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Precipitation climatology over the Mediterranean Basin — Validation over Cyprus

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ABSTRACT

A study for a 15-year period (1998–2012) embracing both satellite and rain gauge data is performed over the Mediterranean basin. Tropical Rainfall Measuring Mission (TRMM) 3B43 monthly data (versions 7 and 7A) are compared with the corresponding E-OBS gridded rain gauge precipitation data over a common 0.25 × 0.25° grid. The study focuses over Cyprus, where a dense and reliable network of rain gauges is available. These in situ measurements are compared with both E-OBS and TRMM data for the aforementioned 15-year period. Monthly and (seasonal) yearly comparisons are presented for each of the 0.25 × 0.25° cells overlaying the island of Cyprus. For each of these cells, at least three rain gauges are sited within its corresponding area. BIAS and mean absolute error (MAE) for TRMM and E-OBS estimates from the corresponding averaged gauge data were extracted. The results show a very good correlation (as high as 0.95) over areas where TRMM data incorporate rain gauge measurements along with satellite data. However, the poor correlation over other areas (as low as 0.05) is of great interest and needs to be studied further. The overall conclusion from this study is that TRMM and E-OBS estimates are well fitted with the gauge data, although they are both influenced by the variation of elevation.

1. Introduction

Rainfall data is an important parameter for water resource management, agriculture, flood and drought monitoring. On the one hand, conventional rain gauge networks provide rainfall data. Such data refers to (relatively) accurate point measurements of precipitation, although often limited to spatial coverage, especially when such networks are not well spatially distributed. Also, these measurements concern small surfaces that, given the chaotic behavior of rainfall, often are not representative for the whole neighboring area. However, ground-based networks have the advantage of providing better temporal resolution.

Satellite based precipitation products offer measurements over both land and ocean areas, thus, filling in, gaps in the ground based network, in addition to providing adequate spatial and temporal resolutions. However, satellite derived estimates are subject to biases and need to be compared and adjusted using in-situ observations.

Another source of precipitation data consists of gridded databases that are based on meteorological stations' data, provided on a rather coarse resolution. A considerable number of observational precipitation datasets are available, with spatial resolution varying from 0.25 to 2.5°. A literature overview of rainfall estimates from satellite, ground based and gridded data could be found in Tapiador et al. (2012) and Michaelides et al. (2009a,b).

Many studies have been focused on verification and validation of satellite-based precipitation data with respect to ground-based data in a variety of temporal and spatial scales. For example, As-syakur et al. (2013) studied the TRMM 3B43 and rain gauge data over the course of 13 years in the Indonesian region. Fleming et al. (2011) evaluated the TRMM 3B43 using gridded rain-gauge data over Australia. A first attempt to compare TRMM precipitation estimates with in situ range gauge data from Cyprus was made by Gabella et al. (2006a,b). TRMM precipitation data can also be used in conjunction with ground based radar derived measurements; in this respect, space measurements can be validated by using ground radar measurements, but, reversely, TRMM data can be used to calibrate ground based radars too, as demonstrated by Gabella et al. (2013).

The aim of this study is to evaluate the rainfall variability determined by TRMM 3B43 products in the Mediterranean region, for the period 1998–2012, with a particular focus on the island of Cyprus. In order to rate the capability of these products to contribute to the analysis of climatic-scale rainfall in Cyprus, rainfall estimated from satellite data was compared with both gauge observations and E-OBS gridded data.

2. Data description

2.1. TRMM 3B43

The Tropical Rainfall Measuring Mission (TRMM), launched by NASA (National Aeronautics and Space Administration) and JAXA (Japan

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Aerospace Exploration Agency) in 1997, has provided critical precipitation measurements in the tropical and subtropical regions of our planet (see Kummerow et al., 1998, 2000). Following the successful mission of TRMM, the two space agencies have embarked on a successor mission with improved and expanded capabilities. Indeed, the Global Precipitation Measurement (GPM) mission launched on February 27, 2014 is set to provide global precipitation measurements with improved accuracy, coverage and dynamic range for studying precipitation characteristics (see Hou et al., 2008).

Level 3 TRMM 3B43 data are often called TRMM Multi-satellite Precipitation Analysis (TMPA) products. The spatial coverage is latitudinally-global, as these data refer to a "belt" between 50°S to 50°N. The data products of 3B43 are the first rain products, combining TRMM precipitation radar (PR) and TRMM microwave imager (TMI) rain rates to calibrate rain estimates from other microwave and infrared measurements (Huffman et al., 2007). The final product is an average value of the monthly rain rate.

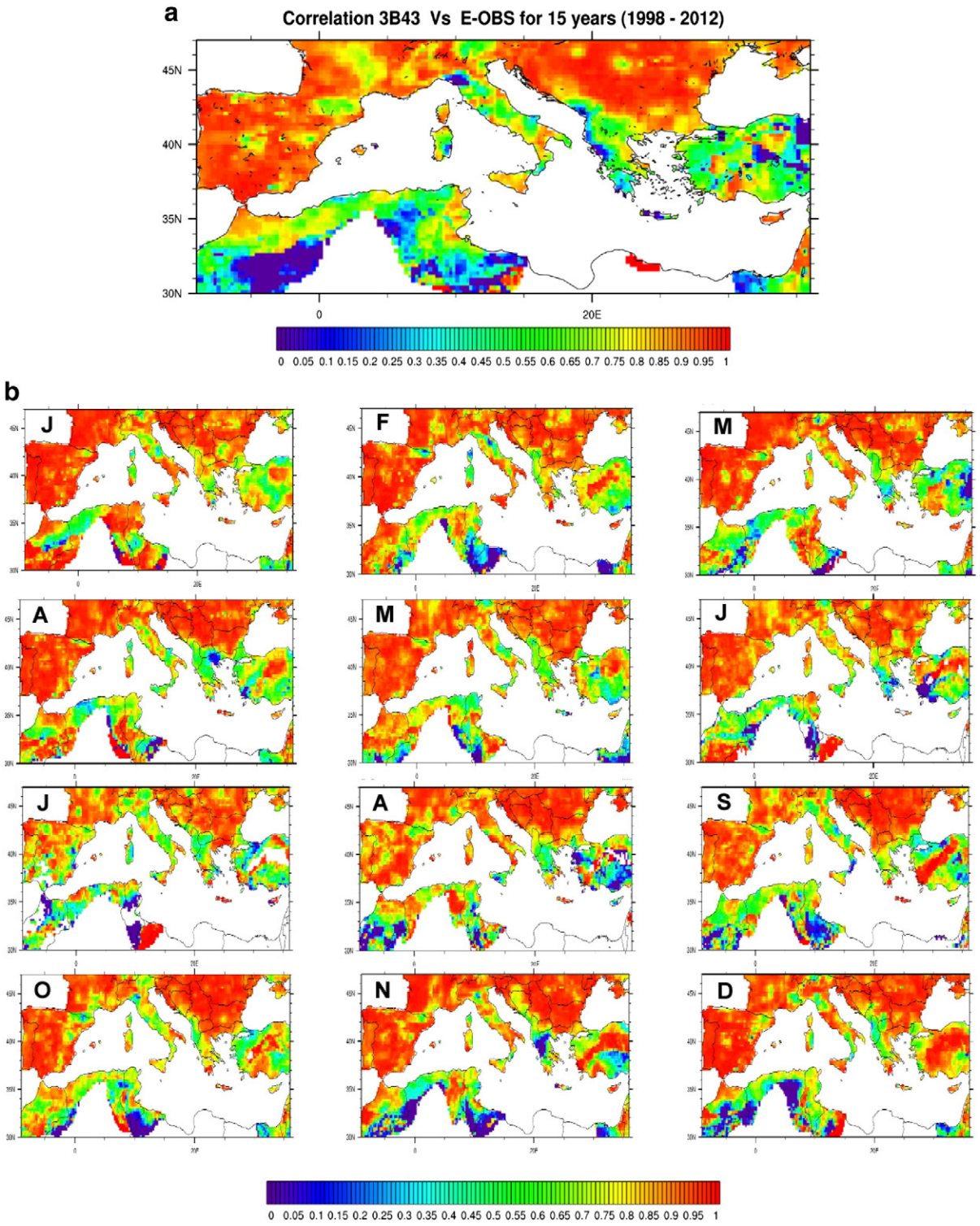

Fig. 1. a. Correlation (r-values) between annual TRMM and E-OBS data for the period 1998–2012. b. Correlation (r-values) between monthly (January to December) TRMM and E-OBS data for the period 1998–2012.