



# Long-term variability of cloudiness over NE Iberia from late 18<sup>th</sup> century: preliminary results



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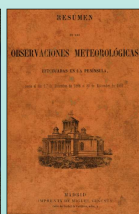
## OBJECTIVE and DATA

- This work presents preliminary results regarding **cloudiness** variability over **northeastern Iberian Peninsula (IP)** covering the **1865-2007 period**
- Primary data are in situ **visual observations** from 40 surface meteorological stations, and the studied variables are **cloud-free** (FREE,  $\leq 1.5$  oktas, daily average) and **overcast** (OVER,  $\geq 6.5$  oktas ) sky frequencies, which are more objectively determined than days with scattered clouds (cloudy days)
- Recent total cloud cover (TCC) observations in oktas (1961-2004, Sanchez-Lorenzo et al., 2009) are related to OVER and FREE sky frequencies in order to verify the reliability of the **"Parameter of Cloudiness"** (PC) proposed by Biel (1963)
- The work is completed with the analysis of digitalized sky state observations taken during the **Early Instrumental Period (EIP)** in **Barcelona** since late 18<sup>th</sup> century

### 1. Cloudiness observations (1865-2007)

- 40 monthly series in the peninsular Spain (Fig. 1, left)
- 1865-1960 → Monthly FREE and OVER sky frequencies from "Resumen de las observaciones meteorológicas efectuadas en la Península" (Fig. 1, right) and "Boletín Meteorológico Mensual"
- 1961-2007 → 3—daily observations taken at 7, 13 and 18 UTC of total cloud cover (TCC) in oktas.

Figure 1 (Left) Location of the 40 cloudiness series obtained for peninsular Spain during the 1865-2007 period (Right) Front page example of the "Resumen de las observaciones meteorológicas efectuadas en la Península" published in 1868 with data covering from December 1866 to November 1867.



- Using annual FREE and OVER sky frequencies (1865-2007) we computed the "Parameter of Cloudiness" (PC) defined by Biel (1963), which is **highly correlated with annual TCC** (Fig. 2)

$$PC(\%) = 50 + \frac{50(O - F)}{N}$$

O, number of OVER days  
F, number of FREE days  
and N, total number of days per year

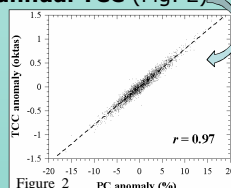


Figure 2

### 2. TCC trends over NE Iberia (1865-2007)

- General increase of PC over the IP during the whole period (Fig. 3)
- Selected 12 series in the eastern/northeastern (E subregion) part of the IP based on a previous regionalization (Fig. 4)
- Annual mean PC series in E subregion (Fig. 5) shows an increase from the 1860s to the 1960s, followed by a negative trend up to the present.

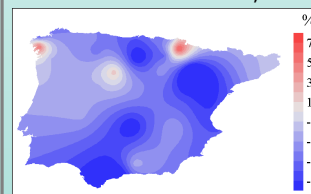


Figure 3 (left). PC (%) anomalies during the 1871-1920 period respect the 1971-2000 mean.

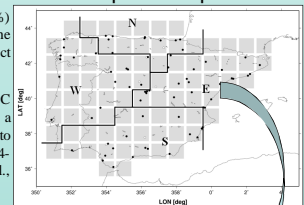


Figure 4 (right). TCC regionalization based on a PCA in S-Mode applied to a 69 series -1961-2004- (Sanchez-Lorenzo et al., 2009)

- DJF TCC variability (1865-1960) in E region is related to NAO (Fig. 6)
- Similar to results for the recent period 1961-2004 (Sanchez-Lorenzo et al., 2009)

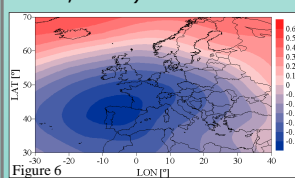


Figure 6. r values between DJF SLP and DJF TCC (%) in E region (1865-1960 period)

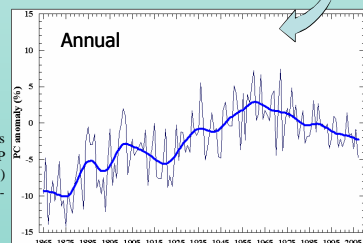


Figure 5. Annual mean PC anomaly in E region

### 3. Early cloudiness observations (< 1860s)

- State of sky observations during the EIP → similar to current cloud cover visual observations categories
- Ongoing project funded by the Meteorological Office of Catalonia to digitalize EIP records (1780-1860s) in Barcelona. At present, only doctor Francesc Salvà observations (1780-1825, Fig. 7) are available, with 3 sky state main categories (Fig. 8)

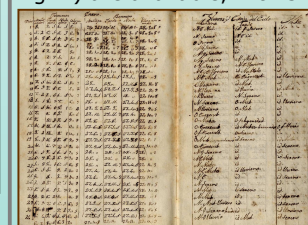


Figure 7. Example of manuscript page of readings by Salvà

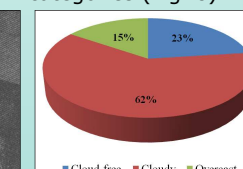


Figure 8. Percentage (%) of total sky state frequencies in Barcelona (1781-1825)

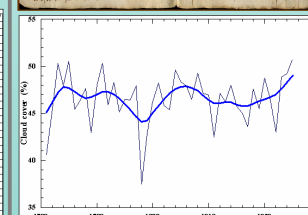


Figure 9. TCC (%) estimation for the 1781-1825 period in Barcelona. Mean 1781-1825 = 46.6% / 1871-1920 = 47.6% / 1971-2000 = 49.7%

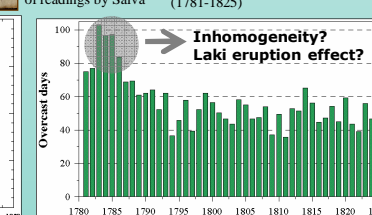


Figure 10. Annual frequencies of OVER days during the 1781-1825 period in Barcelona. Note the highest values recorded during the 1783-1786 period.

## CONCLUSIONS

- A new dataset of cloudiness over the IP, based on 40 series covering the 1865-2007 period including monthly frequencies of FREE and OVER days, is presented
- The estimated PC annual mean series in the NE Iberia shows an increase of around 8% during the analyzed 1865-2007 period. Its winter time variability is strongly correlated with the NAO
- Regarding EIP observations of sky conditions in Barcelona our preliminary results confirm a possible interest of these observations, which remains unexplored in other EIP series across Europe

### References:

- Biel, A. (1963), *Boletín Mensual Climatológico - Julio*, National Meteorological Service, Madrid, 2-9
- Sanchez-Lorenzo, A., J. Calbó, M. Brunetti, J. Calbó, and C. Deser (2009), *J. Geophys. Res.*, **114**, doi:10.1029/2008JD011394

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