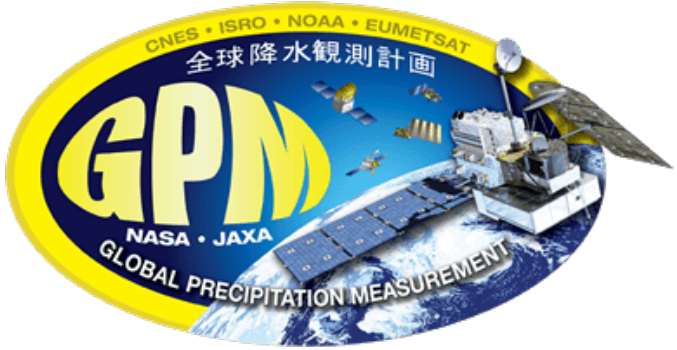
A Global Survey of Kelvin Waves and Tropical Cyclogenesis

Carl Schreck[1]

Jim Kossin[2]

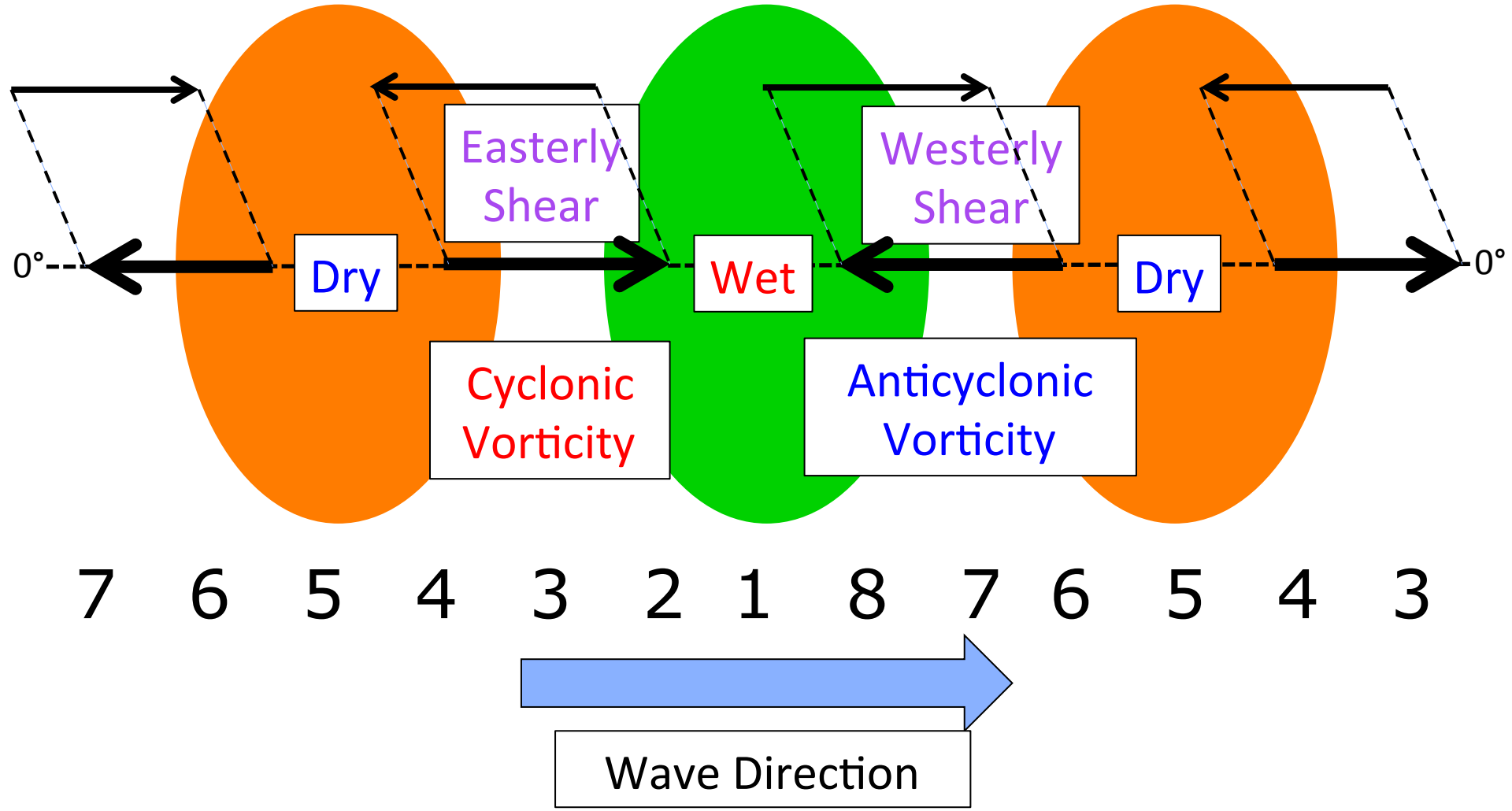
1 Cooperative Institute for Climate and Satellites cics.nc

2 National Oceanic and Atmospheric Administration NOAA U.S. Department of Commerce

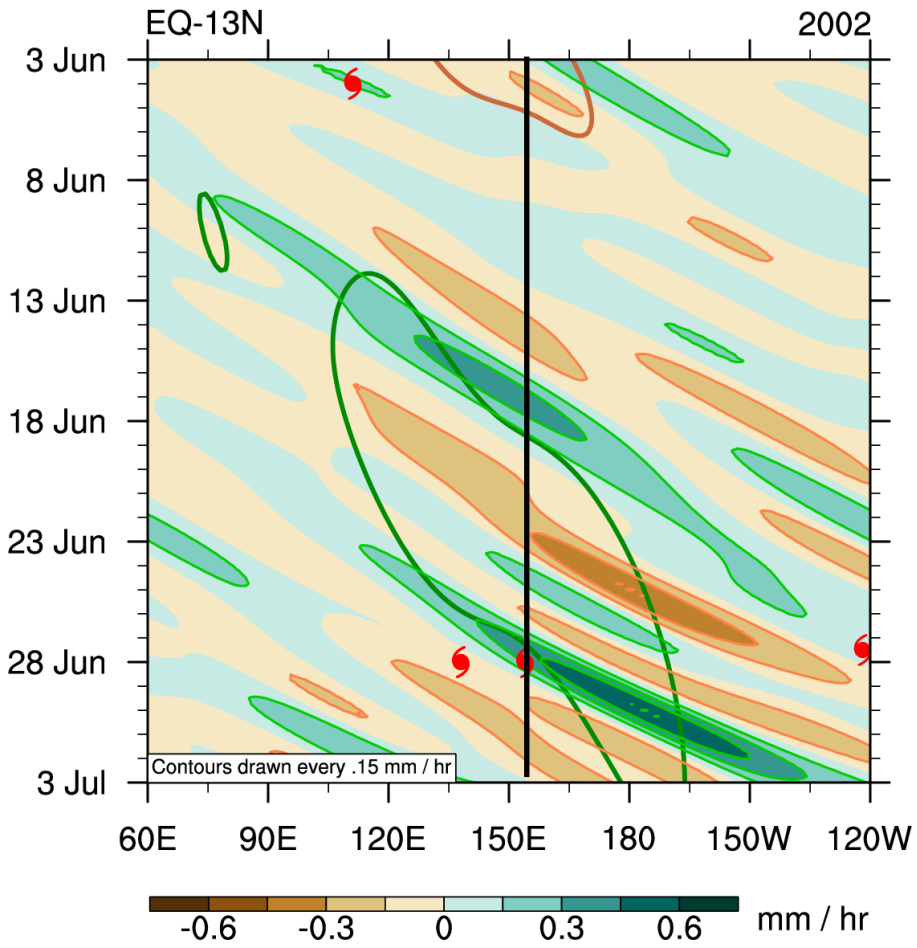


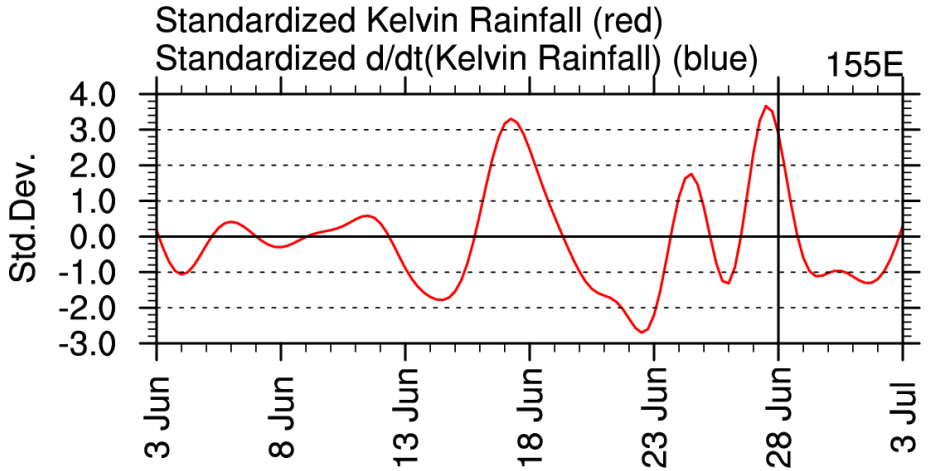
31st AMS Tropical Conference
March 31–April 4, 2014
San Diego, CA

Kelvin Waves Structure



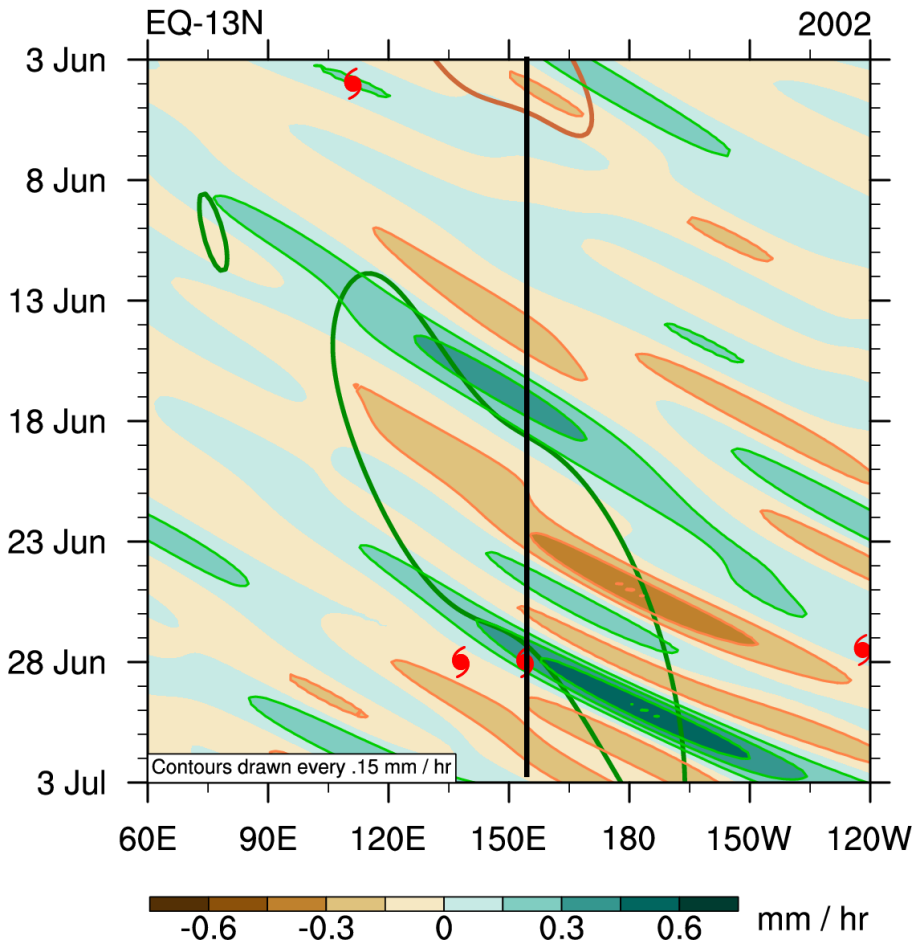
Phase Identification

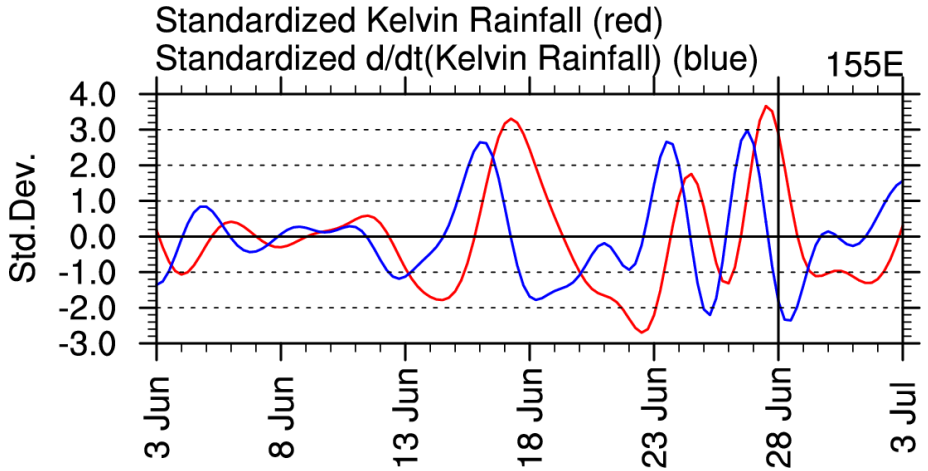


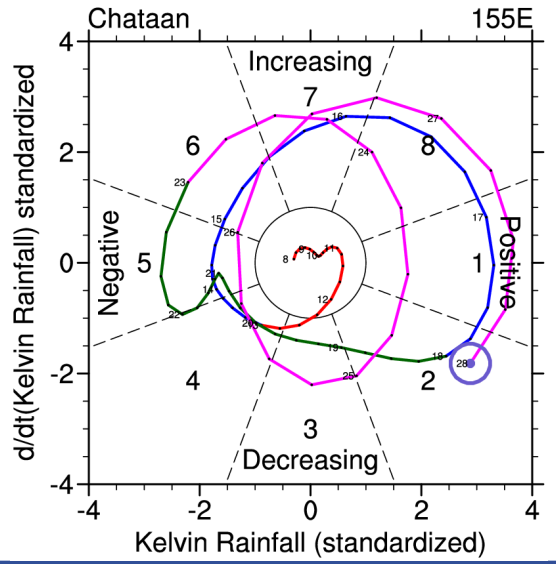


Schreck & Molinari (2011, MWR)

Phase Identification

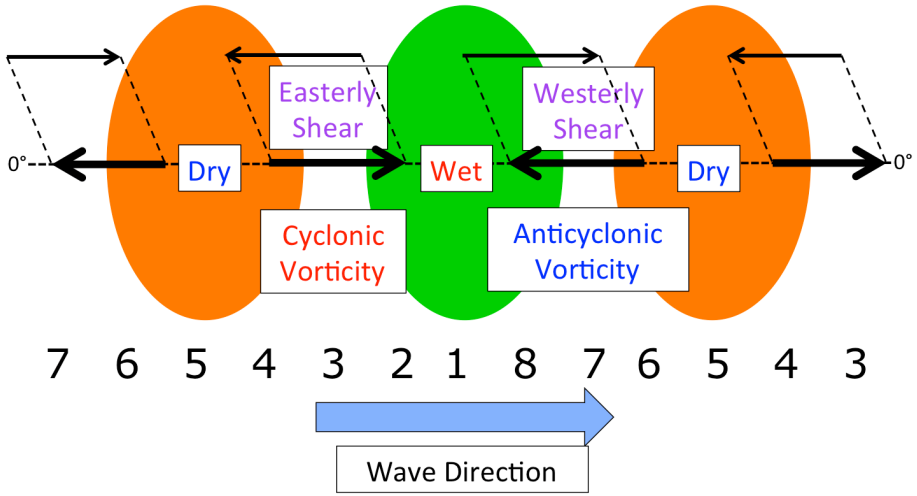




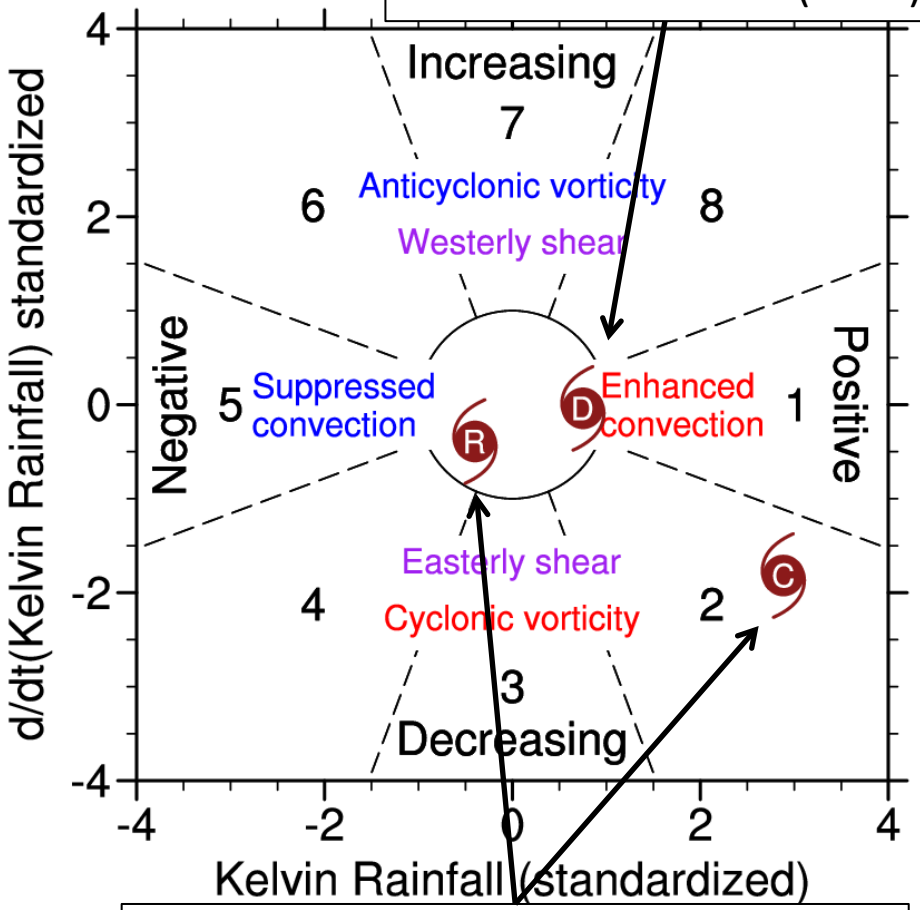


Schreck & Molinari (2011, MWR)

Hypotheses



Debby: Atlantic 2006
from Ventrice et al. (2012)

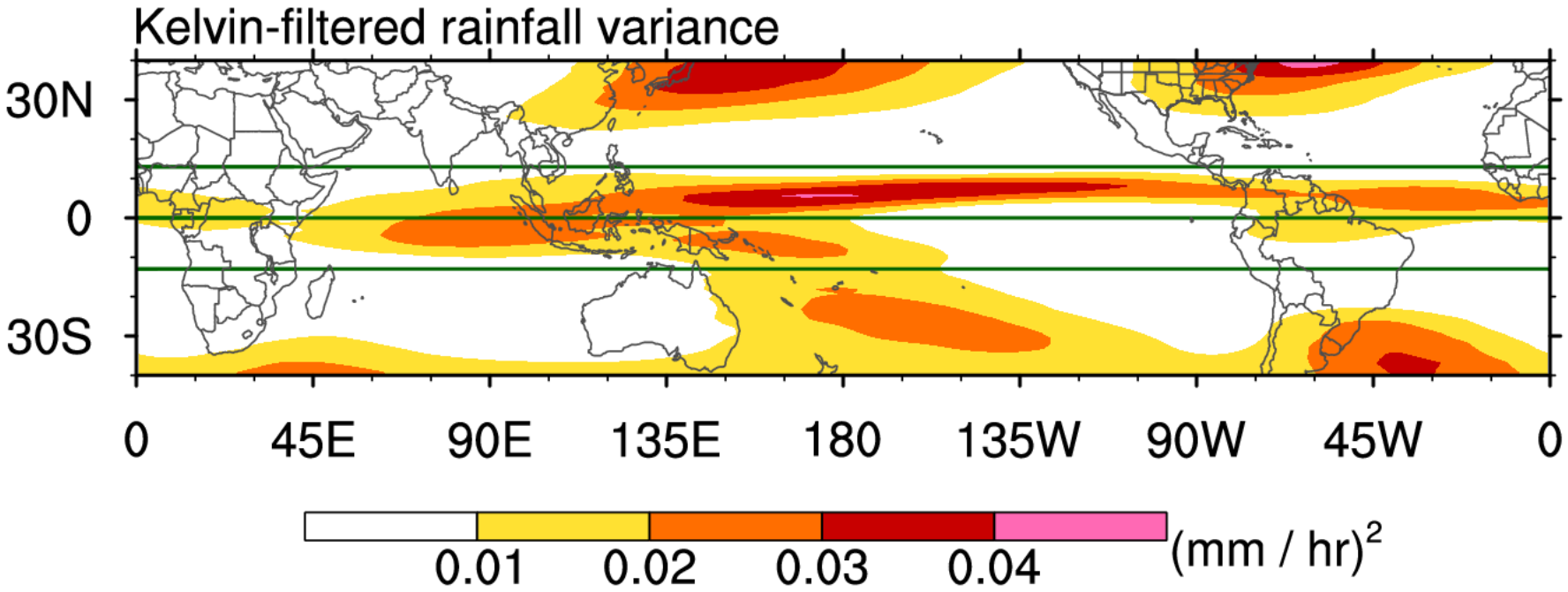


Rammasun and Chataan: W.Pac. 2002
from Schreck & Molinari (2011)

Data

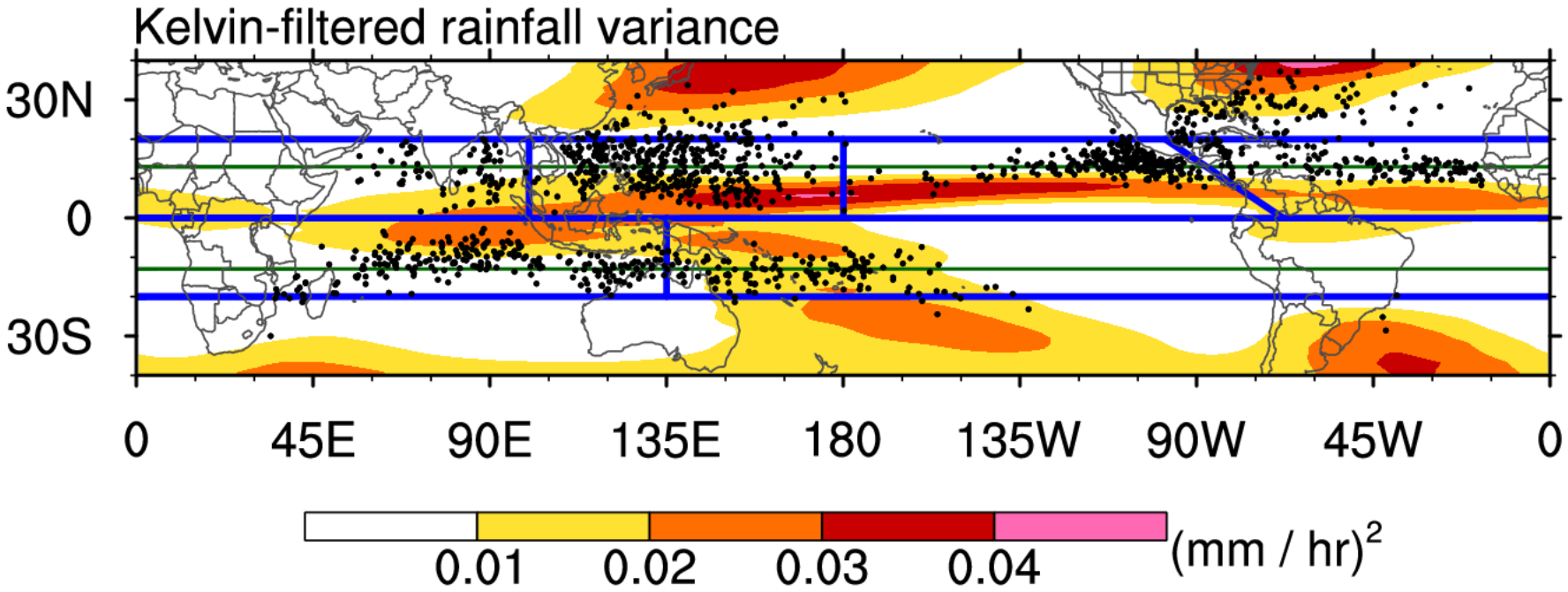
- Genesis locations
  - IBTrACS: NHC+JTWC
  - Genesis = First location in the track
- Kelvin wave identification
  - NASA TRMM multisatellite precipitation analysis (3b42)
  - Filtered for MJO & Kelvin waves similar to Wheeler–Kiladis (1999, JAS)
  - Tropical Cyclone signals removed following Schreck et al. (2011, JAS) and Aiyyer et al. (2012, J. Clim.)
  - 1998–2012
- Dynamic and thermodynamic factors
  - NASA MERRA

Latitude Bands



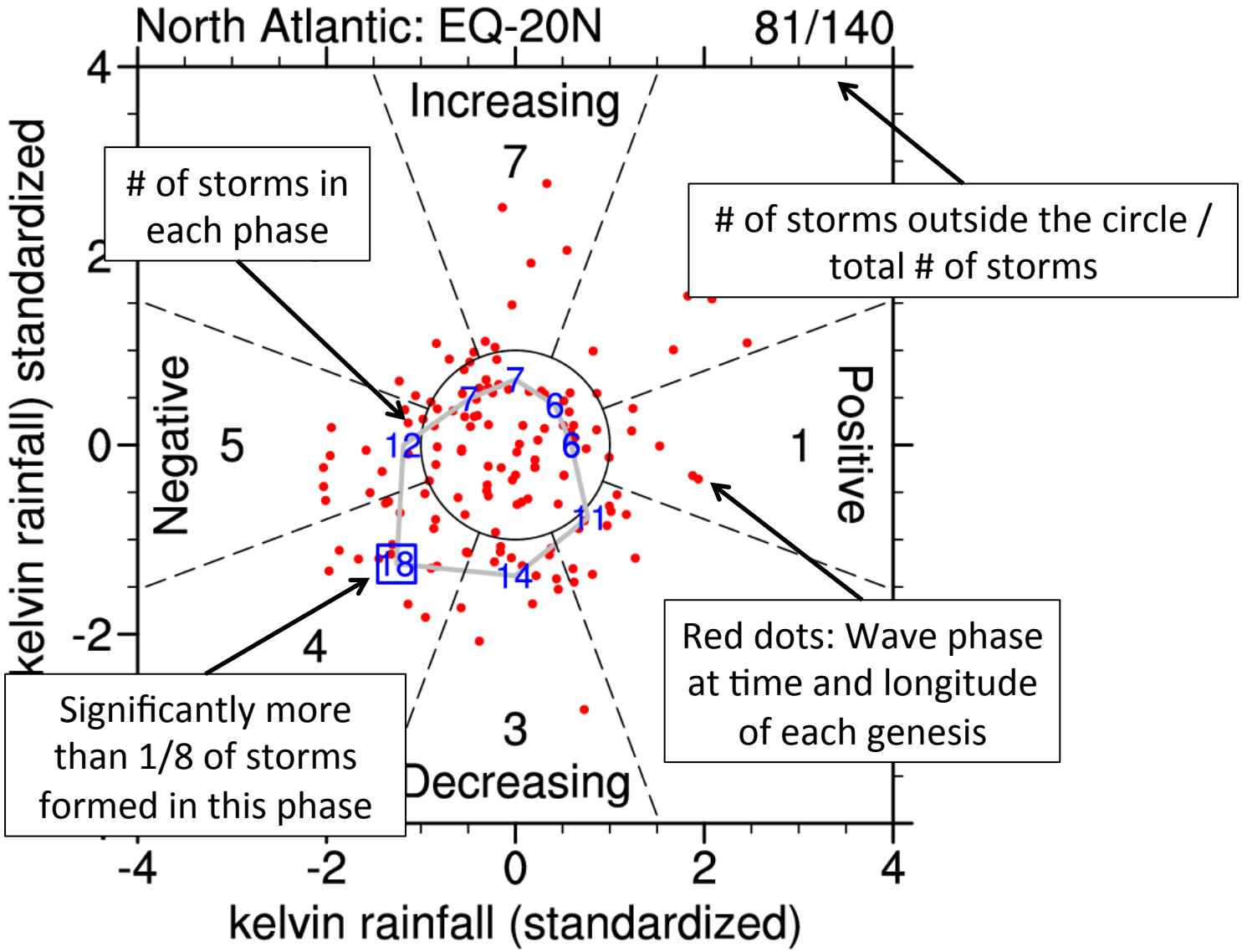
- Identifying Kelvin-filtered rainfall anomalies averaged from Eq – 13° latitude

Basins and Latitude Bands

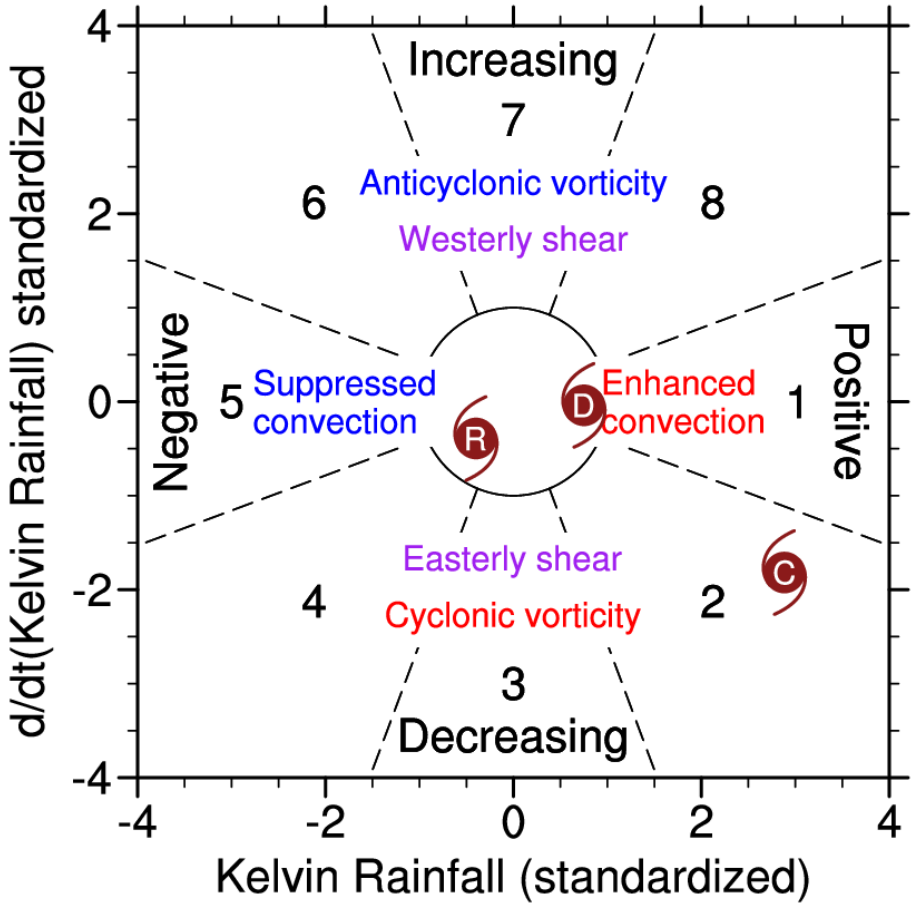


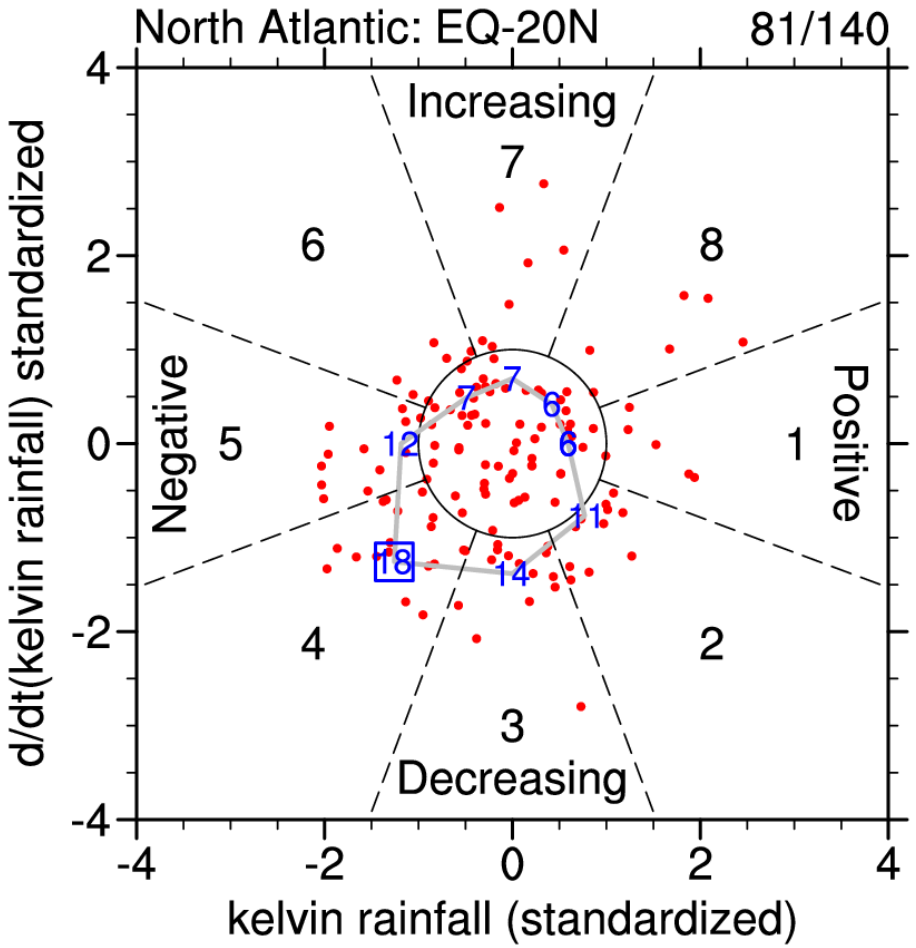
- Identifying Kelvin-filtered rainfall anomalies averaged from Eq – 13° latitude
- Matching with the time and longitude of storms forming Eq – 20° latitude

Phase Results



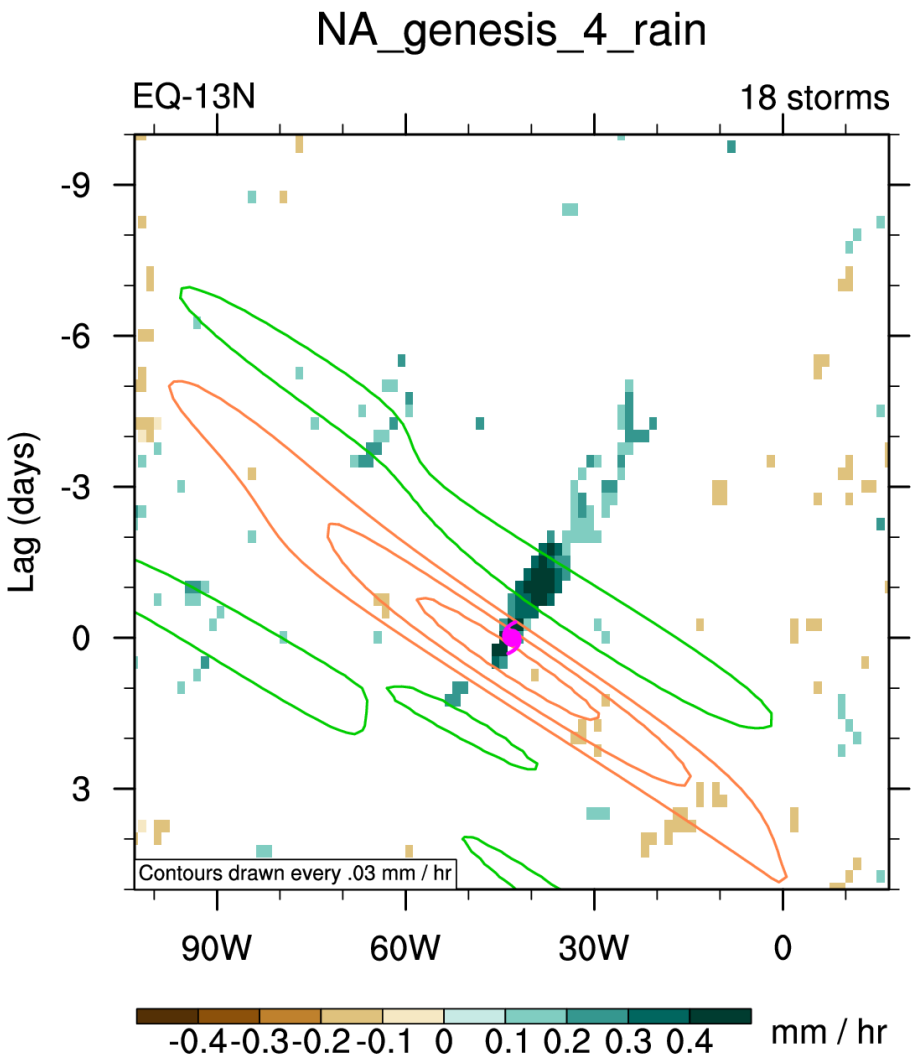
Atlantic


Increasing
7
6
Anticyclonic vorticity
Westerly shear
8
Negative
5
Suppressed convection
R
D
Enhanced convection
1
Positive
Easterly shear
4
Cyclonic vorticity
2
C
3
Decreasing
d/dt(Kelvin Rainfall) standardized
Kelvin Rainfall (standardized)
4
2
0
-2
-4


North Atlantic: EQ-20N
81/140
Increasing
7
6
8
Negative
5
1
Positive
4
2
3
Decreasing
d/dt(kelvin rainfall) standardized
kelvin rainfall (standardized)
7
7
6
12
6
11
18
14
4
2
0
-2
-4

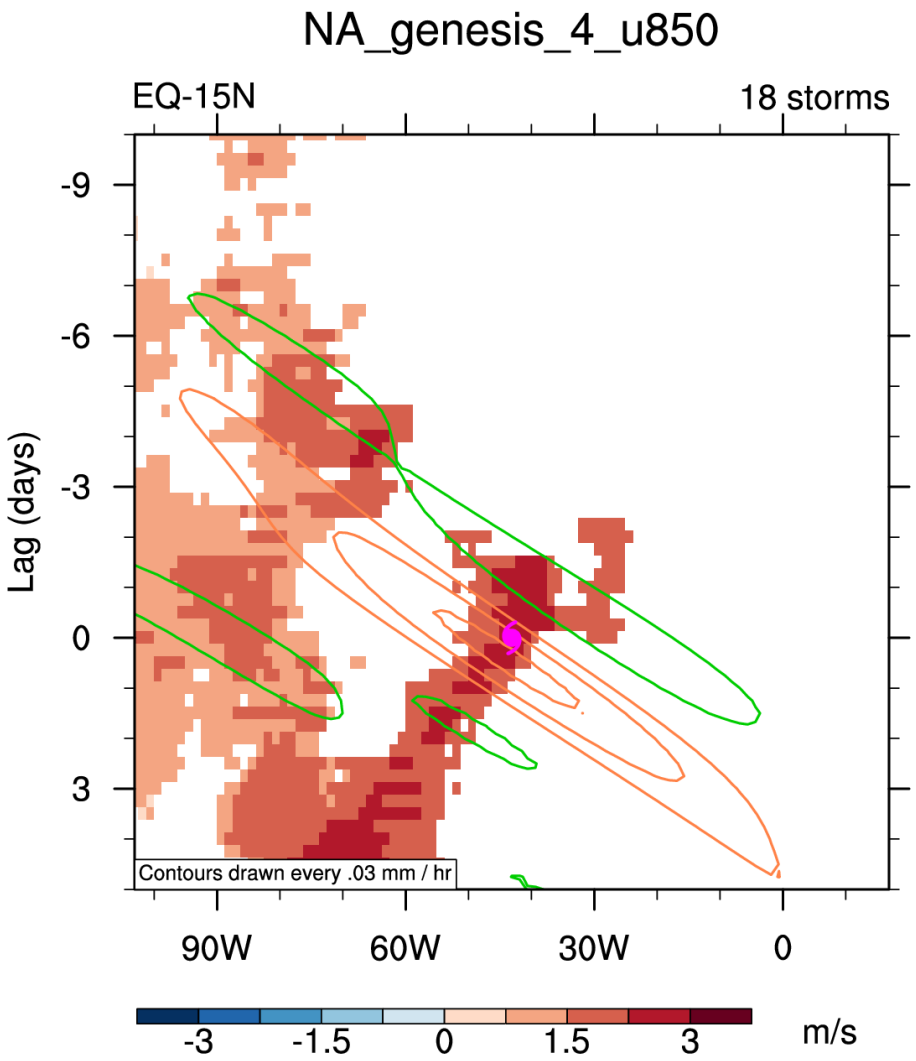
Atlantic Storm-Relative Hovmöllers

- Time and longitude shifted relative to storm
- Longitudes on x-axis are for reference
  - Based on median genesis longitude
- No clear Kelvin signature in unfiltered rainfall?



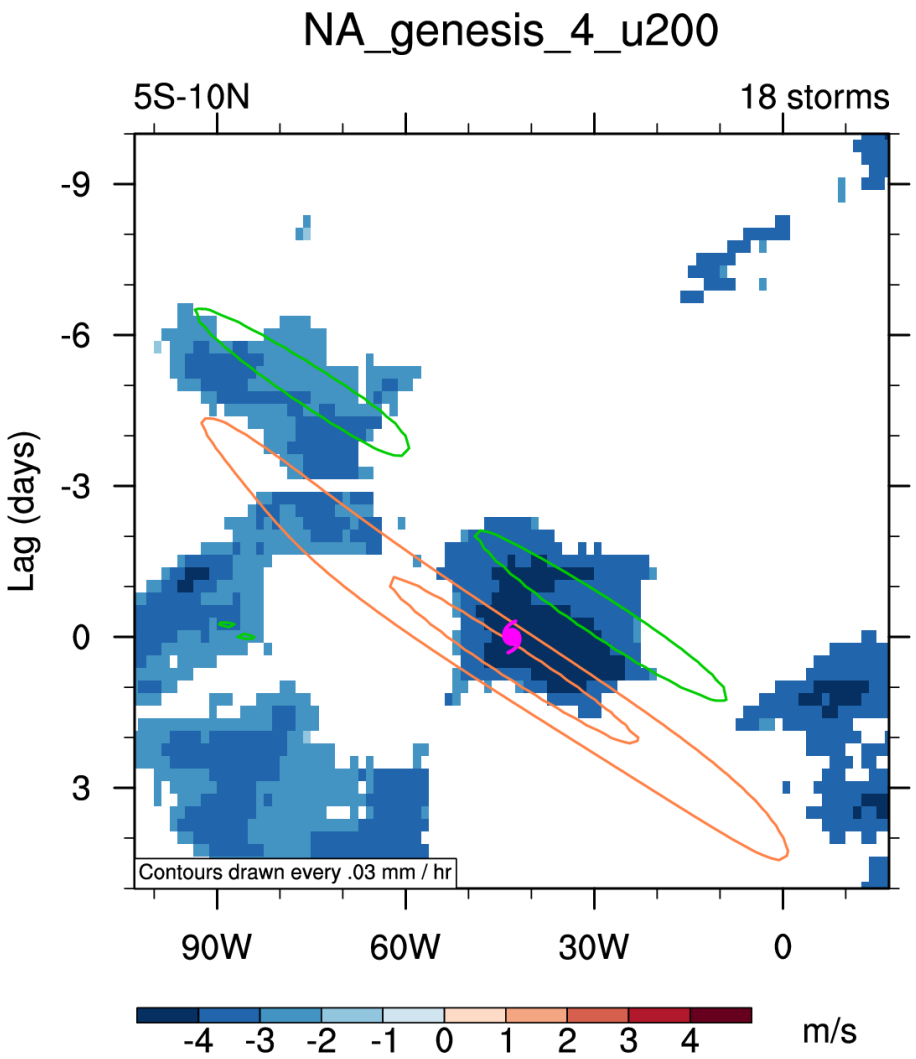
Atlantic Storm-Relative Hovmöllers

- 850-hPa westerlies spread eastward with convective phase
- Westerlies persist during and after dry phase
- Kelvin signal dissipates after genesis

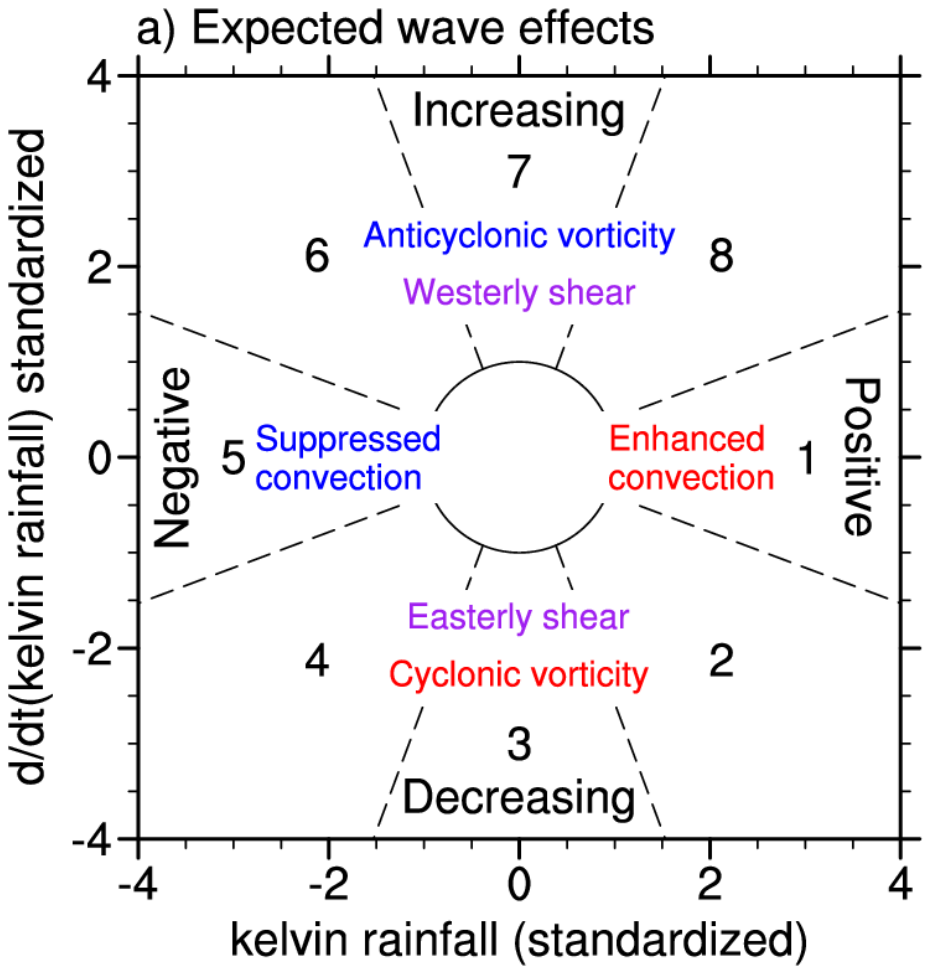


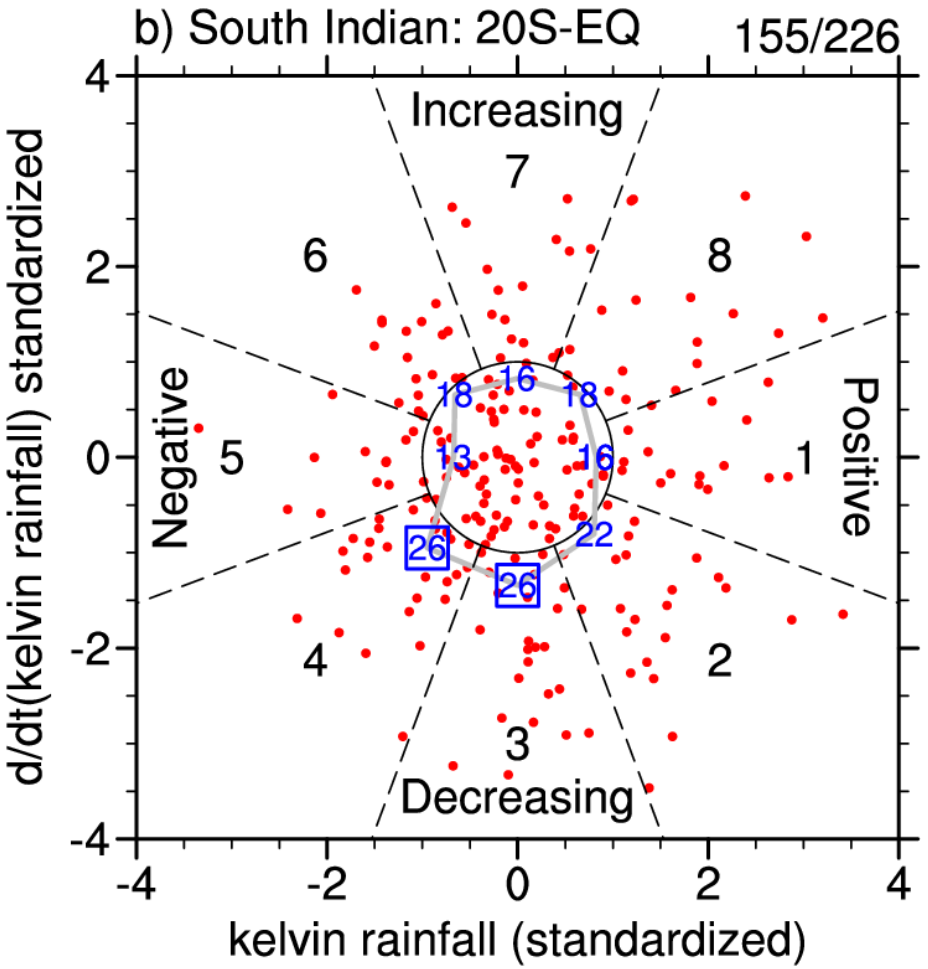
Atlantic Storm-Relative Hovmöllers

- 200-hPa easterlies move eastward with wave



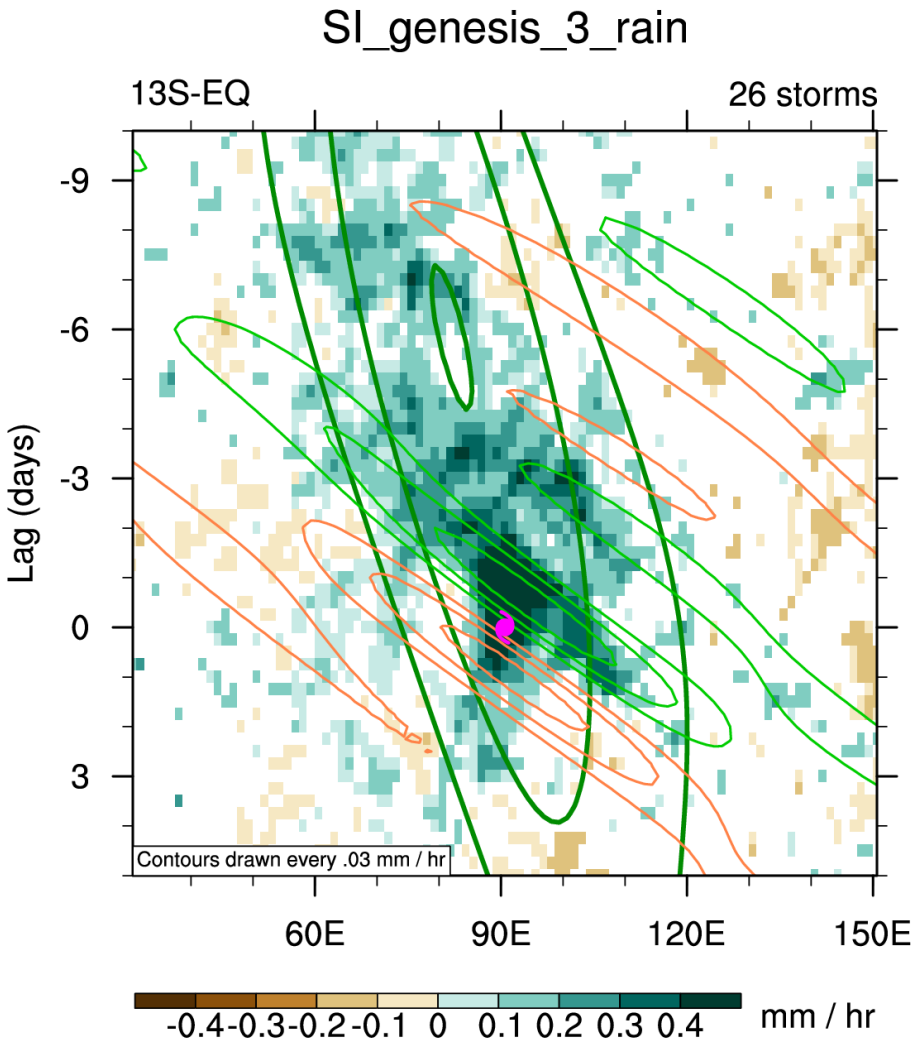
South Indian





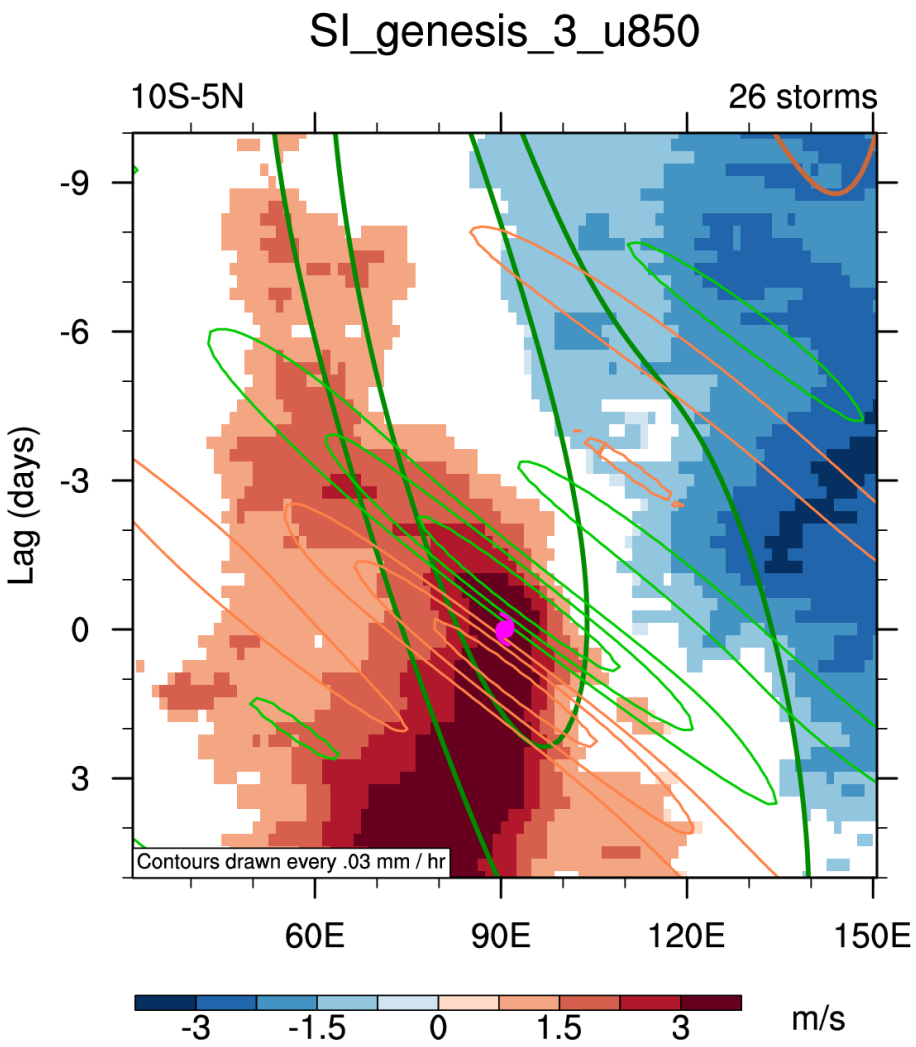
S.Indian Storm-Relative Hovmöllers

- Kelvin wave is embedded within an MJO
- Heaviest rain in the MJO is associated with the Kelvin waves

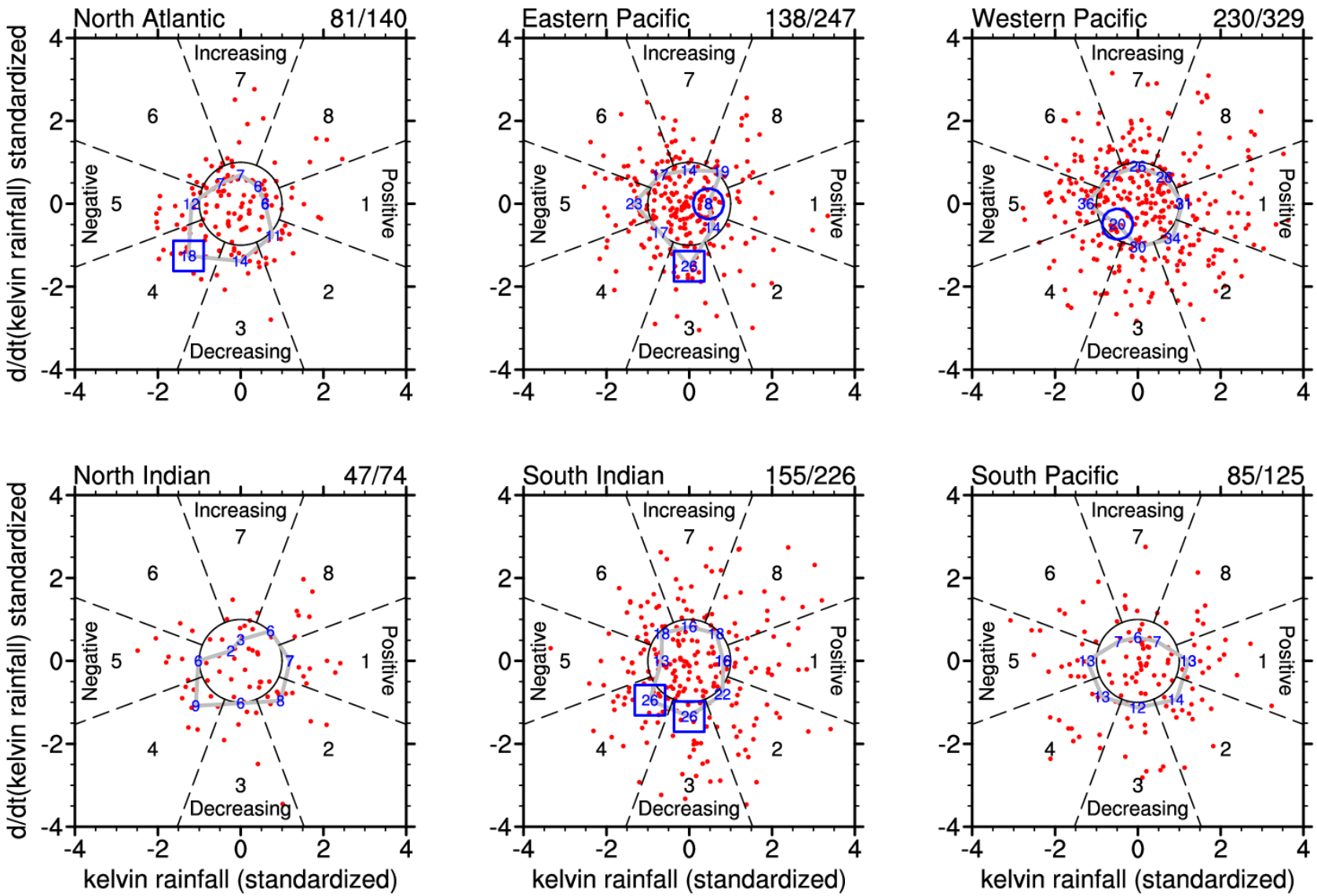


S.Indian Storm-Relative Hovmöllers

- Transition from easterlies to westerlies with the MJO
- Westerlies surge eastward with the Kelvin wave

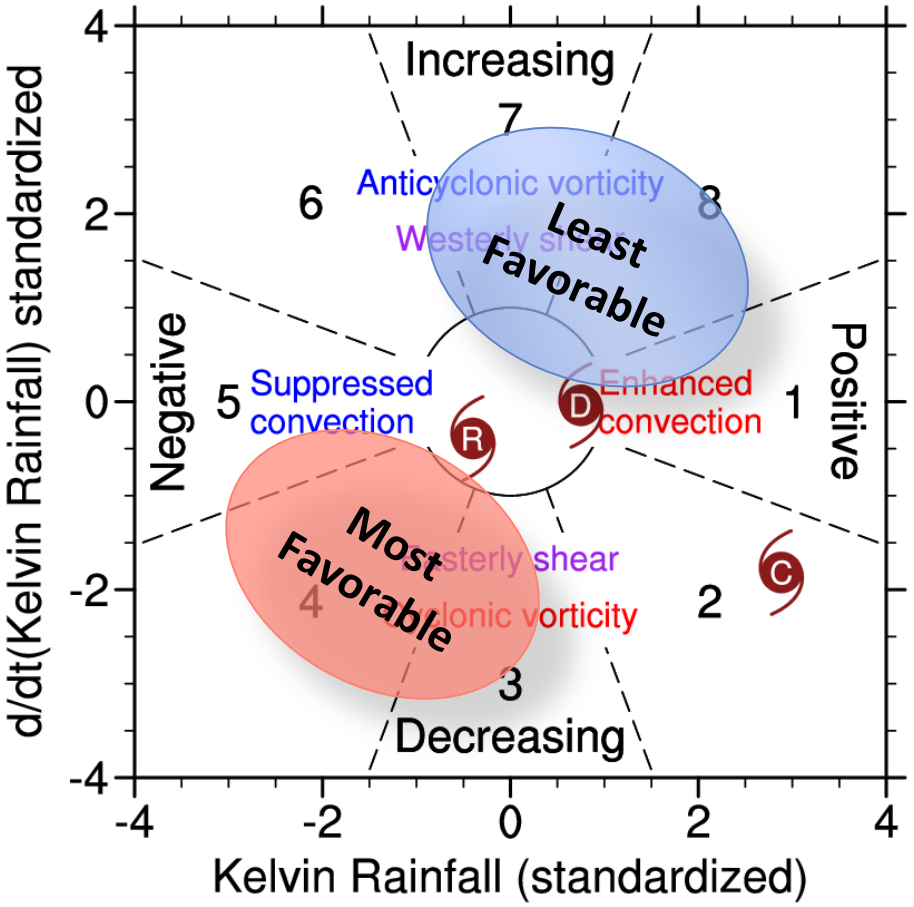


All basins


North Atlantic 81/140
Eastern Pacific 138/247
Western Pacific 230/329
North Indian 47/74
South Indian 155/226
South Pacific 85/125
Increasing
Decreasing
Negative
Positive
d/dt(kelvin rainfall) standardized
kelvin rainfall (standardized)

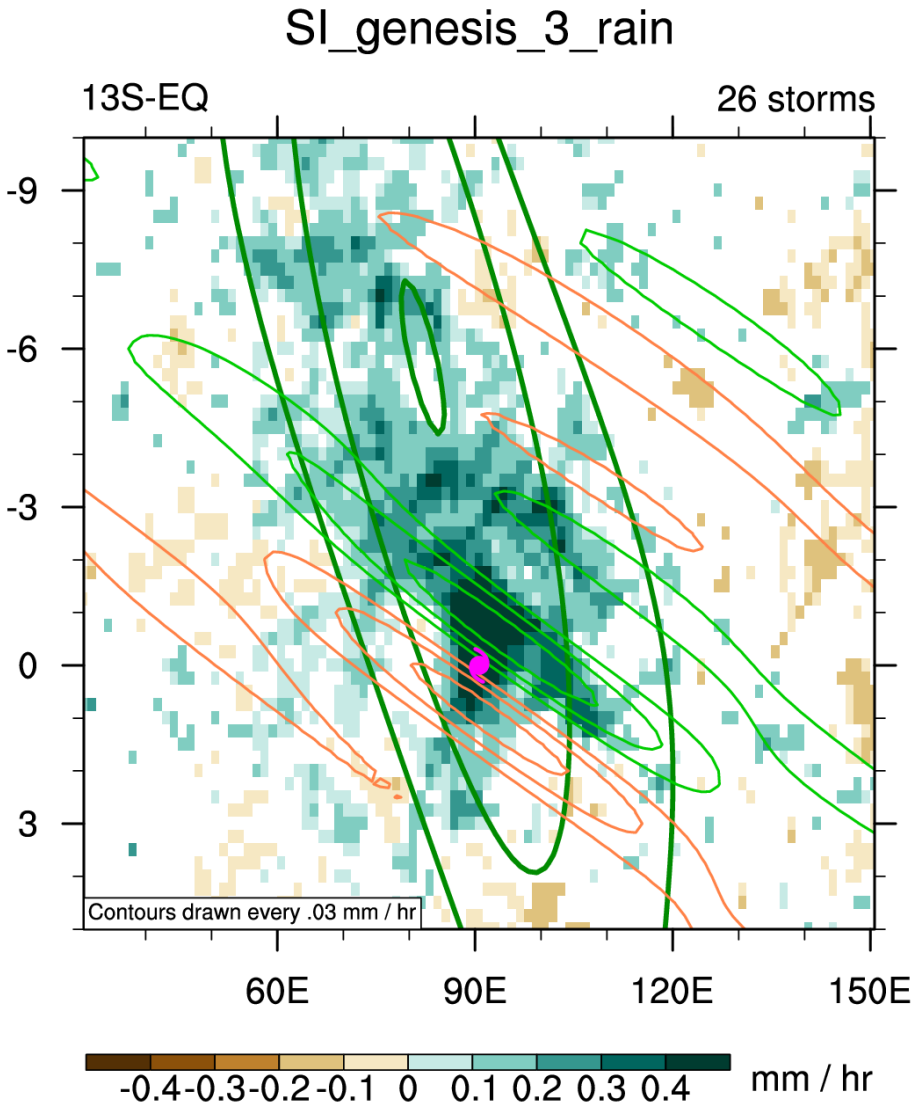
Summary

- Low-level westerlies
  - Persist into the suppressed phase of the Kelvin waves
  - Provides cyclonic vorticity
- Upper-level easterlies
  - Possible easterly shear anomalies
  - Possible enhanced TC outflow
- Temperature and moisture signals were inconclusive



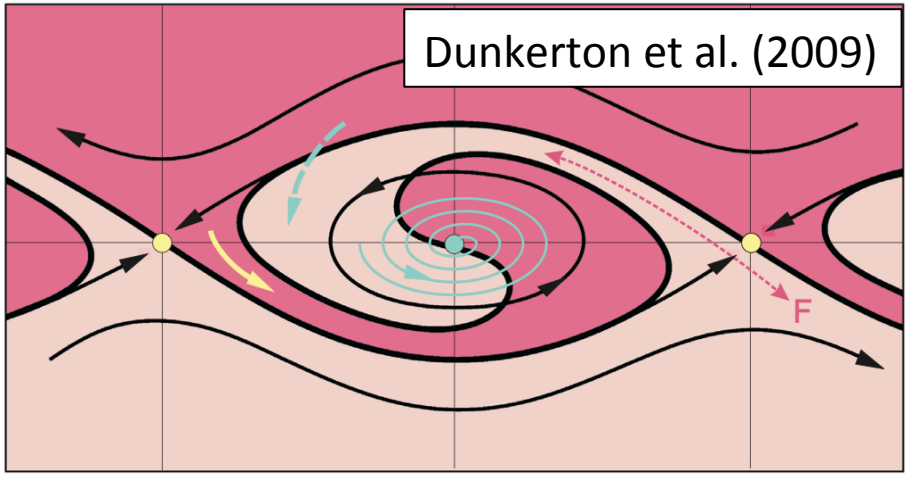
Remaining Questions

- What are the relative importance of the MJO and the Kelvin waves in the Eastern Hemisphere?

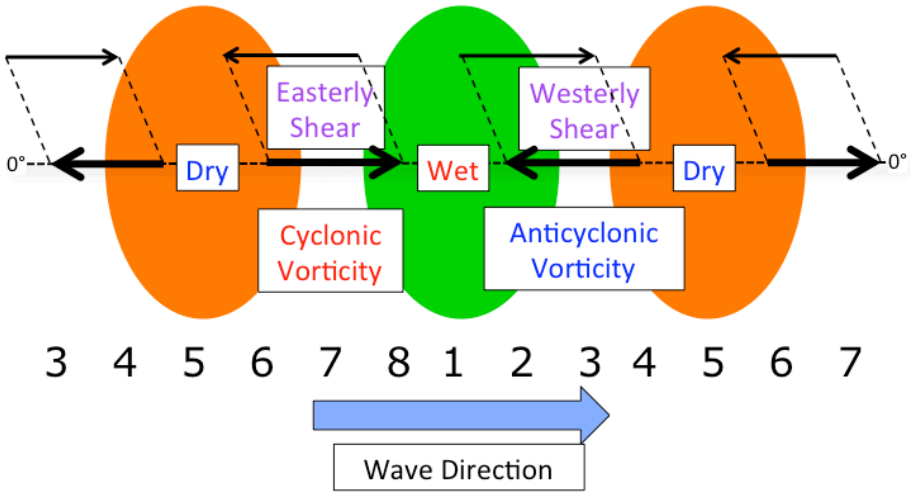


Remaining Questions

- What are the relative importance of the MJO and the Kelvin waves in the Eastern Hemisphere?

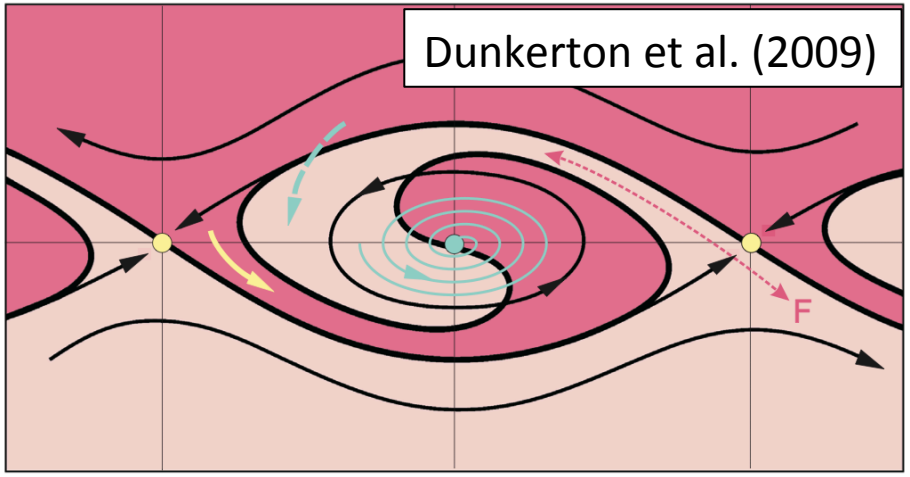


- How do Kelvin wave westerlies interact with Lagrangian recirculation?



Remaining Questions

- What are the relative importance of the MJO and the Kelvin waves in the Eastern Hemisphere?



- How do Kelvin wave westerlies interact with Lagrangian recirculation?