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Assessing the role of internal variability in Regional Climate Paleosimulations

Juan José Gomez-Navarro (1), Juan Pedro Montávez (1), Sonia Jerez-Rodríguez (1), Pedro Jiménez-Guerrero (1), Raquel Lorente-Plazas (1), J. Fidel González-Rouco (2), Eduardo Zorita (3), and Juan Andrés García-Valero (1)

(1) Universidad de Murcia, Murcia, Spain (jjgomeznavarro@um.es), (2) Universidad Complutense de Madrid, Madrid, Spain, (3) Helmholtz-Zentrums Geesthacht, Geesthacht, Germany

In the last years an important effort has been devoted to understand the internal variability and its role in the evolution of the climate in the last millennium. This has allowed to put the short instrumental period in a broader climatic context, and to understand some of the physical mechanisms underlaying the climatic events. These efforts come mainly from two subjects: climate reconstructions based on proxy indicators and climate models. Exercises comparing both approaches are useful to validate the models, as well as some aspects of the techniques employed in the proxy reconstructions.

Regarding the model, the impressive evolution of computing power in the last years has made the use of General Circulation Models (GCMs) possible in order to simulate consistently the climate system for periods of time up to several centuries. Nevertheless, due to the huge computational cost involved, this kind of models implements a too coarse spatial resolution which hampers the reproduction of fine regional characteristics of local climates. This may difficult the comparison of proxy data reconstructions and model simulations. The use of Regional Climate Models (RCM) is a common technique that allows improving the spatial resolution of GCMs, and it is commonly used in climate change projections.

However, an important caveat in the use of models to simulate the past climate is the fact that the model has its own internal variability. For this reason, the evolution of the simulated climate has an important charge of uncertainty. In particular, it is not easy to assess whether a simulated cold period is driven by variations in the external forcings (and thus it makes sense when compared with proxy reconstructions) or simply due to a random fluctuation of the simulation. Regarding this issue, ensembles of simulations may help to assess the internal variability of models. However this kind of ensembles are rare nowadays due to the huge computational cost involved.

In this study we present a comparison between two simulations of the past climate performed with a climate version of the regional model MM5. The model domain covers the Iberian Peninsula with a spatial resolution of 30km. Both RCM simulations are driven by paleoexperiments, ERIK1 and ERIK2, performed with the GCM model ECHO-G for the last millennium. Both simulations were forced by the same reconstructions of the evolution of solar power, big volcano events and evolution in the concentration of greenhouse gases. The only difference between the two simulations is therefore the initial condition in the GCM. This leads nevertheless to a different evolution of the simulated climate, due to the internal variability of the model.

The intercomparison between the two simulations depicts a number of cold and warm periods that are simultaneous in both experiments; these periods match with some well known cold periods, such as the Maunder Minimum. This good fit supports the idea that models are capable to reproduce some of the physical processes leading to recent past climate events. There are nevertheless other periods when the match is not so good. The degree of agreement between the simulations can be used to assess the role of the internal variability in the simulation, and allow to identify in which areas its influence governs the simulation. In these areas, a good agreement between the model and the proxy records should not be expected.