

## ***Interactive comment on “Do GCM’s predict the climate... or macroweather?” by S. Lovejoy et al.***

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This is an excellent, much needed assessment of the ability of multi-decadal climate models to accurately simulate climatic conditions on this time scale.

As I wrote in my paper

Pielke, R.A., 1998: Climate prediction as an initial value problem. Bull. Amer. Meteor. Soc., 79, 2743-2746

“weather prediction is a subset of climate prediction and that both are, therefore, initial value problems in the context of nonlinear geophysical flow.”

and

“...longer-term feedback and physical processes must be included. This makes climate prediction a much more difficult problem than weather prediction”.

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In our paper

Rial, J., R.A. Pielke Sr., M. Beniston, M. Claussen, J. Canadell, P. Cox, H. Held, N. de Noblet-Ducoudre, R. Prinn, J. Reynolds, and J.D. Salas, 2004: Nonlinearities, feedbacks and critical thresholds within the Earth's climate system. *Climatic Change*, 65, 11-38

we concluded that

"The Earth's climate system is highly nonlinear: inputs and outputs are not proportional, change is often episodic and abrupt, rather than slow and gradual, and multiple equilibria are the norm."

With respect to what the authors refers to as "macroweather", however, there remain major issues with the ability of climate models to skillfully simulate the real world climate system. Examples of papers that document this limitation include

1. Fyfe, J. C., W. J. Merryfield, V. Kharin, G. J. Boer, W.-S. Lee, and K. von Salzen (2011), Skillful predictions of decadal trends in global mean surface temperature, *Geophys. Res. Lett.*,38, L22801, doi:10.1029/2011GL049508

who concluded that

"...for longer term decadal hindcasts a linear trend correction may be required if the model does not reproduce long-term trends. For this reason, we correct for systematic long-term trend biases."

2. Xu, Zhongfeng and Zong-Liang Yang, 2012: An improved dynamical downscaling method with GCM bias corrections and its validation with 30 years of climate simulations. *Journal of Climate* 2012 doi: <http://dx.doi.org/10.1175/JCLI-D-12-00005.1>

who find that without tuning from real world observations, the model predictions are in significant error. For example, they found that

"...the traditional dynamic downscaling (TDD) [i.e. without tuning] overestimates pre-

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precipitation by 0.5-1.5 mm d-1.....The 2-year return level of summer daily maximum temperature simulated by the TDD is underestimated by 2-6°C over the central United States-Canada region."

3. van Oldenborgh, G.J., F.J. Doblas-Reyes, B. Wouters, W. Hazeleger (2012): Decadal prediction skill in a multi-model ensemble. *Clim.Dyn.* doi:10.1007/s00382-012-1313-4

who report quite limited predictive skill in two regions of the oceans on the decadal time period, but no regional skill elsewhere, when they conclude that

"A 4-model 12-member ensemble of 10-yr hindcasts has been analysed for skill in SST, 2m temperature and precipitation. The main source of skill in temperature is the trend, which is primarily forced by greenhouse gases and aerosols. This trend contributes almost everywhere to the skill. Variation in the global mean temperature around the trend do not have any skill beyond the first year. However, regionally there appears to be skill beyond the trend in the two areas of well-known low-frequency variability: SST in parts of the North Atlantic and Pacific Oceans is predicted better than persistence. A comparison with the CMIP3 ensemble shows that the skill in the northern North Atlantic and eastern Pacific is most likely due to the initialisation, whereas the skill in the subtropical North Atlantic and western North Pacific are probably due to the forcing."

4. Anagnostopoulos, G. G., Koutsoyiannis, D., Christofides, A., Efstratiadis, A. & Mammassis, N. (2010) A comparison of local and aggregated climate model outputs with observed data. *Hydrol. Sci. J.* 55(7), 1094–1110

who report that

".... local projections do not correlate well with observed measurements. Furthermore, we found that the correlation at a large spatial scale, i.e. the contiguous USA, is worse than at the local scale."

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5. Stephens, G. L., T. L'Ecuyer, R. Forbes, A. Gettleman, J. ÅrC. Golaz, A. BodasÅRSalcedo, K. Suzuki, P. Gabriel, and J. Haynes (2010), Dreary state of precipitation in global models, J. Geophys. Res., 115, D24211, doi:10.1029/2010JD014532.

who wrote

"models produce precipitation approximately twice as often as that observed and make rainfall far too lightly.....The differences in the character of model precipitation are systemic and have a number of important implications for modeling the coupled Earth system .....little skill in precipitation [is] calculated at individual grid points, and thus applications involving downscaling of grid point precipitation to yet even finerÅRscale resolution has little foundation and relevance to the real Earth system."

I had an informative and effective exchange of the first author, and I posted on my weblog in the post - Excellent New Paper "The Climate Is Not What You Expect" By Lovejoy and Schertzer 2012 [<http://pielkeclimatesci.wordpress.com/2012/06/29/new-paper-the-climate-is-not-what-you-expect-by-lovejoy-and-schertzer-2012/>].

The current paper under discussion will add very significantly to this discussion. My only substantive disagreement is with the conclusion in the paper that

"....we show that control runs only reproduce macroweather".

As illustrated by the papers I presented earlier in this comment, the models do not accurately simulate even "macroweather".

Indeed, the use of the multi-decadal climate models to skillfully project (predict) the effects of anthropogenic climate change have an even higher bar to pass. They must not only

i) skillfully the statistics of the current climate,

but also

ii) skillfully simulate the changes in climate statistics over the modelled time period.

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Certainly on the regional scale [which is by far the most important in terms of impacts to the environment and society] these models have shown little if any skill when run in a hindcast mode.

We discuss this challenge, for example, in our paper

Pielke Sr., R.A., and R.L. Wilby, 2012: Regional climate downscaling – what's the point? *Eos Forum*, 93, No. 5, 52-53, doi:10.1029/2012EO050008. <http://pielkeclimatesci.files.wordpress.com/2012/02/r-361.pdf>

and in a set of weblog posts [<http://pielkeclimatesci.wordpress.com/?s=cmip5>].

My only recommendation for the authors before final acceptance, is a discussion of these issues.

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Interactive comment on *Earth Syst. Dynam. Discuss.*, 3, 1259, 2012.

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