# Joint homogenization of sunshine duration and global solar radiation Spanish series

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11th EMS Annual Meeting (12-16/Sep-2011, Berlin)

# Intro

- Surface Solar Radiation (SSR) is the main component of surface energy balance
- Negative (dimming) trends have been identified around 1955-85, followed by positive (brightening) trends (reflected in temperature series)
- $\Longrightarrow$ Interest in SSR series homogenization
- Problem: SSR series are short and scarce

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# Method

- More abundant observations of sunshine duration ($S$)
- Relative sunshine hours are a good proxy for cloudiness fraction ($F_c$): $S_r = S/S_x \simeq 1 - F_c$
- And also for global radiation ($Q$) relative to $Q_o$ (global radiation out of the atmosphere): $Q_r = Q/Q_o \simeq a + b\,S_r + c\,S_r^2$
- $R^2_{aj} > 0.80$ in 53 (of 59) stations. Worse values: 0.16, followed by 0.45
- Also possible: $S_r = S/S_x \simeq d + e\,Q_r + f\,Q_r^2$

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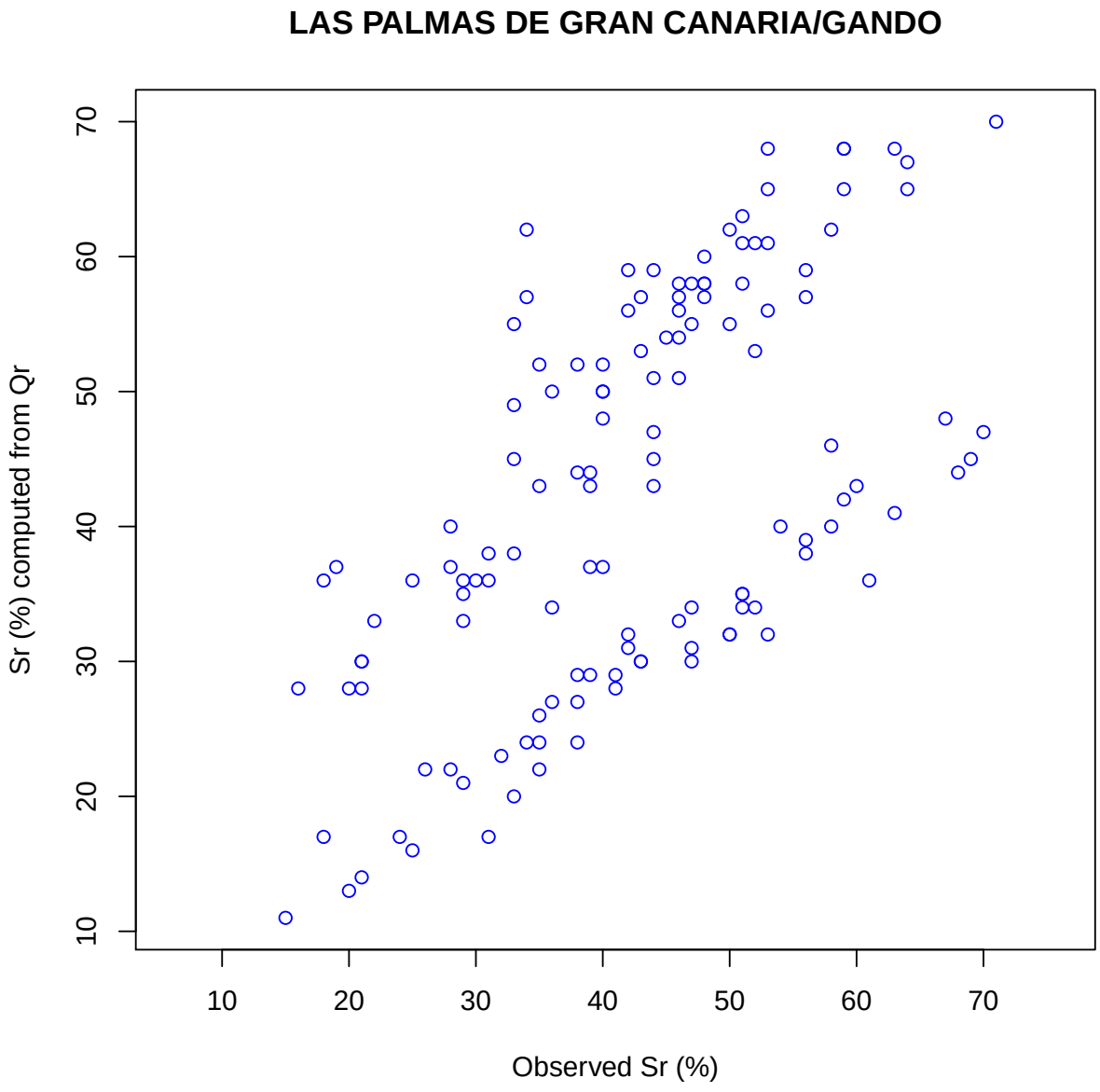
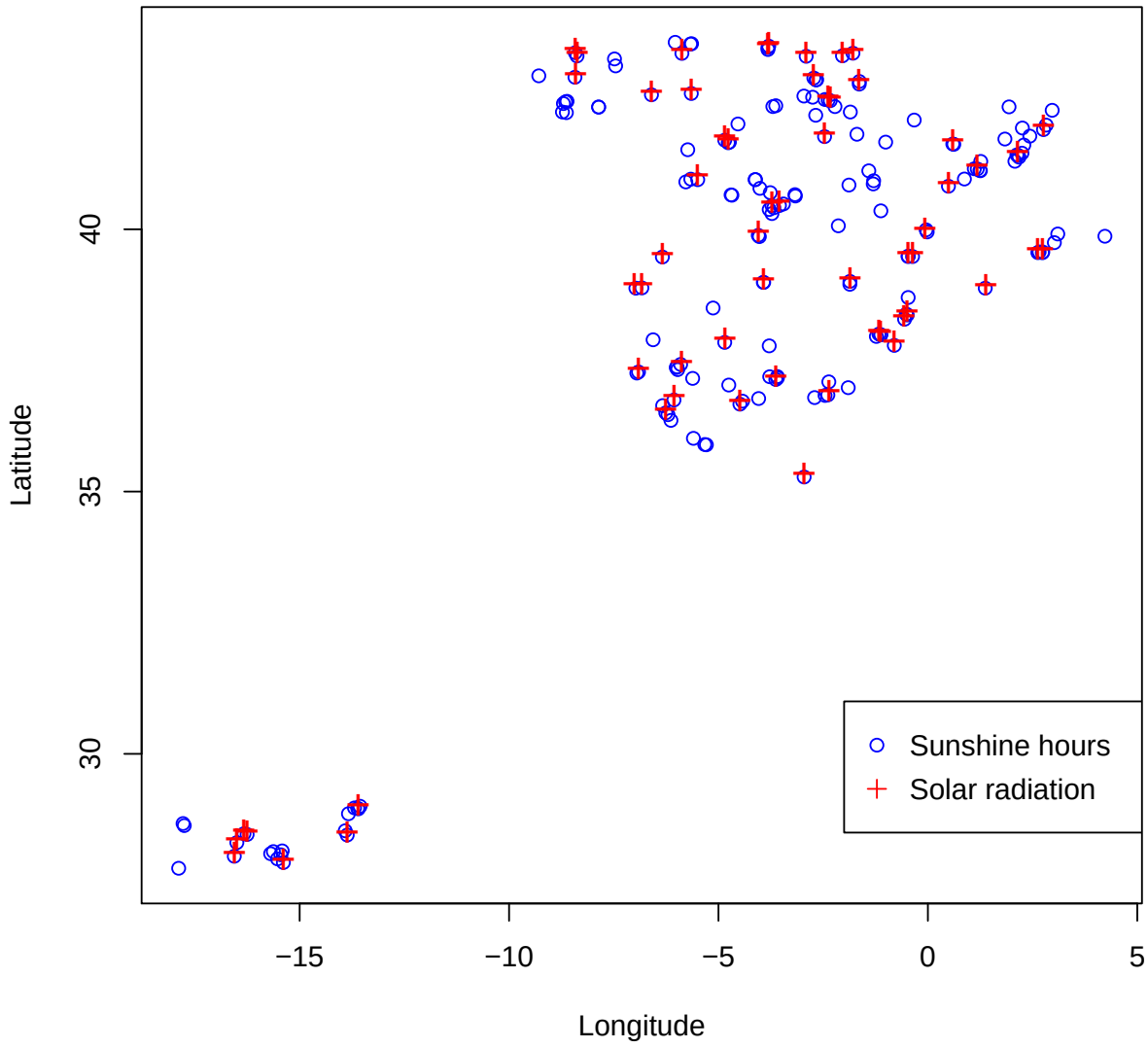
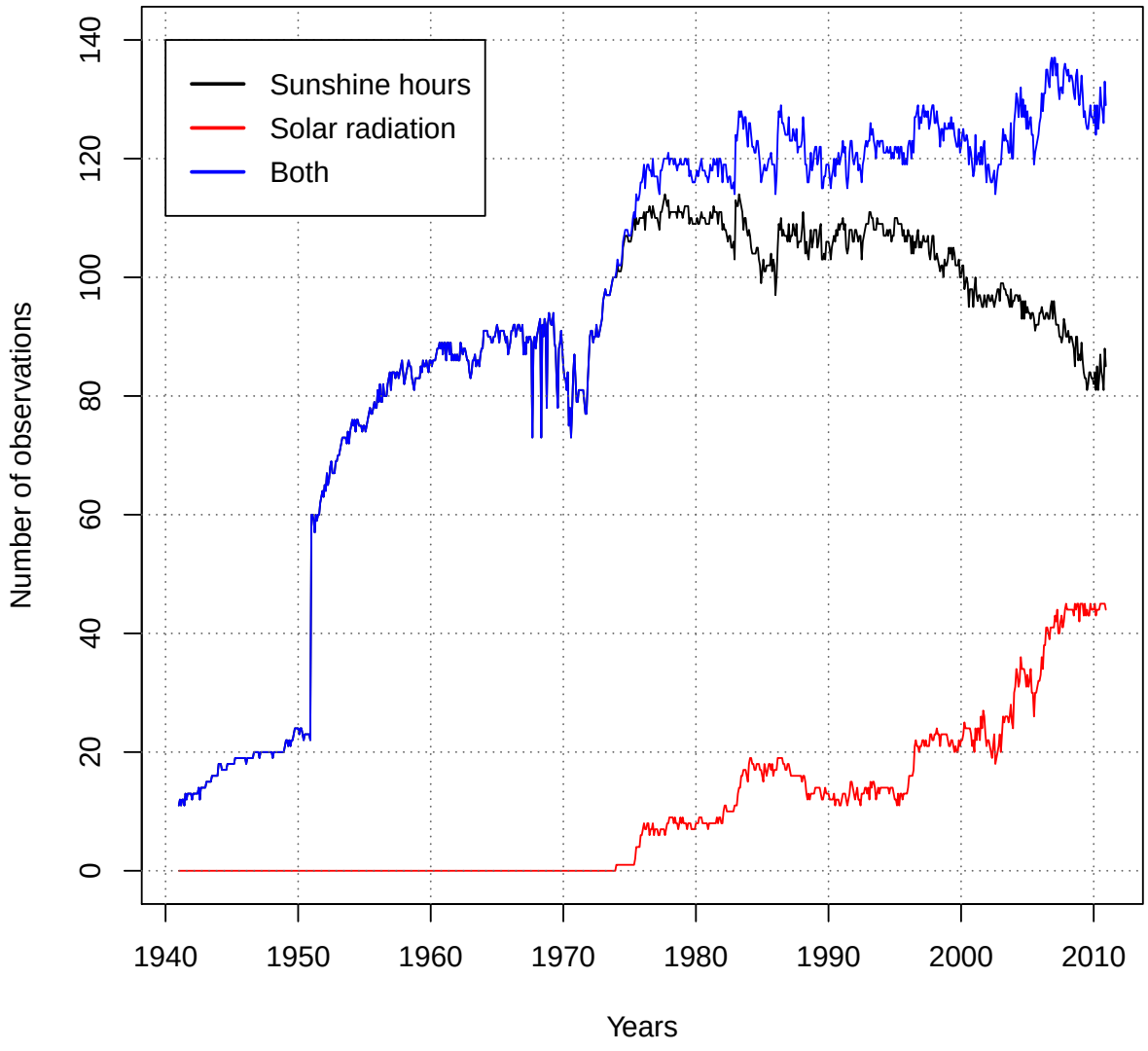



Observed and computed Relative Sunshine Duration




Location of the 178 sunshine duration and 59 solar radiation stations




Sunshine duration and solar radiation available data

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# Method

- Homogenization performed with Climatol (pre-2.2) on:
- 59 SSR radiation series 1974-2010
- 178 Relative sunshine hours (1941-2010)
- 237 Relative sunshine hours (178 observed + 59 derived from SSR)

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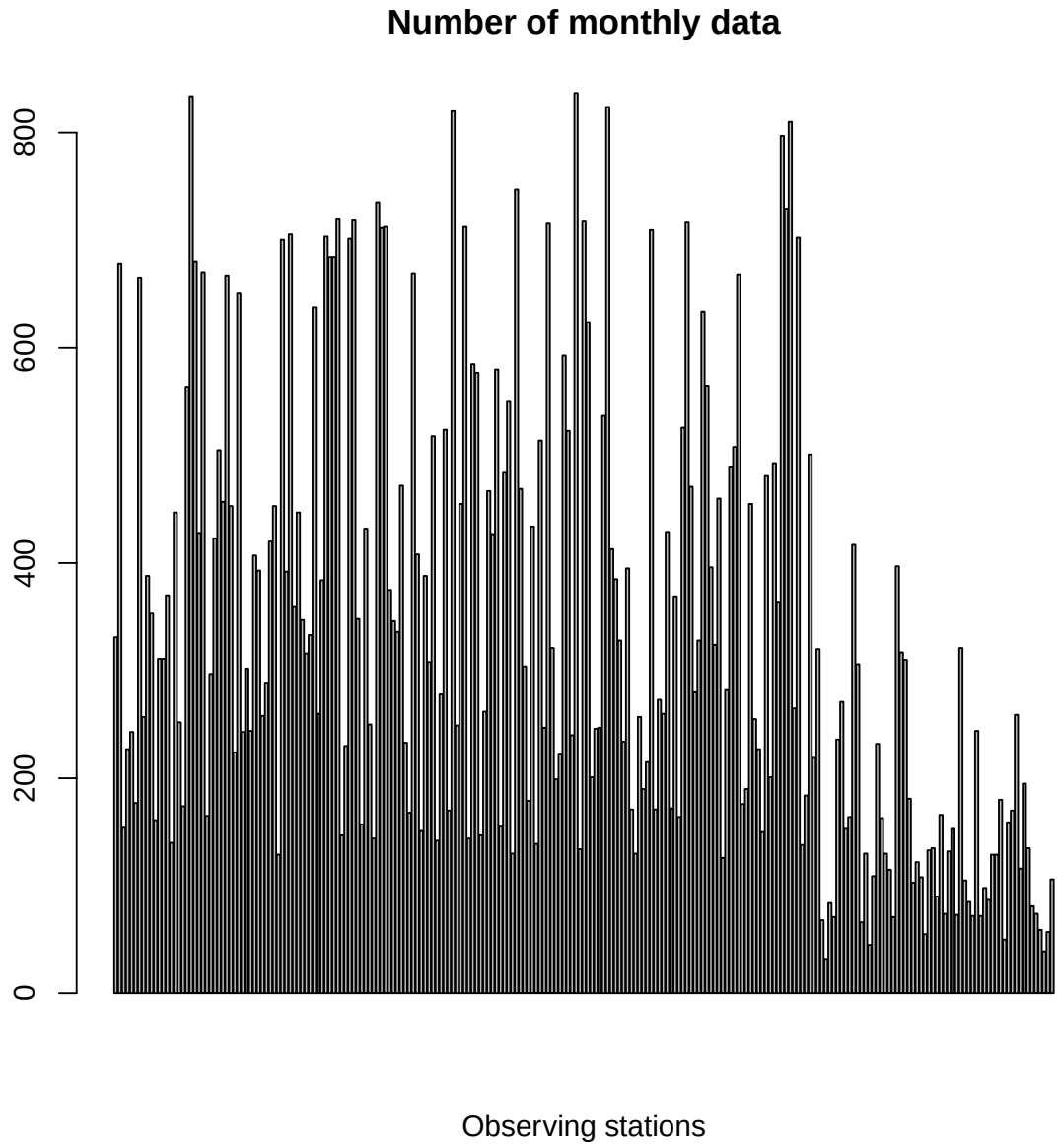
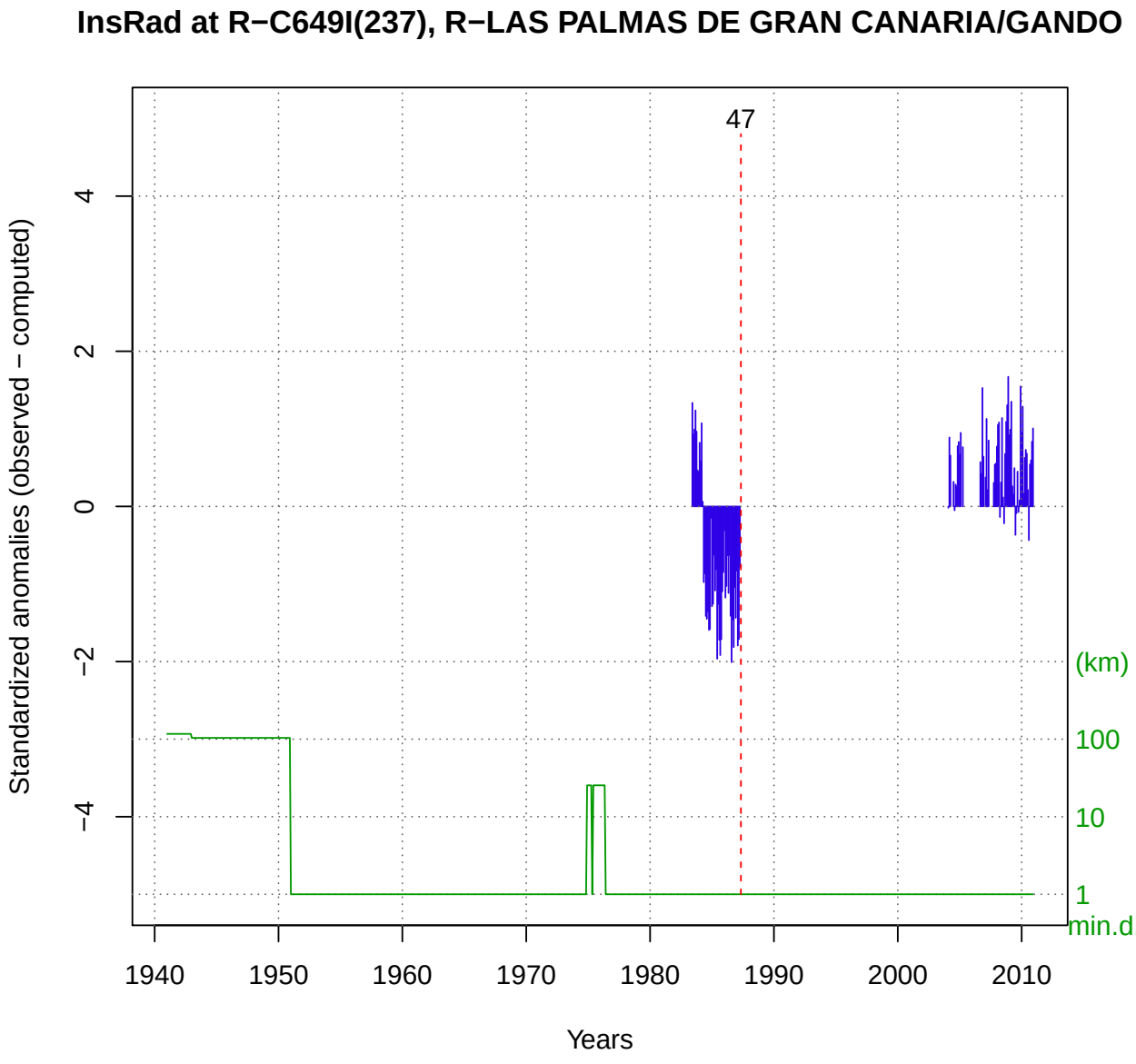
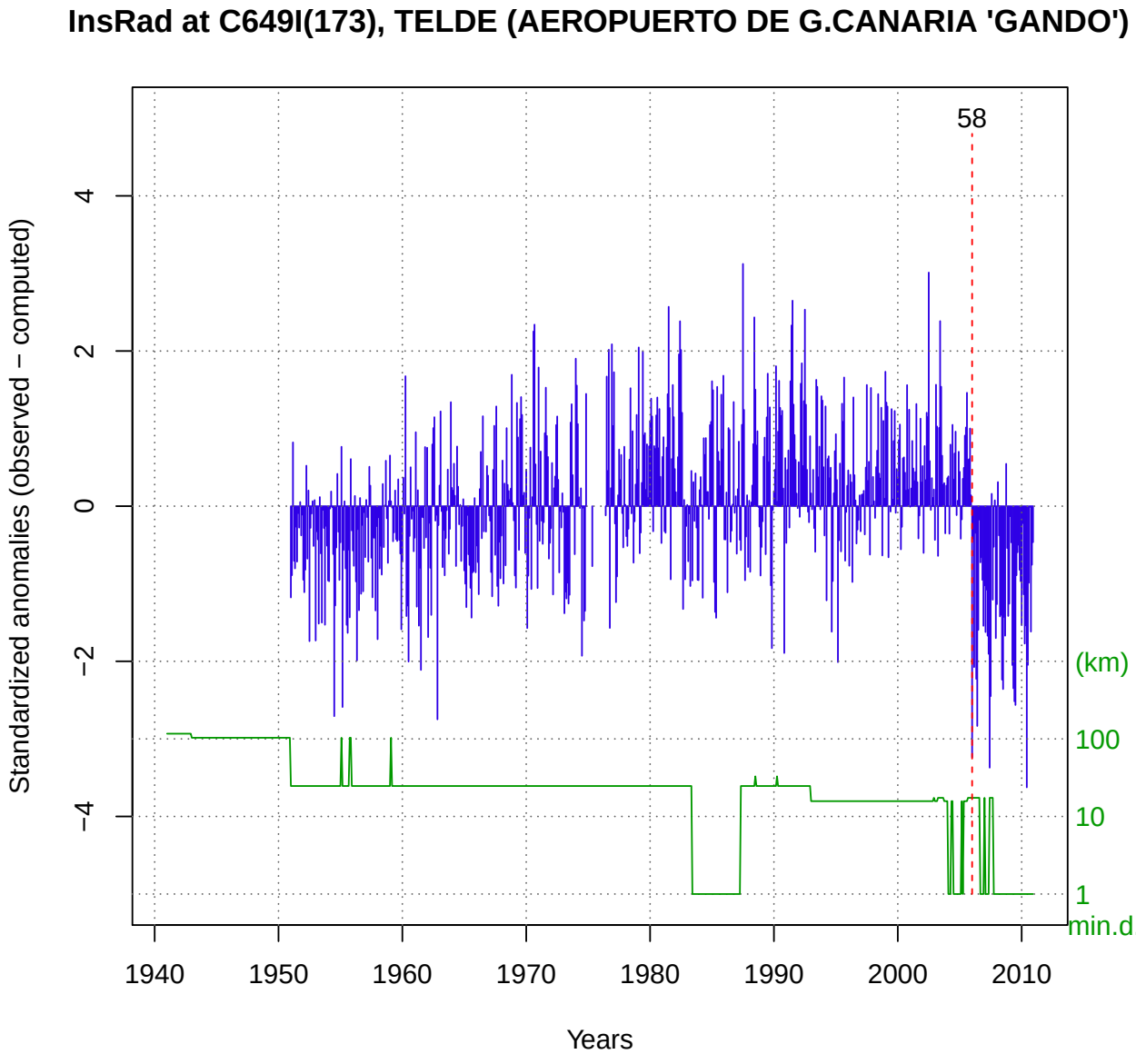

Number of monthly data
0
200
400
600
800
Observing stations




Standardized anomalies of Gran Canary airport solar radiation

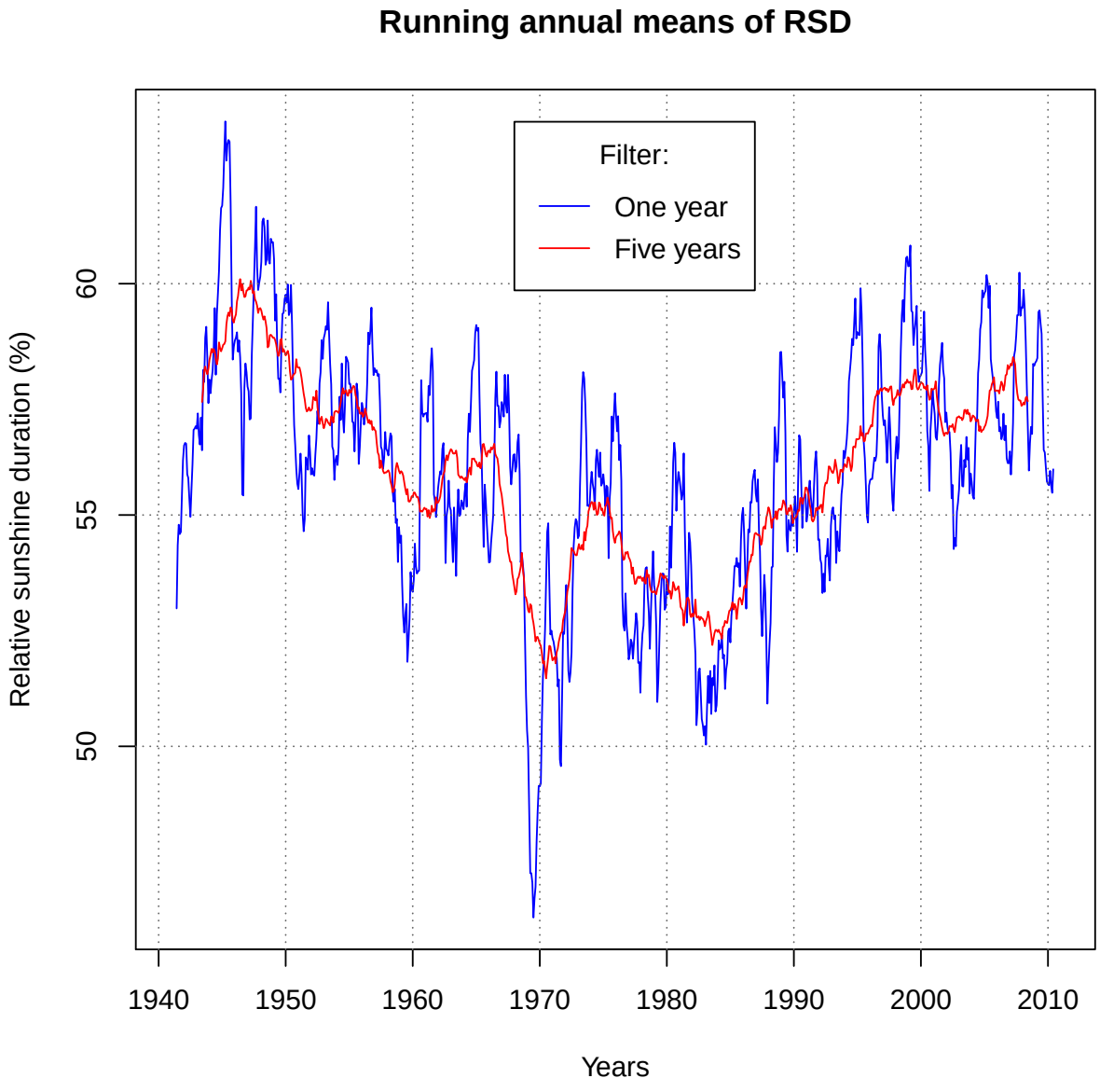



Inhomogeneity due to change of instrumentation

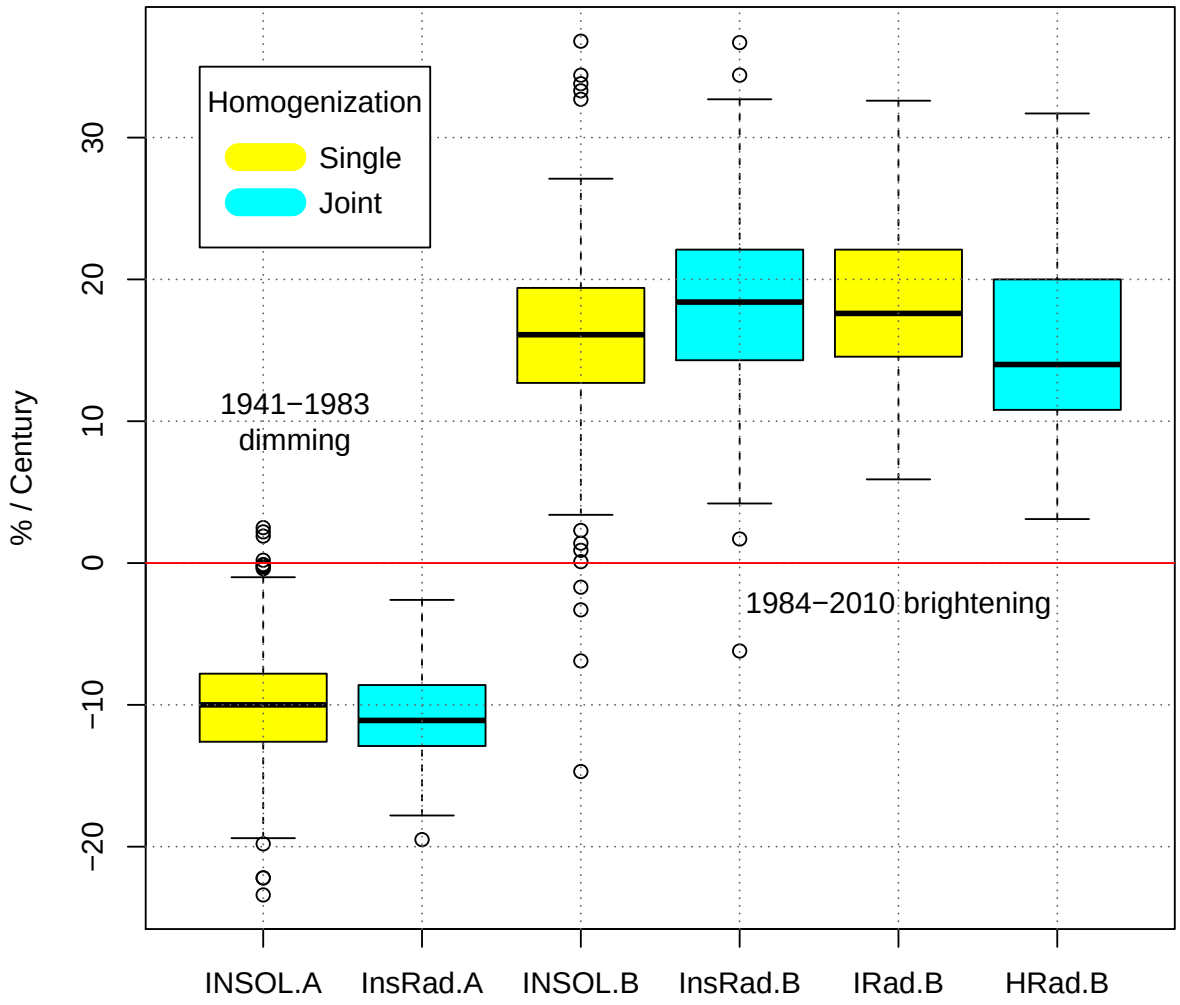
# Results

Number of shifts corrected in single (top) and joint (bottom) homogenizations:

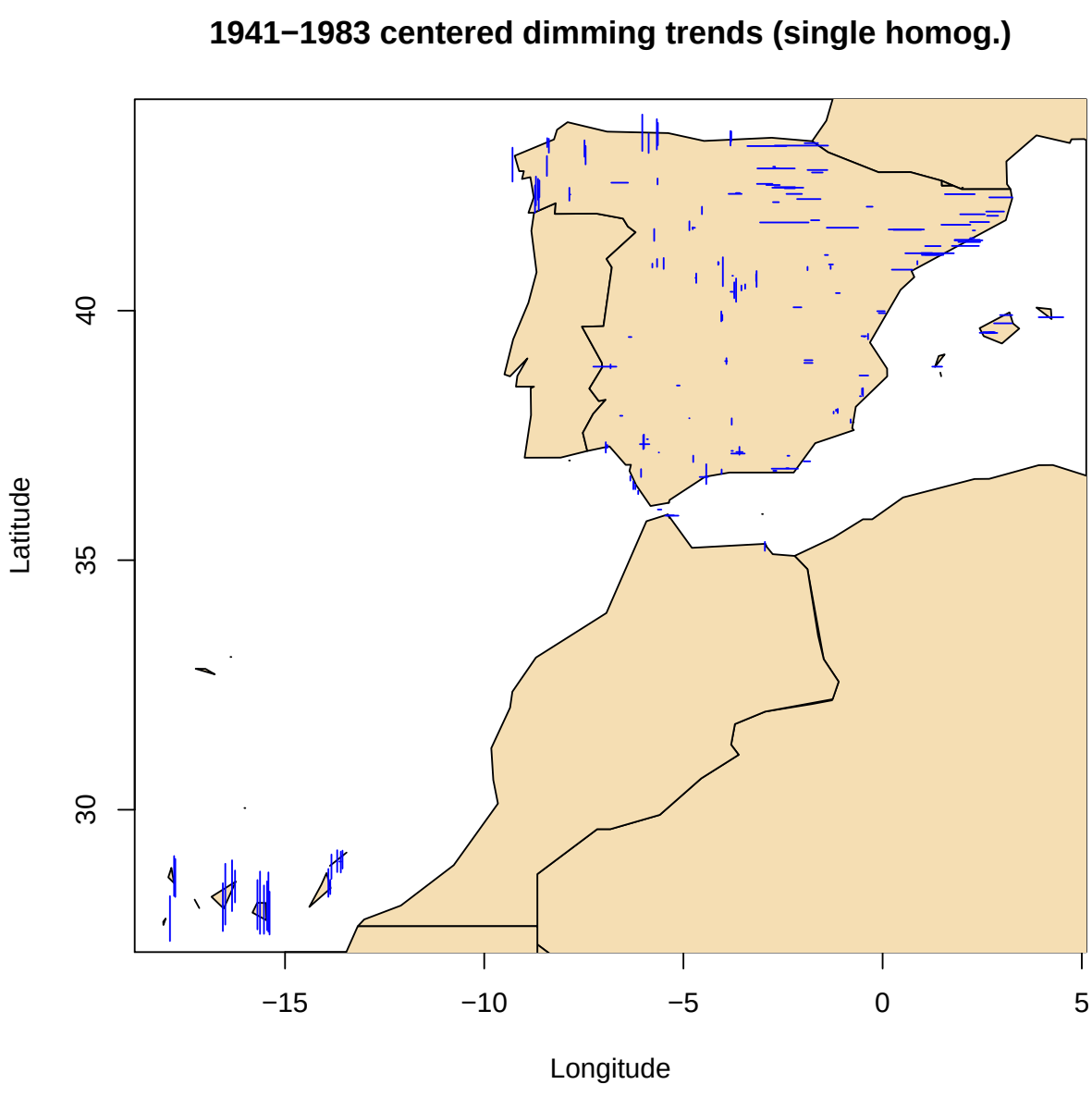
| | 1941-2010 | 1941-1973 | 1974-2010 |
|---|---|---|---|
| Sunshine duration | 120 | 41 | 79 |
| Solar radiation | – | – | 31 |
| S. duration from radiation | – | – | 20 |
| Sunshine duration | 214 | 98 | 116 |
| S. duration from radiation | – | – | 34 |

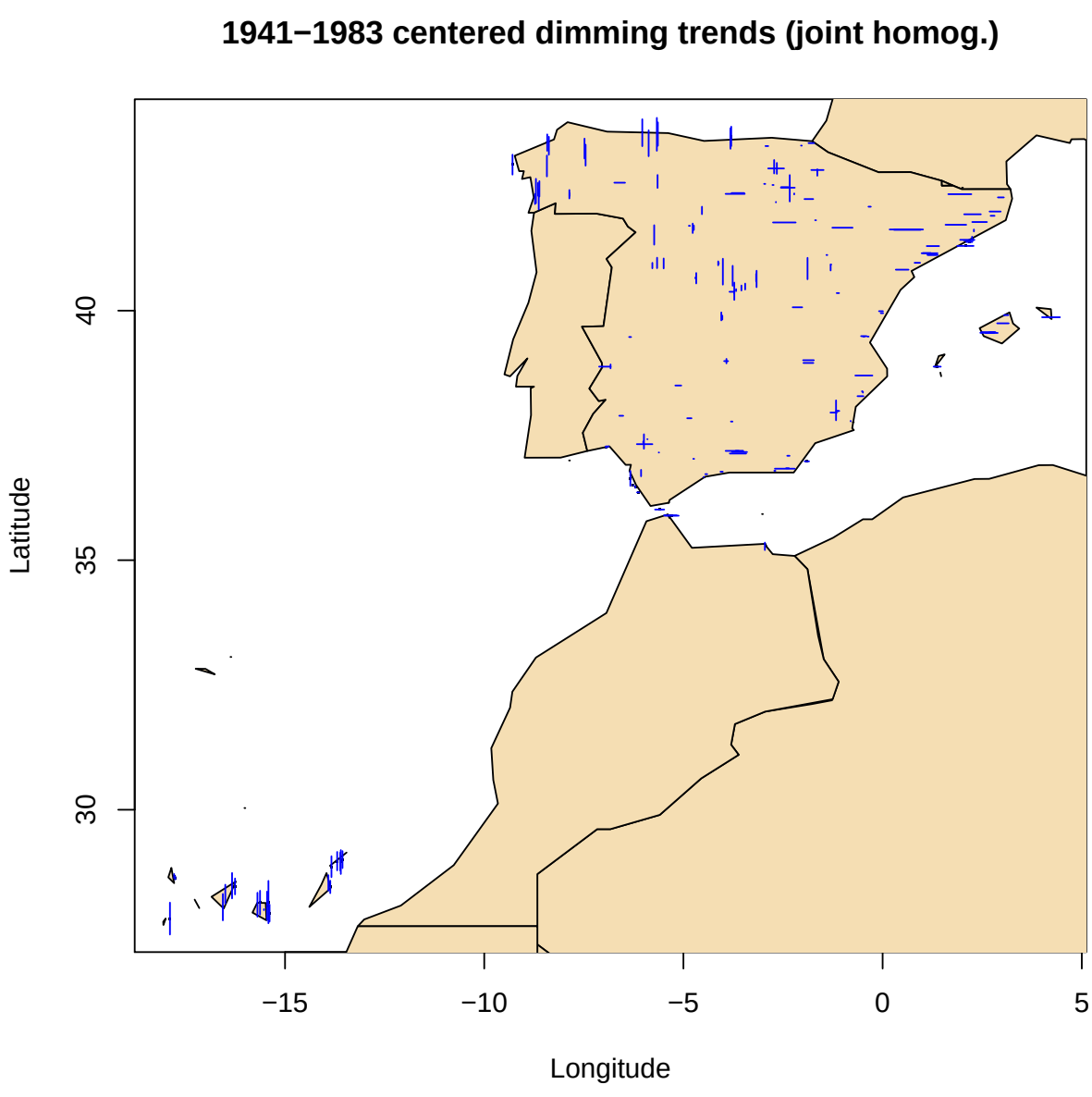



Bulk average of all Relative Sunshine Duration data




Trends of Relative Sunshine Duration and Solar Radiation proxy after single and joint homogenization


1941−1983 centered dimming trends (single homog.)
Latitude
40
35
30
−15
−10
−5
0
5
Longitude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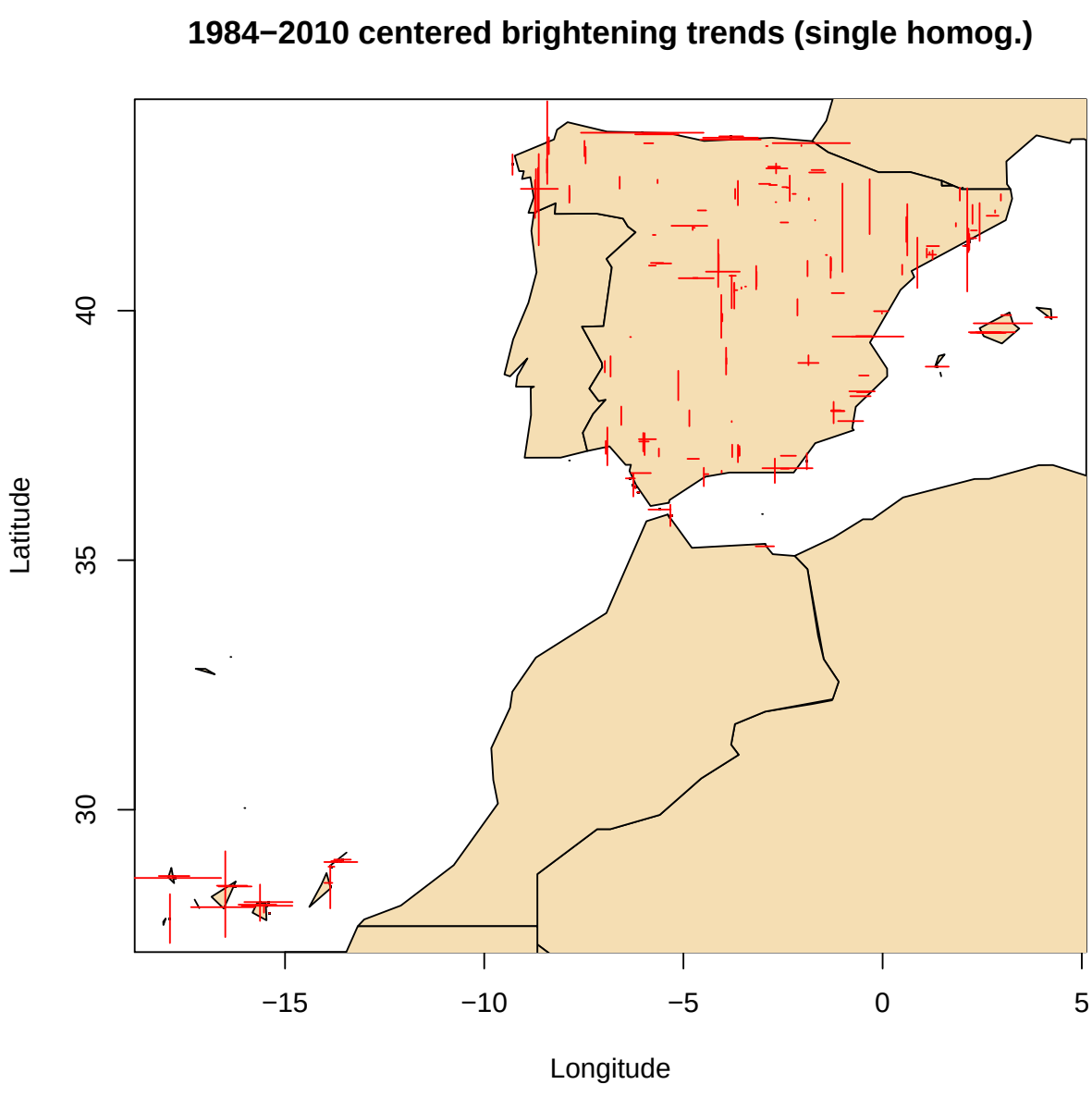
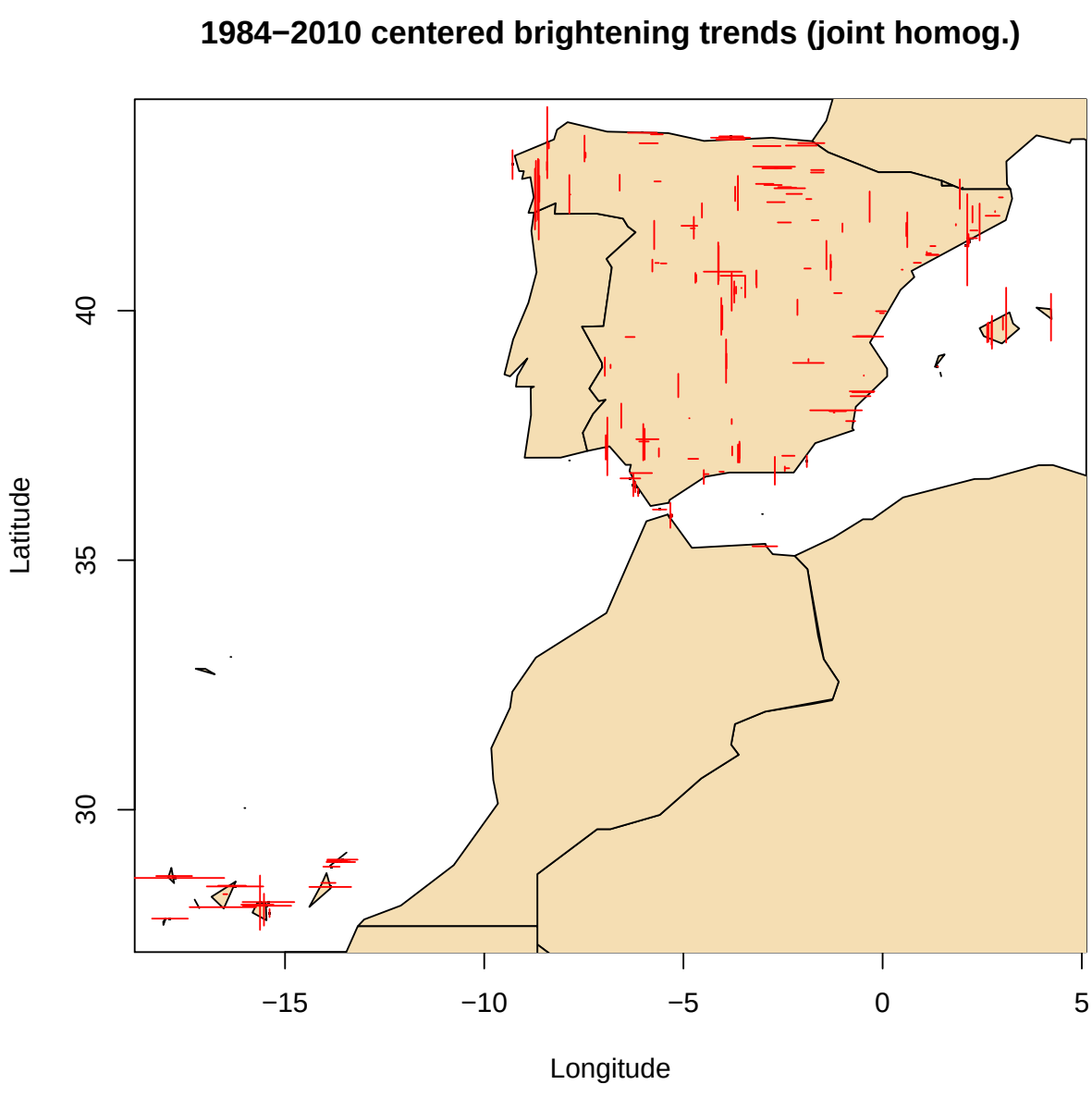

1984−2010 centered brightening trends (single homog.)
Latitude
40
35
30
−15
−10
−5
0
5
Longitude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# Conclusions

- The recent change in sunshine duration instrumentation in the Spanish airports has produced a clear reduction in the means of these series
- The joint homogenization of closely related variables improves:
  - The spatial density of observations
  - The reliability of the homogenization

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