

# Role of Kelvin Waves in Tropical Cyclogenesis

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## Background

### Convectively Coupled Kelvin Waves

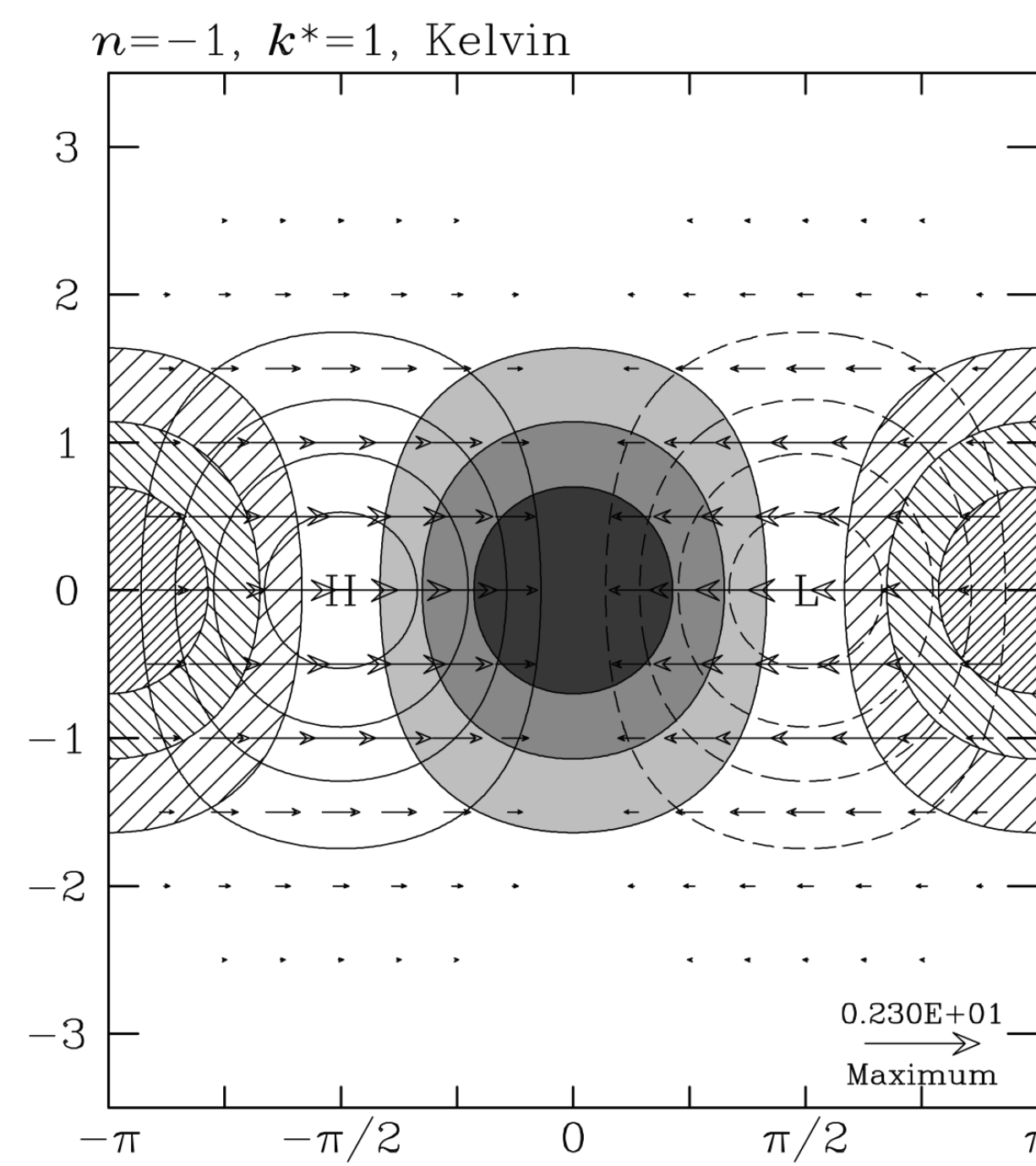
- Often equatorially asymmetric and including meridional winds
- Diabatic heating can generate PV
- Tilted first baroclinic vertical structure
- Eastward propagation at 10–20 m s<sup>-1</sup>
- 3–10 day period
- 2000–4000 km wavelength

### Linear Shallow Water Kelvin Waves

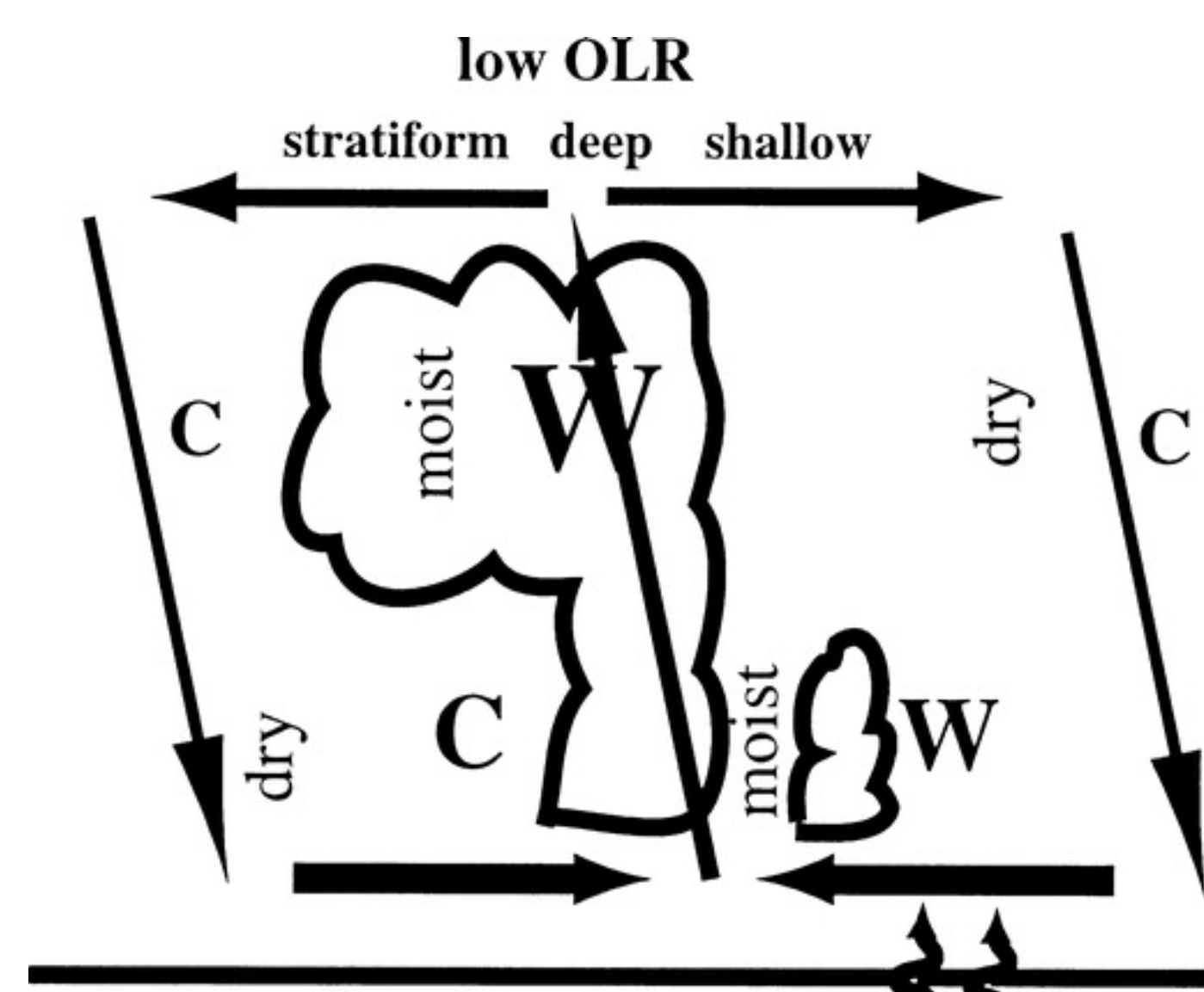
- Equatorially symmetric horizontal structure featuring alternating easterlies and westerlies
- Geopotential anomalies balance the relative vorticity anomalies, so no potential vorticity (PV) perturbations

### Impacts on Tropical Cyclogenesis

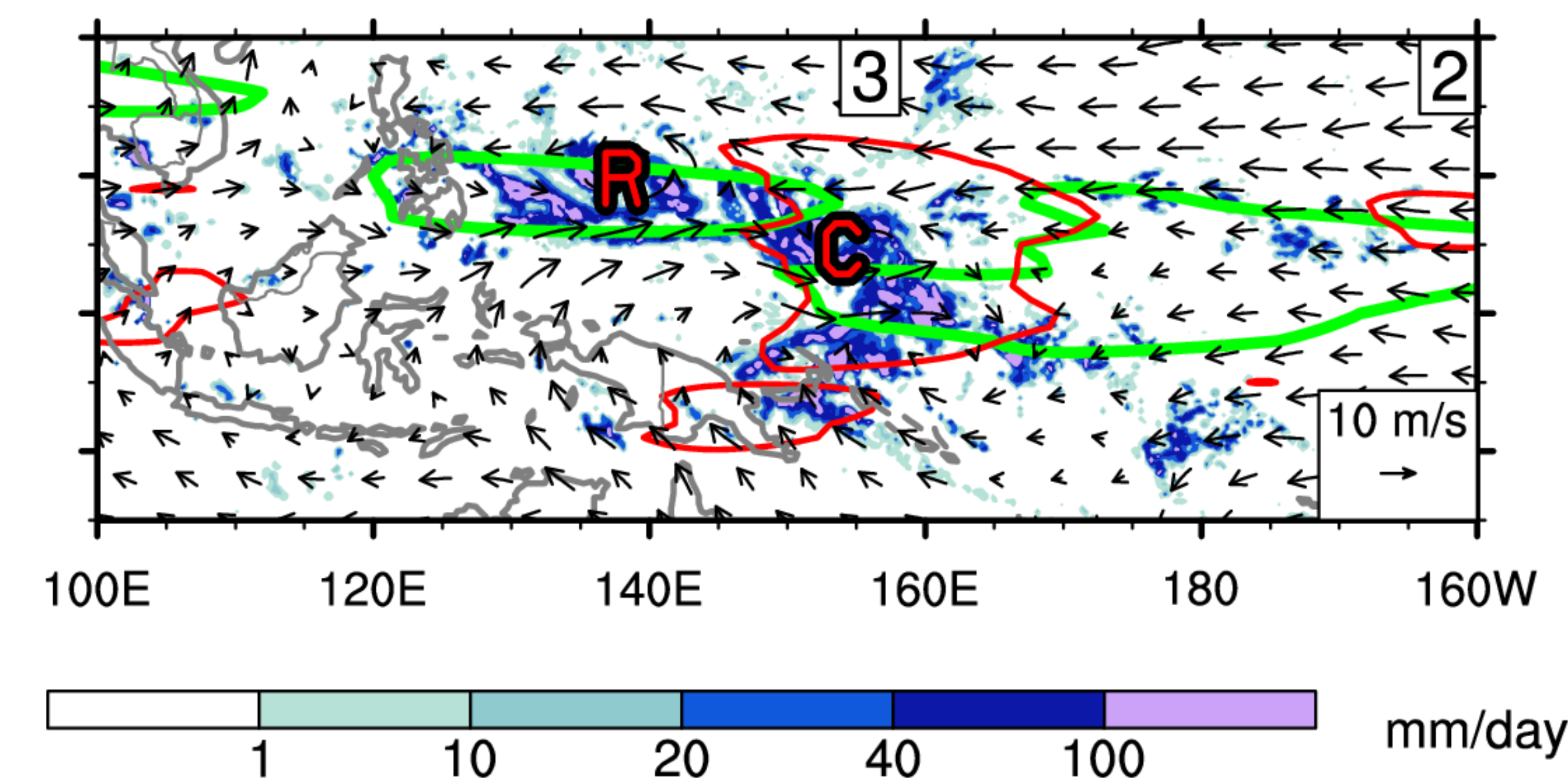
- Case studies have shown that Kelvin waves modulate key factors for cyclogenesis:
  - Relative vorticity
  - Convection
  - Vertical wind shear
- Previous climatologies give a mixed message on the relative importance of Kelvin waves.



Linear shallow water solution for Kelvin waves (Kiladis et al. 2009)



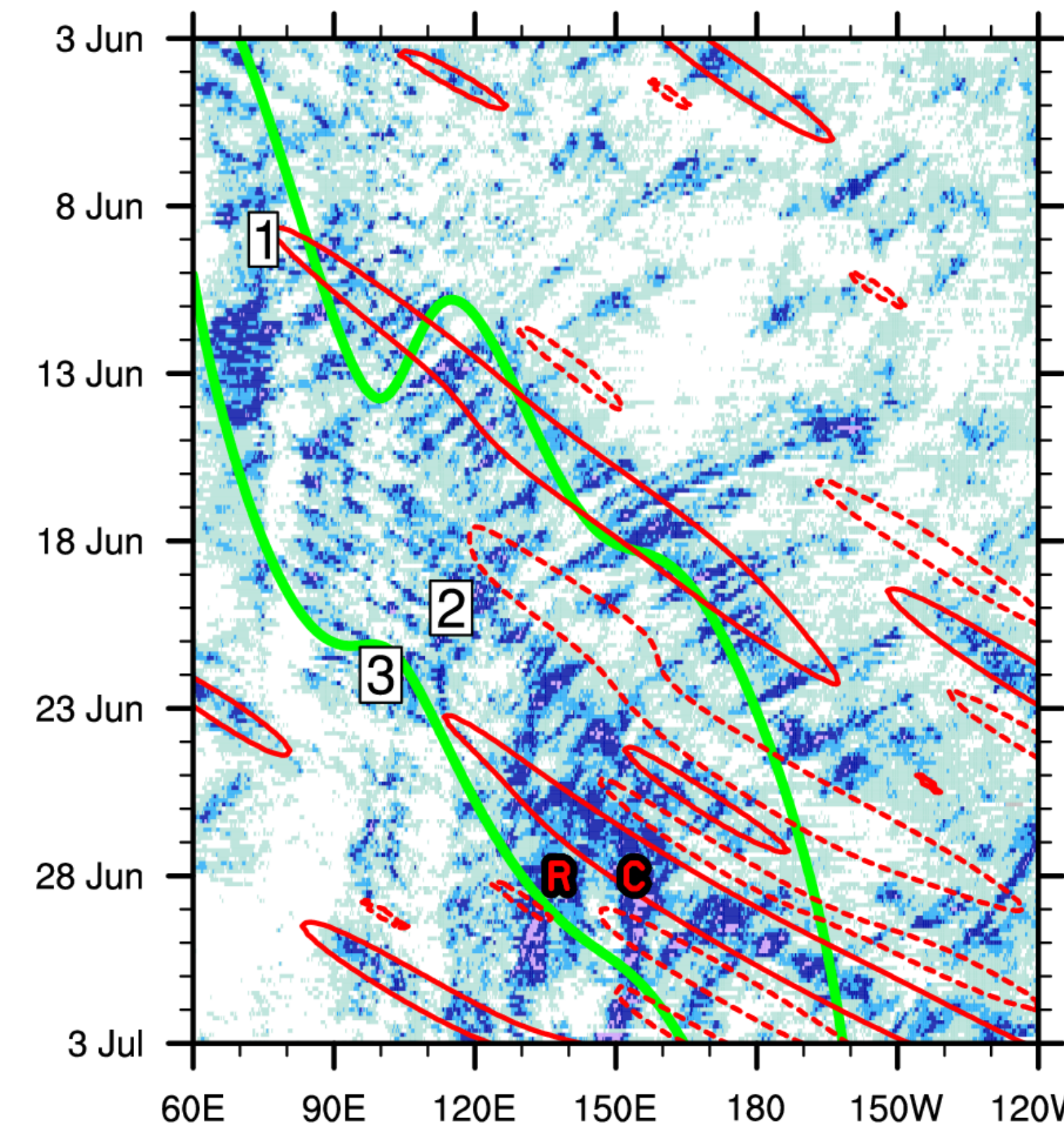
Schematic vertical structure of Kelvin waves (Straub and Kiladis 2003)



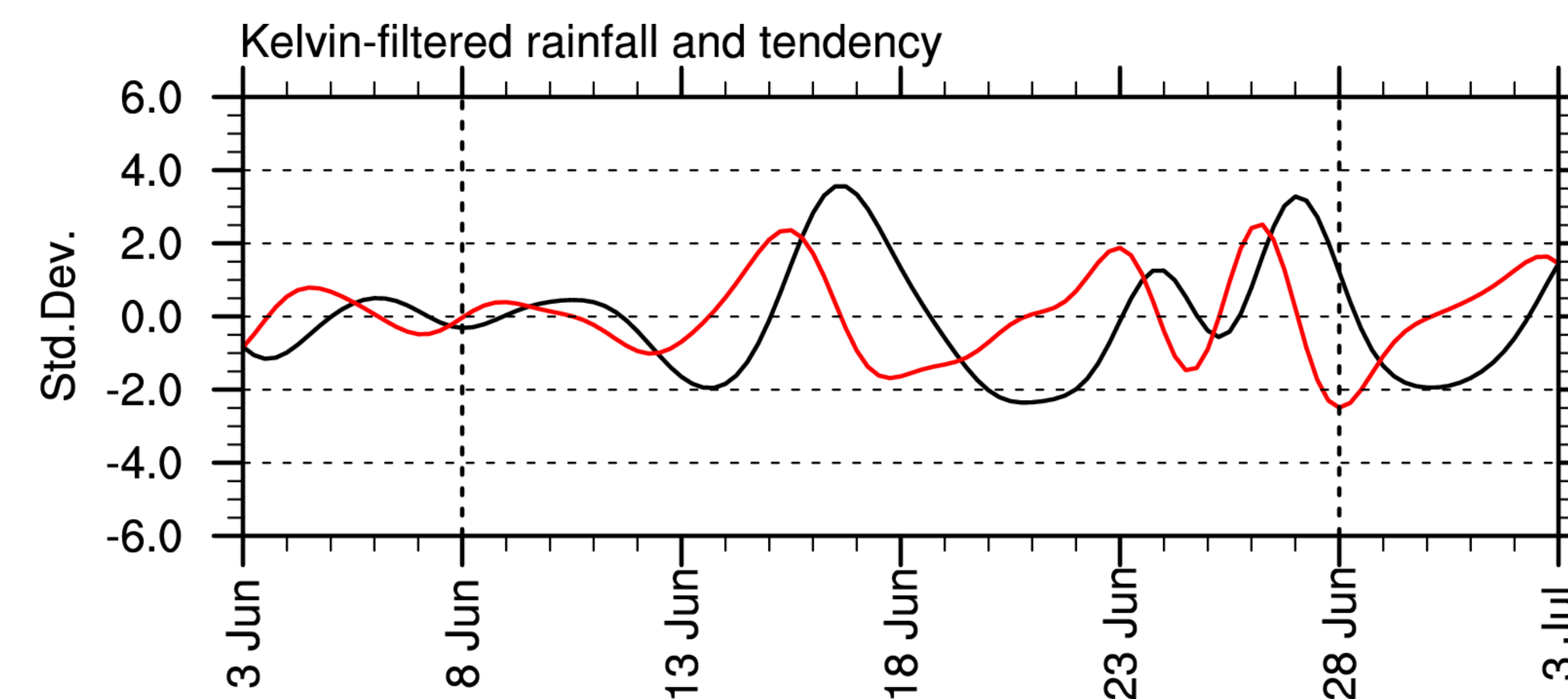
850-hPa winds, unfiltered (shading), Kelvin-filtered (red), and MJO-filtered (green) TRMM3B42 rainfall from 0000 UTC 28 June 2002. Typhoons Rammasun (R) and Chataan (C) developed in the wake of a series of Kelvin waves. From Schreck and Molinari (2011).

## What phase of the Kelvin waves is most conducive for tropical cyclogenesis?

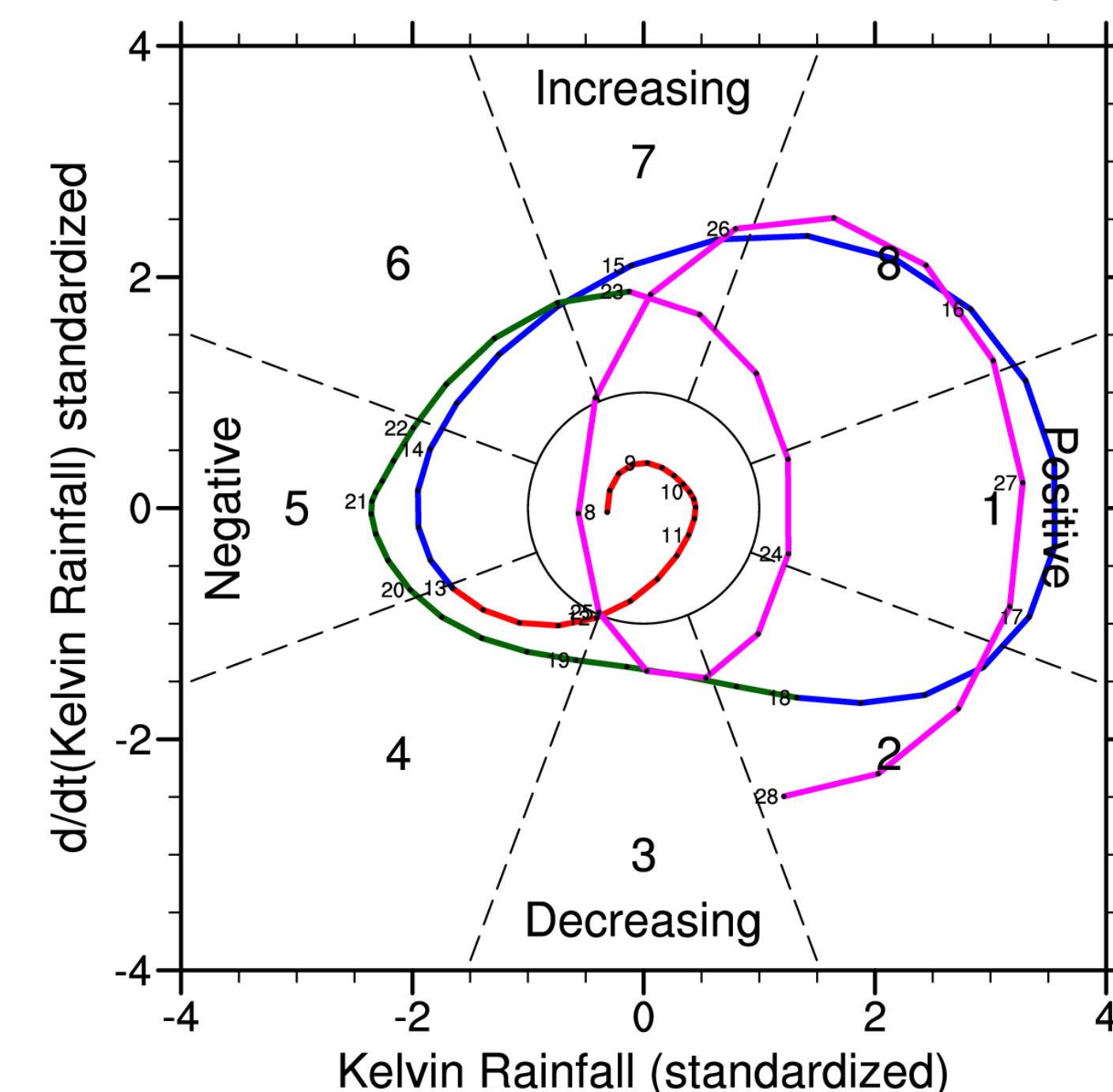
- Schreck et al. (2011, 2012) attributed tropical cyclogenesis to Kelvin waves if the filtered TRMM3b42 rainfall exceeded a threshold value (e.g., 3 mm/day).
- That methodology only considered the influence on convection.
- The proposed research will count how many storms form in each phase of the Kelvin waves in each basin.
- Kelvin phase will be identified using a phase space of standardized Kelvin-filtered rainfall and its tendency as in Riley et al. (2011).



Unfiltered (shading), Kelvin-filtered (red), and MJO-filtered (green) TRMM3B42 rainfall. From Schreck and Molinari (2011).

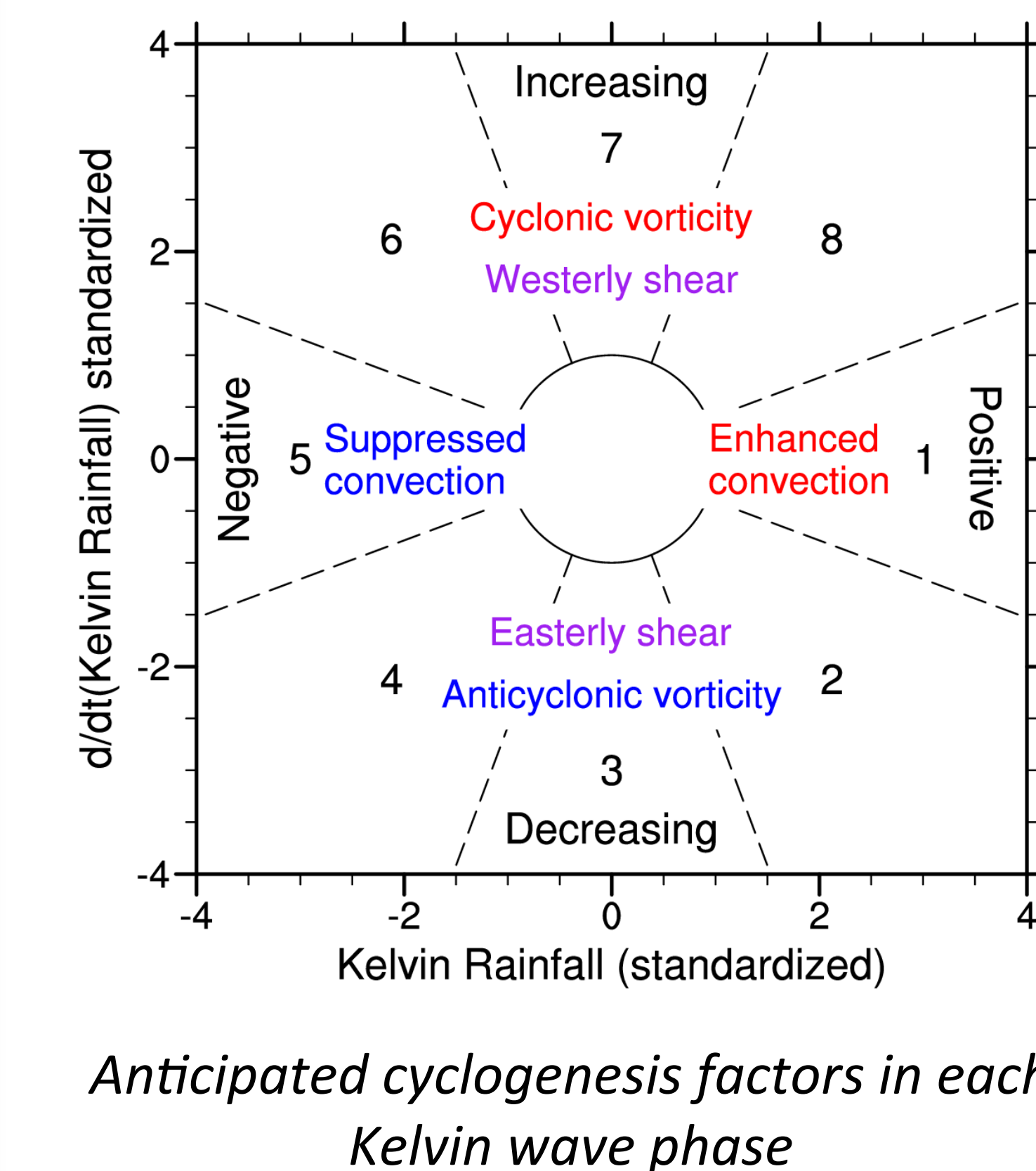


Time series shows Kelvin-filtered rainfall (black) and tendency (red) over Rammasun and Chataan.



Kelvin phase space confirms that these storms formed behind the peak of Kelvin rainfall.

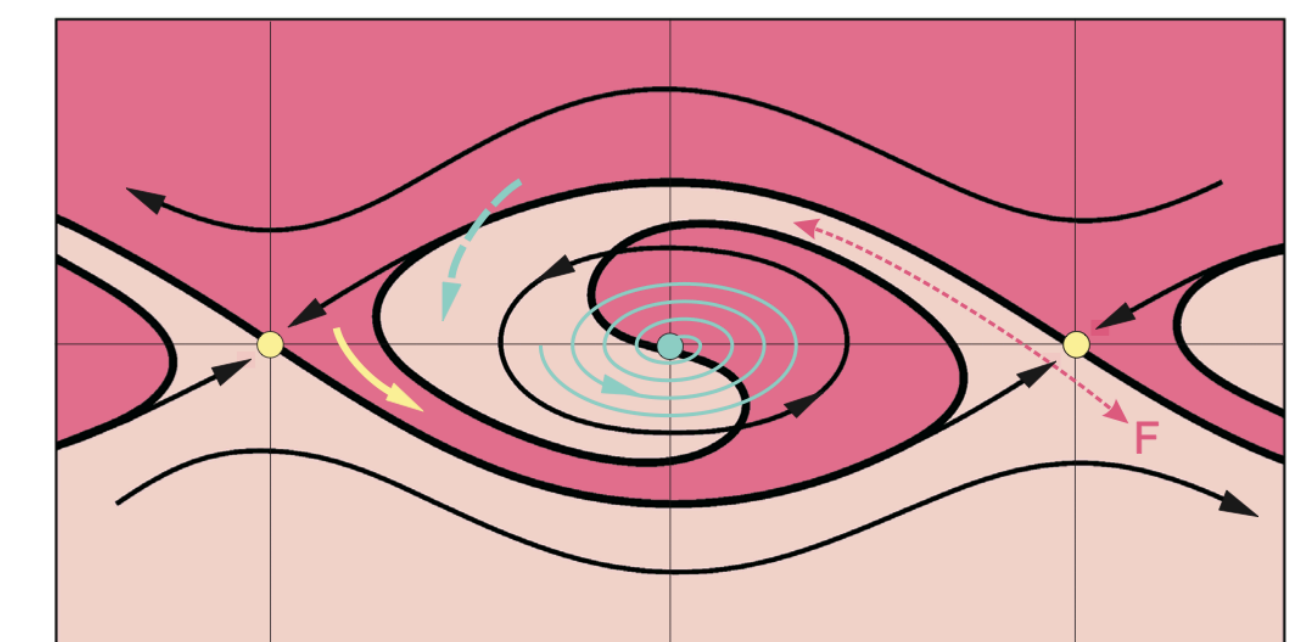
## How do Kelvin waves influence the environment for tropical cyclogenesis?



- Composites for each basin and each phase of the Kelvin waves will identify how tropical cyclogenesis factors change from one phase to the next.
- NASA MERRA data will be used to evaluate:
  - Column-integrated water vapor
  - Potential vorticity
  - Vertical wind shear
- The results will demonstrate *how* Kelvin waves influence tropical cyclogenesis.

## Do Kelvin waves affect Lagrangian recirculation?

- Dunkerton et al. (2009) showed that a Lagrangian framework can identify the recirculation of moisture within easterly waves
- The proposed research will investigate how this recirculation is affected by the equatorial easterlies and westerlies from Kelvin waves.



Schematic of an easterly wave embedded in latitudinal shear (Dunkerton et al. 2009).

## References

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