Due to the increased interest about climate variability and change, number of methods have been developed in order to deal with the inhomogeneity problems of long term climatic series, since these series reflect the real changes of the climate and provide the most accurate information about the climate evolution. In the early 20th century Conrad (1925) tried to homogenize two precipitation series using the Heidke criterion (Heidke, 1923) and some years later, in the middle of 20th century, (Kohler, 1949) introduced the double mass curve for the break point detection (Venema et al., 2012). Since then many methods have been proposed for the homogenization of climatic series and nowadays around 20 different methods are widely used (Domonkos, 2011).

The main goal of this work is to detect abrupt or more gradual changes in precipitation series from almost the whole Greek meteorological stations network, using three different homogenization methods and to improve precipitation series. It should be pointed out that this is the first attempt to homogenize Greek precipitation series from a large network.

**Target Area**

Greece occupies the southernmost part of the Balkan Peninsula, jutting out into the Eastern Mediterranean Basin, having the Aegean Sea on the east, the Ionian Sea on the west and the Libyan Sea on the South. Its territory lies approximately between latitudes 34 and 42 N and longitudes 19 and 30 E and comprises the mainland (the interior sector of the country), the islands (almost 6000 islands, islets and rocky islets) and the Aegean basin.

**Methodology**

- **Three different homogenization methods were applied for the detection and correction of inhomogeneities in precipitation series.**
  - **MASH - Multiple Analysis of Series for Homogenization** (Szentimrey, 2008) is a relative homogenization method based on multiple comparisons between the climatically similar time series and does not assume homogeneous reference series. The time step of comparisons may be annual, monthly or seasonal and the break point detection is based on hypothesis test for a given significance level, here equal to 1 %.
  - **HOMER** is a new relative method for homogenizing monthly and annual temperature and precipitation data (Mestre et al., 2013). It was developed in the frame of the European COST Action ES0601 called HOME, devoted to evaluate the performance of homogenization methods used in climatology. It incorporates the best characteristics of some other methods such as PRODIGE (Caussinus and Mestre, 2004), ACMANT (Domonkos, 2011), CLIMATOL (Gjijjaro, 2011), that performed good results in benchmark tests (Venema et al., 2012). The detection on break points (for precipitation series) is based on a combination of Dynamic programming and penalized likelihood criteria and on joint segmentation. The correction is based on ANOVA two factors model.
  - **ACMANT** is a fully automatic homogenization method developed by (Domonkos, 2011). The most important characteristics are a) harmonization of examinations in different time-scales, b) usage of the optimal segmentation and Caussinus-Lyazhri criterion in the detection of inhomogeneities, c) usage of ANOVA for the final corrections of inhomogeneities. It uses a pre-homogenization phase where the large errors from the reference composites are filtering.

**Results**

The examined precipitation series in Greece are fairly homogeneous. Inhomogeneities were found only at 20 % of stations (HOMER, 41 % (ACMANT) and 44 % (MASH)).

**Number of Breaks**

<table>
<thead>
<tr>
<th>Breaks (outliers not included)</th>
<th>Number of Stations</th>
<th>Homogenized with HOMER, 38 with MASH, 40 with ACMANT.</th>
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<tbody>
<tr>
<td>Zero break points for 55 stations</td>
<td></td>
<td>One break for the majority of inhomogeneous series.</td>
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</table>

**Temporal Distribution of Breaks**

(Outliers not included)

40-50% of breaks have been detected during '80s. Due to aviation needs HNMS’s weather station network upgraded between middle of ‘70 and early ‘90.

**Adjustments on annual time series**

Homogeneity of precipitation series (homogenized/original)

Corrections with HOMER and ACMANT were more or less equally positive and negative while most corrections with MASH were positive.

**Impacts of Homogenization**

The results were different than those found from the homogenization of temperature series (Marama et al., 2013:2014)

**Boxplot of standard deviation of average annual precipitation series**

**Boxplot of standard deviation of average annual precipitation series**

**Absence of substantial deviation between raw and homogenized annual series**

**Average annual precipitation series for the whole network for the period 1974-2004**

There is no improvement of precipitation series after homogenization.

**Regional trends per year of annual and semi-annual series**

Mann Kendall test was used (Kendall, 1979) + stat.significance at 90%

**Negative trends of no significance are prevailing**

After homogenization, trend (October-March) in Region 2 and trend (April-September) in Region 4 are positive.

In general, homogenization reduced trend size with exception Region 3 (April-September) where trend size increased.

**References**


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