



Development of a homogeneous long monthly precipitation dataset for Spain

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INTRODUCTION AND PURPOSE

- The purpose of this study is to extend, revise, improve and update the Spanish monthly/annual centenarian precipitation series in order to achieve more consistent variability and trend analyses. We present the compilation of a dataset integrated by 66 long monthly precipitation series, which covers mainland Spain and the Balearic Islands (Figure 1 and Table).
- The reconstruction of a single long time series from a number of shorter series belonging to nearby observatories enables the optimization of fragmented precipitation data sets. The reconstruction is based on the hypothesis that the cessation of data recording at one observatory is followed by the establishment of a new observatory very close to the closed one (in many occasions, just in-town relocations).
- To maintain them as two independent series is not useful for climate analysis because of their short length. If the observatories are very close, the differences in monthly precipitation amounts are usually very small and data from two or more series can be combined in order to form a very long record series. This series is attributed to the last observatory that is now a days working and will be probably working in the future.
- Reasonably, the resulting combined series can exhibit inhomogeneities which must be identified and removed from further analyses

1 43.53 -5.63 Gijon 191-2008 34 40.82 0.48 Torbas 1880-2002 2 43.52 -7.02 Castropol 1924-2008 35 40.65 -4.88 Aviia 1901-2003 3 43.45 -3.32 Santander 1912-2003 36 40.65 -3.17 Guadalajara 1901-2006 4 43.37 -8.42 Coruña 1877-2008 37 40.4 -3.67 Madrid 1859-2006 38 40.35 -1.12 Teruel 1978-2002 38 40.27 -5.85 Henas 1913-2008 40 40.07 -2.13 Cuenca 1908-2007 43.3 -2.03 San Sebastian 1878-2008 41 39.95 -0.07 Castellon 1912-2008 42 39.88 4.25 Mahon 1865-2006 14 39.88 4.03 Toleva 1912-2008 142 25.88 4.03 Toleva 1912-2008 142 25.88 4.03 Toleva 1912-2008	ID	Latitude	Longitude	Name	Record	ID	Latitude	Longitude	Name	Record
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28 41.62 -3.48 Vid de Aranda 183-2008 61 37.4 -6 Sewilla 1866-2002 29 41.48 -5.75 Zamora 1909-2008 62 36.83 -2.38 Almeria 1911-2002 30 41.28 2.12 Barcelona 1850-2008 63 36.75 -5.2 Grazalema 1912-2002 31 41.1 -1.4 Daroca 1909-2008 64 36.72 -4.48 Malaga 1876-2002 32 40.95 -4.12 Segovia 1901-2008 64 36.72 -4.48 Malaga 1876-2002 33 40.93 -5.48 Salamanaca 1865-2008 66 36.15 -5.35 Gibraltar 1817-2002	27	41.62	0.58	Lleida	1913-2008	60	37.18	-3.6	Granada	1898-2008
29 41.48 -5.75 Zamora 1909-2008 62 36.83 -2.38 Almeria 1911-2000 30 41.28 2.12 Barcelona 1850-2008 63 36.75 -5.2 Grazelema 1912-2000 31 41.1 -1.4 Daroca 1909-2008 64 36.72 -4.48 Malaga 1878-2007 32 40.95 -4.12 Segovia 1901-2008 65 36.45 -6.2 San Fernando 1817-2007 33 40.93 -5.48 Salamanaca 1865-2008 66 36.15 -5.35 Gibraltar 1852-2007	28	41.62	-3.48	Vid de Aranda	1883-2008	61	37.4	-6	Sevilla	1866-2008
30 41.28 2.12 Barcelona 1850-2008 63 36.75 -5.2 Grazalema 1912-2006 31 41.1 -1.4 Daroca 1909-2008 64 36.75 -4.48 Malaga 1878-2006 32 40.95 -4.12 Segovia 1901-2008 65 36.45 -6.2 San Fernando 1817-2006 33 40.93 -5.48 Salamanca 1865-2008 66 36.15 -5.35 Gibraitar 1832-2006	29	41.48	-5.75	Zamora	1909-2008	62	36.83	-2.38	Ameria	1911-2008
31 41.1 -1.4 Daroca 1909-2008 64 36.72 -4.48 Malaga 1878-2000 32 40.95 -4.12 Segovia 1901-2008 65 36.45 -6.2 San Fernando 1817-2006 33 40.93 -5.48 Salamanaca 1865-2008 66 36.15 -5.35 Gibraltar 1852-2000	30	41.28	2.12	Barcelona	1850-2008	63	36.75	-5.2	Grazalema	1912-2008
32 40.95 -4.12 Segovia 1901-2008 65 36.45 -6.2 San Fernando 1817-2008 33 40.93 -5.48 Salamanca 1865-2008 66 36.15 -5.35 Gibraltar 1852-2008	31	41.1	-1.4	Daroca	1909-2008	64	36.72	-4.48	Malaga	1878-2008
33 40.93 -5.48 Salamanca 1865-2008 66 36.15 -5.35 Gibraltar 1852-2008	32	40.95	-4.12	Segovia	1901-2008	65	36.45	-6.2	San Fernando	1817-2008
	33	40.93	-5.48	Salamanca	1865-2008	66	36.15	-5.35	Gibraltar	1852-2008

HOMOGENIZATION

In order to detect, and adjust for, possible multiple change points or shifts that could exist in the precipitation series, the RHtestV3 software package has been used (Wang et al, 2008). It is based on the penalized maximal T and F tests. The time series being tested could have a linear trend throughout the whole period of the data record, and the annual cycle, linear trend, and lag-1 autocorrelation of the base series is estimated through iterative procedures while accounting for all the identified mean-shifts. The RHtestsV3 software package includes provision of Quantile-Matching (QM) adjustments (Wang et al. 2010). The objective of the QM adjustments is to adjust the series so that the empirical distributions of all segments of the de-trended base series match each other

To assess the importance of network density to the detection and correction of inhomogeneities, the previous homogenization procedure has been compared with the results of an application of the R package Climatol (Guijarro, 2006) to the homogenization of the 2722 stations with a minimum of 30 years with data in the period 1920-2009.

Results of both procedures are showed in Figure 2. 39 stations are homogeneous by both procedures while the lower number of inhomogeneous series detected by Climatol is due both to the shorter period of application and the conservative threshold imposed to avoid false break detection.

As an example, PMFT results for Coruña station are displayed in Figure 3. This station is no homogeneous with a shift in 1914. Metadata indicate that around the years 1916 -1917 the location and type of rain gauge were changed.

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Figure 1: Geographical distribution of precipitation series in Spain. The orography is displayed.



Figure 2: Map showing the homogenization results. Red crosses indicate homogeneous stations, blue diamonds no homogeneous stations by PMFT, black dots no homogeneous stations by Climatol, yellow squares no homogeneous stations by both procedures



Figure 3: Example of the PMFT results for Coruña station (ID =4). A shift can be observed in 1914.