„Climate data supporting Climate Services”

(9th EUMETNET Data Management Workshop)

6th—8th November 2013

El Escorial, Spain

Abstracts

Improving data rescue and climate data management capacities: Current WMO activities

Authors: Peer Hechler, Omar Baddour, Karolin Eichler

Institute: WMO

The overall importance of climate data rescue and efficient climate data management is accepted widely. Current GFCS activities are reinforcing respective needs in order to establish powerful data bases for strengthened climate services at national, regional and global levels. Integrating data rescue and data management components into specific climate research or climate service related projects and activities greatly facilitate its recognition and successful implementation. Sustainability beyond project execution remains a considerable challenge, specifically in developing countries.

WMO promotes collaboration among its Members to improve data rescue and climate data management capacities by establishing standards, best practices and guidance as well as by facilitating the implementation of relevant projects and activities at national, regional and global levels.

Due to the existing linkage between climate data and development issues, WMO and partners have set up sub-regional initiatives for accelerating data rescue and digitization of climate records, in support of climate change adaptation which has cross-border implications. Current major data rescue activities with WMO engagement and partner involvement include MEDARE (MEditerranean Climate DAta REscue), West Balkan project on DRR, WACA-DARE (West African Climate Assessment and Data Rescue, utilizing the ICA&D climate services concept) and the African Microfiche Recovery and Digitization project by ACMAD. Several other individual country-based DARE projects are supported also by WMO, such as the recent project in Jordan and Palestine (WMO and ESCWA), and the planned ones in Southeast Asia, Uzbekistan, Rwanda etc.

Relevant best practices are provided in WMO's Guidelines on Climate Data Rescue (WMO-TD No. 1210). An international data rescue portal is currently under discussion within WMO's Commission for Climatology in order to connect national and regional projects and communities, and to serve as a worldwide information exchange platform.

A recent WMO survey on the status of Climate Data Management Systems (CDMS) suggests that at least 50 Member countries do not have a proper CDMS in place while another 25 Members report that their modern CDMS is only partially operational or not operational at all. Accordingly, the survey outcome provides a sound basis for resource mobilization efforts in order to assist countries in need to improve their climate data management. Relevant training and CDMS implementation activities are carried out in a number of countries worldwide including West Balkan and Middle East countries in WMO Regional Association VI (Europe and Middle East).

WMO Members benefit from emerging climate data management tools including CDMSs. In response, WMO experts drafted a WMO CDMS Specification Document, which is currently under expert review. This document aims to specify the functionality that is expected within a CDMS in order to (i) set related standards and best practices as well as (ii) to assist Members in selecting the appropriate CDMS, where required. Atop of this, WMO prepares for an initiative to launch a High-Quality Global Climate Data Management Framework in order to meet future GFCS climate data requirements. The initiative is expected to provide a

regulatory framework, including the definition of relevant processes, standards and best practices, for worldwide climate data collection, management and exchange across national, regional and global levels.

In response to respective user requirements, and due to the fact of climate change, WMO is currently adapting its definition of Climatological Standard Normals. The new proposal aims at (i) updating the 30 years Climatological Standard Normals every 10 years (instead of every 30 years according to the current practice) and (ii) fixing 1961-90 as the WMO reference period for long-term climate change assessment until such time as scientific reason dictates that a new reference period is required.

ICA&D: Climate Services across borders

Author: Aryan van Engelen

Institute: KNMI

Country: The Netherlands

The development of climate services, enabling nations a better management of the risks of climate variability and change, is dependent on the availability of long term high quality observations on a regional scale, serving monitoring, assessing and projecting climate change.

The International Climate Assessment & Dataset (ICA&D) climate services concept aims to the disclosure of and access to high quality station data sets with a daily resolution, the provision of climate monitoring information and climate change assessments for as many stations in a region as possible. ICA&D combines and extends the work of WMO's Expert Team on Climate Change Detection and Indices (ETCCDI) and WMO's Task Team on Data Rescue (TT-DARE).

ICA&D builds on the knowledge, software and governance concept developed for the European Climate Assessment & Dataset (ECA&D), a service consisting of a regional web portal for daily station data (brought together through regional cooperation between NMHS's) and derived climate information. ECA&D is linked to the Mediterranean Data Rescue (MEDARE) initiative. ECA&D serves as the climate data node in WMO-RAVI Regional Climate Centre (RCC).

The ICA&D concept integrates disclosure and dissemination of basic climate data and information on regional climate variability, monitoring of the current evolution of the climate, placing significant events into the historical context, and assessing climate change. Climate station data, with regular updates of records from weather stations, is processed in an automated way to provide useful information such as adaptation relevant indices for drought, flooding, heatwaves, etc. Both trend maps, climate anomalies and extreme event statistics are included. Web users are able to access this derived climate information to help them in their decision making process to support disaster risk reduction.

This concept has proven itself in Europe, where ECA&D was initiated in 1998. The ICA&D concept is already applied in three climate vulnerable developing regions in the world. The Southeast Asian Climate Assessment & Dataset (SACA&D) in WMO region V has been active for two years now and the Latin American Climate Assessment & Dataset (LACA&D) for WMO Region III and the West African Climate Assessment and Data Rescue initiative (WACA-DARE) are under development.

The set up of such a regional system is generally initiated through a combined ETCCDI - TT-DARE regional workshop, followed by a capacity development and implementation period organized by the hosting institute and KNMI in close contact with the WMO office in Geneva. Transfer to other regions is made easy because the website, underlying database and all processing software are freely and openly available. In order to guarantee and safeguard the data and information, KNMI provides a mirrored backup system. Also, the required training and consultation in relation to ICA&D implementation is provided by KNMI.

New web-based program to digitalize precipitation observation

Author: Minna Huuskonen

Institute: Finnish Meteorological Institute, FMI

Country: Finland

The Finnish Meteorological Institute has already started to digitize weather observation in the 1980s. At that time, the main focus was to digitize basic weather parameters like air temperature and precipitation from the original observation books to Excel spreadsheets. Also other weather parameters were digitized from observation annals at that time. Nowadays we have almost 50 long time series which has been digitized as a whole from the beginning of the establishment of each weather observation stations.

In addition to climatological weather observation stations, the Finnish Meteorological Institute has a long history in precipitation observations. The first six precipitations stations were established in 1891. The golden age of precipitation observations was in the beginning of 1940s when there were over 700 precipitation stations in Finland.

The Observation Service of the Finnish Meteorological Institute has developed a new digitizing program in the autumn 2012. In addition to digitize precipitation observation values and the metadata of observation stations, we can save more background information on the observation with the help of the new web-based program. All notes made by observers are digitized to further details (e.g. when the nearest lake was frozen) and also subjective quality of each observation sheet is marked by looking the completeness of metadata and each observation values separately. The program includes also huge amount of different quality checks, which helps digitizer to notice the potential inconsistency between observation values.

There is a lot of work to be done. According to the archieve register of the Finnish Meteorological Institute, there is 263 148 precipiation observation sheets from 1891 to 1965. Up to now, it has been digitized over 37 500 (14%) sheets with the new program.

The Finnish Meteorological Institute has made its data sets freely available for public use in June 2013. There is now available climatological data from 1959 onwards. Therefore, there is a increasing need to digitize weather observations more systematic and more goal-directed way, listening to users' demands.

A questionnaire concerning climate data rescue, a EUMETNET initiative

Authors: Ingeborg Auer[1]), Barbara Chimani[1]), José A. Guijarro[2)] and the EUMETNET Expert Team on Data Rescue and Recovery[3])

Institute: [1)] Zentralanstalt für Meteorologie und Geodynamik, Austria, [2)] Agencia Estatal de Meteorología, Delegación Terri- torial en Illes Balears. Palma de Mallorca, Spain

Representatives of the national meteorological services of Austria: I. Auer, B. Chimani, A. Jurkovic, Belgium: M. Vandiepenbeeck, Czech Republic: M. Repka, Croatia: J. Milkovic, Cyprus: S. Pashiardis, Estonia: Ain Kallis, Finland: M. Huuskonen, Germany: H. Mächel, Hungary: M. Lakatos, Ireland: S. Walsh, Italy: G. Mondaccini, Latvia: L. Lizuma, Lithuania: J. Kilpys, Netherlands: A. van Engelen, Ge Verver, Norway: E. Lundstad, Poland: D. Limanowka, P. Kilar, Romania: E. Mateescu, A. Manea, Slovakia: D. Galo, Sweden: W. Josefsson, Switzerland: H. Kunz, Spain: J. Guijarro, M. Brunet, United Kingdom: M. McCarthy

Country: Austria

Long-term datasets are of great importance for climate research. They allow describing the undisturbed past climate together with today's anthropogenic influenced climate and its variability, highly resolved in space and time and important for re-analyses and model evaluation. Especially early instrumental series are the connecting link to the paleoclimatic community. Data rescue guarantees that all collected data will be preserved and available for further studies also in the future. In Europe there is a good data coverage since the 1960ies, however to capture the full climate variability including extremes time series are often too short. Although a considerable part of long-term series has already been digitized and made available, there are still millions of data to be recovered and rescued. Due to a number of completed or running activities (http://www.climatol.eu/DARE) the number of digital available data has been increasing continuously, however an extended overview has not been made available so far. The EUMETNET Expert Team will contribute to the European climate services by providing an extended inventory of digitized and non-digitized data, focusing on centennial or even longer daily data, long-term mountain stations of at least 50 years and data in sparse regions.

The presentation will present a synopsis of the results of a questionnaire developed within this activity and distributed among the members of the WMO Regional Association VI.

On the bias introduced by the automatization of temperature observation in Spain

Authors: Aguilar, E[1]., Gilabert, A[1], López-Diaz, J.A.[2], Serra, A. [3] , Luna, Y. [2], Prohom, M.[3], Boroneant[1], C., Coll[1], J.R., Sánchez, J.C.[2], Sigró, J.[1]

Institute: [1].- Centre for Climate Change, C3, Universitat Rovira i Virgili, Tortosa/Tarragona, [2].- Agencia Estatal de Meteorología, AEMET, [3].- Àrea de Climatologia, Servei Meteorològic de Catalunya, SMC

Country: Spain

Climate time series are subjected to a number of impacts which compromise their homogeneity. Some of these inhomogeneities - such as the introduction of Automatic Weather Stations, AWS - are related to changes occuring quasi-simultaneously within a network, even globally, and can cause significant biases in regional/global series. There is a growing concern to understand the magnitude and shape of this kind of inhomogeneities. The analysis of parallel measurements - whenever they are available - is a powerful tool to evaluate such problems

In this work, conducted under the **MCINN Grant CGL2012-32193 "Determinación y ajuste del sesgo introducido por la automatización de las estaciones metereológicas en las series climáticas"**, we explore a dataset of more than 50 stations, provided by the Agencia Estatal de Meteorología (AEMET) and the Servei Meteorològic de Catalunya (SMC), with temperature measurements taken simultaneously with AWS and conventional instruments. Most of the series are collocated, although a few of them are extracted from sites in very close locations. Observations are not limited to temperature - studied in this work - but include other elements. The length of the parallel observations ranges from 17 years in Fabra Observatory (Barcelona), to a few series with no more than 3 months of data.

The difference series have been submitted to standard quality control techniques to locate anomalously large differences and identify if they are related to observational problems and must be removed from the analysis or are legitimate differences within observations systems. In the later case, if information on other elements, such as wind or sunshine hours is available, their values have been evaluated.

We also perform over the difference series a breakpoint detection, based on the joint-detection principle of the new method HOMER. The goal is to identify sudden jumps in the relation between the AWS and conventional observations, which have been often related in those stations with metadata available, to changes in the sensor or its exposure.

Once the quality control has removed erroneous observations and the different homogeneous segments have been identified, we study the differences in the median and different percentiles, and the percentage of values inside a +- 0.5 range, which is the minimum combined uncertainty of the automatic and conventional instruments. The results are diverse and the impact of the instrument and the shelter is obvious, with better results achieved when the sensor is located inside a Stevenson Screen.

To explore the feasibility of the application of state-of-the-art adjustments, selected series will be homogenized with quantile-match based methods and the results compared with the real observations.

Homogenization, quality control and gridding in CARPATCLIM project

Author: T. Szentimrey[1], Z. Bihari[1], M. Lakatos[1]and S. Szalai[2]

Institute: [1]Hungarian Meteorological Service, [2]Szent István University

Country: Hungary

CARPATCLIM project was a consortium of ten organizations founded for a tender published by Joint Research Centre. The objective of the project was to investigate the detailed temporal and spatial structure of the climate of Carpathian Region using unified methods.

The main aim was to produce gridded climatological database for this region. The grids cover the area between latitudes 44°N and 50°N, and longitudes 17°E and 27°E. Daily values of more than ten meteorological variables were calculated on a 0.1° spatial resolution grid for the period 1961-2010. Climate statistics (monthly and annual values) and different climate indices were also determined from the daily grids.

For ensuring the usage of largest possible station density the necessary work phases were implemented on national level but by the same methods and software. The commonly used methods and software were the method MASH (Multiple Analysis of Series for Homogenization; Szentimrey) for homogenization, quality control, completion of the observed daily data series; and the method MISH (Meteorological Interpolation based on Surface Homogenized Data Basis; Szentimrey and Bihari) for gridding of homogenized daily data series. Besides the common software, the harmonization of the results across country borders was promoted also by near border data exchange.

The main steps of homogenization, harmonization and gridding were as follows.

1. Near border data exchange before homogenization.

2. Homogenization, quality control, completion of the daily data series on national level by using near border data series.

3. Near border data exchange after homogenization.

4. Control procedure for harmonization after homogenization by using near border homogenized data series.

5. Interpolation or gridding of the daily data series on national level by using near border data series.

CARPATCLIM homepage: http://www.carpatclim-eu.org/pages/home/

Homogenization of precipitation time series with ACMANT

Author: Peter Domonkos

Institute: Centre for Climate Change, UniversityRovira i Virgili, Tortosa, Spain

Country: Spain

ACMANT automatic homogenization method has beendeveloped in the recent years. Its first versions (ACMANTv1) homogenised monthly temperature timeseries only. In ACMANTv1, change-points are searched with optimal step function fitting, minimizing the residual error for two annual variables, i.e. annual mean and summer-winter difference. This concept of change-point detection is named bivariate detection. Correction-terms are calculated by ANOVA. Tests proved that step function fitting and ANOVA are very efficient tools in time series homogenization. The bivariate detection is advantageous whentwo variables often have coincidental change-points.

In 2013, ACMANTv2 has been created with important innovations relative to the earlier versions. ACMANTv2 has different programs for homogenising daily minimum temperatures, daily mean or daily maximum temperatures and precipitation totals. Although ACMANT works on annual and monthly scales, the new package can treat daily data, i.e. both can develop raw monthly series from daily input and downscale the monthly results to daily output.

For homogenizing precipitation totals, values are subjected first to a quasi-logarithmic transformation then the routines of ACMANTv1 are adapted with few modifications. Even the parameterisation of the precipitation homogenization is the same as that of the temperature homogenization.

One general problem of precipitation homogenization is that precipitation total may come both from rain events and snowfalls in many geographical regions. The technical problems and their temporal inhomogeneities are often differentfor rain and snow. Unfortunately, rain and snow data are usually not separated in climatological archives. Users ofACMANT must define the snowy season of the year (if it is applicable for the region). In the snowy season at least 50% of the precipitation is supposed tobe originated from snowfalls, whilein the rest of the year the principal source of precipitation is rain events. ACMANT searches the change-points of precipitation series with bivariate detection, since snow and rain precipitations often have the change-points with the same timing, although with different magnitudes. ANOVA is applied separately for the snowy and rainy seasons, consequently two kinds of correction-terms are calculated, one for the rainy season and another for the snowy season. No other seasonal variation of precipitation inhomogeneitiesis considered in ACMANT.

The software has been tested with the benchmark precipitation dataset of COST ES0601 (“HOME”) and the results prove the high efficiency of the precipitation homogenization with ACMANT. The efficiency results with HOME, the main steps of the methodology and some general problems of precipitation homogenization will be shown in the presentation.

Homogenization of Croatian Temperature Data Sets Using the ACMANT Method

Dubravka Rasol

Institute: Meteorological and Hydrological Service, Croatia

Country: Croatia

Surface air temperature data sets used for various types of studies and especially the monitoring of climate change should be of the highest quality. In Croatia, very few stations have not have any influence that causes non-climatic changes in temperature data. Accordingly, homogenization of all Croatian temperature data series is required. In this study monthly mean, maximum and minimum temperature data sets from main and climatological meteorological stations were homogenized using the ACMANT method. Most of the data series cover a period from the late 1940's to 2012 yet the data from 5 stations date back to 1900. Prior to the homogenization process the data were quality controlled by the RClimDex extra-QC package. Here, the results of mentioned quality control and homogenization processes are presented.

HOMERUN: Homogenisation of the station network and formulation of a data rescue plan for Ireland's climatological record

Authors: Mary Curley[1], John Coll[2†], Séamus Walsh[1], John Sweeney[2]

Institute: [1]Met Éireann, Glasnevin Hill Dublin 9, Ireland, [2] Irish Climate Analysis and Research Units, Department of Geography, NUI Maynooth, Maynooth, Co Kildare, Ireland [†] Presenting author

Country: Ireland

Accurate climate data is the first prerequisite for basing climate related decision making on. As Ireland moves towards finalising a national climate change adaptation strategy and the provision of a climate services platform, the need for a reliable assessment of past and present climate trends and variability is indispensable. Consequently, there is a need for homogenisation to be carried out on the climatological data held by Met Éireann (ME), with the collation of metadata a necessary pre-requisite. Additionally, since it is not feasible to homogenise Ireland's long-term series of 5 climatologically diverse stations, data rescue efforts need to be targeted at those stations which have long-term records. This will facilitate the creation of more long-term temperature and precipitation time series for Ireland and enable a robust reference series to be constructed.

All climatological station data are available in electronic format since 1961, and for rainfall stations from 1941; whereas data from synoptic stations is typically available from the date on which the station opened or 1939. Preparation of the new 1981-2010 Long Term Averages (LTAs) involved the implementation of comprehensive quality control procedures on all digital temperature and rainfall ME data (Walsh, 2012). Good progress has also been made on the homogenisation of all the digitised Irish temperature records from 1961 using HOMER 2.6, with an expectation that this task will be substantially completed by the end of 2013. This software choice recognises the importance of comparative study and common practice in improving homogenisation methods, and the algorithm is the main deliverable from substantial European collaboration (Szentimrey and Lakatos, 2013 and References therein).

Initial analysis is underway for the rainfall station network using established methods of exploratory analysis for time series data, these include e.g.; decomposition analysis, together with detrending and differencing for some of the longer series. As well as identifying some preliminary features and trends in the data prior to further analysis, these pre-screening routines recognise that results for HOMER 2.6 to date are not as good for precipitation compared to temperature (Venema *et al*., 2012). As the properties of statistical breaks in precipitation data are less well understood, the aim is to explore the full range of analytical tools available to inform the homogenisation process.

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Production of reliable long term series for analysing climate change at Météo-France

Authors: Anne-Laure Gibelin, Sylvie Jourdain, Philippe Dandin, Brigitte Dubuisson

Institute: Météo-France

Country: France

Climate change analysis requires reliable long term series. The first step to produce such series of climate observations is so-called Data Rescue, and includes searching documents, saving the archives, inventorying the data, selecting useful set of data, digitising documents and data, and controlling the data. The second step is to homogenize the series, in order to correct the biases due to changes in observation conditions.

The Direction of Climatology is in charge of the coordination of Data Rescue activities at Météo-France, in metropolitan France and French overseas departments and territories, as archives collections are numerous and spread in different locations. Météo-France is also involved in several national and European projects. For example, Météo-France and French National Archives collaborate in the framework of the Access to Climate Archives French project, co-funded by the BNP-Paribas Foundation, in order to make available historic climate archives currently stored in buildings contaminated by asbestos. Météo-France contribution to the FP7 European project ERA-CLIM, led by ECMWF, consists in identifying and providing data and metadata to the European reanalysis over the XXth century, especially upper-air data before 1958, in metropolitan France and French overseas territories and ex-colonies.

However, the long raw series contain numerous heterogeneities, due to the successive changes in measurements conditions along time. The related biases can be of the same magnitude as the climate change signal that we are analysing. Homogenization is a statistical process allowing to detect and correct the breaks due to these heterogeneities. Since 2010, Météo-France has undertaken the homogenisation of its best quality monthly series from the 1950s up to now. The process is under way, temperature series will be available at the end of 2013, precipitation at the end of 2014. First results can however be analysed. This new set of series will bring an up-to-date diagnosis for climate evolutions over France, with a high spatial density useful for climate impact and adaptation studies. Several climatologists have been trained to the homogenisation method PRODIGE and HOMER. These series will be regularly updated in the future to provide the best estimation of observed climate evolutions in France.

How the extreme events have changed by changing meteorological network in Italy

Authors: Fratianni Simona[1], Acquaotta Fiorella[1]

Institute: University of Turin, Department of Earth Science, Turin, Italy

Country: Italy

Italy has a leading role in the development of meteorological observations. This role is well highlights by the invention of some of the most important meteorological instruments (Galileo Galilei's thermometer, 1607, Torricelli's barometer, 1643, and Cusano's hair hygrometer) and the foundation of the first observers network (Accademia del Cimento, 1657). This interest in meteorology has allowed to accumulate, during the last three centuries, a wealth of observational data of enormous value.

This long legacy also means that the Italian networks have experienced many technological, economical and organizational changes, which may affect the homogeneity of the record. Consequently, studies on non-climatic changes are necessary to be able to reliably interpret climatic changes.

In this study we will analyze the recent transition to automatic precipitation measurements in Piedmont, Italy. Our study will be based on 11 pairs of nearby high-quality stations with up to 15 years of overlap measurement of precipitation. We have selected only 11 location because the first analysis of the monthly precipitation series have not showed significant deviation between the meteorological stations.

In this analysis we have tried to understand if the two instrument have recorded not only the same amount of rain but the same rain events. We have divided the daily precipitation in precipitation class based on the percentile. We have calculated the number of event and the amount of precipitation for every class. We have estimate the difference between the class and calculated the thresholds that allow us to evaluate if the two instruments have measured the same events.

The work has shown most clearly that the inhomogeneities have affected for the rain events classified as weak and moderate, whereas strong precipitation is not much affected.

Reconstruction and homogenization of old high-Arctic climate series

Authors: Eirik J. Førland & Øyvind Nordli

Institute: Norwegian Meteorological Institute

Country: Norway

Land areas in the Arctic have since the 1970s experienced stronger warming than any other region on the earth. This "Arctic amplification" may be due to various "feed-back" mechanisms; e.g. loss of snow cover or sea-ice, or changes in atmospheric and oceanic circulation. However, there is large climate variability in these regions; on annual, decadal and longer time scales. Access to long and comprehensive climate series are crucial to be able to understand and model the feedback mechanisms and natural variability in the Arctic.

The first regular weather station at Spitsbergen was established in 1911. This station was closed in 1930, and the station history for the succeeding weather stations at Spitsbergen reveals frequent relocations. To try to establish long homogeneous climate series, automatic weather stations (AWS) have during the latest years been set up at old measuring sites. Some of these old locations were operated for just a few years by hunters who were equipped with meteorological instruments during the period 1894-1914. Two closed-down weather stations were operated by the Norwegian (Isfjord Radio 1934-1976) and Russian (Pyramiden 1947-1957) meteorological institutes.

In a joint Norwegian-Russian project the comprehensive old diaries from Isfjord Radio and Pyramiden are now being digitized, and AWSs are recently established at the old measuring positions at these two locations. Also Russian handwritten manuscripts with data on sea ice conditions observed from Barentsburg (1936-present) and Pyramiden (1947-1957) are now being digitized within this project. In a Polish-Norwegian project the diaries from several old "hunting stations" were digitized and linked to the recent AWS-recordings from the original measuring sites.

The analyses of old and new climate series from Spitsbergen have resulted in a homogenized temperature series for Svalbard Airport/ Longyearbyen from 1898-present. The presentation will demonstrate how this homogenized series is established, and highlight what this series tells about the long-term temperature trends and variability on Spitsbergen. Also preliminary results for the production of "homogenized" series for Isfjord Radio (1934-present) and Pyramiden (1947-present) will be presented.

NORDHOM - Nordic collaboration on establishing long-term homogeneous climate data records

Authors: E. Lundstad (1), E. Engström (2), T. Carlund (1), A. Drebs (3), M. Laapas (3), J. Aalto (3), H. Tuomenvirta (3), O.E. Tveito (1), E.J. Forland (1)

Institute: (1) Norwegian Meteorological institute, (2) Swedish Meteorological and Hydrological Institute, (3) Finnish Meteorological Institute

Country: Norway

Background

Analysis of climate variability and change demands access to long term high-quality instrumental climate records. Such series are however often affected by inhomogeneities (artificial shifts) due to changes in the measurement conditions (relocations, instrumentation, change in environment, etc.). These changes may have the same magnitude or even exceed the multi decadal climate signal. When studying long-term variations, trends or cycles in climate a direct analysis of raw data series can therefore lead to wrong conclusions about climate variability and change.

To deal with this problem homogenization procedures have been developed for detecting and adjusting inhomogeneities. Several methods exist. COST Action ES0601 HOME made a comparison of the methods most commonly used applying benchmark datasets with known synthetic inhomogeneities.

The climate services at the Nordic NMHSs have a long profound tradition in cooperation on activities having common interest at all institutes. One of the more successful activities within this collaboration was the NACD[1]-project carried out in the 1990'ies. The outcome of this project was the NACD data set (1890-) that was continued as the Nordic Climate Dataset (NkDS). This dataset consists of high quality long term climate series. In NACD the series for important climate elements were tested for homogeneity and in many cases adjusted for detected inhomogeneities. All Nordic institutes applied the same method for this analysis, namely the SNHT method developed at SMHI by Hans Alexandersson.

Since the mid-1990'ies there have been little systematic homogenization effort at the Nordic Meteorological Institutes. As a result of the abovementioned COST Action this important activity has been highlighted and there are concrete plans to establish new homogenization procedures at least at FMI, met.no and SMHI.

At an expert meeting held at met.no 3. - 4. December 2012 national plans and a possible Nordic collaboration applying common tools and procedures were discussed. The conclusion was that the national activities would profit from a Nordic cooperation. The next paragraphs presents possible activities where collaboration will be a support to the national activities and where exchange of data and knowledge will improve the quality of Nordic long term climate series. The focus is on synergetic activities where significant results should be obtained within a time frame of two years.

WP 1) Reference climate data sets

[1] NACD. North Atlantic Climate Dataset; Frich, P. (Co-ordinator), H. Alexandersson, J. Ashcroft, B. Dahlström, G. Demarée, A. Drebs, A. van Engelen, E.J. Førland, I. Hanssen-Bauer, R. Heino, T. Jónsson, K. Jonasson, L. Keegan, Ø. Nordli, T. Schmith, P. Steffensen, H. Tuomenvirta, and O.E. Tveito, 1996: North Atlantic Climatological Dataset (NACD Version 1) - Final Report. Danish Meteorological Institute, Scientific Report, 96-1, 47 pp. (*www.dmi.dk/dmi/sr96-1.pdf)*

A reference data set consisting of homogenous data series is the basis for all homogeneity testing. Establishing a common Nordic reference data set will increase the robustness of the national homogeneity analyses, particularly in the border regions and areas with sparse data coverage. The reference data set will be merged from the national reference data sets.

NkDS (1890-) is an outstanding high quality climate data set widely applied among climate researchers. It is however not updated since around 2000. We suggest to re-establish NkDS based on the previous NACD/NkDS datasets and the activities described in WP 1.

Deliverable D1.1 Investigate possibilities to "re-launch" NkDS

Internal checking at SMHI (Responsible: SMHI/Deliverable ready: **Q2-2013**)

The current version 1.0 of NkDS dataset is still available at http://www.smhi.se/hfa_coord/nordklim/. This dataset cover the period 1890-2001. As a first stage the current version is relaunched with updating the temperature and precipitation series until 2012. The NkDS is currently consisting of quality controlled data, but not necessarily homogenous series.

Some functionality on the website just needs to be improved. By the end of 2014 we can also update the website with available updated homogenized series.

Deliverable D1.1.2 Opening the first version of the new webpage (Q1-2014, SMHI)

Deliverable D1.2 NORDHOM wiki-site established (met.no / Q2-2013)

Deliverable D1.3 Datasets of monthly temperature and precipitation for homogeneity testing from Finland, Norway and Sweden uploaded on wiki-site **(All/Q3-2013)**

Deliverable D1.5 Agreement on formats for metadata. Uploading of metadata at wiki-site

(FMI **/Q2-2014)**

Deliverable D1.6 Nordic dataset of homogenized monthly series of at least 50 years made available at the wiki-site (internal) and on the NkDS-web-site (external). **(Coordination with ECA&D?) (all/Q4-2014)**

Deliverable D1.7 Re-launch of NkDS consisting of homogenous and/or homogenized climate data series and metadata covering the period 1890-present time **(SMHI/Q4-2014)**

WP2) Common methods for homogeneity testing and adjustment for inhomogenieties.

One of the outcomes of the COST HOME Action was open source software (in R) for homogeneity analysis. We suggest applying this software as a common (reference) method within the Nordic countries in practice and agreeing general principles of using metadata information. This will ensure consistent analysis within the Nordic NMHSs and also be in line with ongoing homogenization work elsewhere in Europe.

The national services will be responsible for analysis of their own climate records. In the border regions cooperation is needed to secure consistent analysis. Establishing common rules and specifications for identifying homogeneity breaks and calculating adjustments will be necessary.

A particularly important aspect of homogeneity analysis is documentation of the reasons for homogeneity breaks in the time series. Corrections and adjustments of the time series should be supported by metadata describing changes at the station. Within the NACD a specific data format for such metadata was defined, but never fully implemented. For

automatic homogenization control and adjustment this needs to be implemented within the homogeneity test software. We suggest to implement metadata in the test algorithms based on the specifications of NACD.

Deliverable D2.1 Joint methodology for homogeneity testing

Choice of method, installation, software etc. available at wiki-page. **(met.no**/ **Q3-2014**)

Comment SMHI: This point needs some clarification. We think we already have agreed upon using HOME-R as method and software and the installation of the software should be completed Q1-2013. To make a link to the software on the wiki-page should not take much time either. But then to agree, learn and document how we in an identical/similar way work with breaks and metadata could demand the time until Q3-2014.

Deliverable D2.2 Development of toolbox for operative homogeneity testing. Available at wiki-site (xx/Q3-2014)

Q (SMHI): Does this mean to write instructions/manuals describing how we should work, or are there plans on

writing/producing new software/scripts for homogenization?

Deliverable D2.3 Specification of criteria for homogeneity testing (with/without metadata) available at wiki-site (xx/Q4-2014)

Q (SMHI): Is this about how to handle breaks as we wrote about concerning D2.1?

Deliverable D2.4 Strategy for homogeneity adjustment of daily values

(xx/Q4-2014)

WP 3) Works shops, training seminars and dissemination.

Common understanding of the algorithms and software used for homogeneity analysis need proper training. Within NORDHOM training seminars and workshops for exchanging experiences and results will be organized. These might be co-organized with the European homogenization community.

In the first phase training on HomeR, the benchmark data provided by COST Action ES0601 HOME will be applied.

For exchange of data, documentation, algorithms etc. a project wiki-site should be set up allowing all participants to upload and share information (Deliverable D1.2). Parts of this wiki-site could be made public. The idea of disseminating information via the wiki-platform is to apply a low-threshold publication platform stimulating information exchange.

Deliverable D3.1: **Upload of documentation etc. on wiki-**site (Continuously) **(xx/Q4-2014)**

Deliverable D3.2: Uploading of NORDHOM-information, metadata, homogenized series, etc. on external NkDS-web-site (Continuously) **(xx/Q4-2014)**

Deliverable D3.3: Nordic workshops and training seminars (xx/Q4-2014).

Survey of timetable and deliverables

	2013	2014						
Activities	1	2	3	4	1	2	3	4
D1.1 Continue NkDS?	**X**							
D1.2 Wiki-page	**X**							
D1.3 Benchmark dataset	**X**							
D1.4 Monthly series on wiki-site	x	x	x	**X**				
D1.5 Metadata		x	x	x	x	**X**		
D1.6 Monthly hom. series at NkDS			x	x	x	x	**X**	
D1.7 Re-launch NkDS 1890-present								**X**
D2.1 Joint methodology for hom.test	x	x	x	x	x	x	**X**	
D2.2 Toolbox	x	x	x	x	x	x	**X**	
D2.3 Criteria						x	x	**X**
D2.4 Daily values						x	x	**X**
D3.1 Documentation on wiki-site	x	x	x	x	x	x	x	x
D3.2 Info on NkDS-web-site		x	x	x	x	x	x	x
D3.3 Workshop / training seminars		x			x			x

Results

Homogenization of time series from Portugal and its former colonies

Authors: Bliznak, V., Valente, M.A., Bethke, J.

Institute: Instituto Dom Luiz, University of Lisbon, Lisboa, Portugal

Country: Portugal

The contribution will present different approaches of homogenization techniques applied to the long-term monthly series of various meteorological variables (e.g. air temperature, precipitation, pressure, etc.) from Portugal, its autonomous regions (Madeira, Azores) and former colonies (Guinea-Bissau, Mozambique, Angola, Macao, Cape Verde, São Tomé and Nova Goa - India). The work is motivated by the ERA-CLIM project activities aiming at the improvement of the available observational record for the early 20th century.

Due to the sparse network of the weather stations with long time series in Portugal and its former territories, absolute and relative homogeneity tests will be employed. Overall, for mainland Portugal, long time (centennial) series from Lisbon, Porto and Coimbra stations are the only ones available. For certain variables (i.e., precipitation) Beja and Guarda'stations can also be used. For the 1915-1946 period, using monthly data, the density of the weather stations in Africa is generally satisfactory. However, taking advantage of the probabilistic approach to the homogeneity test performance, absolute and relative techniques will be applied in other weather stations as well. The main goals of the contribution can be summarized as follows: (i) to apply different homogenization software packages on the time series, (ii) to assess the suitability of various types of statistical tests on the local data and to compare the results with metadata (if possible) and (iii) to provide a list of non-climatic shifts to support a new global atmospheric reanalysis within the ERA-CLIM project.

Homogenization in areas of high climatic variability and low station density

Authors: Stefanie Gubler [1], Clara Oria [2], Michael Begert [1], Gabriela Rosas [2], Mario Rohrer [3], Mischa Croci-Maspoli [1], Thomas Konzelmann [1]

Institute:

[1] Swiss Federal Office of Meteorology and Climatology MeteoSwiss, Zurich, Switzerland

[2] Meteorological and Hydrological Service of Peru (SENAMHI), Lima, Peru

[3] Meteodat GmbH, Zurich, Technoparkstrasse 1, Switzerland

Country: Switzerland

Reliable climate information forms the basis to plan mitigation and adaptation strategies to climate change. Adaptation strategies are particularly important in highly vulnerable regions such as mountain areas and developing countries. To obtain reliable climate information from observed climate data, homogenization of the meteorological time series is crucial to distinguish between artificial (e.g., station relocation, change of observers, change of the device) and climate signals.

The project CLIMANDES (module 2) is a joint project between the Meteorological and Hydrological Service of Peru (SENAMHI) and the Swiss Federal Office of Meteorology and Climatology MeteoSwiss with support from Meteodat GmbH. It aims to establish sustainable climate services by extending and implementing the entire data quality process at SENAMHI and by producing reliable climate information in two Andean regions in Peru, Cuzco and Junín. Before climate data can be used to produce climate information, it must be homogenized to avoid artificial signals in the series. Different challenges complicate the detection of breaks in the data record at Peruvian stations, such as the low station density in the complex terrain in the Andes (sparse availability of long-term time series), the numerous data gaps (sometimes more than a year of missing data), and the lack or sparse availability of metadata that is used to corroborate the breaks detected by statistical methods. The mainly convective precipitation regime in Peru and the high spatial gradients typically encountered in mountain regions pose additional challenges to correlation-based break detection.

Here, we focus on testing different homogenization methods (e.g., rsnht, MASH, HOMER) on at least three stations in the Peruvian und the Swiss mountains at monthly resolution. To simulate Peruvian conditions, the Swiss station network is artificially thinned-out to lower the inter-correlation between the stations, and artificial large data gaps are introduced in the time series. In this setting, the Swiss stations serve as benchmark to identify the most suitable homogenization method, as dates and size of inhomogeneities are known. In addition to the reliability of the break detection and correction, the method should be easy to implement and apply.

We present the results and challenges that were faced in the benchmarking procedure, and show possible breaks detected at the Peruvian stations. We discuss the problem of missing metadata, and provide ideas to improve the collection and systematization of metadata in developing countries.

Importance of homogenized data series for a climate change adaptation project

Authors: Mario Rohrer[1], Delia Acuña[2], Amelia Diaz[2], Stefanie Gubler[3], Christian Huggel[4], Gabriela Rosas[2],Thomas Konzelmann[3], Nadine Salzmann[4,5], Manfred Schwarb[1]

Institute:

[1] Meteodat GmbH, Zurich, Technoparkstrasse 1, Switzerland.

[2] SENAMHI: Meteorological and Hydrological Service of Peru, Lima, Peru

[3] Swiss Federal Office of Meteorology and Climatology (MeteoSwiss)

[4] University of Zurich, Zurich

[5] University of Fribourg, Fribourg

Country: Switzerland

The Swiss Agency for Development and Cooperation (SDC) project "Proyecto de Adaptación al Cambio Climático en el Perú" (PACC) addresses possible measures for adaptation to climate change in the perspective of water resources, disasters and food security in the Peruvian Andes regions of Cusco and Apurímac.

Adaptation measures offer advantages and chances, but also bear the risk of disadvantages for the population and ecosystems. So e.g. disproportionate water harvesting measures, as over-dimensioned river-dams, may result in excessive evaporation, upstream-downstream – and other problems. That is the reason it is advocated here, that adapting to adverse impacts of climatic change should not only be based on experiences and perceptions of the local people only, but also on objective information about the past and future climate. This requires homogeneous data series on local scales as a baseline for the actual trends and as a verification of (regional) climate models.

But, in mountain regions, where impacts are expected to be particularly high and adaptive capacity of the people is often low, reliable long-term climate time series are rare and spatial and temporal data coverage is typically low. Therefore, adequate tools and methods are needed to generate a reliable data baseline for climate change adaptation.

We present a possible solution by implementing a project data portal including several data series of different sources to assess data quality and homogeneity. Instead of using a single long-term record as a reference station, clusters of available station series were used which then served as a substitute for one single, "reference" station. The homogeneity of the station cluster can be checked using the data portal by forming station couples and applying several statistical tests. Based on this information, homogenized time series of important variables as air temperature and precipitation can be calculated.

These data series serve as an input for hydrological, glaciological, agronomical and integrated ecosystem models. As the use of flawed and/or inhomogeneous meteorological data as input for such models can lead to wrong decisions concerning the implementation of adaptation measures, high-quality climatological series are a prerequisite for adaptation to climate change.

Parallel measurements to study inhomogeneities in daily data

Authors: Victor Venema [(1)], Enric Aguilar [(2)], Renate Auchmann [(3)], Ingeborg Auer [(4)], Theo Brandsma [(5)], Barbara Chimani [(4)], Alba Gilabert [(2)], Olivier Mestre [(6)], Andrea Toreti [(7)], and Gregor Vertacnik [(8)]

Institute:

[(1)] University of Bonn, Meteorological Institute, Bonn, Germany,

[(2)] University Rovira i Virgili, Center for Climate Change, C3, Tarragona/Tortosa, Spain,

[(3)] University of Bern, Institute of Geography, Bern, Switzerland,

[(4)] Zentralanstalt für Meteorologie und Geodynamik, Austria,

[(5)] Royal Netherlands Meteorological Institute, The Netherlands,

[(6)] Météo-France, Direction de la Production, Toulouse, France,

[(7)] Justus-Liebig Universitaet, Giessen, Germany,

[(8)] Slovenian Environment Agency, Ljubljana, Slovenia.

Country: Germany

Daily datasets have become a focus of climate research because they are essential for studying the variability and extremes in weather and climate. However, long observational climate records are usually affected by changes due to nonclimatic factors, resulting in inhomogeneities in the time series.Looking at the known physical causes of these inhomogeneities, one may expect that the tails of the distribution are especially affected. Fortunately, the number of national and regional homogenized daily temperature datasets is increasing. However, inhomogeneities affecting the tails of the distribution are often not taken into account.

In this literature review we investigate the physical causes of inhomogeneities and how they affect the distribution with respect to its mean and its tails. We review what is known about changes in the distribution from existing historical parallel measurements. We discuss the state of the art in the homogenization methods for the temperature distribution. Finally, we provide an overview of the quality of available daily datasets that are often used for studies on changes in extremes and additionally describe well-homogenized regional datasets.

As expected, this review shows that the tails of the distribution are more affected by changes in monitoring practices than the means. Many often-used daily datasets are not homogenized (with respect to the distribution). Given the strong interest in studying changes in weather variability and extremes and the existence of often large inhomogeneities in the raw data, the homogenization of daily data and the development of better methods should have a high research priority. This research would be much facilitated by a global reference database with parallel measurements.

The climate community, and especially those involved in homogenization, bias correction and the evaluation of uncertainties, should take an active role to foster the compilation of such a reference database. We have started an initiative collecting parallel datasets. Its aims will be explained and its progress will be presented.

Detection of inhomogeneities in daily data: a test based in the Kolmogorov-Smirnov goodness-of-fit test

Authors: Robert Monjo, Javier Pórtoles, and Jaime Ribalaygua

Institute: Climate Research Foundation (FIC, Fundación para la Investigación del Clima), Madrid

Country: Spain

At present, more and more climatological works use daily data to analyze climate extremes and the typical daily variability (cold/ heat waves, dry/ wet spells ...).

Therefore, an analysis of the quality of the data is required to filter the series. However, there are difficulties in assessing the inhomogeneities present at a daily scale. Generally, the daily data are aggregated at a monthly scale and then it is applied a homogeneity test (like the SNHT by Alexandersson).

In this work we propose a method for detecting inhomogeneities at a daily scale by using the non-parametric test of Kolmogorov-Smirnov (KS). The method consists of two steps: First, potential candidates of inhomogeneity are detected by analyzing the p-value of the N mutual days between two consecutive years. The candidate years are chosen from a p-value equal or less than the one obtained from an artificially introduced inhomogeneity. Second, we analyze the similarity of the data sets that are cut by the candidates. In this way we distinguish between isolated odd years (possible outliers) and inhomogeneous time segments.

Some advantages of this method are that it does not only detect the changes in the mean but it is also capable of detecting changes in the daily deviation and even other changes in the form of the probability distribution.

Homogenization of daily Chinese surface air temperatures: From CHHT 1.0 to its updated version

Author: Qingxiang Li

Institute: National Meteorological Information Center, China Meteorological Administration, Beijing 100081

Country: China

One of the primary goals of Chinese Homogenized Historical temperature (CHHT) version 1.0, released in December 2006, was to build a set of homogenized observational climatic datasets. The CHHT1.0 Dataset (1951-2004) consists of monthly and daily surface observations from all national stations in mainland China. CHHT 1.0 includes mean, maximum, and minimum temperature data; assessments of data quality; and gridded versions of the three temperature variables. In the recent updating version, we homogenizes time series of daily maximum and minimum temperatures recorded at 825 stations in China over the period from 1951 to 2010, using both metadata and the penalized maximum t test with the first order autocorrelation being accounted for to detect changepoints, and using the quantile-matching algorithm to adjust the data time series to diminish non-climatic changes. Station relocation was found to be the main cause for non-climatic changes, followed by station automation.

Applying homogeneous climate time series for gridding, does it make a difference?

Authors: Ole Einar Tveito, Helga Therese Tilley Tajet and Lars Andresen

Institute: Norwegian Meteorological Institute

Country: Norway

The development of spatial interpolation algorithms for gridding data sets is a nice opportunity to provide regionally averaged climate information or information at locations without observations. MET Norway developed a gridded dataset of monthly precipitation sum and mean monthly temperatures extending back to 1901. This dataset is extensively used for various climate related applications and statistics. The gridded datasets are established by interpolating the monthly anomalies from the standard normal monthly mean values 1961-1990.

As a result of the COST HOME Action (ES 0601) a large number of Norwegian temperature series are homogeneity tested and adjusted for identified inhomogeneities. These homogenous series are used as basis when calculating new temperature normal values for the period 1981-2010. For that purpose a dataset of complete monthly temperatures for 187 stations covering the period 1961-2010 has been established. Series having gaps within this period has been completed by a multiple linear regression applying the three highest correlated series as independent series. The analysis is carried out on a monthly basis.

A validation of the linear regression estimates the series also are interpolated applying the same residual kriging technique applied for making the daily temperature grids provided by MET Norway. The interpolation is for this purpose carried out at station level applying a classical leave-one-out cross-validation technique. Both homogenized series as well as series not adjusted for inhomogeneities are applied in order to reveal differences between homogenized and non-homogenized data. Comparisons are done at point scale and at regional scale. Regional averages are calculated for domains with expanding size in order to reveal if the spatial scale plays a role in the influence of homogenization.

The influence of station density on the quality of gridded climate data

Author: Ole Einar Tveito

Institute: Norwegian Meteorological Institute

Country: Norway

Users of gridded data are increasingly demanding frequent updated and almost real time gridded data of weather and climate data. One of the more important applications of such data in Norway is the natural hazard forecasting system for floods, landslides and snow avalanches. MET Norway is currently producing daily gridded precipitation data with a spatial resolution of 1 x 1 km. The dataset is updated on a daily basis.

In gridding is the availability of observations often a challenge. Climatological monitoring networks are commonly designed for describing climatological features in terms of long term variability. For precipitation the gross number of stations is observing daily precipitation sums only. However gives automation of the weather observation network better access to real time observations. This increased data basis should potentially give a possibility to provide more frequently updated gridded data.

We have therefore investigated the dependence between station density and the accuracy of gridded precipitation. The analysis is carried out on daily precipitation from the full station network (around 480 stations). Daily precipitation is interpolated to observation station locations by leaving-one-out cross-validation approach. The accuracy of the spatial interpolation depending on station density is assessed by gradually thinning out the observation input. In each iteration ten percent of the stations are removed, and the procedure is repeated until only 10% of the original input stations remains. Which stations to remove in each step is decided by a random procedure. In order to keep temporal consistency the random selection is kept static throughout the analyzed period.

The gridding accuracy of both the determination of precipitation occurrence and the amounts of precipitation is assessed. Several skill scores are applied both on station and regional level. Preliminary results indicate that the uncertainty of the grid estimates does not change significantly before the station coverage is reduced to about 50%.

Model Based Quality Control of Surface Data

Authors: Christian Sigg, Claudine Hotz and Thomas Konzelmann

Institute: Swiss Federal Office of Meteorology and Climatology (MeteoSwiss)

Country: Switzerland

The increasing number of available measurements demands an automated quality control (QC) system to guarantee the integrity, timeliness and cost effectiveness of the acquired data. In accordance with WMO recommendations, MeteoSwiss runs a multitude of rule based tests to identify implausible measurements, e.g. limit tests which flag values that exceed magnitude or variability bounds.

A quantitative analysis of the past performance of our QC system has shown that the true positive to false positive ratio is favorable for “simple” rules such as limit tests. However, the ratio is unsatisfactory for rules which try to identify more complex problems, e.g. an inconsistency between measurements of different instruments. The reason for the unsatisfactory performance is the difficulty of capturing the inherent complexity of meteorological phenomena in a small number of hand designed rules. As a consequence, the high number of false positives generated by such rules entails a substantial manual effort to remove erroneous QC flags.

MeteoSwiss therefore has initiated a project to complement the existing rule based QC with a model based QC that is statistical in nature. There are two key differences between theseapproaches. While rules are designed by experts to detect particular failures in the measurement process (e.g. a flatline in a temperature curve), a single statistical model can infer the regular behavior of meteorological variables from training data. Therefore, the model can identify various kinds of failures as deviations from regularity. Second, while the flags generated by a rule based system are discrete (a rule is either violated or not violated), a statistical model generates a continuous measure of plausibility in the form of quantiles of the probability distribution of measurements.

We give a concise overview how one-class classifiers infer powerful models from a limited amount of training data, and present examples from several measurement domains how these models successfully identify outliers. We also discuss the challenges of deploying a model based QC system for operational use at MeteoSwiss, from issues of computational complexity to reproducibility of the generated plausibility information.

Data Digitalization and Quality Control in Orographic Complex Terrain - Transregional Project 3PClim

Authors: Anita Jurković[(1)], Silke Adler[(1)], Susanne Drechsel[(2)], Hermine Fürst[(1)], Hermann Galavics[(1)], Gerald Lang[(1)], Wolfgang Lipa[(1)], Alexander Mandl[(1)], Phillip Tartarotti[(3)], Daniela Teuschler[(1)], Johannes Vergeiner[(2)], Ilona Vossberg[(1)]

Institute:

[(1)] ZAMG-Central Institute for Meteorology and Geodynamics, Vienna, Austria

[(2)] ZAMG-Central Institute for Meteorology and Geodynamics, Innsbruck, Austria

[(3)] Hydrographic Office of the Autonomous Province of Bolzano

Country: Austria

In the framework of the INTERREG Project 3PClim [www.3pclim.eu] the ZAMG, the Hydrographic Office of the Autonomous Province of Bolzano and the Regional Agency for environmental Prevention and Protection of Veneto (ARPAV) started a cooperation with main focus on analyzing the past, present and perspective climate. One of the aims of this transregional project was and still is to summarize the current knowledge about the climatic trends for the coming decades for an orographic complex area of North Tyrol, South Tyrol and Veneto and implement additional information of surrounding areas.

For all projects that are relevant for environment and climate, checked and -if existent- long term datasets are a basis for climatological analysis and modeling. Due to this fact the task of work package (WP) 2 and 3 was the data-acquisition, -digitalization, -correction and in last instance the data-homogenization of meteorological parameters, mainly available in daily resolution.

To supply the data in an outstandingly good and uniform quality, the collected and partly new digitalized datasets were tested within a Multi-stage-quality-control process that was subdivided in 5 steps:

- PRE-checks - during collecting /transforming/ importing data
- Completeness checks
- Plausibility-inner consistency checks
- Spatial consistency checks
- Supplementary checks [POST-checks]

For the POST checks a number of supplementary software applications (e.g.: testing tool snow or global radiation), mainly developed in-house were performed. By the implementation of these modules and routines – based on spatial and statistical test algorithms - many outliers and errors could be detected, flagged and in a final step automatically or manually corrected.

So in general this presentation shows the importance of recovering historical data to generate long term time series, gives an overview of the actual methods and criteria that were used during the procedures of quality control and demonstrates main aspects and the importance of data quality control procedures.

Quality Control of wind observations database for North Eastern North America

Authors: Etor E. Lucio-Eceiza [(1)], J. Fidel González-Rouco [(1)], Jorge Navarro [(2)], Ángela Hidalgo [(3)], Pedro A. Jiménez [(1,2)], Elena García-Bustamante [(4)], Nuria Casabella [(2)], Jorge Conte [(3)] and Hugo Beltrami [(5)]

Institute:

(1) Universidad Complutense de Madrid, Astrofísica y Ciencias de la Atmósfera, Spain

(2) Dpto. Energías Renovables. CIEMAT. Madrid, Spain

(3) GLOBAL Forecasters, S.L., Madrid, Spain

(4) Universidad de Murcia, Departamento de CC. Físicas, Murcia, Spain

(5) Climate & Atmospheric Sciences Institute, St. Francis Xavier University, Antigonish, Nova Scotia, Canada.

Country: Spain

Over the last decades, a policy change in energy sources has been fostered in Atlantic Canada. The object of this has been, on one hand, to reduce the dependency on energy produced abroad and on the other hand, to propose feasible alternatives with the aim of reducing greenhouse gas emissions. The region offers a high potential for the development of wind energy facilities and studies within the framework of wind resource assessment are encouraged. Studies of this nature rely on the quality of observational data. Henceforth, it is essential to develop procedures that ensure the reliability of observations before they are subjected to any subsequent analysis.

This work summarizes the Quality Control (QC) process applied to an observational database of surface wind module and direction in North Eastern North America. The data set consists of 525 stations compiled from three different sources: 344 land sites from Environment Canada (EC; 1940-2009) located in the provinces of Atlantic Canada and Quebec; 40 buoys distributed over the East Coast and the Canadian Great Lakes provided by Fisheries and Oceans Canada (FOC; 1988-2008); and 141 land sites over both Eastern Canada and North Eastern USA provided by the National Center of Atmospheric Research (NCAR; 1975-2010). The combined time-span of the records lasts close to 70 years with varying time resolutions of hourly, 3 hourly and 6 hourly data, and uneven measurement units, time references and heights.

Once the data were compiled, a set of QC techniques were applied to explore the detection and potential suppression of errors within measurements. The QC process is structured into 5 phases that deal with the detection of specific problems in data quality: 1) unification of measurement units and recording times; 2) duplication errors; 3) physical consistency in the ranges of recorded values; 4) time consistency, regarding abnormally high/low variability in the time series; and 5) detection of long term biases in mean and/or variance. Most of the checks are common to both wind module and direction, although some of them specifically address only one of the variables.

The quality controlled dataset will be subjected to statistical and dynamical downscaling studies. The statistical approach allows for an understanding of the wind field variability related to changes in the large scale atmospheric circulation as well as their dependence on local/regional features The dynamical downscaling, from the other hand, allows for process understanding assessments by performing high spatial resolution simulations with the WRF model. The temporal extension and resolution of this database brings the opportunity to

analyze the wind variability at different temporal scales, from daily to multidecadal. Likewise, the area covered by this database permits the analysis of a series of phenomena such as land-sea interactions, channeling effects and wind behavior over ice/snow coverage, among others. A model validation will also be targeted through the comparison with observations.

Management and quality control of precipitation data with high time resolution from a tipping bucket network

Authors: Karianne Ødemark, Alexander Bürger, Ole Einar Tveito

Institute: Norwegian Meteorological Institute

Country: Norway

The need for precipitation data with short temporal resolution are more and more important for a range of different users, like the road administration, railway administration and municipalities. MET Norway have a limited number of gauges that meets the need for such a high time resolution, thus they are not often in the place of need for a user.

Many users therefore establish a net of precipitation gauges, often tipping buckets, within their municipality or by a place of interest. MET Norway often helps with finding suitable locations, and can advise on equipment. Data from these local networks of a few gauges can offer useful information for other users as well; therefor have MET Norway taken the role as a coordinator of such data by collecting data from all available gauges, performing quality control, providing IDF statistics and redistributing the data through MET Norway's open data access portals. In that way, e.g. a municipality will get hold of precipitation data in a much larger extent than if all parties had kept the data in their own local systems.

This coordinating role have substantially increased the number of tipping buckets in MET Norway's observation system, promoting the need for a modernized quality control and data management system. Now a new system to detect errors has been implemented. The system consists of several checks running every hour. By detecting a suspicious value, the system flags the value according to which of the checks that was triggered. In the next step, the human quality control takes action thereafter.

In this way, MET Norway can provide short term precipitation data with good quality back to the community. In addition, with access to a denser network of precipitation data, MET Norway will in turn be able to strengthen our precipitation based products.

The design of the quality control checks will be presented, as well as a summary of MET Norway's experience with the system after the implementation. In addition the experience as a coordinating part for precipitation data will be addressed.

Real time quality control of raingauge observations for a radar/raingauge merging scheme

Author: Martyn Sunter

Institute: Observations Quality Manager, Met Office, Saughton House, Edinburgh, EH11 3XQ, UK

Country: United Kingdom

Good quality observations of rainfall accumulation are a vital source of information in providing weather and flood forecasting services. Raingauge observations collected in real time are known to suffer from various sources of error which, if left uncorrected, would have an impact on the quality of downstream systems. The aim of this paper is to describe the development of an automated quality control system for raingauge observations which would enable the creation of an improved assessment of rainfall accumulations in real time through a merged raingauge/radar product. The requirement was for a system that would provide quality control at a resolution of 15 minutes with the output being suitable for real time applications.

This paper will provide an overview of the sources of error in rainfall measurements from raingauges and describe techniques that have been developed during the project for the quality control of raingauge data in real time.

The starting point was the creation of a rainfall dataset to enable testing of the quality control procedures. This comprised raw raingauge observations using tip-time data from the Environment Agency (for England and Wales), 1 minute rainfall accumulations from the Met Office and data from the Scottish Environment Protection Agency (SEPA) to give more than 1000 gauges in total. A dataset of the 15 minute radar accumulations at the corresponding gauge locations was also created. The system also used 1 minute data from Met Office observing sites reporting present weather, air temperature, 10cm soil temperature and snow depth to aid the quality control process.

The raw tip-time and 1 minute rainfall data were stored in a sub-hourly rainfall table in the Met Office climate database (test version), along with any “suspect” flags placed on the data at source. These were then used to create 1 minute, 15 minute and 60 minute datasets and a procedure was run to remove double tips from the raw data. These datasets are then used in conjunction with near-neighbour data and the additional observed parameters to apply the following quality control:

- Basic range checks on the 1 minute, 15 minute and 60 minute data.
- Range checks using station climatology records on a rolling 24 hour period of data.
- Spatial checks, comparing gauge data with neighbouring sites.
- Partial raingauge blockage check which analyses the pattern of tip times.
- A check for high, isolated 1 minute accumulations.
- Flags to indicate the likelihood of gauges being affected by snow or freezing conditions

All these checks set separate flags on the data to indicate any observations which are suspect, or potentially suspect. The flags and data are then all combined into a final 15 minute dataset which will be used in the final radar/raingauge merged product.

Integration and Data Quality Control of National Meteorological Data from Foreign - not WMO accordant - Surface-Station-Networks: A Feasibility Study

Authors: Wolfgang Lipa, Martin Auer, Anita Jurkovic, Hermine Fürst, Susanne Zach-Hermann

Institute: Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Wien, Österreich

Country: Austria

In the framework of collecting national meteorological data from different station network-owners outside our well-known partner-organizations like the federal hydrological services, the Austrian military weather service, the Austrian aviation weather service and other meteorological institutes – which are completely integrated in our own station network - a ZAMG internal project called “FOREIGN DATA” was launched in 2012.

Aim of the project FOREIGN DATA was to perform a feasibility study, which implied the search for new partners that provide meteorological data in Austria and determine the data volume and resolution resp. in time and quality. At the end of the project a rough estimation of the costs for interfaces and data for each new network and the gain for the ZAMG to use these additional datasets should be presented.

The presentation will give a first overview of the outcome, like the listing of

- private weather services
  - Blue Sky
  - Ubimet
  - MOVI
- Governmental and “Private governmental” organizations
  - Austrian railway company (ÖBB)
  - Austrian highway administration company (ASFINAG)
  - Environmental services of the Province/federal states of Austria (HZB,HD)
  - Water power companies like TIWAG, SAF
  - Warning services for avalanches
  - Bundesforschungzentrum für Wald (BFW)
- Universities
  - Wegener Net
  - University of Natural Resources and Life Sciences, Vienna (BOKU)
  - Department of Meteorology and Geophysics Vienna (IMGW)
  - Institute of Meteorology and Geophysics Innsbruck (IMGI)
- Private user groups like Skywarn
- windparks (about 113 in Austria)
- web cams

At the kick off meeting in summer 2012 - where first results of the project FOREIGN DATA and some data quality control (DCQ) routines, used at our institute, were presented - the Vienna Environmental Communal Service (MA22) showed a very high interest to collaborate with ZAMG. At present our institute operates the DCQ for all meteorological data from MA22.

The effort of implementing foreign datasets of not WMO conformal stations was and still resp. is very high. One of the main tasks was the reorganization and adaption of the old DQC system. Nevertheless at least it was worth the effort: Our station network has a higher

station density (more data in urban area) and can use the data for scientific and commercial activities.

Monitoring of Climate Change in Germany - An overview of ongoing activities at DWD

Authors: F. Kaspar, T. Deutschländer, A. Kaiser-Weiss, J. Keller, H. Mächel, E. Penda, K. Zimmermann

Institute: Deutscher Wetterdienst, Frankfurter Str. 135, 63067 Offenbach, Germany

Country: Germany

Germany's national meteorological service (Deutscher Wetterdienst, DWD) is the responsible authority for monitoring climate change in Germany. To fulfill this task it operates the National Climate Data Centre ("Nationales KlimaDatenZentrum, NKDZ"). The historical and current instrumental measurements and visual observations of DWD's station network are archived, quality-controlled and used to provide aggregated products, as for example daily and monthly means or climate normals. Phenological observations and radiosonde data are also part of the data base.

In recent years, additional historical data have been digitized to expand the data base.

Gridded data are generated and used to derive time series of national and regional averages. The products are used for informing the public, e.g. as an element of the German climate atlas (www.deutscher-klimaatlas.de). One major recent activity was the provision of information for the new climatological reference interval 1981-2010 and an updated climatological analysis based on the newly digitized data.

Such updates, as well as the digitization and the continuous quality-control of the historic data lead to modifications and an expansion of the data base. In order to allow users to provide a clear reference which version they used in their application, a concept to provide regularly updated versions of the data base is currently implemented.

A new approach for provision of consistent climatological information for Germany and Europe is currently tested within the Hans-Ertel-Center for Weather Research. DWD's NWP-model COSMO is used for a high-resolution regional model-based reanalysis.

On the accuracy of historical daily mean temperature calculations

Author: Hermann Mächel

Institute: Deutscher Wetterdienst, Offenbach, Germany

Country: Germany

Since the beginning of the temperature measurementsnot only the thermometer type and their placement but also the observational time and the procedure of daily mean temperature calculations has been changed. This may influence significantly the temperature frequency distribution, extreme value statistic and the long-term trends.

In this contribution the biases resulting from calculations of daily mean temperature (from sub-daily observations) using different existing formulas compared to the "true" 24-hour averages will be quantified. The correction factorsare estimated dependent on season and station elevation. To assess the errors the correction factors are calculated for a training period and applied to an independent test-period.

Special focus is set on the quantification of the differences between the calculated daily mean temperature from 24-hour averages and from maximum and minimum values. Many historical climate records from different countries contain more frequently maximum and minimum temperature measurements than sub-daily observations.

Computation of Spanish precipitation normals for 1981-2010

Authors: Roser Botey, José A. Guijarro, Alberto Jiménez and Antonio Mestre

Institute: State Meteorological Agency (AEMET), Spain

Country: Spain

Precipitation is a key climatic element both for climate characterization and monitoring because it affects a great number of environmental processes and human activities. Yet it is a problematic element, especially in semi-arid areas with a complex orography like Spain, due to its high variability in time and space. Many rain-gauges were deployed across our territory to account for this variability, but only a small proportion have yielded complete series during the period 1981-2010, thus making difficult the computation of normal values for those years.

This communication aims at describing the process followed to overcome these difficulties, that consisted in the following stages:

- Selection of all monthly precipitation series with a minimum of 15 years of observation in the period 1981-2010 from our climatological data-base (4350 series).
- Application of a quality control and missing data attribution process to the series, including detection of inhomogeneities.
- Removal of inhomogeneous or otherwise bad quality series from the selection, and correction of detected errors (when feasible) in the data-base.
- New acquisition of the series of the selected stations from the corrected data-base, increasing the data availability requirement from 50 to 60% in the study period 1981-2010 (2621 series).
- Completion of these series by a new missing data attribution process and computation of their monthly normals.

The quality control, data attribution and normal value computation were performed with the R package 'Climatol', and the resulting monthly normals are publicly available in an electronic publication that can be downloaded from:

http://www.aemet.es/documentos/es/conocermas/publicaciones/Valores_mensuales_1981_2010/Normales_mensuales_1981_2010.zip

Most of these monthly normals belong to stations from our cooperative network, and therefore cannot be used for climate monitoring in near real time. Automatic Weather Stations (AWS) are needed for this daily monitoring, but their normals were not computed in this work because their deployment is too recent to match the required amount of available data. Moreover, the frequent data gaps and generalized deficit of precipitation measurements assessed by comparison with manual rain-gauge observations pose new problems that need further investigation. (A pilot study computing normals for short lived AWS stations will be the object of a separate presentation).

Online Analytical Processing applied to meteorological and air quality data visualization and analysis

Authors: Ana Santurtún [(1)], Alejandro Villar [(1)], José Carlos González Hidalgo [(2,3)] & María T Zarrabeitia [(1)].

Institute:

[(1)] University of Cantabria, U. Legal Medicine, Santander, Spain

[(2)] University of Zaragoza, D. Geography

[(3)] IUCA, University of Zaragoza

Country: Spain

Meteorological and air quality data access and processing, especially when dealing with different data sources, can prove to be a difficult task, given the heterogeneity of variables, storage systems and even idiosyncrasies that come into play. In addition, data is usually offered solely as hourly, daily or even yearly dumps, preventing casual users from visualizing it, and very often only a subset of relatively current values are presented, forcing potential users (such as researchers) to issue formal petitions in order to obtain historical data. This also contradicts the emergent trend to adopt Open Data and Open Government philosophies, which revolve around making data collected by public administrations easily available to citizens.

Online Analytical Processing (OLAP) is a collection of methodologies and technologies conceived to aid in the task of analyzing and visualizing large data collections. OLAP leverages the different relationships existing between data sets and their diverse categorizations to offer a multidimensional approach to data analysis and consolidation. Initially created to help improve decision making in business environments (and thus a part of what is called Business Intelligence), it is being progressively introduced in other knowledge domains, such as statistics diffusion, and coupled with data Extraction, Transformation and Load (ETL) systems, which facilitate integration of data from heterogeneous sources, can provide a new range of solutions for the issues presented in the previous paragraph.

In this presentation we describe the implementation of a data visualization system formed by an OLAP engine (Pentaho Mondrian) and a OLAP data browsing library (JPivot) integrated in a custom-developed Web application that allows users to easily navigate through and aggregate either daily (for meteorological data) or hourly (for air quality data) data points previously loaded into a relational database by means of several ETL processes created using the Pentaho Data Integration suite. A collection of pre-compiled data arrangements, consisting of different types of calendars and time series with varying filters, categorizations and aggregation levels, can be selected by end users, either as a way to obtain a quick visualization of existing data or as a starting point from which to browse through all the different aggregation levels, and optionally exported to a range of file formats.

Meteorological data was obtained from the Spanish Agencia Estatal de Meteorología (AEMET), while air quality data was gathered from several sources throughout Spain, ranging from municipalities to government departments of autonomous communities (Consejerías), using a disparity of data formats.

From raw data to climate normals in a few simple steps

Author: José A. Guijarro

Institute: State Meteorological Agency (AEMET), Balearic Islands office, Spain

Country: Spain

Raw series from climate observational networks have a number of problems that make them unsuitable for most studies about climate and their variability: uneven space sampling, different length of observing periods, errors and inhomogeneities caused by a variety of causes (observation or transcription errors, relocations, changes in instrumentation or land use of the surroundings, etc).

In many cases climatologists try to avoid some of these problems by using only the best and longest series of a data-set, but in this way a good amount of potentially valuable climate information is disregarded. The alternative is to apply tedious and time consuming statistical procedures to correct those errors and inhomogeneities and to attribute reliable estimates to the missing data. This can be easily done with the R package *'Climatol'*, that implements a set of functions to facilitate the process, starting from the raw data and obtaining homogenized series and some statistical products derived from them (averages, percentiles, trends, etc).

After a brief presentation of its underlying basis, an application case is presented in which climate normals and percentiles are computed for the Automatic Weather Stations (AWS, some of them with only a few years of history) deployed in the Balearic Islands, in order to use their incoming daily data for climate monitoring purposes. A peculiarity of AWS series is their frequent missing data gaps, originated in sporadic periods of malfunctioning that, although lasting only a few hours in many cases, prevent the computation of some daily and monthly data. Therefore, the process consisted in the following steps, applied to precipitation and maximum and minimum temperatures:

- Missing data attribution at the daily scale for the more recent AWS operating period (2007-2012), and computation of monthly values when a minimum of 15 observed daily data were available.
- Homogenization of all available monthly data during the years 1951-2012.
- Computation of normal values and percentiles for the reference period 1981-2010.
- Implementation of a web page, updated daily, where AWS values for the current month can be compared to the historical series (whether observed or attributed).

After an explanation and discussion of these steps, examples of the web monitoring tool will be shown.

Climatic maps for risk assessment of cereal crops in Spain

Authors: Andrés CHAZARRA, Esperanza AVELLO, Roser BOTEY, Antonio MESTRE

Institute: Agencia Estatal de Meteorología

Country: Spain

The objective of this study is to describe the methodology used in the Spanish Meteorological Agency for obtaining gridded fields of some climatic variables which are useful in the risk analysis of cereal crops in Spain. Some examples are shown, including several climatic maps generated using GIS techniques for the analysis of brown rust (*Puccinia spp.*) infection risk and shrivelled grain risk in some extensive crops. These maps were produced in the frame of the Life Project SigAgroAsesor.

In the case of the brown rust study, the variable considered was the annual average of the sum of the daily mean temperatures between November 1 and March 31 for the last ten years (2003-2012). For every year, multivariate regression analysis was applied in relation to some topographic variables (altitude, latitude and distance to the coast), to which the residual component obtained by interpolation was added. The ten year average grid was finally calculated from every year grid.

Regarding the shrivelled grain study, the number of days between April 15 and June 30 with a maximum temperature above a threshold was chosen. The spatialisation method for this variable was the same to that of the brown rust case.

Finally, a validation process was made by taking apart a 25% of the data and repeating the process with the 75% remaining data. The mean absolute error, the root mean square error and the correlation coefficient were used to obtain a measure of the skill of the spatialisation methods.

GLOBCLIM: A Database for Global Climatologies based on Radio Occultation Data

Authors: Ulrich Foelsche, Barbara Scherllin-Pirscher, Marc Schwärz, Johannes Fritzer, and Gottfried Kirchengast

Institute: Wegener Center for Climate and Global Change (WEGC) and Institute for Geophysics, Astrophysics, and Meteorology, Institute of Physics (IGAM/IP), Univ. of Graz, Austria

Country: Austria

The GLOBCLIM website (www.globclim.org) is a data and information resource of the Wegener Center (WEGC) for global and large-scale climate monitoring with initial focus on the atmosphere as probed by the radio occultation (RO) technique. The WEGC RO profile retrieval, termed “Occultation Processing System” (current version: 5.6) starts with excess phase and orbit data from different processing centers. Currently we use data from UCAR (University Corporation for Atmospheric Research) in Boulder, CO, USA (COSMIC, GRACE, SAC-C, CHAMP, and GPS/MET), GFZ (German Research Centre for Geosciences) Potsdam, Germany (CHAMP, GRACE), and EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites) in Darmstadt, Germany (METOP-GRAS).

WEGC RO climatologies of atmospheric parameters from bending angle to temperature are obtained by “binning and averaging”, using the CLIPS (Climate Processing System) software tool. All RO profiles in a predefined geographic domain (“bin”) are sampled and averaged (weighted by the cosine of the latitude), using a common (mean-sea-level) altitude grid with regular 200 m spacing, the standard latitudinal resolution is 10°. Seasonal climatologies are obtained by averaging three monthly climatologies, annual climatologies by averaging twelve monthly mean climatologies within a calendar year. In addition we provide error estimates, like the systematic difference between retrieved profiles and collocated reference (ECMFW analyses), the standard deviation of the retrieved parameter, and the estimated sampling error, caused by undersampling of the “true” spatial and temporal evolution. RO climatologies and derived error estimates are provided (for free use) in netCDF format, quicklooks in pdf format. Single RO profiles in netCDF, which have been used to create the climatologies, come with additional information, like tropopause parameters.

FMI's experience of using narrow database tables for the surface observations

Author: Ari Aaltonen

Institute: Observations, Finnish Meteorological Institute

Country: Finland

In 2013, Finnish meteorological institute (FMI) has executed a radical change of its observation database structure. Several flat and wide relational database tables were replaced by one tall and narrow table structure. The former are tables with many columns and fewer rows, while the latter has few columns but many rows.

Some databases can use a plain index as data storage structure, instead of a separate index and a heap table. The Oracle database calls this concept Index Organized Tables (IOT). Whereas a table stored in a heap is unorganized, data in an IOT is stored and sorted by primary key. IOTs behave just like "regular" tables, and you use the same SQL to access them.

Motivation for the change was related to a number of problems with the old database. We had a large number of observation data tables, and each table was different. Hence input and output had to be programmed individually for each of them. Automation has brought new sensors and new measurands. Today we can e.g. have several temperature or visibility measurements from one station. Also data processing needs and produces a large number of new parameters such as quality flags. Adding new columns for all of them would have increased the already wide tables to extremely wide tables, complicating their use even more.

The change was executed in context of the release of Open Data for the public.

As a result of this change, we have automatically clustered the data based on the primary key, consisting of station ID, measurand ID and observation time. Thus the observations have been organized in chronological order by station and measurand. This results in the following main benefits 1) Less memory and IO. Only the data of used measurands is kept in cache memory, and only the wanted measurands are retrieved from disk. 2) Increased performance. Above changes alone result in increase of performance. In addition, the new structure leads to efficient retrieval of time series.

The change has given us increased performance due to pre-sorted data. Especially time series of a single measurand are quick to retrieve. The simple database inquiries take less coding and less code, which has enabled quick development for Open Data. Also the QC and input processes becomes more simple.

In my talk I will show benefits of IOT with practical examples of performance and illustrate how the table structure has been applied at FMI. Our application has been built upon ORACLE database but the solution is principally platform independent.

Climate Analysis Tools - An operational environment for climate products

Authors: Rebecca Hiller[1], Rebekka Posselt[1], Sophie Fukutome[1], Mark A. Liniger[1]

Institute: [1] Federal Office of Meteorology and Climatology MeteoSwiss

Country: Switzerland

MeteoSwiss established an internal framework to implement and operate the analysis of climate data in an operational context. It aims at coordinated development, automatic production, and easy maintenance of climate products that are internally available on an internal interactive product database, and partially also published on the public website of MeteoSwiss.

Climate researchers develop new methods and create new visualizations to monitor the current climate, analyze its past, or predict its future. These developments are integrated in the common framework of the Climate Analysis Tools (CATs). The CATs are organized as a collection of *R* packages with mandatory documentation. To ease maintenance, functions are structured in three separate categories of modules: (1) direct data retrieval from the MeteoSwiss data warehouse (DWH) or other sources, (2) statistical analysis, and (3) graphical, tabular or data output. Selected analyzed data are delivered to the DWH and available for further use. The final CATs are installed in an operational environment managed by the IT department. The production is fully automated by cron-jobs and monitored by IT professionals.

The wide palette of about 80,000 graphical and tabular climate products include various products for station data such as climate indicators (MeteoSwiss, 2013) and trend analyses (MeteoSwiss, 2009) as well as gridded products such as sunshine duration, temperature and precipitation fields (MeteoSwiss, 2012), and many more. Recent extreme weather events have shown that these automatically updated products provide a highly valuable input e.g. for warning and information services.

This contribution will present the strategy and structure underlying the CATs and will discuss the experience with this framework as a link between climate research, statistics, and operational production for a federal agency. Examples of products and use cases will be given.

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Climatic cadastral database of Georgian territory

Authors: Z. Tskvitinidze, M. Pkhakadze, L. Tskvitinidze, L. Megrelidze, N. Dekanozishvili

Institute: Hydrometeorological Observatory Georgia State Department of Hydrometeorology

Country: Georgia

The special importance obtains the identification of realistic picture of main climatic characterizations of heterogeneous territory of Georgia for the whole 100 year period and revealing the changing tendency for the last 15 year period.

Therefore it is urgent under Georgian conditions:

- The systematization of climatic cadastral data of Georgian territory and its separate regions and the assessment of climate factual change tendency on the base of regular meteorological monitoring data;

- On the bases of corresponding meteorological monitoring data, preparation of year-books electronic version of climatic cadastral data and obtaining of their hard copies by printed materials (Transactions of climatic cadastral data - for each years of discussed 1991-2005 period);

- Identification of local climatic peculiarities of Georgia as of the whole country also for separate regions, on its base the climate factual change tendency would be defined for discussed region in XX Century and for nearest 15 year period.

It have to be emphasized, that after the decomposition of the former USSR, many of soviet republics (among them Georgia), that obtained the status of independent republics, lost the possibility of obtaining the results of computer processing of initial (raw) data of regular meteorological monitoring conducting on the state territory in real terms (that was implemented by the leader organization, located in Obninsk, Russian Federation.). By the mentioned reason, the untreated data of meteorological monitoring of regular hydrometeorological net stations and posts during the last 15 year have been collected. The target processing of those data (among them -the certification of initial data obtained over observations and measurements and the ascertaining of the secure-climatic characterizations) is connected with the fulfillment of the whole complex of laborious and high-skill job. Besides, there exist the principal difficulties, with the storage-protection of the initial data, because the data in the registration journals were made by pen on the paper. Practically it is impossible to use the initial data to ascertain the climatic characterizations and need to be certified and target processing, as it has been mentioned above, applying specialized programming-technical complex and the possibilities of modern computers.

Within the research the systematization of regular observation materials of non less the 24 meteostation and all functioning posts in type of climatic cadastral data have been considered.

The replacement of meteostations has be selected considering the requirements, to appear climatic peculiarities of separate regions of Georgia with maximum effect.

A maturity index concept for climate datasets

Authors: F. Kaspar (1), J. Schulz (2), A. Kaiser-Weiss (1), V. John (2), R. Roebeling (2), A. Obregon (1)

Institute: (1) Deutscher Wetterdienst, Offenbach, Germany (2) EUMETSAT, Darmstadt, Germany

Country: Germany

The Global Climate Observing System (GCOS) has defined a set of 50 so-called Essential Climate Variables (ECVs) for three domains (atmospheric, terrestrial and oceanic). An essential climate Variable (ECV) is a geophysical variable that is associated with climate variation and change as well as the impact of climate change onto Earth. Climate Data Records (CDRs) for Essential Climate Variables can be generated from (a) in-situ data records alone (station based and interpolated to map representation), (b) individual and combined satellite data records as well as (c) global and regional model-based reanalysis.

The GMES/COPERNICUS Climate Service is aiming to provide information products that are of climate quality. Within the GMES project CORE-CLIMAX (COordinating Earth observation data validation for RE-analysis for CLIMAte ServiceS) a methodology is developed to rate the maturity of Climate Data Records. The structured process to deliver CDRs needs to assure, that the CDRs are preserved, accessible, extensible, scientifically defensible, transparent, continuously assessed and improved, reproducible, and sustainable.

Maturity index concepts, which had originally been developed for software engineering, proved already useful for satellite data management. With some adaptations, such a tool can measure the progress in climate data production, covering either satellite, in-situ or reanalysis products.

CORE-CLIMAX has generalized the maturity concept to especially cater for in-situ and reanalysis data. CORE-CLIMAX has further developed and added measures to cover, for instance, uncertainty characteristics and public access. The CORE-CLIMAX Maturity Matrix considers six main categories with which the quality of a CDR production should be analyzed: (1) software readiness, (2) metadata, (3) user documentation, (4) uncertainty characteristics, (5) public access, feedback and updates, (6) utility.

The project will invite CDR producers to perform a self assessment of their respective data products.

Data Rescue (DARE) Web Site of WMO RA-VI (and CCl) TT-DARE

Authors: José A. Guijarro[1], Ingebor Auer[2], Manola Brunet[3] and Aryan van Engelen[4]

Institute:

[1] ***State Meteorological Agency (AEMET), Balearic Islands Office, Spain***

[2] ***Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Wien, Austria***

[3] ***Centre for Climate Change (C3), Univ. Rovira i Virgili, Tarragona, Spain, and Climatic Research Unit, School of Environmental Sciences, University of East Anglia, Norwich, UK***

[4] ***Royal Netherlands Meteorological Institute (KNMI), De Bilt, The Netherlands***

Country: Spain

Data Rescue (DARE) activities, i.e., preservation, digitization and quality control of old records currently in paper and other not-ready usable formats, has as ultimate goal to enable access and use of high-quality long-term climate data on a regional scale, serving monitoring, assessing and projecting climate change. This is an important basic step in the development of Climate Services to the public, addressing a better management of the risks of climate variability and change. The World Meteorological Organization (WMO) Regional Association (RA) VI established a DARE Task Team within the Working Group on Climatology and Hydrology to promote, coordinate and provide guidance on these activities, whose main deliverable has been the implementation of a Web site holding information about them.

This site is located at http://www.climatol.eu/DARE/, and aims also to serve the needs of the related DARE Task Team of the WMO/Commission for Climatology (CCl XV) Open Panel of CCl Experts 1 (OPACE1), which share common interests and some team members.

This poster presents the web page, which is structured in sections gathering links to DARE activities, data repositories and available homogenization packages. This last section provides comparative tables about the characteristics of the different homogenization programs, and a separate web page offers the results of those able to be run in a completely automatic way when applied to hundreds of homogenization problems posed through several sets of randomly sampled series. The general conclusion is that most relative homogenization methods significantly improve the quality of the series, hence encouraging their use before carrying out any analysis of climate variability based on them.

A call is made to EUMETNET and other WMO members and general users to update the contents of this web site by providing any relevant link to DARE activities in the region or worldwide.

Creation of a homogenized climate data base for the Pyrenees mountain range

Authors: Serrano, R. [1]; Prohom, M. [2]; Cuadrat, J.M. [1]; Cunillera, J. [2]; Saz, M.A. [1]; Tejedor, E. [1]; Esteban, P. [3]; Soubeyroux, J.M. [4]; Deaux, N. [4]

Institute:

[1] Zaragoza University

[2] Servei Meteorològic de Catalunya

[3]Centre d´Estudis de la Neu i la Muntanya d´Andorra

[4] Météo–France, Direction de la Climatologie

Country: Spain

High resolution climatologies offer a broad spectrum of opportunities for further applications in climate and climate change research. Although this is a well-known fact, up to now a precipitation and temperature climatology has not existed for the Pyrenean region.

Climatologic studies have been numerous in recent years on both sides of the Pyrenees mountain range, but remain limited by purely national approaches, reducing the ability of comprehensive analysis of climate changes.

On the impulsion of the new Climate Change Pyrenees Observatory (OPCC), the four national meteorological services of the mountain range (AEMET, Meteo France, SMC and CENMA) and academic institution (Zaragoza University), have initiated an inventory of data and applications for a climatic characterization of the Pyrenees and its current evolution.

The identification of the long data series and the homogenization works in mountainous area are very difficult and justify a special attention and support. In this work we focused on create a climate database of 66 monthly temperature series and 120 monthly precipitation series in the period 1950-2010. Each series has been quality controlled and homogenized by HOMER script, developed in R language, which incorporates the latest methods and techniques on data management, including outlier removing, pairwise detection, and breakpoint selection (enhanced by metadata). To evaluate the quality of initial series through the homogenization process is used the MDA (Minimum Detectable Amplitude) value. The final series provide homogenized data to analyze the evolution of the climate, trend detecting of each observatories, and climatic behaviour of different zones in Pyrenees depending on its elevation and situation.

Daily and subdaily homogenised time series for Austria

Authors: Chimani B, Türk K, Nemec J, Auer I

Institute: Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Wien, Österreich

Country: Austria

Daily and even subdaily data is getting more and more into the focus of climate research due to urging questions of the public concerning changes in extreme weather situations due to climate. As is true of monthly data also daily data is influenced by non-climatic effects which cause so called inhomogenities or breaks in the time series. During the last years a lot of effort was put into the development of homogenisation procedures for daily data (e.g. COST-Action ES0601, Advances in homogenisation methods of climate series: an integrated approach HOME).

Using one of the methods developed in the frame of this COST-Action, daily minimum and maximum temperature and daily precipitation have been checked for homogeneity and if necessary/possible adjusted.

To study subdaily precipitation events (heavy precipitation events with more than 40mm/6h) a combination of the hourly measurements and the daily homogenised precipitation dataset was used.

This poster will include some information on the homogenisation method used for data on daily resolution, the refinement for subdaily precipitation values and results gained from this data concerning heavy precipitation in Austria.

Homogeneity of monthly wind speed time series in the Northeast of the Iberian Peninsula

Authors: N. Casabella (1), J. F. González-Rouco (2), J. Navarro (1), A. Hidalgo (3), E. E. Lucio-Eceiza (2), J. Conte (3), and Enric Aguilar (4)

Institute:

(1) Dpto. Energías Renovables, CIEMAT, Madrid, Spain

(2) Instituto de Geociencias (UCM-CSIC), Facultad de CC. Físicas, Universidad Complutense de Madrid, Spain

(3) GLOBAL Forecasters, S.L., Madrid, Spain

(4) Center for Climate Change, Univ. Rovira I Virgili, Tarragona, Spain

Country: Spain

Long instrumental climate records are essential for assessing century-scale trends, for the validation of climate models, as well as for the detection and attribution of climate change at global and regional scales. Most observational series of atmospheric variables suffer from inhomogeneities due to changes in instrumentation, station relocations, changes in local environment or the introduction of different observing practices. If such changes are not taken into account, they can have an impact on the assessment of long term variability with implications for the understanding of mechanisms contributing to local and regional multidecadal and centennial variability or, for instance, for model-data comparison in model verification exercises.

Several studies have analyzed the homogeneity temperature and precipitation datasets, while efforts focused on wind speed are scarce. In this work we use a dataset that comprises 738 time series of monthly wind speed recorded in weather stations located in the northeast of the Iberian Peninsula, and 14 buoys in coastal regions of Spain; the longest records spanning from 1938 to 2010. The original time resolution of these data vary from 10 minutes to 6 hours. A quality control (QC) process was previously applied to this dataset and the most important biases were corrected whenever possible. However, the QC has not addressed long term inhomogeneity problems and there could still be a number of unidentified breakpoints that make necessary an homogeneity assessment.

The Standard Normal Homogeneity Test (SNHT) has been used to identify inhomogeneities in this dataset. This method has been selected for this assessment because of its flexibility to work with a high number of series and its good performance in comparison with other methods. The method was tested with synthetic series reproducing wind statistics by imposing inhomogeneities with different percentages of change in mean and variance at different positions within the time series. The application of the SNHT to the wind observations has been done by considering regional reference series that are optimally selected in an iterative procedure. The results are compared with the available metadata. The spatial and temporal occurrence of inhomogeneities will be described, as well as their impact on the analysis of long-term wind speed trends.

Break Correction of Swiss Daily and Sub-Daily Temperature Series

Authors: R. Auchmann[1], F. G. Kuglitsch[2], and S. Brönnimann[1]

Institute:

[1] Institute of Geography and Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland

[2] GFZ German Research Centre for Geosciences, Potsdam, Germany

Country: Switzerland

Many applications in climate science require high-quality, long-term data at a high temporal resolution. However, such records are often affected by artificial breaks. The challenging task of homogenizing daily and sub-daily data has only been addressed in recent years. Therefore, the number of available datasets providing homogeneous daily and sub-daily series is still small compared to the volume of monthly or annual data.

In this study, series of daily maximum (Tmax), daily minimum (Tmin), morning (Tmorn), noon (Tnoon) and evening (Teve), and daily mean (Tmean) temperatures measured in 61 stations of the Swiss climate observation network were corrected for artificial breaks. The break detection for the above mentioned series was accomplished in a former study by using a combination of three different break detection methods. Here the previously determined breakpoints are corrected by applying the method of higher-order moments for autocorrelated data (HOMAD), which is an improved version of the higher-order moments method (HOM), providing an objective choice of regression parameters.

CHARMe: Characterization of Metadata to enable high-quality climate applications and services

Authors: R. Alegre[1;3], J.D. Blower[1;3], D.J. Clifford[1;3], F. Kratzenstein[4], P.J. Kershaw[2;3], J.P. Lewis[1;3], K. Marsh[2;3], M. Nagni[2]

Institute:

[1] **Department of Meteorology, University of Reading, Reading, United Kingdom**

[2] **STFC Centre for Environmental Data Archival, Rutherford Appleton Laboratory, Didcot, United Kingdom**

[3] **National Centre for Earth Observation, United Kingdom**

[4] **Deutscher Wetterdienst, Germany**

Country: Germany

CHARMe as a GMES/COPERNICUS-project is supported by the EU-FP7 (SPACE) and is a contribution towards a European Climate Service. The project aims to link climate datasets with publications, user feedback and other items of "commentary metadata". CHARMe will help users learn from previous community experience and select datasets that best suit their needs, as well as providing direct traceability between conclusions and the data that supported them. The project applies the principles of Linked Data and adopts the Open Annotation standard to record and publish commentary information. CHARMe contributes to the emerging landscape of "climate services", which will provide climate data and information to influence policy and decision-making.

This presentation will introduce the main motivation and basic ideas of the project. It will describe the selected technical approach and will give a brief overview of the proposed system architecture.

Climate of the Carpathian region according to the results of the CARPATCLIM project

Authors: TAMAS KOVACS, MONIKA LAKATOS, ZITA BIHARI, TAMAS SZENTIMREY

Institute: Hungarian Meteorological Service, Hungary, 1525 Budapest, Pf. 38.

Country: Hungary

Climate change challenges natural ecosystems and also human activity, and is expected to result in significant changes in temperature and precipitation in Europe. The study of regional climate conditions is encouraged worldwide to gather as much knowledge on this matter as possible, since the exact knowledge of the observed tendencies is crucial for responsible awareness. Past datasets show that changes have accelerated in recent decades with various spatial differences, causing numerous regions to witness a higher increase in weather extremes than the global average. In our work we examined the temperature and precipitation conditions of the last few decades in the Carpathian region. In addition to multi-decadal average values, several climate indices are used to describe the changing climate. The changes often mean an increase in extreme events, which may not be influencing long term averages, but nevertheless cause significant threat. Therefore in many cases the examination of the changes is carried out by the analysis of extreme climate indices.

This study is based on the results of the CARPATCLIM - Climate of the Carpathian region project, hold by JRC and lead by the Hungarian Meteorological Service. The homogenized and interpolated database was produced in daily temporal resolution for the period 1961-2010 and in 0.1° spatial resolution for the 44°N - 50°N, 17°E - 27°E area for many basic meteorological variables. The harmonized database provides relevant outcomes for climate change studies and other climatological research. The data used are freely accessible on the CARPATCLIM homepage: http://www.carpatclim-eu.org/pages/home/

International longterm climate database HISTALP

Authors: Chimani B, Ganekind M, Auer I, Türk K, Nemec J

Institute: Zentralanstalt für Meteorologie und Geodynamik (ZAMG), Wien, Österreich

Country: Austria

As climate zones do cross borders an easy excess of climate data in neighbouring countries can be of great value. Individual data request can be tiring for both the institution needing data for their research and the institution in charge of these data. The installation of a common database in combination with a webpage containing the essential information on the dataset can be an easy solution for those problems, as the data will be updated regularly and can be accessed by the user via web.

HISTALP is one database of this kind including long term climate data of nearly 200 stations all over the Greater Alpine Region (4-19°E, 43-49°N). HISTALP is an successful l example of an international database on long term climate data. The earliest stations included reach back to 1760 for temperature. Besides temperature the database holds information on precipitation, sunshine duration, air pressure, cloudiness and air humidity. The data is quality controlled and homogenized in order to be useful for climate analyses. Regular maintaining of the database is done. Besides the data is analysed in different ways (gridded data, regional means, climate monitoring...).

This poster will give some information on the data included, the quality control and homogenisation procedure, the operational activities, climate analyses and the future perspective of HISTALP.

Up-to-date CLINOs for Austria

Ingeborg Auer, Konrad Andre, Barbara Chimani
Zentralanstalt für Meteorologie und Geodynamik (ZAMG)

Country: Austria

WMO defines Climatological normals as averages of climatological data computed for the following consecutive periods of 30 years: 1 January 1901 to 31 December 1930, 1 January 1931 to 31 December 1961, etc. In this respect 1961 to 1990 would be valid for our actual climate. Customers, however assess the value of CLINOs 1961-1990 as out of date information. Even the human perception claims for an updated reference period. Therefore ZAMG decided to calculate “operational” normals for the period 1881-2010. For temperature and precipitation only homogenized data was used by applying HOMER, a software package developed within the COST ES0601. For all other elements our homogenization experience is limited, we had to trust on the quality checked series supplemented by metadata and visual inspection. The following operational normals 1981-2010 have been calculated: air temperature (11 characteristic parameters), precipitation (4), sunshine (7), humidity (3), snow (4), days with hail and days with thunderstorms, wind (4).

The new data set is freely available from ZAMG as an essential contribution to Austrian’s Climate Services. Users will come from various parts of the science community, institutions for education but also from various economic sectors.

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Swiss climate normals in a changing climate - the new norm period 1981-2010

Authors: Begert M, Frei C, Kunz H.

Institute: Swiss Federal Office of Meteorology and Climatology MeteoSwiss

Country: Switzerland

Climate normals form the basis of numerous climate services and applications. They serve to describe the climate of a specific region and are used to compare current climate conditions to that of the past or to what is considered “normal”. In a non-stationary climate the question about the representativeness of the more than 20-years old WMO standard norm period 1961-1990 arises. In accordance with a proposal of the Commission for Climatology of the WMO and along with many other national climate services the Swiss Federal Office of Meteorology and Climatology MeteoSwiss has introduced climate normals of the 30-year norm period 1981-2010. Monthly and annual values for temperature, precipitation and sunshine duration have been calculated for stations and gridded at 2km resolution. Comparing the new long term means with those of the standard period sheds light on the variability and trends of climate variables in Switzerland over the last 50 years. In annual mean the temperature increase amounts to 0.8° Celsius between the two norm periods. The increase is more pronounced in spring and summer than in autumn and winter. Sunshine duration has increased only on the Swiss plateau whereas no differences can be found looking at mean annual precipitation sums. The significance of the spatial structure of the differences is analyzed using cross validation techniques. Since 2013 the new climate normals 1981-2010 are used in all products of MeteoSwiss where current climate conditions are assessed such as the annual climate status report or the monthly climate bulletin.

Adaption of the Data Quality Control Procedures at SENAMHI Peru

Authors: Clara Oria [1], Stefanie Gubler [2], Olimpio Solis [1], Felix Cubas [1], Marcia Valdez [1], Delia Acuña [1], Gabriela Rosas [1], Christian Barreto [1], Deborah van Geijtenbeek [2], Mario Rohrer [3], Mischa Croci-Maspoli [1], Thomas Konzelmann [1]

Institute:

[1] Meteorological and Hydrological Service of Peru (SENAMHI), Lima, Peru

[2] Swiss Federal Office of Meteorology and Climatology MeteoSwiss, Zurich, Switzerland

[3] Meteodat GmbH, Zurich, Technoparkstrasse 1, Switzerland

Country: Switzerland

Climate information and derived products are crucial for planning purposes in sectors such as agriculture, health, transportation, energy, mining, hydrology, or tourism, and for planning mitigation and adaptation strategies to climate change. In this context, the provision of high-quality climate data to decision makers is especially important in highly vulnerable countries such as Peru.

The project CLIMANDES (module 2) is a joint project between the Meteorological and Hydrological Service of Peru (SENAMHI) and the Swiss Federal Office of Meteorology and Climatology Met eoSwiss with support from Meteodat GmbH. It aims to establish sustainable climate services by extending and implementing the entire data quality process at SENAMHI, and by producing reliable climate information in two Andean regions in Peru, Cuzco and Junín. The goals of CLIMANDES include the automatization and improvement of the data quality control (DQC) procedures at SENAMHI. Currently, basic and manpower intensive DQC procedures are implemented at SENAMHI used to detect and correct suspicious climate data. It is planned to adapt and improve the DQC rules (e.g., gross error checks, spatial, temporal, and internal consistency) according to common guidelines, to automate the detection of suspicious data values, and to reduce the manual effort in the data correction procedure.

Experience in the DQC process at SENAMHI has shown that suspicious data at conventional stations are mainly due to typos. One possibility to subsequently verify these suspicious values is the manual comparison of data values with the original data sheets stored in the archive. To facilitate the manual work, it is envisaged to digitize the data sheets and make them available online for data correction.

For spatial interpolation, an automatic selection of appropriate neighbouring stations will be implement-ed. Furthermore, additional data sources (e.g., satellites, data from re-analyses) might be used and will be provided automatically for data quality control and interpolation of missing values.

The new developed procedures can be used to improve the data quality and time series of climate stations in developing countries with low station density, and, typical for high mountain regions as en-countered in Peru, high topographic and climatic variability. We present the adapted and improved data chain that will be implemented at SENAMHI.

Adjustment functions to wind induced bias on solid precipitation measurements

Authors: Karianne Ødemark, Mareile Wolff, Ketil Isaksen, Asgeir Øverland

Institute: Norwegian Meteorological Institute

Country: Norway

Solid precipitation measurements are highly biased by wind causing a substantial under-catch. This under-catch introduces one of the greatest unknowns to climate data, hampering the ability to monitor precipitation trends in areas where solid precipitation events are frequent. With the expected increase in temperature, the distribution of precipitation type will in some areas shift from solid to liquid phase. Knowing that the wind induced under-catch of liquid precipitation is much less than for solid, it is to expect that we measure higher precipitation amounts. We may thus observe trends of increasing precipitation that are not in fact caused by a real increase in precipitation.

In all climatological work the need for accurate data sets are essential. Especially does the consequence of an increased precipitation catchment need to be considered.

Norway has large areas dominated by frequent solid precipitation events, often accompanied by high wind speeds. To get a better understanding of the amount of solid precipitation regular precipitation gauges with limited wind-shield under-catch, an extensive measurement site was established at a mountain plateau in Southern Norway in 2010.

Here, precipitation data of different automatic gauges are compared with data of a reference gauge surrounded by a double fence construction to minimize wind impact. Additional meteorological parameters are measured simultaneously. Today, almost 200 parameters are measured by 25 instruments.

Beside its original purpose to develop a set of adjustment functions relevant for Norway's typical climate, the site now also acts as a host-site within the World Meteorological Organization's solid precipitation intercomparison experiment and as a reference site for a national project on avalanche forecasting.

Results from 3 winter periods will be presented. As expected, the data show a high correlation between under-catch and wind speed during solid precipitation events. The data however show a large scatter, which might be explained by other determinants such as precipitation intensity and type. This will be addressed in addition to presentation of the adjustment functions.

Development of new daily rainfall quality control procedures in Met Éireann

Author: Séamus Walsh

Institute: Met Éireann

Country: Ireland

Quality control is an essential element in the delivery quality products to customers. Manual quality control is labour intensive and can be subjective, particularly in the case of rainfall which shows great spatial and temporal variability. A semi-automatic quality control system has been developed which combines spatial techniques with manual intervention, this speeds up the process and makes the quality control more objective. Automatic spatial tests have been incorporated into the process which flags suspect values. The final decision on whether to accept, reject or amend a value is still made by a manual operator. An automatic system for the redistribution of cumulative daily values has also been implemented. The implementation of these new quality control procedures have reduced the level of manual scrutiny required, made the process more objective and speeded up the delivery of data to customers.

MOTEDAS: MOnthly TEmperature DAtabase of Spain 1951-2010. (1) Quality control

Authors: D. Peña-Angulo (1), N. Cortesi (1), (3), M. Brunetti (3), J.C. González-Hidalgo (1-2)

Institute: Department of Geography, Zaragoza University, Spain, (2) IUCA, Zaragoza University, (3) ISAC-CNR, Bologna

Country: Spain

We present the global procedure of quality control for the development of the MOnthly TEmperture DAtabase of Spain (MOTEDAS) created after exhaustive analyses and quality control of the original digitalized data of the Spanish National Meteorological Agency (AEMet), under the frame of the Project HIDROCAES (Spanish Ministery of Research CGL2011-27574-C02-01). MOTEDAS was developed to study at subregional level and highest spatial density as possible the maximum (Tmax) and minimum (Tmin) monthly temperature trend during the last decades.

Quality control was applied without any prior reconstruction, i.e. on original series. Then, from the total amount of series stored at AEMet archives (more than 4680) we selected only those series with at least 10 years of data (3066 series) (see Poster MOTEDAS 2). The monthly distribution of series varies in time, with a maximum at the end of the XX century. Anomalous data in the original series were detected by coherence analyses, and by comparison with reference series. The reference series were calculated with up to 100 neighbors stations (<200 km), at least 7 years with common period, highly correlated (monthly positive values, annual mean value r>0,60), and mean standardized during the common period. Anomalous data were considered when difference between Candidate and Reference were three times higher than interquartile distance. The total amount of monthly suspicious data recognized and discarded at the end of this analyses was less than 0,8% of original total monthly data, for both Tmax and Tmin. No spatial pattern was detected and month by month Tmin shows maximum detection in summer months, while Tmax does not show any monthly pattern. The homogeneity analysis was performed on series free of anomalous data by using an arrays of test (SNHT, Bivariate, T de Student and Pettit) after new reference series calculated. The tests were applied at monthly, seasonal and annual scale (i.e. 17 times per method). Statistical inhomogeneity detections were accepted as follows:

1. Annually, 3 detections must be found in SNHT or Bivariate test.

2. The total amount of annual detections by the four tests was greater than 5% of the total possible detection per year.

3. Before any correction we examined the Candidate and reference series chart.

Finally, we considered series as inhomogeneous if criteria 1 or 2 were identified. The total amount of series affected by inhomogeneities was 1013 (Tmax) and 1011 (Tmin), i.e. 1/3 of original series was considered as inhomogeneous. We notice that identified inhomogeneous series in Tmax and Tmin usually do not coincide. This apparently small amount of series compared with previous work could be originated because of the mean length of series is around 15-20 years.

In the MOTEDAS 3 we present the final reconstruction of series after quality control.

MOTEDAS: MOnthly TEmperature DAtabase of Spain 1981-2010. (2) Spatial variability of maximum and minimum monthly temperature in Spain during 1981-2010 evaluated by Correlation Decay Distance (CDD)

Authors: N. Cortesi [1-2], D. Peña-Angulo [1-2], M. Brunetti [3], J.C. González-Hidalgo [1-2]

Institute:

[1] Department of Geography, Zaragoza University, Spain

[2] IUCA, Zaragoza University

[3] ISAC-CNR, Bologna

Country: Spain

We present an analysis of spatial variability of minimum and maximum monthly temperatures (Tmin and Tmax) in the conterminous land of Spain (Iberian Peninsula, IP), between 1981-2010, by using the Correlation Decay Distance function (CDD), with the aim of evaluating, at sub-regional level, the optimal threshold distance between neighbouring stations that makes the network (in terms of stations density) well representative of the monitored region. To this end, we calculated the correlation matrix among Tmax and Tmin series from AEMet (National Spanish Meteorological Agency) archives. The series analyzed are included in the frame of MOTEDAS database, free of anomalous and inhomogeneities (see Poster MOTEDAS 1, Project HIDROCAES, Spanish Ministery of Research CGL2011-27574-C02-01), and contain at least 90% of total possible monthly data for that period.

In the conterminous land of Spain the distance at which couples of stations have a common variance above the selected threshold (50%, i.e. Pearson r ~ 0,70) on average does not exceed 400 km, with relevant spatial and temporal differences, with values that decrease below 100 km in coastland areas, particularly in summer months. The spatial distribution of the CDD shows a clear coastland-to-inland gradient at annual, seasonal and monthly scale, with highest spatial variability along the coastland areas and lower variability inland. The highest spatial variability coincides particularly with coastland areas surrounded by mountain chains and suggests that the orography is a driving factor causing higher interstation variability. Moreover, there are some differences between the behaviour of Tmax and Tmin being spatially more homogeneous Tmin than Tmax, but its lower CDD values indicate that night-time temperature is more variable than diurnal one. The results suggest that in general local factors affect the spatial variability of Tmin more than Tmax and then higher network density would be necessary to capture the higher spatial variability highlighted for nocturnal temperature (Tmin) respect to diurnal temperature (Tmax).

MOTEDAS: MOnthly TEmperature DAtabase of Spain 1951-2010. (3) Reconstruction of max and minimum monthly temperatures series in mainland Spain

Authors: D. Peña-Angulo (1), N. Cortesi (1), (3), M. Brunetti (3), J.C. González-Hidalgo (1-2)

Institute: Department of Geography, Zaragoza University, Spain, (2) IUCA, Zaragoza University, (3) ISAC-CNR, Bologna

Country: Spain

We present the procedure applied to reconstruction series of maximum (Tmax) and minimum (Tmin) monthly temperature in the new MOnthly TEmperature DAtabase of Spain (MOTEDAS) created from the original digitalized data of stored at Spanish National Meteorological Agency (Agencia Estatal de Meteorología, AEMet) under the frame of the Project HIDROCAES (Spanish Ministery of Research CGL2011-27574-C02-01). The reconstruction is applied after quality control explained in MOTEDAS Poster 1.

Main question: it is very common that climate series, continuous in time and spatially close, do not overlap. How can we produce a long climate series when the original data do not overlap, or the overlapping period is too short, and avoid creating an artificial inhomogeneity?. To solve this problem we developed the following approach:

1. From original series, free of anomalous data and inhomogeneities (see MOTEDAS Poster 1), we calculated the Reference ones (R1) from station overlapped at least 7 years, highly correlated (mean monthly r>0.6, monthly positive values only), and <200 km apart (see Poster MOTEDAS 2). The neighbor stations are introduced in the Reference series after standardizing the mean and deviation during the common period with the Candidate serie. The algorithm applied is $1/distance^2$.

2. We reconstruct temporally the original data (Candidate series, C) with the previous Reference (R1), to obtain overlapping period between close stations not overlapped in the original series (C+R1).

3. We calculate in the pseudo reconstructed series from the previous paragraph 2 (C+R1) a new Reference (R2) following the previous conditions from paragraph 1.

4. The final reconstruction is made with original data (C) and R2 from paragraph 3. A special attention is given in the R2 about the origin of reconstructed data by distances.

5. Given that the procedure is applied to complete original series, for final climate analyses the final selection of reconstructed series combines different criteria accordingly percentage of original data and origin of reconstructed data during 1951-2010.

The final dataset of MOTEDAS (1951-2010) included 965 monthly complete series, homogeneous and free of anomalous data for monthly Tmax and Tmin; 63% of final data are original ones, and the rest of series from 25 km.

Observed time trend in extreme heat events over mainland Spain

Author: M. Castellà Sánchez[1], M. Brunet[1, 2]

Institute:

[1] Centre for Climate Change (C3), Campus Terres de l'Ebre, Universitat Rovira i Virgili, Avda. Remolins, 13-15, Tortosa

[2] Climatic Researh Unit, School of Environmental Sciences, University of East Anglia, Norwich, NR4 7TJ, UK

Country: Spain

This contribution is aimed at investigating changesin the observed extreme daily maximum and minimum temperatures for summer season (June, July and August) in mainland Spain. A statistical modelling is carried out by fitting extreme temperatures distribution with time varying location parameter using the recently developed technique of the Point Process approach. In addition, the derived 20 year effective returns levels were estimated.

The statistical analysis was based on the Spanish Daily Adjusted Temperature Series (SDATS, which is composed of 22 daily adjusted maximum (Tx) and minimum (Tn) temperature series covering the 1850-2005 period (Brunet et al. 2008). 21 out of the 22 locations were selected from SDATS and updated to 2010 from the Spanish Meteorological Agency (AEMET).

In this analysis two sub-periods from the period 1940-2010 have been examined: 1940-1972 (1973-2010), characterised by stagnation and declining (increasing) regional trends.

The results show that both extreme daily Tx and Tn have different behaviour in the temporal change during the two selected sub-periods: significant negative linear trend at 0.001(0.1%) level in the location parameter of the extreme distribution during the earlier period (1940-1972) and significant positive linear trend at 0.001 (0.1%) in most of the stations during the last period (1973-2010) were estimated.

For the last warm period, it has been observed for both variables an increase in μ towards higher values shifting the distribution and increasing all extremes. The highest positive trends in extreme Tx during the period 1973 -2010 are 3.6ºC at Valencia, 2.8ºC at Salamanca, 2.6ºC at Burgos and Malaga stations. The extreme Tn shows the highest positive trend in Seville with 4.2ºC, Ciudad Real with 3.9ºC, Murcia with 3.4ºC and Valladolid with 3.2ºC.

The highest 20 year return levels were identified in the southernmost part of Spain at Seville and Murcia stations with 45.5ºC and 44.6ºC for daily Tx respectively, and at Seville and Malaga with 28.1ºC and 28.0ºC for dailyTn respectively.

EXTREME WIND SITUATIONS: METHODOLOGY FOR THE DELIMITATION OF HIGH WIND GUSTS

Authors: RODRIGO, M. [(1) (2)], LÓPEZ, J. A. [(2)]

Institute:

[(1)] CCS (Consorcio de Compensación de Seguros), Spain

[(2)] AEMET (Agencia Estatal de Meteorología), Spain

Country: Spain

Extreme wind is one of the climatic risks that strike our country, Spain. The CCS (Consorcio de Compensación de Seguros) is the Spanish body that covers risk against extraordinary winds, defined as those with wind gusts exceeding 120km/h. The accurate delimitation of areas that meet this condition is fraught with difficulties because of the scarcity of wind observations and the complexity of the terrain.

AEMET (Agencia Estatal de Meteorología) makes technical reports which specify the geographical area affected by extreme wind. The operational methodology carried out for the estimation of wind gust areas applies a geostatistical technique, the universal kriging, based on the observations of maximum wind gust and drawing also on physiographic variables, terrain elevation and distance from the shore, and wind gust field output from HIRLAM forecasting model.

The kriging considers the observations as a theoretical random field and postulates an estimated field at any point as a linear combination of the observations in the rest of the points properly weighted. To determine the weights the condition is imposed that the estimator be unbiased and its variance minimal. In particular, the universal kriging postulates a linear trend model, so that the expected value of the random field at any point is expressed as a linear combination of the values at that point of the auxiliary functions. Furthermore, the structure of the semivariogram used is specified without “nugget effect”, the estimated value matches the observed value.

Climatologies of extreme wind situations are chosen to perform several validation analyses. These situations are also compared with reanalysis studies given by ECMWF (European Centre for Medium-Range Weather Forecasts) models.

The validations show a systematic negative bias for the estimated high wind gusts, as the kriging is globally unbiased but, for a particular range of observations, the estimator gets close to the average. To improve the bias for high wind gusts the same technique is applied, universal kriging, but using only observational values from meteorological stations with high wind gusts, above 80km/h, while ensuring data spatial coverage.

This work shows a new methodology which combines both mentioned fields, according to the observational data utilized. The combination is performed through a grid-point based weighting that depends on the local observation network density. The proposed methodology reduces the bias by about 60% at those stations that have maximum wind gust values above 80km/h.

Finally the economic impact of the new methodology is assessed under different scenarios.

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A Modular and Portable Software Solution for Climate Monitoring

Author: Dan Hollis

Institute: Met Office, Fitzroy Road, Exeter, EX1 3PB, UK

Country: United Kingdom

The Met Office's National Climate Information Centre is responsible for producing a wide range of UK climate monitoring products, including maps, graphs and tables for our web site and intranet, and ad hoc reports for a variety of audiences including policy makers, the media and commercial business. A large number of these products are created from an archive of gridded climate data that we have built up over the last 14 years.

The software that we use to generate both the gridded data and the downstream products is now in need of a major overhaul. The current version was originally written about 10 years ago but has been developed and extended ever since as new requirements have arisen. Most of the code is written in Avenue, the proprietary scripting language used by ArcView 3.2 GIS software. ArcView has been unsupported by the software vendor (ESRI) for some years and it has now reached a stage where the code will not run under the latest versions of the Windows operating system.

This presentation will describe some current work to migrate the entire system to a new platform and thus create a modern and flexible tool for our climate monitoring activities. The design of the new software is aimed at fixing some of the deficiencies of the current system. In particular we are hoping to achieve greater levels of automation, modularity, portability and speed. We are also aiming to improve various aspects of the interpolation, quality control and validation processes, as well as implementing better version control and metadata. The various components of the software will be described along with the most likely solution that we are considering for each part. The benefits of the new system and some further plans for the future will also be discussed.

As this is ongoing development work the aim is also to encourage discussion and feedback regarding lessons learned and good practices adopted by other institutions.

Climate Services for monitoring the recent evolution of climate in Murcia Region

Authors: Elisa Hernández García, Luis María Bañón Peregrín

Institute: Delegación Territorial de AEMET en la Región de Murcia

Country: Spain

According to the Climate Watch System from World Meteorological Organization (WMO), a "Climate Watch", based on observations of current and/or future climate anomalies, can serve as a mechanism to warn the user community that a significant climate anomaly exists or might develop. In this respect, climate observations are necessary in real and historical time in order to monitor and predict effectively climate extremes.

Regarding to this Climate Watch System, we have developed graphics products which show the evolution of climate in "real time". These products seem to be very useful for attention to media, as input for other climate services, for the user community, etc.

Graphics products show thermal and pluviometric information, and the general procedure is based on three modules: climatological data, recent past data and forecasted data.

The climatological data module is based on historical daily series from 25 automated weather stations (AWS) located in Murcia Region. These 25 AWS were selected from a homogenised and filled daily database (Climatol R package) among 86 Murcia Region stations. Statistics from 1981-2010 historical series were obtained for each of the 25 AWS daily database and for a regional daily database using the Inverse Distance Weighted (IDW) from RSAGA.

The recent past data module obtains the last 30 days observations data of these 25 AWS and works out daily regional values using IDW from RSAGA. The forecast data module obtains similar information for the next seven days forecasted: from 25 AWS and regional daily values. Afterwards, recent past and forecasted files are joined obtaining 40 days files for each of the 25 AWS and for regional level.

Graphics products show the last 30 days observed data and statistic from historical data of temperature and precipitation values with indication of the character. At the same time, graphics products show the next seven days forecasted values with indication of the character. Similar graphics have been built for monthly and annual data.

Validation and bias correction of RegCM simulations

Authors: Constanţa Boroneanţ[2], Mihaela Caian[2]

Institute:

[1]Center for Climate Change, Geography Department, University Rovira I Virgili, Tortosa, Spain

[2]Rossby Centre, SMHI, Norrköping, Sweden

Country: Spain

Climate models, both global and regional, are primary tools that aid in our understanding of the many processes that govern the climate system. They are also intensively used in different greenhouse gas emission scenarios to assess projected climate changes at global or regional scales.

The results show that both general circulation models (GCM) and regional climate models (RegCM) may project different patterns of change of climatic variables across some regions, some areas showing even opposite developments or different magnitudes of changes. Such uncertainties in the performance of GCMs or RegCMs may arise from various causes: the parameterization of small-scale physical processes or other uncertainties related to the structures used to represent large-scale climate processes.

RegCM simulations at 10 km over different sub-regions of Central and South-Eastern Europe, including Romania, have been conducted in the framework of the EU-project CECILIA (Central and Eastern Europe Climate Change Impact and VulnerabiLIty Assessment). This paper presents the validation analysis and bias correction of the simulations with the Abdus Salam International Center for Theoretical Physics (ICTP) RegCM3. The RegCM3 was driven 1) by the ERA-40 reanalysis data set and 2) by a 25 km RegCM run driven by the ECHAM5 GCM for a recent past climate (1961-1990). The domain was centered over Romania at 46ºN, 25ºE and included the western Black Sea and the Romania's neighboring countries.

The RegCM3 simulations of monthly temperature means at 2 m and total precipitation were compared with the CRU TS3.0 land observation dataset and with the ERA-40 reanalysis data set, both originally at a horizontal resolution of 0.5º lat x 0.5º lon and then interpolated onto the RegCM3 grid using a bilinear interpolation. To evaluate the model at local scale we present an additional validation of monthly-mean temperature and precipitation against observed data at some representative stations in Romania.

The results show that the biases are not uniformly distributed throughout the year and, their magnitudes are regionally dependent. Overall, the model overestimates the temperature during the cold season (November to March) and underestimate the temperature during the warm season (April to October). Precipitation is overestimated during the cold season (September to March) and highly underestimated during the warm season (April to August).

The RegCM3 simulations were bias corrected both against 1) ERA-40 reanalysis and 2) CRU TS3.0 observations using the Delta method (Deque, 2007). Comparative results and conclusions on the appropriate choice are presented.

Recent Improvements on the Spanish National Climatological Database

Author: Celia Flores, Cesar Rodríguez and Antonio Mestre

Institute: State Meteorological Agency (AEMET), Spain

Country: Spain

A series of improvements have been implemented in the National Climatological Database during the last two years, since the last data management meeting hold in Edimburgh. Some of the improvements include the addition of new functionalities to existing products and, on the other hand, new applications have been developed.

This communication aims at describing the new functionalities developed, in particular the following: display of radar and satellite images from browsing and editing applications, development of our own GIS module integrated in all applications and a new system of communication between the main meteorological stations capture programs and its automatic stations, in order to automate data input and facilitate a quicker access to the data.

The new developments that have been carried out will be also considered, including among others: a new application to incorporate certificates and reports of episodes, or any kind of useful documents (photographs, videos, etc..) into the database, the development of a tool to calculate return periods of different climate variables, the development of an application to incorporate phenological data into the National Database and the elaboration of maps from the Automatic Weather Station Network data on an hourly basis. This application includes the elaboration of cuasi-real time maps marking areas with variables over specific thresholds related to the Meteolarm (alerting Europe for extreme weather) system.

Development and usage of climatological database in the Republic of Armenia

Authors: Nazaryan Satenik, Z. Petrosyan, H. Melkonyan

Institute: Armstatehydromet

Country: Armenia

Republic of Armenia is located on the territory of Armenian uplands, consequently, its relief consists of numerous high mountain ridges (about 47 % of the territory), intermountain hollows, extinct volcanic mountains, plateau and plains. Taking into account the diversity of weather-climatic conditions there was a necessity of creation of dense meteorological network. Number of stations working in Armenia varies from year to year, and now it reaches 45 working stations. Several stations have an experience of collecting climatological data for more than 120 years. Currently, in order to preserve observations contained during these years, Armenian meteorological service is creating digital data base. During the process of creation of database several obstacles were faced and solved. First, saving of the paper based historical data on modern digital carriers. Second, formation of historical data arrays in unified format. Third, creation of metadata of conforming stations. Forth, filling of missing meteorological elements from the paper based journals. And finally, regular update of the database with current observations. Since 1997 Clicom environment was implemented for the creation of the database. However, nowadays due to insufficient performance of the Clicom transition to Cliwere environment is in process. Data quality checking, with both numerical and graphical points of view, became possible because of the creation of a unified database. Moreover the unified database promoted the development of climatological as well as operational modeling based on historical observations. Accuracy of such models proved to increase during last years. In 2010 Food and Agriculture Organization of the United Nations (FAO) implemented a model of prediction of crop yield based on regression analysis for which newly created dataset was of crucial importance. Moreover, this newly crated dataset is nowadays used in various climatological researches as well as in construction meteorology, energy economics, etc.

Keywords: Database, climatological, Republic of Armenia, regression analysis.

THE PAN EUROPEAN PHENOLOGICAL DATABASE PEP725: DATA CONTENT AND -QUALITY

Authors: Anita Jurković [(1)], Thomas Hübner[(1)], Elisabeth Koch[(1)], Wolfgang Lipa[(1)], Helfried Scheifinger[(1)], Markus Ungersböck[(1)], Susanne Zach-Hermann[(1)]

Institute: ZAMG-Central Institute for Meteorology and Geodynamics

Country: Austria

Phenology - the study of the timing of recurring biological events in the animal and plant world - has become an important approach for climate change impact studies in recent years. It is therefore a *"conditio sine qua non"* to collect, archive, digitize, control and update phenological datasets. Thus and with regard to cross-border cooperation and activities it was necessary to establish, service and promote a pan European phenological database (PEP725).

Such a database - designed and tested under cost action 725 in 2004 and further developed and maintained in the framework of the ECSN program PEP725 - collects data from different European governmental and nongovernmental institutions and thus offers a unique compilation of plant phenological observations. The data follow the same classification scheme - the so called BBCH coding system - that makes datasets comparable.

Europe had a long tradition in the observation of phenological events: the history of collecting phenological data and their usage in climatology began in 1751. The first datasets in PEP725 date back to 1868. However, there are only a few observations available until 1950. From 1951 onwards, the phenological networks all over Europe developed rapidly: Currently, PEP725 provides about 9 million records from 29 European countries (covering approximately 50% of Europe).

To supply the data in a good and uniform quality it is essential and worthwhile to establish and develop data quality control procedures, so that the collected, partly new digitized historical resp. updated datasets, can be tested in an appropriate way. Consequently, one of the main tasks within PEP725 is the conception of a multi-stage-quality control. Currently the tests are stepwise composed: completeness-, plausibility-, time consistency-, climatological- and statistical checks.

In a nutshell: The poster exemplifies the status quo of the data content of the PEP725 database and incipient stages of used and planned quality controls, respectively. For more details, we would also like to promote and refer to the PEP725 website (http://www.pep725.eu/) and invite additional institutions and regional services to join our program.

Quality control and homogenization of temperature series of the ECA&D

Authors: P. Štěpánek[1,2], P. Zahradníček[1,2], P. Skalák[2], A. Farda[1]

Institute:

[1] Global Change Research Centre AS CR, v.v.i., Brno, Czech Republic

[2] Czech Hydrometeorological Institute, Czech Republic

Country: Czech Republic

Climate research requires existence of homogenised time series of various meteorological variables. In the last years, a big effort has been devoted to the development and comparison of methods for detection of inhomogeneities at monthly time.

In this work we focused on quality control and homogenization of mean, maximum and minimum temperature series available from the European Climate Assessment & Dataset (http://eca.knmi.nl/). This database is used, among others, for creation of regular grid points E-OBS dataset, that is often used for validation of climate models or other climate analysis and where good quality of the data is very important.

The problems faced included especially varying station density (in publicly available dataset some regions are badly covered with stations). Many problems in the dataset were addressed: e.g. errors caused by incorrect marking of missing values, where instead of flag zero values were used. Furthermore we detected few values with mean temperature higher than 50°C (maximum 190.6°C). Homogenization methods selected for data processing are among those tested in the framework of the ES0601 COST Action (HOME). We found one third of the series being inhomogeneous (in case of maximum temperature it was even half of them).

We will continue in the next stage with other meteorological elements.