

# Final comment on low frequency linearity, nonlinearity

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Any readers who have followed the exchange of our opinion (<http://www.earth-syst-dynam-discuss.net/esd-2016-10/esd-2016-10-SC1-supplement.pdf>, <http://www.earth-syst-dynam-discuss.net/esd-2016-10/esd-2016-10-SC2-supplement.pdf>, <http://www.earth-syst-dynam-discuss.net/esd-2016-10/esd-2016-10-SC3-supplement.pdf>) with those of Rypdal and Rypdal (2016a-e) (R+R, below) up to this point will have noticed that the linearity check, which was the main focus of R+R (2016a), fails since we showed (in SC3) that for scales up to  $10^{1.7} \approx 50$  years the RMS structure function of  $T_{s+v} - T_s - T_v$  (either for the first 195 years or for the whole study period) never exceeds  $\sqrt{3}\Delta E$  (as suggested by R+R, 2016a) but rather remains close to  $\sqrt{2}\Delta E$ . Notably, R+R (2016e) did not explain this failure.

We take their AC3 response (R+R, 2016c), - the analysis of a completely different set of model runs (NorESM) – to be an indirect admission that our original paper was correct. If one day this new analysis of new model outputs is published in the peer reviewed literature, it could be a useful contribution to our understanding of approximate linearity in nonlinear climate models, but would not in any case invalidate the published analyses of the different model outputs in Lovejoy and Varotsos (2016).

## References:

- Lovejoy, S., and C. Varotsos (2016), Scaling regimes and linear/nonlinear responses of last millennium climate to volcanic and solar forcings, *Earth Syst. Dynam.*, 7, 1–18, doi:10.5194/esd-7-133-2016.
- Rypdal, K., and M. Rypdal (2016a), Comment on “Scaling regimes and linear/nonlinear responses of last millennium climate to volcanic and solar forcings” by S. Lovejoy and C. Varotsos, *Earth Syst. Dynam. Discuss.*, doi:10.5194/esd-2016-10, 2016.
- Rypdal, K., and M. Rypdal (2016b), Interactive comment on “Comment on "Scaling regimes and linear/nonlinear responses of last millennium climate to volcanic and solar forcing" by S. Lovejoy and C. Varotsos” by K. Rypdal and M. Rypdal, *Earth Syst. Dynam. Discuss.*, doi: 10.5194/esd-2016-10-AC1, 2016.
- Rypdal, K., and M. Rypdal (2016c), Interactive comment on “Comment on "Scaling regimes and linear/nonlinear responses of last millennium climate to volcanic and solar forcing" by S. Lovejoy and C. Varotsos” by K. Rypdal and M. Rypdal, *Earth Syst. Dynam. Discuss.*, doi:10.5194/esd-2016-10-AC2, 2016.
- Rypdal, K., and M. Rypdal (2016d), Interactive comment on “Comment on "Scaling regimes and linear/nonlinear responses of last millennium climate to volcanic and

solar forcing" by S. Lovejoy and C. Varotsos" by K. Rypdal and M. Rypdal, Earth Syst. Dynam. Discuss., doi:10.5194/esd-2016-10-AC3, 2016.

Rypdal, K., and M. Rypdal (2016e), Interactive comment on "Comment on "Scaling regimes and linear/nonlinear responses of last millennium climate to volcanic and solar forcing" by S. Lovejoy and C. Varotsos" by K. Rypdal and M. Rypdal, Earth Syst. Dynam. Discuss., doi:10.5194/esd-2016-10-AC4, 2016.