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Scaling linear Inverse Models (SLIM) for regional macroweather forecasting and the development of Global Macroweather Models (GMM's)

Lenin Del Rio Amador, Shaun Lovejoy, Raphael Hebert, and Norberto Majdis
Physics department, McGill University, Montreal (QC), Canada (delrio@physics.mcgill.ca)

By using slightly different initial conditions, and exploiting the sensitive dependence on initial conditions, GCM's generate a statistical ensemble of future states. The high frequency "weather' is essentially treated as a source of noise. This has lead to attempts to directly generate the noise and the low frequencies that they force using stochastic models, the most well known are the linear inverse models (LIM). These have been presented as a benchmark for decadal surface temperature forecast. Using the LIM, some authors have obtained hindcast skill comparable to and sometimes even better than skill of the phase 5 of the Coupled Model Intercomparison Project (CMIP5). Nevertheless, the exponential decorrelation in time of the LIM models is not only quite unrealistic (the true decorrelations are power laws), but also – as a consequence - limits its useful forecast horizon to roughly one year: it enormously underestimates the memory of the system.

In this work we make a scaling analogue of the LIM: Scaling Linear Inverse Modelling (SLIM) that exploits the power law (scaling) behavior in time of the temperature field and consequently, make use of the long history dependence of the data to improve the skill. When applied to macroweather time scale range (from 10 days to 100 years) this allows us to achieve skills much better than those reported previously using LIM or different GCM's. The SLIM model is the predictive component of a new Global Macroweather Model (GMM) currently under development at McGill.

The prototype SLIM divides the planet into 10º x 10º regions from -70º to 70º latitude and analyzes the temperature series for each region. As a first step, we removed the anthropogenic component of each time series based on its sensitivity to equivalent CO_2 concentration for the last 130 years, the residue is our estimate of the natural variability that SLIM predicts. The parameters of the model can be obtained directly from the actual data. We report maps of theoretical skill predicted by the model and we compare it with actual skill based on hindcasts for some regions of interest. A comparison between our results and previous results using LIM or other GCM's is also shown. We also studied the interconnection between different regions and how they can mutually affect the corresponding predictability.