Quaternary International 409 (2016) 75–80

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Extreme precipitation over the Crimean península

Elena Voskresenskaya, Elena Vyshkvarkova*

Federal State Budgetary Scientific Institution «Institute of Natural and Technical Systems» (INTS), Lenin St., 28, Sevastopol 299011, Russia

ARTICLE INFO

Article history:
Available online 17 February 2016

Keywords:
Extreme precipitation
Concentration index
Pacific decadal oscillation
Crimean peninsula

ABSTRACT

Based on daily precipitation data for 1951–2009 from 18 hydrometeorological stations all over the Crimean peninsula, a 58-year data series of extreme precipitation parameters (precipitation concentration, level of extreme precipitation and number of days with extreme precipitation) were calculated. Linear trends of calculated parameters are estimated in this paper. Manifestations of the Pacific decadal oscillation (PDO) of the extreme precipitation changes were analyzed. The precipitation concentration is found to increase in the Crimean Mountains region in the winter season, but in the summer season the precipitation concentration is characterized by uniform distribution. Linear trends of the winter and summer precipitation concentration during the last 58 years are predominantly negative over Crimea. The maximum values of precipitation level in the winter season are typical for the Crimean Mountains region. In the summer season, values of precipitation change insignificantly. The number of days with extreme precipitation exhibits decreasing trends in the winter season over the territory of Crimea. In the summer season, the number of days with extreme precipitation in south-eastern part of Crimea has increasing trends. The negative PDO phase in the winter season was found to accompany increased precipitation concentration (up to 11%) all over Crimea and by decreased concentration (up to 4%) in the summer season in central, southern, and eastern regions of Crimea. The number of extreme precipitation days in the winter season is up to 30% higher in the negative PDO phase over the whole territory of Crimea, while in the summer it is up to 60% lower in the south-eastern part of peninsula.

1. Introduction

IPCC Assessment Report 5 concludes that substantial increases are found in heavy precipitation events. Annual heavy precipitation events had disproportionately increased compared to mean changes between 1951 and 2003 over many mid-latitude regions, even where there had been a reduction in annual total precipitation (IPCC, 2013). Extreme precipitation has a large influence on the efficiency of the activities in many sectors of economy. Extreme precipitation can lead to the threat of flooding, erosion, and landslides in the mountains. It remains an open question if it is a consequence of global warming or natural variability.

A large number of authors have studied extreme precipitation over the globe and over the different regions. For example, Tromel and Schonwiese (2007) have shown that climate in Germany was getting more extreme in winter in 1901–2000. A similar result was shown in Zolina et al. (2008): positive linear trends in heavy precipitation were found for winter, spring and autumn seasons, however the heavy precipitation mostly showed negative trends for the summer season. Trends of the frequency and intensity of extreme precipitation in Greece (Kioutsioukis et al., 2010; Karagiannidis et al., 2012) have significantly decreased during the second half of the 20th century. Extreme precipitation variability and climate uncertainty over Iberian Peninsula (Gonzalez Hidalgo et al., 2003; Costa and Soares, 2009) became greater in recent times. Analysis of extreme precipitation events in U.S. (Kunkel, 2003) indicates that their frequency had sizably increased. For Central America and northern South America (Aguilar et al., 2005) rainfall events have been intensifying, and the contribution of wet and very wet days has increased over 1961–2003. Significant increases in extreme precipitation were found in western China (Zhao et al., 2014), in the mid–lower reaches of the Yangtze River, and in some parts of the southwestern and southern China coastal area for 1951–2000. Alexander et al. (2006) has shown the positive tendency of daily climate extremes in vast areas of the globe. The positive trends of extreme precipitation over Europe in the summer and winter 1946–1999 was found by Klein-Tank and Konnen

* Corresponding author.
E-mail address: aveiro_7@mail.ru (E. Vyshkvarkova).

http://dx.doi.org/10.1016/j.quaint.2015.09.097
1040-6182/

(2003). Haylock and Goodess (2004) have noted negative signs of trends for the shorter period in 1961–1990.

The results of the authors referenced above demonstrate that there are trends of opposite signs for different short-term periods across the globe against a background long-term positive trend of extreme precipitation parameters. Doubtless, it happens because of the low-frequency variability in the atmosphere-ocean system. There are low-frequency processes in the atmosphere-ocean system responsible for the behavior of meteorological elements including extreme precipitation, including Pacific decadal oscillation (PDO), Atlantic multidecadal oscillation (AMO), and others. These processes together have an influence on climate but it is a difficult task to study them. Consequently, we divide this work on small tasks. In this paper, we focus on PDO manifestations in precipitation concentration and parameters of extreme precipitation changes in Crimea.

The phase change of Pacific decadal oscillation explains the changes in the mode of different hydrometeorological parameters in the mid-1970s which were named as a climate shift by some authors (Nitta and Yamada, 1989; Trenberth, 1990). It is undeniable that such large-scale ocean anomalies have an influence on the global atmosphere circulation. PDO manifestations in decadal variability of European river run-offs and some hydrometeorological parameters were studied (Pekarova et al., 2006; Bardin and Voskresenskaya, 2007). Voskresenskaya and Maslova (2011) noted that storm-tracks changed their typical location over Europe in different PDO phases were found. In this way, a negative PDO phase is accompanied by a storm-track shift to the southern Europe and intensification of cyclonic activity in the Mediterranean-Black sea region including Crimea. In positive PDO phases, storm-tracks move to the north of the European continent. These changes manifest in precipitation distribution because the precipitation depends directly on the passing of cyclones. The aim of the paper is to study the winter and summer precipitation concentration, precipitation extremes level and its frequency on the Crimean peninsula, to discuss their trends, and to study the PDO manifestations in the changes of extreme precipitation parameters.

2. Regional setting

The territory of the Crimean peninsula is quite small (27,000 km^2) but its climate is characterized by the wide variety of types: steppe, mountain and the climate of southern coast of Crimea. Each type of climate zone is characterized by its own characteristics: precipitation patterns, temperature, and other meteorological parameters. One of the most important parameters is precipitation due to its extreme importance for sustainable development of agriculture and freshwater availability. Differences in precipitation modes (Fig. 1) exist for annual precipitation at two Crimean stations located in different climatic zones – Dzhankoy (steppe zone) and Yalta (climate of southern coast of Crimea). Climate of the steppe zone is mild continental, there is maximum precipitation in the summer, and annual precipitation is about 350 mm. The southern coast is characterized by sub-Mediterranean climate with maximum precipitation in the winter and annual precipitation about 650 mm. The Crimean peninsula is a widely known international recreation and touristic zone.

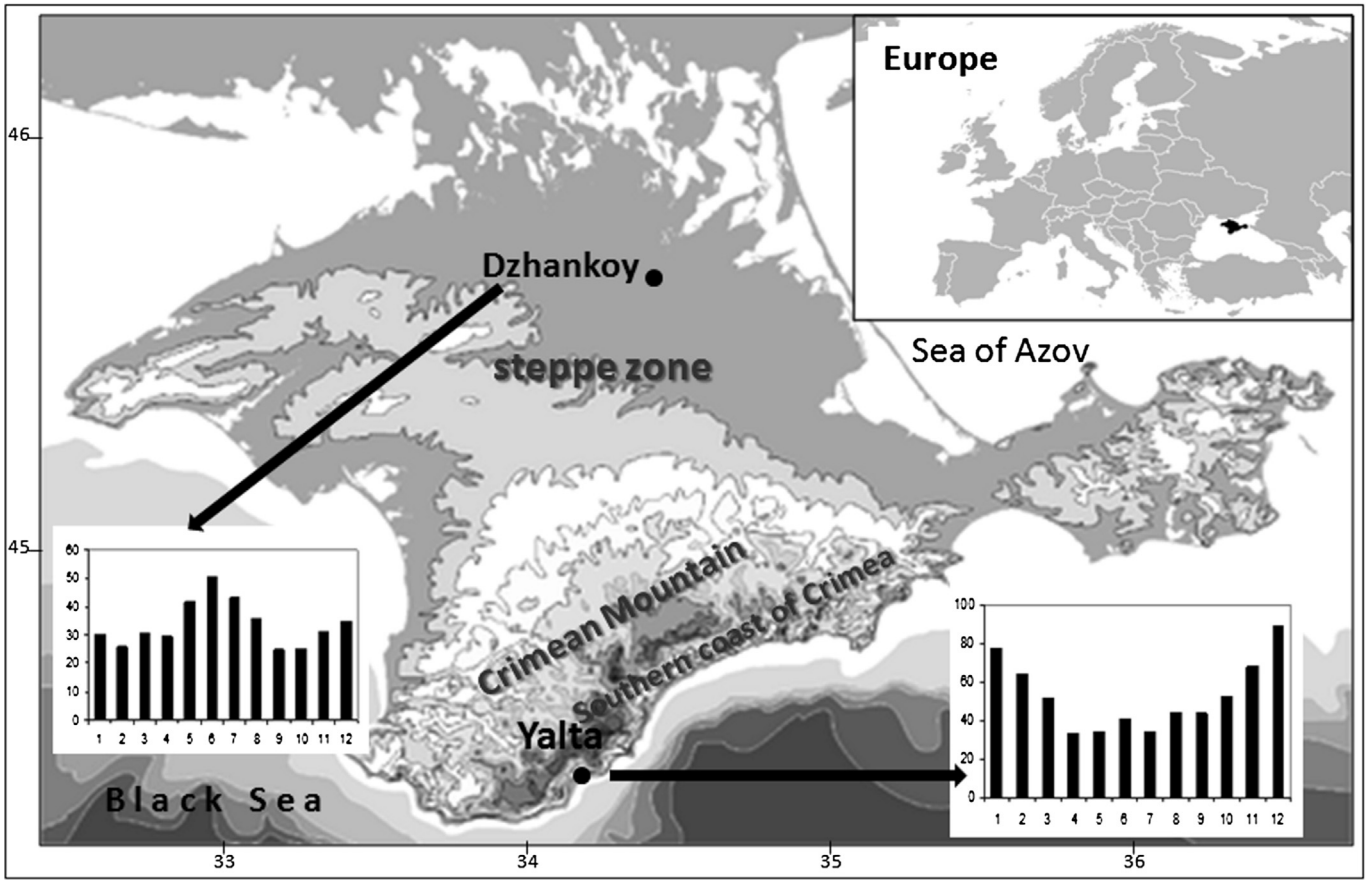

Fig. 1. Location of the Crimean peninsula. Annual precipitation modes in the steppe zone (Dzhankoy station) and southern coast of Crimea (Yalta station) during 1951–2009.