The MJO and the 2005 Hurricane Season

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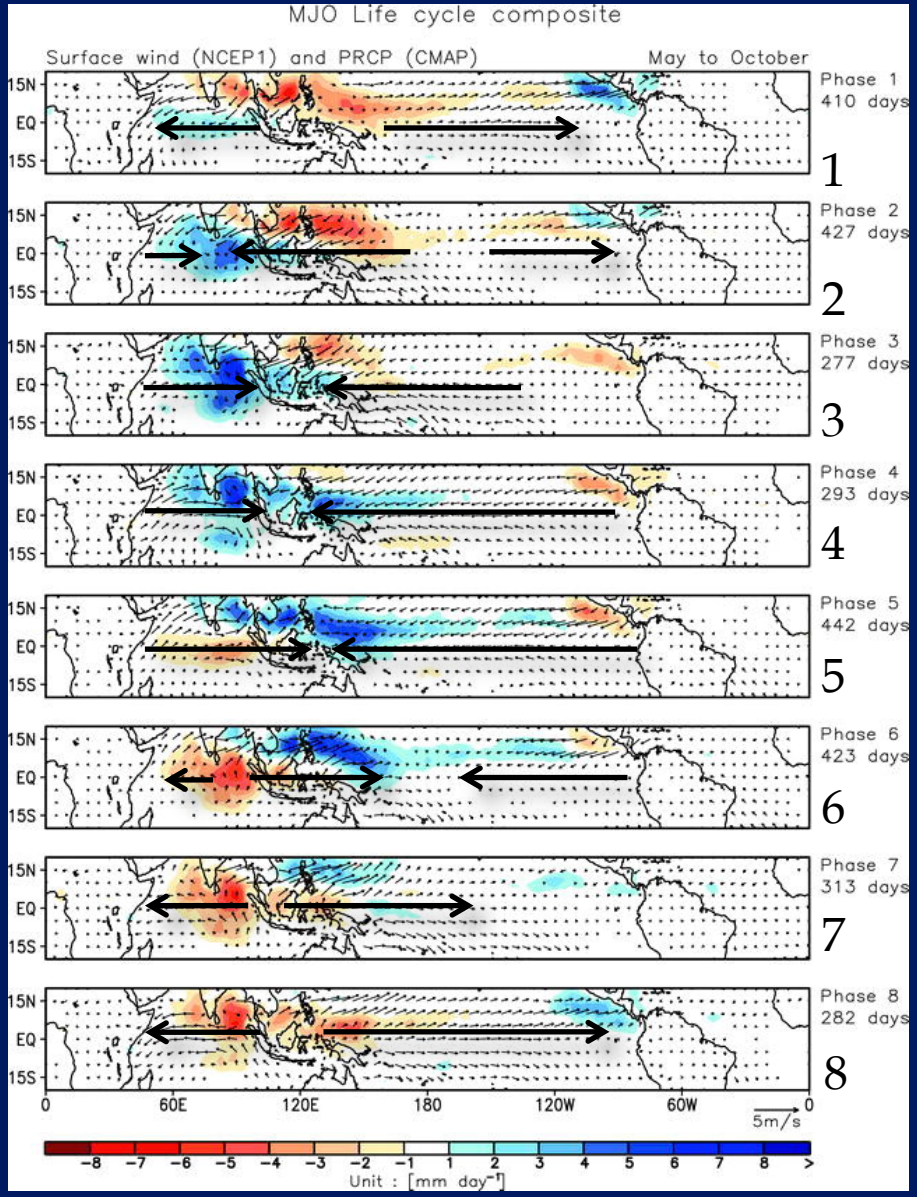
Summary

- MJO was active during the 2005 Hurricane Season
  - Wheeler–Hendon RMM shows weak, disorganized signal
  - Velocity potential and Water Vapor identify clear eastward propagating signal
- MJO influenced hurricane activity in the eastern Pacific and the Atlantic
  - Particularly in the eastern Pacific or equatorward of 20°N
- MJO modulated key factors that determine tropical cyclone activity
  - Convection
  - Moisture
  - Shear
  - Low-level westerlies
- Monitoring for future events
  - http://monitor.cicsnc.org/mjo/

Composite MJO

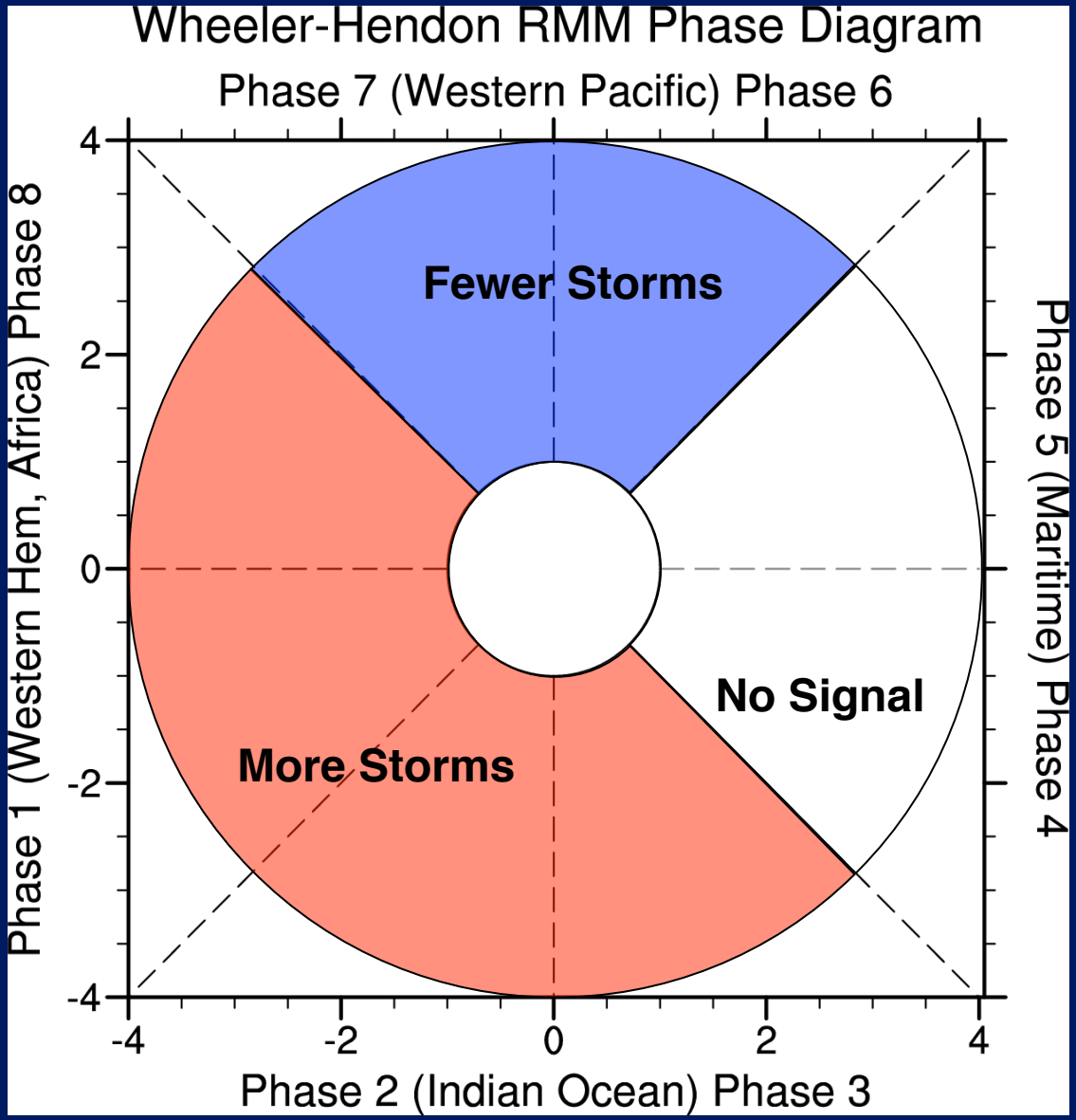
- Based on the RMM Index for May–June
- Each phase is ≈6 days apart
- Eastern Hemisphere dominates
- Weaker signal in eastern North Pacific
  - But important for hurricanes!



Anomalies of rainfall (shading) and surface winds
(CLIVAR MJO Working Group 2009, J. Climate)

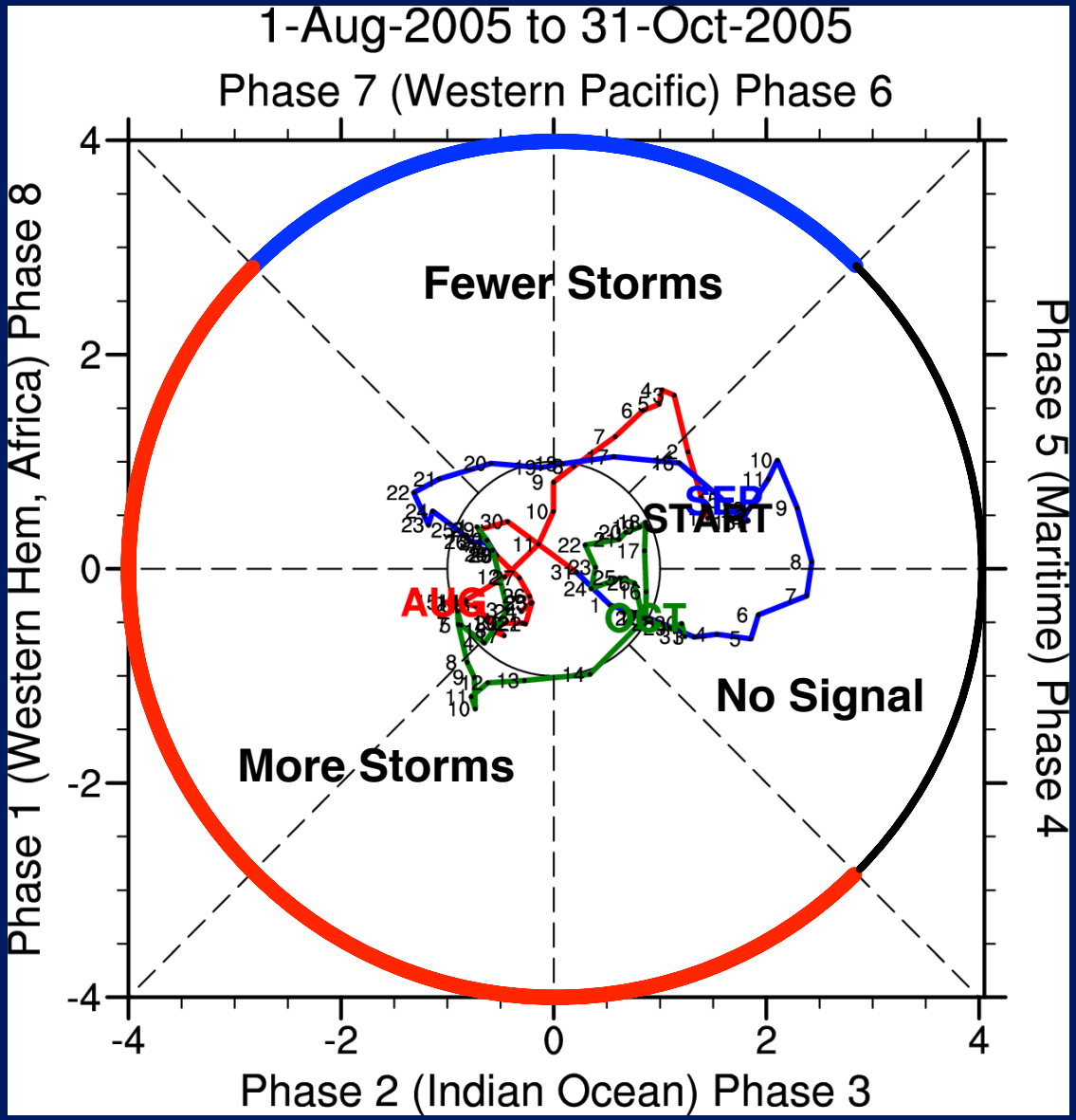
MJO Impacts on Hurricanes

- Strongest signals:
  - Eastern Pacific
  - Gulf of Mexico
  - MDR?
- Likely mechanisms:
  - Vertical Wind Shear
  - Moisture
  - Easterly Wave activity



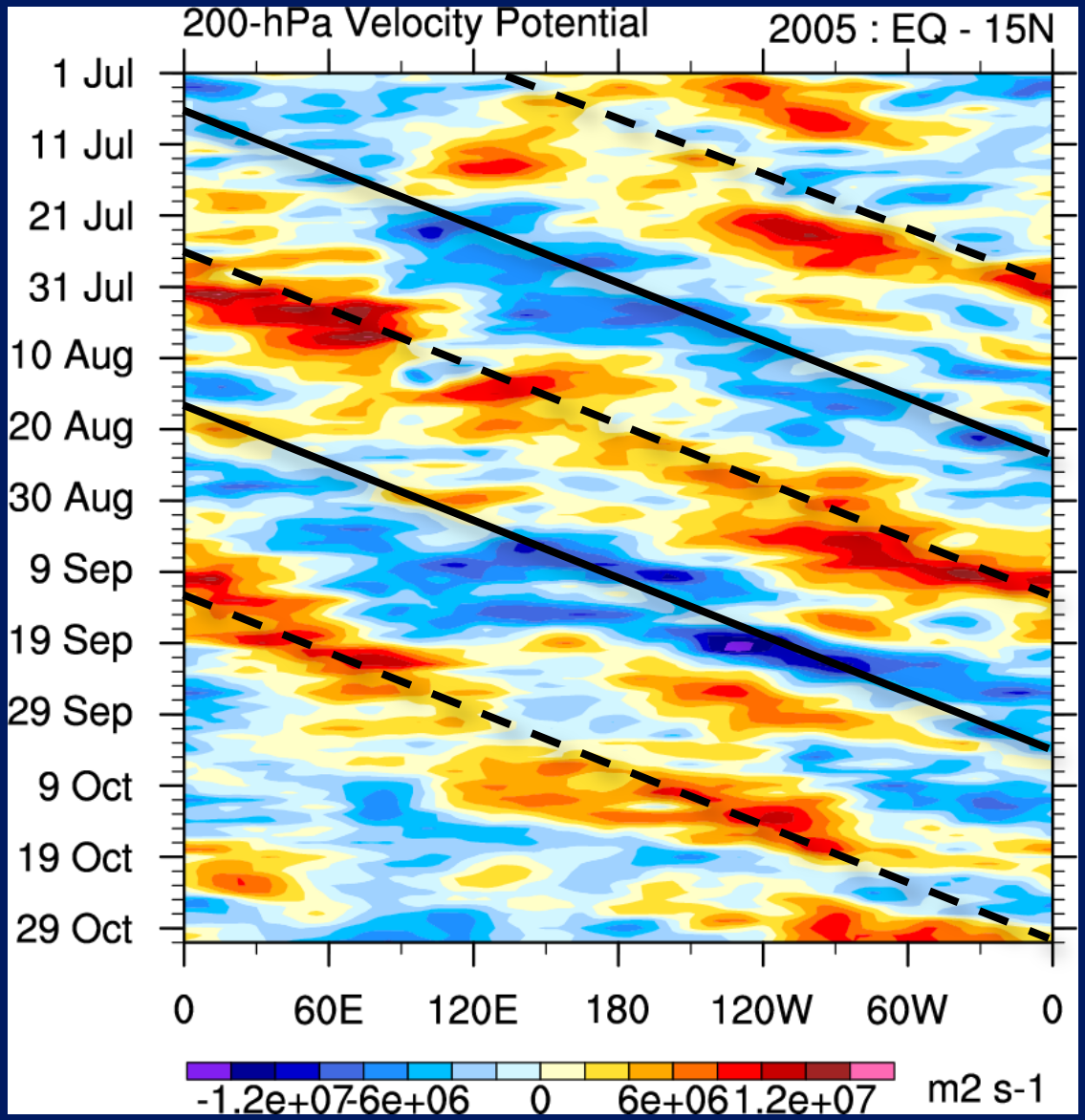
2005 Hurricane Season

- RMM Signal was weak and disorganized
- Suggests minimal influence on Atlantic TCs



200-hPa Velocity Potential

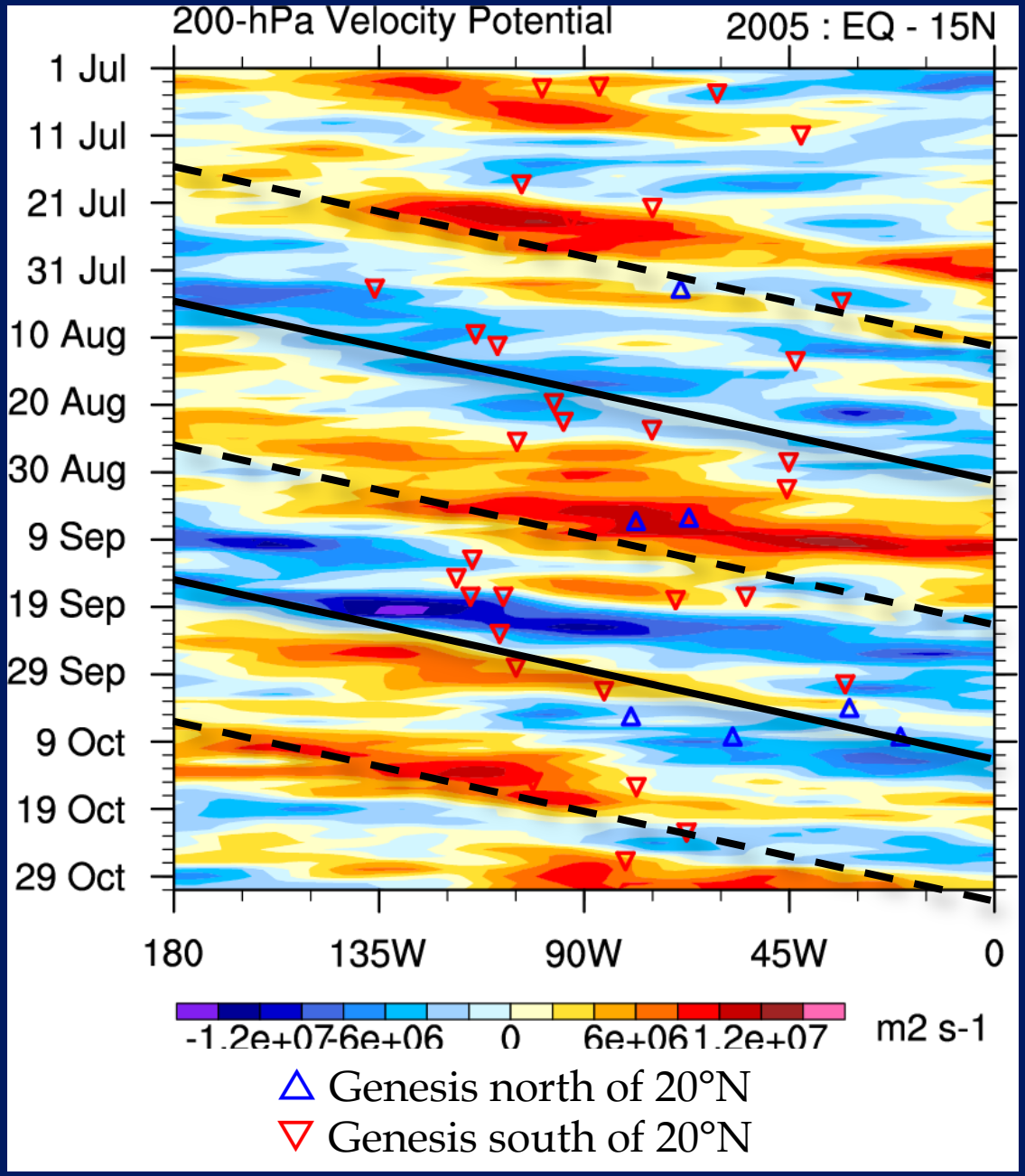
- Another common diagnostic for the MJO
  - Negative values indicate upper level outflow
- Clear eastward propagation
  - Period ≈ 40 Days
  - Phase Speed ≈ 10 m/s

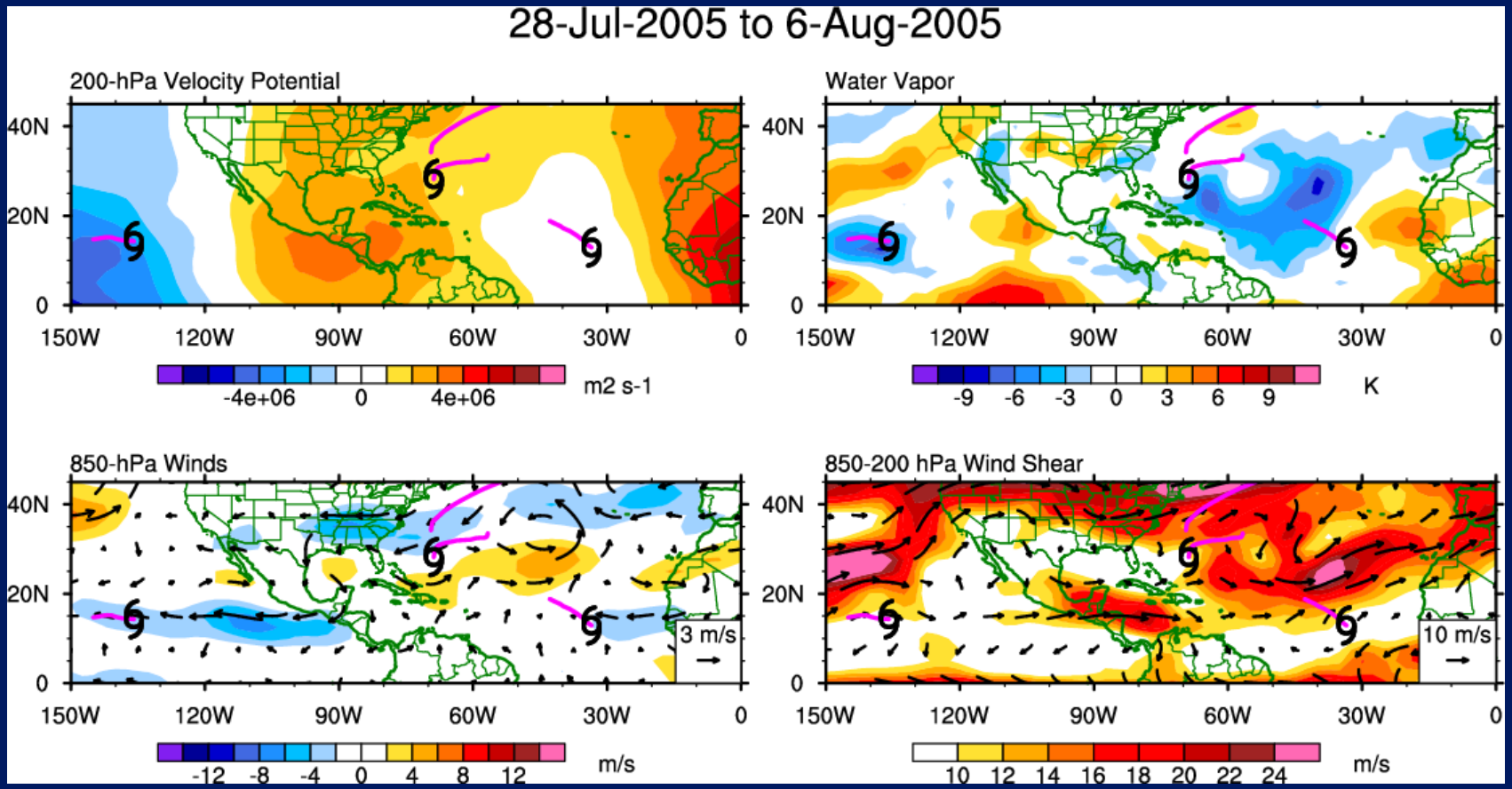


Data from the NCEP-DOE Reanalysis 2

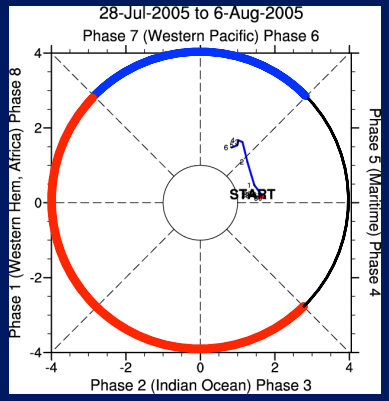
Western Hemisphere Tropical Cyclogenesis

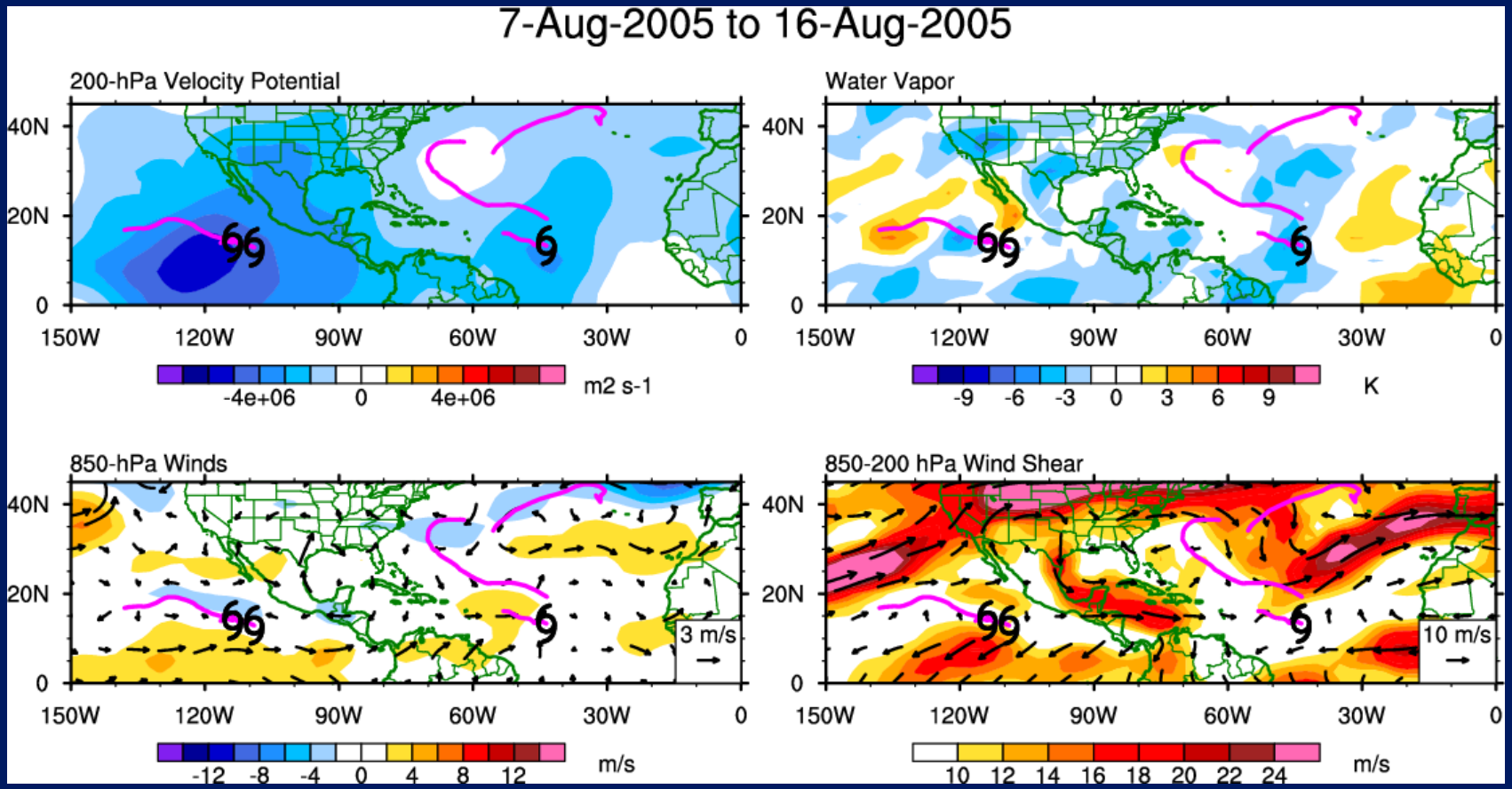
- Genesis points move eastward with MJO
- Strongest signals
  - Eastern Pacific
  - Equatorward of 20°N



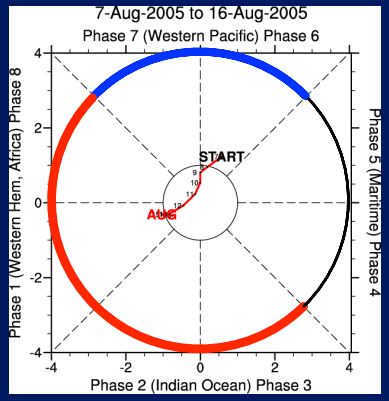


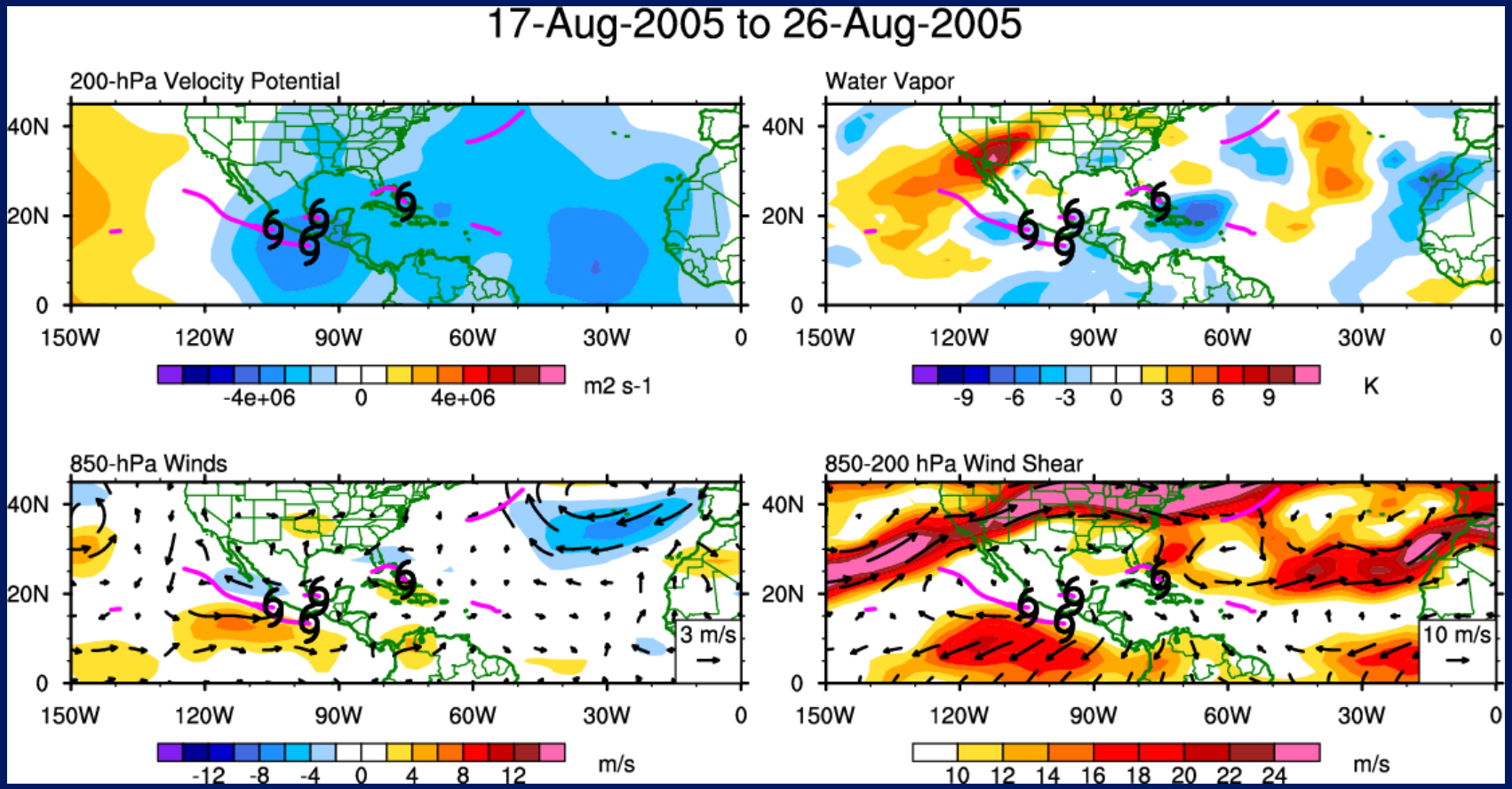
- Enhanced convection and enhanced moisture in far eastern Pacific
- Amplified trade easterlies over eastern Pacific
- No storms around Central America within suppressed convection



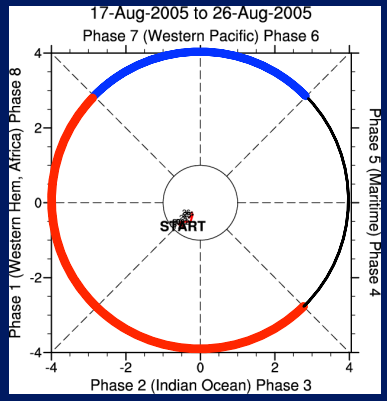


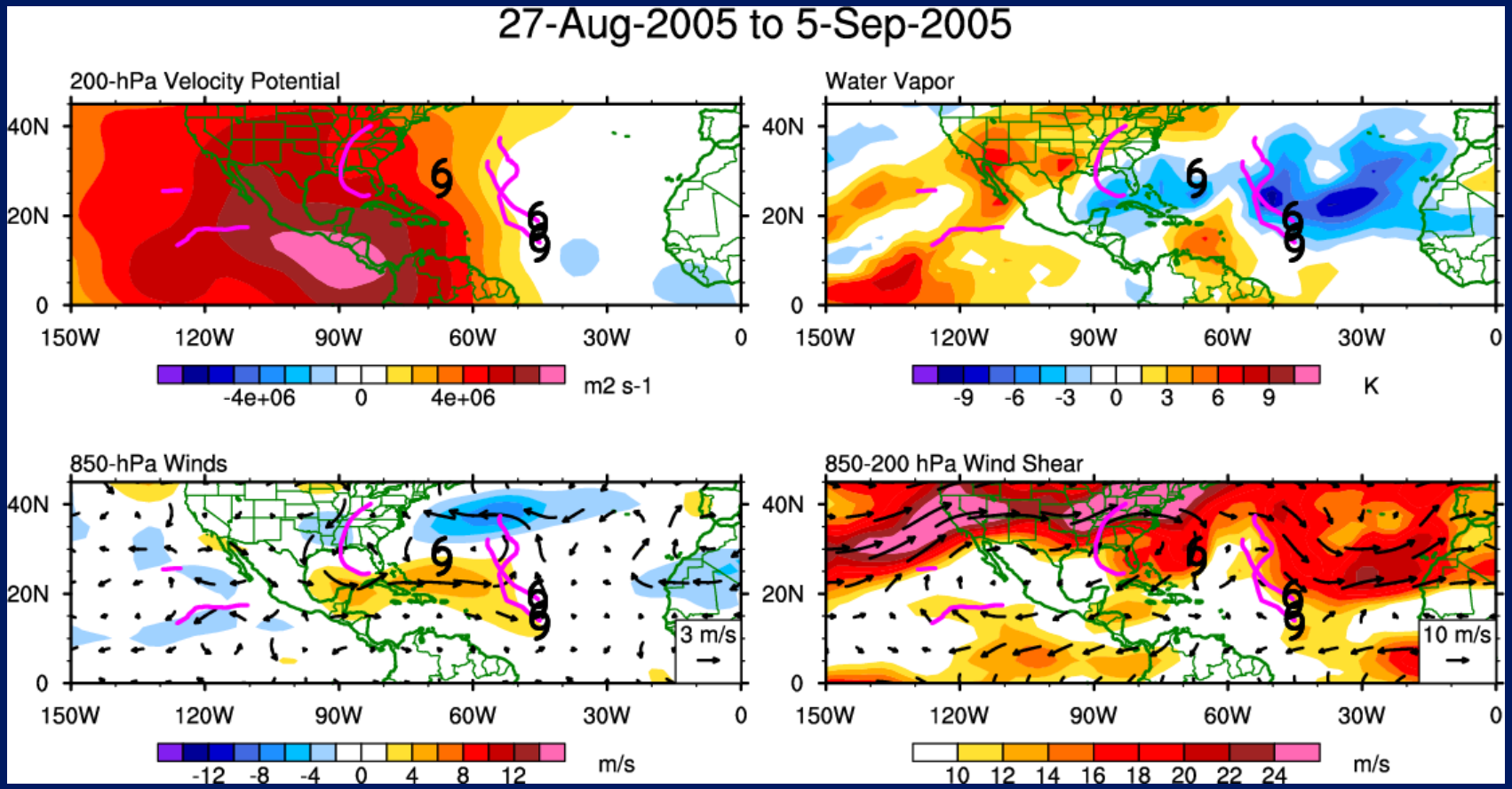
- Enhanced convection and moisture spread eastward
- Westerly anomalies develop over eastern Pacific
- Shear begins to increase over eastern Pacific



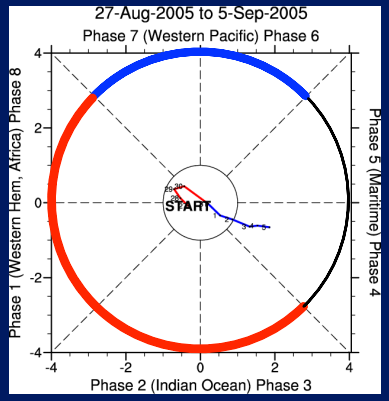


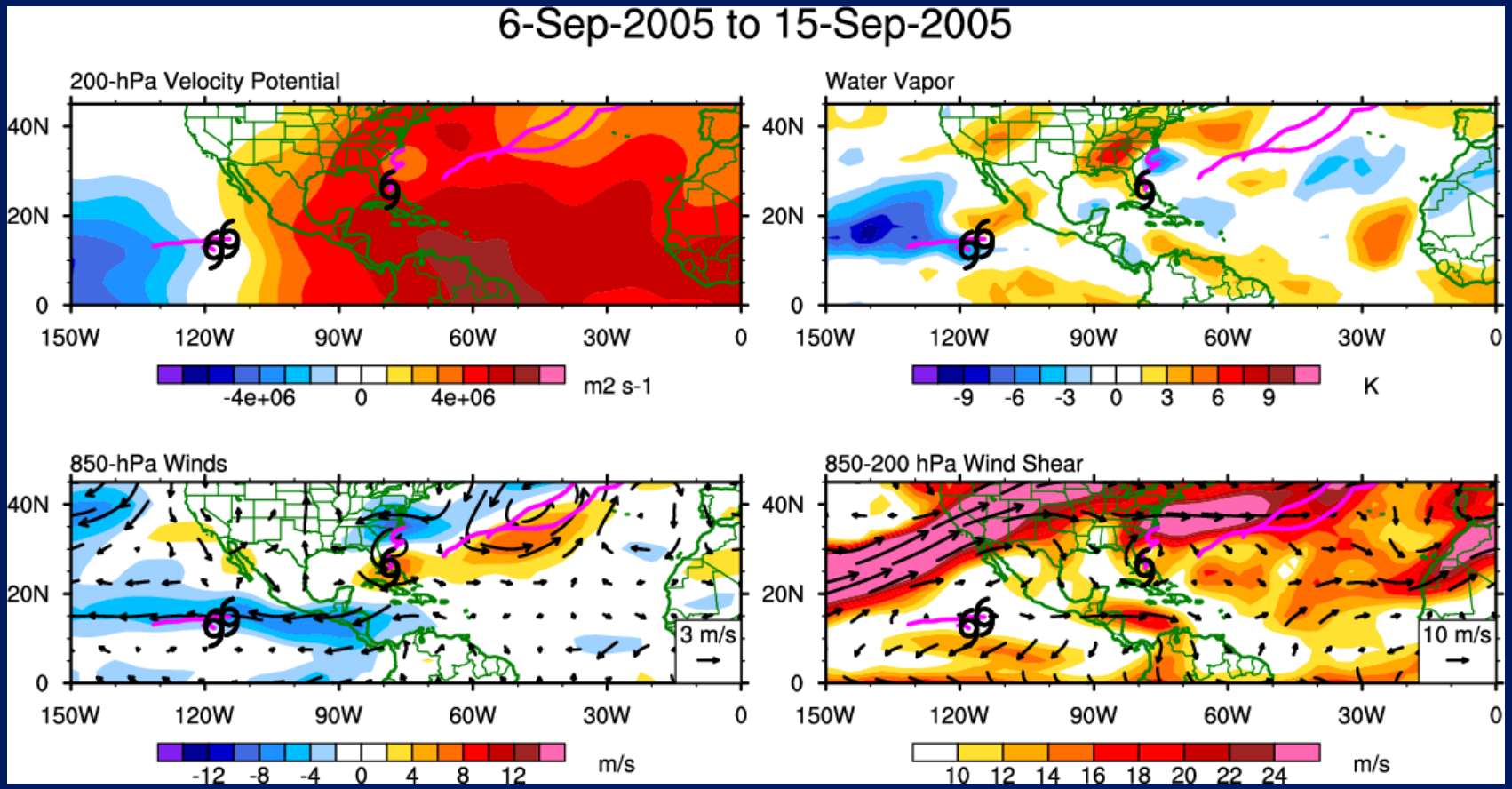
- Enhanced convection and moisture around Central America
- Westerly anomalies intensify over eastern Pacific
- Strengthening shear pushes eastern Pacific storms closer to the Mexican coast
- Katrina forms on Eastern edge of moist envelope



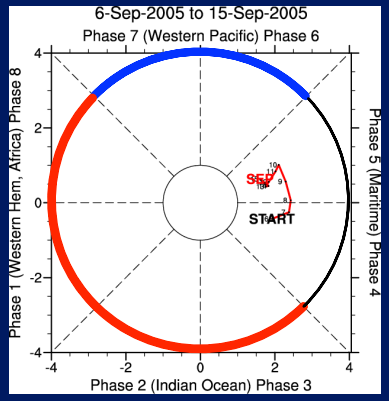


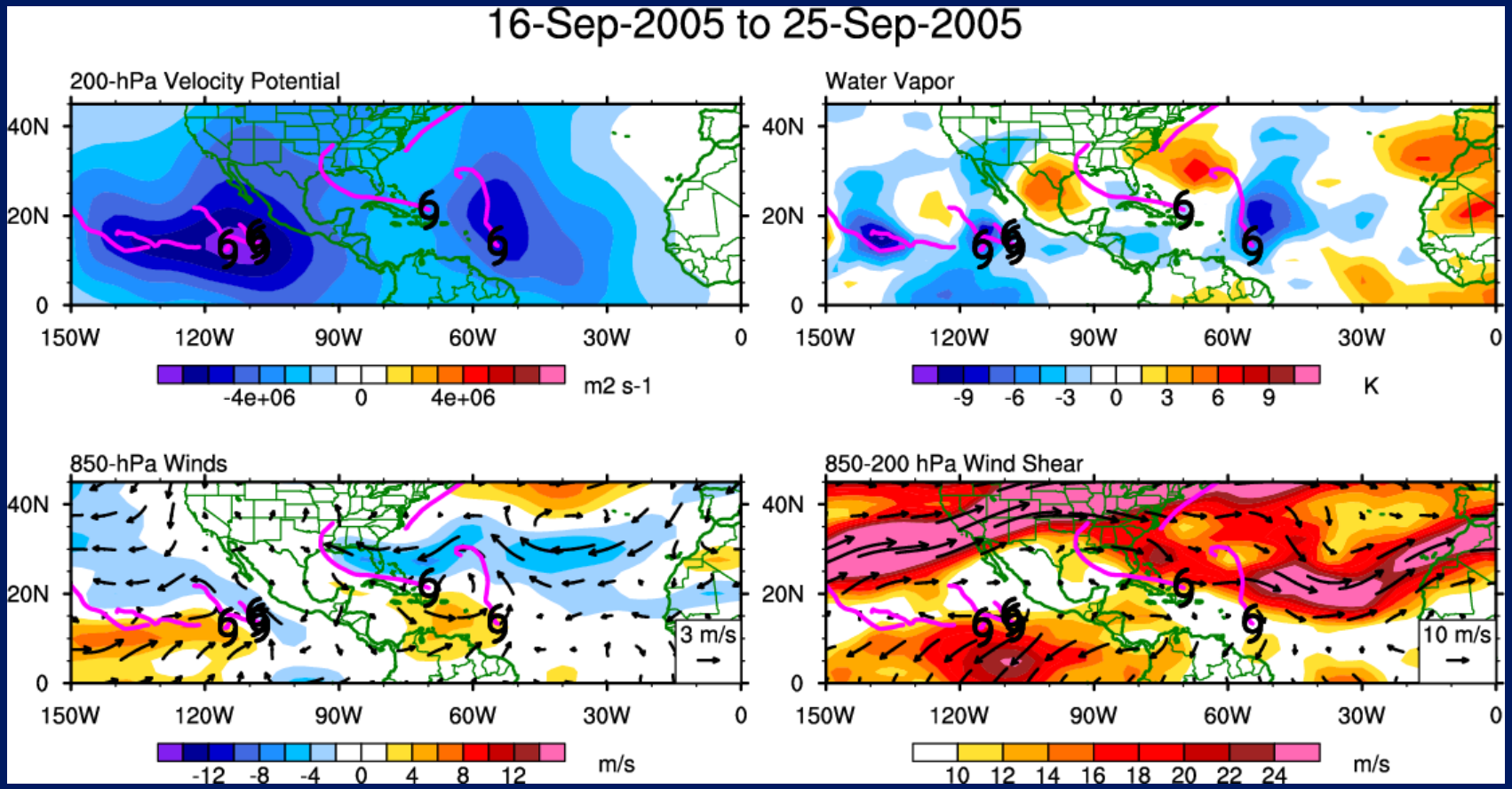
- Moisture and westerly anomalies move northeastward into Atlantic
- Dry anomalies extend from equatorial eastern Pacific to North America
  - No genesis in eastern Pacific, Gulf, or Caribbean



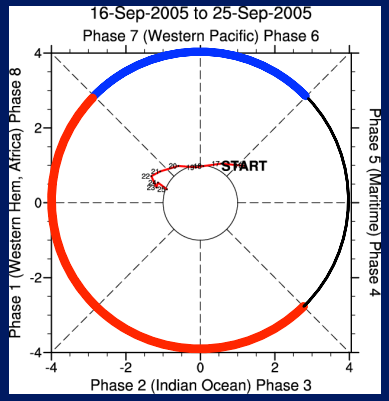


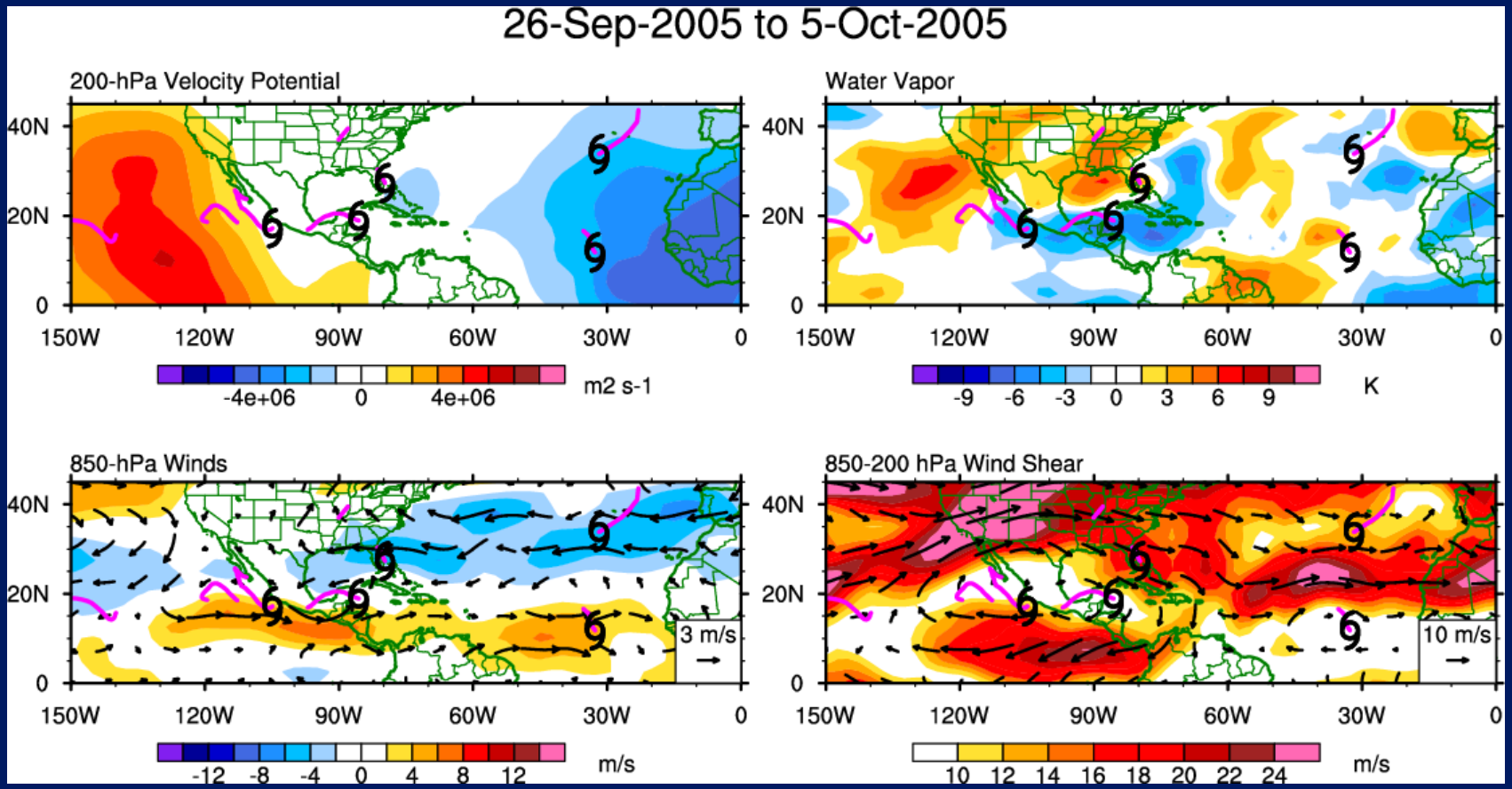
- Convection and easterly anomalies return to eastern Pacific
- Shear has weakened over the eastern Pacific
- Only genesis in Atlantic is Ophelia at the beginning of the period (6-Sep)



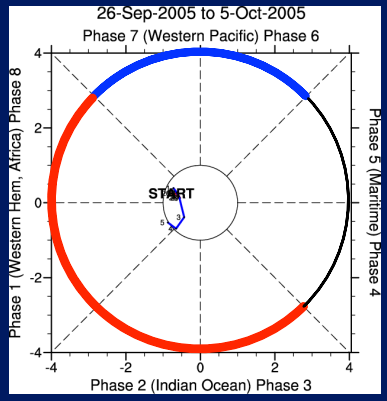


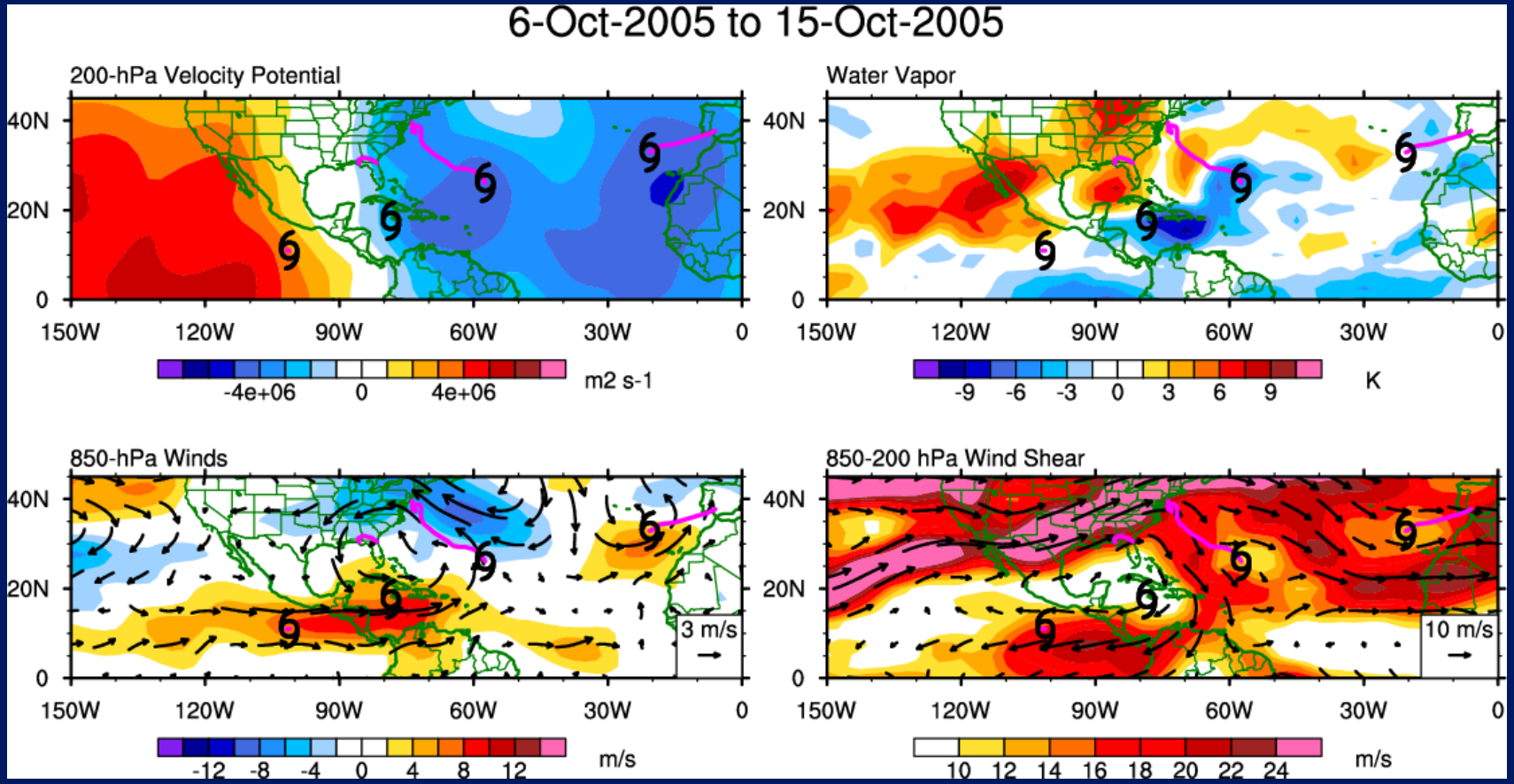
- Westerly anomalies develop as convection moves eastward
- Rita develops within weak envelope of moisture
- Shear intensifies over both basins
- Water vapor suggests a connection to the Southern Hemisphere



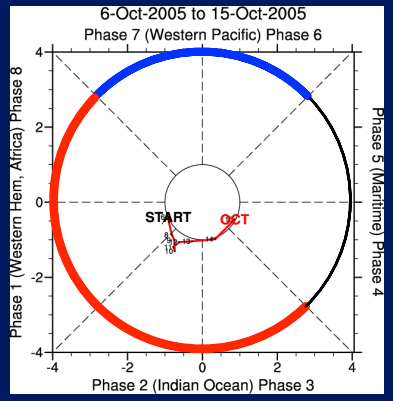


- Upper divergence moves to eastern Atlantic
- Anomalous westerlies and moisture straddle Central America
- Shear has strengthened over both basins





- Westerlies strengthen as upper divergence extends back into western Atlantic
- Wilma develops within envelope of enhanced moisture



Future Work

- Examine precipitable water using SSMIS data
- Develop a real-time MJO index for the Western Hemisphere
- Construct a climatology of these events

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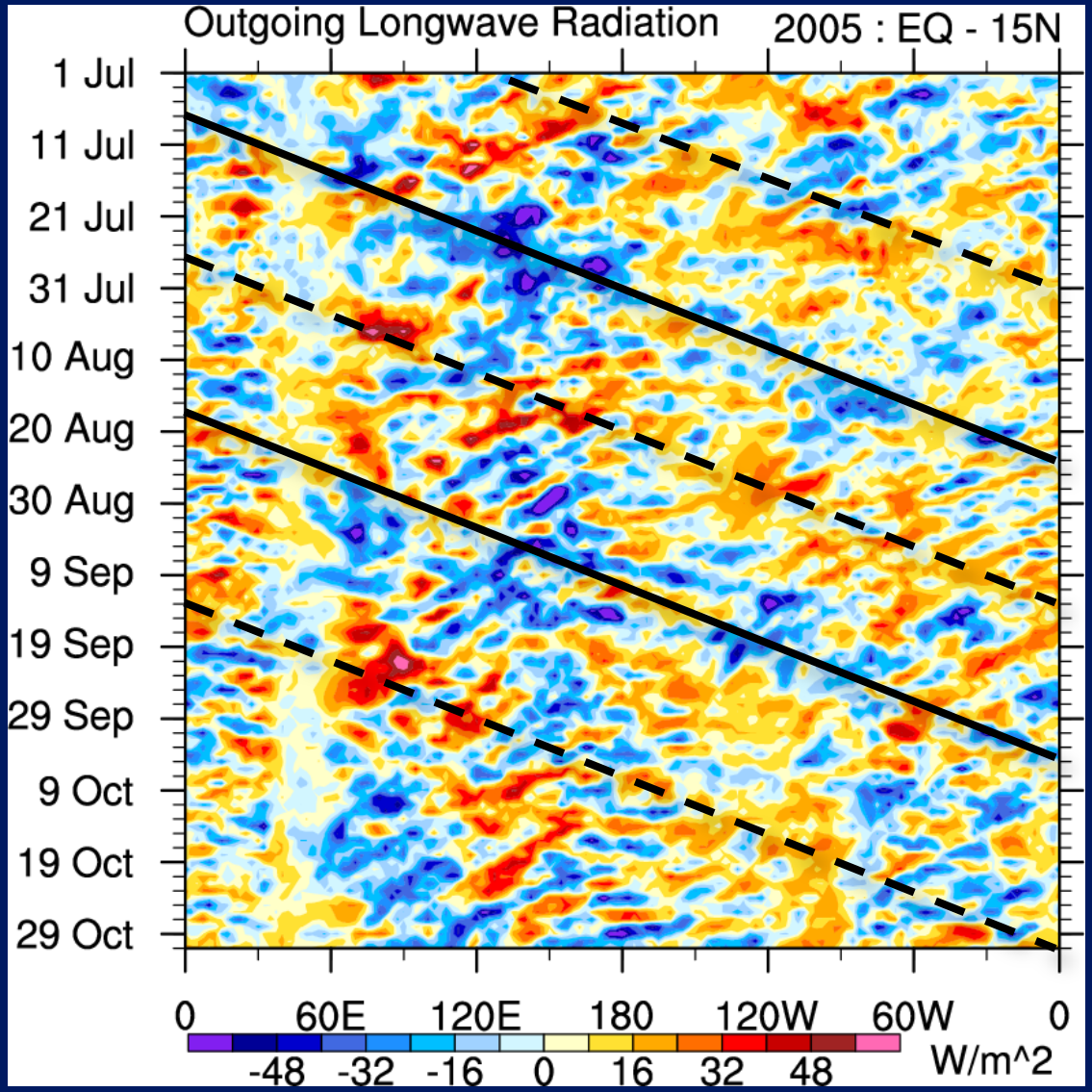
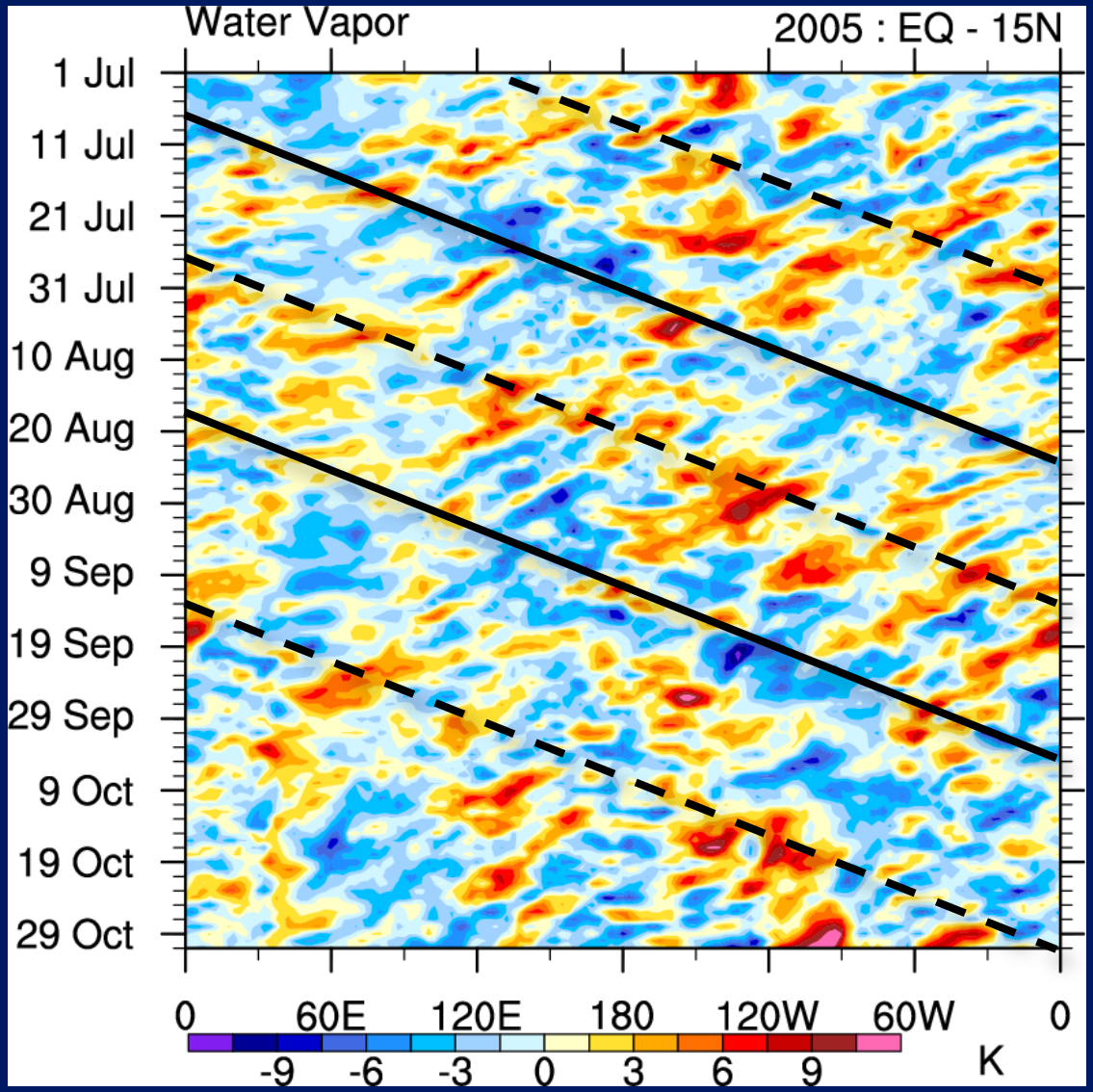
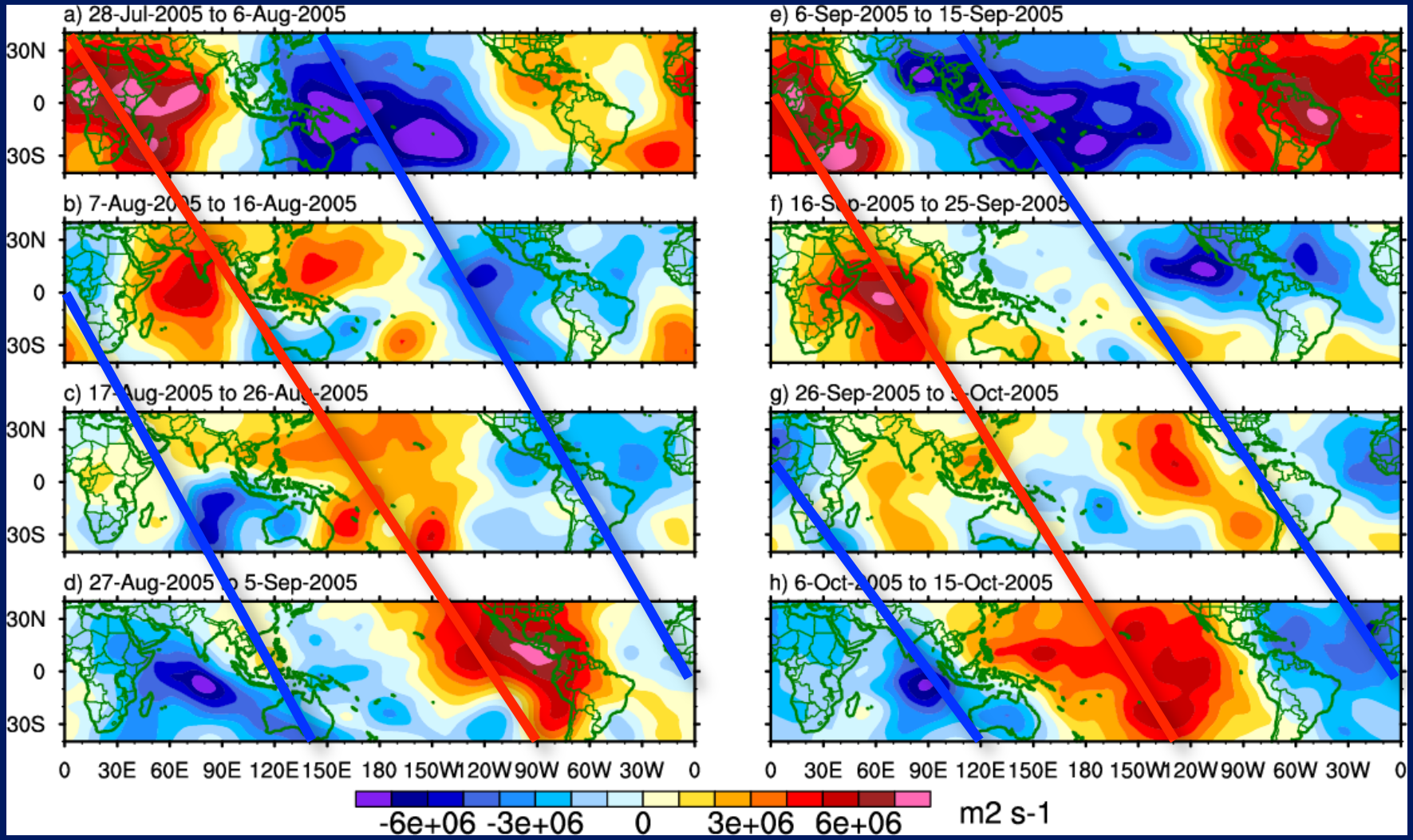
Extra Slides

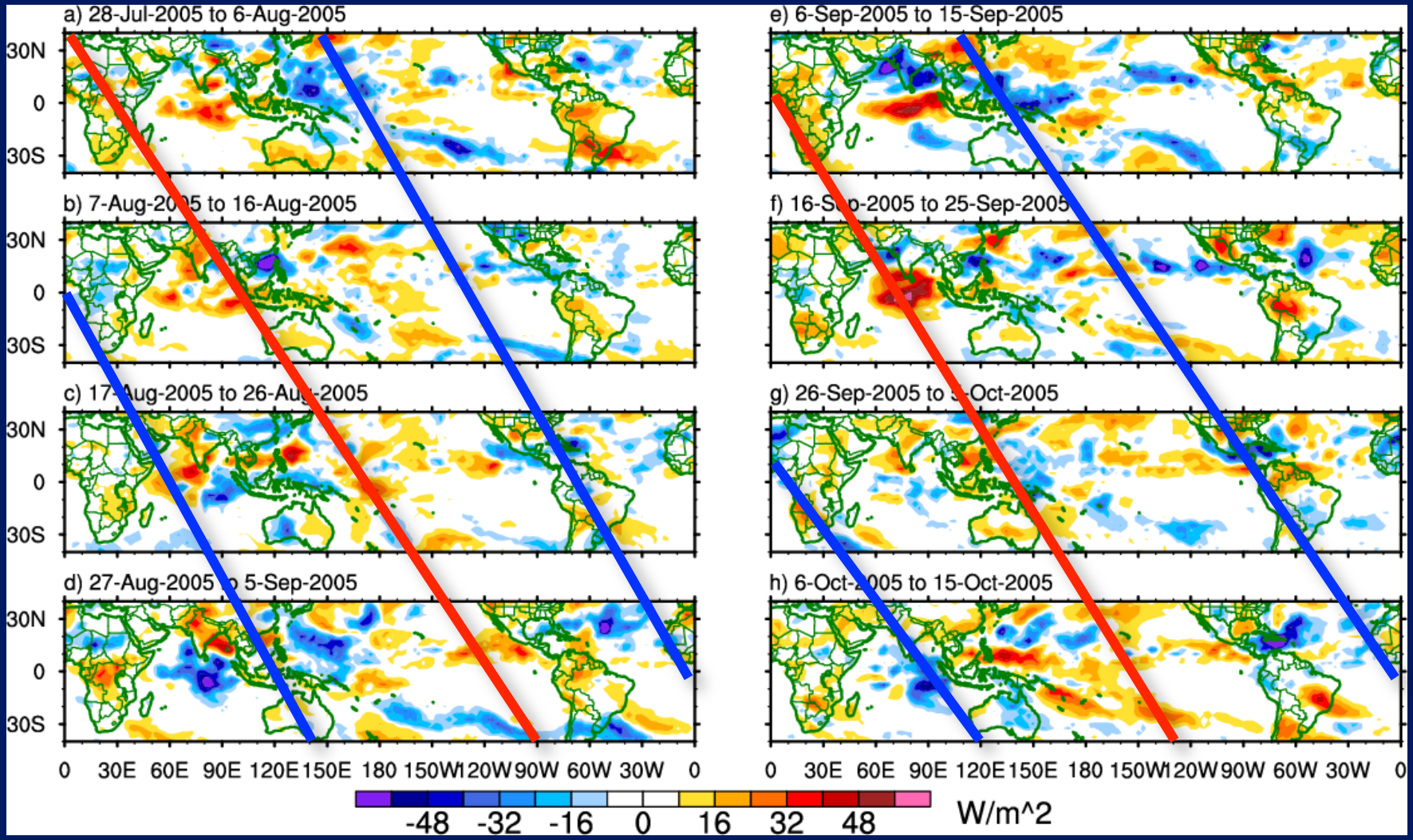

Outgoing Longwave Radiation
2005 : EQ - 15N
1 Jul
11 Jul
21 Jul
31 Jul
10 Aug
20 Aug
30 Aug
9 Sep
19 Sep
29 Sep
9 Oct
19 Oct
29 Oct
0
60E
120E
180
120W
60W
0
-48
-32
-16
0
16
32
48
W/m^2


Water Vapor
2005 : EQ - 15N
1 Jul
11 Jul
21 Jul
31 Jul
10 Aug
20 Aug
30 Aug
9 Sep
19 Sep
29 Sep
9 Oct
19 Oct
29 Oct
0
60E
120E
180
120W
60W
0
-9
-6
-3
0
3
6
9
K

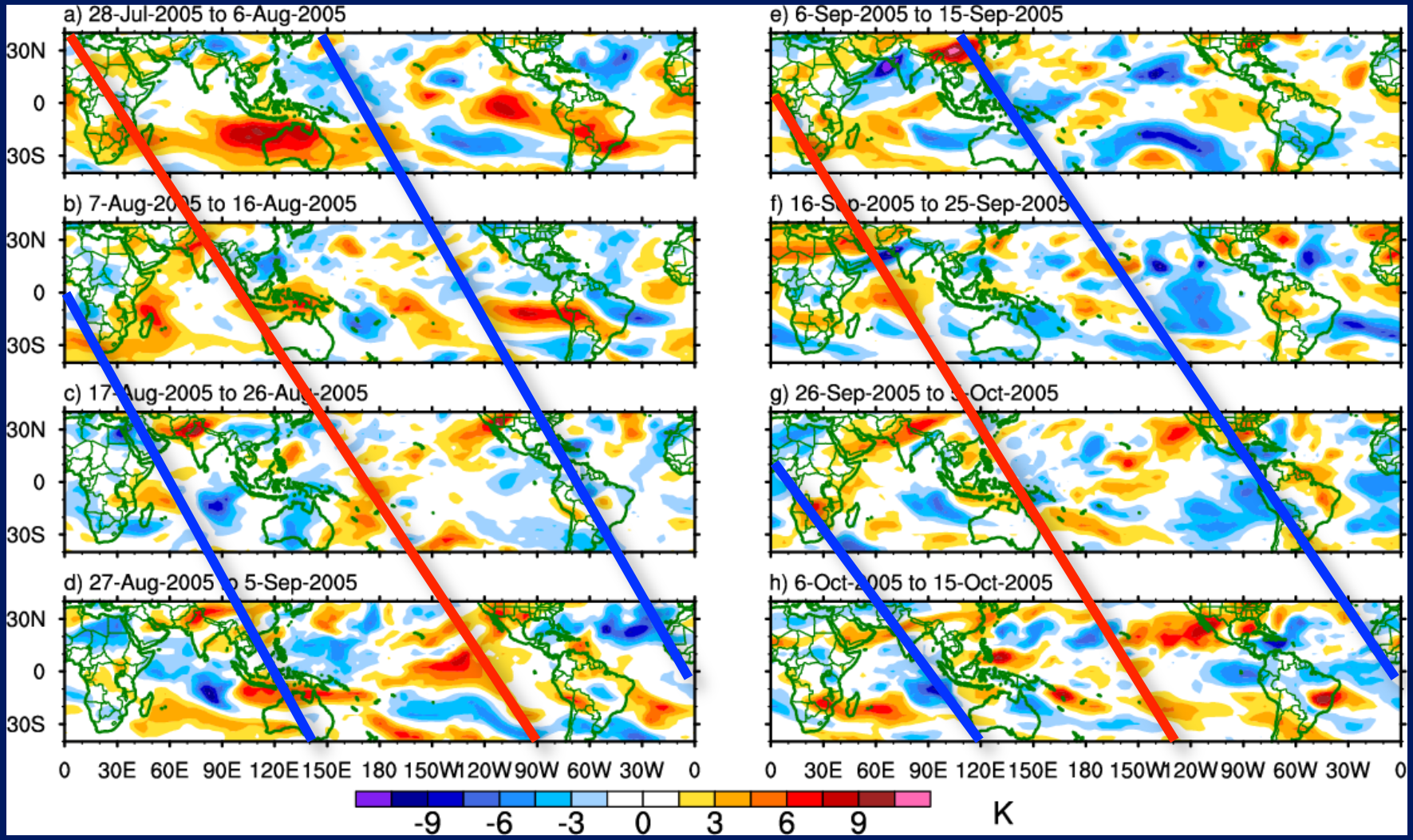
200-hPa Velocity Potential



OLR


a) 28-Jul-2005 to 6-Aug-2005
b) 7-Aug-2005 to 16-Aug-2005
c) 17-Aug-2005 to 26-Aug-2005
d) 27-Aug-2005 to 5-Sep-2005
e) 6-Sep-2005 to 15-Sep-2005
f) 16-Sep-2005 to 25-Sep-2005
g) 26-Sep-2005 to 5-Oct-2005
h) 6-Oct-2005 to 15-Oct-2005
30N
0
30S
0 30E 60E 90E 120E 150E 180 150W 120W 90W 60W 30W 0
-48 -32 -16 0 16 32 48
W/m^2

Water Vapor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g) 26-Sep-2005 to 5-Oct-2005
h) 6-Oct-2005 to 15-Oct-2005
30N
0
30S
0 30E 60E 90E 120E 150E 180 150W 120W 90W 60W 30W 0
-9 -6 -3 0 3 6 9
K