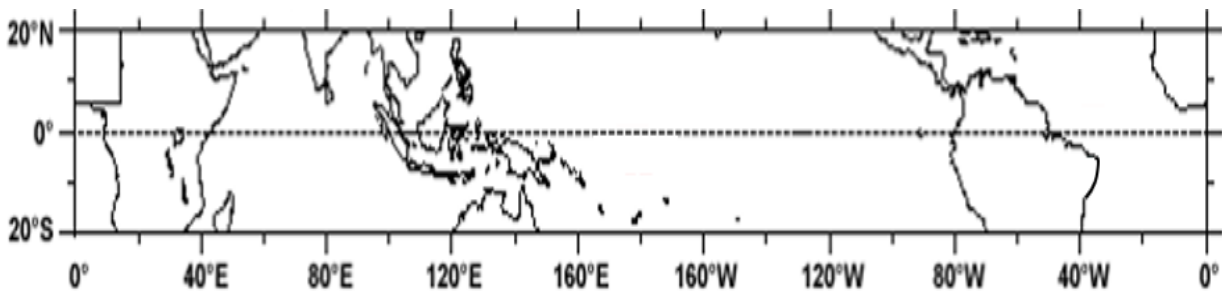


Tropical Meteorology – Homework #2

Due Date: 1 March 2016

1. (30 pts) For this question, please refer to Figure 1 at the end of this assignment.
 - a. (18 pts) In Figure 1, areas of enhanced and suppressed convection associated with $n = 1$ equatorial Rossby, Kelvin, and mixed Rossby-gravity waves are depicted. Using this information, please sketch on the figure below the lower tropospheric wind field resulting from the observed equatorial waves. Please limit your sketch to the Eastern Hemisphere. You may find it helpful to first sketch on Figure 1 the wind field for each wave type in isolation before blending them together below.



- b. (12 pts) The NOAA/ESRL/PSD website enables daily mean composites of many atmospheric fields to be created using NCEP/NCAR Reanalysis data. This site is available at:

<http://www.esrl.noaa.gov/psd/data/composites/day/>

Go to this website. Choose “Vector Wind” as your variable. Choose “850mb” as your analysis level. Enter a single year, month, day as 2008 11 18. Choose a plot type of “Mean.” Choose “Custom” as your region of globe. Enter -20 and 20 as your lowest and highest latitude, and 0 and 180 as your westernmost and easternmost longitudes. Finally, click on “Create Plot.” This will create a plot of the daily mean 850 hPa wind for 18 November 2008, the same day as in Figure 1. Right-click on the resulting plot and choose “Save image as...” (or similar) to save it to your local computer. Attach it to your completed assignment. How well does this 850 hPa wind analysis compare to your sketch above? Please discuss noteworthy areas of agreement and disagreement.

2. (70 pts) For this question, please use the Hovmöller plots available on the course website at <http://derecho.math.uwm.edu/classes/TropMet/assignments/HW-EW/>. There are a total of twenty-one images in this directory, encompassing the period from 1 April 2011 to 11 February 2016. Images are numbered sequentially in time. All images are courtesy Carl Schreck's webpage at <http://monitor.cicsnc.org/mjo/v2/>.

In general, Hovmöller plots include time as one of their axes, commonly the y axis. In the plots available on the course website, time increases moving downward along the y axis, with longitude plotted along the x axis. Please focus only on the portion of each plot above "Begin Forecast." Outgoing longwave radiation anomalies averaged between 7.5°S and 7.5°N, are shaded per the color bar at the bottom of each image. Negative (positive) values indicate enhanced (suppressed) convective activity. Contours indicate outgoing longwave radiation anomalies associated with the Madden-Julian Oscillation (blue), $n = 1$ equatorial Rossby waves (black), and Kelvin waves (green). Solid (dashed) contours indicate enhanced (suppressed) convection associated with each wave type.

For parts (b) and (c) of this question, please only focus on waves that last for at least seven days (contours extending between two consecutive tick marks along the y axis) and travel at least 30° longitude (contours extending between two consecutive tick marks along the x axis).

- a. (20 pts) Contours depicting $n = 1$ equatorial Rossby waves have steeper slope of an opposite sign to contours depicting Kelvin waves. Why do the contours for $n = 1$ equatorial Rossby waves have steeper slope than do those for Kelvin waves? Why are the contours for $n = 1$ equatorial Rossby waves sloped in the opposite direction than are those for Kelvin waves?
- b. (25 pts) For this question, please consider only the convectively-enhanced phase of $n = 1$ equatorial Rossby waves (the solid black contours).
 - i. (6 pts) Over what range of longitudes are $n = 1$ equatorial Rossby waves most commonly found?
 - ii. (6 pts) During what times of year are $n = 1$ equatorial Rossby waves most and least common?
 - iii. (13 pts) Archived tropical cyclone data for 2011-2016 are available from Unisys at <http://weather.unisys.com/hurricane/>. Which tropical cyclones in the Western Pacific and South Pacific formed at the time and longitude of the convectively-enhanced phase of an $n = 1$ equatorial Rossby wave? Of all of the tropical cyclones that formed in these basins between 2011-2016, what percentage formed at the time and longitude of the convectively-enhanced phase of an $n = 1$ equatorial Rossby wave?

- c. (25 pts) For this question, please consider only Kelvin waves (the green contours).
- i. (6 pts) Over what range of longitudes are Kelvin waves most commonly found?
 - ii. (6 pts) During what times of year are Kelvin waves most and least common?
 - iii. (13 pts) Archived values of the Oceanic Niño Index, reflecting the three-month-averaged sea surface temperature over the region 5°S-5°N, 120°W-170°W, are available from [NOAA](#). Values greater than +0.5°C denote El Niño conditions, while values less than -0.5°C denote La Niña conditions. Use a plotting program (Excel, GrADS, MATLAB, etc.) to plot the ONI between April 2011 and December 2015. Ensure that all axes are appropriately labeled. Attach the plot to the completed assignment.

There are four time periods of interest: July-December 2011 (La Niña); March-August 2012 (weakening La Niña); January-June 2014 (failed El Niño initiation); and March-August 2015 (developing El Niño). How does Kelvin wave activity vary between these time periods? Are you able to discern any connection between Kelvin waves and El Niño and/or La Niña? Speculate on the cause of any connections that you identify.

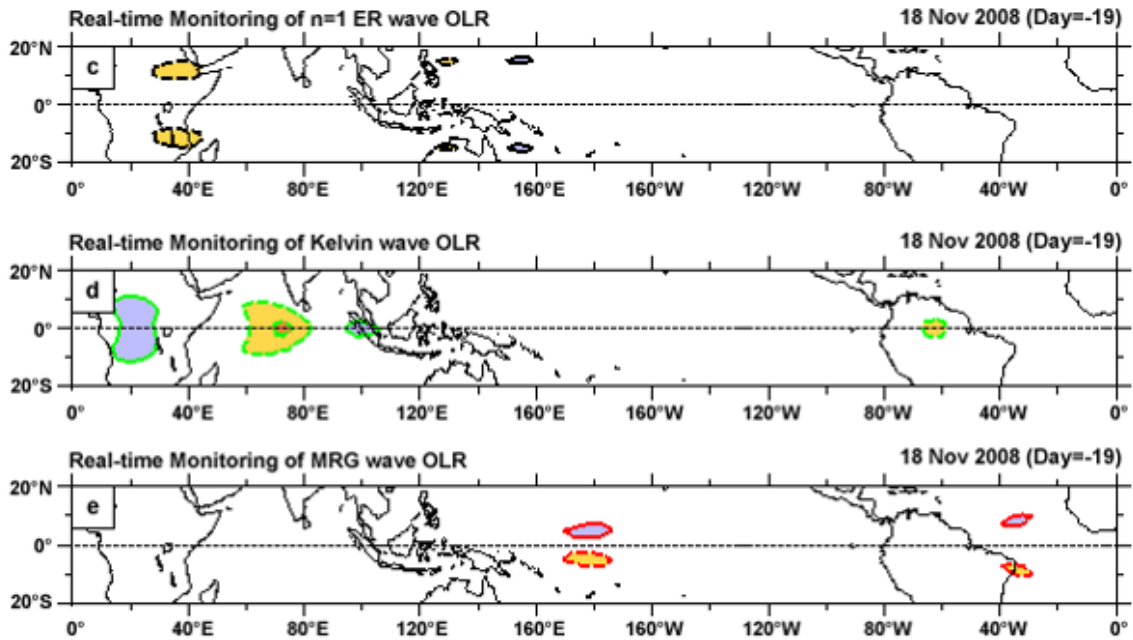


Figure 1. Filtered outgoing longwave radiation anomalies (W m^{-2} , shaded/contoured) for (top) $n = 1$ equatorial Rossby, (middle) Kelvin, and (bottom) mixed Rossby-gravity waves. Blue-shaded and solid contoured areas denote regions of below-normal outgoing longwave radiation and, by extension, enhanced convection. Yellow-shaded and dashed contoured areas denote regions of above-normal outgoing longwave radiation and, by extension, suppressed convection. Figure courtesy of the Australia Bureau of Meteorology, as reproduced in [An Introduction to Tropical Meteorology, 2nd Edition](#).