Abstract: Prevailing definitions of climate are not much different from "the climate is what you expect, the weather is what you get". Using a variety of sources including reanalyses and paleo data, and aided by notions and analysis techniques from Nonlinear Geophysics, we argue that this dictum is fundamentally wrong. In addition to the weather and climate, there is a qualitatively distinct intermediate regime extending over a factor of ≈ 1000 in scale. For example, mean temperature fluctuations increase up to about 5 K at 10 days (the lifetime of planetary structures), then decrease to about 0.2 K at 30 years, and then increase again to about 5 K at glacial-interglacial scales.

Both deterministic GCM's with fixed forcings ("control runs") and stochastic turbulence-based models reproduce the first two regimes, but not the third. The middle regime is thus a kind of "macroweather" not "high frequency climate". Averaging macroweather over periods increasing to ≈ 30 yrs yields apparently converging values: macroweather is "what you expect". Macroweather averages over ≈30 years have the lowest variability, they yield well defined "climate states" and justify the otherwise ad hoc "climate normal" period. However, moving to longer periods, these states increasingly fluctuate: just as with the weather, the climate changes in an apparently unstable manner; the climate is not what you expect. Similarly, we may categorize climate forcings according to whether their fluctuations decrease or increase with scale and this has important implications for GCM's and for climate change and climate predictions.