Building a Global Tropical Easterly Wave and Latent Heating Climatology in NASA Data

Elinor Martin | Margaret Hollis |University of Oklahoma | elinor.martin@ou.edu Margaret.A.Hollis-1@ou.edu
Justin Stachnik | Carrie Lewis-Merritt | University of Kansas | stachnik@ku.edu clewismerritt@ku.edu
Rachel McCrary | NCAR| rmccrary@ucar.edu

Goals and Objectives

Use satellite data to understand precipitation and heating during the lifecycle of tropical easterly waves (TEWs) to improve model biases in the representation of these waves.

Objective 1: Determine and analyze the amount and structure of convection and precipitation over the lifecycle of TEWs across the tropics.

Objective 2: Examine the latent heating profiles within TEWs and their relationship with TEW intensity and evolution.

Objective 3: Diagnose variability in TEW precipitation processes spatially (region-to-region) and temporally (year-to-year).

Objective 4: Identify and understand discrepancies in latent heating profiles of TEWs in MERRA-2 reanalysis and the NASA-GISS climate model.

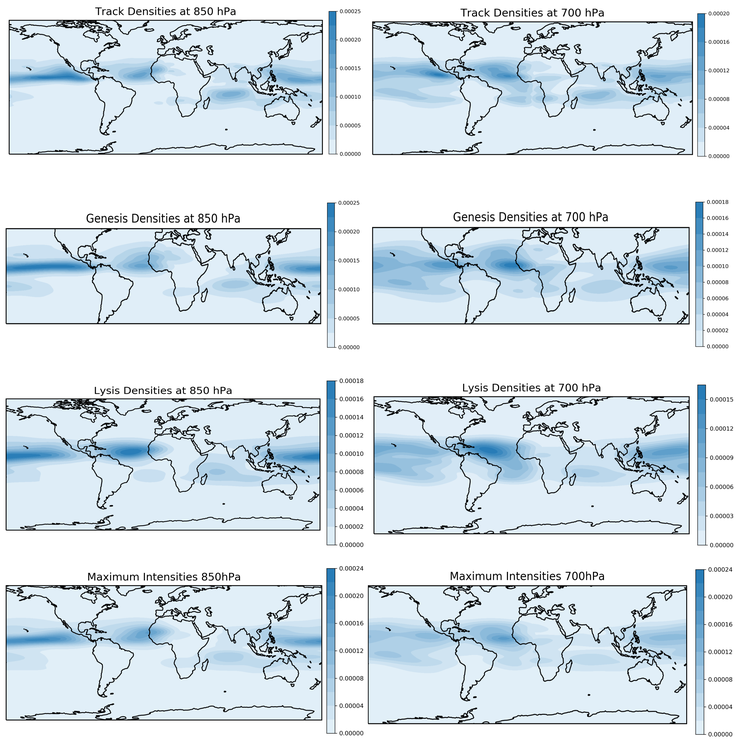
Summary

- Regional and hemispheric differences in TEW climatology at 850 hPa and 700 hPa.
- TEW track density at 850 hPa best matches spatial pattern of spectrally filtered precipitation in IMERG.
- IMERG spectra shows signal in TEW region but less than TRMM – IMERG "noisier"
- Large differences in climatological latent, radiative, and sensible heating in regions where TEWs active

- Future Work:
  - Co-locate precipitation and heating with the TEW tracks
  - Objectively diagnose the lifecycle of TEWs using strength and tendency to identify wave phase
  - TEW heating as a function of total lifetime (i.e., short- vs. long-lived waves), areal coverage and size (i.e., small vs. large), and intensity (weak vs. strong waves).
  - Energy budget analysis in MERRA-2 and NASA GISS ModelE in relation to TEW heating

Tropical Easterly Wave Climatology

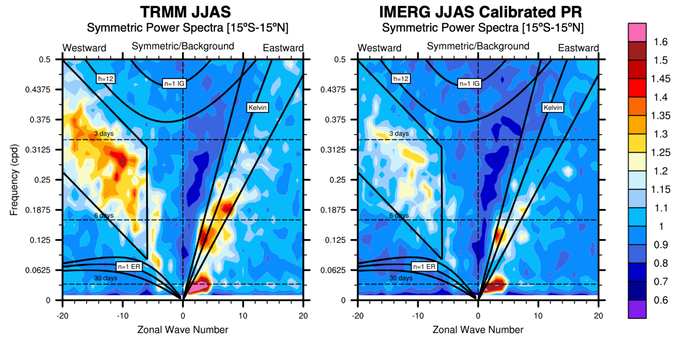
- TEW database in MERRA-2 (3 hourly)
- TEW database using TRACK (Hodges, 1995) with curvature vorticity and T63 filtering
- Removed waves that did not originate in the tropics and did not move westward at least 15°.
- Broader track regions at 700 hPa
- Southern hemisphere TEWs more evident at 700 hPa outside of Indian Ocean
- Large maximum intensity differences between 850 hPa and 700 hPa particularly in East Pacific



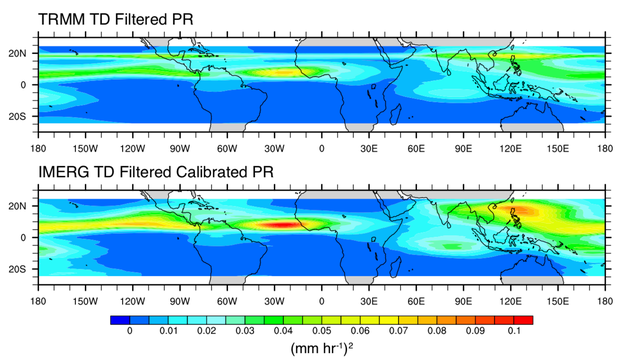
TEW characteristics from MERRA-2 at 850 hPa (left) and 700 hPa (right)

Tropical Easterly Waves & Precipitation

- The spectral peak for TEWs is found westward-propagating zonal wavenumbers greater than 6 (~7000km) and a frequency of 2-8 days
- The signal-to-noise ratio of TEW power is much lower in IMERG than TRMM.
- The spatial patterns of the TEW filtered precipitation is similar in the two products, but the anomalies are larger in the IMERG dataset.
- Spatial patterns match well with tracks at 850 hPa



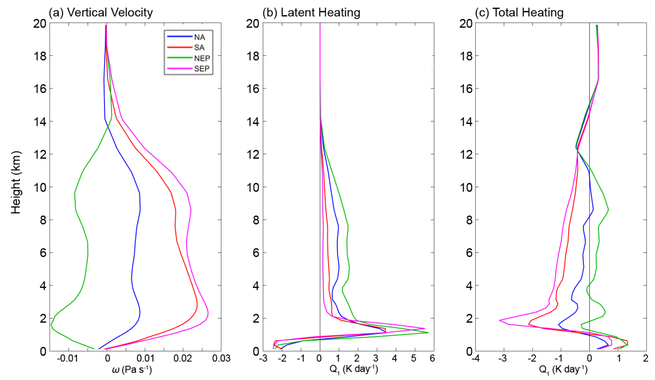
Average JJAS signal-to-noise space–time spectra averaged between 15°S and 15°N at all longitudes for disturbances that are symmetric about the equator from TRMM 3B42 precipitation and IMERG L3 calibrated precipitation.



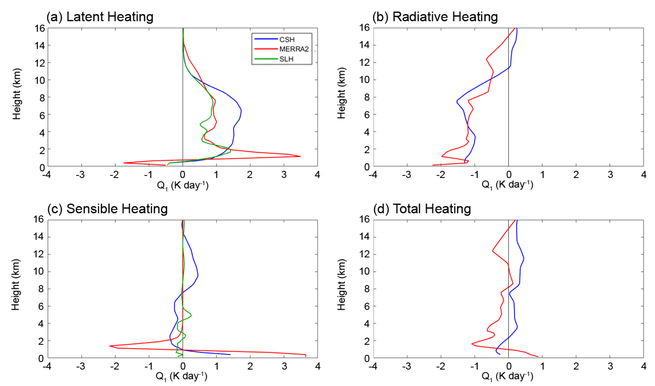
JJAS mean variance of TEW-filtered precipitation from TRMM (top) and IMERG (bottom).

Diabatic Heating Climatology

- Heating and vertical velocity vary significantly over domains with high TEW track densities
- North Atlantic:
  - MERRA-2 overestimates LH at low-levels and peaks at a slightly lower altitude than the SLH.
  - CSH has a broad peak for mid-level heating between 6-8 km.
  - Total heating has a different sign in CSH and MERRA-2.



MERRA-2 climatology (1998-2014) of omega and heating for the North Atlantic (NA), South Atlantic (SA), Northeast Pacific (NEP) and Southeast Pacific (SEP)



North Atlantic (20-70°W, 5-25°S) climatological (1998-2014) heating profiles for MERRA-2, TRMM CSH (3H31 v7), and TRMM SLH (3HSLH v6)