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## Changes and trends in total yearly precipitation of the Antalya district, Turkey

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### Abstract

In this study, long term changes and trends in the annual rainfall of the Antalya Part, which is the region located in the western Mediterranean coast of Turkey containing many agricultural areas in its surrounding, were analysed. The aim of this study was to analyse the long term changes and trends in rainfall totals and present spatial distributions of annual and seasonal rainfall variability over the part. Rainfall data from 7 meteorological stations (Antalya, Alanya, Manavgat, Gazipaşa, Finike, Korkuteli and Elmalı) covering the years 1970-2011 were used in this study. Prepared rainfall variation maps clearly show that the highest annual variation is Antalya, while the lowest variation is Manavgat. According to the results obtained in trend analysis, in general, while a decreasing trend in winter rainfall is apparent, there is an apparent increasing trend in autumn rainfall. These results show a shift in seasons causing long-term droughts and potential infertile land to emerge. At some stations in the vicinity, there has been a prominent change from humid conditions to semi-arid conditions from beginning of 2000s. This study is expected to contribute to better understanding the effects of global climate change over precipitation in Antalya vicinity.

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## 1. Introduction

Show that there have been marked increases in precipitation in the latter part of the 20th century over northern Europe, with a general decrease southward to the Mediterranean. According to Piervitali, Colacino and Conte. (1998) and Romero, Guijarro, Ramis and Alonso (1998), dry wintertime conditions over southern Europe and the Mediterranean. Generally, important decreasing trends were observed in the winter rainfall, annual rainfall of Turkey and rainfall of the East Mediterranean Basin are associated with very high frequency in the Mediterranean low pressures and frontal middle latitude pressures dominating in this region (TÜBA, 2010). Some studies (Türkeş and Erlat, 2003; 2005; 2006) determined that changes and variability in the North Atlantic Oscillation (NAO) winter indices are one of the major atmospheric sources for controlling spatial and temporal variability of winter precipitation in Turkey, as much as in the Atlantic, the Europe and the Mediterranean Basin. As a result of climate change, many studies on changes related to atmospheric circulation types and anomaly affecting in Mediterranean Basin and long term surface air temperature changes and trends are formed for countries situated within Mediterranean Basin and its surrounding (Metaxas et al., 1991; Arseni-Papadimitriou and Maheras, 1991; Kutiel et al., 2002; Kutiel and Maheras, 1998; Price et al., 1999; Gönençgil and İçel, 2010; Bahadır, 2011). In these studies, decreasing trends in the amount of rainfall are determined, especially in the East Mediterranean. As temporal and spatial, rainfall is the most variable element of climate and this variability is the most prominent feature of the arid, semi-arid and continental climates (Türkeş, 1990). There are many studies on year by year changes in annual and monthly rainfall in Turkey (Kadioğlu, 2000; Türkeş and Erlat, 2003, 2005; Tatlı, 2007; Ölgün, 2010). The results of these studies indicate that the vulnerability in annual rainfall and longer term rainfall changes are associated with NAO, Arctic Oscillation, Mediterranean Oscillation and El-Nino-Southern Oscillation (ENSO).

In this study, trends and changes in the annual and seasonal rainfall of Antalya Part using the rainfall data sets were examined in detail. The data sets include monthly and annual rainfall totals (mm) recorded at the stations of the Turkish State Meteorological Service (TSMS), most of which are principal climatological stations. The maps showing the spatial distribution of these trends and changes were formed using GIS. The purpose of this study was to determine changes in the spatial dispersion and inter-annual variations of rainfall. The results of this study are important for Antalya Province with its many agricultural areas.

## 2. Study area

The study area is situated within the Antalya section of the Mediterranean Region, with Antalya city at the centre. Antalya Province (including districts) has an area of 20723km<sup>2</sup>, while Antalya coast is 630km long. The province is surrounded by the Burdur, Isparta and Konya Provinces to the north; Karaman, Mersin provinces to the east and Muğla to the west and the Mediterranean Sea to the south. The Antalya Part overlooks the Mediterranean Sea of Taurus Mountains situated between Antalya Gulf to the west and Manavgat district to the east (Fig. 1). The Antalya Part contains the productive agricultural areas of the Serik district. For this reason, changes in climate are very important for this part. Agriculture is performed all year round and yield is obtained twice yearly (Atalay and Mortan, 2007).

The northeast-southwest trending mountain chains extend in the west of the Antalya Part. Many valleys are found among these mountain chains. These mountains are Akdağ (2375m), Beydağları (3069m), Mount Elmalı (2490m), Bozdağ (2421m), Mount Çiçekbaba (2294m), Mount Geyik (2529m) and Mount Dedegöl (2980m) is found in the east of the Antalya Part. These mountains consist of limestone. The lakes and valleys are found in the tectonic and subsidence areas among these mountains (Yücel, 1987). The rainfall of Antalya Part is determined by topography and frontal activities. According to Atalay and Efe (2007), the rainy area of the region is the southwest slopes of the Taurus Mountains due to the fact that the fronts coming from the Mediterranean Sea are mostly shielded by the mountains. The mean annual precipitation of Antalya and Manavgat is above 1000mm because the fronts coming from the Mediterranean Sea are prevented by the mountains as well as Antalya. Orographic rainfall also causes an increase in precipitation, especially on the southern high slopes of the Taurus Mountains (Atalay and Efe, 2007). The frontal system depending on air mass penetrating into the Mediterranean Basin and formation of low-pressure manage air conditions of the Mediterranean coast from the end of October to May (Koçman, 1993; Kafalı Yılmaz, 2008). During the summer the fronts form between the maritime tropical air mass (mT) coming from the Atlantic

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