Theme: Hydraulic and hydrological modeling
IAHR Thematic Priority Area: [TPA-4] Digital Transformation
https://doi.org/10.3850/iahr-hic2483430201-167

Reconstruction of Maximum and Minimum Temperature Time Series for the Mediterranean's Largest Island

Calogero Mattina[1], Dario Treppiedi[1], Antonio Francipane[1], Leonardo Valerio Noto[1]

[1] Dipartimento di Ingegneria, Università degli Studi di Palermo, Palermo, Italy

Corresponding author: calogero.mattina01@unipa.it

Abstract. Analyzing potential indicators of climate change necessitates access to extensive historical datasets. However, measurement gauges are subject to frequent replacement or upgrades, resulting in spatial and/or temporal inconsistencies that undermine the reliability of these datasets. This is the case of Sicily, the largest island in the Mediterranean Sea, which is characterized by the presence of two different monitoring networks, spanning partially different periods. By using a spatial interpolation method, we merge the information from these networks and obtain continuous daily maximum and minimum temperature series for the 1980-2023 period in a 2x2 km grid.

Keywords: climate characterization, temperature, time series reconstruction

1 Introduction

The analysis of possible signals of climate change requires historical datasets covering as long periods as possible. These datasets are essential not only to reconstruct past climate, but also to validate the results of climate models, so as to examine how future climate will evolve. Among all the climate variables, temperature is one of the most responsive to the impacts of climate change. Depending on the future greenhouse gasses emission scenarios, the global temperature change is projected to vary between +1°C (i.e., very low emissions) and +4°C (i.e., very high emissions) by the end of the 21st century [1]. Satellite or reanalysis datasets provide estimates of weather and climate variables that are continuous over time, but they are often characterized by significant biases [2]. On the other hand, measurement gauges are often replaced or upgraded, creating spatial and/or temporal discontinuities that do not allow for their straightforward use [3]. Hence, we apply here a methodology based on the spatial interpolation of temperature data from two different networks in Sicily Island (Italy). This allows us to obtain a spatially and temporally continuous dataset from observed temperature data (T-ATLAS), which is useful for reconstructing the Island's climatology, but also for searching for possible climate change signatures.

2 Data and Methods

We focus on Sicily Island, which is the largest island in the Mediterranean Sea and is located in the transition area between the arid climate of North Africa and the more temperate European climate [3]. Focusing on maximum and minimum daily temperatures, the island is characterized by two different monitoring networks: the first one provided by the Osservatorio delle Acque – Agenzia Regionale per i Rifiuti e le Acque (OA-ARRA), which covers the period 1980-2012, and the second one provided by the Servizio Informativo Agrometeorologico Siciliano (SIAS), which provides data from 2002 to the present. Since these two datasets cover partially different periods, we aim to use a spatial interpolation method to integrate data from these networks and to obtain continuous daily maximum and minimum temperature series for the 1980-2023 period. To do this, we combine the Ordinary Kriging (OK) with a daily environmental lapse rate (ELR), that it is useful to consider the role of the altitude in the interpolation process. We firstly use the observations from the OA-ARRA dataset to reconstruct daily temperature values over the period 2002-2012 at the coordinates of SIAS stations. With a reasonably long period of overlap between the two networks (i.e., 2002–2012), we test the accuracy of the OK-ELR method in reconstructing the temperature signal through different performance indices. After this validation procedure, we interpolate the data with the UK-ED method by using a high-resolution grid (i.e., 2x2 km), covering the whole Sicilian territory.

3 Results

We firstly use the daily temperatures from the two datasets to compute a daily environmental lapse rate. Exploiting the relationship between air temperatures and altitude is necessary to i) refer the variable to see level before applying the OK, ii) re-enter the altitude information after the OK. This procedure has been preferred to using a constant value over the year, as it was found that it greatly varies seasonally, presenting a peak in winter and lower values in summer.
Hence, it has been tested the reliability of the OK-ELR procedure. As an example, Figure 1 shows the comparison of the re-constructed signal from the OA-ARRA and the recorded values from the SIAS network for Palermo station point for the year 2003. As it is possible to observe, the series overlap almost perfectly, confirming the reliability of the two datasets and the interpolation method.

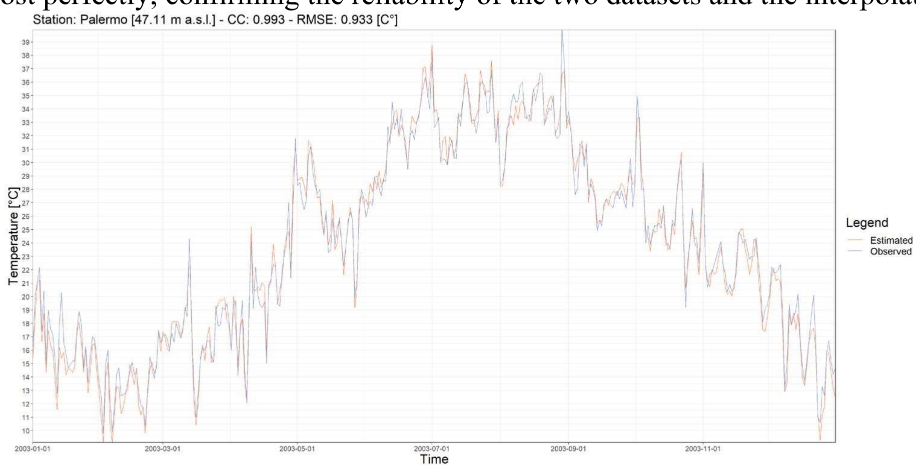

Figure 21 – Comparison between the daily maximum temperatures in 2003 from the OA-ARRA interpolated network (orange) and the SIAS recorded values network (blue) for Palermo station.

Therefore, we interpolate maximum and minimum temperature values from 1980 to 2023 using a 2x2 km grid, reconstructing a spatially and temporally continuous ATLAS for Sicily.

4 Conclusions

In recent years, Sicily has been often identified as a primary hotspot of climate change. Availability of datasets as extensive as possible is critical for recognizing any changes in weather-climate variables, and it is also useful for validating climate model outputs. Due to the presence of two different temperatures dataset, we reconstruct a gridded temperature ATLAS (T-ATLAS) for the period 1980-2023 by combining the Ordinary Kriging with the environmental lapse rate. We found that this procedure provides reliable results, providing remarkably accurate estimates for the interpolated variables.

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