Diurnal forcing, trapped waves, and the meridional extent of the tropics.

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Abstract:
This talk proposes a dynamical theory explaining the sharp transition between tropics and extra-tropics in terms of the diurnal cycle of thermal forcing by the sun. This transition, at a latitude of 30 degrees, coincides with the outer edge of the Hadley cells, and is marked by a steep jump in the height of the troposphere, from fifteen kilometers in the tropics to nine in the mid and high latitudes. The tropics, equatorwards of 30 degrees, are characterized by easterly surface winds -the Trades- and a strong diurnal signal in the wind, pressure and temperature, often marked by regular daily storms in the rainy season. Polewards of 30 degrees, the winds are westerly, and the weather systems have longer spatio-temporal scales.

All of this behavior can be explained in terms of diurnal waves, created by thermal forcing and trapped equatorwards of 30 degrees by the Coriolis effect. These create - in a dynamical model of starting from a globally uniform atmosphere - regions of enhanced mixing of stratospheric air into the troposphere in the tropics and to the Hadley circulation in a layered shallow-water model. We shall present first simple mathematical model of a forced linear shallow water problem and expand to nonlinear conservation laws with entraining discontinuities at the tropopause (troposphere-stratosphere boundary) and also accounting for the entrainment into the troposphere from the surface boundary layer.

References: