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Using Scaling for accurate stochastic macroweather forecasts (including the “pause”)

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At scales corresponding to the lifetimes of structures of planetary extent (about 5 - 10 days), atmospheric processes undergo a drastic “dimensional transition” from high frequency weather to lower frequency macroweather processes. While conventional GCM’s generally well reproduce both the transition and the corresponding (scaling) statistics, due to their sensitive dependence on initial conditions, the role of the weather scale processes is to provide random perturbations to the macroweather processes.
The main problem with GCM’s is thus that their long term (control run, unforced) statistics converge to the GCM climate and this is somewhat different from the real climate. This is the motivation for using a stochastic model and exploiting the empirical scaling properties and past data to make a stochastic model. It turns out that macroweather intermittency is typically low (the multifractal corrections are small) so that they can be approximated by fractional Gaussian Noise (fGN) processes whose memory can be enormous. For example for annual forecasts, and using the observed global temperature exponent, even 50 years of global temperature data would only allow us to exploit 90% of the available memory (for ocean regions, the figure increases to 600 years).
The only complication is that anthropogenic effects dominate the global statistics at time scales beyond about 20 years. However, these are easy to remove using the CO_2 forcing as a linear surrogate for all the anthropogenic effects.
Using this theoretical framework, we show how to make accurate stochastic macroweather forecasts. We illustrate this on monthly and annual scale series of global and northern hemisphere surface temperatures (including nearly perfect hindcasts of the “pause” in the warming since 1998). We obtain forecast skill nearly as high as the theoretical (scaling) predictability limits allow. These scaling hindcasts – using a single effective climate sensitivity and single scaling exponent are already more accurate (have smaller RMS errors) than existing GCM’s over the 1 – 10 year range. At annual scales they are almost as accurate as the (stochastic) Linear Inverse Modelling (LIM) approach (with hundreds of parameters) and are more accurate than LIM for scales beyond three years or so.