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Period of Heavy Precipitation Extreme? The Western Mediterranean's extraordinary October

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Abstract

Heavy precipitation and flash flooding are particularly common in the Mediterranean region. These weather-related risks plague the area every autumn, often with extremely serious and expensive repercussions. What intensifies a period of heavy precipitation that was already potentially harmful? This study's fundamental topic is how to find anomalies that encourage this intensification by looking at the atmosphere and ocean conditions in October 2018. Furthermore, climatological, seasonal, and event-based COSMO high-resolution model simulations are used to examine the model representativity of the over-averaged precipitation period and underlying anomalies across scales.

Keywords: Significant rainfall • Mediterranean • Large-scale circumstances SST • Model resolution in high • Glaciers

Introduction

Our research demonstrates that October 2018 in the framework of the climatological series from 1982 to 2018 may be regarded as an exceptional period due to the existence of powerful and numerous low-pressure systems. Additionally, the high percentiles of the TCWV hourly anomalies caused atmospheric moisture readings to be higher than the climatological average at this period. With the exception of pressure levels lower than 700 hPa, specific humidity exhibited similar behaviour as TCWV, perhaps in relation to the development of the former Hurricane Leslie. The interplay between the atmosphere and the ocean resulted in significant evaporation and Sea Surface Temperature (SST) anomalies. While October 2018 exhibits both a high monthly anomaly and intense evaporation peaks preceding the most extreme precipitation events, April to October SST clearly surpasses climatological norms. Anomalies in these large-scale characteristics were generally. The high-resolution regional climate model simulations at climatic and seasonal scales generally did a good job of capturing the anomalies of these large-scale phenomena, resulting in an accurate portrayal of accumulated precipitation during the month of October. However, the numerical weather prediction simulations on an event scale demonstrated low predictability, which is in line with earlier findings, as a result of variations at the location and intensity of the cut-off lows and particularly at the atmospheric moisture field. Heavy Precipitation Events (HPE) and flash flooding regularly affect the western Mediterranean region especially in the fall. The region's geomorphological features, such as the steep orography surrounding the WMed and the heavily populated coastal areas, favour HPEs that are mostly convective in origin Small catchments encourage and exacerbate flash flooding. According to Dobroviová et these occurrences are defined by their severity and disastrous macroeconomic effects.

A favourable large-scale scenario and low-level convergence are also present Convection's origins have been linked to the area's orography and moisture concentration Late summer and early fall, the warm Mediterranean Sea serves as a heat and moisture reservoir from which low-level jets carry moisture and instability towards HPE areas.

Seventy-five percent of the largest episodes of HPEs in the WMed occur in the months of September, October, and November (SON). As a result, the region's "severe precipitation season" might be thought of as the months of fall. These periods' high intensity may be due to a few exceptional extreme precipitation events, the accumulation of precipitation from numerous less intense precipitation events, or a combination of these factors. or a mix of the two elements. We still have a long way to go before we have a thorough understanding of the factors that cause excessive wet seasons, including their underlying mechanics and socioeconomic effects. Improved understanding of rainy seasons has been the focus of some recent research projects which show the intricate relationship between seasonal precipitation and synoptic-scale weather patterns and identify cyclones and warm conveyor belts as major causes of extreme wet seasons in most parts of the world. These investigations typically concentrate on the global level and investigate the large-scale weather systems that are in charge. Numerous research done over the past year indicate that the water cycle is becoming more intense on a worldwide scale. the global water cycle became more intense between 1950 and 2000. observational data and climate projections to characterise this intensification. Regionally, found that from the middle of the 1970s, the Mediterranean has experienced a rise in evaporation that is predominantly caused by rising SST. These changes in evaporation and SST may contribute to a longer-term increase in the likelihood that HPEs and extreme events will arise in the Mediterranean region as a result of climate change. However, the water cycle is affected by these intensification and feedback mechanisms. On shorter time scales, however, similar feedback/intensification mechanisms that are present in the water cycle can potentially contribute to excessive precipitation seasons at the regional level. Therefore, accurate understanding of the mechanisms underlying these severe precipitation events is essential for improving HPE forecasts and mitigating any potential future harm. This is especially important given that future climate forecasts for the NWMed predict an increase in the frequency and intensity of HPEs.

This study aims to shed light on the climatic factors and related anomalies that contributed to the excessively destructive wet fall of 2018 in the NWMed. Spain France, and Italy throughout this time and Italy were severely impacted, having disastrous effects on both the economy and the number of casualties. Additionally, using high-resolution COSMO model simulations, the model's representativity of the extreme rainy period is evaluated across scales at the climatic, seasonal, and sub-seasonal levels.

The layout of this study is as follows: The data utilised and the methodology used. The autumn of 2018 is described in Section 3 in terms of precipitation activity, and the findings are discussed in Section 4 with an emphasis on the synoptic circumstances, the atmospheric water vapour distribution, the SST, and related evaporation. ERA5 is a comprehensive global reanalysis dataset that covers the period from 1979 to almost real-time and incorporates the greatest number of observations in the near-surface and upper air. The European Centre for Medium-range Weather Forecasting (ECMWF) and the EU-funded Copernicus Climate Change Service have created the ERA5 reanalysis of the world's weather and climate (C3S). Through the C3S Climate Data Store (CDS) facility hourly geopotential and specific humidity data on pressure levels, as well as total column water vapour data, from 1982 to 2018 were obtained for the current study. An interpolation post-processing conversion from the usual latitude-longitude grid (0.25° for the high-resolution deterministic reanalysis) on 37 pressure levels was chosen.

The CDS utility directly provides the native reduced-Gaussian grid. No-gaps for a large region, EU consistent data may be gathered to create a cohesive picture of our regional system.

We used information from the National Centers for Environmental Information to examine sea surface temperature. 2020. Daily L4 Optimally Interpolated SST (OISST) In situ and AVHRR Analysis Version 2.0 PO. DAAC daily data available from September 1981 to the present, AVHRR OI is a blended SST data collection that covers the Mediterranean region with a smoothed and full field at 0.25° spatial resolution. In which contains a wealth of details and descriptions of the data set, the authors discuss how it is appropriate for climate analysis. We have used the Objectively Analyzed air-sea Fluxes (OAFlux) for the Global Oceans project data set to study evaporation. This dataset contains information on several air-sea fluxes and variables, and we have chosen moisture flux as our focus (ocean evaporation). OAFLUX data provides daily data since 1985 and monthly data from 1958 to 2018 with a 1° spatial resolution that spans the entire planet. Since we wanted to create an adequate long-term climatology of evaporation in the Mediterranean region, we used monthly data in our study.

The non-hydrostatic Consortium for Small-Scale Modeling (COSMO) model, version 5.0, is utilised for the simulations in this investigation. Three different simulations are performed: a climatological run (CLIM) covering the years 1999-2018 (the year 1999 is treated as a spin-up), a seasonal run (SS) covering the months of September 1 through October 31, 2018, and event simulations (EV) for each of the investigated episodes covering only a brief time frame of a few hours to days.The COSMO model's climate mode (COSMO-CLM), utilising CLM version 15, is used to execute the climatological and seasonal simulations. The episodic simulations are done in Numerical Weather Prediction (NWP) mode. The slow-changing variables, such SST, plant cover, and others, are updated often in COSMO-CLM since they are maintained constant during the simulation period.

Investigated and compared to the historical average of Octobers from 1982 to 2018, the synoptic circumstances that occurred in October 2018 were examined. In particular, geopotential heights for ERA5 hourly data on various pressure levels (1000 hPa) at 0.25° spatial resolution were examined. These heights were retrieved through the C3S-CDS facility. Each dataset had a full month's worth of geopotential heights for each of the 0.25° grid points, and a percentile analysis was done on each dataset. As a consequence, 21 percentile maps representing the geopotential percentiles ranging from 0th to 100th in 5th steps were obtained for each of the pressure levels for each of the 37-year Octobers. Each of the geopotential percentiles' 2D distributions of climatological means were produced using the mean of Octobers from 1982 to 2018 with a 0.25° spatial resolution.

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