Spatial and temporal variations in cloud-radiation feedbacks and gross moist stability in GFDL AM4 and ERA-Interim

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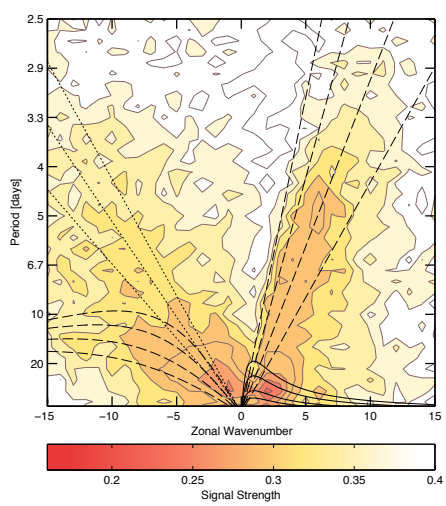
This study investigates spatial and temporal variations of cloud-radiative feedbacks (the ratio between radiative heating and precipitation) and the normalized gross moist stability (NGMS). Multiple simulations of varying complexity from version 4 of GFDL's Atmospheric Model (AM4) with fixed sea surface temperatures are used, in addition to daily data from ERA-Interim. On the basis of spectral and linear regression analysis, it is found that longwave-radiative feedbacks per unit of precipitation are strongest at the largest scales and at the lowest frequencies. Conversely, the normalized gross moist stability is smallest at the largest scales and the lowest frequencies. This relationship is consistent across all model simulations and in reanalysis. Some differences are found, however, in the average magnitude of the two fields. It is hypothesized that variations in cloud-radiation feedbacks may be related to variations in the morphology of convection across spatial and temporal scales. Variations in NGMS are found to be related to the profile of vertical velocity, consistent with the framework of Kuang (2011). Implications for convectively coupled equatorial waves and the Madden-Julian Oscillation will be discussed.



Signal strength of symmetric ERA-Interim NGMS averaged over the 10°N/S latitude belt. The MJO-related dispersion curves (solid lines) correspond to those presented in Adames and Kim (2016). Dispersion curves are also plotted for Kelvin and Equatorial Rossby (dashed lines). Dotted lines indicate constant phase speeds of 7.0, 9.0, and 11 m s^{-1}, which are representative of westward-propagating TD and easterly waves. Contour interval is every 0.05 signal strength fraction beginning at 0.55.

Reference:
Kuang, Z., 2011: The Wavelength Dependence of the Gross Moist Stability and the Scale Selection in the Instability of Column-Integrated Moist Static Energy. J. Atmos. Sci., 68, 61–74, doi: 10.1175/2010JAS3591.1.