, summer not shown but is similar)

For wind speed the standard deviation scores were very close for both summer and winter for 10-m wind speed. ALARO has a small positive bias during the winter (not shown).

The winter scores are very close for total cloud cover. ALARO is a little bit better during the summer, ALADIN has a small negative bias (not shown).

There were somewhat mixed results for 12 hour precipitation, in the winter ALADIN seems to do better with the smallest and highest amounts, for the intermediate amounts almost the same scores. In the summer ALARO is better for the smallest and highest amounts, but here ALADIN is better in between (Fig. 15 and 16)

Standard deviation curves for temperature at standard pressure levels are close both summer and winter, ALADIN has slightly better values in the lowest levels in winter. There is a cold bias in ALARO, both winter and summer in the two lowest levels.

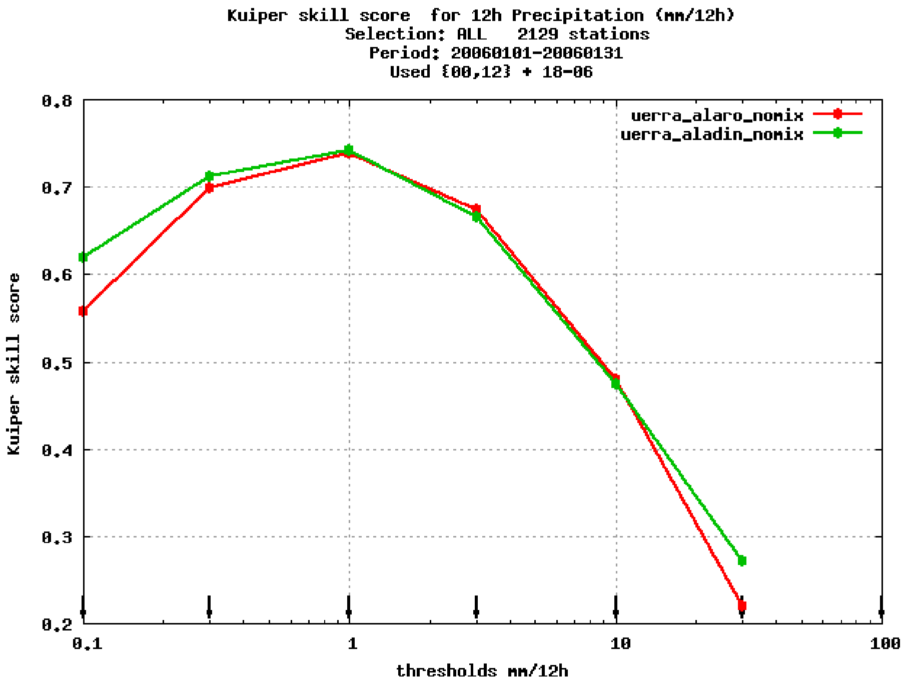

Figure 15. Verification of 12 hours precipitation January 2006, Kuiper's skill score for thresholds, ALADIN in green and ALARO in red.

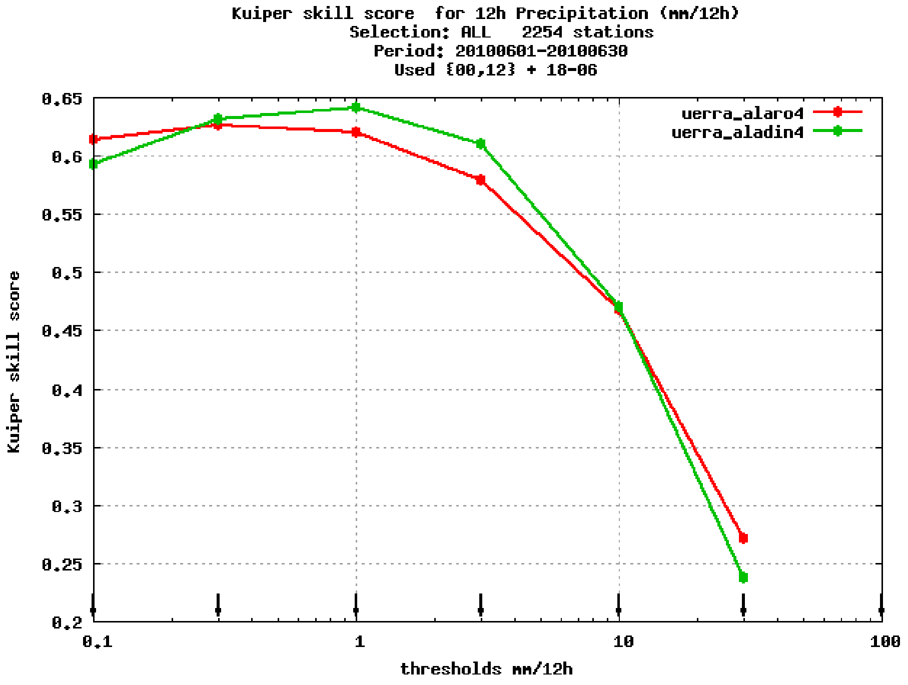

Figure 16. Verification of 12 hours precipitation June 2010, Kuiper's skill score for thresholds, ALADIN in green and ALARO in red.

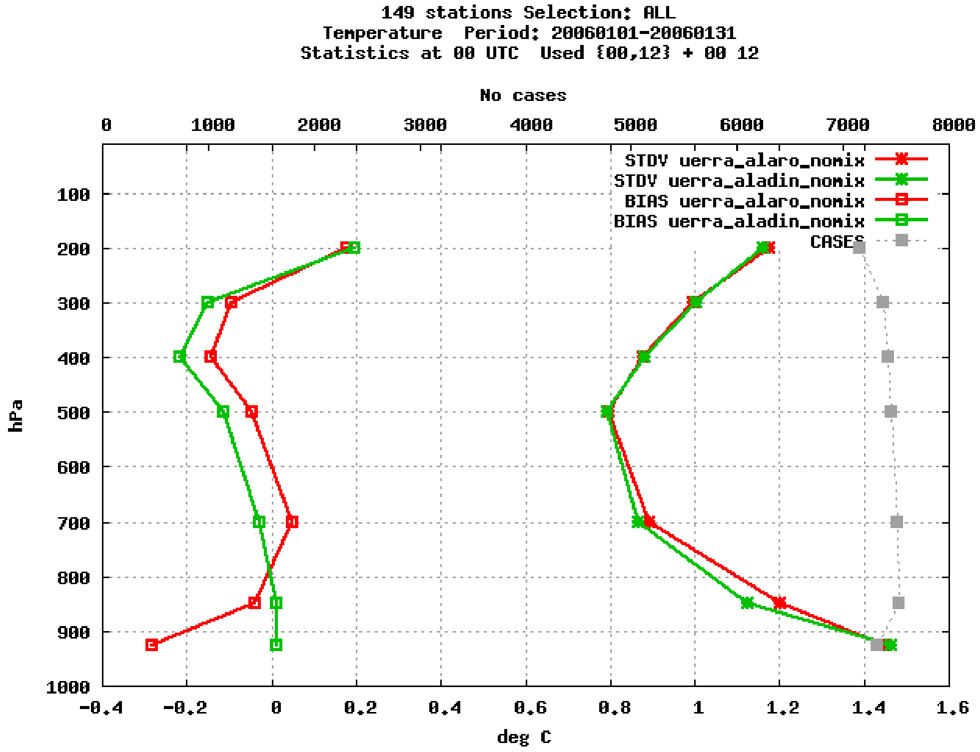

Figure 17. Verification of temperature profiles January 2006, standard deviation and bias, ALADIN in green and ALARO in red.

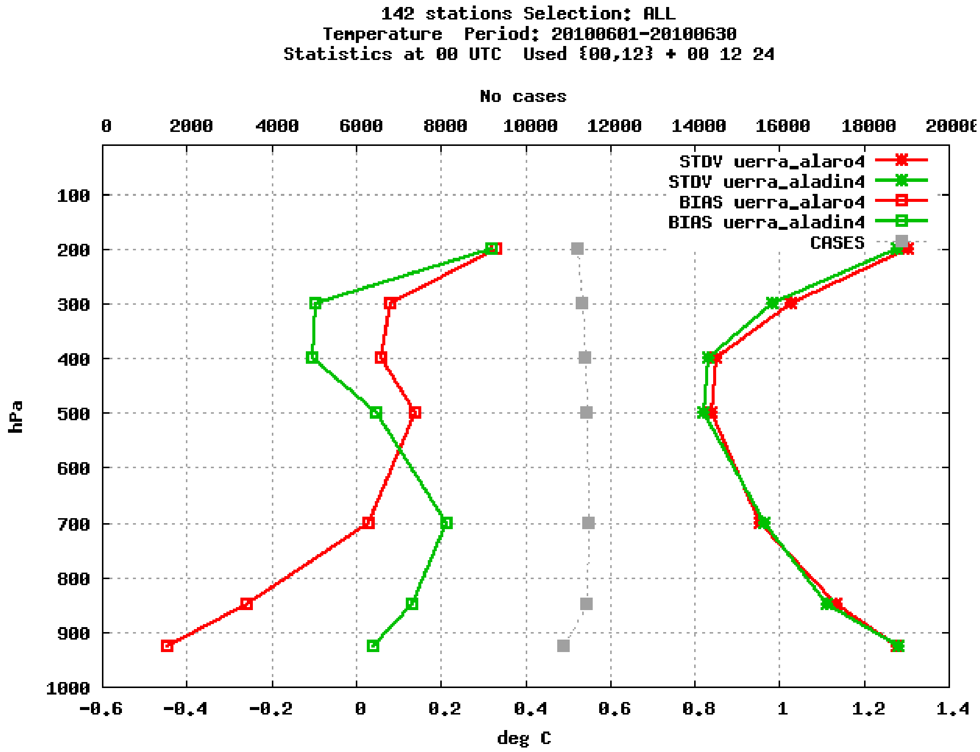

Figure 18: Verification of temperature profiles June 2010, standard deviation and bias, ALADIN in green and ALARO in red.

For most part of the atmosphere there is a small negative bias in wind speed for both models and both seasons. This bias is a little bit bigger for ALARO at the lowest levels. The standard deviation curves are close (not shown).

There is a small negative bias in relative humidity for both models during the winter. Apart from the lowest levels this negative bias is also present during the summer month. There were a little bit lower standard deviation values for ALADIN.

HARMONIE Data Assimilation definitions and setup

A 3D-Variational Data Assimilation is used in the HARMONIE upper-air data assimilation. For each model setup, in this case ALARO and ALADIN, and domain it is necessary to generate background error covariances, also referred to as structure functions. An ensemble of 6 hour HARMONIE forecasts is created that covers two seasons; January and July 2012. The ensemble is created by downscaling four ECMWF ensemble members at 00 and 12 UTC. Differences between the HARMONIE ensembles is the statistical sample that is used to derive the background error statistics. The derived structure functions for ALADIN and ALARO were very similar when compared, see e.g. Fig. 19..

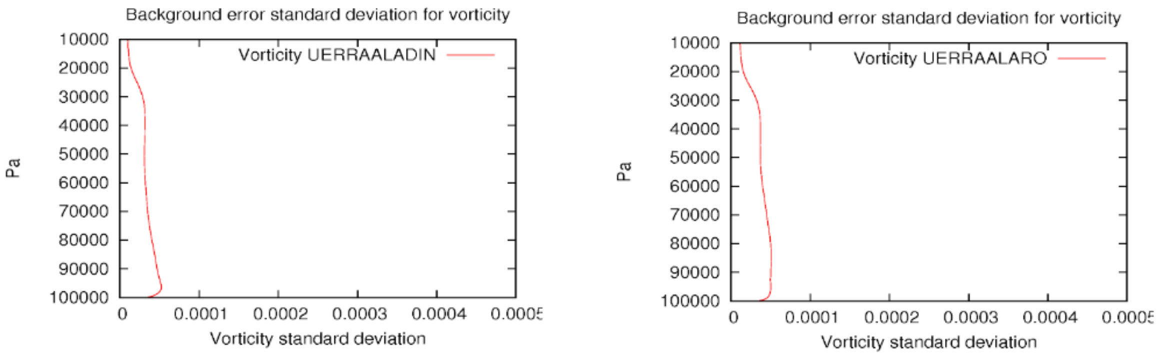

Figure 19. Examples of structure functions for ALAIN and ALARO. Vertical profile of vorticity standard deviations of background errors.

In the predecessor project EURO4M the large scale vorticity field from the coupling system ERA-Interim was used as an extra lonstraint in the HIRLAM 3D-Var cost function by adding it as en extra term called Jk, see Dahkgren and Gustafsson, 2012. We wanted to do something similar in UERRA and the HARMONIE system offers two ways of mixing the large scales from the coupling system. One is the HARMONIE implementation of Jk described in Guidard and Fisher, 2008, and the other is called LSMIXBC which is used operationally in AROME at SMHI and MET Norway. LSMIXBC creates a modified first guess for the 3D-Var analysis by merging the large scales from the coupling system with the small scales from regional model. It is necessary to calculate the coupling model error variance spectra in the regional model geometry in order to use Jk. These variances are used to determine the weight of the Jk term in the 3D-Var analysis. The statistical sample needed to do this can come from ensembles, as in the calculation of Jb statistics, or so called NMC differences i.e. differences between forecasts valid at the same time. No way of extracting such a sample from ERA-

Interim data was found and therefore ensemble differences from the ECMWF EDA system was used. The EDA ensembles have 50km distance between the grid points which is at least close to the ERA-Interim resolution which is 80km, so the errors calculated are assumed to be representative for ERA-Interim error variances.

Jk and LSMIXBC have been compared by running a forecast impact experiment for January 2006 using the ALADIN physics. A third experiment with no large scale mixing was also done. It turned out that both Jk and LSMIXBC improved the forecasts compared to using no mixing, Figure 20, At forecast lead time 0, i.e. the analysis, Jk had a worse fit to observations than LSMIXBC and the no mixing option.

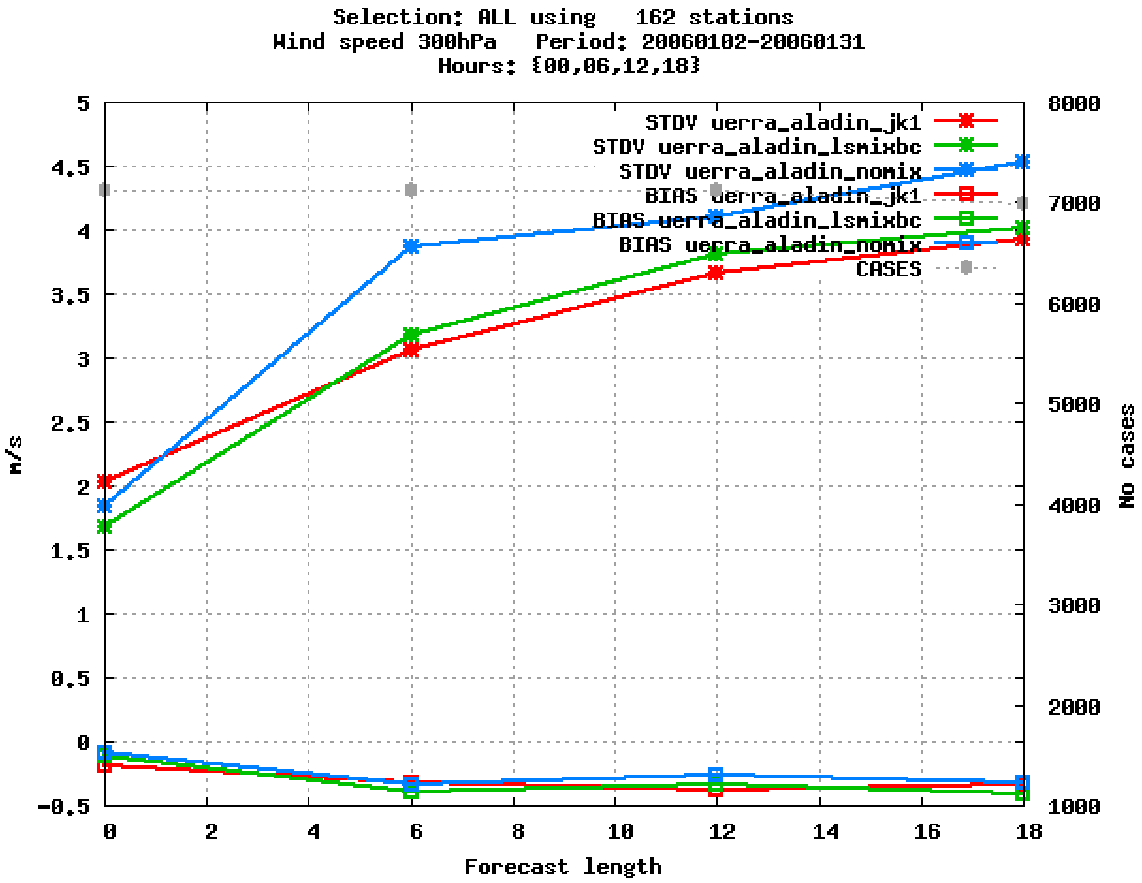

Figure 20. Forecast standard deviation errors and bias of wind speed at 300 hPa from the 3 experiments with J_{k},, LSMIXBC and no mixing of large scales.

Both Jk and LSMIXBC are using the ERA-Interim analyses to get the large scales from the coupling system. A consequence of this is that the information in Jk or LSMIXBC is not independent from the observations used in the HARMONIE analysis. It was therefore speculated that using a short ERA-Interim forecast instead of an analysis would be more beneficial. This was tested using Jk and ALADIN in January 2006. The results showed that using a short ERA-Interim forecast degraded the HARMONIE system in terms of observation verification scores, contradictory to what was assumed.

Transient vegetation properties for climate models and reanalysis

In HARMONIE the surface modelling platform SURFEX (Masson et al., 2013) is used with both ALADIN and ALARO physics.

The leaf area index (LAI) in SURFEX can be prescribed or prognostic. For these simulations prognostic LAI will be used in which LAI evolves depending on climate conditions and has the potential to capture important annual and interannual variability such as leaf onset during spring and LAI decrease during drought.

The implementation of prognostic LAI cannot be done directly since the assimilation requires SURFEX to run on one patch (one surface cover for the entire grid) while prognostic LAI needs SURFEX to run on 12-patches. A work around is to run SURFEX in offline mode with prognostic LAI in parallel to the ordinary simulation. The offline simulation will be forced by variables from coupled simulation and return updated LAI to the coupled simulation daily.
Before the implementation of a parallel offline SURFEX two sensitivity experiments will be conducted. (1) Run SURFEX with and without prognostic LAI to quantify the effect of prognostic LAI on variables such as precipitation and latent heat flux. The simulation without prognostic LAI will use LAI information from the land surface database ECOCLIMAP. (2) Run SURFEX offline forced with reanalysis to evaluate the prognostic LAI against different observational LAI-products.

One should mention that we have surveyed possibilities for introducing historical transient data for land and biosphere properties. No suitable data sets have been found, only one for a past climate, and the interpolation is not attractive plus that the technical work of introducing such foreign data is excessive.

2.2.2.3 Downscaling (T2.3)

The MESCAN 2-dimensional univariate analysis system has been developed based on the optimal interpolation method. A description of the system may be found in the EURO4M report D2.6. Analyses tests of 2m temperature and relative humidity have been done using two types of background (i) a statically downscaled 6-h forecast from 11 to 5.5 km and (ii) +6-h forecast from integration of the model at 5.5 km. The later method is known as dynamical downscaling. The analysis have been assessed by computing standard scores (bias, RMS error and standard deviation) against surface observations. In terms of analysis scores, the advantage of using the background from dynamical downscaling instead of a statically downscaled one is not clearly pointed out yet.

Devoted work for WP3 to produce 6-hourly files in GRIB1 format from EURO4M MESCAN reanalyses has been done. The GRIB files contain seven variables: (i) analysis of temperature and relative humidity analysis at 2m above ground and 24-h accumulated precipitation, (ii) downscaled forecasts of 10m wind components, downward short- and long wave radiation flux at ground surface. The GRIB1 files are created for the period 2008-2009 and are going to be archived at ECMWF. As already stated in the EURO4M datasets table, row 16 (see www.euro4m.eu, Datasets), such data are available for the period 2007-2010 in the netCDF format.

The ALADIN atmospheric model and the externalized surface model SURFEX (Masson et al., 2013) have been set up at 5.5km grid over a large region encompassing Europe. The domain has been nested into the coarser domain at 11 km grid set up at SMHI as a requirement for downscaling purposes. Indeed, SMHI will provide initial and lateral boundary conditions for running atmospheric models at higher resolution of 5.5km horizontal grid covering almost the same area. In addition, one salient task is to produce 50-year reanalyses at 5.5km. In this respect the high-resolution background will be the downscaled forecast from SMHI. Another task is to assess the uncertainties in the analyses. This work will be done by multi-model approach. Thus, two atmospheric models (ALADIN and ALARO) with different physical parameterization schemes and two surface schemes (ISBA and SURFEX) will be used. The ALADIN (ALARO) model has been developed with a built-in surface scheme called ISBA

(Noilhan and Mahfouf, 1996), but it can also employ SURFEX instead. By running ALADIN (ALARO) with ISBA and SURFEX respectively, four background fields at high-resolution will be generated. Due to a better description of the orography at high-resolution, it is assumed that the background from the model integration at 5.5km grid will provide better fields than the downscaled one. In order to prove that, numerous forecast tests for a 3 month period on both domains (11km and 5.5 km grid) with ALADIN and ALARO models employing respectively ISBA and SURFEX surface schemes have been carried out. The forecast fields of 2m temperature and humidity, accumulated precipitation and 10m wind speed and direction have been evaluated over France against observations by computing scores. Of particular interest are the scores at +6-h forecast because they allow an estimate of the quality of the background fields that will be used for re-analysis of screen-level variables. The left panel of Fig. 21 illustrates that globally over France, the forecasts of T2m at 5.5km are better than at 11km. In addition, as shown in Fig. 21 (right panel) and Fig. 22 (left panel) the scores are also improved over the complex orography for T2m and 10m wind speed respectively, though in wind direction may not be much difference (Fig 22, right panel).

Comparison of 24-h accumulated precipitation forecast with the EURO4M gridded reanalyses has shown a large positive bias particularly over the mountains. When examining bias and standard deviation (Table 3) computed for precipitation forecasts performed with different models at different resolution it appears that ALADIN model has smaller errors but slightly larger biases than ALARO. Nevertheless, this evaluation about the precipitation should be extended on a longer period in summer and winter. The experiments done at 5.5km with ALADIN and ALARO use exactly the same settings without any optimisation in terms of horizontal diffusion or physical parameterization.

In Fig. 23 it can be notice the spatial variability in terms of standard deviation, particularly over complex topography (the Alps, Scandinavia etc), more significant at 5.5km (left panel) than at 11km grid (right panel). The circles emphasize two distinct aspects of the EURO4M analysis. While the black circle in south-eastern France point out the climatology of the region for that particular month of June 2010, the red circle in the north-eastern Europe reveals rather an issue in the reanalysis. The precipitation reanalyses have been performed to be close to the rain-gauge measurements aiming for using the whole set of available data at the analysis time. An example with an extreme event is the period 06 UTC 15June 2010 – 06 UTC 16 June 2010 when in the south-eastern France (black circle) precipitation amounts between 100mm and 397mm in 24 hours were recorded by 35 stations (12 reports with amount greater than 200 mm) whereas the peak of the accumulated precipitation forecast in the region was less then 70mm. These rain gauge measurements have been validated by the Climatological department of Météo-France. For reanalysis purpose, it is supposed to use the observations that have already passed the quality control for gross errors. Hence, we have presumed that the precipitation observations are only affected by the representativity errors and measurement errors due to instrumental uncertainties. Under that hypothesis the reanalysis system would be able to use outliers and the resulting precipitation fields should better depicts the climate variability of the region.

In data sparse regions as the eastern Europe where the observations are usually not available the analysis will be close to the background fields. In additional, the observations may be affected by gross errors generating spurious patterns as pointed out by the red circle in Fig. 23. Indeed, the investigations have revealed an amount of 220 mm/day at Belozersk station, Russia. Such precipitation amount for high latitudes (60^{o}N) that may be considered unrealistic is not unusual across the Mediterranean basin. This finding points out the need of an improved quality control of rain gauge measurements and the necessity of plugging in the observation quality control check during the reanalysis process.

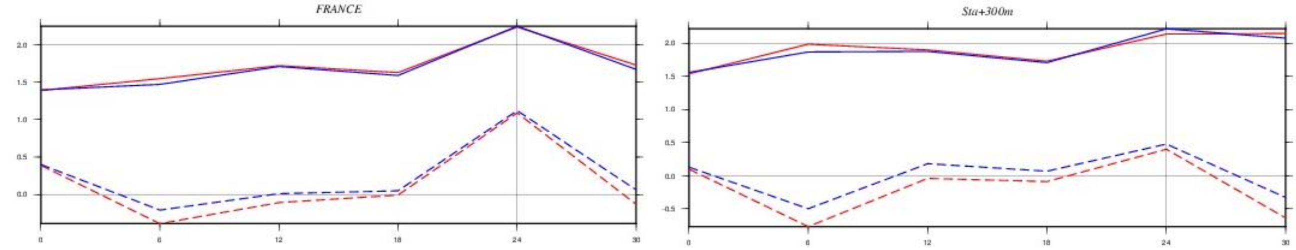

Figure 21. Time evolution of T2m forecast bias and rmse of computed over France for June 2010 (left panel) verified against all the observations, and (right panel) the observations with altitude above 300m. Scores for the forecasts performed with the ALADIN model at 5.5 km grid (blue lines) and at 11km grid (red lines).

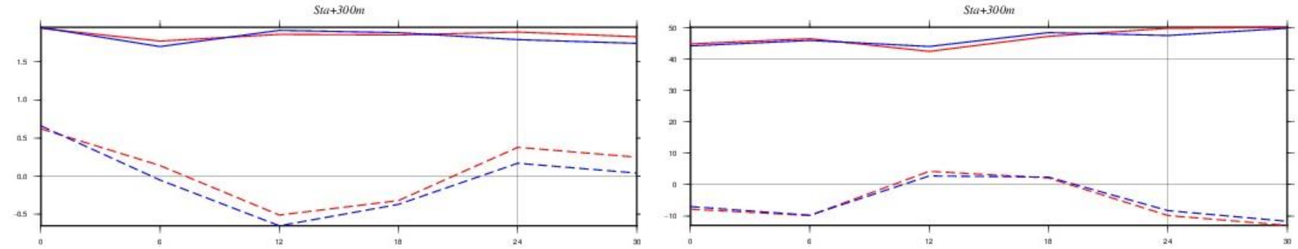

Figure 22. Time evolution of bias and rmse of 10 m wind speed forecast (left panel) and direction (right panel) computed over France for June 2010 verified against stations with altitude above 300m. Scores for the forecasts performed with the ALADIN model at 5.5 km grid (blue lines) and at 11km grid (red lines).

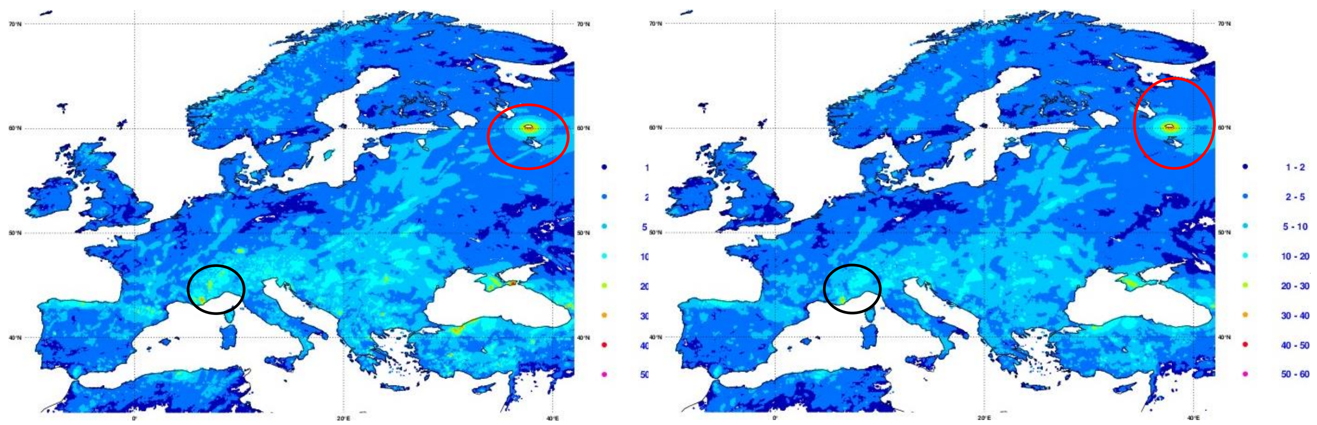

Figure 23. Monthly standard deviation of 24-h accumulated precipitation forecast for June 2010 computed against EURO4M precipitation reanalyses over land on a regular grid of 0.1o. ALADIN forecasts with ISBA at 5.5 km grid (left panel) and 11 km (right panel).

Horizontal grid (km)	ALADIN			ALARO		
	Bias (mm)	RMSE (mm)	SD (mm)	Bias (mm)	RMSE (mm)	SD (mm)
11	0.35	3.99	3.87	0.30	4.89	4.75
5.5	0.43	4.21	4.08	0.23	4.83	4.70

Table 3. Monthly mean Bias, RMSE and standard deviation (SD) of 24-h accumulated precipitation forecast for June 2010 against EURO4M precipitation reanalyses computed over land on a regular grid of 0.1^o. Forecasts performed with the ALADIN and ALARO atmospheric models employing ISBA surface scheme.

2.2.2.4 Ensemble-Nudging DA Reanalysis (T 2.5)

As part of WP2 in UERRA, **UB** will provide a high-resolution regional ensemble reanalysis system as well as a proof of concept data set for Europe. Substantial progress has been made during the first year. Deviations from the DoW (Task T2.5) have not occurred at this stage.

In a first step, a new hybrid LETKF/ ensemble nudging system is developed. The system will be based on two DWD (Deutscher Wetterdienst) data assimilation systems:

- the nudging scheme (Schraff, 1997)
- the local ensemble transform Kalman filter for the convective scale (Reich et al, 2008).

In the system, these two DA approaches will be linked which is considered particularly useful for reanalysis purposes as it combines the positive features of nudging and LETKFs yielding low RMS errors (LETKF) and a smooth time series with small error spikes (nudging).

During the first year, UB has been working on the following activities in accordance with the DoW:

- development of an ensemble nudging scheme based on deterministic nudging including perturbed observations
- development of a statistical model to derive pseudo observations for assimilation in observation sparse reanalysis time spans.

Ensemble nudging

Ensemble nudging is based on deterministic nudging which has been operationally used at DWD since 1997. Nudging is the continuous relaxation of the prognostic variables of the numerical weather prediction model towards direct observations during the forward integration of the model. Ensemble nudging works in almost the same manner, however, the ensemble members are nudged towards observations perturbed by means of the respective observation error. Technical details of the implementation:

- Ensemble capabilities have been implemented into the operational COSMO nudging scheme including the feedback output of ensemble nudging which allows for a post-monitoring of observation perturbations.

- In a first step, the perturbation process of observations has been implemented as part of the COSMO nudging scheme. A perturbed observation o_p is given by the original observation plus a perturbation o' sampled from a normal distribution $o' \sim N(0, \sigma_o)$ with zero mean and a standard deviation given by the observation error σ_o. Due to a general lack of knowledge of observation error correlations these are currently not taken into account in the perturbation procedure.
- In order to provide physically sound perturbations, perturbed observations exceeding reasonable value ranges are corrected accordingly.
- Furthermore, vertical lapse rates becoming super-adiabatic due to perturbation are corrected to prevent a rejection of observations.

Ensemble nudging case studies

In order to investigate the performance of ensemble nudging, case studies have been simulated assimilating observations including TEMPS, PILOT, SYNOP, DRIBU, AMDAR, ACARS, wind profiler, AIRREP as well as SHIP reports. A summer and a winter case study have been examined. The validation includes the evaluation of

- spin up time
- spread (see Figure 1x as an example) as well as the influence of perturbed lateral boundary conditions
- global, vertical and level dependent ensemble perturbation evolution
- reanalysis surface variables such as precipitation and temperature
- the possibility of omitting observations for later verification purposes
- the interplay of ensemble nudging with latent heat nudging (Stephan et al., 2008) and the perturbation of the latter to better represent the uncertainty of precipitation.

The case studies yield very promising results and show the potential of ensemble nudging for reanalysis purposes.

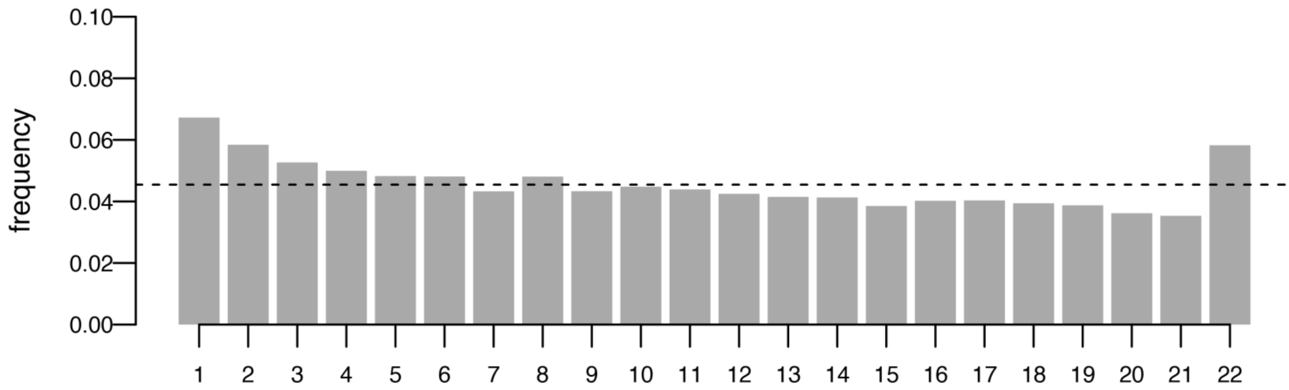

Figure 24. Analysis rank histogram of precipitation from a COSMO ensemble nudging run at 0.11° horizontal grid spacing. Model data is stratiform plus convective precipitation from 20 members plus one control run at 04.06.2011. It is verified against hourly precipitation sums from approximately 1400 German rain gauges.

Pseudo observations

Methods for deriving pseudo observations based on statistical models to be assimilated in observation sparse reanalysis time spans are being explored. A method for predicting spatially and temporally highly-resolved precipitation probabilities based on satellite data and rain gauges has been developed. It will allow for assimilating precipitation information in reanalysis time spans lacking radar observations.

Furthermore, statistical techniques for deriving pseudo upper-air observations including linear regression, canonical correlation analysis and Kalman model output statistics are explored. In a first approach, these utilize 850 hPa ERA-Interim temperature data as well as SYNOP temperature observations.

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

2.2.3.1 Coordinating uncertainty evaluation (T 3.1)

Progress of WP3 (Assessing uncertainties by evaluation against independent observational datasets) towards its objectives was achieved within Task 3.1. Task 3.2 had not started yet (which is in accordance with the projects plans). There were no deviations to task achievements as outlined in Annex I (the DoW).

This first year was spent determining the optimal methods for the WP3 objective: 'to evaluate deterministic, ensemble reanalyses and downscaled reanalyses through comparison to ECV datasets'. Central to this objective was the workshop on the definition of a common evaluation procedure which was held in Offenbach, Germany on 26th and 27th June, 2014 (D3.1). It was particularly beneficial, that early in the project, in preparation of this workshop. An online interactive document was set up which laid the ground for the lively WP3 discussion on possible evaluation methods, suitable parameters, and independent data sets to be used and applied for the envisaged common evaluation procedure. In particular, the prerequisites and benefits of the following six methods were discussed in detail: a) feedback statistics, b) station observation, c) gridded fields, d) satellite data, e) ensembles, and f) user-related models. In the workshop 14 participants from the project took part, three independent users from DWD were present, and three additional German users were consulted.

The result in the form of a report of the workshop can be found on the UERRA web site (http://www.uerra.eu/project-meetings/wp3defworkshop/18-report.html). This and the continuation of scientific online discussion led toward the WP3 objective of 'To establish a consistent knowledge base on the uncertainty of reanalyses across all of Europe'.

Further discussion on feasibility and scientific benefit let to our preliminary table summarizing common evaluation procedures (D3.2) shared within WP3, which were also presented at the international conference of the European Meteorological Society EMS&ECAC 2014 in Prague, Czech Republic. The discussion is proceeding in the living document. Of particular importance were the discussion contributions and the review from the producers (i.e., from WP2).

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 combined WP3/WP4 discussion (on which UERRA output to store and in which way), again with considerable WP2 contribution, covered specifically the user needs which might go beyond what WP3 requires. Using the output of the FP7 project CORE-CLIMAX proved useful for this. As preparation for the next deliverable (D3.3, planned 2015: a portable set of algorithms) we have discussed a set of suitable parameters to store by all producers from WP2, considering the user needs as identified in the WP3 workshop. This set includes distinct lists of parameters on model levels, height levels, and for the surface as well as on which levels to store the data. This work concerned the storage of the UERRA reanalyses which will be finished and available towards the end of the project. WP3 needs data to experiment on, considerably earlier. Because of this, it has been agreed on within WP2, WP3, WP4, and the project management, to store a subset of the precursor project EURO4M reanalyses on the MARS archive at ECMWF for WP3 developments and testing. This work is ongoing.

The WP3 objectives not addressed in this year concern the application of the methods discussed so far. This will happen in the years to come (in accordance with the planning).

Clearly significant results include:

- D3.1 and D3.2 submitted.

- Common knowledge base on methods of uncertainty characterization is building up.

- UERRA contribution at the EMS/ECAC in Prague (paper submitted to ASR).

- User questions and scientific questions are identified, which WP3 will strive to answer with these methods.

- EURO4M evaluation results for precipitation in the Alpine region were finalized and published in: Isotta et al. (2014).

There were no deviations from the plan in the DoW (Annex I).

Method	Data source	Parameter	Details	Scientific questions	User questions
A: feedback statistics	Radiosonde soundings	temperature wind speed relative humidity	focus on lower troposphere; bias and RMSE of time series; store in ODB format;	How stable are the regional reanalyses (RRAs) with respect to multi-annual trends on a spatial scale of roughly 100 km?	How well represented are trends and climatologies of wind speed at heights which are relevant for wind energy?
B: point measurements	B1: (independent) mast station data; B2: (dependent, i.e., assimilated) station data	B1: wind speed B2: Tmin, Tmax, and number of days of threshold exceedance of temperature and precipitation	There are many more suitable observations available for B2 than for B1.	At which time scales can we find correlations between reanalysis fields and station observations?	On which time scales of variability can we use the RRAs (for which parameters) similar to the use of a station measurement?
C: gridded measurements	Gridded data products for the Nordic region and the UK; EOBS,	Precipitation; Tmin and Tmax	To consider whether a part of underlying station observations	What differences do we get with different products when	Which scales of the RRAs (temporal, spatial) can be interpreted?

	APGD		was assimilated into the reanalysis.	determining the useful spatial and temporal scales of the RRAs?	
D: satellite data products	Satellite data products of CM-SAF and CCI	Global radiation; total cloud cover; snow water equivalent		How well do the RRAs fit to the satellite observations - or exceed their quality?	Depending on the parameter, is the RRA or the satellite the better data product for the user to use?
E: Ensemble based comparison	WP1 created ensemble of gridded data with derived uncertainty estimates;	precipitation , Tmin, Tmax, Tmean;	Ensemble based uncertainty estimates will be performed on (1) the newly (WP1) created data products.	Does the ensemble provide a more detailed and spatially and temporal more resolved estimate of uncertainty compared to a deterministic reanalysis?	Which uncertainty characteristics can be interpreted from the reanalyses ensembles for user relevant parameters?
	products as in methods A through D	parameters as in A through D	(2) the basis of methods A through D when available.		
F: User related models		Tmean; Tmax and Tmin pseudo analysis; wind speed; precipitation;	SURFEX by Météo France uses the reanalyses as input		Is the result of a user model forced by RRAs significantly better than with the original forcing?

Table 4. The evaluation procedures that were decided in the WP3 Workshop at DWD June 2014.

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

ECMWF and KNMI have started the work on data services and visualization services in this WP. Staffing difficulties in both institutes have caused delays in the first deliverables promised, but towards the end of the year the work is in good progress. Also, important links to other projects (in particular CLIPC) have been established.

Several activities in this WP build on previous work in EURO4M, such as the data visualization prototype which has been extended as part of UERRA. ECMWF have successfully used the prototype to visualize selected datasets archived in their MARS system.

Technical difficulties have slowed down the data services activities. It turns out that reformatting GRIB and connecting MARS to the ESGF require more effort than foreseen. As intended this work is performed jointly with CLIPC.

The user relevant activities on climate indices have started and an important deliverable on connecting atmospheric reanalysis data with hydrological modelling has been completed.

2.2.4.1 Establishing Data services (T 4.1)

A first test to include EURO4M reanalysis data sets stored at ECMWF into the pilot visualization tool developed as part of EURO4M has been successful, see euro4mvis.knmi.nl. This tool can be used for future data visualization activities in UERRA working jointly with ECMWF. The INSPIRE compliant data dissemination plan (D4.2) which is due in Month 12 is delayed by several months because of the staffing situation and internal reorganization at KNMI. However, as part of this work contacts with the CLIPC project have been established to discuss the hand-over of UERRA reanalysis data sets using the ESGF.

The work on UERRA data portal and all related tools for data processing and visualization at ECMWF has started. As the UERRA test samples are not ready yet the former EURO4M data subsets will be used as a testbed. The first EURO4M data samples (table 1) were received from the partners and have been converted into GRIB2 UERRA compliant files. The necessary related modifications of ECMWF's grib encoding tool GRIB_API have started. WMO approved two new grib codes which will allow to identify UERRA type of data in MARS.

Model	**Data status**	**Next milestone**	**By when**
HARMONIE (SMHI)	Test data received	Convert to UERRA compliant GRIB2 files	Feb 2015
MESCAN (MF)	Test data received	Convert to UERRA compliant GRIB2 files	Feb 2015
COSMO (DWD)	Test data received	Convert to UERRA compliant GRIB2 files	Feb 2015

Table 5. Current status of UERRA/EURO4M data received from the partners

The knowledge from previous similar projects (TIGGE, TIGGE-LAM, S2S) is used for creation of standardized procedures for data collection, processing and archiving. In the following after appropriate amendments the users will be able to take advantage of a lot of existing ECMWF's infrastructure (data portals, batch archive access, data transformation and visualization tools etc.) for getting the UERRA/EURO4M data from the archive and its further processing.

The current ECMWF's WMS server has been used successfully to display some fields from available EURO4M data. The WMS set up changes necessary to be able to provide full service for EURO4M/UERRA data have been identified and are being implemented by ECMWF's METVIEW team. The target is to connect the amended ECMWF's WMS service with KNMI's tool http://euro4mvis.knmi.nl/adagucviewer/. This should also fit well for D4.2 (INSPIRE compliant data dissemination plan).

2.2.4.2 User-oriented products (T 4.2)

KNMI, with input from DWD, has created a new Climate Indicator Bulletin (CIB) which was issued on 16 December 2014. The bulletin is about the year 2014, which turns out to become the warmest year on record in Europe (see: http://cib.knmi.nl/mediawiki/index.php/2014_warmest_year_on_record_in_Europe). These bulletins are generic in the sense that they serve the full range of climate users and applications sectors in Europe within the wider global community. The analyses made use of the E-OBS gridded data set which was updated as part of the UERRA project. The activity to calculate derived climate change indices which are relevant for applications using the E-OBS gridded data set has started.

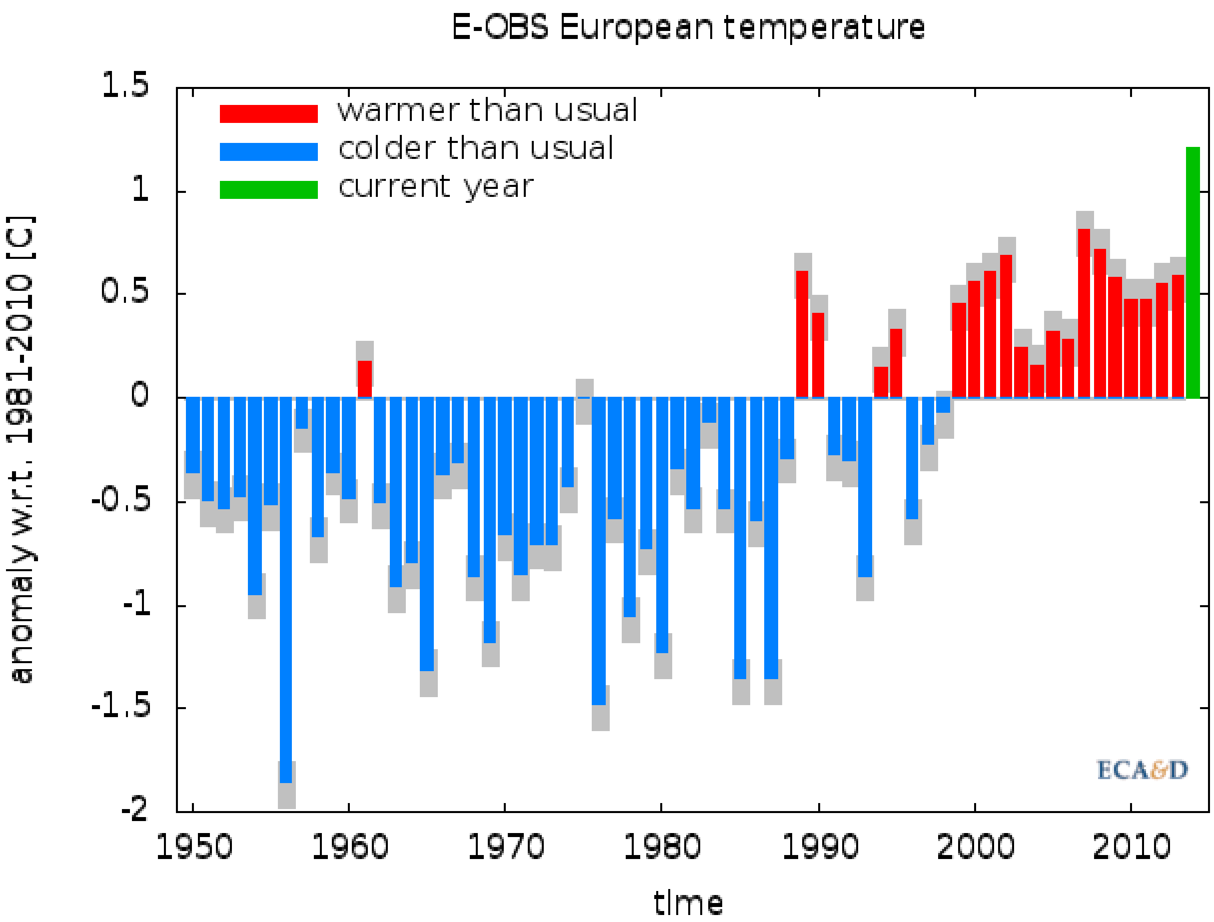

Figure 25. E-OBS annual mean temperatures 1950-2014 compared to the normal.

HYPE EURO4M Evaluation

For the deliverable D4.6, http://www.uerra.eu/component/dpattachments/?task=attachment.download&id=43, the goal is to explore the use of observed discharge as an evaluation tool for accumulated precipitation over a catchment area to evaluate long term mean precipitation, for example from the EURO4M-HIRLAM reanalysis simulation. The main idea is to make use of observed records of discharge from river catchments across Europe, which in a long term mean can be expected to be balanced by the precipitation falling within the upstream area and the loss through evapotranspiration. The precipitation is given by EURO4M, whereas evapotranspiration can only be estimated. In a first part of the evaluation, the catchment delineation and routing routines of a large-scale hydrological model for Europe, E-HYPE, are used to accumulate the precipitation spatially over a catchment. Then the temporally and spatially aggregated precipitation is compared with observed discharge from the corresponding catchment. An accumulated precipitation less than the discharge (even without considering evapotranspiration) indicates inadequate precipitation. For the second part of the evaluation, simulations with E-HYPE are carried out, and similar analyses are performed as in part one, but using the simulated values of discharge, now including an estimated evapotranspiration.

Model and Data

The E-HYPE model

The E-HYPE model is the European set up of the HYPE model (Hydrological Predictions for the Environment; Arheimer et al., 2008). It is a semi-distributed, process-based model that simulates hydrology following a multi-basin concept, where multiple catchments (here over all of Europe) are modelled in a consistent way. The landscape is divided into different classes according to altitude, soil type and vegetation. In E-HYPE there are over 35'000 catchments with an average size of 250 km^2.

E-HYPE is used for two purposes in this study: (i) to accumulate gridded precipitation over catchments to perform a simple routing of all water to the river mouth, and (ii) to simulate hydrological processes including retention in the soil, groundwater and lakes to make assessments of the loss of water to the atmosphere through evapotranspiration.

Precipitation is introduced to the model as single time-series for each catchment, and to arrive at those time-series, a pre-processing of the original gridded source precipitation data is necessary. This is carried out in two steps. First, each catchment area is assigned an area weighted average of all grid boxes of the precipitation field that overlaps the catchment. This determines the total amount of precipitation that falls within the catchment each day. There is a large range of catchment sizes in E-HYPE (from 2000 m^2 to 18000 km^2), and with increasing area, such averaging acts to remove much of the variability of rainfall intensity. So in the second step, a grid point from the precipitation data set that is deemed representative for the variability close to the center of the catchment is chosen. The time series of that grid point is then scaled to have the same average on a monthly time scale as the total of all precipitation falling within the catchment. Thus, water is conserved on a monthly timescale while the variability remains similar to that of a single grid point. The latter effect is important, e.g., for the simulation of flood and drought events. However, for the current study, the first step of water conservation is of main importance.

For the second aspect of the E-HYPE modelling of this study, evapotranspiration plays an important role, as besides routing of water, this is the only way water can leave the system. Evapotranspiration encompasses direct evaporation (sublimation) of water (snow) from soil moisture and open water, as well as transpiration from plants and trees. In the current set up of E-HYPE, evapotranspiration is calculated using a simple temperature exceedance relationship. This equation estimates the evapotranspiration assuming a linear relationship with the daily mean temperature above a threshold temperature, usually 0. This has been shown to achieve a sufficiently good simulation of evapotranspiration in a large range of catchment scales, climates and physiographies, such that the balance between precipitation, evapotranspiration and discharge is achieved (e.g. Oudin et al. 2005).

Data sources and experiments

EURO4M-HIRLAM

The operational weather forecast model HIRLAM was in the EURO4M-project (http://www.euro4m.eu) used to perform reanalysis simulations of the ERA-Interim reanalysis (Dee et al., 2011). The reanalysis were performed by one-way nesting of HIRLAM, using ERA-Interim information at the lateral boundaries, including additional large scale constraint by ERA-Interim vorticity (Dahlgren and Gustavsson, 2012) and 3D-VAR assimilation of conventional observations.

The simulation covers the period 1989-2010, and has about 22 *km* spatial resolution (0.2 *degrees*). Here, daily precipitation and surface temperature was used as inputs to E-HYPE.

WATCH Forcing Data Era-Interim (WFDEI)

WFDEI is a merged model and observational product (Weedon et al., 2011), using the ERA-Interim reanalysis (Dee et al., 2011) together with different gridded observational data sets. The procedure to calculate corrected data varies between variables, but the main principle for all variables is that each monthly mean value of ERA-Interim are corrected to that of the observational data set. For precipitation, the correction is performed toward GPCC (Rudolf et al., 2010) by first correcting the number of dry days (precipitation below 1 *mm/day*) following observations from the CRU data set (Mitchell and Jones, 2005), and then scaling precipitation for each time-step during one month with the ratio of the monthly accumulations of ERA-Interim and observations for that same month. This means that the monthly means of WFDEI agrees with the observations, and the sub-monthly timesteps are scaled to fit with that. In a last step, and under-catch correction, based on local estimates based on the gauge type and weather conditions, is applied. Thus a higher temporal resolution data set is constructed while retaining similar characteristics as the monthly time-scale observational data.

WFDEI is a global data set with a 50 *km* spatial resolution, and is currently used as a standard for setting up the E-HYPE model. Here, only temperature (corrected with CRU data) and precipitation are used.

Discharge observations

The discharge observations have been collected from various sources all over Europe. Initial quality checks have reduced the number of stations used for validation and calibration of the model to over 2500 stations. For the analysis presented here, we have further reduced the selection of stations to 637 by removing stations with too much missing data. For annual accumulations, years when the station has more than ten missing days are discarded in the climatological statistic. This is because missing data can have a large impact on the annual total discharge, depending on which time of the year the data gap occurs. **Fel! Hittar inte referenskälla.** shows the total percentage of missing data between 1991 and 2010 for each of the discharge gauges.

For reasons of availability of discharge data, and of local characteristics found in the analysis, this study will provide analyses for Scandinavia and the British Isles in particular, and Europe in general.

E-HYPE experiments

Simulations are performed for the period 1990-2010, with the first year used as a spin up and later discarded for the analysis. The WFDEI data set is used for the control simulation. Two additional simulations are performed using EURO4M-HIRLAM for both temperature and precipitation, and using EURO4M-HIRLAM for precipitation, but WFDEI for temperature.

Evaluation

Overview for Europe

EURO4M-HIRLAM is generally wetter than WFDEI on average over the year.. This is most clearly seen in mountainous regions throughout Europe with difference even above 100%. This indicates that it might in part be due to the difference in spatial resolution of the two data sets. But also regions with little orography tend to be wetter in EURO4M-HIRLAM. The two data sets deviate strongly for Iceland, and since this is a region poorly covered by observational data, we leave it out of the following analysis.

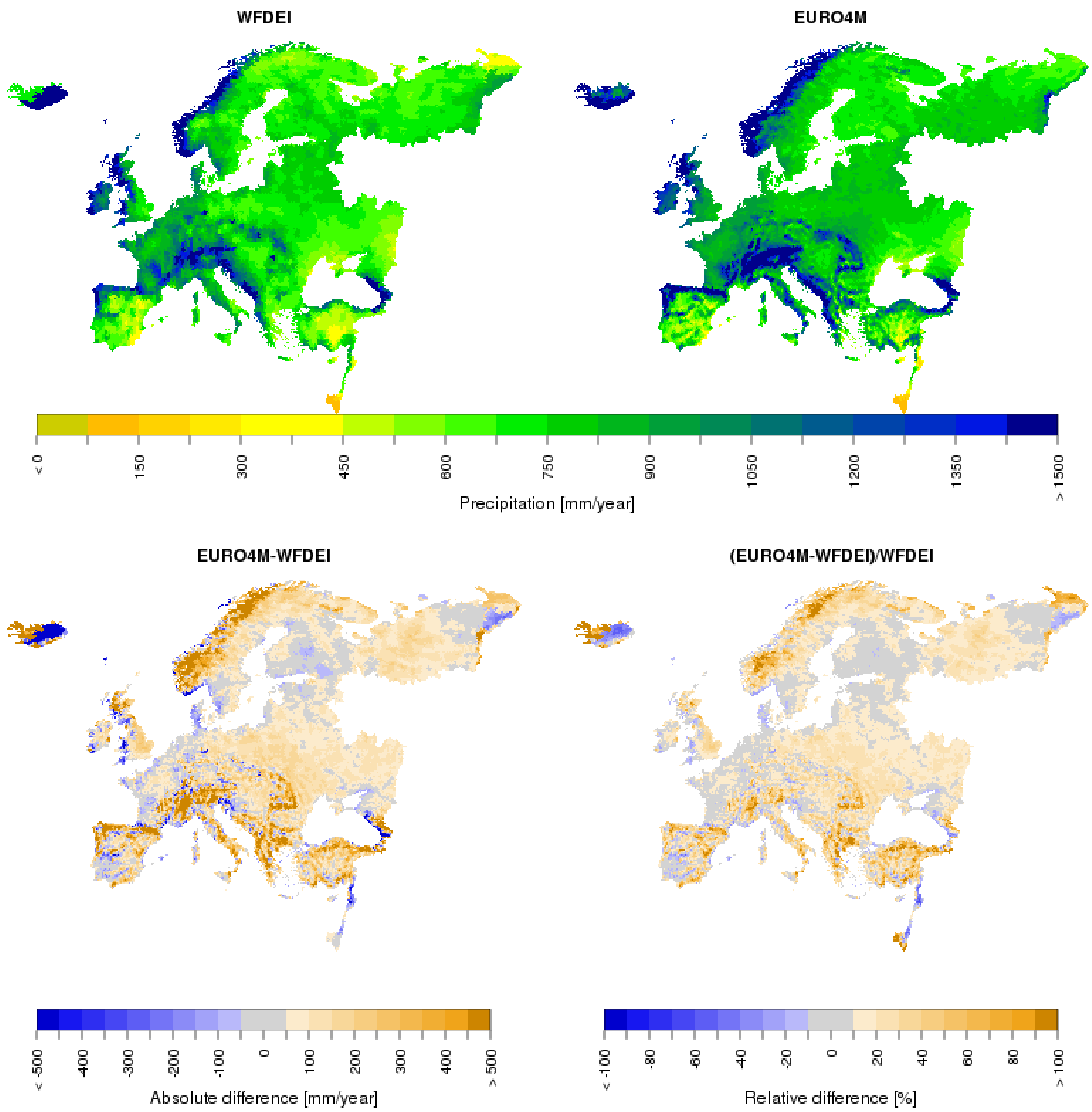

Figure 26. Annual mean precipitation of WFDEI, EURO4M-HIRLAM and their absolute and relative differences, after distributing the data to the E-HYPE catchments.

Figure 27 compares measured discharge for stations across Europe with precipitation from EURO4M-HIRLAM. The Q/P-ratio is calculated directly with observed discharge, Q_{obs}, as well as with model simulated discharge, Q_{mod}. A few regions with ratios above 100% (black areas in Figure 27) are clearly visible in Scandinavia, Iceland and southern Poland, but there are also some regions in the British Isles. These indicate regions where precipitation is likely underestimated by EURO4M-HIRLAM. Interestingly, also the E-HYPE simulation sometimes produces a ratio higher than 100%, i.e. in northern Sweden and in north-eastern Iceland. The northern Sweden case is a river bifurcation not accounted for in the model, where routed water is exchanged between two adjacent catchments, and the large Q/P-ratio is therefore physically correct and balanced by a lower ratio in the other catchment. The results for both Iceland and Poland suffer from large uncertainties due to the small data sample and Iceland, furthermore, has a more complex geological structure which is not well simulated in the model. The results for these regions are therefore not investigated further in this report.

Comparing the Q/P-ratios for observed and simulated discharge, a pattern of generally lower ratios are seen for the model. Some main exceptions are seen for Scandinavia and north-west of the Alps, where the Q/P-ratios are higher for the model. These are mountainous regions, and the reason for the different behavior could be related to snow processes, and to some very limited extent to glaciers. Temperature biases could play a part in this behavior too as this affects the evapotranspiration calculation in the hydrological model.

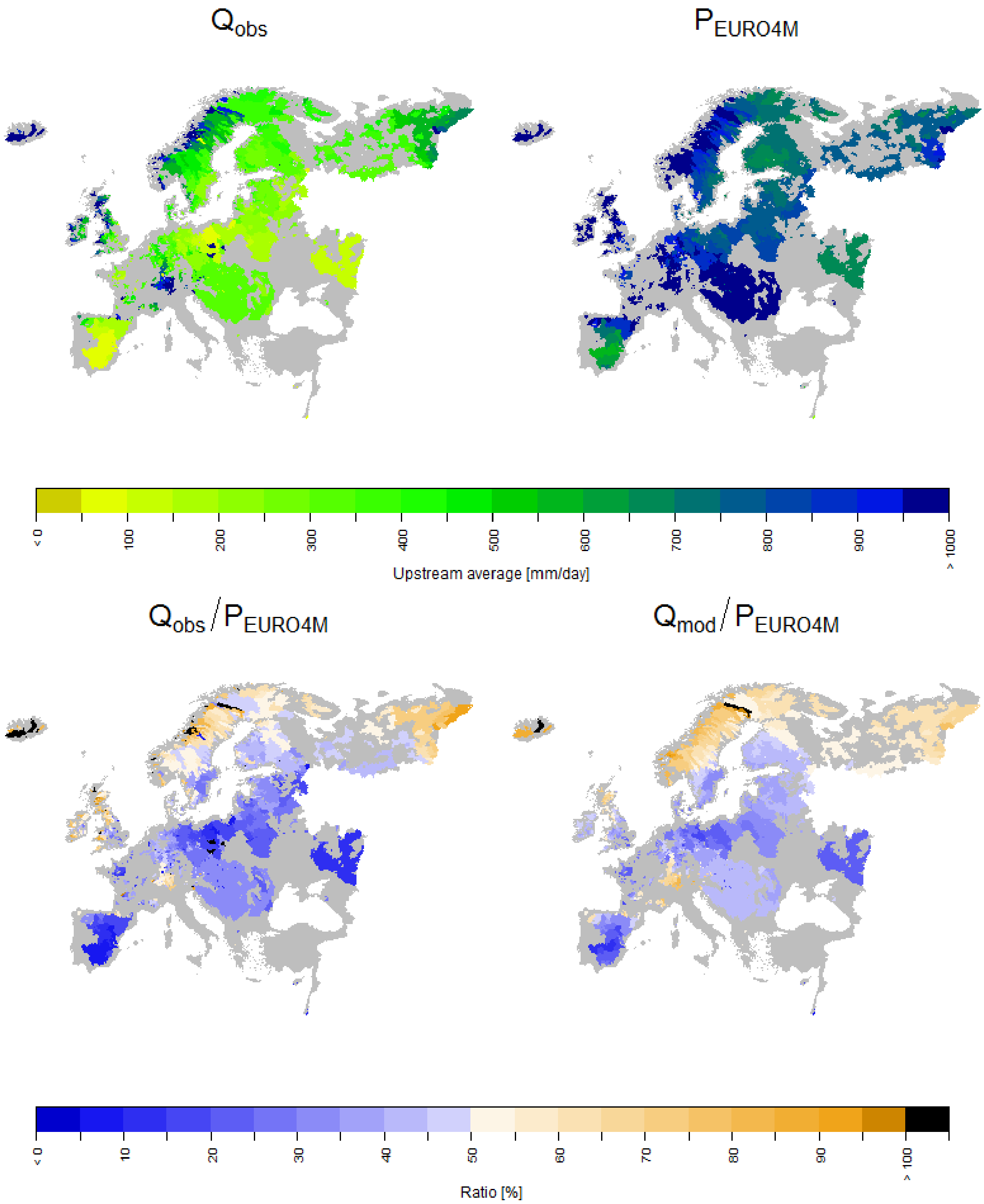

Figure 27. (a) Discharge from observations, (b) precipitation from EURO4M-HIRLAM, (c) Q/P-ratio for observed discharge, and (d) Q/P-ratio for modeled discharge. All panels show annual means for the period 1991-2010. Values of discharge and precipitation are projected upon the upstream area of each Q-station.

Conclusions and remarks of the results

In this study we explored a novel method of employing a multi-basin hydrological model together with discharge observations to evaluate precipitation data sets. The E-HYPE model framework was applied to distribute precipitation from the WFDEI and EURO4M data sets over the catchments of E-HYPE in order to evaluate the accumulated values in two separate steps. In a first step (i), the accumulated precipitation was compared to observed discharge at the river mouths, and in a second step (ii) E-HYPE simulations were carried out to estimate losses due to evapotranspiration or longer term storage. This was performed for average values for the period 1991-2010.

Both of the analysis steps have distinct uncertainties. The main uncertainty is the amount of loss of water between the precipitation event and the water leaving the catchment as discharge. E-HYPE can estimate evapotranspiration, but little observations are available for evaluation, and the more advanced parameterizations require more uncertain input data, e.g. near surface winds. A simple parameterization purely based on daily average temperature was therefore used in this study; although more advanced schemes can be explored in subsequent studies in UERRA.

Comparing the Q/P-ratios for both observed and modelled discharge revealed some interesting features for different regions. The east-west gradient of differences was highlighted for Scandinavia and the British Isles, where a likely explanation for the gradient is a too deep inland penetration of precipitating systems in the dominant westerly flow. Furthermore, a seasonality issue was observed for the Scandic and Alps mountain ranges. The value of the explored method is in indicating where such issues with the precipitation data are, but subsequent meteorological analyses are necessary to find the exact circumstances of the biases of the atmospheric model.

2.2.5 Work package 5 – Consortium Management

See under Management of the Project.

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. 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 November and partners were asked to send contributions in the first part of December in order to be able to review the Project for the GA 27-28 January. Several contributions were received and edited and compiled before the end of the year.

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 1st 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 the 1st Period.

They concerned the progress in the WPs and particularly the Deliverables. There were some early Deliverables from the Coordinator or with KNMI about Management and Dissemination plans which were delayed a few months due to late start in the project and summer vacations. On the other hand the Project web site www.uerra.eu was set up right in the beginning and information was added continuously and thus easily communicated to the partners and their institutes as well as other projects and the outside world.

There has also been more 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)

Coordination plan (D6.1)
The Coordination plan was worked out and discussed with the MST before submitting is as a Deliverable. It was slightly delayed due to a late start.

MST activities
At the earliest the project internal communication structures have been set up and 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 1: In connection with the GA in Exeter 27 March.

MST meeting 2: Telephone conference 2 September.

MST meeting 3: In connection with the EMS/ECAC conference in Prague 8 October.

MST meeting 4: Telephone conference 10 December.

The MST meetings have dealt with issues in the WPs and communication between the WPs as well as organisation of meetings and reporting. On some occasions 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.

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.

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 and no corrective actions was needed as the work was in progress. In other cases corrective measures in terms of resource allocation were discussed between the Project management and the partner(s). 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 has been set up and it is constituted by 3 persons with extensive experience from EEA, ECMWF and DG CLIMA. So far there have only been short communication of organisational nature. The first real work will be in connection with the 2nd GA 27-28 January 2015.

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
Kick-off and 1st General Assembly	26-27th March 2014	Exeter (UK)
WP3 meeting, Definition of evaluation WS	26-27th June 2014	Offenbach (DE)
EMS/ECAC conference (external meeting but involving several of the Project staff)	6-10 October 2014	Prague (CZ)

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

Problems encountered and corrective actions

There are accrued or anticipated delays for two of the partners in WP2, SMHI and UB. The SMHI deliverable D 2.5 will be significantly delayed since the production of the reanalysis ensembles were only possible to start about the delivery time (M12). There have been many technical and model specific problems to sort out. The matter is under attention and more efforts with help from more staff at SMHI to improver the system have become involved. The plans for SMHI in the DoW were very ambitious and in hindsight it would have been unlikely to progress that fast, especially with a new modelling system compared with the pre-cursor EURO4M reanalysis effort.

For UB the resources outside of UERRA from DWD have been reduced due to change of priorities. (More on validation and less on reanalyses). The UERRA efforts of UB will however continue with some slight delay foreseen but with less outside of UERRA support for new developments. The matter will be brought up at the GA in January 2015.

In WP4 there are some delays of Data services and visualisation. Particularly the archiving of EURO4M test data in MARS at ECMWF and the SMHI HARMONIE reanalysis data are behind schedule by some months. (The Deliverable of the prototype D 4.3 was only due at M12 and this will only be delayed by about a month). 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 develop the services as soon as possible, during the first three months of 2015 (expected).

2.2.7 Work package 7 – Dissemination & Outreach

2.2.7.1 Dissemination (T 7.1)

UERRA Web portal

Early in the Project the www.uerra.eu web site was set up with the help of a sub-contractor who provides the basic content management system and hosts the site. A very cost effective solution was established based on competitive tendering (mini tendering considering the small amounts involved).

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

Dissemination plan

SMHI and the Coordinator developed the dissemination plan with the help from KNMI. (D7.1). The delivery time was quite optimistic (M3) considering the kick-off/GA in March and there was a delay until after the summer, but without any real consequences for the Project.

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.

2.2.8 Work package 8 – User feedback

2.2.8.1 Third party evaluation of reanalyses and products (T 8.1)

The work towards an initial review of existing user consultation reports has started by collecting user consultation results from other projects and activities, including EURO4M, CLIPC and C3S. Also, the information from the WP3 user workshop has been added. This activity has not led to a review report (D8.1) yet, but this report is expected before 1 April 2015.

2.2.9 Work package 9 – Overarching Coordination Copernicus climate change projects

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

The first version of the rolling coordination plan will be delayed until early 2015, because of the staffing situation and internal reorganization at KNMI.

2.2.9.2 Coordination meetings organization (T 9.2)

Coordination meetings (telecons) have been organized between the project coordinators of the five C3S precursor projects on a 3-monthly basis. This has contributed to exchange of information about the progress in each project and the potential contribution to the future C3S. The ECMWF coordinator for C3S (Jean-Nöel Thépaut) has attended the last telecon and will participate in future telecons.

There were 3 (three) of these meetings during Y1.

2.2.9.3 Common web page (T 9.3)

The first version of the common web page for the five C3S precursor projects is delayed until April 2015. A preliminary version produced by CLIPC has been considered but ideally it should be hosted separately from one of the five projects and populated by some background information why these projects are connected.

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3 Project management during the period

3.1.1 Work package 5 – Consortium management

The management structure and procedures of UERRA are described in detail in section 2.1 and in WP5 description of the DoW and will not be repeated here. All procedures described there have been implemented at an early stage of the project, proved to work as designed and to be appropriate for a project of this size and ambition.

3.1.1.1 Management (T5.1)

The management first concentrated on setting up the structures and procedures for a good and efficient project management. The main tasks performed and the achievements are briefly described in the following.

<u>Consortium Agreement</u>

A consortium agreement (CA) was prepared and signed by all partners already during the negotiation phase. Among others, the CA governs the responsibilities of the partners, the liability, the management structure, rules for decision making and conflict solving, financial provisions and payments as well as the IPR. The maintenance of the Consortium Agreement is an ongoing task for the Consortium Management.

<u>Communication - internal</u>

Internal communication structures have been set up and implemented with several mailing lists consisting of all beneficiary contacts. These are maintained on-going to be up to date and are used frequently for all kind of communication from the Coordinator to beneficiaries.

<u>Reporting and financial management</u>

A project specific database has been implemented for the reporting and financial management. The structures of periodic reporting have been set up accordingly to deliver the 1st Periodic report in time.

<u>General management and follow up</u>

There have only been a few questions discussed with some partners in connection with the interpretation of the DoW or organisation of the GA.

<u>Communication with EU and REA</u>

Some short communications took place between the Coordinator and the PO in the REA to resolve minor questions.

2 project status updates has been communicated REA during the 1st Period and they were mainly Scientific progress reports of the status in the different WPs. See more under WP6 below.

There have been rather few issues that needed more extensive communication due to UERRA being started earlier in the year.

GA/Kick-off meeting

The UERRA Kick-off and 1st General Assemble was organised and held in Exeter, UK 26-27 March 2014. It was back-to-back with the last GA of the pre-cursor EURO4M FP7 Project since most UERRA partners were also in EURO4M.

The preparations of the 2nd GA at URV in Tortosa started at the end of October in close cooperation with URV.

Changes in the consortium

There were no changes to the consortium.

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

Budget & distribution of funds

In order to guarantee the distribution of funds in line with the DoW a list of banking details of partners has been set up. The first action was the distribution of the advance payment without delay.

Communication - internal

Internal communication structures have been set up and implemented with several mailing lists consisting of all beneficiary contacts. These are maintained on-going 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 some short communications about technical issues with the Participant Portal during the period since it has evolved, been developed and new releases have come. 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:

http://www.uerra.eu/project-overview/all-deliverables.html

Below is the table for the reporting period, M1-12 of the Project.

Table 6. Deliverables									
Del. no.	**Deliverable name**	**Version**	**WP no.**	**Lead beneficiary**	***Nature***	**Dissemination level**[1]	**Delivery date from Annex I (proj month)**	**Actual / Forecast delivery date** Dd/mm/yyyy	**Status** **No submitted/** **Submitted**
D1.1	Dare list of sources	V1	WP1	7 URV	R	PU	M6	03/07/2014	Submitted
D1.2	Dare station locations	V1	WP1	7 URV	R	PU	M10	25/11/2014	Submitted
D3.1	Definition workshop	V1	WP3	10 DWD	O	PU	M3	19/09/2014	Submitted
D3.2	Evaluation procedures	V1	WP3	10 DWD	R	PU	M6	02/10/2014	Submitted
D4.6	HYPE report	V1	WP4	1 SMHI	R	PU	M10	22/10/2014	Submitted
D6.1	Coordination plan	V1	WP6	1 SMHI	R	PU	M8	03/11/2014	Submitted
D7.1	General dissemination plan	V1	WP7	1 SMHI	R	PU	M3	28/10/2014	Submitted
D2.5	HARMONIE physics ensemble		WP2	1 SMHI	R	PU	M12	1/06/2015	Not submitted
D4.2	Data plan		WP4	3 KNMI	O	PU	M12	01/04/2015	Not submitted
D4.3	Visualisation		WP4	9 ECMWF	P	PU	M12	01/04/2015	Not submitted
D8.1	Initial review of user requirements		WP8	3 KNMI	R	PU	M12	01/04/2015	Not submitted
D9.2	Web portal		WP9	1 SMHI	O	PU	M6	01/06/2015	Not 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 "

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 dd/mm/yyyy	Comments
MS7	KFENDA Observation	WP2	12 UB	M9	No	01/05/2015	Staffing and start up
MS9	Common evaluation procedures	WP3	10 DWD	M6	Yes	02/10/2014	Start up small delay