Adjustment of new daily data from thermograph and pluviograph to a conventional series: the case of Fabra Observatory, Barcelona (1904-1913)

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1. Background and objectives

2. Digitalization process

3. Reference series and quality control

4. Homogeneity analysis – Break point detection (HOMER)

5. Homogeneity analysis – Daily adjustment on temperature (SPLIDHOM)

6. Homogeneity analysis – Monthly adjustment on precipitation (HOMER)

7. Results and conclusions
1. Background and objectives

Fabra Observatory (in Barcelona, 412 m asl) has one of the longest, continuous and unchanged location series of Iberia.

For years it was believed that meteorological observations began in August 1913. In 2012, evidence of previous observations appeared and the data and metadata was detected and recovered from the archives of the Royal Academy of Sciences and Arts of Barcelona.
1. Background and objectives

- New data covered the period from 1905(Dec) up to 1914(June).
- Was recorded by weekly thermographs and pluviographs.
- The site was located at the roof of the observatory.

Location of the undocumented observatory
1. Background and objectives

Weekly thermograph and tipping-bucked rain gauge, both Richard manufacturers

15/12/1904 up to 30/06/1914

97.9% data recovered for T and

100% for precipitation (hourly and daily)
1. Background and objectives

**MAIN OBJECTIVE**: adjust the daily T data (Tx and Tn) and the monthly PPT data to the conventional series.

**ACHIVEMENT**: the longest and more continuous series of Catalonia, located in a single point.

- Data recovery (digitization of stripes)
- Identification of reference series
- Quality control of the daily data (RCLIMDEEx + extra qc)
- Homogeneity analysis (break point detection T and PPT – HOMER)
- Homogeneity analysis (daily adjustment T – SPLIDHOM)
- Results
2. Digitalization process

Several steps:

a) Scanning of the thermograph and pluviograph stripes.
b) To obtain the digitized values (time, variable) according to WINDIG methodology.
c) Applying algorithms for the required corrections:

- **T**: correction due to time marks curvature and determination of hourly and daily Tmax and Tmin.
- **PPT**: determination of 0 level at the beginning of the record, Determination of the time and values of the maxima and minima due to the discharge process, evaluating the precipitation during this interval, and creating a new increasing time-precipitation series.

d) Quality control: coherency controls.

e) Main difficulties: determination of time and likely malfunctions, especially for rain gauge data.
2. Digitization process

Before time-mark curvature correction  After time-mark curvature correction  Increasing time-precipitation series

Hours (0 is 00:00 09/03/1909)
5 daily Tx and Tn series were detected with >80% of data (1904-1930)
2. Reference series (PPT)

7 monthly PPT series were detected with >80% of data (1904-1930)
3. Quality control

RCLIMDEX (+extraqc) was applied to daily TN and TX candidate (Fabra) and reference series.

- 13 daily TN and 14 daily TX anomalous values were detected
- No anomalous data were detected for PPT
4. Break point detection (HOMER)

HOMER approach (COST ES0601) was used for break-point detection: the whole set of series were used.

A clear BP was detected in 1911/12 at the end of “thermograph” period.
5. Adjustment of daily TX and TN (SPLIDHOM)

SPLIDHOM was used to adjust the daily series, taking into account 1913 BP.

The most well correlated series from the set were:

<table>
<thead>
<tr>
<th></th>
<th>DJF Bef/Aft</th>
<th>MAM Bef/Aft</th>
<th>JJA Bef/Aft</th>
<th>SON Bef/Aft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mataró</td>
<td>0.85/0.80</td>
<td>0.86/0.80</td>
<td>0.82/0.79</td>
<td>0.92/0.94</td>
</tr>
<tr>
<td>Sabadell</td>
<td>0.85/0.85</td>
<td>0.77/0.79</td>
<td>0.84/0.79</td>
<td>0.92/0.92</td>
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</tbody>
</table>

**TX**

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Mataró</td>
<td>0.79/0.80</td>
<td>0.85/0.79</td>
<td>0.82/0.80</td>
<td>0.90/0.93</td>
</tr>
<tr>
<td>Montserrat</td>
<td>0.83/0.83</td>
<td>0.87/0.75</td>
<td>0.79/0.87</td>
<td>0.90/0.93</td>
</tr>
</tbody>
</table>

**TN**
6. Adjustment of daily TX and TN (SPLIDHOM)

Corrections are always negative and quite large, for both TX and TN, confirming the warming effect of the roof (summer) and wind damping effect (TN, in winter).

**Summer:** -2.1/-2.4°C (TX)  
-2.7/-3.7°C (TN)

**Winter:** -0.9/-0.6°C (TX)  
-1.5/-3.5°C (TN)
6. Adjustment comparison: SPLIDHOM vs. HOMER (TX)

Annual averages of daily corrected TX series (■) compared to raw (▲) and monthly homogenized series by HOMER (solid line).
6. Adjustment comparison: SPLIDHOM vs. HOMER (TN)

Annual averages of daily corrected TN series (□) compared to raw (▲) and monthly homogenized series by HOMER (solid line).
6. Adjustment of monthly PPT (HOMER)

Two breakpoints were detected: 1907 (unknown) and 1913.

A clear underestimation of rainfall totals was detected, probably due to exposition and/or instrumental problems.
6. Adjustment of monthly PPT (HOMER)
7. Some conclusions...

- Early daily and sub-daily undocumented data from Fabra Observatory (Barcelona) has been digitized and recovered.

- HOMER succeeds in detecting the “new” period recovered.

- Adjustment results differ if we apply a daily (SPLIDHOM) or monthly (HOMER) approach… why?
  - HOMER works with 5 stations while SPLIDHOM just 1
  - The correlation is not good enough (around 0.8) for daily adjustments in some seasons.

- **Data rescue activities:** completing existing series and digitizing unknown ones = improves break-point detection and adjustment.

- **To be done:** contrasting SPLIDHOM findings with other methods as percentile-matching (PM) algorithm (Trewin, 2012).

- **Breaking news!**
Parallel measurements were taken in the roof and the garden, from **July 1913 up to October 1920**.
THANKS FOR YOUR ATTENTION !