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New Climatological Diagnostics of Midlatitudes Moist Stability

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We describe a technique to simplify our understanding of moist isentropic analyses based on a careful decomposition of the isentropic mass flux joint distribution. Our decomposition splits the joint distribution into directional components according to whether mass fluxes are poleward or equatorward. We apply this decomposition to the mass flux joint distribution computed from ERA40 reanalysis data.

We project the directional components onto dry isentropes and thus obtain a decomposition of the dry isentropic meridional circulation. The resulting projected directional components should be seen as differentiating between moist poleward flows and dry equatorward flows. In midlatitudes, they uncover fluxes that would otherwise be canceled in a dry isentropic average. In particular, we observe that the Ferrel cell represented by directional components reaches all the way to the tropopause and deep within the subtropics.

Simultaneously, our method produces profiles of equivalent potential temperature corresponding to each one of the directional components. The recovered directional equivalent potential temperature profiles show midlatitudes eddies that have a very asymmetrical distribution of moisture. Poleward components are shown to be uniformly moist and equatorward components are shown to be dry in the mid troposphere but moist in the lower troposphere. The difference in equivalent potential temperature between the two directional profiles is large and is on the order of two to three times the equivalent potential temperature standard deviation. This indicates that midlatitudes moist stability can be explained entirely with the poleward profiles of equivalent potential temperature and we show that these profiles are everywhere less stable than profiles obtained from simpler climatological averages. Because these profiles provide more sensitive measures of moist stability, we can determine more clearly whether deep convective adjustments or slantwise convective motions are more likely in different regions.

Finally, we use our technique to explain the connection between surface temperature statistics and midlatitudes moist stability.