Regional Changes in Interannual Precipitation Variability in Italy

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Abstract

Over the last few decades, researchers have focused on the variability of precipitation in space and time. The majority of the literature concentrated on long-term changes in average climate and climate extremes. Analyses of changes in inter-annual climate variability (year-to-year variability), which represent an index of climatic risk, have received far less attention, but they are an important issue in quantifying the socioeconomic impact of climate change on water resources. An analysis of the precipitation coefficient of variation, assumed as an index of inter-annual climate variability, was performed over the period 1918-2015 to depict a general characterization of the long-term climate variability for the Campania region, located in Southern Italy within the Mediterranean basin and compared to the same region's annual precipitation regime and intra-annual precipitation variability. To detect the sign and significance of temporal changes, the Mann-Kendall and modified Mann-Kendall tests were used, and Sen's test was used to quantify temporal changes in inter-annual variability.

Keywords: Weather • Prediction • Temperature • Radiosondes

Introduction

Water scarcity is a recurring and global phenomenon, with spatial and temporal characteristics that vary greatly between regions. Climate change is likely to accelerate climate-meteo-hydrological processes that can lead to severe drought episodes and understanding historical precipitation variability is required to plan mitigation strategies for future climate change impacts. Precipitation variability in space and time has been a topic of study for decades. The majority of the literature focused on long-term changes in average climates, such as monthly or annual scale precipitation and air temperature data. Climate change has an undeniable impact on water resource assessment, flood and drought management, as well as plant growth, agricultural production, and the biogeochemical cycle. In addition to drawing the maps, computers also forecast how the maps will appear in the future. Numerical weather prediction is the term used to describe weather forecasting by computers. "Precipitation on Malden Island ranges from 100 mm to 2.000 mm and more in some years." "The relative variability is 71%." He introduced the relative variability index on a global scale, using 384 rain gauge stations, and discovered that it decreased in general with an increase in Mean Annual Precipitation (MAP). However, relative variability deviated significantly from the overall global trend over large areas. Later, Nicholls and Wong (1990) found very similar results using the coefficient of variation (CV) as a measure of precipitation inter-annual variability. In a global scale study, MAP only explains 16% of CV variations and that an additional index that describes intra-annual variability, the PCI (Precipitation Concentration Index; Oliver (Oliver 1980), could help improve the interpretation of inter-annual precipitation variability.

The majority of the studies on inter-annual variability involved future predictions of CV values and temporal patterns under conventional IPCC climate change scenarios. The analysed scale was a global scale in general, and the general trend predicted an increase in inter-annual variability.The examined scale was a global scale in general, and the general trend predicted an increase in inter-annual variability. However, water scarcity varies significantly from region to region and studying precipitation inter-annual variability at this scale is also critical, particularly for quantifying the socioeconomic impact of climate change on these specific systems. Regional-scale analyses, on the other hand, are uncommon in the current literature. Only two studies analyzed CV temporal patterns derived from historical precipitation time series, one in a tropical climate region and one in a Mediterranean climate-type region, confirming an increase. Another limitation is the widespread use of projected climate data. Regional-scale analyses, on the other hand, are uncommon in the current literature. Only two studies analyzed CV temporal patterns derived from historical precipitation time series, one in a tropical climate region and one in a Mediterranean climate-type region, confirming an increase in the CV. Another limitation is the widespread use of projected climate change scenarios from which to infer the climatological characteristics of a specific area. Because of the high precipitation variability that affects specific regions of the globe, coarse spatial resolution data from global weather datasets or climate models are ineffective; thus, historical in situ measurements are critical for reliable drought conditions assessment. especially in light. The Mediterranean basin, in particular, is well known to be characterized by high climate variability. Most outstanding "Hot-Spots" in future climate change predictions. Numerous studies on Mediterranean long-term precipitation found a moderate to significant decrease in precipitation over the last 50 years. As Giorgi shows, the significant decrease in average precipitation is accompanied by an increase in precipitation variability, particularly during the warm season (2006). He created a regional climate change index using the CV as a measure of precipitation variability.

The current study first demonstrated the CV average and spatial variability at the regional scale. In order to analyze the temporal changes in the CV patterns, thirty years of moving windows CV time series were reconstructed for each station. For auto correlated time series, the Mann-Kendall and Mann-Kendall modified tests were used to determine statistical significance and the sign of the changes and Sen's slope test was used to determine the magnitude of temporal changes in CV. Finally, the inter-annual precipitation changes were compared to the previously studied annual precipitation regime and intra-annual precipitation variability changes to depict a broad picture of long-term climate variability. For the period 1918-1999, the SIMN Servizio Idrografico e Mareografico Nazionale managed the rain gauge network for the investigated region. Data available include annual and monthly precipitation time series for over 300 sites spread across Campania and Lazio. A data quality control process, and only 163 rain gauge stations passed a time series homogeneity statistical analysis.

After 1999, the Regional Civil Protection Department was in charge of reorganizing and managing the rain gauge network. Around that time, there was a change in the consistency, spatial location, and typology of rain gauge stations, which hampered the possibility of database merging. In fact, only 30 stations were discovered. In fact, only a subset of 30 stations were discovered to share the same location in both databases and to exhibit statistical homogeneity features from 1918 to 2015.The change in gauge location, in particular, prevented the possibility of reconstructing a long precipitation time series by merging the two databases for the remaining stations. From 2000 to 2015, finer time scale resolution precipitation at 10 mins was available, which was aggregated at the monthly scale for comparison with data recorded by the former meteorological service.

The current analysis was carried out with the goal of demonstrating, on the one hand, the long-term variability over the longest available period and, on the other hand, the broadest spatial pattern variability. The current analysis was carried out in two steps. Initially, the investigation was focused on the 163 stations for which data were available from 1918 to 1999 in order to represent spatial variability at the regional scale. Second, the subset of 30 stations was investigated to represent the temporal variability over the longest available period.

A comparison of the results from 1918 to 1999 and 1918 to 2015 was also carried out. For the years 1918 to 2015, daily, monthly, and annual time series are available. The current analysis is on an annual scale. CV time series were tested for trend detection in time. A trend is a significant change in a random variable over time that can be detected using statistical parametric and non-parametric procedures. The current study provided and compared non-parametric Mann-Kendall (MK), modified Mann-Kendall (MMK), and Sen's tests results. The Mann-Kendall test is one of the most widely used methods in climatology analysis for detecting trends. It is used to look for consistent increasing or decreasing trends in data collected over time (monotonic). It is a non-parametric test, which means it works for all distributions. As a result, tested data does not have to meet the assumption of normality, but it should have no serial correlation. To account for the presence of both positive and negative autocorrelation in analyzed data, which may increase the probability of detecting trends when none exist, the modified Mann-Kendall test can be used, in which the effective sample size is used to modify the Mann-Kendall statistic. The Sen estimator is a method for robustly fitting a line to a set of sample points by selecting the median of all line slopes through pairs of points. In terms of statistical power, it outperforms non-robust simple linear regression (least squares) for skewed and heteroskedastic data and competes well with least squares even for normally distributed data. A study on long-term changes in annual precipitation was conducted using the same database and region as the current study (163 stations from 1918 to 1999). It was discovered that, across the entire region, the trend in annual precipitation appears predominantly negative, but that the significance of the changes only holds for a very small number of total rain gauge stations, approximately 9% in the case of negative trends and 27% in the case of positive trends. Later the intra-annual variability of the precipitation regime was studied for a larger database and a larger region, which included the area used in the current study, Previous studies over the region under consideration revealed a general, but not statistically significant, tendency toward a reduction in total precipitation and a general, but not statistically significant, tendency toward a more uniform distribution of total precipitation throughout the year (reduction in climate seasonality).The spatial distribution of mean annual precipitation, precipitation concentration index, and average coefficient of variation. The orography of the region has a strong influence on the spatial pattern of mean annual precipitation, with the tallest reliefs running north-west to south-east, where the highest values of MAP, between 1500 mm and 2000 mm, can be found. Similarly, the orography and distance from the coastline have a significant impact on the average PCI spatial distribution. Coastal areas have the highest PCI values, ranging from 13 to 16, while inland areas have average PCI values as low as 11. The specific findings reported for the region under investigation appeared to contradict the main findings illustrated by the relevant literature. Although some edge effects may influence the spatial distribution of the observed quantities due to interpolation issues, the main motivation is likely represented by a limitation of the case study that presents, on the whole, some rather characteristics of climatic homogeneity.

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