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Kelvin Waves and Tropical Cyclones in a Lagrangian Framework

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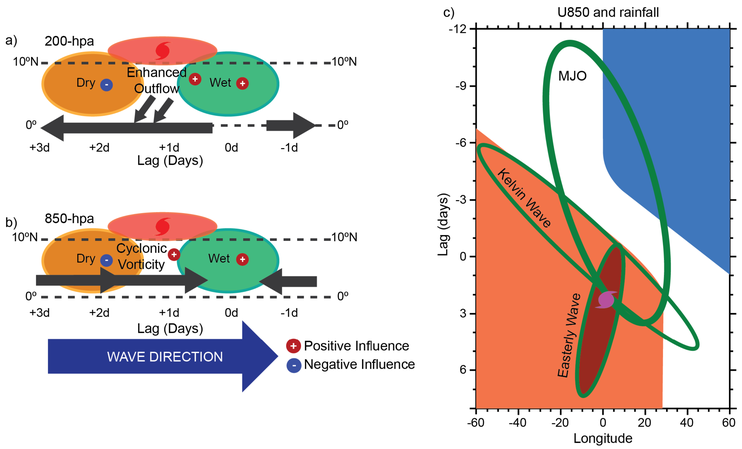
Kelvin Waves and Tropical Cyclones



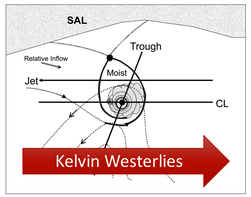
Schematic of Kelvin Wave composites from all basins. Adapted from: Schreck, C. J., 2015: Kelvin waves and tropical cyclogenesis: A global survey. *Mon. Wea. Rev.*, **143**, 3996–4011, doi:10.1175/MWR-D-15-0111.

- **Convectively coupled Kelvin waves**
  - Eastward propagation at 10–20 m s^{-1}
  - 3–10 day period, 2000–4000 km wavelength
- **Kelvin Waves modulate key factors for cyclogenesis**
  - Low-level vorticity, convection, vertical wind shear
  - But net impact on tropical cyclone activity is uncertain
- **Tropical cyclones inhibited for 3 days before Kelvin wave passage and enhanced 3 days after**
- **Circulation seems to be the dominant factor**
  - Low-level vorticity
  - Upper-level outflow
- **Kelvin waves frequently interact with the MJO and easterly waves during genesis**

Summary

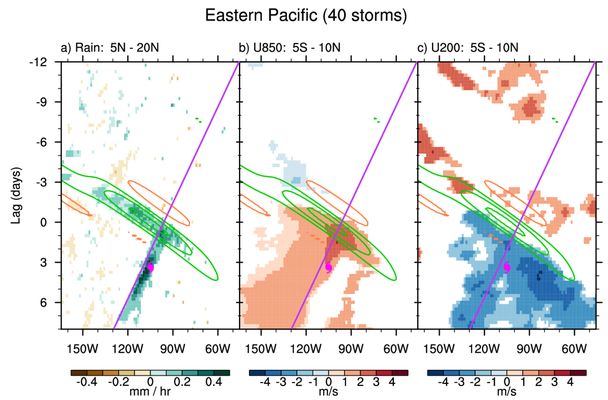
Equatorial westerlies from Kelvin waves help close the pouch's circulation

- Kelvin waves are tilted westward with height
- Cyclogenesis occurs when the Kelvin wave westerly anomalies reach mid-levels (600 hPa)
- This tilt may explain the 0–3 day lag between Kelvin wave passage and genesis.



*Schematic of an easterly wave's pouch. Adapted from Wang et al. 2010, J. Atmos. Sci., **67**, 1711–1729.*

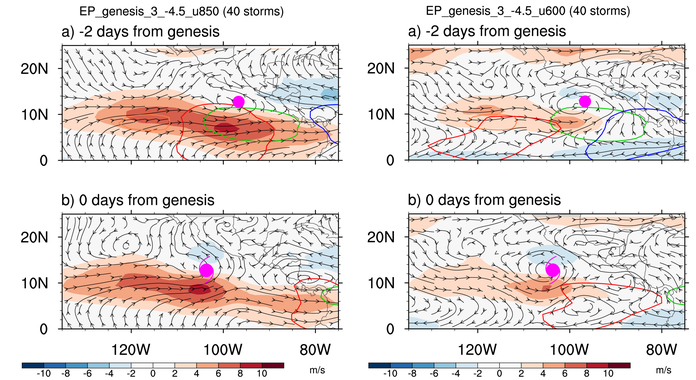
Pouch Phase Speed



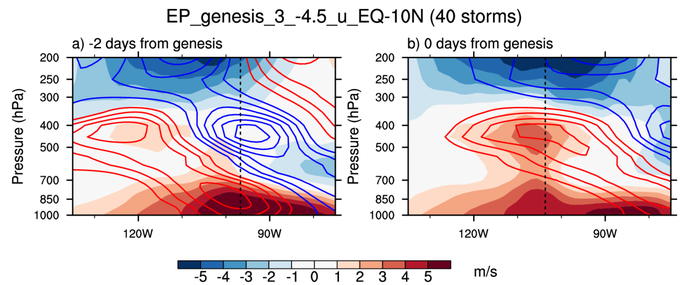
Composite Hovmöllers of (a) Rainfall, (b) 850-hPa zonal wind, and (c) 200-hPa zonal wind anomalies for tropical cyclones that formed 3.5 days after Kelvin wave passage. Magenta lines denote the estimated phase speed of 4.5 m s^{-1}.

- **Easterly wave phase speed is estimated from composite Hovmöllers of tropical cyclogenesis with Kelvin waves**
- **This phase speed is subtracted from the composite zonal winds to produce Lagrangian streamlines**

Pouch Composites



Composite maps of easterly wave-relative zonal winds at 850-hPa (left) and 600-hPa (right). Green and orange contours identify wet and dry envelopes of the Kelvin waves, respectively. Similarly the red and blue are the westerly and easterly phases.



Composite cross-sections of easterly wave-relative zonal winds Red and blue contours identify are the westerly and easterly phases of the Kelvin waves.

- **Convection and storm-relative low-level westerlies intersect easterly wave 2–3 days before genesis**
- **Westward tilt of Kelvin waves mean that its midlevel westerlies intersect the easterly wave at genesis**
- **Easterly wave's westerlies are stronger and deeper from their overlap with the Kelvin wave**

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