

Homogenization and trends of Spanish mean wind speed monthly series

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Outline



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Motivation

Methodology

Homogenization results

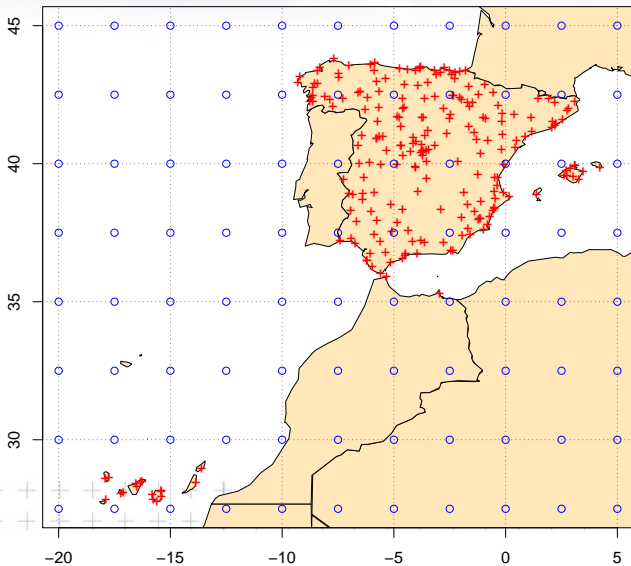
Wind speed trends

Conclusions

- ▶ Wind is important for many economic areas:
 - ▶ Agriculture (modulating evapotranspiration)
 - ▶ Water resources (controlling evaporation from dams and natural surfaces)
 - ▶ Leisure (outdoor activities, sailing, ...)
 - ▶ **Renewable energy production**
- ▶ ⇒ Interest to study its variability and trends
- ▶ Current discussion on an observed wind stalling in many areas: Is it due to atmospheric circulation changes, or rather to an increase of surface roughness around the observatories? (buildings and/or vegetation growth)

- ▶ Selection of all Spanish monthly mean wind speed series for the period 1951-2014 (≥ 10 years of data): 233 series
- ▶ Wind speed has been derived from hourly observations at 07, 13 and 18 h UTC, due to its greater availability
- ▶ Ten years of hourly data were used to check the reliability of the 07, 13 and 18 h averages
- ▶ Monthly wind speeds from NCEP reanalysis were downloaded for comparison

Stations and NCEP grid points



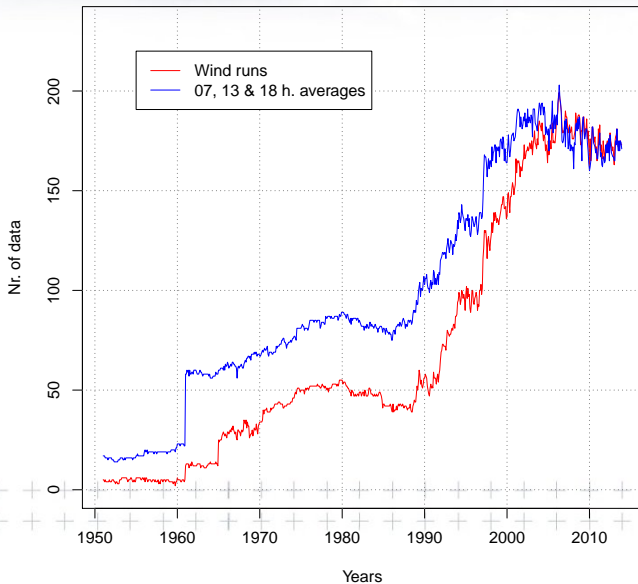
Data availability



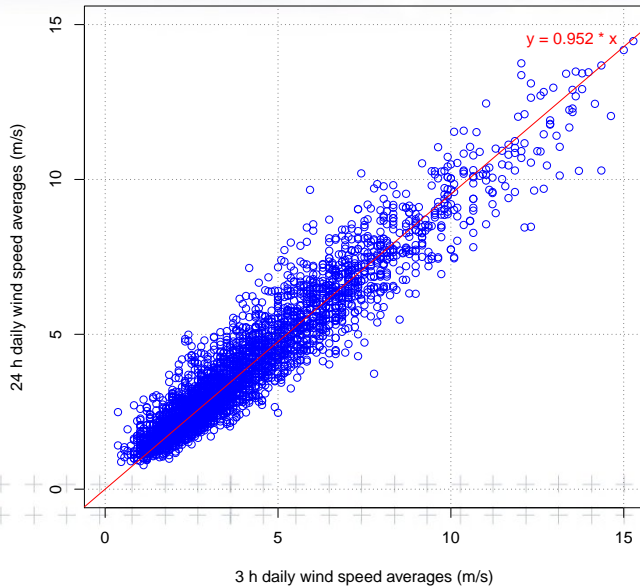
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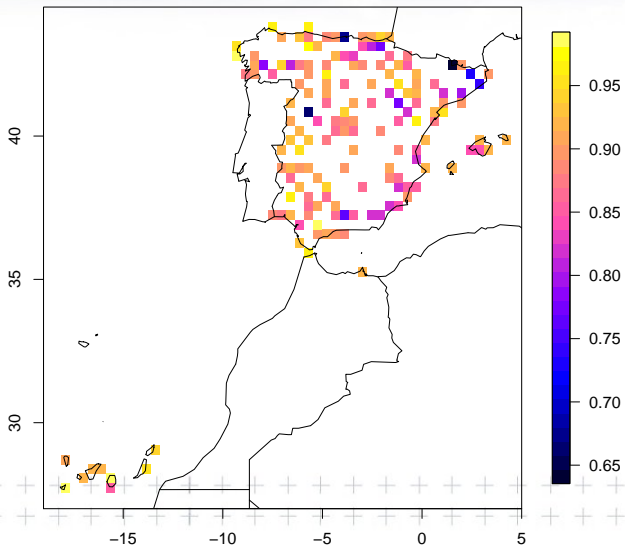
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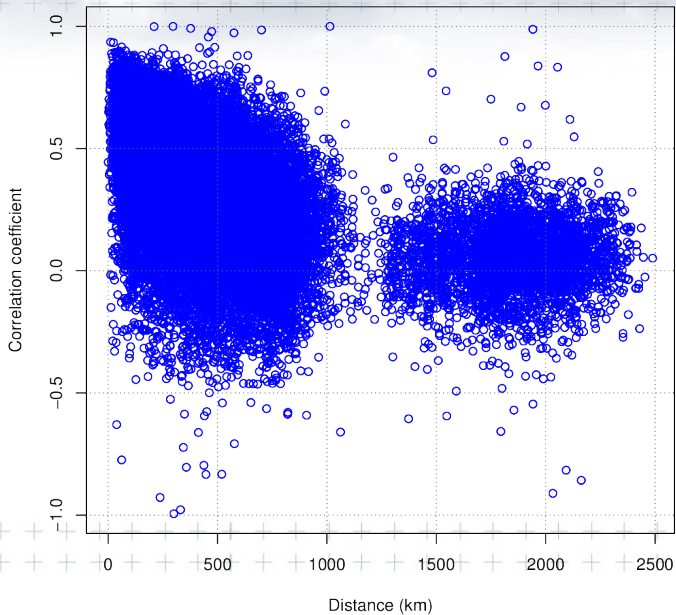
San Sebastián, Igueldo



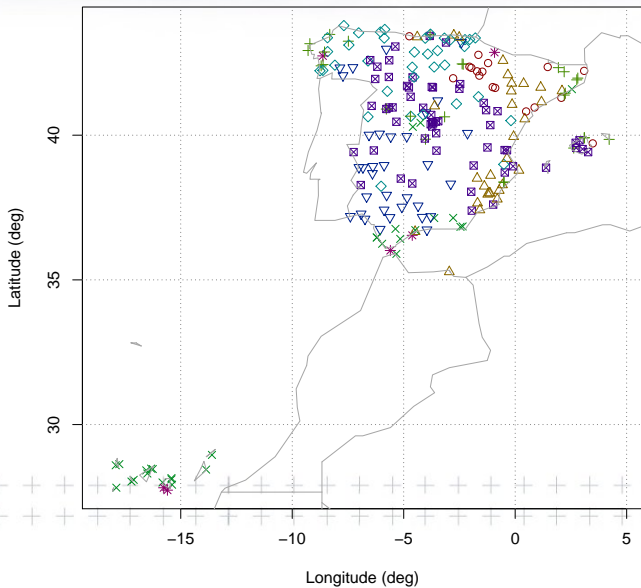


- ▶ Automatic quality control (outlier correction), homogenization (shift correction), and missing data attribution
- ▶ References based on distance: Able to use nearest reference data even without any common period of observation
- ▶ Break detection by SNHT, applied in stepped windows (to cope with multiple breaks) and on the whole series
- ▶ Automatic computation of reference series from neighboring data
- ▶ Iterative application: from big to small corrections in successive passes
- ▶ Good results when compared with other methods:
<http://www.climatol.eu/DARE/testhomog.html>
- ▶ Freely downloadable from <http://www.climatol.eu/>

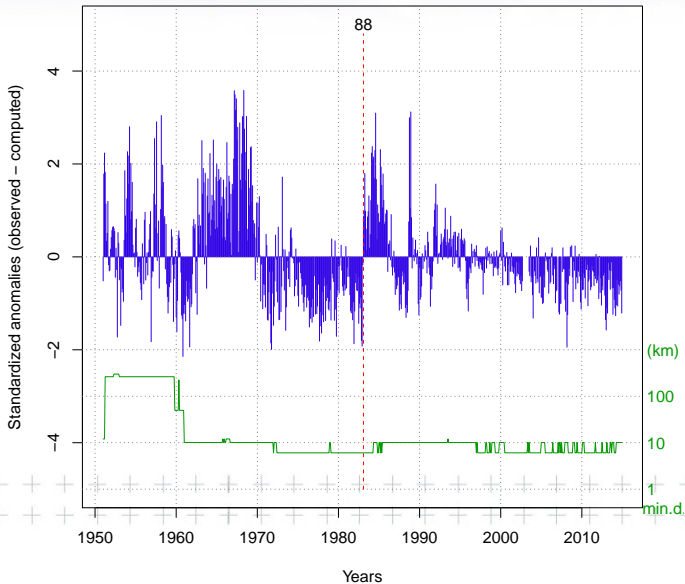
Correlogram



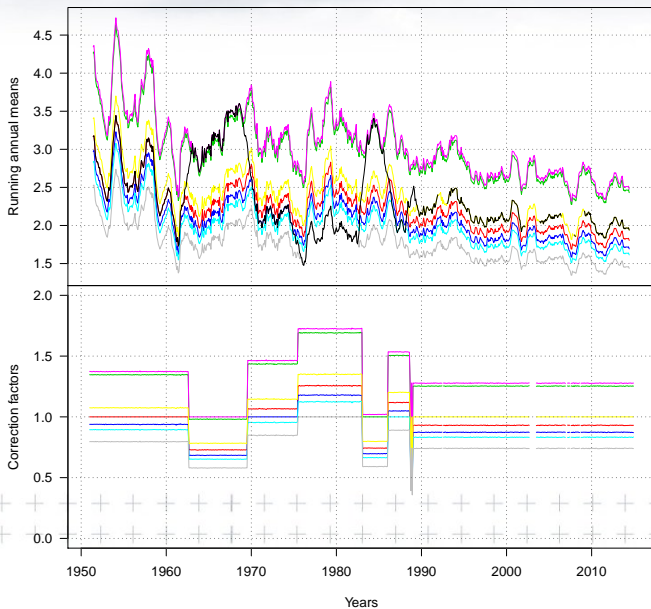
WSm3 station locations (8 clusters)



WSm3 at 3195(92), MADRID RETIRO

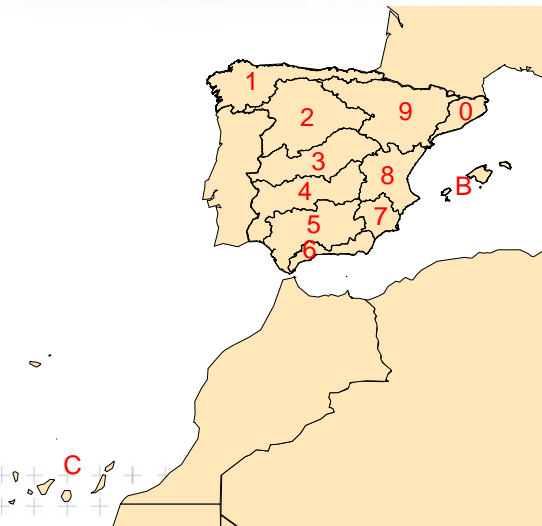


WSm3 at 3195(92), MADRID RETIRO

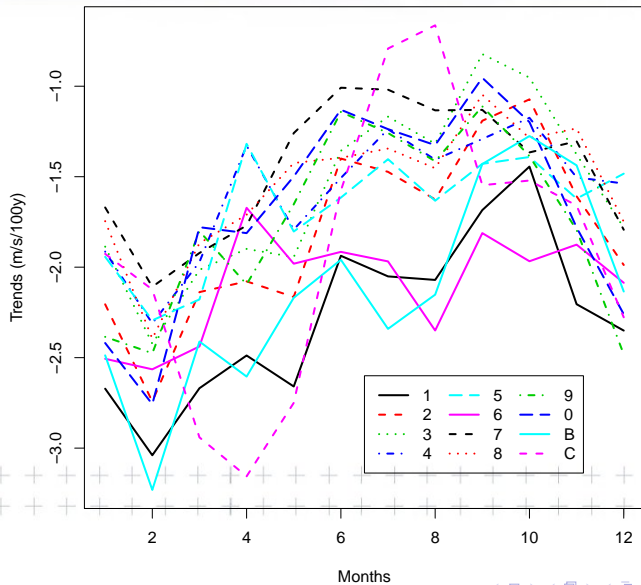


- ▶ 38 monthly data rejected (outliers)
- ▶ Only 1/3 (78 out of 233, a 33.5%) of the series were found homogeneous
- ▶ 356 shifts in the mean (breaks) corrected, distributed in this number of stations (breaks):
74 (1), 29 (2), 19 (3), 18 (4), 8 (5), 3 (6), 3 (7), 1 (8)

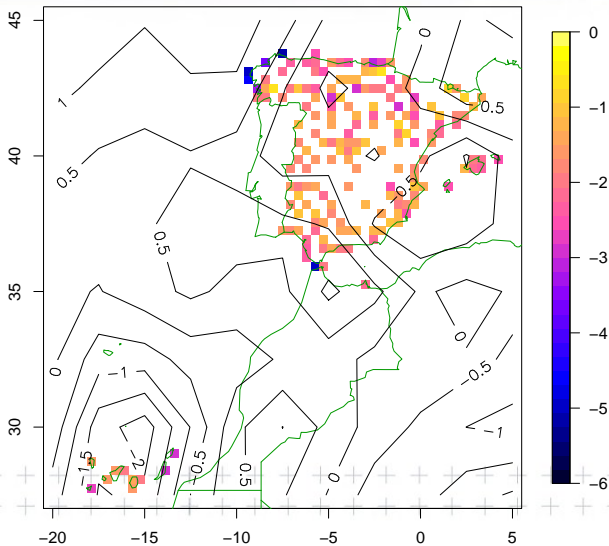
Main Spanish basins



Monthly trends (1951-2014)

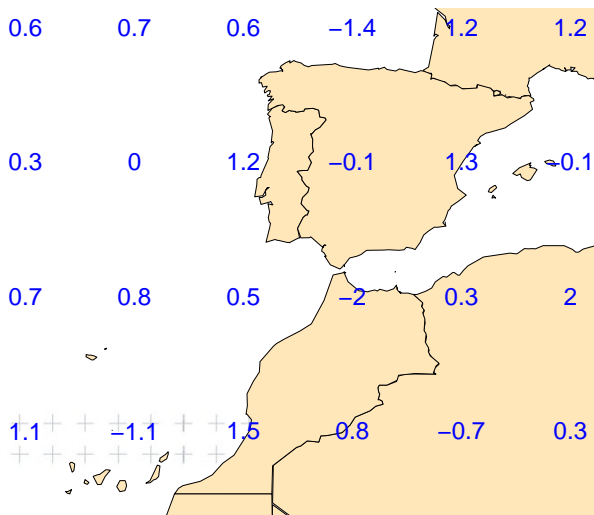


Annual trends (1951-2014)



Annual trends

NCEP-ERAi (1981-2013)



Statistical summary of annual trends
in mainland Spain (m/s/100y):

Statistic	Observed 205 series	NCEP 12 grid points
Minimum.	-5.240	-0.935
1 st Quartile	-2.150	-0.412
Median	-1.670	-0.222
Mean	-1.815	-0.162
3 rd Quartile	-1.310	0.070
Maximum	-0.650	0.613

- ▶ Wind is a climatic element very sensitive to changes in the surrounding and difficult to homogenize due to the poor spatial correlations
- ▶ In spite of that, the Climatol package has managed fairly well to homogenize the 233 monthly wind speed series
- ▶ Calculated trends reveal a clear stilling effect
- ▶ But NCEP wind trends do not support these observational trends
- ▶ ⇒ Most of the observational negative trends can be attributed to an increment of the surface roughness around the observatories