Assesing the role of internal variability in regional climate paleosimulations

EGU2011-8294

J. J. Gómez-Navarro*, J. P. Montávez, S. Jerez, P. Jiménez-Guerrero, R. Lorente-Plazas, J. F. González-Rouco, E. Zorita

*Regional Atmospheric Modelling group, Department of Physics, University of Murcia

(Contact: Juan José Gómez Navarro, jjgomeznavarro@um.es)

UNIVERSIDAD DE MURCIA

Abstract

Two high resolution paleoclimate simulation for the last millennium over the Iberian Peninsula have been performed with a climate version of the mesoscale model MM5. The only difference between the simulations is the initial condition in the GCM driving the simulations. Due to internal variability in the model, the evolution of simulations should be independent, unless the external forcings (shared by the two simulations) are capable to connect physically the simulations. Thus, the correlation of variables between simulations permits to assess the relative role of internal variability in the model. Temperature has found to be strongly driven by external forcing, meanwhile precipitation is more affected by internal variability. Only in some areas (different depending on the season) the precipitation seems to respond to the forcing.

1. Introduction

The climatic system can be simulated in past periods through the use of general circulation models (**GCM**). However they involve a huge computational cost, which results in their **coarse spatial resolution**. Regional Climate Models (**RCM**), commonly used in climate change projections, are a powerful tool to improve the spatial resolution, and hence physical realization, of paleoclimate simulations, bridging the gap between models and reconstructions.

However, as the climatic system, the models are affected by **internal variability**, which dominates some aspects of the simulation. It is important to identify at what extent the evolution of a simulation is dominated by this non-forced variability, since the conclusions we can draw from the comparisons of proxy-based reconstructions and models depend on the ratio between forced and non-forced variability.

2. Simulations description

Two 1000 years-long simulations of the last millenium have been performed over the Iberian Peninsula with a spatial resolution of 30 **Km** with a climate version of the mesoscalar model **MM5**.

The model was driven by two respective simulations performed with the general circulation model ECHO-G. The only difference between these two global simulations is the initial condition.

Both GCM simulations (hereafter ERIK1 and ERIK2) were forced equally by reconstructions of several **external factors** such as variations of solar irradiance, the effect of big volcano events and GHGs concentrations.

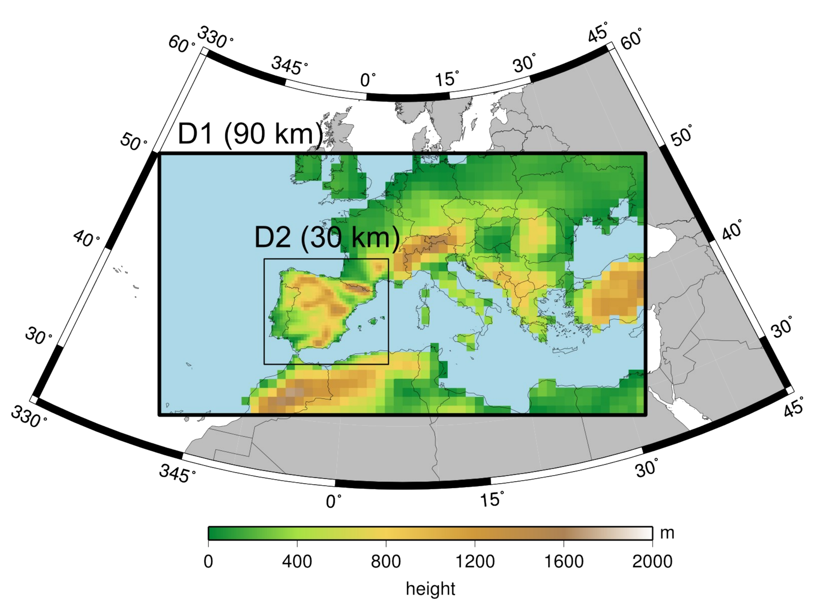

Fig. 1: Two two-way nested domains of 90 and 30 km, respectively, employed in the regional simulations.

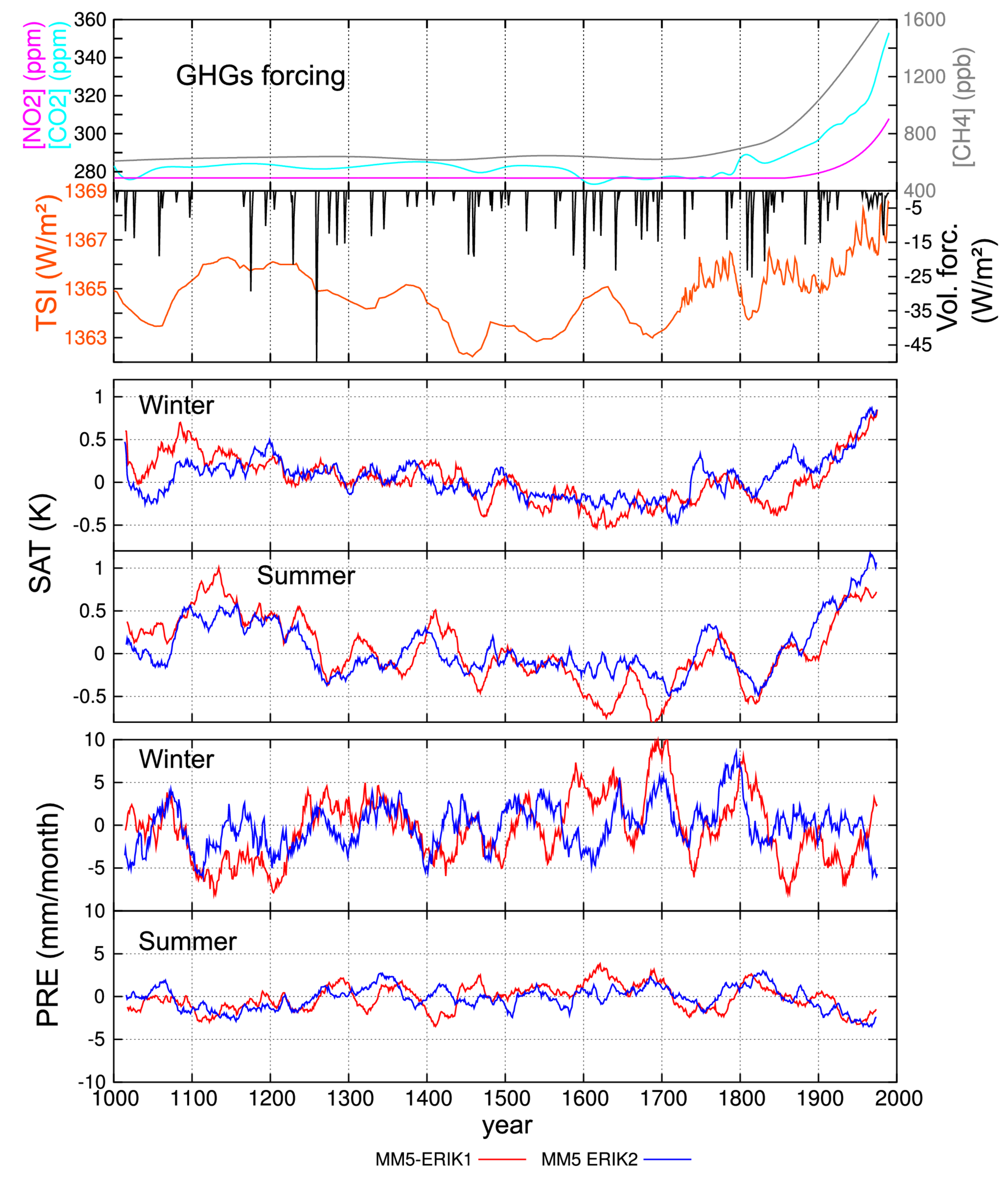

Fig 2: Reconstructions of external forcings employed in the simulations (up). Evolution of the spatial-averaged SAT (middle) and PRE (bottom) for the IP in the two RCM simulations.

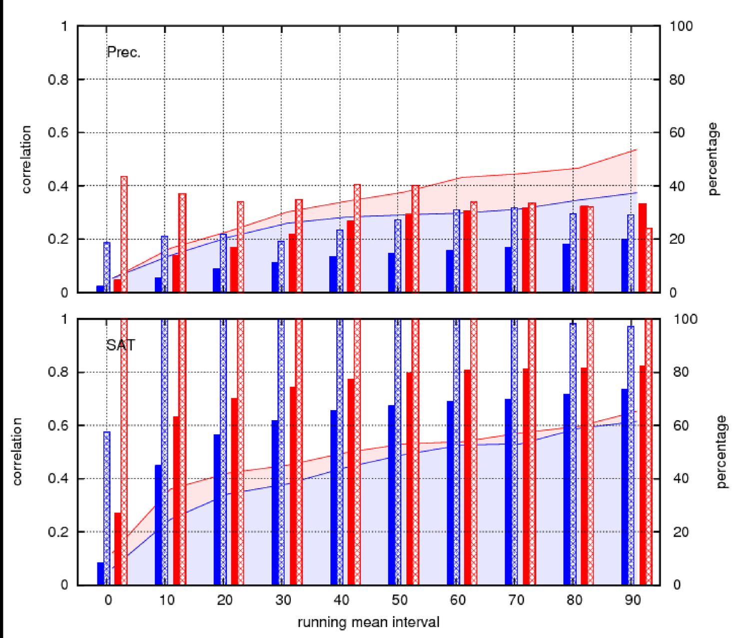

Fig 5: Filled bars represent the spatial-averaged correlation of PRE (up) and SAT (bottom) between the two simulations. Shadows denote the confidence interval (at 95% confidence level). Non-filled bars denote the percentage of grid points whose correlation is significative. The horizontal axis represents several running means used to smooth the series.

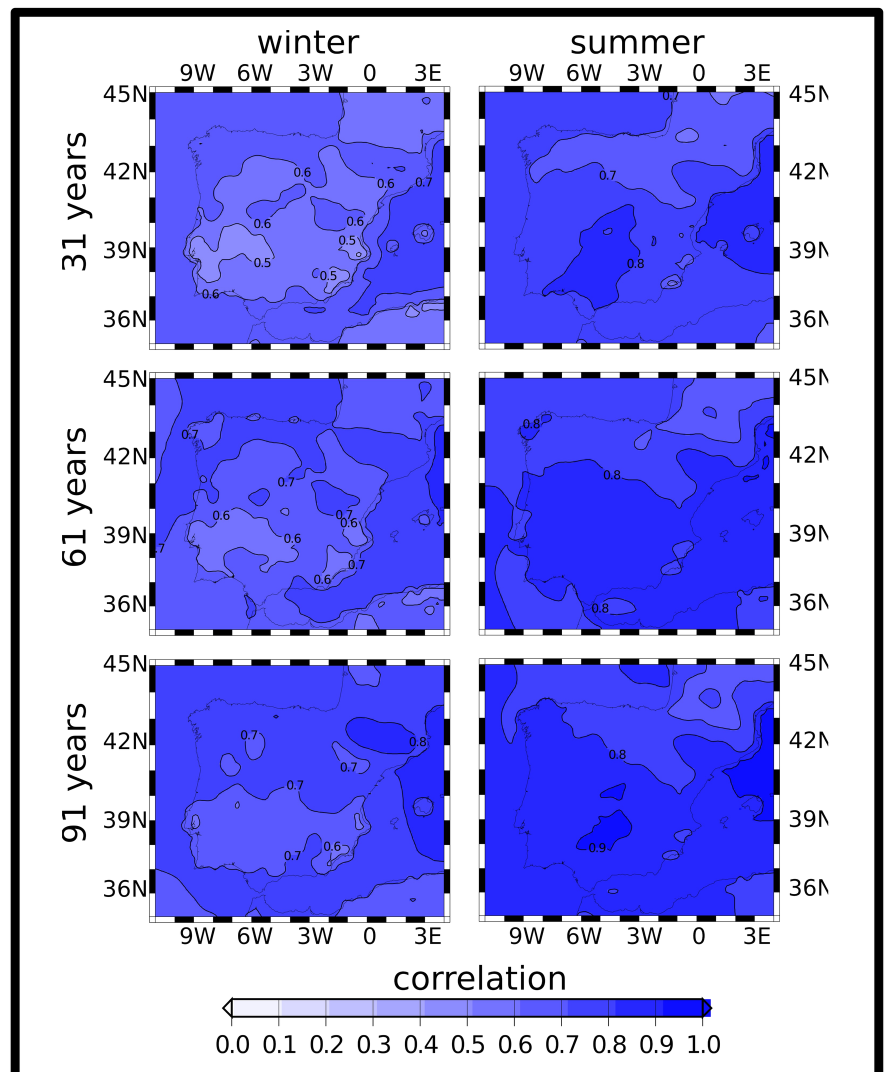

Fig 3: Temporal correlation between T2M in the two simulation using different running means.

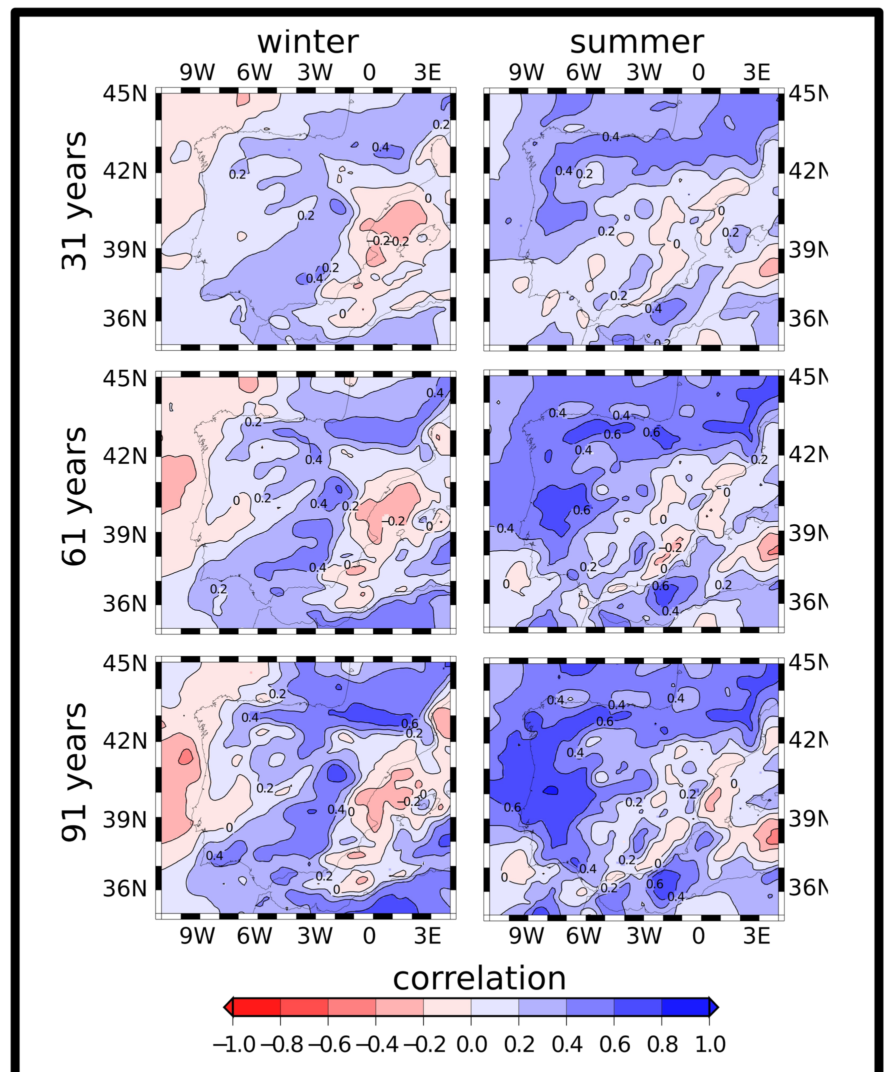

Fig 4: Temporal correlation between PRE in the two simulation using different running means.

3. Results

Top panels of Fig. 2 show the reconstruction of external forcings employed in the simulations (both in the GCM and the RCM). Middle (bottom) panels shows the spatial averaged values of near-surface air temperature (SAT) and precipitation (PRE) for winter and summer, respectively.

SAT seems to be clearly driven by variations in solar constant in some cold periods. In particular, a Little Ice Age (~ 1300-1900) appears in the two simulations. Fig. 3 shows the correlation in each grid point separately, calculated after filtering the series with different running means. Correlation between experiments is strong all over the domain, showingn the strong influence of external forcing in this variable.

PRE is not so clearly driven by external forcing. Fig. 4 is the equivalent to Fig. 3 for PRE. There are only some areas where the correlation is significant. In other areas than these, the evolution of this variable is dominated by non-forced variability (internal variability).

Fig. 5 shows the spatial averages of Figs. 3 and 4 (solid bars) for several running means, as well as the percentage of grid points where the correlation is significative. Althoug the correlation in PRE is not significative in spatial average (coarse resolution), it is in a number of grid points.

4. Conclusions

- The downscaling of two millennial simulations allows to address the relative role of internal variability in climate simulations.
- The evolution of **SAT is driven by the external forcings** (evolution of solar irradiance, volcanic events and GHGs concentrations).
- The evolution of **PRE is strongly governed by non-forced factors** (internal variability).
- There are only some areas (different depending on the season) where PRE is capable of responding to the external forcing. These areas can be identified with the RCM.
- In areas where PRE is dominated by internal variability in the simulation, a comparison with proxy-based reconstrucions is difficult, and a **good temporal agreement between should not be expected, even if the model and the reconstructions were perfect**.