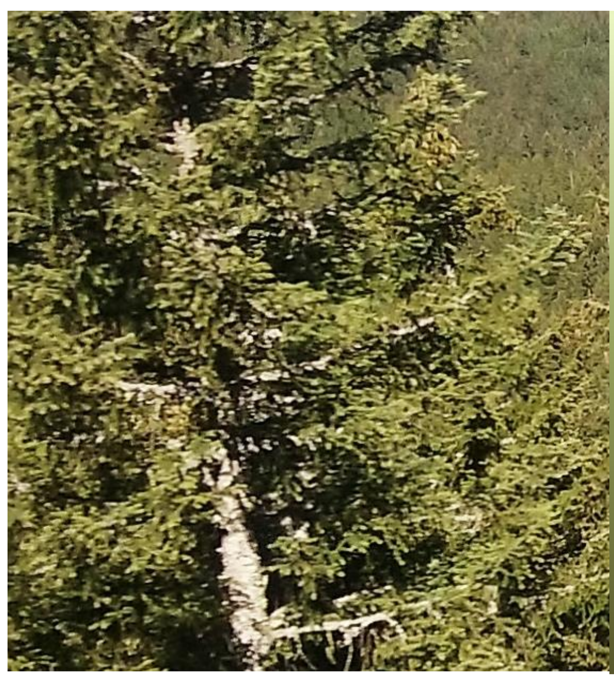

MODELLING PINUS PINASTER WOOD RADIAL GROWTH IN PORTUGAL

Célia M.Gouveia[1], Rita M.Cardoso[1], Ana Russo[1], José Lousada[2], Cathy Kurz-Besson[1]

(1)Instituto Dom Luiz (IDL), Faculdade de Lisboa, Universidade de Lisboa, Lisboa, Portugal (cmgouveia@fc.ul.pt)

(2)Centro de Investigação e de Tecnologias Agro-Ambientais e Biológicas, Universidade de Trás-os-Montes e Alto Douro, Portugal

1. Motivation

Trees respond physiologically to the prevailing climatic conditions. Wood formation and growth are also recognized to be strongly affected by climate conditions and mostly constrained by water availability, namely in drier regions of Mediterranean basin.

Wood radial growth highly benefits from the strong decay of the number of cold days and the increase of minimum temperature. Yet the benefits are hindered by long term water deficits, which result in different levels of impact on wood radial growth.

2. Data

- Monthly means of climate variables (maximum [TMAX], minimum [TMIN] and mean temperature [TMED], , precipitation [PREC],), climate indices (dry spell [DRYS], heat sum [HEAT], number of days with Tmin<5ºC [DTMIN5], number of days with Precip>0.1mm [DPREC], number of days with Tmax>30ºC [DTMAX], max number of consecutive days with Tmax>30ºC [DHEAT]) and drought indicators (SPEI for the times scales from 1 to 12 months);
- Wood ring cores sampled in Companhia das Lezirias (38º 47’ 24.01 N; 8º 54’ 11.10 W) located in the northern-east part of the Alentejo region (Fig. 1). The sampling size was limited to ten cores and only one core by tree.

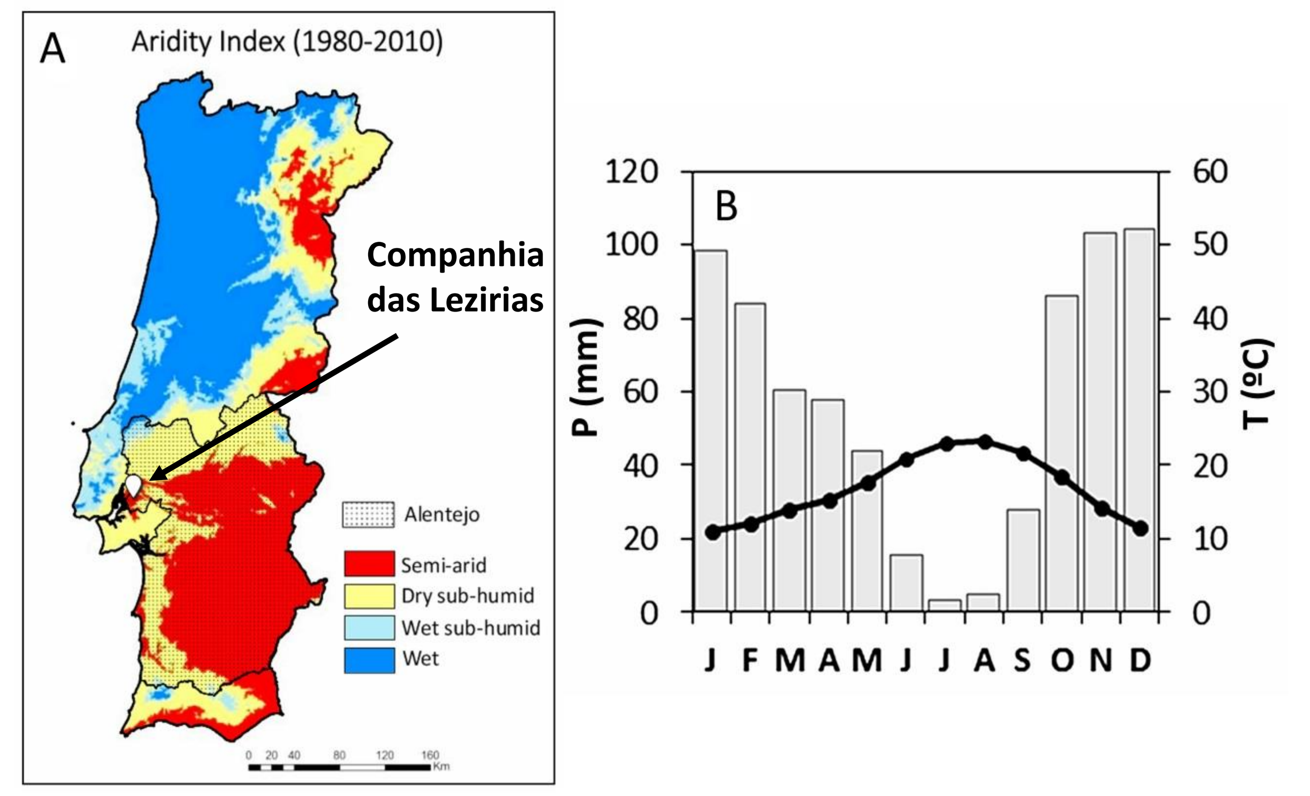

Fig. 1 – A. Location of the Companhia das Lezirias sampling area (white icon) in the semi-arid Alentejo region in Portugal (dotted area). (Aridity map adapted from PFNCNUCD, 2011). B. Climatic diagram considering the average monthly values of precipitation and temperature of the period 1957-2012. (Kurz-Besson et al., 2016)

3. Methodology

We modelled the vulnerability of Pinus Pinaster wood radial growth (TWG) to climate variability by means of two linear regression models which were developed with the aim of forecasting Pinus Pinaster wood radial growth in Alentejo region using climate variables and indices by one hand, and different time scales of SPEI by the other (Fig. 2).

4. Wood radial growth and Climate variables

The regression model for the estimation of Pinus Pinaster wood radial growth (TWG_C) was obtained by a stepwise regression approach, performed over the climate variables and indices (TMAX, TMIN, DRYS PREC, DPREC, DTMAX and DHEAT), as follows:

$$TWG_C = -0.04 - 0.27 \times [TMAX_{Jun} + TMAX_{Dec}] - 0.75 \times [TMIN_{Mar} - TMAX_{Jul}] - 0.23 \times [DRYS_{Jan} - PREC_{Feb} - PREC_{Jul}] - 0.30 \times DPREC_{Abr} - 0.47 \times DTMAX5_{Jul} - 0.15 \times DHEAT_{Oct}$$

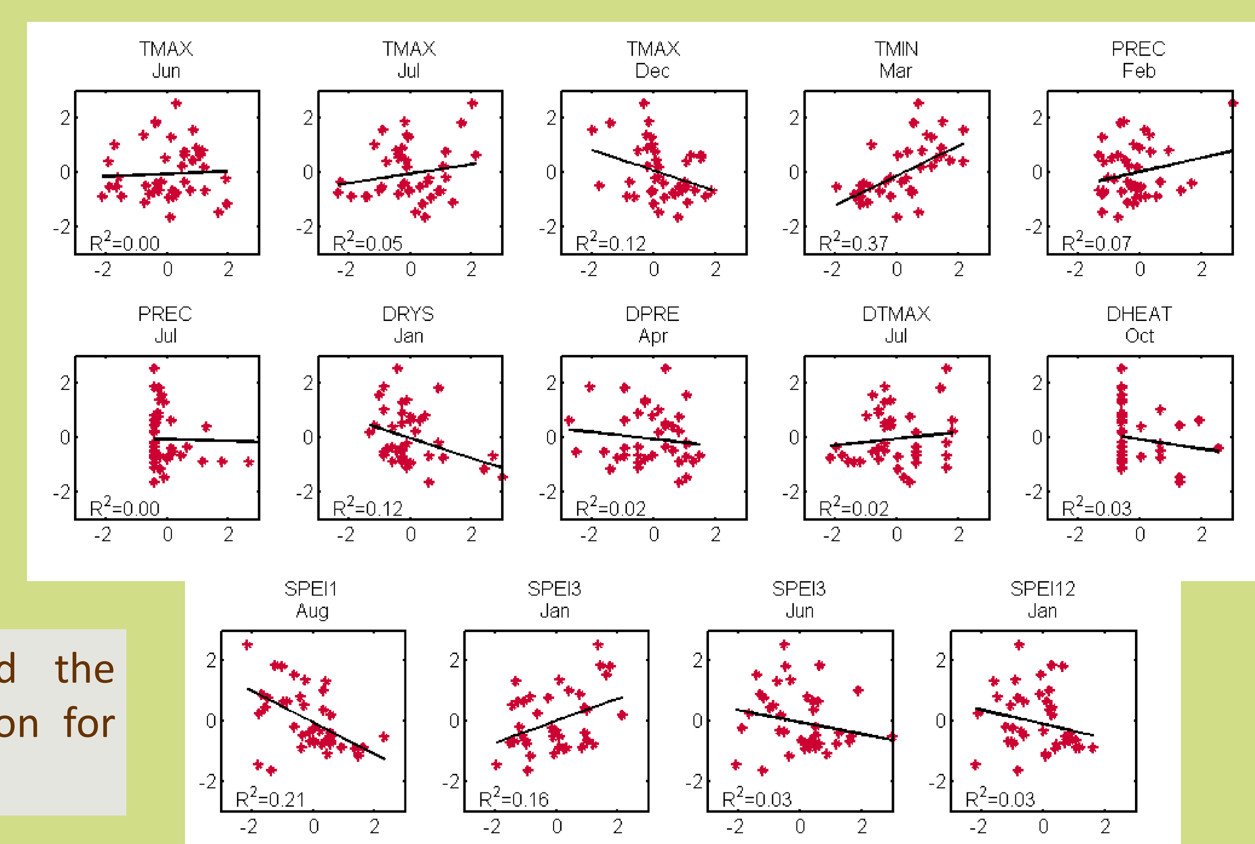

Fig. 2 Scatter plots between TWG and the predictors selected after stepwise regression for both models.

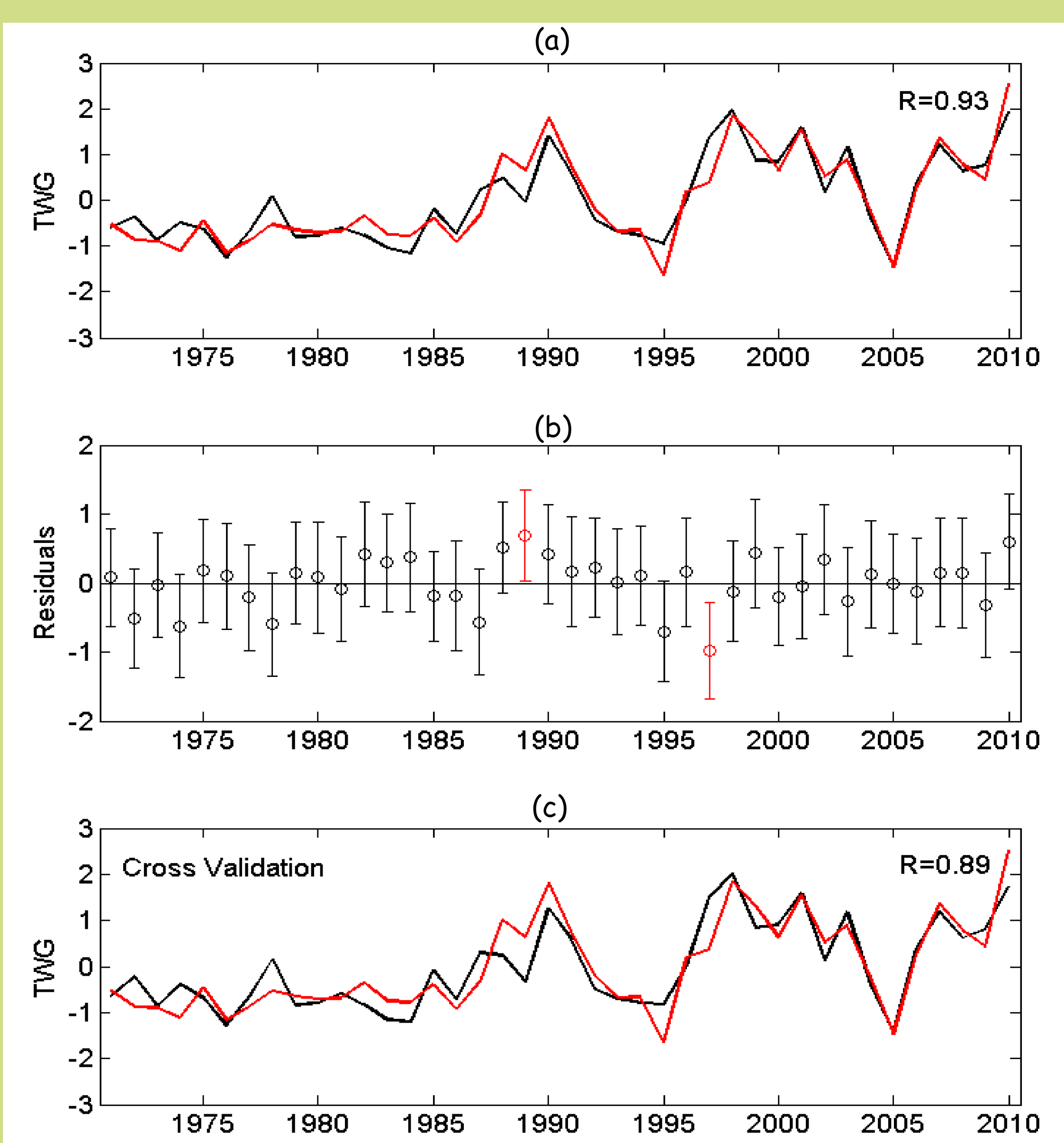

Fig. 3 – (a) Observed (red curve) TWG and corresponding modelled values (black curve) using a linear regression based on climate variables and Indices. (b) Residuals and respective 95% level confidence intervals; 2 outliers (in 1989 and 1997) are highlighted in red. (c) As in (a) with modelled values obtained from the leave-one-out cross validation procedure.

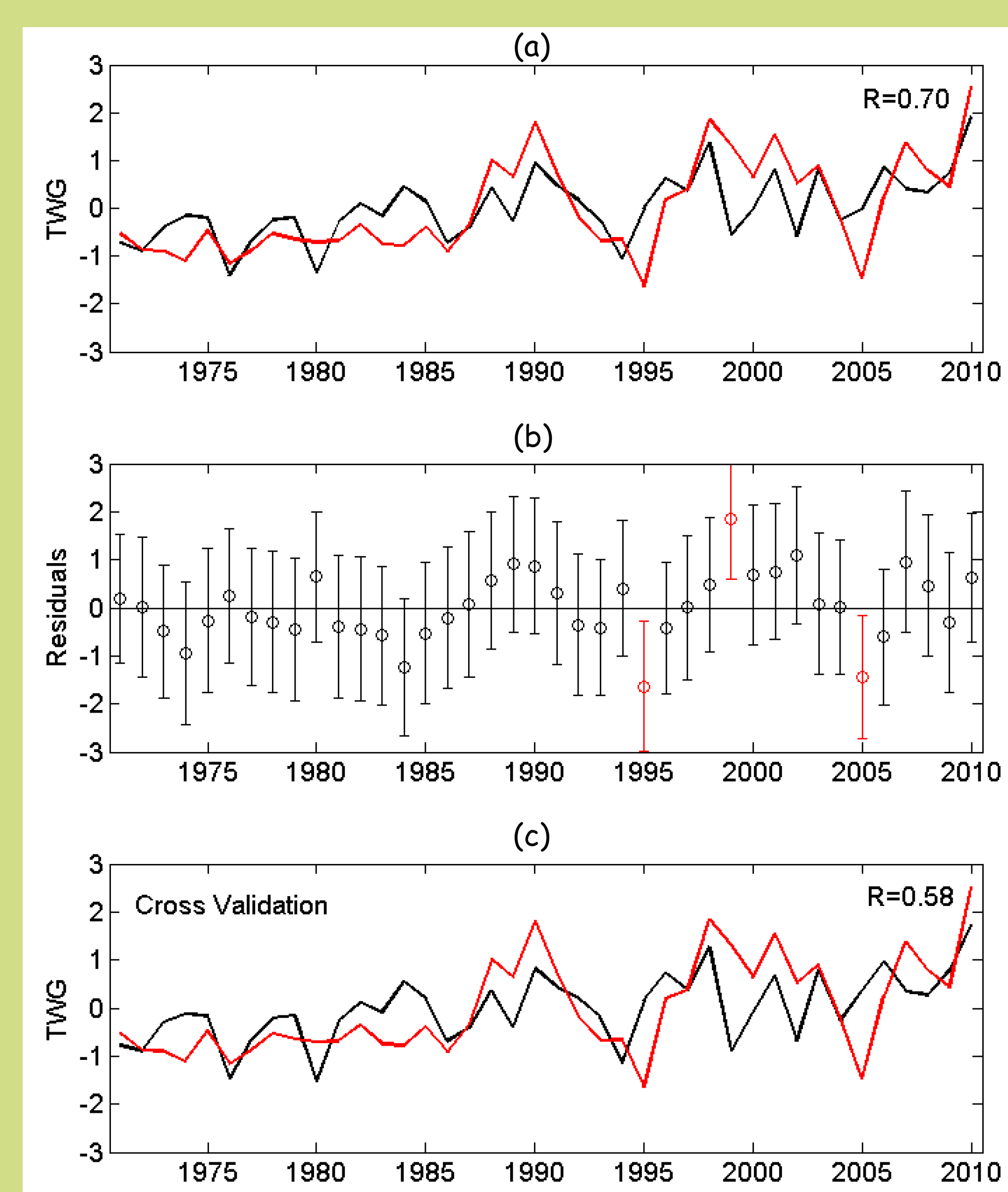

Fig. 4 – As in Fig.3 but using SPEI. Three outliers (in 1995, 1999 and 2005) are highlighted in red.

5. Wood radial growth and SPEI

The regression model for estimates of Pinus Pinaster wood radial growth (TWGS) was also obtained by a stepwise regression approach, performed this time over the SPEI (for the times scales from 1 to 12 months):

$$TWG_S = -0.11 - 0.45 \times SPEI01_{Aug} + 0.61 \times SPEI03_{Jan} + 0.28 \times SPEI03_{Jun} - 0.48 \times SPEI12_{Jan}$$

6. Final Remarks

Both models performed well in terms of robustness and reliability; they are able to explain respectively 85% and 49% of the total variance of TWG (Fig. 3 and 4).

Results from the leave-one-out cross-validation scheme (bottom panel) support the robustness of the regression model, given the slight decrease from the values of R = 0.93 and 0.70 to the values RCV = 0.89 and =0.58 of correlation between the observed time series and the one obtained by cross validation.

Our results reflects the strong impact of changes in maximum and minimum temperature and precipitation on interannual variability of Pinus Pinaster wood radial growth.

References

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Acknowledgments: This work was partially supported by national funds through FCT (Fundação para a Ciência e a Tecnologia, Portugal) under project PIEZAGRO (PTDC/AAG-REC/7046/2014). Ana Russo thanks FCT for the granted support (SFRH/BPD/99757/2014).