

Cloudiness, solar radiation, and sunshine duration in the Iberian Peninsula since the early 20th century

Josep Calbó, Arturo Sanchez-Lorenzo*, Josep-Abel González, Aarón Enríquez-Alonso

Grup de Física Ambiental, Universitat de Girona (GFA-UdG)

* Centro Superior de Investigaciones Científicas, Pirinean Institute of Ecology (IPE-CSIC)



1 – INTRODUCTION

- Climate change studies have focused mostly on temperature and precipitation changes, but other climate variables are also varying. In fact, **surface solar radiation** is the driver of other changes, but in turn it is strongly modulated by **cloudiness**.
- Research on the decadal changes of these variables has been carried out by our group in recent years. Here, a synthesis of the obtained results is presented.
- In particular, evidences of global dimming and brightening in the Iberian Peninsula, and explanations for this phenomena, have been searched.

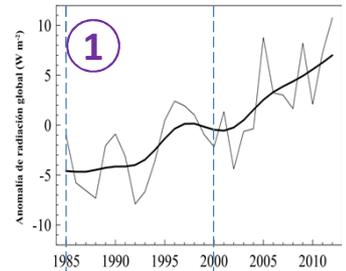
2 – SUMMARY OF PUBLISHED RESULTS

1

Mean annual series of sunshine duration radiation (thin line), 1930-2004, built from data from 72 stations (including 3 in Portugal, 1 in Gibraltar, and 1 in France); along with the result of applying a low-pass Gaussian filter (thick line). Series is expressed as relative deviations from the 1971-2000 mean. Dashed lines are used prior to 1951 owing to the lower number of records for this initial period. **Main finding:** dimming period (1950s – 1985) followed by brightening period (1985-2004). From Sanchez-Lorenzo et al. (2007).

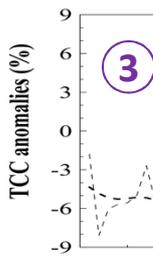
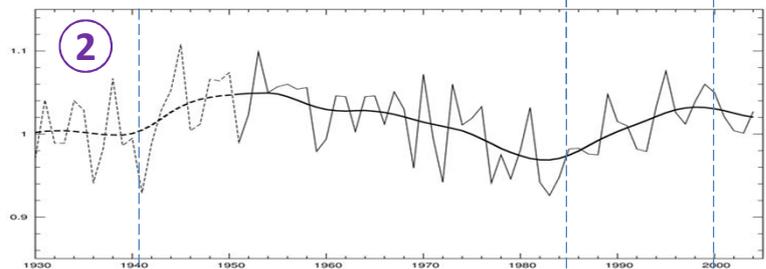
1

Mean annual series of global solar radiation (thin line), 1985-2012, built from data from a network of 13 Spanish stations; along with the result of applying a low-pass Gaussian filter (thick line). Series is expressed as anomalies with respect to the 1991-2010 mean. **Main finding:** significant linear trend of $+3.9 \text{ Wm}^{-2}$ per decade (1985-2012). Modified and updated after Sanchez-Lorenzo et al. (2013).



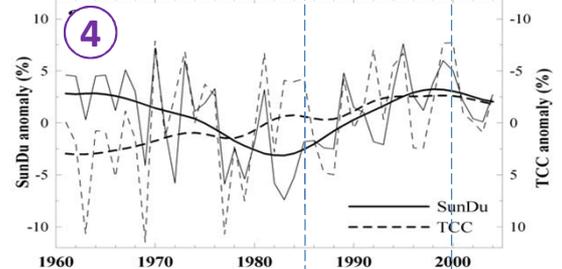
2

Mean annual series of total cloud cover (TCC, thin line), since 1865, built from data from 39 stations in Spain; along with the result of applying a low-pass Gaussian filter (thick line). The series is expressed as anomalies from the 1971-2000 mean. Dashed lines are used before 1913 to indicate the lower number of series available before this year. **Main finding:** general tendency to increasing TCC from the beginning of the series ($+0.44\%$ per decade, 1866-2010); but a clear negative trend since the 1960s (-0.80% per decade, 1961-2010). From Sanchez-Lorenzo et al. (2012).



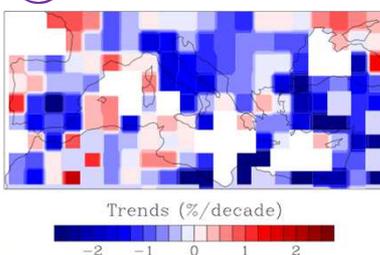
3

Annual time evolution of both sunshine duration (SunDu, solid lines) and total cloud cover (TCC, dashed lines) series (thin lines) for the whole Iberian Peninsula during the 1961-2004 period, plotted together with a Gaussian low-pass filter (thick lines). The series are expressed as relative deviations (%) from the 1971-2000 mean. Note that the scale for TCC series has a reversed axis. Mean series built from 72 stations (SunDu) and 69 stations (TCC) across the Iberian Peninsula. **Main finding:** SunDu and TCC variations are strongly negatively correlated ($r \sim -0.8-0.9$), but a large discrepancy between the SunDu and TCC records occurs from the 1960s until the 1980s when the SunDu series shows a decrease that it is not associated with an increase in TCC. From Sanchez-Lorenzo et al. (2009).



5a

EECRA 1971-2005

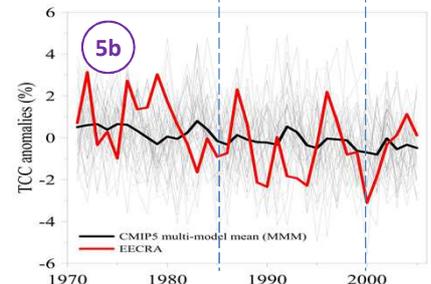


5a

Trend of TCC in the Mediterranean area, from a gridded dataset built upon the Extended Edited Synoptic Cloud Reports Archive (EECRA), i.e., ground observations of clouds. **Main finding:** most regions in the Mediterranean area show decreasing cloudiness.

5b

Temporal evolution of the mean TCC in the Mediterranean area, from EECRA data, along with the evolution of 44 CMIP5 "historic" simulations, and their multimodel mean. **Main finding:** the overall decreasing trend is captured by most global climate models and by their multimodel mean. Modified after Calbó et al. (2014).



3 – CONCLUSIONS

- The global dimming (1950-1980) and brightening (1980-2010) phenomena has a clear signal in the Iberian Peninsula: it has been found both in sunshine duration series and in solar radiation series.
- Variations of total cloud cover may partly explain the brightening period, as TCC has decreased since the 1960s.
- The dimming period cannot be explained from TCC variations, so other causes (as changes in aerosol content in the atmosphere) must be explored.

4 – REFERENCES

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