A 19-Years Period (2000-2018) Dataset of Annual and Monthly Spatial Distribution of Rainfall and Average Air Temperature in a Temperate Region for Climate Change Studies

ABSTRACT

Aims: Temperature changes in the air, land and ocean together with the hydrological cycle and changing precipitation patterns are some of the topics assessed by scientist all over the world in order to study the signals of a changing climate. As the impacts of climate change are expected to be noticed both at global and local scale, a dataset of real-world precipitation and average air temperature at regional scale spanning a period of 19 years is provided and described in the present paper.
Study design: Starting from cumulative precipitation and average air temperature data, a set of annual and monthly spatially distributed maps have been generated in order to provide the scientific community with regional-scale data related to a temperate climate area.
Place and Duration of Study: Marche Region, East-Central Italy, between January 2000 and December 2018.
Methodology: We used in-situ rainfall and air temperature data provided by Marche Region (Italy) Security and Civil Protection Department in the framework of the regional meteorological and hydrological monitoring network (SIRMIP). SIRMIP network is composed of a mechanical and a telemetric sensing system. SIRMIP network consists of, among others, 230 rain gauges and 137 thermometers.
Rainfall and air temperature data have been interpolated on a 1 km-resolution regular grid using Inverse Distance Weighting (IDW) spatial interpolation. Temperature data were further processed through a linear regression using elevation from a high-resolution digital terrain model (DTM).

Results: The generated dataset described in this paper consists of 228 monthly- and 19 annual-spatially distributed maps of rainfall and air temperature.

Keywords: Dataset, Climate Change, Temperate Climate, Data Interpolation, Spatial Distribution of Rainfall and Air Temperature

1. INTRODUCTION

Climate change is recognized as one of the most important issues humans have to face in the coming decades. Indeed, the recent Special Report released by the Intergovernmental Panel on Climate Change (IPCC) clearly states that human-induced warming reached approximately 1°C (likely between 0.8°C and 1.2°C) above pre-industrial levels in 2017, increasing at 0.2°C (likely between 0.1°C and 0.3°C) per decade [1].

The Mediterranean area is one of the most affected by climate change: in particular, this area is the only one in the world where most models agree in predicting less precipitation in all seasons [2]. The impacts of climate change, however, are expected to be noticed at smaller scales (local to regional); this is particularly true for the Mediterranean climate, which is characterized by high temporal and spatial variability [3].

For this study we focused our attention on Marche Region, located in Eastern Italy. Marche region extends over an area of about 10,000 square kilometers of the central Adriatic slope between Emilia-Romagna to the north, Tuscany and Umbria to the west, and Lazio and Abruzzo to the south, the entire eastern boundary being formed by the Adriatic Sea. Most of the region is mountainous or hilly, the main features being the Apennine chain along the internal boundary and an extensive system of hills descending towards the sea. The mountains do not exceed 2,400 m, the hilly area covers two-thirds of the region and it is interrupted by wide gullies with several rivers and by alluvial plains perpendicular to the principal chain. Climate of Marche region is temperate: in particular, it is continental in the mountainous areas with cold and often snowy winters, and Mediterranean by the sea.

In order to provide the scientific community with regional-scale data related to a temperate climate area useful for climate change studies, we generated a set of annual and monthly spatially distributed maps of precipitation and air temperature. Details of the methodology we followed for producing distributed maps are given in the following sections.

2. MATERIAL AND METHODS

Rainfall and air temperature data used for the present study come from the regional meteorological and hydrological monitoring network (SIRMIP), managed by Marche Region Civil Protection Service [4]. Data are publicly available through a web application named SIRMIP on-line [5].

SIRMIP is composed of a mechanical (disused at the end of 2014) and a telemetric sensing system. The sensor network consists of water-level sensors, thermometers, rain and wind gauges, atmospheric pressure sensors, relative humidity, solar irradiance and snow-level sensors. All types of sensor have 30-minutes sampling, except wind gauges (10 minutes) and rain gauges (15 minutes). Mechanical thermometers provided the minimum and maximum daily values.

First of all, cumulative rainfall and average air temperature data have been collected according to monthly and annual intervals for the period 2000-2018. Then, data have been interpolated on a regular grid having spatial resolution of 1 km. Gauss–Boaga (G-B) cartographic projected coordinate system [6], one of the most used in Italy, was used for the grid.

Spatial interpolation was performed using Inverse Distance Weighting (IDW) technique [7]. IDW is a type of deterministic method for multivariate interpolation starting from a known scattered set of points. This type of interpolation explicitly makes the assumption that points that are spatially close to one another are more alike than those that are farther apart. The assigned values to unknown points are calculated by a weighted average of the values available at the known points. Weights are proportional to the inverse of the distance between the known data point and the prediction location raised to the power value p [7]; when $p = 2$ (the value we used for this study) the method is known as the inverse distance squared weighted interpolation.

Interpolated air temperature data were further processed through a simple linear regression between temperature and elevation [8] by means of a LIDAR (Light Detection and Ranging)-derived digital terrain model (DTM) of Marche region [9]; DTM we used has a vertical resolution of 1 m and is built on the same regular grid employed for interpolation.

3. RESULTS

The dataset generated for the present work covers the years from 2000 to 2018 and consists of 228 monthly- and 19 annual-spatially distributed maps of rainfall and air temperature. Maps are provided in ASCII raster file format [10]; such format is commonly used to transfer raster data between various applications. It basically consists in a simple text file with a few lines of header data followed by lists of values. Header data are related to the following information: the number of columns and rows in the file, the coordinates of the lower left point on the map, the distance between two consecutive points of the regular grid and the value associated to missing data in the file. All files are grouped in four folders and provided in a compressed archive available as supplemental material. A brief description of some elaborations produced starting from the provided maps is given in this section.

In Figure 1 the spatial distribution of mean annual cumulative rainfall on Marche Region is given; boundaries of regional hydrographic catchments are also represented with red lines. Latitude and longitude are reported in Gauss–Boaga (G-B) North and East coordinates, respectively. The Apennine chain is located along the internal (Western) boundary of the region.

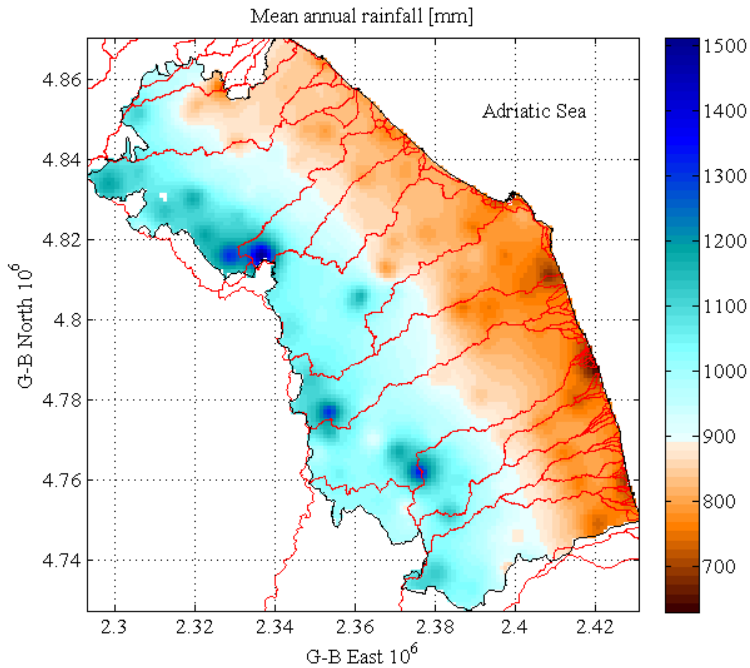

Fig. 1. Spatial distribution of mean annual cumulative rainfall on Marche Region in 2000-2018 years. Red lines represent the boundaries of regional hydrographic catchments. G-B stands for Gauss–Boaga cartographic projected coordinate system.

Annual air temperature on Marche Region averaged over 2000-2018 years is shown in Figure 2. In this case, black lines were used to represent the hydrographic catchments on the map

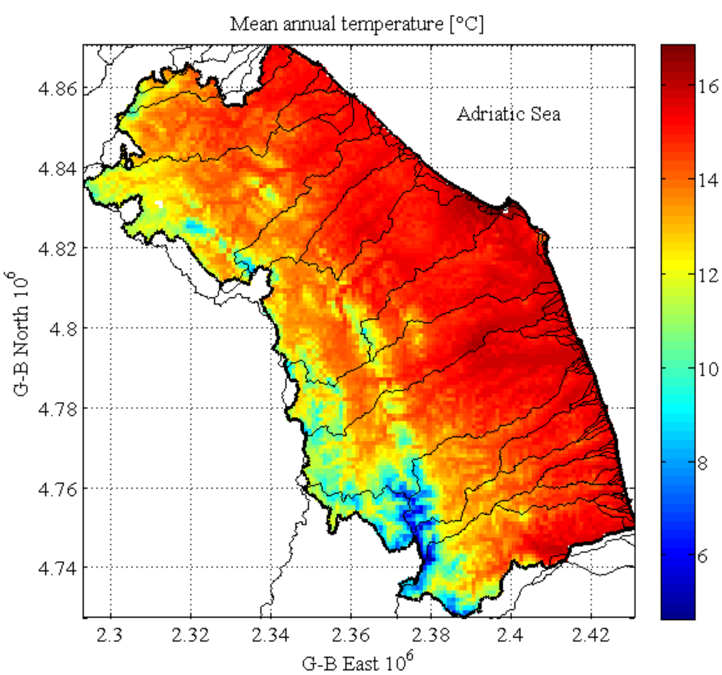

Fig. 2. Spatial distribution of mean annual air temperature on Marche Region in 2000-2018 years. Black lines represent the boundaries of regional hydrographic catchments.

In Figure 3 and Figure 4 monthly air temperature averaged over 2000-2018 years only during January and July, respectively, is reported.

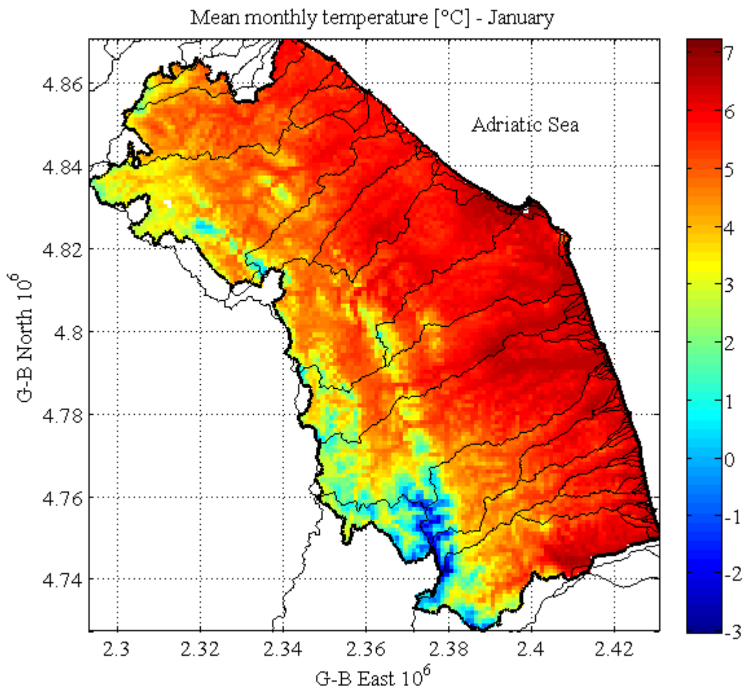

Fig. 3. Spatial distribution of mean monthly air temperature during January on Marche Region in 2000-2018 years.

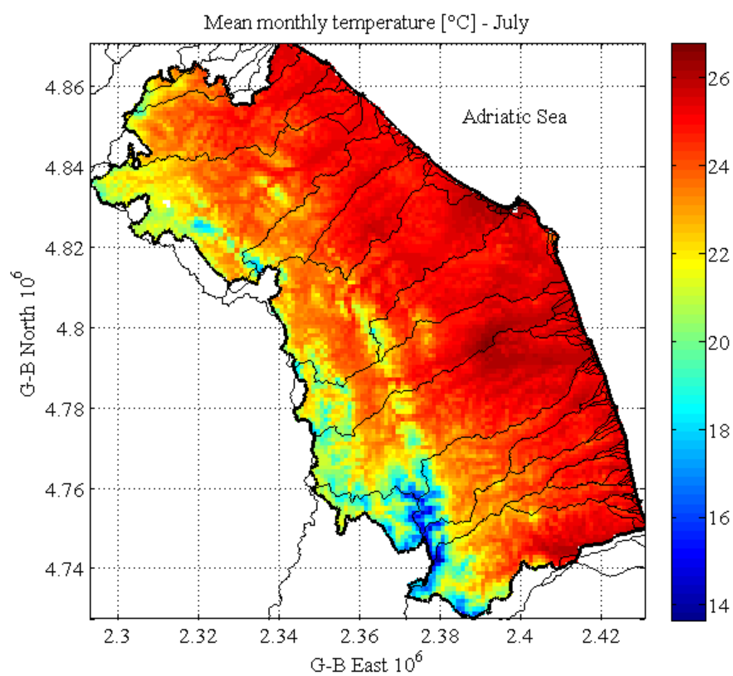

Fig. 4. Spatial distribution of mean monthly air temperature during July on Marche Region in 2000-2018 years.

COMPETING INTERESTS

Authors declare that no competing interests exist.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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