The development of the Spanish Daily Adjusted Temperature series (SDATS): A case-study discussing from data rescue procedures to daily adjustments application

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A simple plot showing long-term Spanish temperature change



Brunet M., et al. 2007. Temporal and spatial temperature variability and change over Spain during 1850-2005. *J Geo Res - Atmospheres*, 112, D12117, doi:10.1029/2006JD008249.

EL CAMBIO CLIMÁTICO EN ESPAÑA. ESTADO DE SITUACIÓN

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Informe para el Presidente del Go



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A Case-Study/Guidance on the Development of Long-term Daily Adjusted Temperature Datasets



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mático Regional

IVAR PAÑA





And developed under EU-funded project: EMULATE



Carried out under the EUfunded project European and North Atlantic daily to MULTidecadal climATE variability (EMULATE), which enabled to develop the EMULATE pressure, temp & prec datasets over 1850-2003, highly contributing to enhance atmospheric influences on climate variability

Could the recently EUfunded EURO4M: European Reanalysis and Observations for Monitoring an opportunity for MEDARE?

But lots of activities involved before arriving to produce that plot

- From climate data location & recovery & digitisation & quality control to data homogenisation
- A set of integrated DATA RESCUE & DEVELOPMENT (DARE & D) procedures and methodologies have been followed and applied to develop long and highquality climate datasets

Locating and digitising the Spanish data

The first step in DARE & D:

- Selecting the network from NMS info. Criteria: long & well distributed stations, climatic representativeness, potential for extending back in time, data continuity from monitored sites at present & in the foreseeable future
- Intensive searches in the documentary sources where the data & metadata could be collected and archived most likely, followed by the recovery of the data (i.e. imaging and storing them), together with an assessment of the potential quality of the source where the data are held (continuity, reliability, primary or secondary source...)
 - In our case data were located & recovered from NMSs archives to libraries either national or international (Spanish Met Office archive, Royal Academy of Medicine, UK-MO National Library & Archive ...)
 - Data recovered from different sources (met bulletins, monographs, books, newspapers...) & formats (paper, scans, digital)
- Data digitisation, time consuming but essential





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Data archaeology, records' Identifying/converting ancient units to SI units Composition & QC

ancient units to SI units Composing records: stations' relocations within same location, nearby & highly related stations...

Passing QCs (gross error checks, tolerance tests, internal consistency, temporal & spatial coherency) separately to data from each composition/source

| | NAME | CODE | PERIOD | NAME | CODE | PERIOD |
|---|------------------------------|-------|-----------|----------------|--------|-----------|
| | ALBACETE | 8178 | 1893-1936 | MURCIA | 7182C | 1863-1950 |
| | AL/LOS LLANOS | 8175 | 1939-2005 | MURCIA | 7182A | 1951-1967 |
| | ALICANTE | 8025E | 1894-1920 | MURCIA | 7182 | 1968-1984 |
| | ALICANTE | 8025G | 1921-1938 | MU/GUADALUPE | 71811 | 1985-2005 |
| | ALICANTE | 8025 | 1939-2005 | PAMPLONA | 9262 | 1880-1974 |
| | BADAJOZ | 4478 | 1864-1954 | PA/NOAIN | 9263D | 1975-2005 |
| | BA/TALAVERA | 4452 | 1955-2005 | SALAMANCA | 2870D | 1893-1944 |
| | BARCELONA | 0201E | 1885-1925 | SA/MATACAN | 2867 | 1945-2005 |
| | BAR/FABRA OB. | 0200E | 1923-2005 | SAN SEBASTIAN | 1024D | 1893-1900 |
| | BURGOS | 2327 | 1870-1943 | SS/IGUELDO | 1024E | 1916-2005 |
| | BU/VILLAFRIA | 2331 | 1944-2005 | SEVILLA | 5787D | 1893-1932 |
| | CADIZ | 5972 | 1850-2005 | SEVILLA | 5790 | 1933-1950 |
| | CIUDAD REAL | 4121C | 1893-1970 | SE/SAN PABLO | 5783 | 1951-2005 |
| | CIUDAD REAL | 4121 | 1971-2005 | SORIA | 2030 | 1893-2005 |
| | GRANADA | 5515A | 1893-1937 | VALENCIA | 8416A | 1863-1932 |
| | GR/ARMILLA | 5514 | 1938-2005 | VALENCIA | 8416 | 1935-2005 |
| | HUELVA | 4605 | 1903-1984 | VALLADOLID | 2422C | 1893-1923 |
| | HUELVA | 4642E | 1984-2005 | VALLADOLID | 2422F | 1924-1940 |
| | HUESCA | 9901F | 1861-1943 | VALLADOLID | 2422C | 1942-1969 |
| | HU/MONFLORITE | 9898 | 1944-2005 | VALLADOLID | 2422G | 1970-1973 |
| | LA CORUÑA | 1387 | 1882-2005 | VALLADOLID AIR | 2422 | 1974-2005 |
| | MADRID | 3195 | 1853-2005 | ZARAGOZA | 9443D | 1887-1950 |
| | MALAGA | 6171 | 1893-1942 | ZARAGOZA AIR | 9434 | 1951-2005 |
| | MA/ROMPEDIZO | 6155A | 1943-2005 | | | |
| | | | Inte | arnal To | mnoral | Spati |
| (| Gross error Tolerance | | | | | |
| | consistency coherency cohere | | | | | |

| Total amount of tested values | 1981192 | | |
|-------------------------------|---------|-------|--|
| Flagged values | 11505 | 0.58% | |
| Recovered values | 8090 | 0.41% | |
| Not recoverable values | 3415 | 0.17% | |

| | | | • | | |
|----------------------------|-----------------------|--------------------|---------------------------------|-------------------------------|-------------------------------|
| | Gross error checks | Tolerance tests | Internal consistency test | Temporal coherency test | Spatial coherency tests |
| Total of flagged values | 4941 (0.25) | 5995 (0.3) | 161 (0.008) | 192 (0.01) | 216 (0.01) |

Addressing data homogenisation

- Long, but also short, climate timeseries affected by nonclimatic factors, such as: changes in station locations, local environments, instrumental exposures & instrumentation, observing practices or data processing and inducing gradual or abrupt breaks in homogeneity that have to be adjusted
- So, need to homogenise records before using them. Better counting with good metadata to guide the Ihs detection, but also possible without
- Both gradual or abrupt changes can be adjusted by relative homogenisation methods easily if they happened at different times at each station of a network, but difficult if occurring at the same time for the entire network, such as changes in the screen to protect thermometers or the "screen bias"
- First homogenisation stage for developing the SDATS: to minimise "screen bias"

The *screen bias*: an untreatable common inhomogeneity in long temp series

- Open stands overestimate Tx, slightly underestimate Tn readings wrt Stevenson screens
- Dual temp observation at Murcia & La Coruña met gardens
- Estimating factors for adjusting affected raw data





A relative approach to detect/correct inhomogeneities

Selecting candidate & reference sets of records (r ~ 0.8)

Detecting breakpoints applying SNHT on annual/seasonal basis





Applying correction pattern to monthly data & interpolating monthly factors into the daily scale

Getting adjusted daily temperature data: the SDATS



Assessing impact of adjustments in Madrid series



Summing up

- The development of high-quality climate data requires undertaking integrated activities involving:
- Locating and rescuing/preserving data
- Transference into digital format
- Applying quality controls
- And testing homogeneity and homogenising records
 - Dataset ready to be confidently used in any climate application, service or study, and of paramount importance when detecting, predicting and responding to climate change



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