Strategic Alliance for the Development of Climate Services in Spain between AEMET and CSIC

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Abstract

Climate services are information systems that convert basic climate data into specific indicators for sectors such as health, agriculture, environment, risk management and renewable energy production, among others. In a society that must adapt to changing climatic conditions, these services are essential tools for making informed decisions about the risks of climate variability, supporting both strategic planning and operational risk management. The Interdisciplinary Thematic Platform for Climate and Climate Services (PTI-Clima) of the Spanish National Research Council, together with the Spanish State Meteorological Agency (AEMET), have joined forces in the project 'Development of operational climate services'. The main objective is to create a climate information system with ten thematic services, thus expanding AEMET's tools in areas of great relevance. The ten climate services include: 1. Seasonal climate prediction: seasonal forecasts and quantifies uncertainties. 2. Meteorological risk of forest fires: estimation of fire risk in real time and in future scenarios. 3. Meteorological drought: drought monitoring and prediction in the short and medium term. 4. Agro-climatology: continuous monitoring of agro-meteorological conditions. 5. Climate change indicators: climate change assessment and monitoring. 6. Extreme temperature events: information on cold and heat waves in real time and in historical series, and short-term forecasting. 7. Extreme precipitation events: historical information and monitoring of high intensity rainfall events. 8. Wind: monitoring of wind speed and direction and its energetic and climatic impact. 9. Radiation: real-time monitoring of radiation and its relation to health and energy. 10. Attribution of extremes to climate change: quantification of the influence of climate change on the intensity and frequency of extreme events. Keywords: climate services; adaptation; indicators; risk management; decision-making. Acknowledgements: This research work has been funded by the Ministry for Ecological Transition and the Demographic Challenge (MITECO) and the European Commission NextGenerationEU (EU Regulation 2020/2094). PRESENTATION TYPE: Poster

Quality Assurance of extreme observational data

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Abstract

How should quality assurance be carried out to underpin extreme observational data of regional or national significance? The measurement process is one that requires rigour throughout its chain of activities, as such when notable extremes occur an extra layer of Quality Assurance (QA) is performed. In addition to this requirement, real time and near real time media and other stakeholder interest has grown significantly over the last 5 years, requiring this quality assurance process to be enacted as soon as these instances are alerted. This activity is carried out by a cross discipline team of operational subject matter experts in the form of the Site Weather Assessments Team (SWAT). This summary paper seeks to lay out the considerations and steps to the completion of this process, including;

- Detection and communication of extremes in near real time.
- Instrument conformance
- Installation conformance
- Exposure consideration
- Observer application.
- Processing.
- Quality Control

As a product of the application of the process, time is then dedicated to the capture of evidence and clear conclusions, in order to enable review of these important events, either today or in the distant future. Too often re-review is difficult without an understanding of which information was available to the operators at the time, compared to that available on re-review. These summaries, published to the national Met Office archive are then made available to the public. This forms an important, but flexible process to ensure Quality Assurance across a complex chain of activities which contribute to the rigour of this data.

PRESENTATION TYPE: presentation

From Archives to Analysis: Data Rescue for Assessing Poland's Long-Term Climate Variability

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Abstract

Long-term climate variability is one of the key issues in the context of the currently observed global warming. The limited availability (in terms of temporal coverage) of both quality-verified observational data and reanalyses means that systematic monitoring is, at present, available mostly from the mid-20th century onward. This applies especially to Poland, whose history in the 18th and 19th centuries deprived it of statehood, and whose territory was under the rule of three different powers for over 100 years. The aim of this work is to expand the database and knowledge of climate changes in Poland during the period before 1919—that is, before the establishment of the State Meteorological Institute. Historical measurement materials (1851–1918) from meteorological stations located in the territories of the three partitions—Prussian, Russian, and Austrian—are being digitized. This includes both the measurement results themselves and the necessary metadata, also covering instructions on how measurements and observations were carried out. This will make it possible to extend existing climatological time series and enhance knowledge about instrumental measurements in the 19th century. Preliminary results are promising. Combining these three data sources will enable the creation of a series of at least monthly area-averaged air temperatures and monthly area-averaged precipitation totals. Developing a synthetic index of climate variability is the final goal of this study. The obtained data will make it possible to assess climate variability in previous decades and to evaluate the long-term variability in the occurrence of so-called extreme events.

PRESENTATION TYPE: presentation or poster

Methodological Evaluation of Temperature and Precipitation Extremes in Central Europe Using Gridded Observation Datasets and Reanalysis Products

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Abstract

As climate warming progresses, changes in air temperature and precipitation patterns across Central Europe (CE) are altering the frequency, intensity, and spatial distribution of extreme events. These changes necessitate robust assessment tools due to the hazards posed by such extremes and their relevance for improving climate projections. This study conducts a methodological evaluation of the representation of temperature and precipitation extremes within two reanalysis datasets (ERA5, ERA5-Land) and two gridded observational products (E-OBS and a newly developed high-resolution CE dataset), using insitu station data as a reference. The analysis focuses on daily maximum and minimum temperatures (Tmax, Tmin) and daily precipitation totals (RR) for the period 1961–2024, covering Poland, Czechia, Slovakia, and eastern Germany. Extremes are identified using both absolute and percentile-based thresholds. The new CE dataset incorporates homogenised data from approximately 500 climate stations and 1000 rain gauges, offering 2×2 km resolution. Validation includes point-to-grid comparisons and areal buffer analyses, with cooccurrence statistics (e.g., hit rate) and standard metrics (e.g., correlation coefficients, bias estimation, cross-validation) applied to assess spatial and intensity characteristics. Results underscore the influence of topographical complexity on dataset performance, reinforcing the importance of high-resolution, locally tailored datasets in environmental modelling and climate impact assessments.

PRESENTATION TYPE: presentation

Optimizing Climate Services for High-Demand Use Cases: The Experience of the Meteorological Service of Catalonia with Insurance-Related Reports

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Abstract

The Meteorological Service of Catalonia (SMC) is responsible for providing reliable climate data and products to the public, private companies, and government administrations in Catalonia (northeastern Spain). Among its most requested services are meteorological reports related to insurance claims. The Climate Services Team (CST) has processed an average of over 4,000 requests annually, peaking at nearly 6,000 in 2020 following Storm Gloria — most related to wind and rainfall events. Producing these certificates individually has required significant time and contributed to longer response times. To address this challenge, a new operational workflow was implemented in 2023, consisting of three steps: anticipating demand, generating reports efficiently, and ensuring open access. First, a daily algorithm identifies the municipalities from which meteorological report requests are most likely to originate. It combines daily maximum wind gusts, rainfall rates, accumulated precipitation, and population data. To focus on areas with higher demand, only municipalities with more than 10,000 inhabitants are considered. To ensure data quality, the algorithm uses meteorological data from two days earlier. This delay gives the quality control team enough time to validate the observations before they are used. Then, a web-based application streamlines the creation of meteorological certificates. This tool integrates data from automatic and manual weather stations, radar-based rainfall estimates and hail probability products, all within a single user-friendly interface. This consolidation facilitates the selection of the most representative data for a given municipality and date, resulting in a standardized and consistent certificate. In most cases, certificates are prepared within the same week of the event, allowing the team to anticipate user demand and publish the certificates before the majority of requests are submitted. Finally, certificates are published on the SMC website and made freely accessible. Users simply select their municipality and can download all available certificates from the past two years. If a certificate is not available for a given location or date, it can still be requested and will be provided regardless of the municipality's population. This new workflow has led to measurable improvements. In 2024, a total of 2,206 certificates were made, covering 442 different municipalities (nearly half of the 947 in Catalonia). Despite the continued growth in the number of requests that year, average response times were reduced from over 15 days in 2021 and 2022 to just 8 days in 2024. The website received nearly 5,000 unique views and 4,600 downloads. The standardized format also improved usability — allowing the same certificate to serve multiple users — and representativeness, especially for convective events where the nearest station is not necessarily the most representative.

PRESENTATION TYPE: presentation

The Italian data rescue projects by the AISAM Association

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Abstract

Italy has played a pivotal role in the history of meteorology, from the invention of several key instruments to the establishment of one of the first international observation networks. As a result, a vast and valuable archive of meteorological data has been accumulated in Italian repositories over the past three centuries. Despite various initiatives and projects that have contributed to rescuing parts of this heritage, a substantial portion of these records remains available only in paper format. These paper archives are at risk of deterioration over time, posing a threat to the loss of data of inestimable value for scientific research and for a wide range of applications in meteorology and climate science, including climate change assessment. This study presents a list of recent projects in which the Italian Association of Atmospheric Sciences and Meteorology (AISAM) has played a central role in national data rescue efforts over the past decades. The first is the Cli-DaRe@School, a Citizen Science project, launched in 2022, which aims to digitize previously unexploited Italian meteorological observations not yet available in digital format. The project focused on digitizing four monographs published by the Italian Hydrographic Service containing monthly temperature and precipitation data for the Italian territory. The temperature records span the period 1926–1955, while the precipitation data refer to the years prior to 1950. Over two academic years, more than 500 students from over 10 high schools contributed to the digitization effort, resulting in approximately 7,931 station records being made available. The second is the Dieci e Lode project, carried out during 2024–2025, which aimed to rescue and digitize meteorological data collected in former Italian colonies and territories. Among the unrecovered materials, a particularly significant subset includes data from regions administered by Italy at various times between the late 19th and early 20th centuries, including Eritrea, Somalia, Ethiopia, Libya, the Dodecanese Islands, Albania, Dalmatia, and Istria. The project undertook an extensive search for meteorological records from these areas, covering the relevant historical periods. The third initiative, the Cli-DaRe@Images, launched in 2024 and currently ongoing, aims to educate and raise awareness among high school students in the Trentino region about climate change through the recovery of historical climate data. Specifically, it seeks to digitize meteorological records preserved at the San Bernardino Library in Trento.

PRESENTATION TYPE: presentation

Advancements in Precipitation Observations Preprocessing for MET Nordic Version 4

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Abstract

MET Nordic is a gridded dataset developed by the Norwegian Meteorological Institute (MET Norway) for near-surface meteorological variables at a 1 km resolution for Scandinavia, Finland, and the Baltic countries. It is publicly available at https://thredds.met.no/thredds/metno.html, with documentation at https://github.com/metno/NWPdocs/wiki/MET-Nordic-dataset. The dataset includes variables such as temperature at two metres, precipitation, sea-level pressure, relative humidity, wind speed and direction, global radiation, long-wave downwelling radiation, and cloud area fraction. The first version of MET Nordic was released in 2018 to support applications like civil protection and public weather services (e.g. Yr.no). The dataset integrates forecasts from the MetCoOp Ensemble Prediction System (MEPS) and observations from various weather stations: conventional stations that adhere to World Meteorological Organization (WMO) standards, non WMO compliant stations, and crowdsourced data from opportunistic measurements and personal weather stations (PWS). These additional data sources, when quality-controlled and corrected, contribute to better analyses and short-term forecasts. The focus of version 4 of MET Nordic is to enhance the preprocessing of precipitation data. PWS hourly precipitation data were compared to WMO observations, demonstrating general agreement but with PWS underestimating the precipitation, particularly during intense events. To address this, a quantile-quantile mapping was applied to PWS data. Furthermore, a method originally designed for wind-induced precipitation undercatch correction using only station observations was adapted to combine model-based meteorological fields with observations. These adjustments aim to reduce systematic errors in hourly precipitation analyses; however, one must be aware that while they improve average performance, they may also introduce greater uncertainty in individual cases. The quality control of all the observations is based on Titanlib, our in-house library available at https://github.com/metno/titanlib, which employs a range of validation techniques, including basic range checks and advanced spatial consistency tests using Bayesian inference. Test parameters in Titanlib are fine-tuned to account for variations in station quality, as well as differences in observation density, ranging from areas of very high station density to regions with sparse coverage. The spatial analysis method has also been updated in version 4. The new Ensemble-based Statistical Interpolation (EnSI), implemented in the GridPP post-processing tool and available at https://github.com/metno/gridpp, combines model output and observations in a multi-scale framework. A "started" Box-Cox transformation is applied to precipitation data so it produces a variable that more closely follows a Gaussian distribution. EnSI was evaluated using 231 heavy precipitation events, including a reconstruction of hourly precipitation and temperature during the 2023 "Hans" extreme weather event in Scandinavia. Results show that the multi-scale approach improves both accuracy and precision compared to a single-scale scheme.

PRESENTATION TYPE: presentation

Climate Data Rescue: New centennial station Klagenfurt

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Abstract

Increasing interest in climate change and interpreting current changes in the light of past climate developments leads to an increased urgency of extending existing time series back into the past as far as possible (Kwok, 2017). This activity is also useful to improve existing reanalysis products and assess performance of climate modelling (Brunet and Jones, 2011). Therefore, Data Rescue (DaRe) became an increasing priority in climate departments of National Meteorological Services (NMS) and one main research topic of the World Meteorological Organization (WMO). Through climate data rescue initiatives, GeoSphere Austria has systematically digitized a vast array of historical climate records, including daily temperature, precipitation, and sun duration data from several decades. This process involves imaging original climate sheets and using specialized software tools for data entry and quality control. The time series of Klagenfurt is an outstanding example of data rescue. Monthly climate data sheets were found in the archive at our regional office in Carinthia and transported over 300 km to the headquarter of GeoSphere Austria. The station's history (locations, equipment, measuring instruments) as well as the quality of observations and measurements, was documented and stored in our central database, the MIDB (Meta Information Data Base). The first step of data digitization included the imaging of more than 3.000 climate data sheets - mainly summarized in anthologies ("Klimabogensammelbände"). Analysis of the recordings showed a continuous and almost complete time series in the period 1830 to 1938. To shorten work processes and save resources, AI-supported systems and software solutions were considered and evaluated. Initially, Transkribus seemed to provide the framework conditions and requirements, such as the encoding of Kurrent as well as the decoding and reading of data values in tabular form. Tests with AI Transkribus, have shown that the software does not fulfil our requirements. Teaching and training the AI proved to be impractical and very time-consuming. After a two-month trial phase that yielded unsatisfactory results, this approach of digitization was stopped and the original method of keying the data into DCT (Data Correction Tool – a digitalization and data quality control system of historical data at GeoSphere) was reintroduced. Currently we are working back chronologically and entering data values from the 1880s. The primary objective is the Implementation and publication of the Klagenfurt 1830-ongoing time series in the framework of the WMO program centennial observing station (https://wmo.int/activities/centennial-observing-stations), in addition to providing a new data set to the community for further analysis of historic climate data (climate change, extreme value analysis,.). Therefore, this presentation gives a short overview on the DARE activities carried out at our institute, giving examples of digitalization and quality control methods with a special focus on the long time series of Klagenfurt.

PRESENTATION TYPE: Presentation or Poster

Detecting inhomogeneities caused by methodological changes using MASH software

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Abstract

At HungaroMet's Climate Research Department, we update our climate database annually with the previous year's measurements. Homogenisation, gap filling, and quality control are carried out using the MASH software. Monthly data series are homogenised through a step-by-step procedure based on the principle of relative homogeneity testing, which compares the values of a given climatic element across several meteorological stations for a given period. The roles of the series (candidate or reference) are rotated within an automated statistical decisionmaking process. Depending on the variable, either an additive model (e.g. temperature) or a multiplicative model (e.g. precipitation) is applied. The semi-automated procedure implemented in MASH ensures the homogenisation of not only monthly, but also seasonal and annual time series. When assessing the homogeneity of daily data, the method relies on the monthly-level breakpoints identified earlier. Daily data validation is also performed automatically, generating representative station series through MASH. The software produces verification statistics as part of the process, which can support meteorologists in identifying the causes of inhomogeneities. In our presentation, we briefly outline the mathematical basis of breakpoint detection and MASH's decision algorithm. We also demonstrate cases where the detected breakpoints can be attributed to changes in observing cycle. For instance, we investigate how the transition from three daily observations to hourly measurements affects the continuity of the data series. The magnitude of the resulting breakpoint, as detected by MASH, is analysed for selected meteorological elements and stations.

PRESENTATION TYPE: presentation

Data rescue of early historical meteorological observations from Ireland

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Historical meteorological observations are crucial for better assessing past climate variability and trends in the frequency, intensity, duration, and distribution of extreme weather events, and for placing the current climate change into historical context. Specifically, long-term highresolution data at daily and hourly scales are essential for a more accurate assessment of past and rare extreme weather events. Historical meteorological observations are crucial for generating climate products, such as reanalysis and gridded datasets. Ireland has a great heritage of early historical instrumental meteorological observations. This presentation will primarily focus on four meteorological collections which have been rescued:

1) Meteorological observations from over 40 locations in Ireland in the archives of the Royal Irish Academy (1783-1854). The meteorological records include observations of air temperature, maximum and minimum air temperatures, dry and wet bulbs, sea temperature, rainfall, pressure, wind direction and force, cloud cover, cloud form, tension of vapour and weather remarks.

2) Meteorological observations from over 40 locations in Ireland registered from 1808 to 1939 and rescued from newspapers. Observed variables include maximum and minimum air temperatures, dry and wet bulb temperatures, rainfall, pressure, wind direction and force, maximum air temperature in the sun, humidity, cloud cover, and state of the weather as qualitative remarks. It is very important to make these observations published in newspapers available since the majority of the original manuscripts are not traceable.

3) Meteorological observations from Dunsink Observatory from 1818 to 1850.

4) Meteorological observations from The Linen Hall, Belfast, from 1796 to 1895. Many well-known historical extreme weather events in Ireland are covered by the instrumental or documentary weather remarks in the meteorological records, such as air temperature extremes and storms. The metadata and data of these meteorological collections have been rescued and will be made available as open-access in upcoming peer-reviewed publications and datasets.

Avoiding the Gordian Knot – the challenges and potential from an Archives point of view

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Abstract

Environmental data archives are a goldmine of unrecovered data with transformative potential for climate science. The National Meteorological Library and Archive has been actively supporting Data Rescue activities for over a decade. and holds a vast resource of UK and global meteorological data. For the UK the archive holds an extensive weather record from the 1850s to present covering all of the key weather elements including pressure, temperature, wind, rainfall and sunshine. Alongside this sits an extensive metadata collection covering which enables scientists to build an accurate picture of the history of observing sites and observations. Data rescue activities have been an increasing focus for around a decade and are now one of the key activities of the archive. This brings challenges for strategy – data rescue is costly and dependent on the current limits of technology, and resources – data rescue is time consuming, even if sending materials off site for imaging. This paper demonstrates how the Met Office National Meteorological Archive (NMA) has managed large scale imaging processes; how data from the National Meteorological Archive has already been used for innovative climate science including new rainfall datasets and storm modelling using 20CRv3; and the enormous potential and challenges that lie ahead as the AI revolution continues apace. This will include file management, long term preservation of imaged files and the need to start preparing the way for the outputs from AI transcription to avoid creating a data rescue Gordian knot.

PRESENTATION TYPE: presentation

Climate Data Rescue in Ireland

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Abstract

Met Éireann, Ireland's National Meteorological Service, maintains the National Climate Archive, a repository of paper and digital climate records dating from the early 1800s to the present day. The archive contains an extensive collection of historical weather observations that include meteorological registers, rainfall registers, climatological reports, weather diaries, monthly weather bulletins and maps. These historical records provide valuable insights into long-term trends and variability, helping to refine climate models and inform policy decisions. However, many early meteorological observations remain undigitised, inaccessible, or at risk of degradation. This presentation will outline ongoing efforts to recover and digitise Ireland's historical weather observations and highlight why historical weather rescue is important. The talk will present examples of past and ongoing data rescue projects that have been undertaken through interdisciplinary collaboration. It will show examples of how the rescued data has been utilised, demonstrating the value of the observations. It will discuss challenges in data rescue and solutions that leverage innovative digitisation techniques and community engagement. In particular, the launch of Met Éireann's Irish Weather Rescue project – a citizen science project to rescue historical daily rainfall observations from stations across Ireland.

PRESENTATION TYPE: presentation

Deep Neural Networks for the quality control of meteorological observations

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Abstract

Reconstructing near-surface weather variables—such as temperature, precipitation, and humidity—can be done using various methods. Traditional approaches include geostatistical techniques like Kriging and methods from inverse problem theory, such as Optimal Interpolation. More recently, machine learning has also been used for this task. At MET Norway, we collect hourly observations from personal weather stations (PWS). These stations provide large amounts of data, especially for temperature, which has been used in operational weather forecasts on Yr.no since 2018. Compared to standard observation networks, PWS data increase the number of available samples by a factor of 50 or more. However, since they are typically operated by private individuals, these data also come with challenges, including variable quality and inconsistent measurement conditions. In this work, we apply a neural network model to estimate hourly values of atmospheric variables at a given location, using data from the 20 nearest stations. The model provides both an expected value and an uncertainty estimate. It is based on a method originally developed for improving numerical weather forecasts and outputs a full probability distribution using quantile functions. These functions are modeled with Bernstein basis polynomials, and the neural network predicts their coefficients. We use Python with the JAX library to implement the model, and training is done on a single Nvidia A30 GPU with 24 GB of RAM. Our domain includes Fennoscandia and the Baltic states, and we train separate models for each month using hourly temperature data from January 2020 to July 2024. Each monthly dataset contains between 145 and 180 million samples. Details about the training setup will be shared in the presentation. This project is ongoing. We are currently exploring key questions: How accurate are the predicted values? Are the uncertainty estimates reliable? Does including additional time and location information improve performance?

PRESENTATION TYPE: presentation

Climate Data Storage – simple, consistent and traceable

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Abstract

In this presentation we will review the Met Office approach to storing in situ climate observations and we will describe new developments to improve, rationalise and simplify the systems we use. There are three are three key systems used for climate data storage at the Met Office: a) a database of the original observations, b) a database of the 'best available daily value' for each station, date and variable, and c) a database of monthly statistics. These are all Oracle relational databases but they were developed at different times using different technologies and with different use cases in mind. We are currently designing a replacement for the database of monthly statistics. There are various challenges that need to be addressed in this redesign: - Multiple use cases (data storage, QC, user applications) - History (legacy systems, diminishing knowledge, evolving IT) - Resources (staff, infrastructure) - Dependent systems (derived datasets, internal/external web sites, customer services) - Different data origins (calculated values, rescued data) - Data licensing In our new system we are aiming for something that is modern, simple, consistent, efficient, traceable, flexible and scalable. We will present some of the thinking behind our decisions, describe the design we eventually chose and provide an update of progress with the development work.

PRESENTATION TYPE: presentation or Poster

The ACMANTv6 homogenization method dpeterfree@gmail.com

Abstract

ACMANT is a relative homogenization method for removing non-climatic biases from daily and monthly climatic time series. It can be applied to the homogenization of temperature, precipitation amount, relative humidity, wind speed, wind gust, sunshine duration, radiation and atmospheric pressure. Inhomogeneous time series are modelled by homogeneous sections between consecutive breaks, although the bias may vary according to seasons and percentiles of the probability distribution. In all parts of the method, the evaluation of the common effects of multiple breaks on the long-term trends and variability is prioritized. ACMANTv6 runs fast, it includes automatic network construction for selecting time series of a given climatic region, and it can be applied to huge datasets. The method includes outlier filtering, highly tolerates missing data and infill data gaps by spatial interpolation. ACMANTv6 has both automatic and interactive versions. The method includes 3 main homogenization cycles, and additional operations thereafter. In each of the main cycles a time series comparison step, a break detection step and adjustments for inhomogeneity bias removal are performed. The default mode of the time series comparison is the use of composite reference series, while the combined time series comparison method is included in the first cycle. Breaks are detected by the Caussinus-Mestre maximum likelihood method, while Benova is applied for the removal of inhomogeneities. The second and third homogenization cycles include ensemble homogenization for the estimation and consideration of uncertainty ranges in the homogenization results. In the first two cycles only annual and monthly data are examined, and the homogenization results are downscaled to daily data only in the third cycle. ACMANT considers the seasonal variation of inhomogeneity biases. From ACMANTv5, the method can use metadata either in automatic or interactive mode. The main novelty of ACMANTv6 in comparison to the earlier versions is that this method includes the homogenization of probability distribution. The HPDTS (Homogenization of Probability Distribution for Time Series) method has been developed for evaluating the joint effects of multiple breaks on the inhomogeneity biases of the probability distribution. HPDTS uses the homogenized time series and the list of detected breaks of the ACMANT procedure coming from the segment for homogenization of the section means. Then the significance of percentile dependence of inhomogeneity biases is evaluated for each break, and significant breaks are subjected to a procedure similar to Quantile Matching (QM). However, HPDTS has at least three important differences from QM: i) Always the best correlating neighbor series are used, disregarding possible breaks in them; ii) The final adjustment terms are calculated by the equation system Cenova, which is an imperfect version of Benova for the inhomogeneity bias removal from discontinuous time series; iii) The homogenization results for section means remain unchanged.

PRESENTATION TYPE: presentation

Facilitating data rescue initiatives

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Knowledge about past climate and extreme weather events is an essential part of understanding future climate change and variability. KNMI is involved in multiple data rescue efforts to uncover the past, which we would like to highlight.
KNMI manages and maintains the web-based portal (https://datarescue.climate.copernicus.eu) with practical information, current data rescue (DARE) projects and metadata inventories that originated from initiatives of both the World Meteorological Organization (WMO) and Copernicus Climate Change Service (C3S). News items with developments from the community are published on this portal on a bi-monthly basis. One of the main features is the opportunity to highlight your data rescue project. By making your efforts known and publicly available, chances are decreased that the same data is rescued twice by other groups. Additionally, we encourage owners of rescued data to share this in a global repository, such as the C3S Global Land And Marine Observations Database, so that the valuable data will not get lost again and is made available for use in e.g. the ERA6 reanalysis.
The C3S Datarescue work package contributes and monitors efforts on using Artificial Intelligence (AI) and Deep Learning for Optical Character Recognition (OCR) to aid data rescue efforts. The development of a data rescue image repository by C3S is in line with future methods to retrieve valuable meteorological data from scanned paper records with OCR.
Within the context of the International Panel on Deltas, Coastal areas, and Islands (IPDC) project, KNMI will advise the National Meteorological Services (NMSs) on the islands of Aruba, Curacao, and St. Maarten on digitization efforts. Additionally, the International Climate Assessment and Dataset (ICA&D) allows for encouragement and individual training on global data rescue efforts.

Analysis of Ankara's Sectoral Climate Indices: Agricultural Frost, Hail, Flood, Drought Damages and Protection Recommendations

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Abstract

This paper aims to evaluate the sectoral impacts of climate change on the province of Ankara by analyzing climate indices derived from daily maximum, minimum temperatures and precipitation data covering the period 1960–2020. Using the ClimPACT software recommended by the World Meteorological Organization (WMO), 11 sector-specific climate indices with significant relevance to agriculture, food security, health, water resources, and energy were examined in detail. Over the past six decades, Ankara has experienced a rising trend of 5.3°C/100 years in average annual temperatures and an increase of 61 mm/100 years in annual total precipitation. Indicators related to extreme heat, such as consecutive dry days (CDD), frost days (FD0), tropical days (SU30), extremely hot days (SU35), tropical nights (TR20), heatwave duration (CTX90-HWD), hot days (TX90p), growing day degrees (GDDgrow), growing season length (GSL), heavy rain days (R20mm) and annual rainfall total (PRCPTOT) have shown notable increases. In contrast, the number of frost days (FD0) has decreased by approximately 32.5 days per century. The growing degree days (GDDgrow) and growing season length (GSL) also exhibit positive trends, offering opportunities for extended agricultural activity but also introducing new risks such as early blooming and inadequate winter chilling. The paper also addresses the growing frequency and intensity of climaterelated disasters—particularly drought, intense precipitation, hail, and agricultural frost—in Ankara. Adaptation strategies such as efficient water use, transition to modern irrigation systems (drip and sprinkler), selection of drought-resistant crops, and disaster risk reduction planning are recommended. In conclusion, this sectoral climate index analysis provides a scientific basis for understanding the local impacts of climate change in Ankara. It offers evidence-based guidance for policymakers and practitioners on risk management, adaptation, and resilience planning. Keywords: Climate change, climate indices, agriculture, Ankara, ClimPACT, sectoral impact, adaptation strategies, disaster risk
PRESENTATION TYPE: presentation

Reanalysis Datasets for Climate Services in Italy: Validation and Inter-Comparison

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Abstract

Climate change intensifies the need for reliable and accessible data to monitor and understand the evolution of atmospheric phenomena. Meteorological reanalyses provide a valuable contribution in this context by offering spatially and temporally consistent gridded datasets that help address the limitations of traditional observations, such as data gaps and spatial inhomogeneity. These features make reanalyses a cornerstone of modern climate services, supporting planning and impact assessment in sectors like water resource management,renewable energy,andurban planning.
This contribution presents a comparative analysis of major reanalysis datasets available over Italy, focusing on two essential climate variables: surface air temperature at 2 meters (t2m) and total precipitation (tp). We review both global products, such as ERA5, produced by ECMWF at ~31 km resolution, and its land-focused refinement ERA5-Land (~9 km), and a suite of regional reanalyses developed by various Italian institutions through dynamical downscaling of ERA5. These include MERIDA and MERIDA-HRES (RSE, 7 km and 4 km), MOLOCH and BOLAM (LaMMA, 2.5 km and 7 km), SPHERA (ARPAE, 2.2 km), VHR-REA_IT (CMCC, 2.2 km), and MORE (ISAC-CNR, 1.8 km), many of which explicitly resolve convection.
To fully harness the potential of reanalyses, it is essential to validate them against high-quality observational datasets. For temperature, the validation covers the period 1991–2020, using a gridded reference derived projecting weather station data onto each reanalysis grid and elevation, to account for different orography representation. This approach enables evaluation at each reanalysis resolution and reveals a general cold bias of approximately 0.5–1 °C, particularly pronounced in winter over the Alpine region. In most cases, climatological (systematic) deviations account for the largest share of the total error, while errors in anomalies (daily variability) are comparatively smaller. Furthermore, reanalyses reproduce trends in some climate indices, such as tropical nights (Tmin > 20 °C), and identify areas of intensification in line with observed patterns.

For precipitation, analyses are conducted over the common period 1995–2019. A wavelet-based spectral analysis reveals the superiority of convection-permitting reanalyses in capturing precipitation events at scales below 10 km, while frequency analyses show that ERA5 tends to underrepresent daily rainfall exceeding 20 mm.

Comparisons against weather stations highlight how higher resolution can introduce spatial misplacements of convective precipitation, especially in summer. Climatological comparisons reveal systematic wet biases in northern Italy during spring and summer, and dry biases in the south during autumn and winter. Annual accumulated precipitation trends also show differences across products and against observations, suggesting caution when using reanalyses for long-term climate trend analysis.
This work underscores the importance of rigorous, scale-aware validation of reanalysis data to identify product-specific strengths and limitations. Such insights are essential to improve climate data quality and ensure informed use in both scientific and operational contexts.
PRESENTATION TYPE: presentation

Automatic Quality Control of temperature and relative humidity observations from a high-resolution network composed of institutional and amateur weather stations

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Abstract

In Italy, CIMA Research Foundation collects observations from local (regional) public environmental monitoring agencies composing a high-resolution national network for the governmental Civil Protection Department (DPC). Moreover, the Meteonetwork (MNW) association collects and makes available observations from stations owned, operated and maintained by private citizens.

In this work a fully automatic Quality Control (QC) procedure is applied to both datasets to obtain a unified and reliable nation-wide high-resolution network of 2-m temperature and relative humidity observations. The procedure includes metadata validation and quality checks on observed values. Metadata validation regards station geographical coordinates, which are checked to detect duplicate stations and data series, and station elevation, which is compared with high resolution digital elevation models. QC checks on observed values are formulated in an Optimal Interpolation context and include a preliminary "background field" (BF) check and a finer Spatial Consistency Test (SCT, Lussana *et al.*, 2010), based on the availability of the leave-one-out Cross-Validation (CV) analysis. QC checks are performed on temperature and relative humidity observations.

The QC procedure is systematically applied before the verification routine performed every month to 00-48 hours numerical weather forecasts operationally running at CIMA. Among all QC-accepted observations, only those with elevations not too different from model orography are selected to that purpose (DZ selection).

The IDI (Integral Data Influence) value and the leave-one-out Cross Validation IDI, CV-IDI, are combined to define a measure of observational redundancy that can be used for data thinning, appropriate for data assimilation. In fact, the QC checks, the DZ selection and the IDI thinning have been used to define a joint (DPC+MNW) 2-m temperature dataset used in assimilation experiments, set in August 2024, with the WRF model in its CIMA operational configuration.

PRESENTATION TYPE: presentation

Stations' Quality Estimate based on the Comparison of Original and Corrected Climate Data

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Abstract

Modernisation of weather observational network at Croatian Meteorological and Hydrological Service (DHMZ) began in 2017. The establishment of modern and high quality system of automatic surface meteorological stations has been leading to the decrease of number of conventional climatological stations. The purpose of this study is to estimate the quality of conventional climatological stations in order to keep the higher quality stations working for as long as possible for parallel measurements.

Dataset from 2008 to 2024 for 82 stations is used in this study. Original and corrected temperature data are compared and the total number of corrections per station is determined. Based on the total number of missing, rejected, corrected and interpolated data, climatological stations are arranged from those with the least corrections to the stations with datasets where data are the most often corrected. The worst and the best stations are easy to detect, but there are a lot of similar results in between, therefore it's necessary to look more deeply into the data from the last few years of measurements for each station. While choosing which stations to close first, efforts will be made to close them in order from the lowest to the highest quality climatological stations.

PRESENTATION TYPE: presentation

Hands on WIS 2.0

WIS2.0, GTS, global data exchange

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Abstract

This oral presentation aims to share insights gained during the transition period from the Global Telecommunication System[1] (GTS) to WMO Information Systems 2.0[2] (WIS2) at GeoSphere Austria. The objective is to provide valuable lessons and assist other meteorological services in avoiding common pitfalls. Additionally, the presentation seeks to deepen the understanding of WIS2 through hands-on sessions with FOSS (free and open source software) tools.

The presentation commences with a concise overview of the WIS2 network, particularly focusing on global brokers, WIS2 nodes, and their connection. Subsequently, an interactive session offers the audience the opportunity to engage individually with WIS2 using FOSS tools (e.g. mosquitto[3], pywis-pubsub[4], wis2box[5]). During this hands-on experience, participants will explore the structure of WIS2 topics and the structure of WIS2 messages.

Next, WIS2 is compared to the GTS system, particularly highlighting the differences between GTS headers and WIS2 topics. Subsequently, various FOSS tools capable of handling BUFR format (e.g., pybufrkit[6], libecbufr[7], ecCodes[8]) are showcased. Furthermore, different software combinations are presented that facilitate the implementation of ETL (extract transform load) processes, such as data storage in databases.

PRESENTATION TYPE: presentation

Detection and correction of the weekend effect in daily precipitation series

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Abstract

Manual precipitation observations have been traditionally made by measuring the water accumulated in Hellmann or similar rain gauges. This implies that, when the observer has not been able to take the measurement in one or more consecutive days, the following reading will include the total rainfall of those days. When the observer reports those incidents, the missing observations may be assigned an accumulation code in the precipitation series ('-4' in AEMET climate database) to have in account these events in any further statistical treatment of the data. The problem is that these accumulations preclude the correct evaluation of monthly statistical parameters such as the maximum amount of daily precipitation or the number of days with rainfall higher that preset thresholds. One way to overcome this difficulty is using the homogenization function homogen included in the climatol R package, which can be called setting the cumc parameter equal to the cumulation code used in the series. By doing so, homogen will redistribute the accumulated precipitation among their corresponding days proportionally to their estimated values calculated from nearby stations. While these adjusted values do not substitute the cumulation codes in the database, they facilitate the calculation of the aforementioned monthly statistical parameters. However, sometimes observations in cooperative stations located in administrative offices may be skipped systematically on weekends without noting in their monthly precipitation reports. In case there is a suspicion that this can occur in some series at some time, a new function weekendaccum has been added to the climatol version 4.2 to detect this events. It is based in the calculation of differences between the frequencies of zero precipitation of every week day with the mean of those frequencies in the 1, 2 and 3 previous days. This test is applied station by station and year by year and, when this difference is higher than a threshold linked to a prescribed significant level (0.01 by default, empirically calculated by a Montecarlo method), those preceding days will be assigned the chosen cumulative code cumc (-1 by default) if and only if the precipitation of all those preceding days is zero. In this way, ulterior application of the homogen function with the same cumulative code will distribute the accumulated precipitation into their corresponding days, allowing a more reliable estimation of monthly statistical precipitation values.
PRESENTATION TYPE: presentation

Interpolation of Wind Variables Using the MISH Software: A Data-Driven Climatological Approach

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Abstract

In meteorology, the availability of long-term station data offers a unique opportunity to model climate statistical parameters both in space and time. The MISH system (Meteorological Interpolation based on Surface Homogenized Data Basis), developed at the HungaroMet Hungarian Meteorological Service, uses these long data series to achieve optimal spatial interpolation for various meteorological variables. Unlike conventional GIS-based geostatistical methods, MISH combines deterministic and stochastic modelling with homogenized climate data, enabling statistically robust interpolation that accounts for spatial patterns and seasonal characteristics of the variables. While the application of MISH for temperature and precipitation has already been presented in several Hungarian and international publications, its use for wind variables – such as wind speed, wind direction, and wind gusts – remains less documented. This poster introduces the theoretical framework and practical aspects for applying MISH to surface wind variables. We discuss the mathematical principles of interpolation using additive or multiplicative models based on the underlying probability distribution of the target variable. Furthermore, we present the wind profile model integrated into MISH, which allows conversion of wind speed data measured at different heights to the 10 m reference height – or to any specified height, using roughness length and wind profile model parameters. The poster provides examples of the application of MISH to wind variables in Hungary, using both daily and monthly homogenized datasets. We also highlight how background information, such as forecast outputs can be incorporated to enhance interpolation quality. This work underscores the importance of integrating climatological insights into data management practices, especially when spatial interpolation of complex meteorological variables is required. This research was supported by the EKÖP-KDP-24 University Excellence Scholarship Program (Cooperative Doctoral Program) of the Ministry for Culture and Innovation, funded by the National Research, Development and Innovation Fund.

PRESENTATION TYPE: presentation

Determination of solid precipitation occurrence using ALADIN model outputs

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Abstract

Due to the declining number of meteorological observers at the Czech Hydrometeorological Institute, it is necessary to find alternative methods for determining the presence of meteorological phenomena at individual stations. In addition to satellite and radar measurements, webcams, and weather detectors, outputs from the ALADIN numerical weather prediction model represent a potentially suitable data source for such tasks, including the assessment of the solid precipitation occurrence in the Czech Republic. To estimate the probability of solid precipitation occurrence at an hourly resolution, four ALADIN model runs are used for a given location and day, available at 6-hour intervals. The parameter ALADIN_SNOW, representing the model-based probability of solid precipitation occurrence, is calculated as a weighted percentage of the positive predictions among the four assessed model outputs. The weights are assigned based on the time interval between the observation and each model run. A detailed validation of this approach was conducted using six years of manual professional observations of solid precipitation phenomena from four different stations in the Czech Republic, two located at an altitude above 1 000 m, and two below 500 m. At 24h and 6h resolution, the total number of correct predictions ranges between approximately 85 % and 92 %. However, at 1h resolution, the model is less accurate. The number of correct predictions varies depending on the station characteristics and the selected threshold of the ALADIN_SNOW parameter. The most commonly missed snow events (false negative predictions) are typically short in duration and low in intensity, often occurring at temperatures near or above 0 °C. In the next phase, the model will be thoroughly evaluated at approximately 150 stations across the Czech Republic, taking into account each station's geographic location and altitude.

PRESENTATION TYPE: Poster

The daily and monthly temperature time series in Brussels–Uccle

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Abstract

Climatological observations began in 1833 at the Royal Observatory of Brussels located near the city center. In 1890, the Observatory was relocated to Uccle in the suburbs of Brussels, where measurements are still being collected today. Based on these observations, the Royal Meteorological Institute of Belgium has produced two types of homogenized temperature time series: 1. Monthly time series of 8-8 LT minimum and maximum temperatures 2. Monthly and daily time series of 0-24 UTC minimum, maximum and mean temperatures. The 8-8 LT series are based on manual observations of the daily extreme temperatures. The homogenization was performed using the HOMER software in which the identification and the correction of the homogeneity breaks makes use of neighboring series. These series are available from 1881 onwards. The 0-24 UTC series are based on thermohygrograph and automatic sensor measurements. The homogenization breaks resulting from the move of observation site and from the transition from open to closed shelters were corrected using parallel measurements. The daily series are available from 1892 for the minimum and maximum temperatures and from 1901 for the mean temperature. The monthly series are available from 1833. Next to the observational time series, temperature series for Uccle have been extracted from the ECMWF ERA5 and ERA5-LAND reanalysis available since 1940 and 1950, respectively. In this presentation, we describe and compare these different time series. Various climate indices are generated and the trends obtained from the different datasets are compared. The goal is to evaluate the robustness of the climatic information derived from the temperature series. We also outline future work aimed at refining and extending the daily time series further back in time.

PRESENTATION TYPE: presentation or poster

Renewal of Quality Control and Ground Observation Storage at Met Norway

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Abstract

The data flow of the ground observations at Met Norway is under transition to a new database and quality control system. The new database, based on PostgresSQL, has a more flexible data structure and a simplified dataflow surrounding it. The ground based observations are sent directly to the ingestor that stores them as a time series in the database, with an associated label that identifies what the data is. New data arriving triggers the quality control for single data point and time series based tests, while other triggers (usually time based) are needed for spatial quality control as well as consistency checks (for example: comparing the outcome of several different checks, or comparison against the model). The outcome from the quality control will also be stored in the database alongside the data. Products (such as aggregations) can be fetched from the database through an egress API and where possible will be calculated on the fly to avoid the issue of the underlying data being changed by quality control but the derived products not being updated. If the certain heavily used products are deemed to be too slow, we will work on a good caching system to speed up their retrieval. All components of the new system (ingestor, egress and quality control checks) are written in Rust. The database is structured to try to best support the two main uses cases for data access: Climate: one or more time series over as many years as it exists Recent data: all recent observations for a given area The later use case is also important for the quality control system, since the new system will rely more on spatial quality control. We have several new tests that take into account nearby stations to check if there are any outliers. Crowd sourced data (not stored in the database), in addition to higher quality station data (stored in the database) can be used in these types of tests. The outcome from the low quality crowd sourced data is mostly used for gridded products, as for this type of data an individual observation is not really something to rely on. To serve the data and quality control flags stored in the database to users we will continue to support the Frost API, extending it to allow different output formats.

PRESENTATION TYPE: presentation or Poster

Gap filling of Swedish snow depth observations for climate normal value calculations

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Abstract

In 2021, the work of calculating new Swedish climate normal values for the new standard normal period 1991–2020 and re-calculation of the corresponding normal values for the reference normal period 1961–1990 and the intermediate normal periods 1971–2000 and 1981–2010 begun at SMHI. Observation based climate normal values for several weather parameters were calculated. Missing data in the observational data set of temperature and precipitation were filled by linear regression on the gridded observational data set ptHBV, while missing data in pressure and humidity observations were filled by linear regression on ERA5 data. Snow depth is not included in the ptHBV data set. Snow depth is indeed included in both the gridded observational data set SMHIGridClim and the European regional re-analysis data set CERRA, but neither of these data sets cover the entire period 1961–2020. SMHGridClim uses CERRA's predecessor UERRA as its first guess and is therefore limited to the period 1961–2018. CERRA on the other hand covers the period 1984–2021. The calculations of climate normal values of snow parameters pose a specific challenge: observational data sets of snow depth generally have much more missing data than data sets of other meteorological observables, for example temperature and precipitation. The large number of missing data are to a large extent due to the failure of recording the absence of snow, especially in times and places when and where snow is not expected. Missing snow depth data thus often has been implicitly interpreted as bare ground. In statistical treatments of larger data sets the missing distinction between missing data and lack of snow is a problem, however. Several methods for the gap filling of the daily snow depth observations data set were considered and evaluated. The methods include snow depth data from SMHIGridClim, ERA5, CERRA, the hydrological model S-HYPE, and a simple 1D precipitation/temperature snow model. The method used for the calculations of the official normal values is based on a hybrid data set of SMHIGridClim and CERRA: The snow depth data set of SMHIGridClim is extended through 2020 by linear regression of CERRA. The observed data set are then gapfilled by using a regression with a dynamic exponent on the hybrid data set after temporal interpolation was conducted for shorter gaps in the observational data set. In the instances where observations of surface status are available, these serve as a pre-process QC-check on the snow depth observations. It was discovered in the course of the project that SMHIGridClim contains episodes of unrealistic snow depths. To identify and correct these erroneous data, a simple 1D precipitation/temperature snow model was used to construct time series for each station. Methods and results will be presented at the workshop.

PRESENTATION TYPE: presentation

Statistical Procedures for the Evaluation of Parallel Measurements in the Automation of the National Meteorological Service Network of Argentina

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Abstract

The National Meteorological Service of Argentina is planning the automation of its meteorological station network. This process involves the installation of automatic weather stations (AWS) at sites currently operated by conventional meteorological stations (CMS). To assess the impact of this change in instrumentation on the quality and homogeneity of historical data series, which are essential for long-term climate monitoring, parallel measurements are expected to be carried out during a transition period. The objective of this work is to define and describe the statistical procedures used to characterize and compare parallel measurements of maximum, minimum, and mean temperature, as well as precipitation, across different temporal scales. The applied methodologies include the identification of systematic biases, the use of statistical tests to assess the significance of discrepancies between records, and the analysis of trends, cycles, and seasonality in the difference series. In addition, the ability of AWS to detect extreme events is analyzed, as well as their performance in accurately accumulating precipitation totals over different time intervals. These procedures were applied to two case studies involving pairs of stations located in Villa Gesell and Pigüé, in the province of Buenos Aires. However, they will be extended to other sites that complete at least one year of parallel data. The results, although varied, reveal statistically significant differences between conventional and automatic observations. Moreover, they highlight the importance of applying statistical methodologies to the comparison of parallel measurements to ensure a proper transition toward an automated network. It is worth noting that this work is aligned with the objectives of the regional ENANDES+ project, carried out in collaboration with MeteoSwiss, at both national and regional levels within the framework of the Regional Climate Center for Southern South America. This project includes activities aimed at advancing methodologies for the evaluation of parallel measurements, as well as the development of technical documentation on quality control and statistical analysis procedures.

PRESENTATION TYPE: presentation

Homogenization of monthly temperature time series across Belgium

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Abstract

Belgium benefits from a dense network of climate records spanning over the past century. These data are essential for analysing recent climate trends and variability across the country. However, long observed temperature series often contain inhomogeneities, i.e. artificial shifts caused by changes in observing conditions, measurement practices, or instruments. Ongoing homogenization efforts using HOMER software have produced 61 monthly temperature time series, covering periods from 1880-1954 up to 2015. Nonetheless, the homogenization process remains highly manual and time-consuming. In this presentation, we describe how techniques from existing automatic homogenization methods were implemented and tailored to the specific characteristics of the Belgian network. A scoring system derived from the BART software developed at SMHI has been incorporated for filtering potential breaks. It facilitated metadata integration during detection and significantly improved time efficiency. Iterations of detection and correction were increased to assess the interdependence of breaks, enabling us to refine the correction of breaks not supported by metadata. Coupled with varying thresholds for break acceptance, we achieved a more efficient workflow for homogenizing temperature series and reduced the risk of over-homogenization at the network scale. Moreover, we emphasize the importance of procedure standardisation and the development of a realistic framework for operationalisation. These efforts aim to ensure the flexibility of the homogenization methods for future adaptation and to enhance the long-term maintainability of the homogenized series. A key challenge remains in the upstream collection and selection of relevant metadata, particularly in translating qualitative information into quantitative indicators suitable for automated processing. To address this, we leveraged large language models to extract and quantify metadata from diverse formats, thus facilitating their integration into the homogenization workflow and improving the quality of the homogenized data.

Enhancing Climate Data Cooperation for Evidence-based Adaptation Policy Making in the Danube Region Mónika Lakatos, Zita Bihari, Sára Bordi, Beatrix Izsák, Otília Megyeri-Korotaj, Olivér Szentes HungaroMet, Hungarian Meteorological Service lakatos.m@met.hu Abstract The Danube-ADAPT project (2025-2028) aims to establish a harmonised climate data and knowledge base for the Danube Region to support evidence-based climate adaptation policymaking. Its core objective is to strengthen and balance the adaptive capacities of settlements, regions, and countries throughout the macro-region. The project's goals will be realised by harmonising macro-regional datasets related to observations, climate change projections, and vulnerability assessments, and by developing territorially integrated, data-driven policy support tools tailored to the region's specific needs. A fundamental output of the project is the creation of a scientifically rigorous Climatological Baseline Database, based on both observed and projected climate data. This database will serve as the empirical foundation for assessing vulnerabilities and designing adaptation responses in the region. As part of this effort, an observational climate database is being developed. Following the methodology of the CarpatClim project, it incorporates a wide range of station data, processed using robust and internationally recognised techniques. The key methods applied are MASH (Multiple Analysis of Series for Homogenization, Szentimrey) to identify and correct inhomogeneities in time series, and MISH (Meteorological Interpolation based on Surface Homogenized data, Szentimrey and Bihari) to generate high-resolution gridded data. The resulting dataset will have a spatial resolution of 0.1° and include

daily data on temperature (mean, max, min), precipitation, relative humidity, sea-level pressure (1970–2024), and from 2000–2024, solar radiation and wind speed. In parallel, the Future Climate Projection Database will be created. Using the EURO-CORDEX ensemble, the most suitable simulations will be selected for the Danube Region based on a thorough validation process. The projections, reflecting three RCP scenarios, will cover the periods 2041–2070 and 2071–2100 at 0.1° spatial resolution. Variables will include daily values for temperature, precipitation, pressure, humidity, solar radiation, and wind speed. This coordinated effort ensures scientific soundness, regional relevance, and effective support for future adaptation planning across the Danube Region. Acknowledgement The DANUBE-ADAPT project (Building an evidence-based, territorially integrated policy support system for climate change forecasting and vulnerability assessment in the Danube Region, project ID: DRP0301445) is financed by the Danube Region ProgrammePRESENTATION TYPE: presentation or Poster

Archiving and access to climate data products

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Abstract

The Met Office National Climate Information Centre (NCIC) are responsible for monitoring the UK's climate based on observations from the land network of weather stations. Our climate data products (gridded data, time-series, maps, graphics) are used extensively by many colleagues within the Met Office and also externally, for example in publications such as State of the UK Climate (Kendon et al, 2023). Statistics can feature prominently in national media (e.g. the BBC). As a small team of 5, how can we satisfy demand to disseminate information efficiently and effectively, while protecting our time for core science activities? Internally the Met Office has over 2,000 staff, with many working in weather and climate science, operational meteorology, public weather and media services and observations who may require climate information and context specific to their application. Demand can be high and appears to be increasing year on year, yet we have finite resources. NCIC's main UK climate monitoring system is called 'ClimateGrid', developed over many years in-house by the team. This comprises a set of python-based code repositories and process scripts which interact with the Met Office's historical station data archive 'Midas', NCIC's gridded climate data archive 'HadUK-Grid' and numerous configuration files. This system is complex and involves many thousands of lines of code. While users would like access to HadUK-Grid climate data products they cannot be expected to understand the inner workings of the ClimateGrid software or run this themselves. ... Or can they? One possible solution NCIC have developed internal to the Met Office is a series of 'self-serve' webpages. These allow any member of staff to run the ClimateGrid software through a browser to return time-series, maps or graphics. Drop-down menus enable flexibility so they can choose, for example, the variable, area or date of interest. In just a few seconds, they could, for example, obtain a map showing the year of the wettest winter for all counties of the UK, a rainfall time-series graph of Devon for the winter half-year October to March, or find out what were the warmest spring days on record in London – at the press of a button. Ultimately these pages are intended to provide relevant climate information and context, whether it be heatwaves, hydrology, drought, variability or trends. Over time, however, NCIC have expanded this set of pages for our own specific use. We can look at maps showing station network coverage, investigate station values used for gridding, examine case-studies of automated QC, or comparing two different versions of our grids. We can look at statistics for multi-day or multi-month periods, or maps showing the difference between two averaging periods. The scope for adding more products is open-ended and seemingly endless: a key challenge is focussing on developing the tools that are the most useful and relevant, but just as important is communicating to users what is available and how to use it effectively. I will present examples of products from this 'self-serve' interface. How do other National Met Services solve this problem?

Kendon, M., Doherty, A., Hollis, D., Carlisle, E., Packman, S., McCarthy, M., Jevrejeva, S., M atthews, A., Williams, J., Garforth, J., & Sparks, T. (2024). State of the UK Climate 2023. International Journal of Climatology, 44(S1), 1–117. https://doi.org/10.1002/joc.8553

PRESENTATION TYPE: presentation

Enhancing Climate Data Cooperation for Evidence-based Adaptation Policy Making in the Danube Region

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Abstract

The Danube-ADAPT project (2025-2028) aims to establish a harmonised climate data and knowledge base for the Danube Region to support evidence-based climate adaptation policymaking. Its core objective is to strengthen and balance the adaptive capacities of settlements, regions, and countries throughout the macro-region. The project's goals will be realised by harmonising macro-regional datasets related to observations, climate change projections, and vulnerability assessments, and by developing territorially integrated, data-driven policy support tools tailored to the region's specific needs. A fundamental output of the project is the creation of a scientifically rigorous Climatological Baseline Database, based on both observed and projected climate data. This database will serve as the empirical foundation for assessing vulnerabilities and designing adaptation responses in the region. As part of this effort, an observational climate database is being developed. Following the methodology of the CarpatClim project, it incorporates a wide range of station data, processed using robust and internationally recognised techniques. The key methods applied are MASH (Multiple Analysis of Series for Homogenization, Szentimrey) to identify and correct inhomogeneities in time series, and MISH (Meteorological Interpolation based on Surface Homogenized data, Szentimrey and Bihari) to generate high-resolution gridded data. The resulting dataset will have a spatial resolution of 0.1° and include daily data on temperature (mean, max, min), precipitation, relative humidity, sea-level pressure (1970–2024), and from 2000–2024, solar radiation and wind speed. In parallel, the Future Climate Projection Database will be created. Using the EURO-CORDEX ensemble, the most suitable simulations will be selected for the Danube Region based on a thorough validation process. The projections, reflecting three RCP scenarios, will cover the periods 2041–2070 and 2071–2100 at 0.1° spatial resolution. Variables will include daily values for temperature, precipitation, pressure, humidity, solar radiation, and wind speed. This coordinated effort ensures scientific soundness, regional relevance, and effective support for future adaptation planning across the Danube Region.

Acknowledgement The DANUBE-ADAPT project (Building an evidence-based, territorially integrated policy support system for climate change forecasting and vulnerability assessment in the Danube Region, project ID: DRP0301445) is financed by the Danube Region Programme. Danube-ADAPT project's overall aim is to create harmonised data availability and knowledge in the Danube Region to support evidence-based climate adaptation policy making, and thus improve and balance the adaptive capacities of settlements, regions and countries across the Danube Region. To this end, a broad and balanced partnership was created with 23 organisations covering 10 DR countries, involving meteorological and hydrological services, academic, policy-making and climate adaptation policy advisor organisations. Partners contribute a wealth of climate change and adaptation data, knowledge, as well as experience in adaptation responses, representing all governance levels. Specific objectives of the project will be achieved through harmonising macro-regional data for projecting climate change and vulnerability assessment, and developing territorially integrated, data-based policy support solutions tailored to the region to facilitate developing policy responses in a uniform manner, fostering transferability across the Danube Region. It will produce a Climatological Baseline Database of high quality, scientifically rigorous database on both observation data and future

climate projections, serving as the basis for vulnerability assessments in the region. Furthermore, it will create data-led policy support solutions specifically for the Danube Region, based on jointly developed methodologies and regionally harmonized data. Development of an observational climate database for the danube Region focuses on producing a harmonised, high-resolution observational database of superior quality compared to currently available public datasets. Following the methodological blueprint of the CarpatClim database, the new dataset will incorporate as many station records as possible, processed using scientifically robust and internationally accepted techniques. The core methodological tools applied are the MASH (Multiple Analysis of Series for Homogenization) method for detecting and correcting inhomogeneities in meteorological time series, and the MISH (Meteorological Interpolation based on Surface Homogenized data) method for spatial interpolation of the homogenised data. These procedures ensure consistency and comparability across the Danube catchment. The final gridded dataset will have a spatial resolution of 0.1°, enabling detailed regional analysis. The database will cover key meteorological variables, including daily mean, maximum, and minimum temperature, precipitation, relative humidity, and sea-level pressure (1970–2024), and global solar radiation and average wind speed (2000–2024). Development of a Future Climate Projection Database for the Danube Region Climate Modelling Group of the Climate Research Department at HungaroMet is responsible for developing a high-resolution climate projection database for the Danube Region, based on the EURO-CORDEX multi-model ensemble. This database will serve as a key input for climate impact assessments and long-term adaptation planning within the region. The projected dataset will build upon the EURO-CORDEX simulations, which provide highresolution regional climate model outputs across Europe. From this ensemble, the most suitable simulations for the Danube catchment will be selected through a rigorous validation process (to be conducted in Activity 1.3). Three Representative Concentration Pathway (RCP) scenarios will be included to account for uncertainty in future greenhouse gas emissions. The selected projections will cover two future periods: 2041–2070 and 2071–2100, with a spatial resolution of 0.11° (~12 km). The database will contain daily values for key meteorological variables, including mean, maximum, and minimum temperature, precipitation, sea-level pressure, relative humidity, wind speed, and global solar radiation. To ensure scientific robustness and regional relevance, a dedicated working group comprising representatives of participating national meteorological services will be formed. This group will oversee the definition of the final database structure, including the choice of models, the reference period, and target projection windows. PRESENTATION TYPE: presentation

Structured Management of Dynamic Geodata - Implementation Guidelines Based on the FAIR Principles

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Abstract

Based on the principle that data are only of societal benefit if they are extensively sed, MET Norway aims to organize its data management to support simple, secure and stable access to dynamic geodata for everyone - from professional users to the general public. Improving the ability for machine discoverability, interoperability and reuse is of particular importance. The FAIR principles are key to achieving this goal. Yet, smart joint use of different systems and solutions is a prerequisite to making data FAIR. A data product annot be FAIR-compliant without well-functioning support systems around the product. This paper outlines the guidelines and solutions for the implementation of the data management at MET Norway, and how they build upon the FAIR principles. The guidelines are organized in three main categories: (1) preservation of data, (2) documentation of data, and (3) publication and sharing of data. The underlying data management model and guidelines are presented and explained, and MET Norway's implementation is summarized.

PRESENTATION TYPE: presentation

Quality Control of Precipitation Data at GeoSphere Austria

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Abstract

GeoSphere Austria, the Austrian national weather service, operates a measurement network comprising 277 volumetric rain gauges, each of them equipped with a precipitation monitor that detects the beginning and the end of a precipitation event. In cooperation with the Austrian air traffic control authority ACG optical present weather sensors are installed at some of the stations which can also measure precipitation amount, these data are currently not implemented in the standard station scope. Operationally, two types of precipitation measuring systems are in use: weighing rain gauges and tipping bucket rain gauges. Weighing gauges are usually used only up to an altitude of 1500 m above sea level. The precipitation data has been quality-checked since 2006, initially within an external automated quality control procedure (QualiMET) and since 2016 as part of an in-house developed quality control tool called AQUAS (short for Austria Quality Service). In AQUAS, individual system components are designed to check the incoming precipitation data with a time resolution of 1 minute. The basic quality control procedures are developed in accordance with the WMO recommendations for plausibility checks and for temporal, spatial and internal consistency of the data. As precipitation is one of the most demanding meteorological parameters in terms of quality control, additional test procedures are being developed that take into account the specific errors of the measuring devices. Common errors with all types of rain gauges are spurious precipitation and missing precipitation events. Both of these errors must be detected and removed or corrected by the quality control system in order to minimize their negative impact on the precipitation climatology. In the case of an erroneous measurement, tipping bucket gauges do not provide any other information that can be used for further investigations. The weighing gauge software provides the raw gauge weight and the amount of precipitation - if no precipitation has been measured, the gauge weight is normally available, except in the case of a total outage of the sensor. We present a basic overview of the precipitation test used in AQUAS and a heuristic approach that combines the raw weight of the gauge and the observation of the precipitation monitor to detect spurious precipitation and precipitation missed by the weighing gauge. The advantage of this method is that the software errors of the weighing gauge are largely intercepted by the combination with an independent measurement. This algorithm currently supports our experts in the manual quality control of precipitation data.

PRESENTATION TYPE: presentation or Poster

Reassessing Ireland's monthly air temperature record values using a standardised operating procedure for historical national climate records

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Abstract

Validated records of past climate extremes are essential for informed decision-making across many sectors, including infrastructure planning, environmental legislation, health, and construction.

To date, we have completed detailed re-assessments of Ireland's overall maximum and minimum air temperature records. Separately, our colleagues developed a Standard Operating Procedure (SOP) to certify new climate records, which has already been implemented to validate July and August maximum temperature records from 2022. The SOP is also currently ongoing to assess provisional wind records from Storm Éowyn (2025) and the April maximum air temperature record.

The aim of our current research is to adapt and implement a similar SOP to systematically assess all historical monthly maximum and minimum air temperature records, aligning the certification process for past records with that used for recent extremes.

Ireland's national climate records date back to the early 1800s. As such, the quality control of observations, sites, and instruments has varied considerably over time. The SOP is designed to overcome these discrepancies by applying a transparent, consistent, and rigorous approach to evaluating records in Met Éireann's databases, regardless of their date.

For pre-1961 records, we use newly digitised data from the Met Éireann archives and integrate reanalysis datasets, station metadata, historical newspapers, and contemporaneous accounts. For more recent records, we use data from the operational Met Éireann database, combined with reanalysis products, synoptic charts, and metadata. Time series analysis and extreme value theory further support the validation process.

The outcome of this work will be a verified list of monthly maximum and minimum air temperature records for Ireland. This approach will later be extended to other climate variables.

PRESENTATION TYPE: presentation

A consistent and homogenized climate data set for a high-latitude region in Norway

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Abstract The high latitude areas are experiencing a climate change that is faster and more intense than in most other regions on the globe. This has a large impact on the natural environment and ecosystems. To understand how ecosystems respond to the strong warming we need to develop high-quality and homogeneous multi-decadal climate data sets in order establish the links between climate trends and ecosystem response. The region Troms in northern Norway has a challenging climate, with an alpine landscape literally along the shore. The climatic gradients are large, with a transition from coastal to continental climate within a few tens of kilometers, and with altitudes spanning from sea level to almost 2000 masl. The meteorological observation network in the region has been sparse, and temporally unstable. The few long term records that exist are from stations located in the larger settlements along the coast. Despite the lack of long time series, several short time series exist. In order to develop climate records for analysing vegetation changes at 133 locations spread within the region we have developed a monthly climate data set exploiting all time series available within the period 1950-present. The time series in this dataset are homogenised by using the HOMER and climatol applications. The few long term series are used as master (reference) series for the homogenisation. In addition to the observation series within the region, national gridded observation data sets and from reanalyses are used to support the analysis.

PRESENTATION TYPE: presentation

Homogenized and gridded daily mean temperature data series from 1851

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PRESENTATION TYPE: Poster

Clustering and studying evolution of observed hourly rainfall extremes in the south of France

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Abstract

Studying the evolution of hourly rainfall extremes is difficult due to the high spatial and temporal variability of this parameter. To bypass these limitations, we opted to use the distribution of the largest extreme statistics of rainfall in spatial zones. This distribution is an extension of the Generalised Extreme Value distribution. This enables the use of more data than a classical GEV approach based on individual station data would allow. Homogeneous spatial zones are determined using a special clustering algorithm adapted to extremes (Bernard et al., 2013). This clustering method relies on the PAM (Partitioning Around Medoids) algorithm using the F-madogram distance. Once clustering has been performed, the evolution of the extremes is computed using vector generalised additive modelling (VGAM, Yee & Wild, 2015) of the parameters of the r largest statistics distribution. The location and scale parameters of the extreme distribution are modelled as spline functions of time. Approximate inferences allow the significance of changes in extremes to be assessed. The results show that the observed extreme trends are far from linear for the period 1993–2024, and instead exhibit a 'U' shape, with lower extremes occurring during the period around the year 2000.

PRESENTATION TYPE: presentation

Unified and uniform access to European in-situ climate observations via the MeteoGate platform

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Abstract

Historically, in-situ climate observations have been made available by national data platforms or through curated datasets like the European Climate Assessment and Database (ECA&D). The newly in force EU open Data Directive 2019/1024 requires National Meteorological and Hydrological Services (NMHSs) to make their High Value Datasets, including meteorological datasets, available through machine readable application programming interfaces (APIs). The RODEO project has worked for the last three years on Open Data infrastructure for observations, weather warnings, climate observations and weather radar data. During the last year of the project, it aims to integrate and consolidate these efforts in the one-stop-shop MeteoGate. This presentation focusses on the benefits for NMHSs for providing their climate data through this Open Data infrastructure. The RODEO climate work package worked on creating uniform in-situ climate datasets. A group of experts decided on the choice of variables to include, granularity of daily and hourly observations, and preferred controlled vocabularies. Data and metadata guidance from WMO, Copernicus, Climate and Forecasting (CF) conventions and Attribute Convention for Data Discovery (ACDD) have all been incorporated to adhere to the FAIR principles. These decisions were finalized in a 'Generic climate observation data format'. Right now, 9 NMHSs and ECA&D are committed to providing their climate data with an OGC API - Environmental Data Retrieval (EDR) following the 'Generic climate observation data format'. A software service called the Climate Aggregator unifies the individual NHMS APIs, so that the users can use all APIs with a single request. Additionally, the service adds output format conversion from CoverageJSON to NetCDF. This makes it possible for end-users to perform a single query across the whole of Europe and have it return a single output file in their desired format. For NMHSs the use of the Climate Aggregator simplifies development and deployment of their Climate API and guarantees uniform and unified access for endusers. The Climate Aggregator will be made accessible via the MeteoGate platform in the near future, and we expect the service to be used for the generation of gridded climate observational datasets such as E-OBS.

PRESENTATION TYPE: presentation

High-Resolution Homogenized Climate Dataset for Central Europe: Daily Maps at 2 km Resolution for a period 1961 Onwards for Climate Change Analysis

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Abstract

We present a newly developed high-resolution gridded climate dataset covering the Czech Republic, Slovakia, Poland, and surrounding regions. The dataset spans the period from 1961 to 2024 and provides homogenized daily values of essential meteorological elements— including temperature, precipitation, humidity, wind, and sunshine duration—interpolated to a 2×2 km spatial resolution. The construction of this dataset involved rigorous multi-stage quality control, homogenization of both station time series and gridded fields, and spatial interpolation techniques adapted for complex topography and data density variations across borders. The methodology adheres to international best practices while incorporating tailored approaches suitable for the region's diverse climate and observational infrastructure. The dataset has been designed to support a broad range of climate analyses, including the assessment of historical trends, extreme events, and changes in circulation regimes. Furthermore, it serves as an observational benchmark for evaluating and bias-correcting regional climate model simulations—enhancing both the reliability of past reconstructions and future projections. Our contribution aims to strengthen cross-border data consistency, encourage reuse in national and international climate services, and foster open collaboration on long-term climate monitoring in Central Europe. Acknowledgements. We acknowledge support from the AdAgriF project – Advanced methods of greenhouse gases emission reduction and sequestration in agriculture and forest landscape for climate change mitigation (CZ.02.01.01/00/22_008/0004635) and the ACECE project (24-14581L) – Atmospheric Circulation and weather Extremes in Central Europe and their representation in climate models, funded by the Czech Science Foundation (GA ČR).

PRESENTATION TYPE: presentation

Comparison of NORDLIS sensor network data with observer data in Latvia from 2005 to 2018

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Abstract As the observation and measurement of atmospheric phenomena has historically shifted from data provided by human observers to data provided by sensors, reliable methods of comparing data from both sources are needed. Thunderstorm observations at meteorological weather stations in Latvia have been conducted starting from the end of the 19th century until the year 2018. Lightning sensor data for the territory of Latvia is available from the NORDLIS (Nordic Lightning Information System) sensor network starting from the year 2005. This short period between the years 2005 and 2018 provides an opportunity to compare observer data with sensor measurements. In this study, thunderstorm data from observers in 24 meteorological stations in Latvia have been compared with lightning discharge sensor data from the corresponding locations by calculating thunderstorm days and thunderstorm hours. In order to more accurately represent lightning observable by a human observer, the sensor data were filtered by various parameters such as distance from the observer, absolute peak current, and others. Thunderstorm days and thunderstorm hours calculated from observer data were used to fit the range of the filter parameters used for the sensor data. The results show that an overall agreement of thunderstorm days per year between observer data and the fitted sensor data for the selected period. Similarities and differences of the spatial distribution of thunderstorms in both datasets are discussed. Observer data is used to describe thunderstorm climate changes in Latvia during the past century. Sensor network data is used to describe the physical properties of lightning discharges in Latvia. PRESENTATION TYPE: Poster

Long-Term Evaluation of ZenithWetDelay TimeSeries and Its Relationship with Precipitation in the Brazilian Territory

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Abstract Global Navigation Satellite System (GNSS) can provide not only positioning data but also information related to the amount of water vapor in the atmosphere. This represents a synergy between Geodesy and Meteorology, giving rise to a field known as GNSS Meteorology. Thus, GNSS receivers can serve as an unconventional source of meteorological data. Through data processing with software such as GipsyX, we can derive a variable called zenith tropospheric delay (ZTD), which is the delay between the actual signal path and the geometrical path due to differences in atmospheric refractivity. ZTD can be split into two components: a hydrostatic component, mainly related to dry gases, and a non-hydrostatic component, primarily associated with the amount of water vapor in the atmosphere. The non-hydrostatic component is also known as the Zenith Wet Delay (ZWD) and is frequently converted into Precipitable Water Vapor (PWV), a variable typically obtained through radiosondes and meteorological models. In Brazil, many published studies focus on using PWV derived from ZWD to support nowcasting, to identify GNSS jumps associated with the rapid development of convective systems, and for data assimilation purposes. As the GNSS receiver network from IBGE (Instituto Brasileiro de Geografia e Estatística) expands and matures, the scientific community will also have the opportunity to use ZWD-derived data as a climatological variable. The aim of this study is to analyse ZWD data from 20 GNSS stations distributed across the Brazilian territory and compare them with precipitation records. Given Brazil's wide climatic diversity, this work seeks to identify the climatic conditions under which ZWD and precipitation are strongly correlated. Preliminary results suggest that the correlation is stronger during the dry season and in climates with well-defined wet and dry periods, such as Aw, Cwa, and Cwb, according to the Köppen–Geiger classification.

PRESENTATION TYPE: presentation

Climatological characterizations of the city of Verona from time series of meteorological observations over the period 1923-2024: the Digital Paths of Verona Project.

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Abstract

Over the past decades, many measurements of meteorological variables, in particular air temperature and precipitation, have been regularly performed at various locations in the city of Verona and its surroundings. However, a series spanning over 50 years has never been defined. The project Percorsi Digitali Veronesi (Digital Paths of Verona), ending in 2022, has launched an accurate search of the available meteorological measurement series in order to summarize the availability of historical data in the urban area of the City of Verona. So far, more than 15 series have been found, both in paper and digital form. The latter are mainly managed by the local authority (ARPAV Veneto) or by enthusiasts of the local meteorological association (Meteo4), while the former comes from historical manual observations. Series cover a century, with a significant completeness between 1923 and 2024. The daily data digitization from the Magistrato delle Acque di Venezia (1923-1996), observations done by the Statistic Office of the Verona municipality at the Angelo Messedaglia high school (1947-2003), and data collected by Emilio Bellavite and Angelo Brugnoli (1948-1992) were performed. A dataset of daily precipitation and temperature was created spanning between 1923 and 2024. All series were subjected to automatic quality control procedures. The last step of the present work aims to contextualize the rescue data in terms of a preliminary climatological analysis. In summary, this research emphasizes the crucial role of dependable historical meteorological data and advocates for the methodical digitization and dissemination of information found in historical annual reports. Future efforts will focus on extending the dataset backward in time and retrieving as much data as feasible to construct a time series of at least daily rainfall and temperature measurements covering more than a century. This will enable Verona to possess its own dataset for comparison with existing long-term series in Northern Italy, despite the data originating from various sites within Verona municipality and its vicinity. Obtaining such long-term temperature and precipitation records is increasingly vital. Indeed, through climatological harmonization and comparison with data from nearby locations, it will be possible to extrapolate for Verona both the impact of global warming and the effect of the urban heat island.

PRESENTATION TYPE: presentation

Analysis of Precipitation Trends and Spatial Patterns Along a Po Plain-to-Bavaria Alpine Transect from Daily Observations (1923-2024)

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Abstract Historical meteorological data are crucial for understanding a region's climate. This research analyzes trends and spatial patterns of precipitation in a transect between the Po Plain near Verona, Italy, and the southern part of Bavaria, Germany. A dataset of more than 160 centenary, still-active, and daily precipitation series was created spanning over the period 1923-2024. The stations come from five regions/autonomous provinces: Trentino, South Tyrol, Tyrol, Veneto, and Lombardy. More than 40 stations were manually digitized from historical annual reports, especially in the period 1923-1949. The entire dataset was quality-checked with suitable procedures, and suspicious data were verified and eventually corrected. The time series were homogenized using the R library Climatol. Moreover, seven climatological precipitation indices were calculated on the homogenized dataset. Additionally, some indices were spatially interpolated for three normal reference periods and over the whole century (1931-1960, 1961-1990, 1991-2020, and 1923-2024). Data normality was first verified. Then, an iterative procedure calculated experimental semivariograms to determine the best interpolation parameters for the theoretical fitting exponential model. The kriging with external drift algorithm was executed. Finally, trends were evaluated using Mann-Kendall test and Sen's slope. Results confirm established climatic features of pre-alpine precipitation distribution. Notably, however, novel spatial patterns have emerged. R95pTOT and R99pTOT show statistically significant positive trends over some sectors of the domain. The amount of precipitation that falls over 95th and 99th percentiles has increased over the last century, but not the number of rainy days with rain higher than these thresholds. The wettest sectors of the rainfall distribution appeared to become wetter over certain areas within the study domain. Furthermore, the Precipitation Concentration Index suggests that, over the last century, the continental areas within the domain have seen a more irregular precipitation distribution throughout the year and in some seasons. However, trends are not statistically significant yet. In conclusion, the present study aims to underline also the importance of reliable historical data from meteorological measurements and encourages the systematic digitization of them.

PRESENTATION TYPE: presentation

Analysis of Urbanization Impact of Ankara by Using Sectoral Climate Indices

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Abstract Understanding the long-term changes in extreme temperature events is important for the detection and attribution of climate change. However, it is unclear how much urbanization affects coming from climate change. In this study, to examine the impact of urbanization on climate comparatively, data from the Ankara climate station (32.53E, 39.57N) with urban characteristics and the Esenboğa station (33.00E, 40.07N) with rural characteristics were evaluated. Daily data from 1960 to 2020 were used in the study, and ClimPACT software was run to create climate indices. Urbanization effects on the trends of extreme temperature indices in Ankara were evaluated. The most decisive climate indices showing urbanization effects were found to be Ice Days (ID0), Frost Days (FD0), Cold Nights (TN10p), and Cold Spell Duration Indicator (CSDI), which showed a decreasing trend in Esenboğa and Ankara, respectively. Other indices, such as Tropical Nights (TR20) and Hot Nights (TN90p), showed increasing trends in both rural and urban areas. The trends in urban areas were found to be stronger than in rural areas. Diurnal Temperature Range (DTR) has increased in Esenboğa while it has decreased in Ankara due to the greater increase in minimum temperature in the city center. Summer Days (SU25) showed increasing trends in both Esenboğa and Ankara with 53.5 and 35.3 days/100 years, respectively. The summer day trend was higher in rural areas because sunlight heats the land surface rapidly. In cities, asphalt and concrete take time to heat up and cool down at night. This increases the minimum temperatures in the city center. The results show that the most significant effect of strong urbanization is on the minimum temperature. Most of these trends are found to be statistically significant at more than a 95% level (p value < 0.05). Keywords: Urbanization, Climate indices, Trend, ClimPACT

PRESENTATION TYPE: presentation

Neural Network Postprocessing of Long-Range Temperature Forecasts in the Czech Republic

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Abstract

Seasonal weather forecasts are a valuable resource for planning in sectors such as agriculture and energy. Their global adoption is increasing, driven by the steady improvement of numerical models. However, in Central Europe—and specifically in the Czech Republic—their reliability and practical applicability remain limited due to regional challenges. This study explores how statistical postprocessing can enhance the utility of long-range air temperature forecasts for the Czech Republic. Dynamical seasonal forecasts rely on comprehensive three-dimensional climate models that simulate atmospheric and oceanic behavior over the coming months, based on current initial conditions. Forecast ensembles offer probabilistic outlooks that estimate the likelihood of deviations from the seasonal norm—whether in terms of temperature or precipitation. The effectiveness of postprocessing methods in improving these forecasts continues to be actively researched. This work applies statistical postprocessing based on empirical relationships between locally observed variables—here, near-surface air temperature—and relevant predictors from global seasonal forecast models. The study utilizes data from the Copernicus Climate Change Service (C3S), specifically focusing on near-surface temperature fields provided at a 1° × 1° spatial resolution. Four forecast systems are analyzed: the European Centre for MediumRange Weather Forecasts (ECMWF), Météo-France (MF), Deutscher Wetterdienst (DWD), and Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC). The analysis is conducted over the 1993–2016 period—the longest overlapping hindcast dataset available across all systems—and focuses on the Czech Republic (49–51°N, 12– 19°E). Neural network methods, implemented via the STATISTICA software, are employed for postprocessing, using model outputs of air temperature and sea level pressure as predictors. Observational gridded station-based temperature datasets serve as the reference. Forecast skill is assessed across three categorical outcomes: above-normal, normal, and below-normal temperatures.

PRESENTATION TYPE: Poster

Observed trends in precipitation extreme indices as inferred from a homogenized daily precipitation dataset for Canada

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Abstract

This study first developed a homogenized daily precipitation dataset for 425 long-term stations across Canada. Then, it used the homogenized data to assess trends in annual maximum oneday and five-day precipitation, annual maximum one-day snowfall, and annual number of heavy precipitation days and of heavy snowfall days. The results show that trends in precipitation extreme indices are dominantly positive across Canada, while trends in extreme snowfall amounts are dominantly negative in southern Canada but dominantly positive in northern Canada. Over the period of 1948-2023, the rate of increase in regional mean indices is estimated to be 3.5% and 1.4% per decade for northern and southern Canada, respectively, for annual maximum one-day precipitation, and 2.8% and 1.0% per decade for annual maximum five-day precipitation. The regional mean annual number of heavy precipitation days is estimated to have increased by 6.0% per decade in northern Canada and 0.8% per decade in southern Canada (increased at 72% and 58% of the stations, respectively). The regional mean annual maximum 1-day snowfall is estimated to have decreased by 0.9% per decade in southern Canada but increased by 2.1% per decade in northern Canada. For regional mean heavy snowfall days, the rate of decrease is estimated to be 4.1% per decade in southern Canada, matched with an increase of 0.5% per decade in northern Canada. Similar trend characteristics are seen at southern stations over their longer data record periods (since 1900 or later but before 1948).

PRESENTATION TYPE: presentatio