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Characterising the dynamical regimes of the global atmospheric circulation using local predictability and persistence measures

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An idealized view of the global atmospheric circulation is the flow arising from a three-way interaction between a simplified Hadley cell, midlatitude zonal jet streams and baroclinically unstable Rossby waves (eddies). Idealized models which resolve these interactions show three main kinds of equilibrated jet streams- a thermally driven subtropical jet, an eddy driven jet, and a merged thermally-eddy driven jet. These regimes differ in the location and variability of the jet stream, as well as in the structure, zonal wavenumber and phase speed of the dominant modes. Many features of this classification carry over to the real atmosphere, for example, the North Atlantic shows many characteristics of an eddy driven jet regime while the North Pacific shows characteristics of a merged jet regime. The Southern Hemisphere summer jet is characteristic either of an eddy driven or a merged jet regime.

Viewing atmospheric flows as a chaotic evolution on an atmospheric attractor, it has recently been shown that each point on the attractor can be characterised by a local dimension - indicative of the predictability of that particular state - and a localised measure of persistence. Moreover, extreme values of the local dimension and persistence correspond to specific atmospheric patterns, and match extreme weather occurrences.

In this talk we examine whether the distributions and abrupt large changes in these measures are indicative of the dynamical regime of the global atmospheric circulation by applying these diagnostic to a set of runs of an idealized model. By gradually varying two external parameters which control the degree of instability of the midlatitude eddies, the equilibrated state of the model varies from a subtropical to a merged to an eddy driven jet, as the eddies become stronger. We find that the different dynamical regimes are characterised by different distributions of localised dimension and persistence. Moreover, these distributions are quite different when calculated from the zonal mean flow or the full 3-D flow in a manner consistent with the dynamical behavior of the jet stream and eddies in each of these regimes. We also find a temporary change in the values and variability of the localised dimension and persistence, in the few runs in which the flow undergoes dynamical regimes transitions. Finally, we apply these diagnostics to the observed zonal mean wind in the Southern Hemisphere to study interannual changes in the circulation regime during summer.