Untangling subtropical dynamics and predictability in wave space

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Understanding the complex, multiscale nature of atmospheric variability, both in space and time, necessitates simplifications of the governing equations. Linearization of the primitive equations on the sphere reveals two main dynamical regimes of horizontally-propagating waves, characterized as eastward- and westward-propagating inertia-gravity waves (fast regime) and Rossby waves (slow regime), along with special tropical solutions, namely Kelvin waves and mixed Rossby-gravity (MRG) waves. These two special solutions complicate the time-scale separation between slow and fast regimes in the tropics, as well as the distinction between waves and coherent flows in observations and models. Physical processes, especially convection, and their interactions with wave flows further challenge our ability to provide causal accounts of observed and simulated variability. Large-scale equatorial waves have been argued to affect, among other things, extratropical predictability. However, details of this process remain to be understood. This involves an understanding of wave-wave and wave-mean interactions in the subtropics using numerical modelling and diagnostic tools. In this seminar, I will discuss the use of linear wave theory on the sphere in the formulation of the Transient Inertia-Gravity And Rossby wave dynamics model (TIGAR) by my group at the University of Hamburg. In TIGAR, each wave is treated as a prognostic variable, analogous to how the stream function represents Rossby waves in quasi-geostrophic models. I will present recent results using the new model regarding subtropical processes, which are relevant for understanding tropical and extratropical predictability.