Geophysical Research Abstracts
Vol. 16, EGU2014-13893, 2014
EGU General Assembly 2014
© Author(s) 2014. CC Attribution 3.0 License.

Scaling fluctuation analysis of forcings and outputs of a simplified last millennium climate model

Shaun Lovejoy (1) and Costas Varotsos (2)

(1) McGill University, Department of Physics, Montreal, Canada (lovejoy@physics.mcgill.ca, +1-(0)514-3988434), (2) Physics department, University of Athens, Greece

Existing climate models are essentially weather models with extra couplings, coarser resolutions and different parametrisations. The model climate is the state to which averages of model outputs will converge for fixed atmospheric compositions and boundary conditions. By changing these, the climate is forced, climate change is thus viewed as the response of the models to "climate forcings". Over the pre-industrial last millennium, the main forcings are volcanic and solar, however – at least for sunspot based solar reconstructions - the statistical character of the these forcings are opposite: the volcanic forcings can be very strong at short time scales, but decrease (in a scaling manner, exponent $\approx$ -0.4), whereas on the contrary, the solar forcings increase with time scale (exponent $\approx$ 0.4). However, multiproxy series show that fluctuations in temperatures start to increase at centennial and millennial scales (exponent $\approx$ 0.4), and it is therefore unlikely that this can be explained by volcanic forcings. In comparison, although the solar forcings do increase with scale, they remain small.

In accord with the forcing statistics, recent results from the GISS ER2 climate model display overly weak centennial and longer variability, but performing large numbers of runs is expensive: it is of interest to consider the response of simplified climate models. In this presentation, we analyze the outputs of the Zebiak–Cane model for the coupled ocean–atmosphere system in the tropical Pacific. Large numbers of realizations were obtained by Mann et al. (2005), and we used scaling fluctuation analysis based on Haar fluctuations to quantify the temporal scale dependence with and without (reconstructed) solar and volcanic forcings. Our results are compared with the GISS-ER2 outputs and with multiproxy variability. At scales less than about 100 years, the Zebiak–Cane responses to volcanic forcings is much weaker than the GISS ER2 volcanic only response and is not far from the data. In comparison, the solar only model responses are quite similar to each other. At centennial and longer scales, the models agree well with each other, but are too weak with respect to the multiproxies.

These results suggest that at centennial and longer scales, new slow climate processes become important, these likely include biogeochemical processes, although other candidates include land ice or deep ocean currents.