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Tropical cyclone eyewall thunderstorms as a driver of upper tropospheric water vapor increases

Colin Price[1], Tair Plotnik[1], Anirban Guha[2], and Joydeb Saha`[2]
[1]Tel Aviv University, Geophysics and Planetary Science, Tel Aviv, Israel (cprice@flash.tau.ac.il)
[2]Tripura University, Physics Department, India

Tropical cyclones have been observed in recent years to be increasing in intensity due to global warming, and projections for the future are for further shifts to stronger tropical cyclones, while the changes in the number of storms is less certain in the future. These storms have been shown to exhibit strong lightning activity in the eyewall and rainbands, and some studies (Price et al., 2009) showed that the lightning activity peaks before the maximum intensity of the tropical cyclones. Now we have investigated the impact of these tropical storms on the upper tropospheric water vapor (UTWV) content. Using the ERA5 reanalysis product from the ECMWF center, together with lightning data from the ENTLN network, we show that the lightning activity in tropical cyclones is closely linked to the increase in UTWV above these storms. We find the maximum enhancement in UTWV occurs between the 100-300 mb pressure levels, with a lag of 0-2 days after the peak of the storm intensity (measured by the maximum sustained winds in the eyewall). The lightning activity peaks before the storm reaches its maximum intensity, as found in previous studies. The interest in UTWV concentrations is due to the strong positive feedback that exists between the amounts of UTWV and surface global warming. Water Vapor is a strong greenhouse gas which is most efficient in trapping in longwave radiation emitted from the Earth in the upper troposphere. Small changes in UTWV over time can result in strong surface warming. If tropical cyclones increase in intensity in the future, this will likely result in increases in UTWV, reducing the natural cooling ability of the Earth. Lightning may be a useful tool to monitor these changes.