Comment on "Volcanic forcing improves atmosphere–ocean coupled general circulation model scaling performance" by D. Vyushin, I. Zhidkov, S. Havlin, A. Bunde, and S. Brenner

R. Blender and K. Fraedrich

Zentrum für Marine und Atmosphärische Wissenschaften, Universität Hamburg, Hamburg, Germany

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[1] *Vyushin et al.* [2004] compare the scaling of the low frequency variability (LFV) in near surface air temperature in observations and atmosphere-ocean general circulation model (AOGCM) simulations. The authors analyze ensemble simulations using ten different combinations of historic greenhouse gases, ozone, sulfate, solar and volcanic forcings. Vyushin et al. claim that the inclusion of volcanic forcing improves the LFV scaling compared to all other forcings leading to the observed scaling. In this comment we present reasons, which question the major result of this publication.

[2] Our arguments are based on recent research on temperature LFV in observations (single stations, HadCRUT [*Jones et al.*, 2001] and NCEP [*Kalnay et al.*, 1996]) and AOGCM simulations (several control runs, up to 1000 years, and two different scenario simulations):

[3] First, the global LFV shows a broad distribution, with approximate $1/f$ noise on the oceans and white spectra on the inner continents. In wide areas along the coasts there is a range of spectral exponents $\beta = 0.2\ldots0.4$, in $S(f) \sim f^{-\beta}$ (corresponding to the fluctuation exponent $\alpha = 0.6\ldots0.7$, based on $\alpha = (1+\beta)/2$) [*Fraedrich and Blender*, 2003]. In these regions the majority of observational stations is located. These results have been substantiated independently in a detailed study at stations on the Australian continent [*Pattantyús-Ábrahám et al.*, 2004]. Therefore, the particular value $\alpha = 0.65$ in Figure 3, coined 'universal' previously [*Koscielny-Bunde et al.*, 1998], is not qualified as a reference value.

[4] Second, AOGCMs reproduce the observed LFV quantitatively [*Fraedrich and Blender*, 2003]. This is valid for control runs without external forcing as well as scenario simulations with greenhouse gas forcing [*Blender and Fraedrich*, 2003]. The only necessary ingredient for LFV in AOGCMs is a complex dynamic ocean model [*Fraedrich and Blender*, 2003]. For the oceanic $1/f$ noise a theory is proposed [*Fraedrich et al.*, 2004].

[5] Third, the uncertainty of the fluctuation exponent is at least about 0.05 [*Fraedrich and Blender*, 2003]. This value is estimated locally for each grid point from an ensemble of time segments of 100 years in a 1000 years simulation. A further contribution to the uncertainty stems from the variation of the exponents across the coasts and the coarse resolution of numerical models, which is not sufficient to resolve these gradients. Both contributions comprise the uncertainty of the exponents so that interpretation of model simulations has to be performed carefully.

[6] Given these results, shortcomings of the investigation by Vyushin et al. become evident. A first issue is that the authors compare a too small number of stations/model areas with an inappropriate reference. Also, they present only an averaged result for the North Atlantic, while LFV in this area shows a pronounced structure with large deviations from the mean. In addition, there is no continental station that could show the lack of long term memory, $\beta \approx 0$ [*Fraedrich and Blender*, 2004; *Pattantyús-Ábrahám et al.*, 2004]. That is, for a comprehensive comparison between models and observations a global analysis is required.

[7] In summary, the data presented by Vyushin et al. do not allow to conclude that the volcanic forcing improves the scaling performance of atmosphere-ocean models. This comment does not advocate neglecting volcanic forcing in climate models but, to simulate the observed low frequency variability, this is not required.

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R. Blender and K. Fraedrich, Zentrum für Marine und Atmosphärische Wissenschaften, Bundesstrasse 55, Universität Hamburg, D-20146 Hamburg, Germany. (blender@dkrz.de)

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