# New Developments Related to Gross Moist Stability

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The concept of gross moist stability GMS was invented by Neelin and Held in 1987. GMS is the ratio of the vertically integrated lateral export of moist static energy from a test region divided by some integral measure of the convective strength. In a steady state, the lateral export of this quantity equals its surface flux minus its tropopause flux. Conductive, convective, and radiative fluxes are included and it is assumed that the moist static energy is conserved. Neelin and Held used the vertical convective mass flux as a measure of convective strength. Given a model yielding the value of GMS as a function of environmental conditions, the vertical mass flux (or other measure of convective strength) can be computed. Based on a simple thermodynamic argument, Neelin and Held assumed that the GMS was a decreasing function of sea surface temperature.

We have recently developed an alternative formulation for the GMS in which the moist entropy replaces the moist static energy and the denominator is the vertically integrated moisture convergence. This normalized gross moist stability (NGMS) is multiplied by a constant that non-dimensionalizes it and certain approximations made by Neelin and Held are eliminated such that it is more applicable to the real atmosphere.

Recent field observations of convection in pre-tropical-cyclone convective clusters and corresponding cloud modeling using the weak temperature gradient approximation have led us to a new model for NGMS. We find that two types of convective environments lead to smaller NGMS. Environments that are moist-statically unstable but dry in the middle levels tend to produce convection with bottom-heavy mass flux profiles leading to smaller NGMS. Somewhat surprising is that moister environments with less moist convective instability do the same. The latter situation is particularly interesting in that it can lead to very heavy rainfall and tropical cyclone spin up. Furthermore, low convective instability in the tropics is typically a balanced thermodynamic response to enhanced mid-level vorticity. This has interesting implications for tropical convective dynamics, with corresponding effects on tropospheric moisture and precipitation.