Indicators of midlatitude atmospheric flow transitions

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The existence of persistent midlatitude atmospheric flow regimes with time-scales larger than 5–10 days and indications of preferred transitions between them motivates to develop early warning indicators for such regime transitions. In this talk, I will present results from a hemispheric atmospheric flow model together with estimates of transfer operators on a reduced phase space to develop an early warning indicator of a zonal to blocked flow transition. It is shown that the spectrum of the transfer operators can be used to study the slow dynamics of the flow as well as the non-Markovian character of the reduction. The slowest motions are thereby found to have time scales of 3–6 weeks and to be associated with meta-stable regimes (and their transitions) which can be detected as almost-invariant sets of the transfer operator. From the energy budget analysis of the model, we are able to explain the meta-stability of the regimes and the existence of preferred transition paths. Even though the model captures only a limited number of atmospheric processes, the skill of the early warning indicator is promising, suggesting that the transfer operator approach can be used to assess forecast uncertainty.