10th Seminar for Homogenization and Quality Control and
5th Conference on Spatial Interpolation Techniques in Climatology and Meteorology

DEVELOPMENT OF HIGH RESOLUTION GRIDDED DATASETS OF MONTHLY TEMPERATURE SINCE 1916 FOR SPAIN

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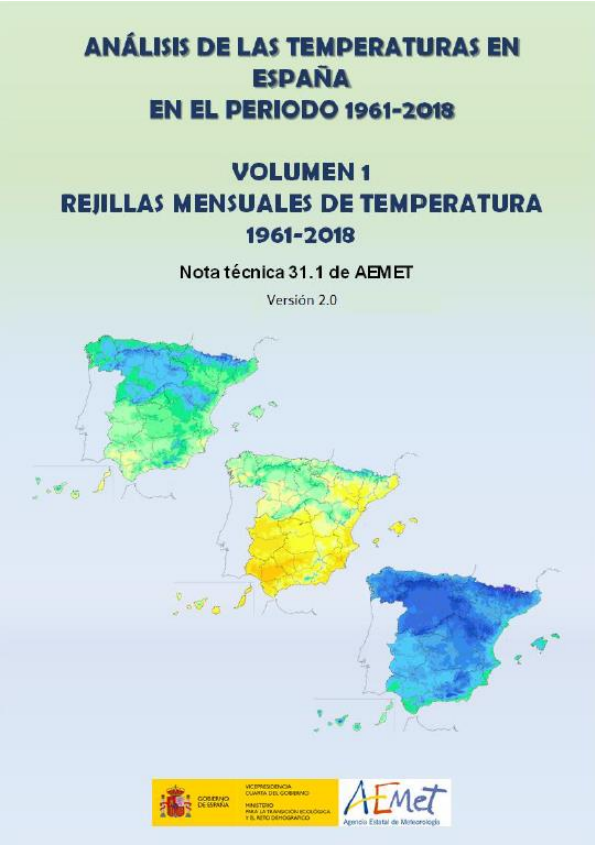
1. INTRODUCTION



- **1 x 1 km gridded datasets** of **monthly temperature** for Spain covering the period **1961–2018** were created and published by AEMET (*Chazarra et al., 2020*)

- These datasets are **continuously updated:** every month the corresponding new grids are generated.

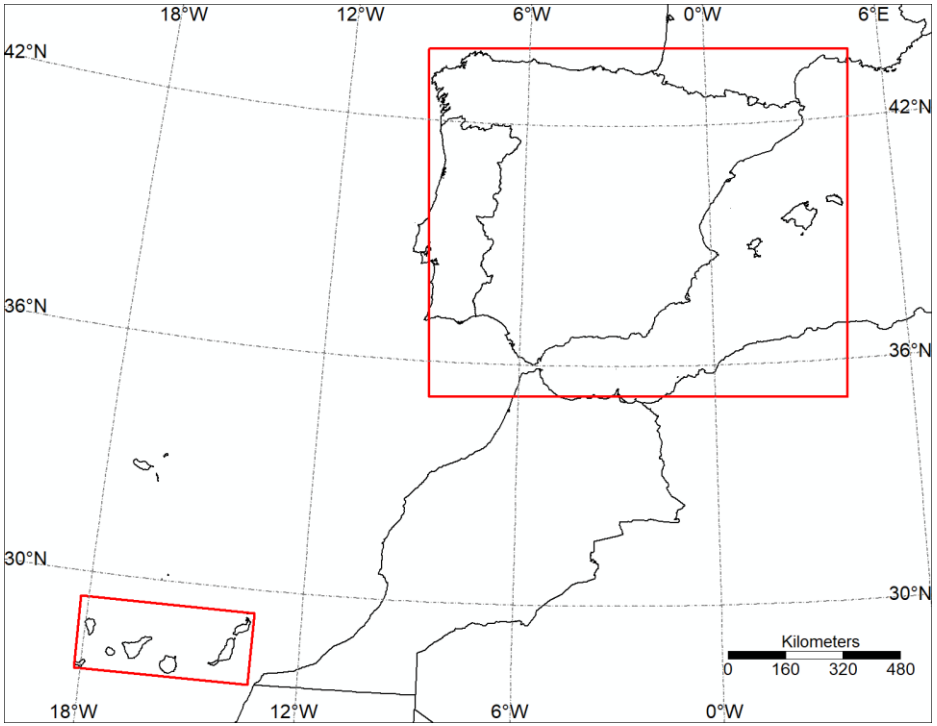
- **New mean temperature series in Spain (1981-2010**) based on these gridded datasets have replaced the previous **reference series** based on a set of 42 stations for climate monitoring.

https://doi.org/10.31978/666-20-003-4

- We are now trying to **extend** the gridded dataset **back in time as long as possible**.
- At present, temperature gridded datasets have been generated for the mainland Spain area **since 1916**.
- In this presentation the **methodology** used for creating the grids is described and the resulting **1916-2018** gridded datasets are analysed.

2. METHODOLOGY

2.1 Study areas



Two study areas were considered:

1) **Mainland Spain**, Balearic Islands, Ceuta and Melilla cities.
2) **Canary Islands**.

2.2 Data

- **Variables** considered:

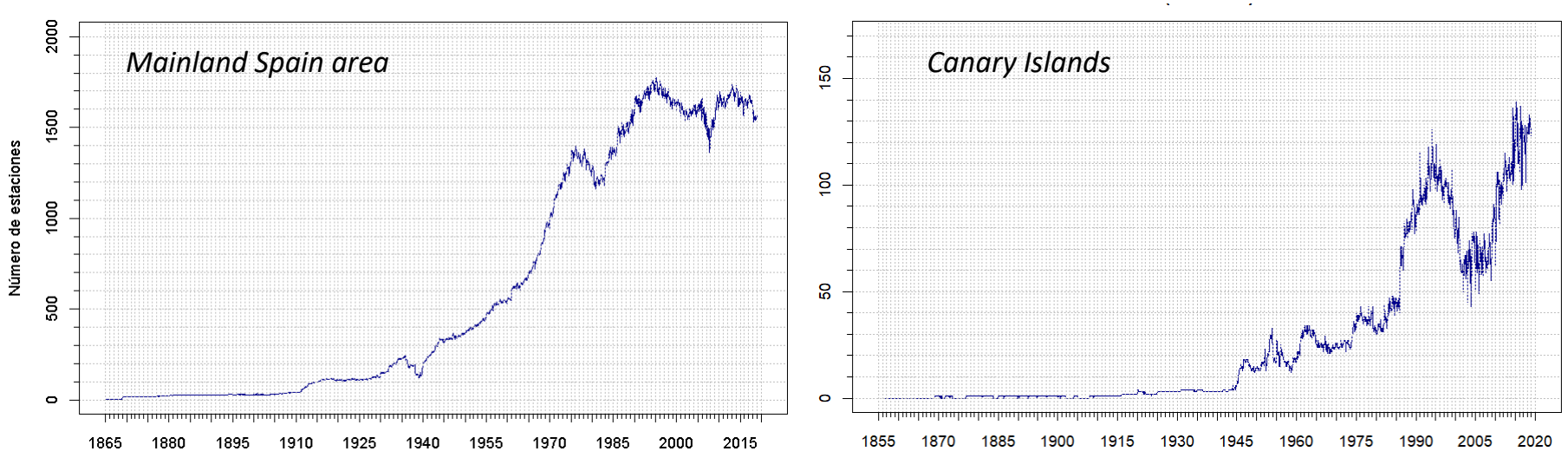
  Monthly mean daily maximum temperature (Tmax)
  Monthly mean daily minimum temperature (Tmin)
  Monthly mean temperature (Tmed)

- The station data **have not been homogenized** before the spatial interpolation → the resulting grids are not suitable for studying the climate variability in a specific point.

2.3 Selection of the study period

Two aspects were considered:

1) **Minimum number of data** for obtaining good quality temperature grids ≈ **100** in mainland Spain and ≈ **20** in the Canary Islands



Number of stations with monthly temperature data

2) Data quality

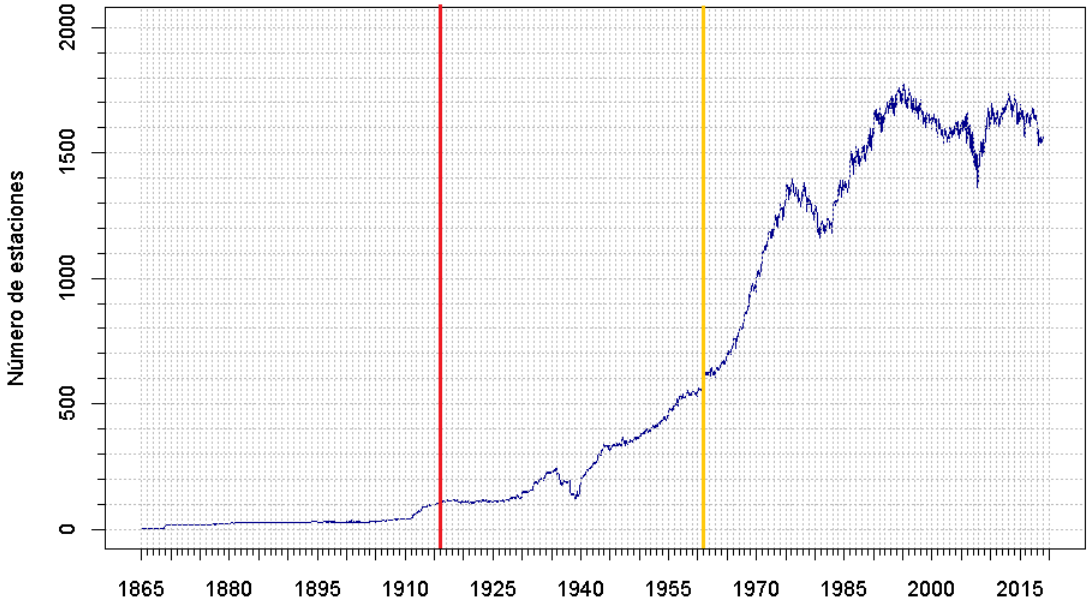
A Montsouri screen (right) and two Stevenson screens (left) used in the SCREEN Project

- In Spain, **open shelters** were used during the XIXth century and the first years of the XXth century before the Stevenson screen became a standard.
- According to some studies (*Brunet et al., 2004*), in old open stands:

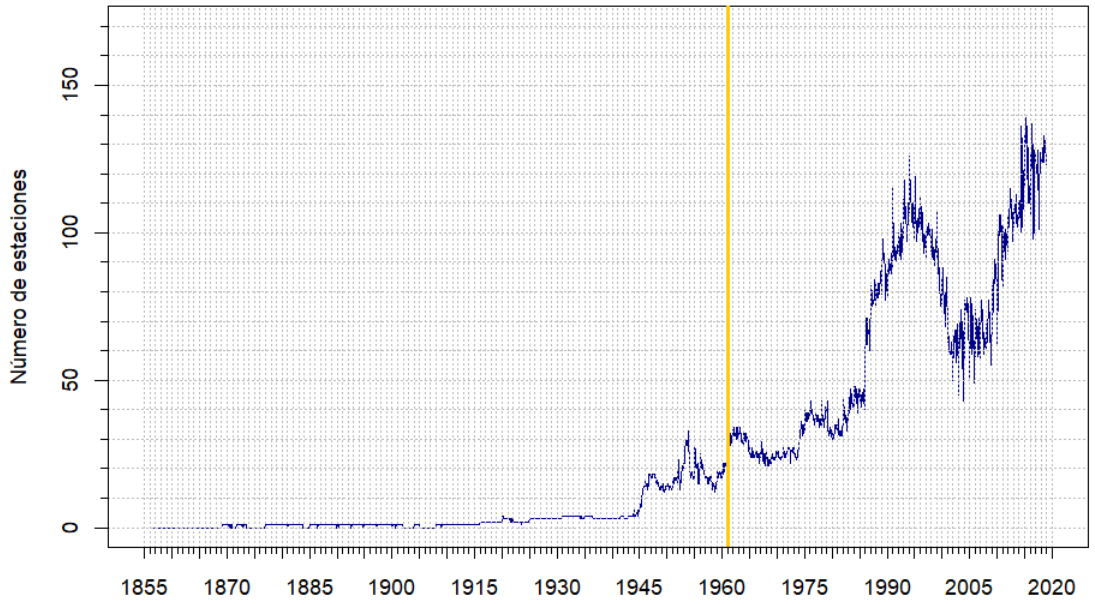
  Tmax → **considerably overestimated**
  (0.14 - 0.28 ºC in average)

  Tmin → **slightly subestimated**
- The old pre-Stevenson screens were not substituted in some main stations until the **mid 1910s**.

- Taking all the above into account, **1916** was chosen as the starting date for the study period in the **mainland Spain area**.

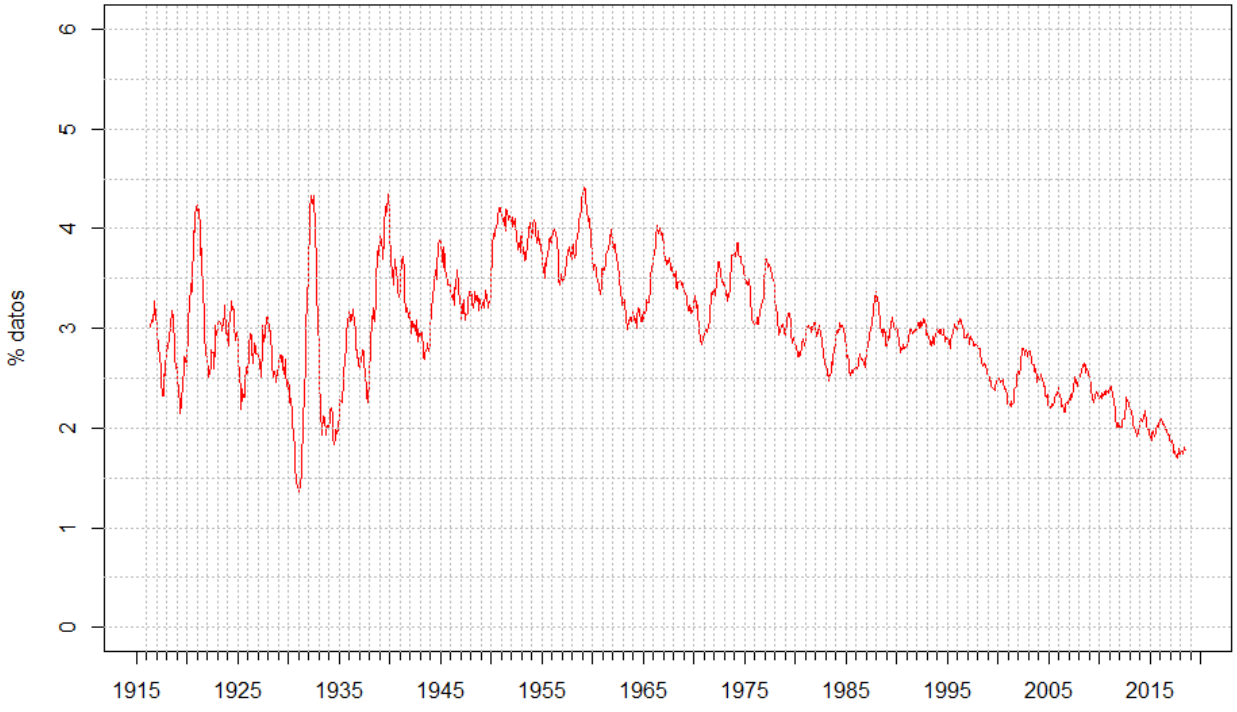


- In the **Canary Islands** the study was **not extended back in time** due to the low density of stations before the 1960s.



2.4 Data quality control

- **Several data quality control procedures** are applied in the Spanish National Climate Database.
- These processes have evolved over time → it is possible to find in the historical temperature series **anomalous data** that have not undergone the present quality control procedures.
- An **automatic validation process** has been applied to test the **spatial consistency** of the data: every temperature data is compared to the estimated value obtained in that point by interpolating the neighbour data, and those data that significantly differ (3 standard deviations) from the estimated value are rejected.

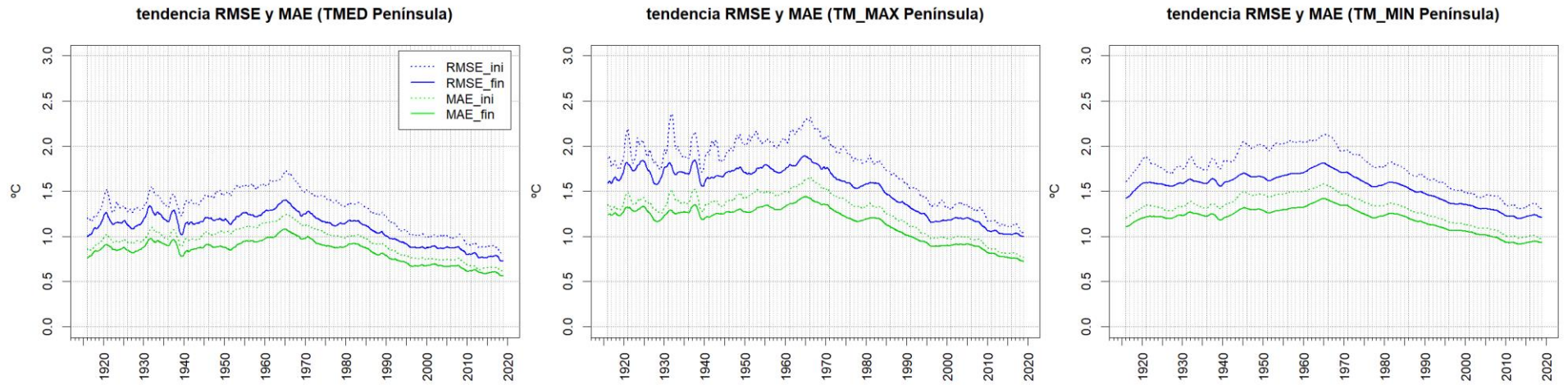


Percentage of monthly temperature data discarded in the automatic validation process

- The automatic control process works properly when there is a **high density of stations** so that it is possible to compare effectively each temperature data with its neighbour data.
- It is to be expected a significantly **lower quality** in the **first half** of the study period grids.

2.5 Grid interpolation and error estimation

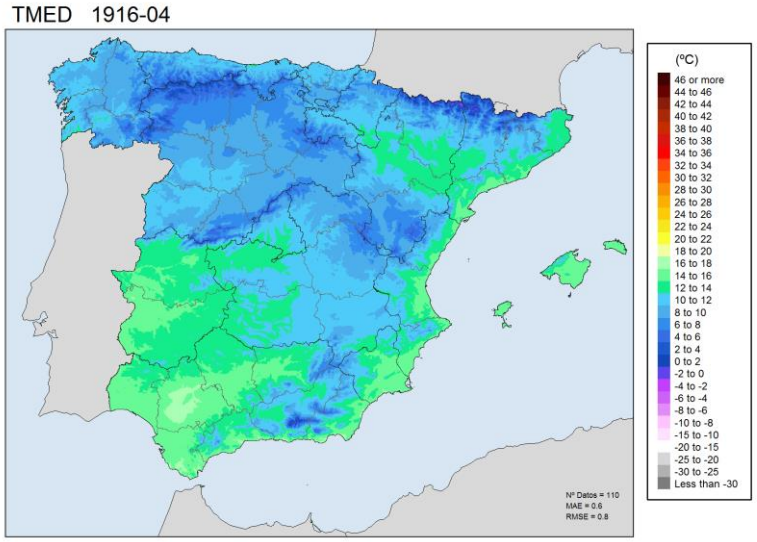
- Spatial interpolation method: **multiple linear regression with ordinary kriging of the regression residuals**, using elevation, easting, northing and distance to the coast as independent variables in the regression.
- An exponential model was used for the variogram adjustment.
- The performance of the spatial interpolation method and the accuracy of each grid were estimated by **leave-one-out cross validation**, calculating for each grid the root mean square error (RMSE) and the mean absolute error (MAE).



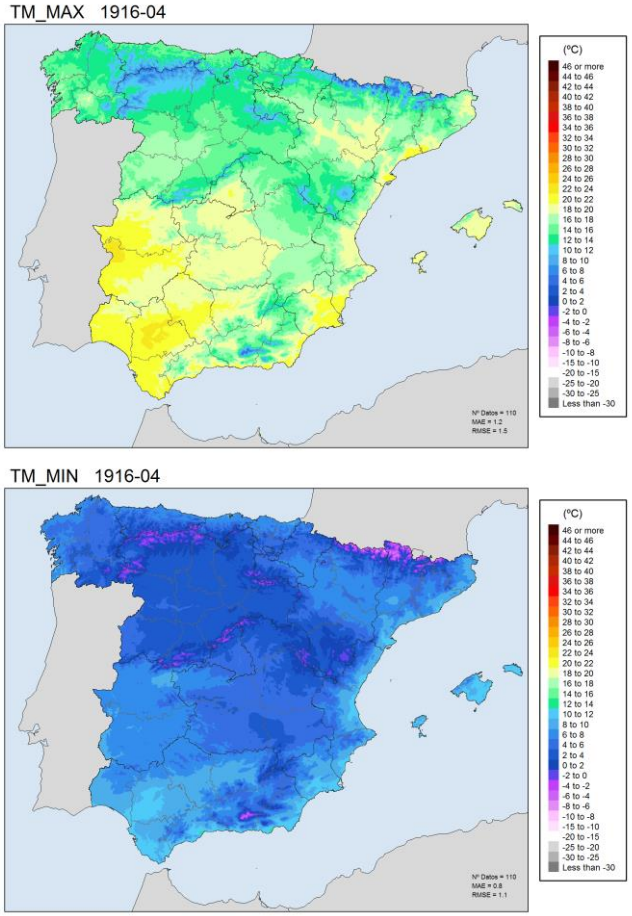
Trends of the root mean square error (RMSE) and the mean absolute error (MAE) for the mean, maximum and minimum temperatures before and after the automatic quality control process

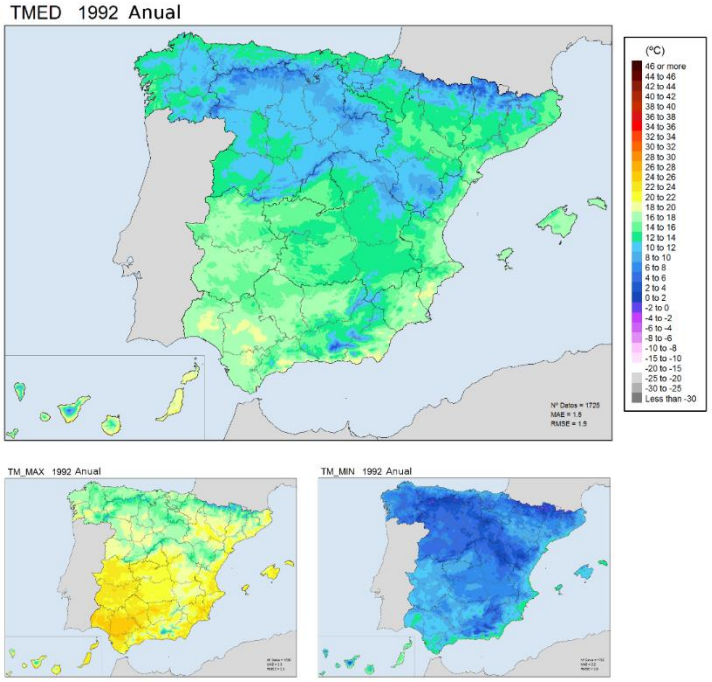
3. RESULTS

3.1 Gridded datasets

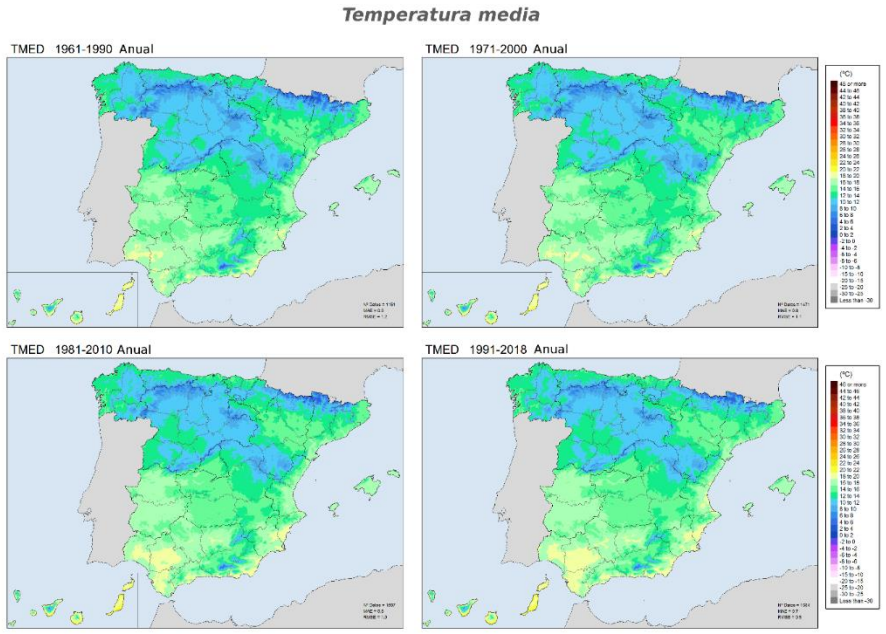


Example of monthly temperature grids
April 1916



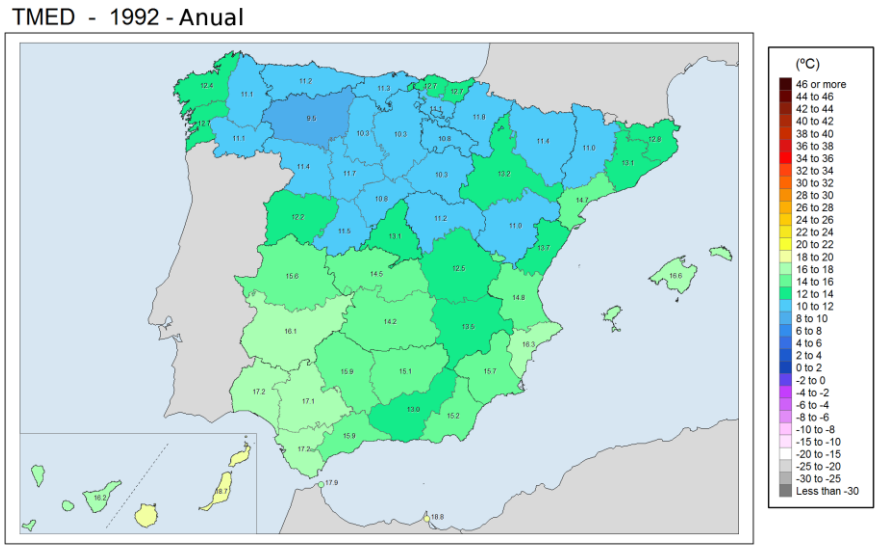


Example of annual temperature grids 1992

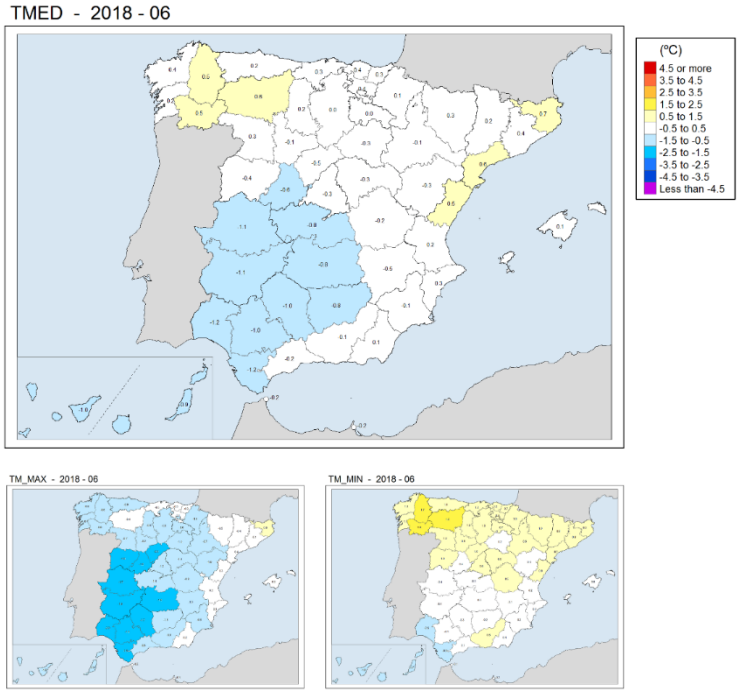


Example of 30-year normal temperature grids

3.2 Provincial and national statistics

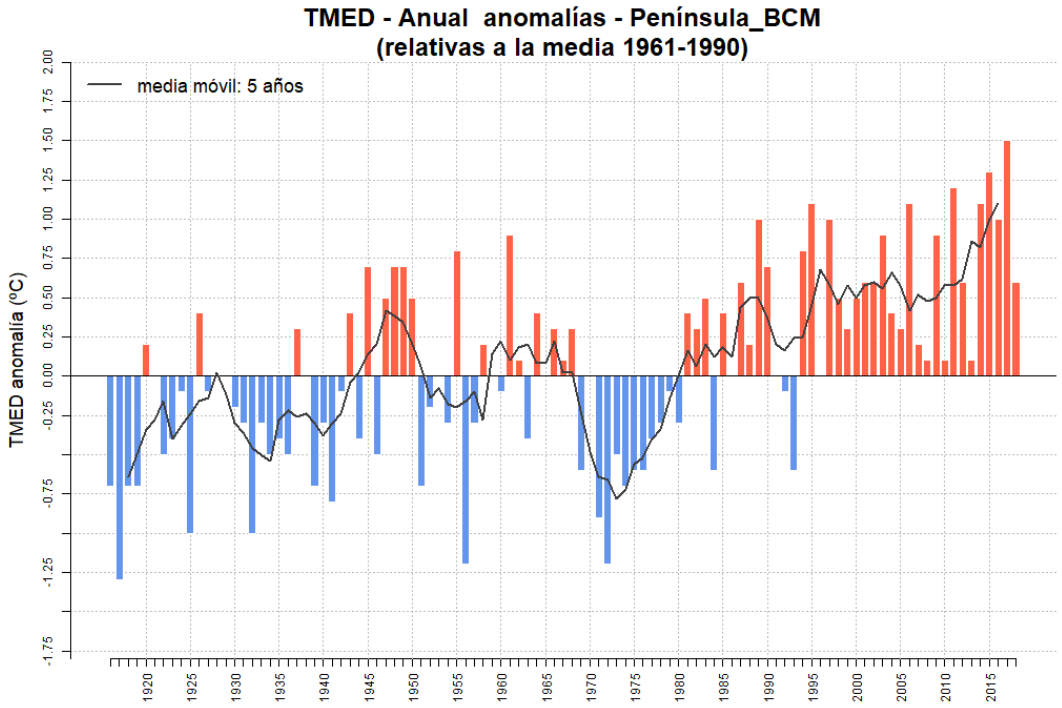


Annual mean temperature
1992



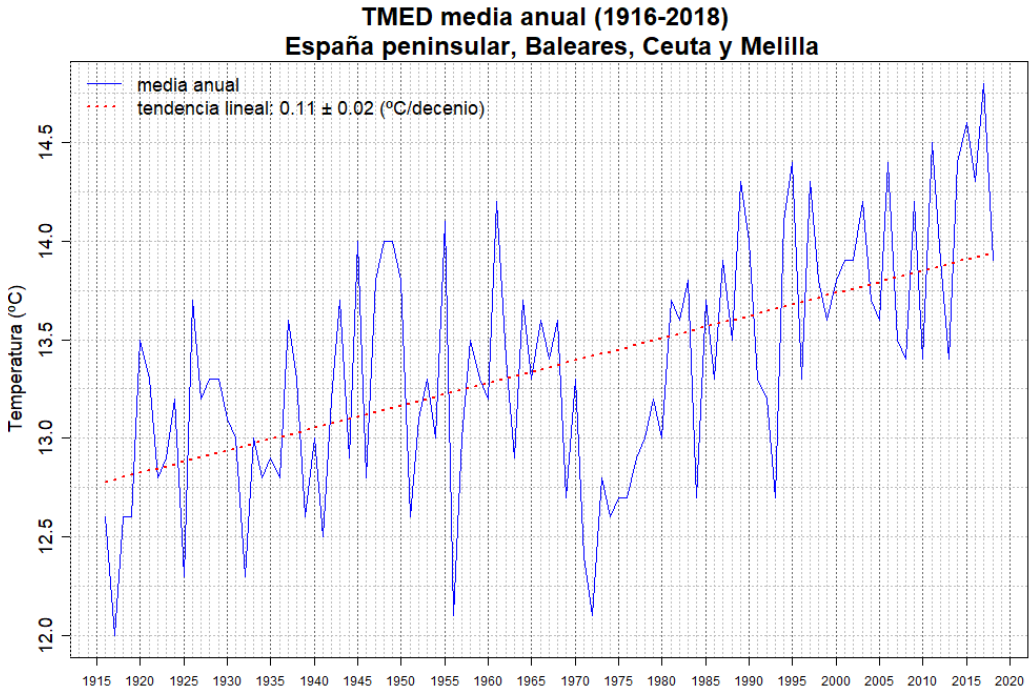
Monthly average temperature anomaly
June 1992
(reference period: 1981-2010)

3.3 Average temperature anomaly series 1916-2018

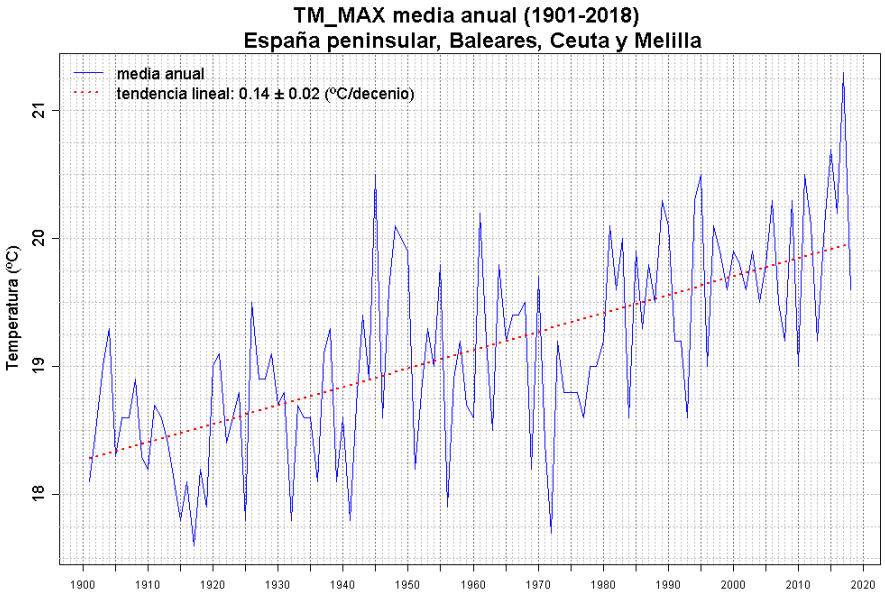


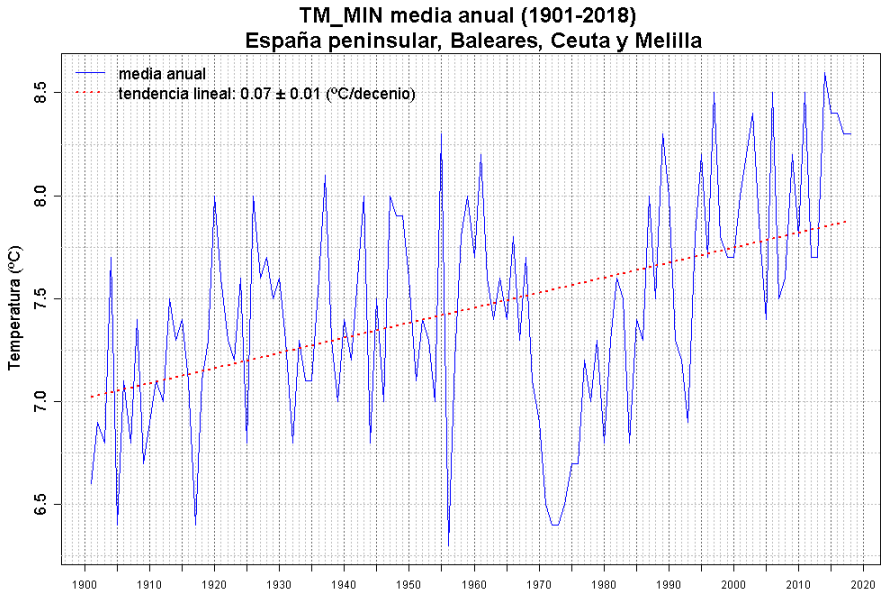
Annual mean temperature anomaly series relative to 1961-1990 mean

3.4 Trend analysis of the annual and seasonal temperatures 1916-2018

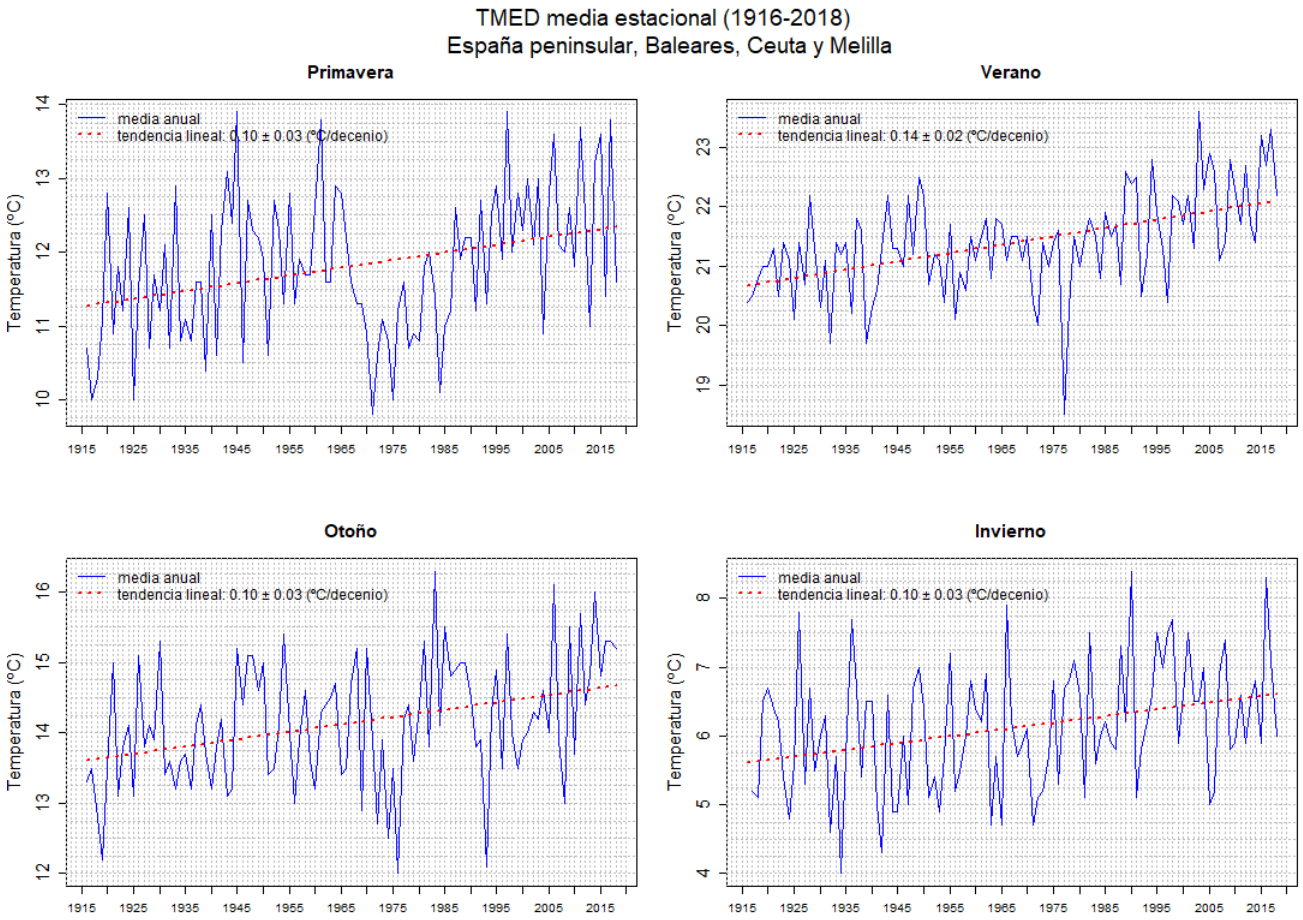


Annual mean temperature series and trend





Annual mean of the daily maximum and minimum temperature series and trends



Seasonal mean temperature series and trends

4. CONCLUSIONS

- At present, **high resolution gridded datasets of monthly temperature** for the mainland Spain area **since 1916** are available, and **since 1961** for the Canary Islands.
- The **quality** of the grids is lower during the first decades of the study period and it **progressively increases**, especially **after the 1960s**.
- Due to possible local inhomogeneities, these datasets are not suitable for studying the climate variability in a specific point, but they are useful for **climate monitoring** in big areas or the whole country.
- Recently, mean temperature series in mainland Spain based on these gridded datasets **since 1961** have replace the old **reference series** based on a set of stations for climate monitoring. In a near future, these series will probably be extended back in time **until 1916**.

Thank you for your attention