Ian Hinds

Geog 133 - Tropical Meteorology

Lab #7: Tropical Disturbances (40pts)

1. What are the main necessary conditions for the formation and strengthening of tropical cyclones? (3pts)

   - ***Warm rising air (warmer than 10000-12000m of local air column),***
   - ***Strong influences from the Coriolis force***
   - ***Weak local vertical wind shear***
   - ***Small low-pressure center***
   - ***An area with low level convergence and upper level divergence***

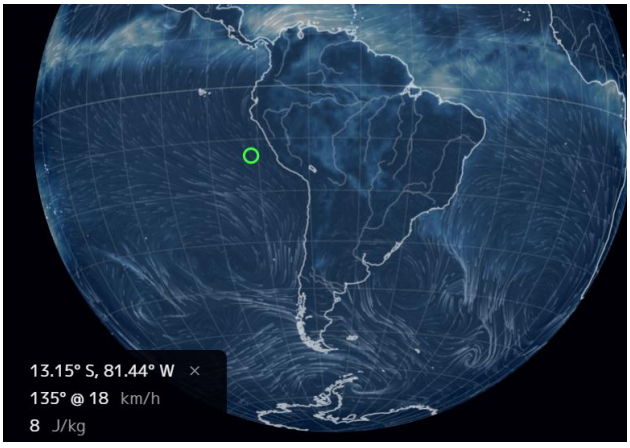
2. Observe the figure below and explain the following statements (use additional maps/composites with sea surface temperature to help your answers if needed; 8pts)

a) Tropical Cyclones are not observed between 5S and 5N

There is no interference from the Coriolis force at the equator, preventing any cyclones in this region.

b) Tropical cyclones do not occur in the west coast of South America and Africa

Vertical wind shear is usually too great and convective energy values are low for cyclones to form (see image for convective energy visual)



c) Tropical cyclones are rare in the east coast of South America. (Hints: easterly waves occur north of the Equator and are more common during the Northern Hemisphere summer. On the other hand, during the Southern Hemisphere summer, deep convection over tropical South America, which is associated with large-scale divergence of winds in upper levels of the atmosphere, creates unfavorable atmospheric conditions for tropical cyclones to form). **Discuss the implications of these statements for the rare occurrence of tropical cyclones near the east coast of South America.** Use diagrams if needed.

Cyclones need warm air convergence and convection at the surface level. However, strong diverging winds in the upper atmosphere outweigh the converging air near the surface, causing an abundance of vertical wind shear and decreasing the possibilities of tropical cyclones to form.

d) The trajectory of tropical cyclones turns eastward as they move to higher latitudes (in both hemispheres)

Above 30^{o} latitude, the westerlies dominate the atmospheric airways, pushing the tropical cyclones eastward.

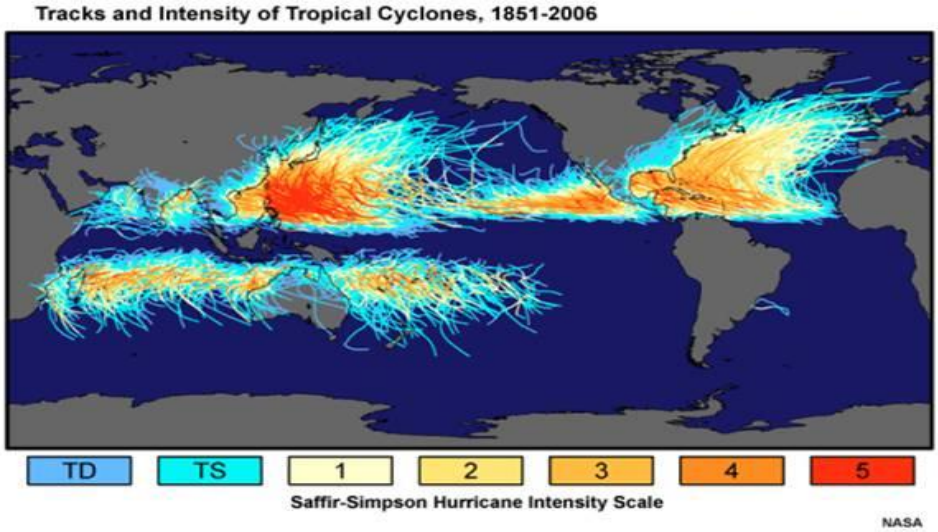


Fig. 10.1. Global distribution of observed tropical cyclone tracks from 1851-2006 (where available).

3. How do easterly waves form, and what is their general structure once they have formed? Why are they important for the formation and development of hurricanes in the Atlantic? (4pts)

   Easterly waves form because of interactions with adiabatic dynamics, boundary layers, moisture and radiative processes. The ITCZ influences easterly waves, as it provides diverging upper atmospheric air. Easterly waves often move ahead in the upper atmosphere, but behind in lower levels. Easterly waves contribute to sporadic weather patterns.

4. a) **Explain** why strong **wind shear** inhibits the organization of tropical cyclones. (4pts)

   Strong wind shear inhibits the organization of tropical cyclones by pushing air moisture, convection, and pressure faster upwards, decreasing the rotational potential in the lower level atmosphere.

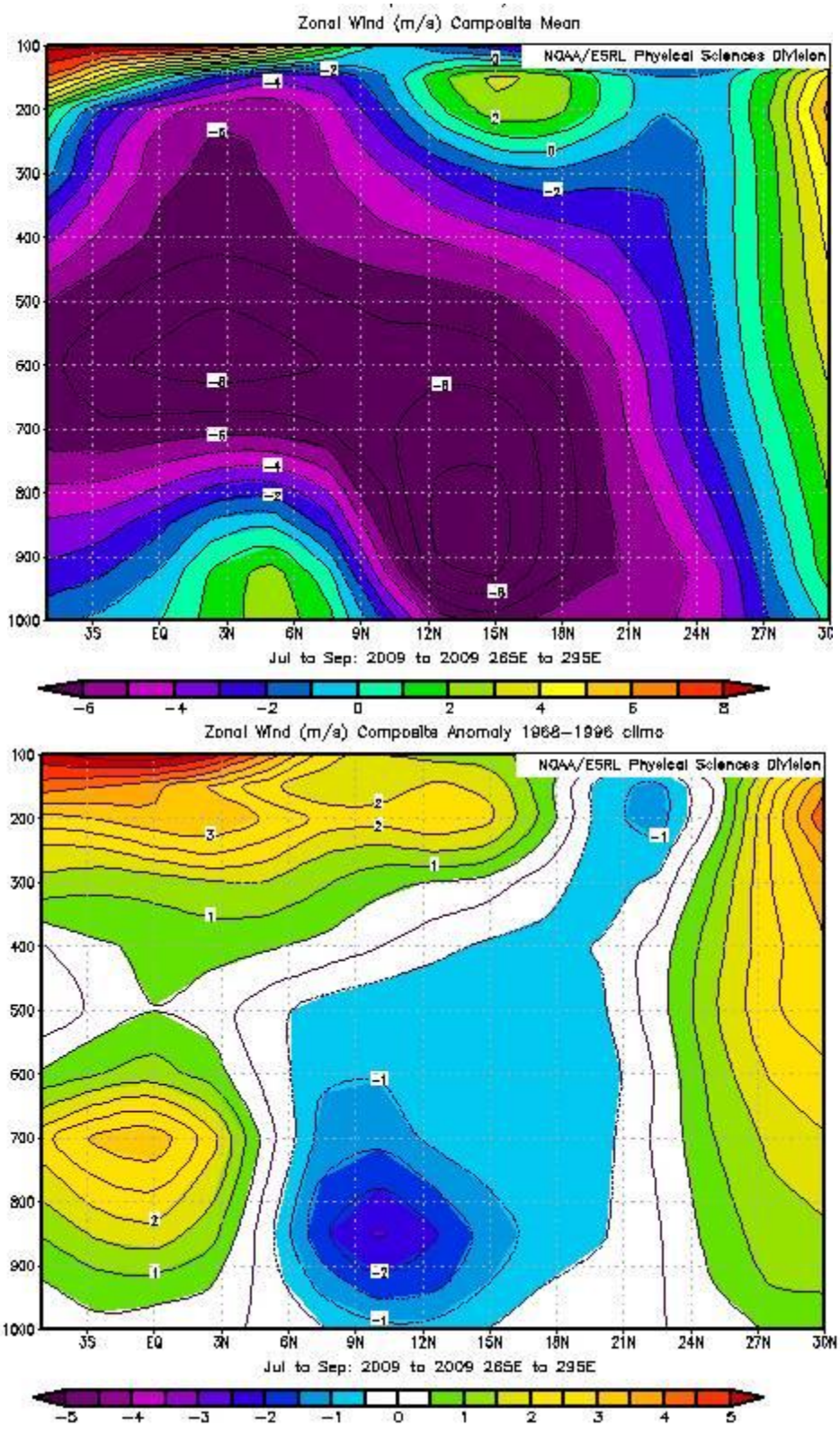
b) The set of figures below shows zonal wind composites (mean and anomalies) from June-September 2009 and June-September 2005. Latitude-height composites are obtained for the longitude range 95W-65W and for latitudes varying from 5S-30N (Look at Google Maps or Google Earth or any available map to find this region!). The 2009 hurricane season was marked by the beginning of an El Niño event. The number of hurricanes in 2009 was below the average whereas in 2005 it was above the average. **Compare the two seasons and show why atmospheric conditions in 2005 were more favorable for a high number of hurricanes in the Atlantic compared with 2009.** (4pts)

(PLEASE BE CAREFUL: COLOR BARS ARE NOT DISPLAYED WITH THE SAME SCALE).

Atmospheric conditions in 2005 were more attractive for hurricanes because of higher than average zonal winds, meaning more convergence with the easterly trade winds and a better potential for hurricane formation. Whereas in 2009, there was less than average zonal wind, meaning less convergence with the Tradewinds and fewer hurricanes.

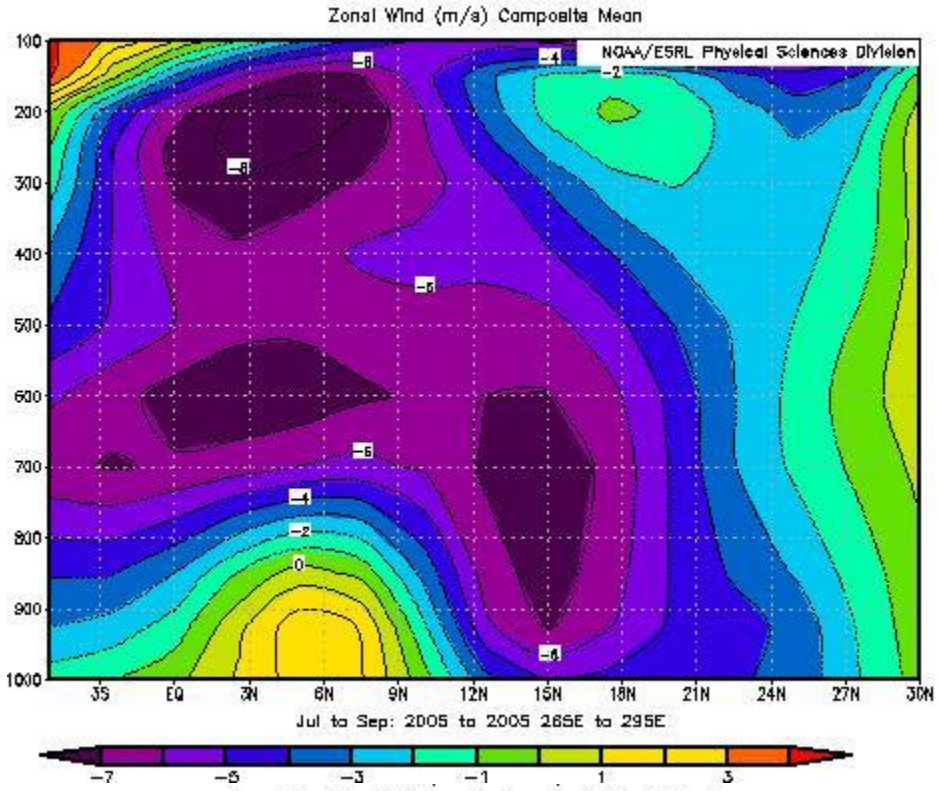
Ian Hinds

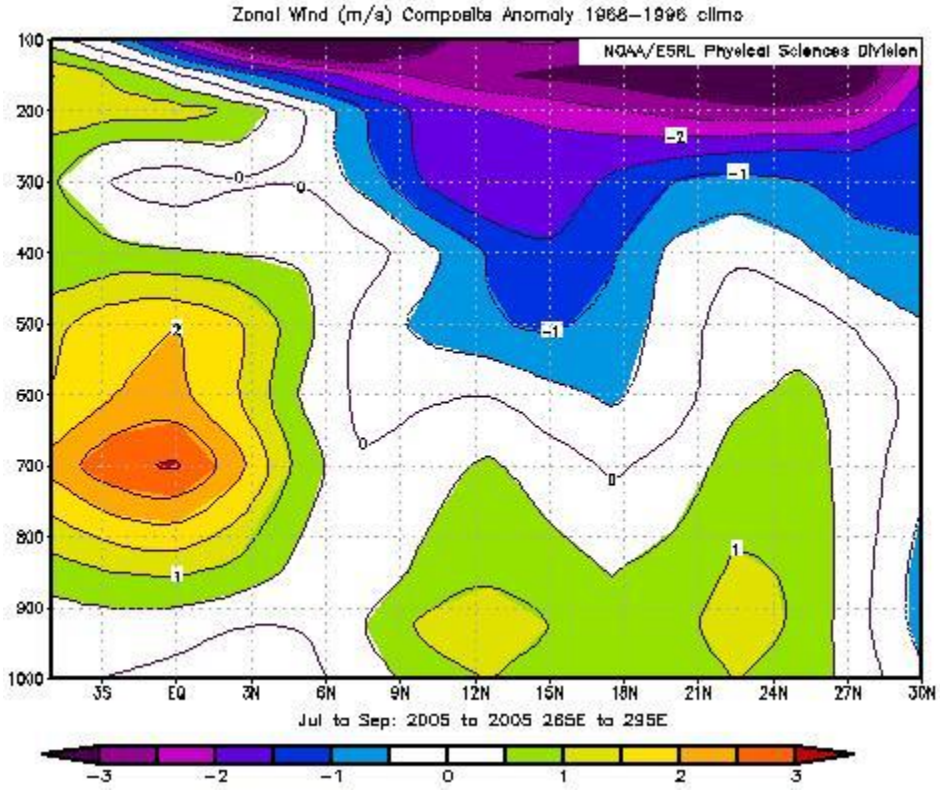
June-September 2009 (zonal wind mean and anomaly)



Ian Hinds

June-September 2005 (zonal wind mean and anomaly)





5. What are some of the key differences between tropical cyclones and extratropical cyclones? (4pts)

   - Warmer center (tropical) vs. Cooler center (extra)

   - Fronts (extra) vs. no fronts (tropical)

   - Latent heat energy (tropical) vs. horizontal temperature gradients (extra)

6. Research a tropical cyclone of your choice that has caused significant damage to areas of human habitation. Briefly summarize when and where the storm occurred, and the types of damage it caused. Don't forget to cite your sources for your research. (5pts)

   Cyclone Harold formed this last April near the Solomon Islands in the south pacific ocean. The storm took 27 lives, caused several injuries, and damages to homes. Local reactions were impacted by lockdowns previously imposed because of COVID-19.

   Cyclone Harold (https://blogs.nasa.gov/hurricanes/2020/04/03/harold-southern-pacific-ocean/)

7. Tropical cyclones have a warm core. Describe the conditions that lead to the formation of the warm core, and the mechanisms that aid in maintaining the warm core. Be sure to discuss cloud types, latent heat, air pressure, and the feedback processes. (8pts)

   Tropical cyclones need warm air convergence at the surface to be able to transmit latent heat of condensation into the atmosphere. This latent heat energy drives the dynamics of the cyclone. A low pressure center assists in maintaining warmer surface air and stronger surface winds, also improving the intensity of the tropical cyclone as there would be less interference from vertical winds. As pressure remains low, heat remains consistent, positively fueling the formation of the cyclone.