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A statistics-based validation of the Whole-Atmosphere Community Climate Model (WACCM) results against the ERA-40 reanalysis data: highlights of the Detrended Fluctuation Analysis (DFA)

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Global circulation models (GCMs) are currently considered as feasible tools to describe the complexity of atmospheric variability and climate evolution on a global scale. However, the large number of existing models shows a wide spectrum of approaches and results, as shown by the intercomparison project of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4).

In this work, a comparison was done of the output obtained with the NCAR Whole-Atmosphere Community Climate Model (WACCM) against the reanalysis products of the European Centre for Medium-Range Weather Forecasts (ERA-40) (from the ECMWF three-dimensional assimilation system based on satellite, radiosondes and other conventional observations). The WACCM simulations were performed by NCAR in a parallel high-performance computing infrastructure, the MareNostrum supercomputer hold by the BSC-CNS. Model outputs are available for the period 1950-2003 at 2x2.5 degrees resolution over 66 vertical pressure levels, but comparisons could only focus on the period 1957-2002 due to the restricted availability of the ERA-40 re-analysis products, obtained at 2.5x2.5 degrees horizontal resolution at 23 pressure levels.

Statistical comparisons are performed in global and regional scales for sea level pres-

sure and latent heat flux at several time scales in order to assess the behavior of the WACCM model in different regions worldwide. Root Mean Square Error (RMSE) and bias computations with respect to ERA-40 and the Detrended Fluctuation Analysis (DFA) methodology were used, and averaged values were analyzed for different seasons and regions over distribution maps. The DFA methodology was included for time series analysis because its ability to filter spurious noise of unknown origin, with the intent to view the results under a different point of view with respect to that of traditional EOF or Wavelets normally used in climate sciences. Moreover, through the use of Taylor diagrams, we quantify and discuss the performance of the model simulated patterns in terms of standard deviation, centered RMSE and their correlations as an evaluation tool for the DFA results.

It emerges that the DFA methodology can provide the same information given by the Taylor diagram analysis on the correlation among climate data, but adding knowledge on how the errors change over different time-scaling regions of very large time series. Under the more physical point of view, the global behavior of the WACCM model is accurate when compared to ERA-40 re-analysis in terms of low bias and RMSE for sea level pressure and latent heat, and very high correlations appear (r around 0.95).