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Long-term change of the atmospheric energy cycles and weather disturbances

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Weather disturbances, including extreme weather phenomena, are the manifestation of mean atmospheric energy cascading into eddies. In this regard, the quantitative assessment of the atmospheric energy structure is a key to understand the weather variability in a changing climate. Whether our observational reanalysis data can lead to a consistent diagnosis on the energy conversion characteristics is thus an interesting question. Here we investigate the atmospheric energy cascades by a simple framework of Lorenz energy cycle, and analyze the energy distribution in mean and eddy fields as forms of potential and kinetic energy. Two widely utilized independent reanalysis datasets, NCEP-DOE AMIP-II Reanalysis (NCEP2) and ERA-Interim (ERA-INT), are selected for the analysis. Both datasets generally agree with the energy distribution and their conversion characteristics; however, they draw different conclusions on the change of weather variability measured by eddy-related kinetic energy. NCEP2 shows an increased mean-to-eddy energy conversion and enhanced eddy activity due to efficient baroclinic energy cascade, but ERA-INT shows relatively constant energy cascading structure between the 1980s and the 2000s. The source of discrepancy mainly originates from the uncertainties in hydrological variables in the mid-troposphere that links dynamics and physics. Therefore, a reliable diagnosis of the weather disturbances and their change as a consequence of man-made greenhouse effect require much improvement in the mid-tropospheric observations.