What is the climate?

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In spite of the rapid growth of climate change science, there is still no agreed-upon objective definition of its subject. The usual idea– that the climate is simply long term average weather – is untenable since it involves a subjective averaging scale and because it implies that there are no qualitatively new - and eventually dominant - sources of low frequency variability.

Using data from meteorological reanalyses, in situ networks, aircraft, multiproxies and paleotemperatures, we update a 25 year-old model in which atmospheric fluctuations follow three scaling regimes. In the first, fluctuations increase with scale out to about 10 days (τ_w), in the second, they decrease out to ≈ 10 - 30 years (τ_c), after which in the third they again increase out to ≈ 50-100 *kyrs*. While the high frequency regime is the weather, the intermediate regime is merely "low frequency weather" – its statistics are predicted both by stochastic cascade models and by GCM's. Only the lowest frequency regime at time scales $>\tau_c$ represents the true climate. Whereas τ_w is the scale of a "dimensional transition" – the quenching of the spatial degrees of freedom at the lifetime of planetary structures - τ_c marks the beginning of the dominance of new climate forcings and/or new mechanisms of internal variability. These scaling regimes can be used as the basis for objective definitions of climate states (averages up to τ_c), and of climate change (the lower frequency fluctuations in the climate states).

Finally, we discuss whether Global Climate Models predict the climate or only low frequency weather, and we examine the implications of this for global warming.