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.

ID	Latitude	Longitude	Name	Record	ID	Latitude	Longitude	Name	Record
1	43.53	-5.63	Gijon	1913-2008	34	40.82	0.48	Tortosa	1880-2008
2	43.52	-7.02	Castropol	1924-2008	35	40.65	-4.68	Avila	1901-2008
3	43.45	-3.82	Santander	1912-2008	36	40.65	-3.17	Guadalajara	1911-2008
4	43.37	-8.42	Coruña	1877-2008	37	40.4	-3.67	Madrid	1859-2008
5	43.35	-5.87	Oviedo	1851-2008	38	40.35	-1.12	Teruel	1978-2008
6	43.3	-2.92	Bilbao	1859-2008	39	40.27	-5.85	Hervas	1913-2008
7	43.3	-2.03	San Sebastian	1878-2008	40	40.07	-2.13	Cuenca	1908-2008
8	43.25	-7.48	Lugo	1914-2008	41	39.95	-0.07	Castellon	1911-2008
9	43	-4.13	Bustamante	1912-2008	42	39.92	-4.87	Talavera	1912-2008
10	42.88	-8.42	Santiago	1906-2008	43	39.88	4.25	Mahon	1865-2008
11	42.76	-1.63	Pamplona	1881-2008	44	39.88	-4.03	Toledo	1909-2008
12	42.75	-0.52	Canfranc	1910-2008	45	39.55	2.62	Palma Mallorca	1862-2008
13	42.72	-3.4	Oña	1882-2008	46	39.47	-6.37	Caceres	1907-2008
14	42.58	-5.65	Leon	1899-2008	47	39.47	-0.37	Valencia	1859-2008
15	42.45	0.98	Cabdella	1915-2008	48	38.98	-3.92	Ciudad Real	1866-2008
16	42.45	-2.32	Logroño	1911-2008	49	38.95	-1.85	Albacete	1866-2008
17	42.43	-8.6	Pontevedra	1901-2008	50	38.87	-6.97	Badajoz	1864-2008
18	42.33	-3.62	Burgos	1862-2008	51	38.77	-4.83	Almaden	1913-2008
19	42.32	-7.85	Ourense	1901-2008	52	38.37	-0.48	Alicante	1856-2008
20	42.8	-4.48	Cervera de Pisuerga	1912-2008	53	38.08	-1.78	Cehegin	1913-2008
21	42.08	-0.32	Huesca	1860-2008	54	37.97	-1.12	Murcia	1863-2008
22	42	-4.53	Palencia	1913-2008	55	37.9	-3	Cazorla	1884-2008
23	41.97	2.8	Girona	1912-2008	56	37.88	-6.55	Aracena	1913-2008
24	41.77	-2.48	Soria	1865-2008	57	37.83	-4.85	Cordoba	1894-2008
25	41.65	-1	Zaragoza	1858-2008	58	37.77	-3.8	Jaen	1867-2008
26	41.63	-4.77	Valladolid	1962-2008	59	37.25	-6.9	Huelva	1903-2008
27	41.62	0.58	Lleida	1913-2008	60	37.18	-3.6	Granada	1898-2008
28	41.62	-3.48	Vid de Aranda	1883-2008	61	37.4	-6	Sevilla	1866-2008
29	41.48	-5.75	Zamora	1909-2008	62	36.83	-2.38	Almeria	1911-2008
30	41.28	2.12	Barcelona	1850-2008	63	36.75	-5.2	Grazalema	1912-2008
31	41.1	-1.4	Daroca	1909-2008	64	36.72	-4.48	Malaga	1878-2008
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

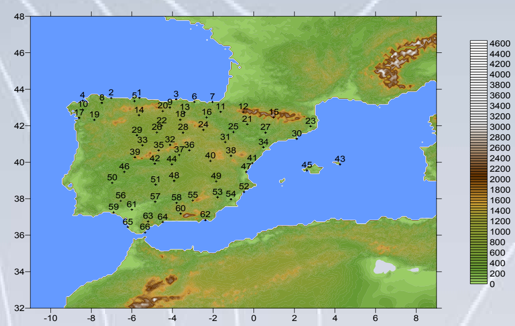

Figure 1: Geographical distribution of precipitation series in Spain. The orography is displayed.

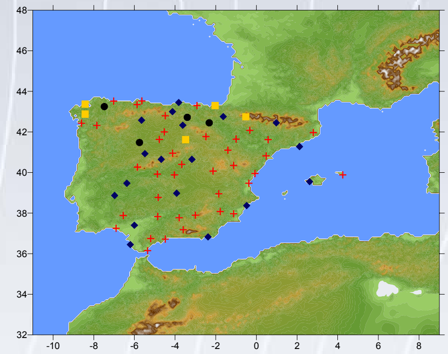

Figure 2: Map showing the homogenization results. Red crosses indicate homogeneous stations, blue diamonds no homogeneous stations by PMFT, black dots no homogeneous stations by Climatol, yellow squares no homogeneous stations by both procedures

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.

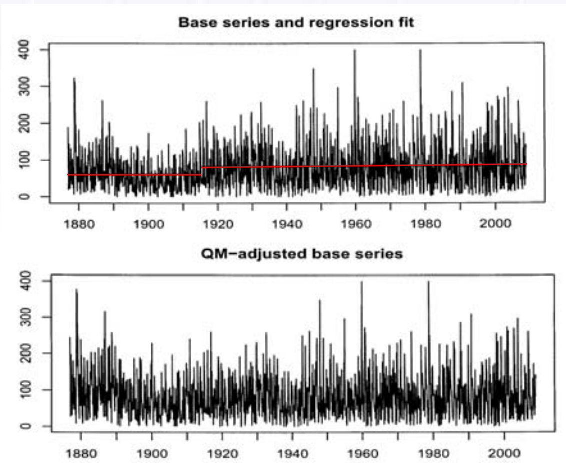

Figure 3: Example of the PMFT results for Coruña station (ID =4). A shift can be observed in 1914.

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