Supplemental Slides

MONSOON

(Very often mentioned, but is it correctly quoted?)

Climatology

Surface streamlines and sea-level isobars

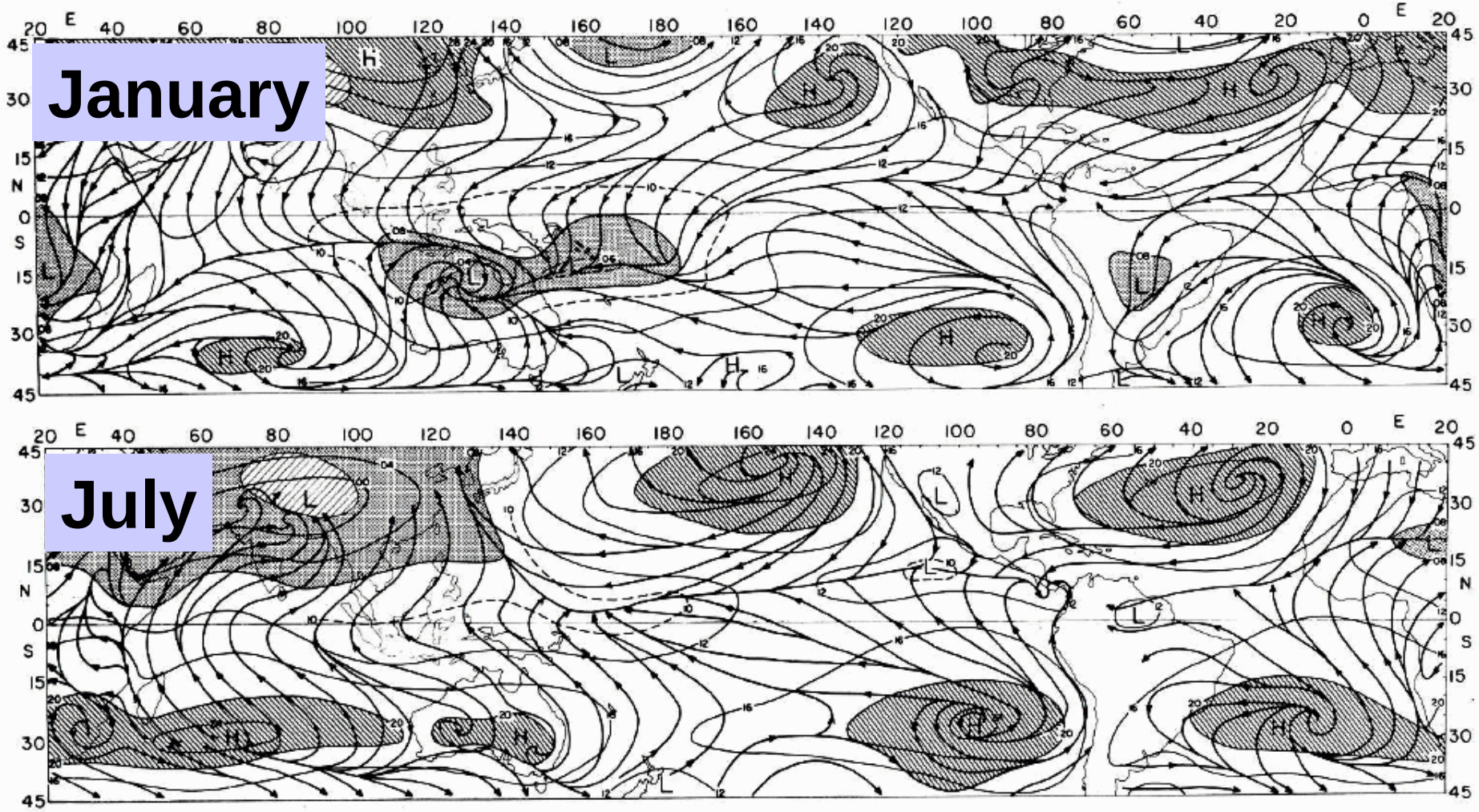


Fig. 1.8. Surface streamlines and sea-level isobars (mb, first two digits omitted). Top: January. Bottom: July. Areas with pressure above 1020 mb are shaded; below 1008 mb, hatched.

Climate and Weather in the Tropics, Herbert Riehl

C. S. RAMAGE'S DEFINITION OF MONSOON

Regions with January and July surface circulations in which:

- Prevailing wind direction shifts by at least 120 degrees between January and July
- Average frequency of prevailing wind directions in January and July exceeds 40%
- Mean resultant winds in at least one of the months exceed 3 m/s
- Fewer than one cyclone-anticyclone alternation occurs every two years in either month in a 5 degree latitude-longitude rectangle

Cont.

C. S. RAMAGE'S DEFINATION OF MONSOON

- *The seasonal wind shifts should not reflect averaging of a shift in the tracks of moving circulations, but rather the replacement of one persistent circulation system by a reverse and equally persistent circulation system*

TUTT

(Tropical Upper Tropospheric Trough)

(Even more often quoted, but just what is it?)

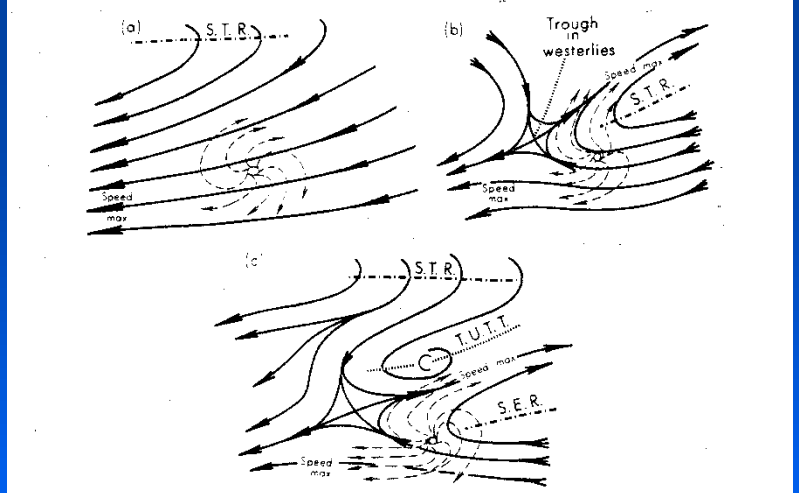


FIG. 1. Schematic of storm outflow interaction (dashed lines) with the larger scale upper tropospheric circulation (solid lines). STR is the subtropical ridge; SER, the sub-equatorial ridge; TUTT, the tropical upper tropospheric trough.

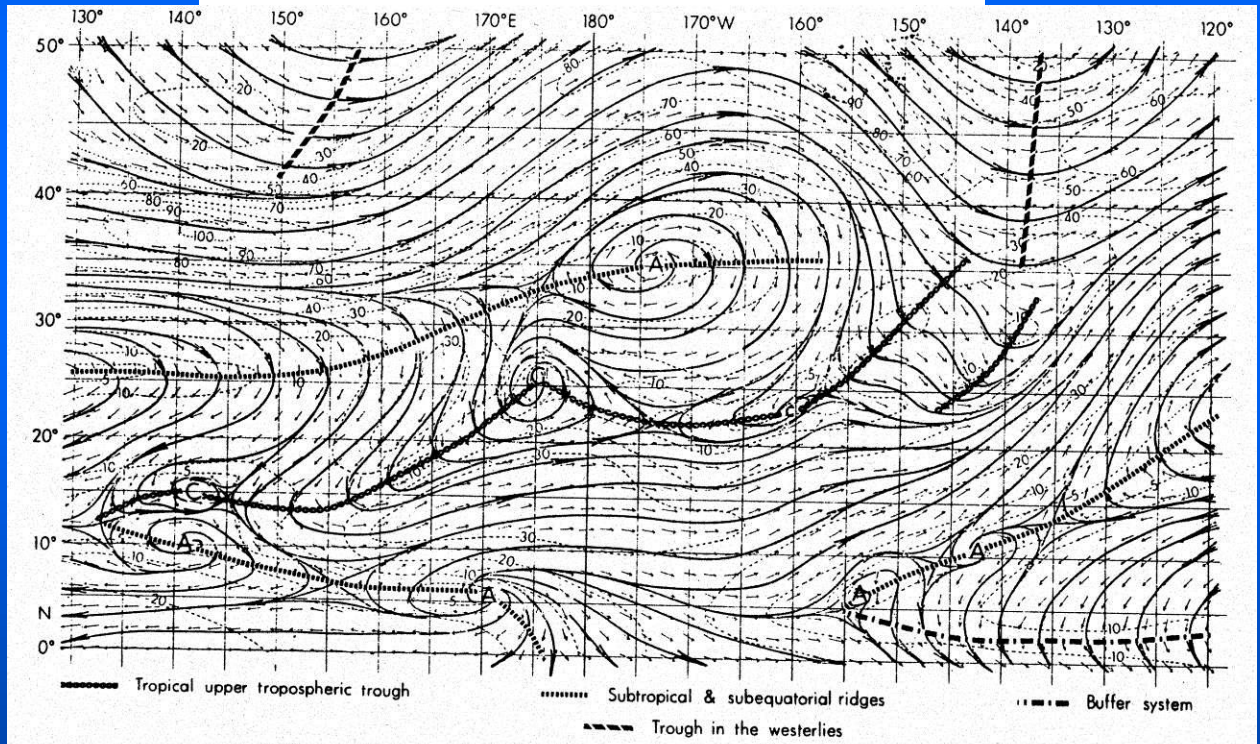


FIG. 2. The mean 250 mb circulation during the period of 13–24 June 1971. Wind speed (kt) shown by dashed lines.

(J. C. Sadler 1976)

TUTT OR MID-OCEANIC TROUGH

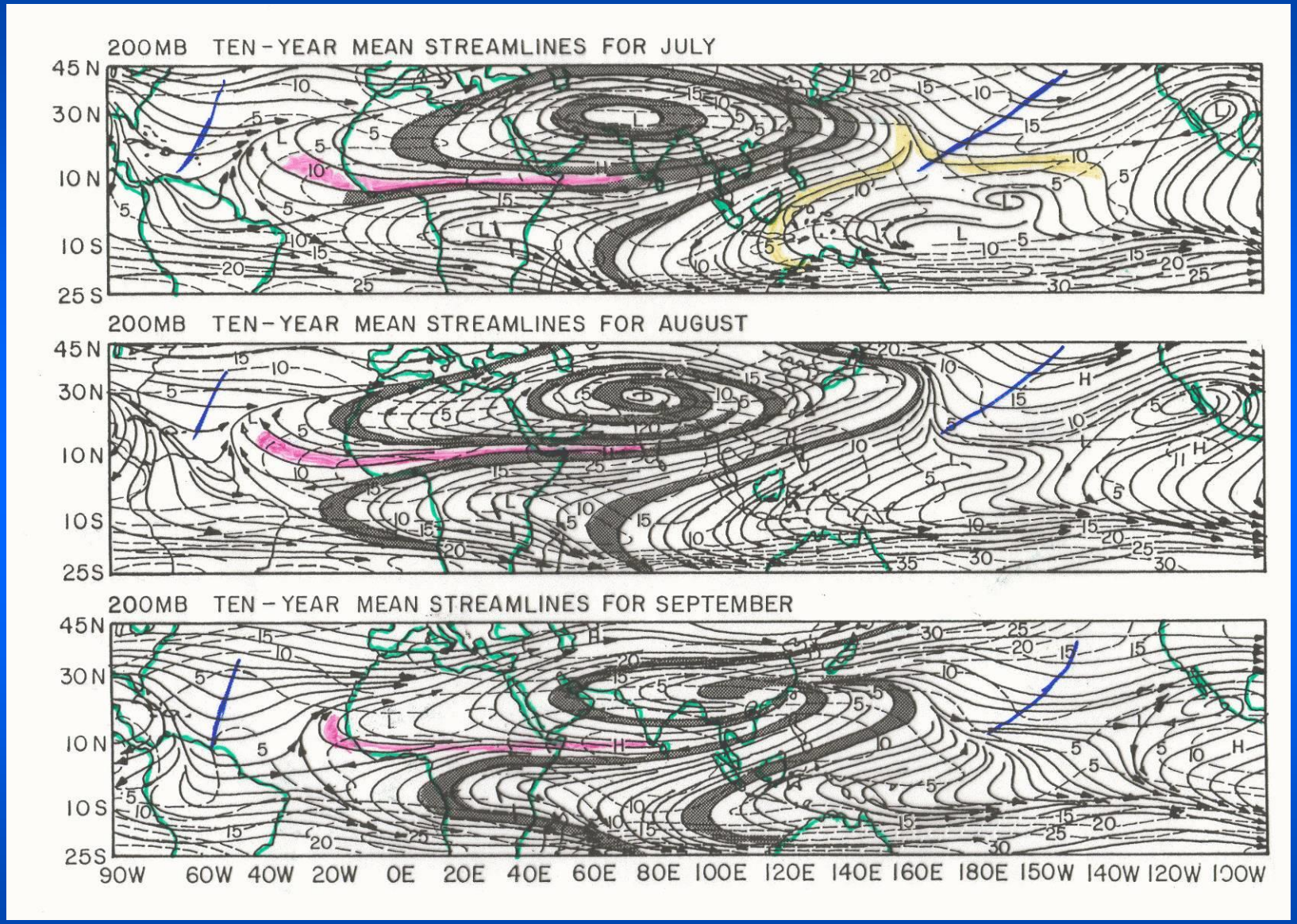
Dean (1956): Climatological summer-time upper level trough over the Pacific west of the Hawaii Islands. (North Pacific trough)

Ramage (1959): Mean summer upper trough from Alaska to Indonesia (not in eastern North Pacific or the North Atlantic). He named it Mid-pacific trough (MPT).

Sadler (1963): Showed that the summer upper trough is a dominant feature of the entire North Pacific and North Atlantic Oceans.

Aspliden et al (1966): Found the upper trough (August 1963) to be a climatological feature across the North Atlantic from Span through the Gulf of Mexico.

- Clearly this is a *climatological* feature. In real-time analysis, how do you know you are looking at a climatological feature and not a synoptic system, or modified by the presence of synoptic systems?
- If they are tropical, why are they are only found over the middle of the oceans?
- Could they be the results of zonal asymmetry, i.e. land-sea contrast and related differential heating?



From Prof. T. N. Krishnamurti's lecture

EQUATORIAL WAVES

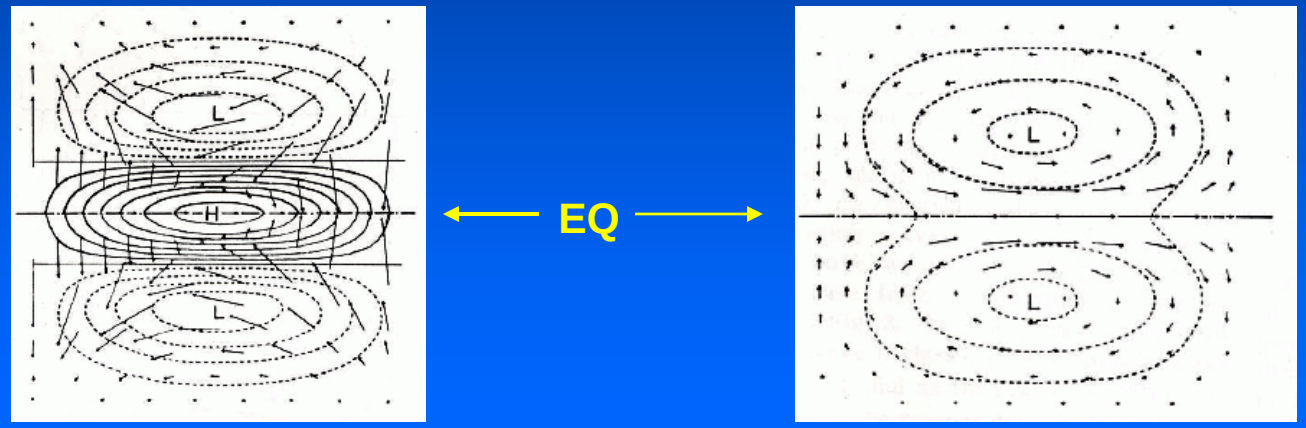
(They have been mentioned more often lately)

EQUATORIAL WAVES

- Kelvin waves
- Gravity waves
- Rossby waves
- Mix Rossby-Gravity waves
- Madden Julian Oscillation (MJO)

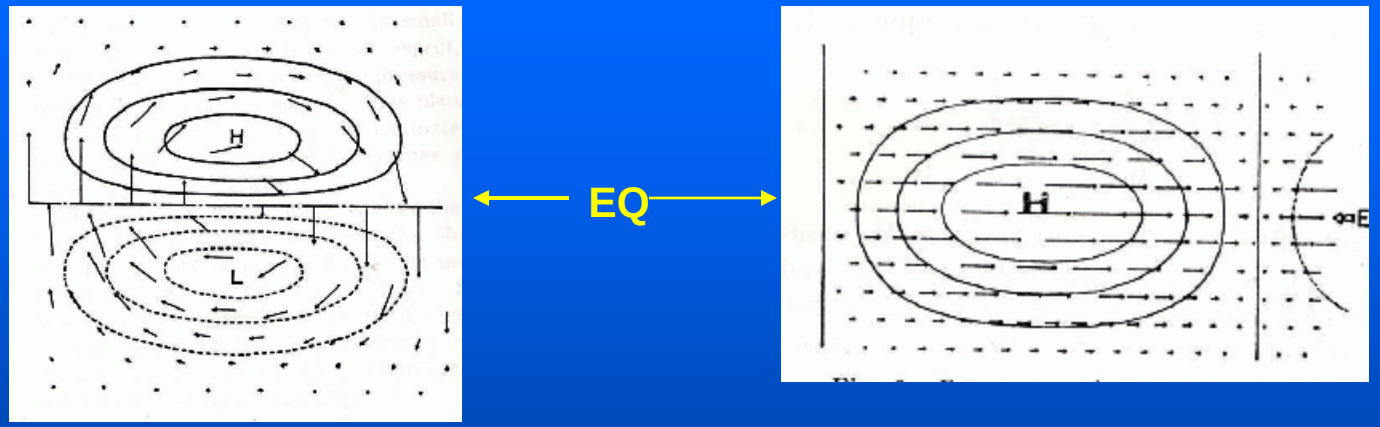
Analytically derived, then verified with observations

PRESSURE AND WIND OF SOME OF THE LOWEST EQUATORIAL NORMAL MODES



Eastward inertio-gravity wave

Rossby wave



Westward mixed Rossby gravity wave

Kelvin wave

T. Matsuno, JMSJ 1966

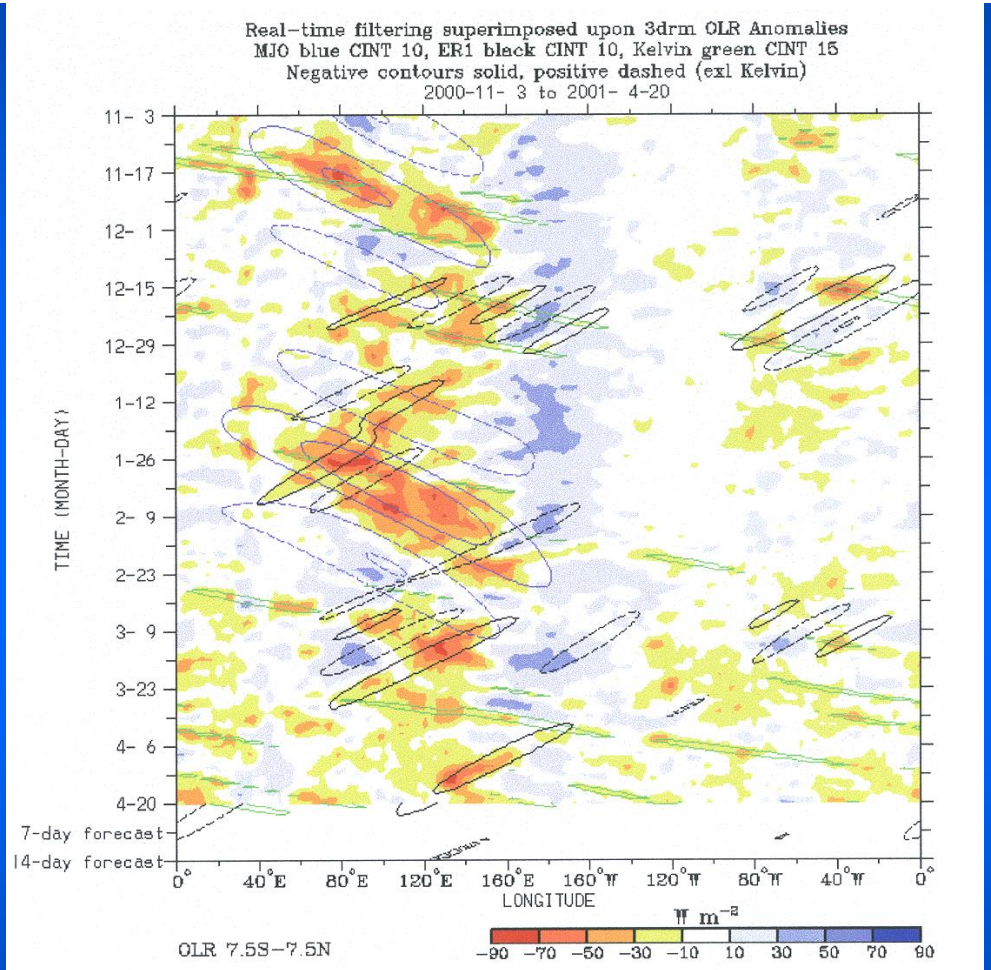
Madden Julian Oscillation

(MJO)

40-60 day oscillation,
35 day oscillation, etc
Wave number 1, eastward propagating

(Mentioned quite often these days and maybe linked to TC genesis)

Using outgoing longwave radiation (OLR) to identify various equatorial waves



Time-longitude (Hovmoller) section of various OLR anomaly products averaged from 7.5S to 7.5N. Shaded are the 3-day running mean anomalies calculated by subtracting the climatological mean and smoothed seasonal cycle from the total field, where the mean and seasonal cycle were based on the 1979 to 1995 period. Contoured are the anomalies calculated by filtering the total OLR for the specific regions of the wavenumber-frequency domain defined in Fig. 1 from Wheeler and Kiladis (1999). Notice the close correspondence between the solid (negative) contours of the filtered fields with the yellow (negative) shading of the 3-day running mean anomalies, indicating the significant amount of variability of the OLR that is captured by the MJO and convectively coupled equatorial waves.

http://www.cdc.noaa.gov/map/clim/olr_modes/novEa.html

Characteristics of the equatorial waves

http://www.cdc.noaa.gov/map/clim/olr_modes/

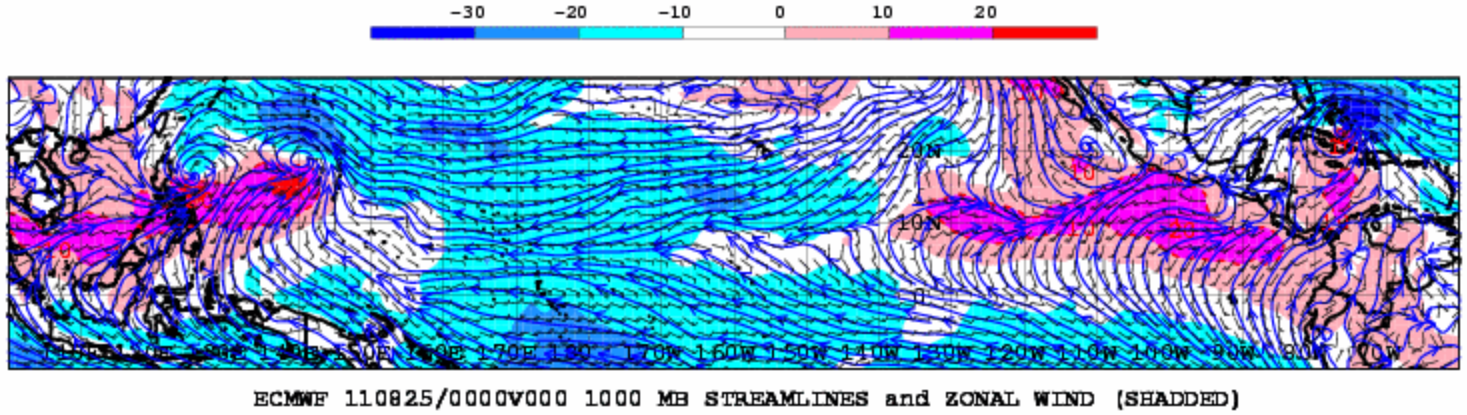
Animation of various modes (OLR)

http://www.cdc.noaa.gov/map/clim/olr_modes/indiv_anim10.html

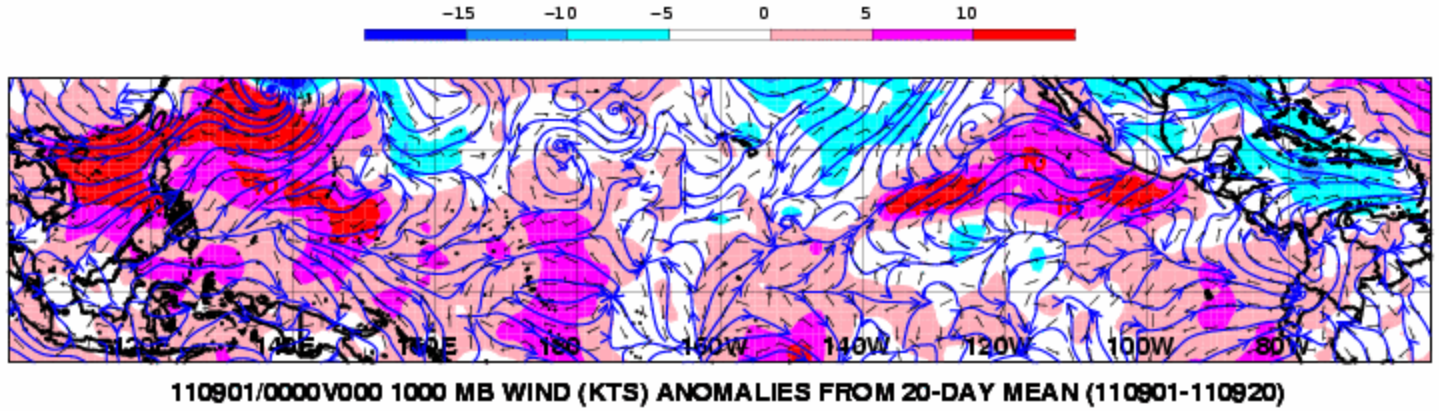
http://www.cdc.noaa.gov/map/clim/olr_modes/hovEa.html

Eastward propagating zonal wind anomalies and convective activities in the EPAC ITCZ MJO or Kelvin waves?

ECMWF 1000 MB WIND
00Z Aug 25-Sep 22, 2011

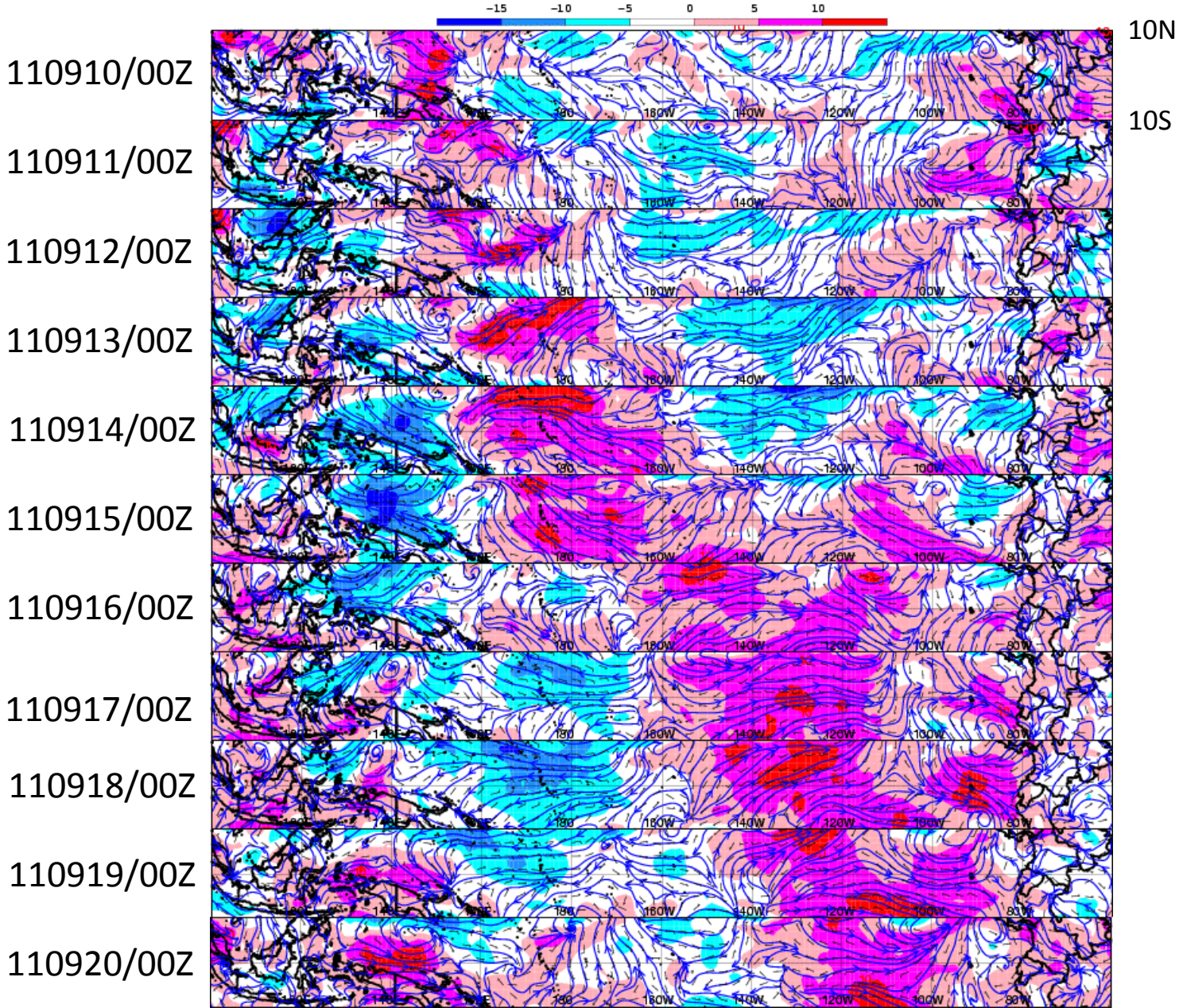


GFS 1000 MB WIND ANOMALIES



110901/0000V000 1000 MB WIND (KTS) ANOMALIES FROM 20-DAY MEAN (110901-110920)

GFS 850MB ZONAL WIND ANOMALIES



GFS 10m ZONAL WIND ANOMALIES

110910/00Z

110911/00Z

110912/00Z

110913/00Z

110914/00Z

110915/00Z

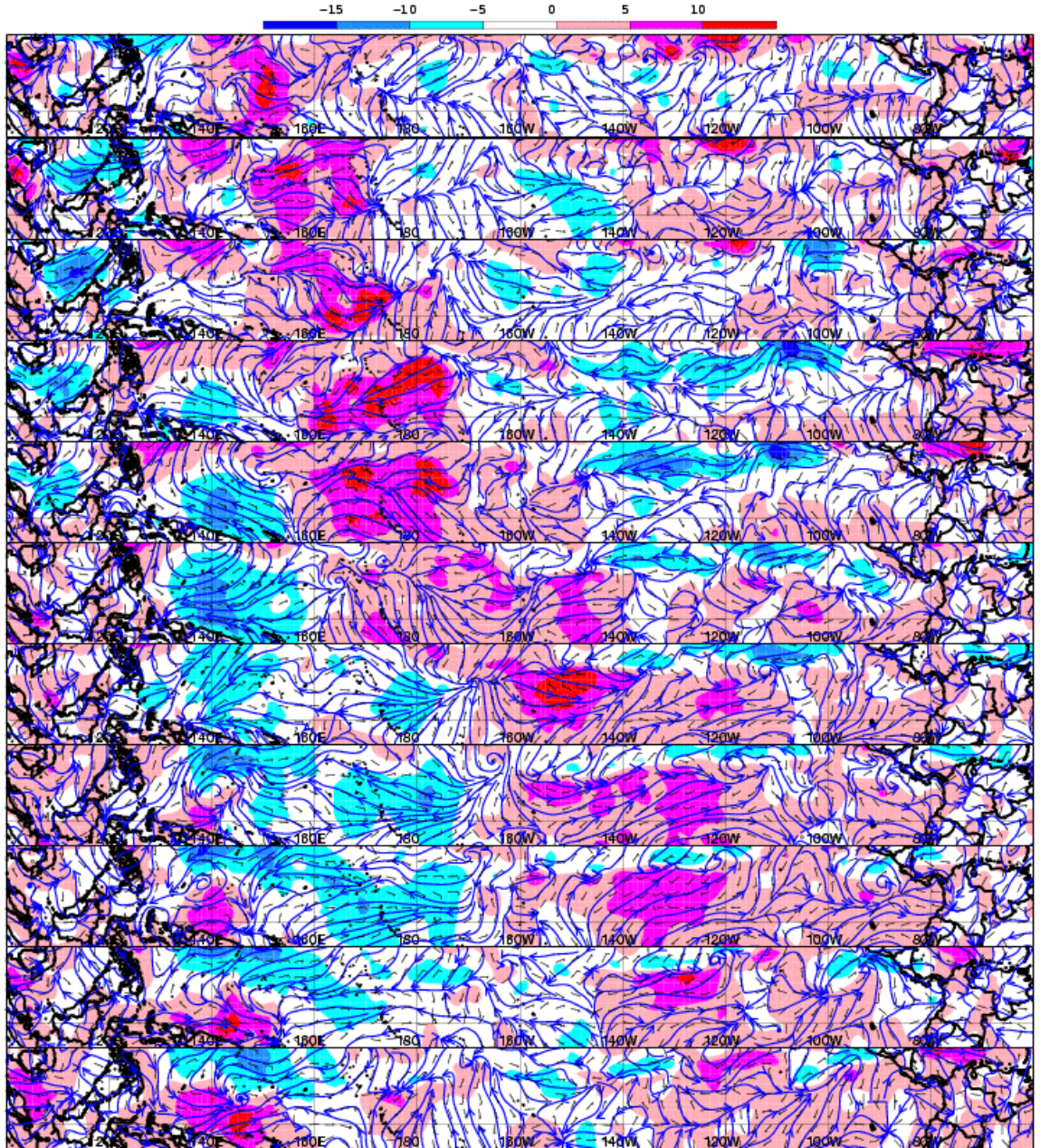
110916/00Z

110917/00Z

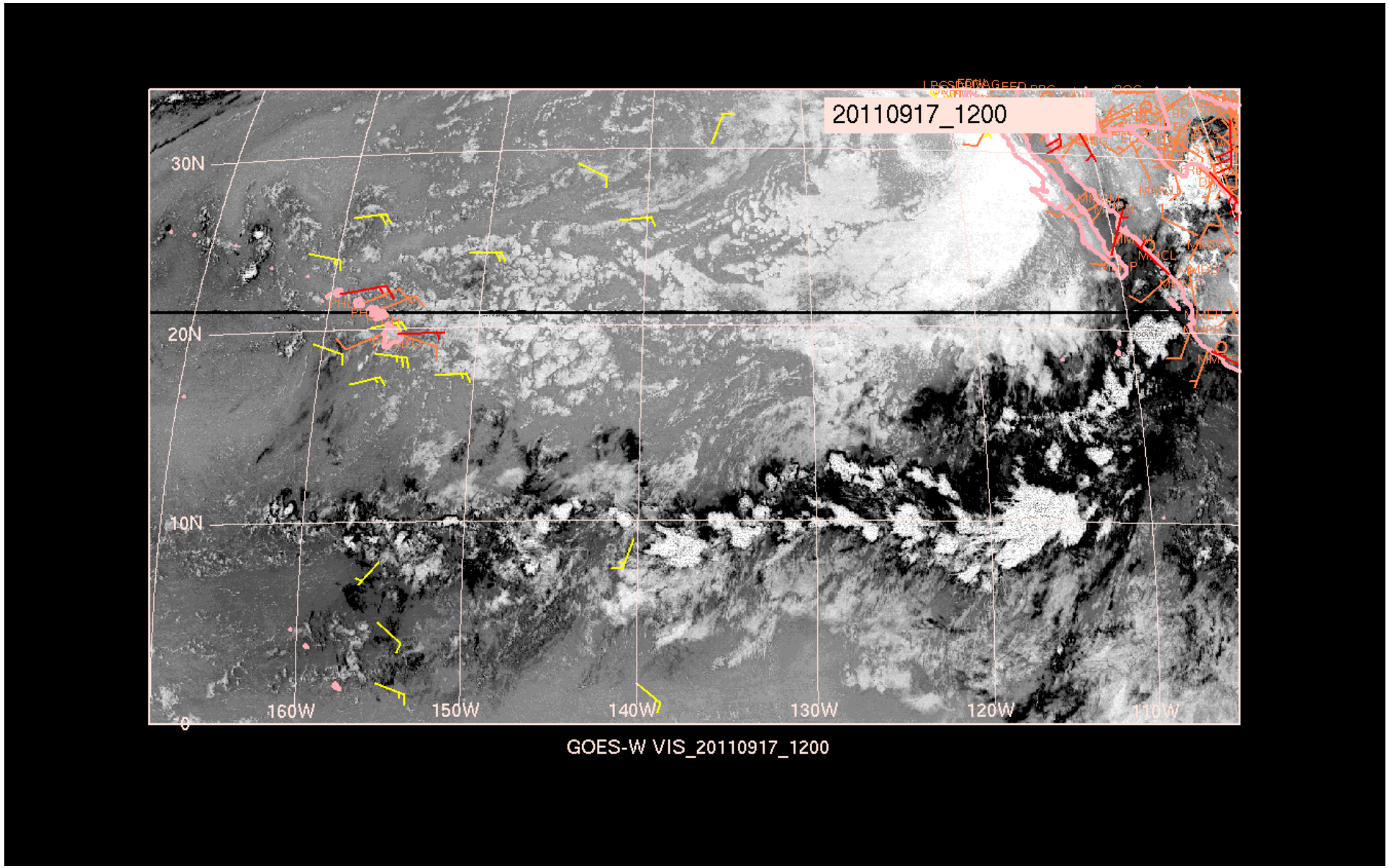
110918/00Z

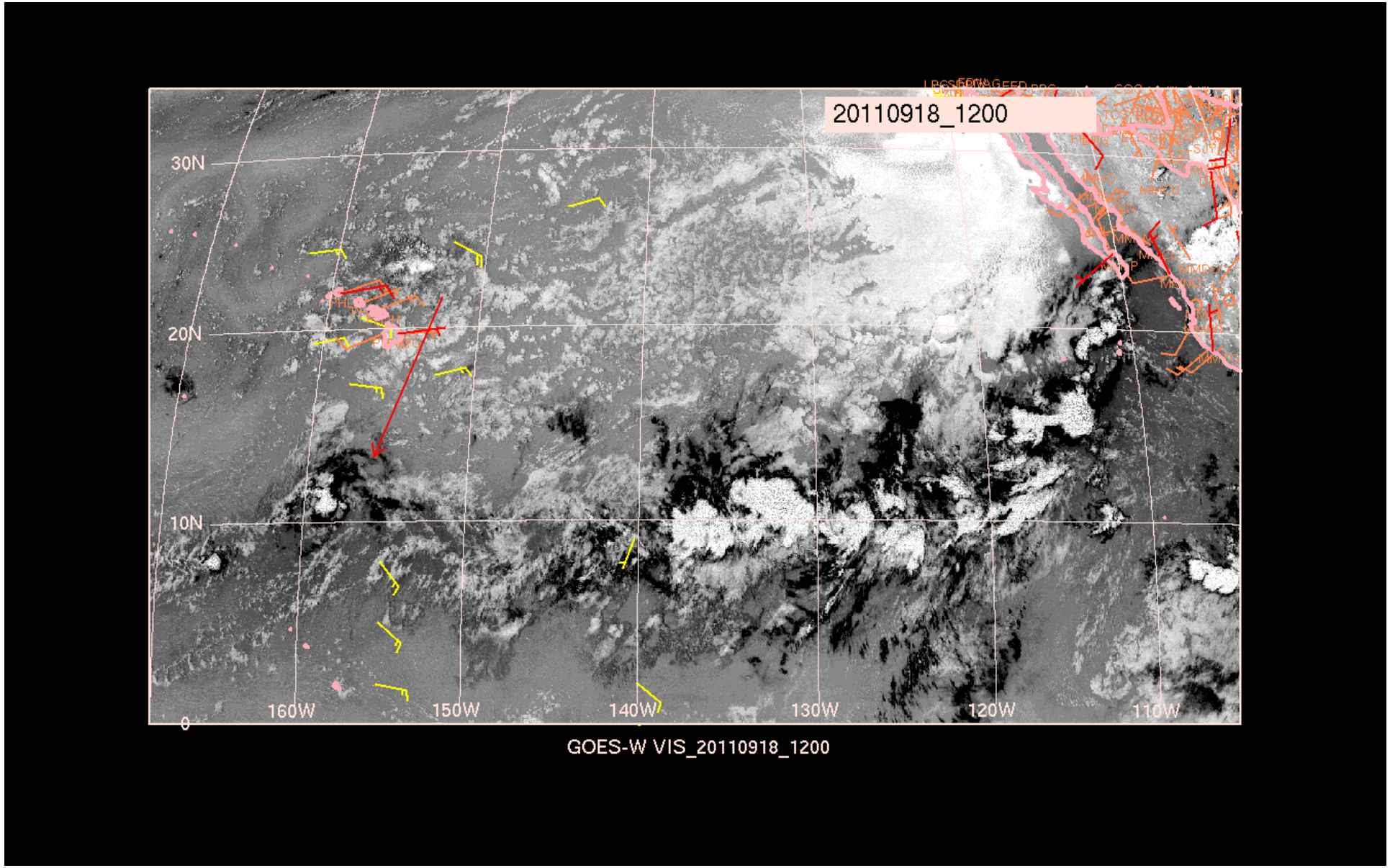
110919/00Z

110920/00Z



ITCZ CLOUD LINE BECOMES PERTURBED DURING 110917-110920

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20N
10N
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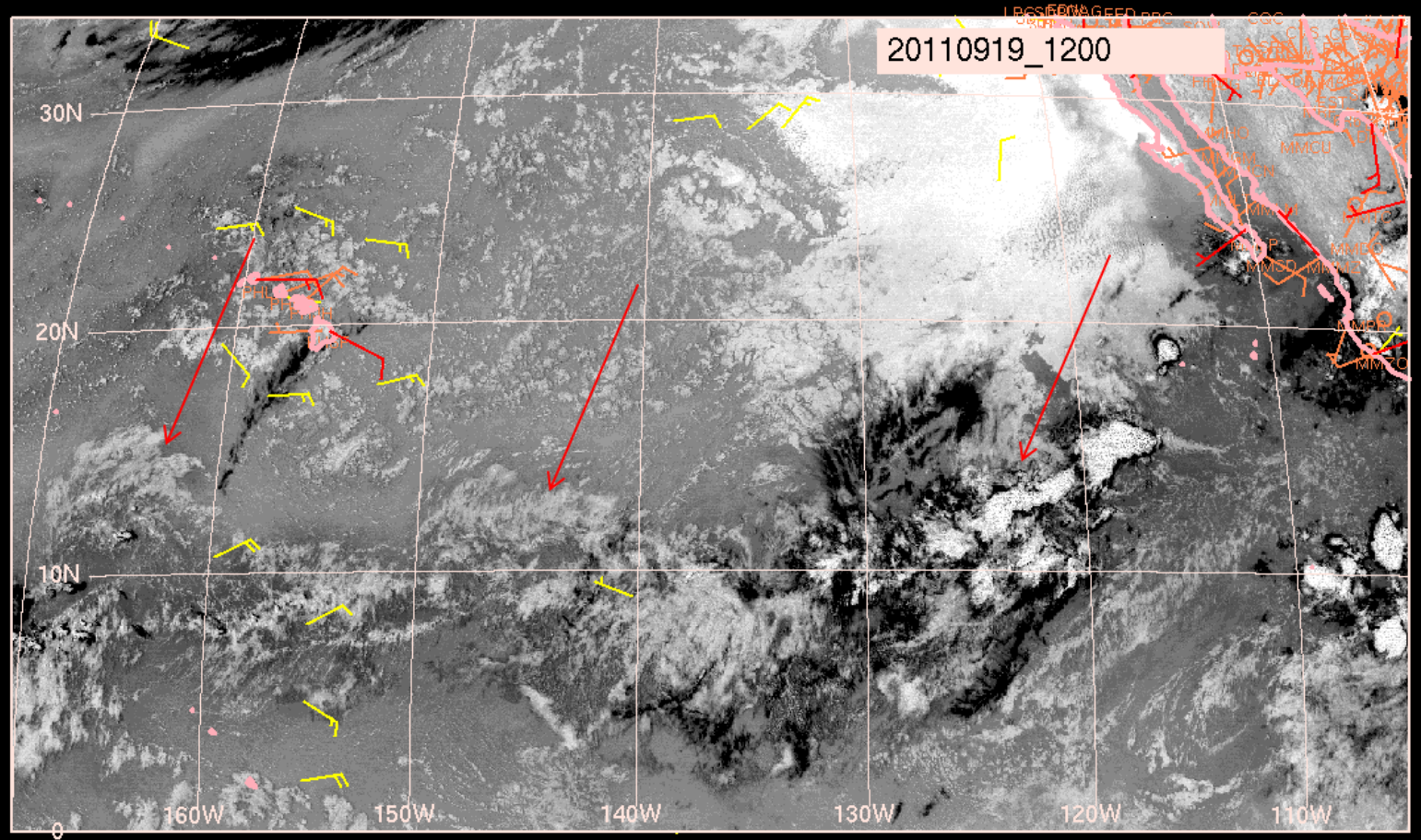
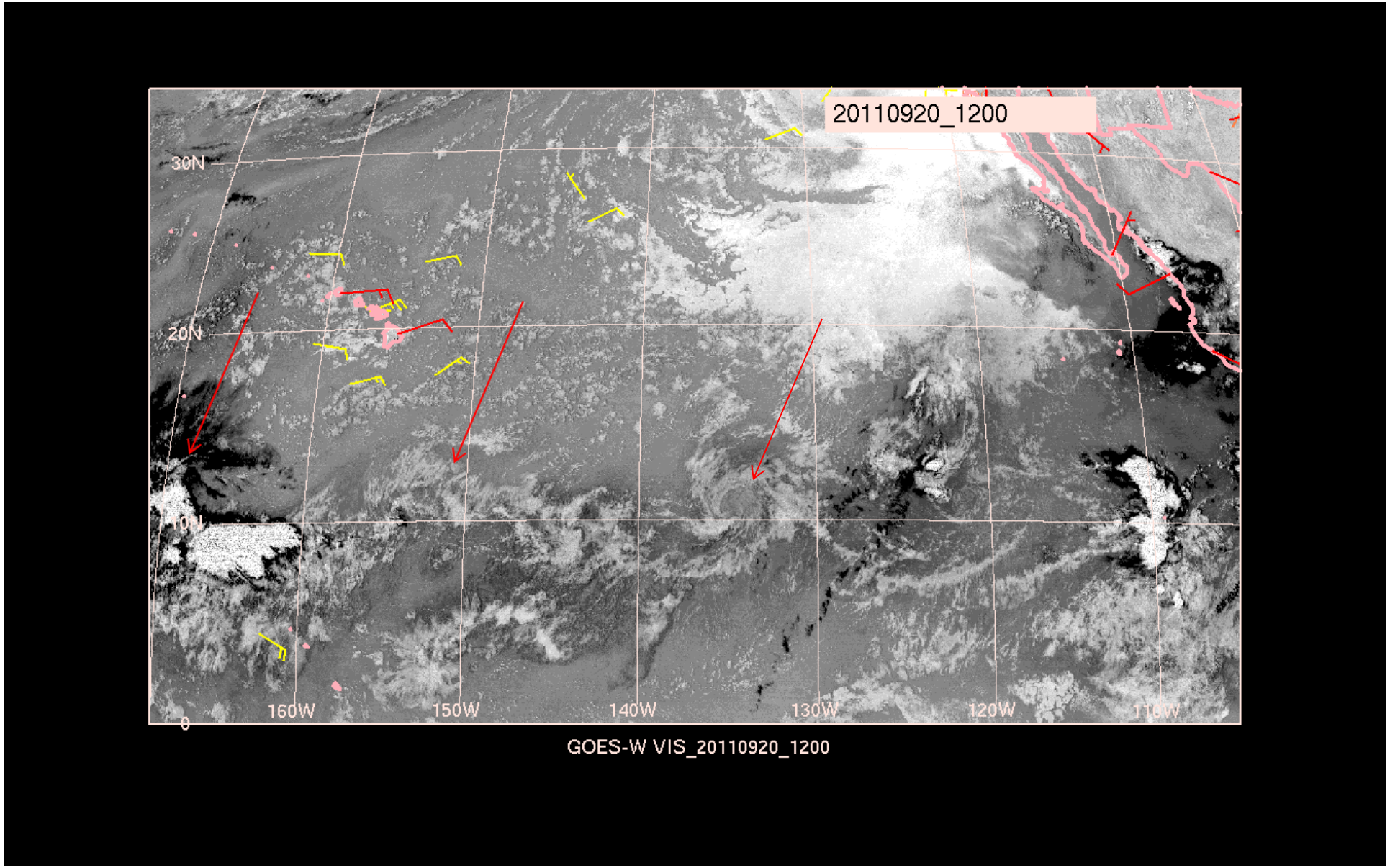
160W
150W
140W
130W
120W
110W
GOES-W VIS_20110918_1200

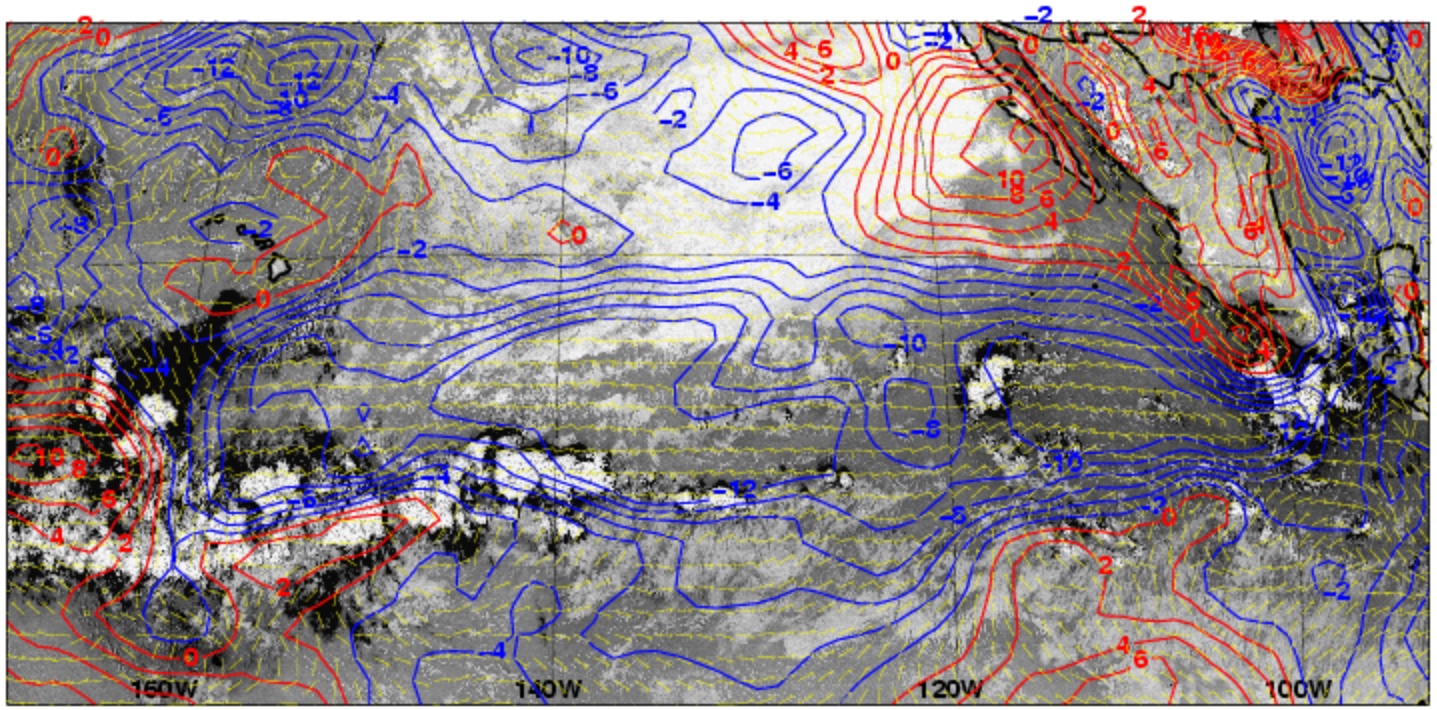


GOES-W VIS_20110919_1200


20110920_1200
30N
20N
10N
0
160W
150W
140W
130W
120W
110W
GOES-W VIS_20110920_1200

850 MB ZONAL WIND ANOMALIES

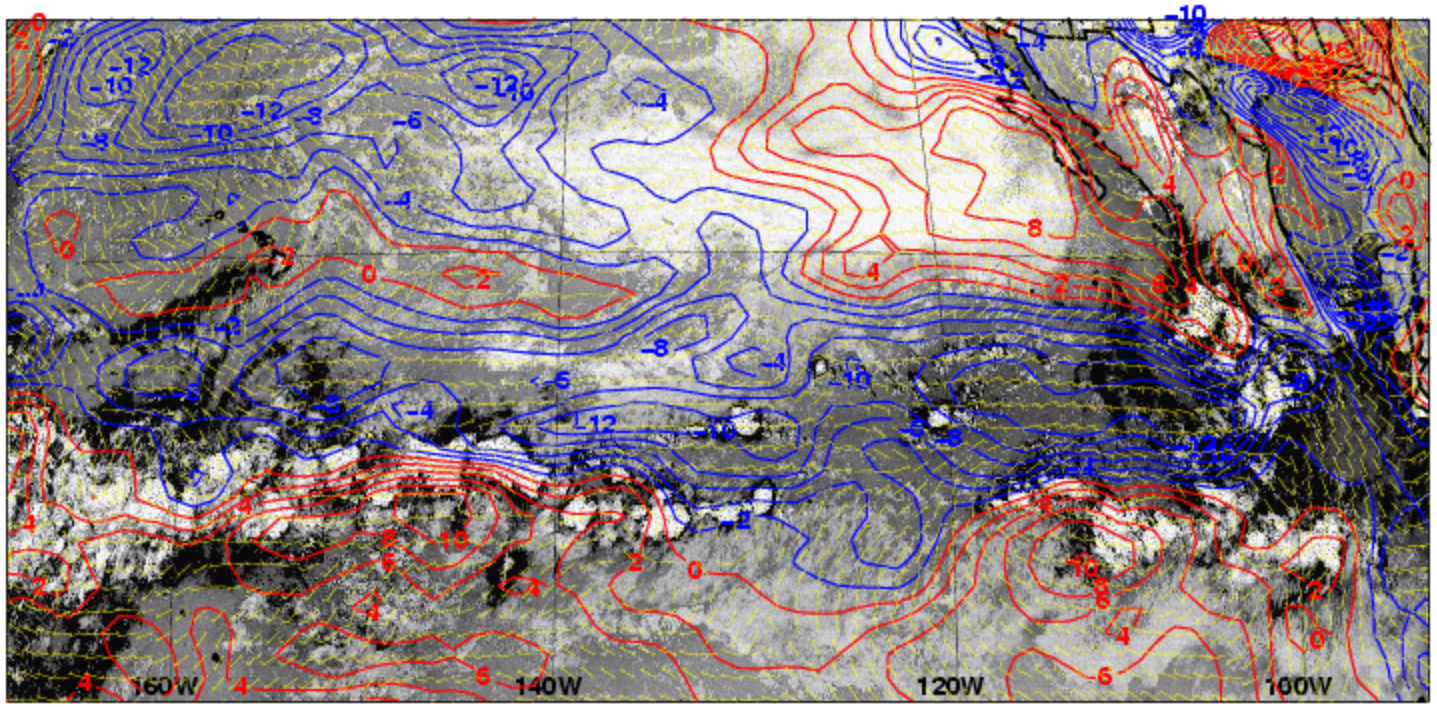
1200UTC Sep 14, 2011



110914/1200V000 850 MB WIND (KTS) ANOMALIES FROM 20–DAY MEAN (110901–110920)

Note: Easterly anomalies dominated eastern tropical Pacific. Convection in this region was not active. Westerly anomalies was moving past the dateline from the west.

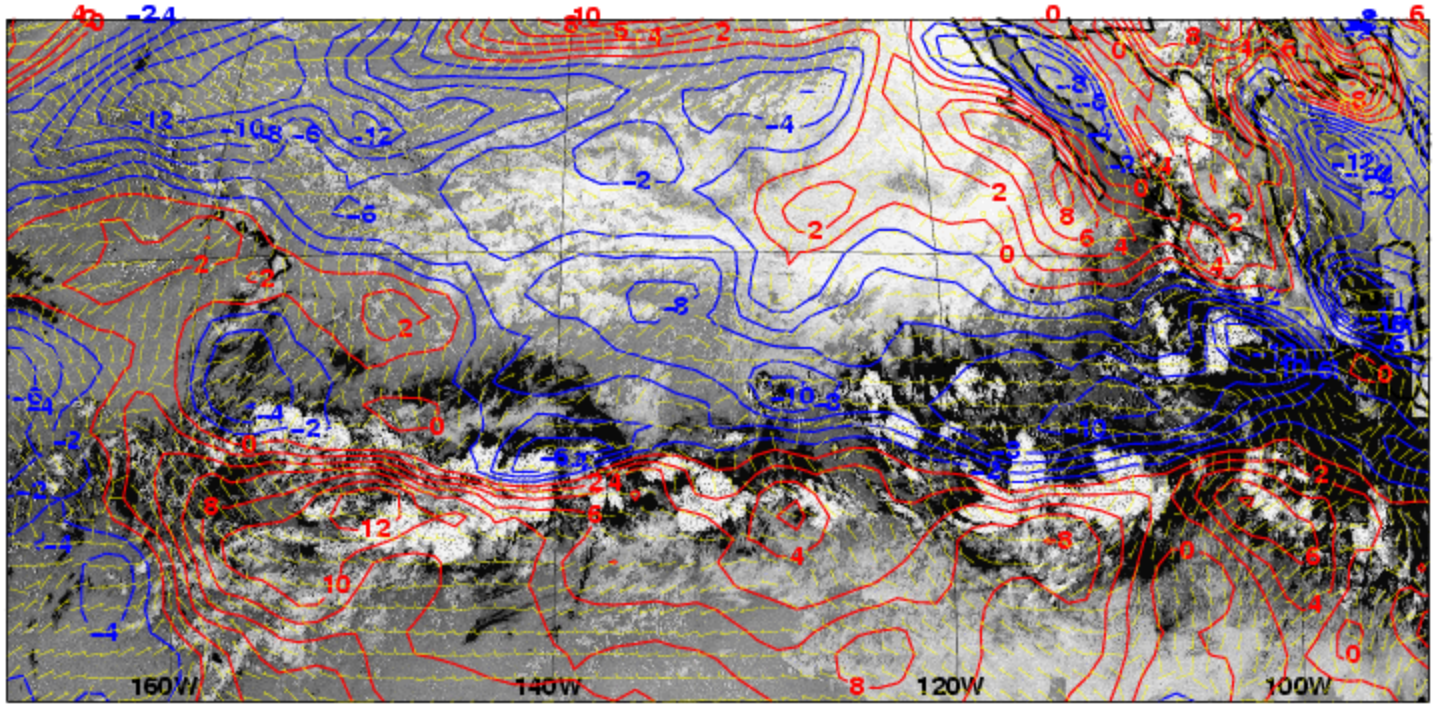
1200UTC Sep 15, 2011



110915/1200V000 850 MB WIND (KTS) ANOMALIES FROM 20–DAY MEAN (110901–110920)

Note: Westerly anomalies moved fast into eastern tropical Pacific.
Convection was active along the northern edge of the westerly anomalies.

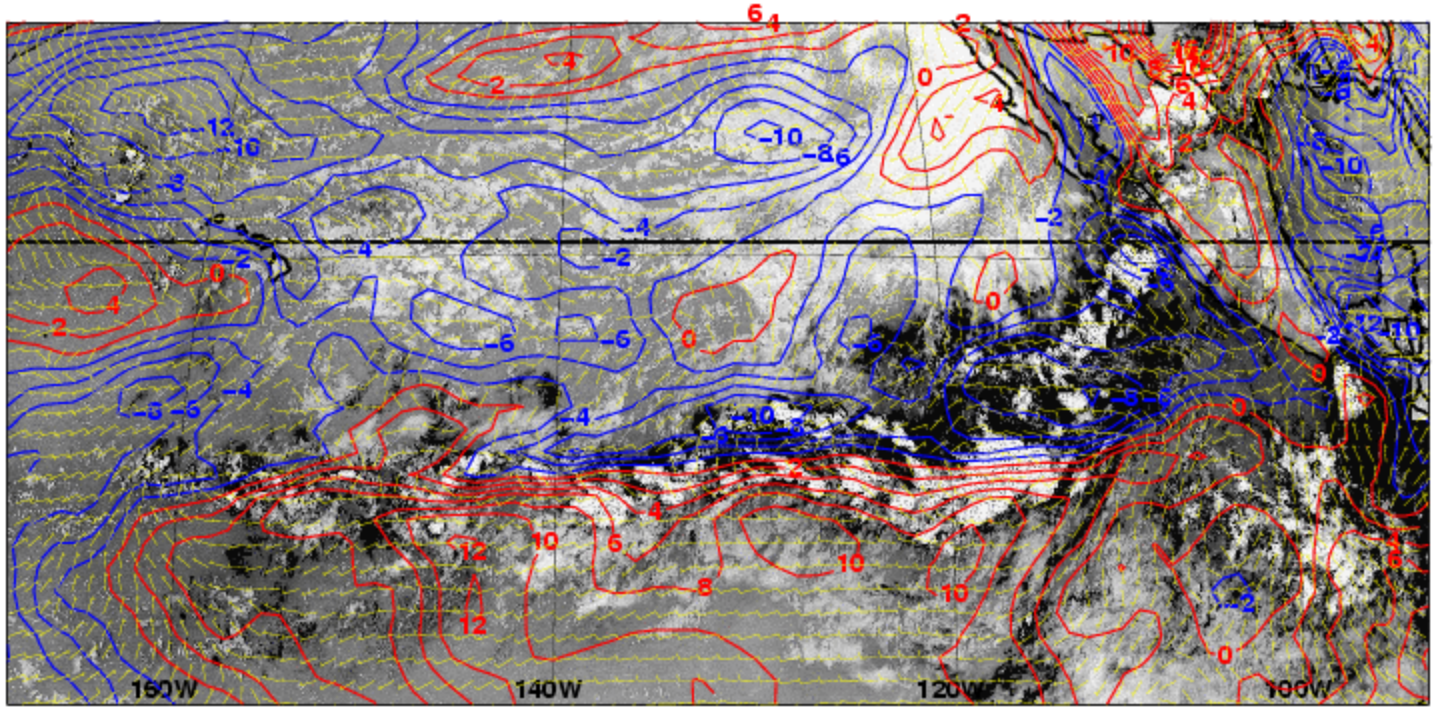
1200UTC Sep 16, 2011



110916/1200V000 850 MB WIND (KTS) ANOMALIES FROM 20–DAY MEAN (110901–110920)

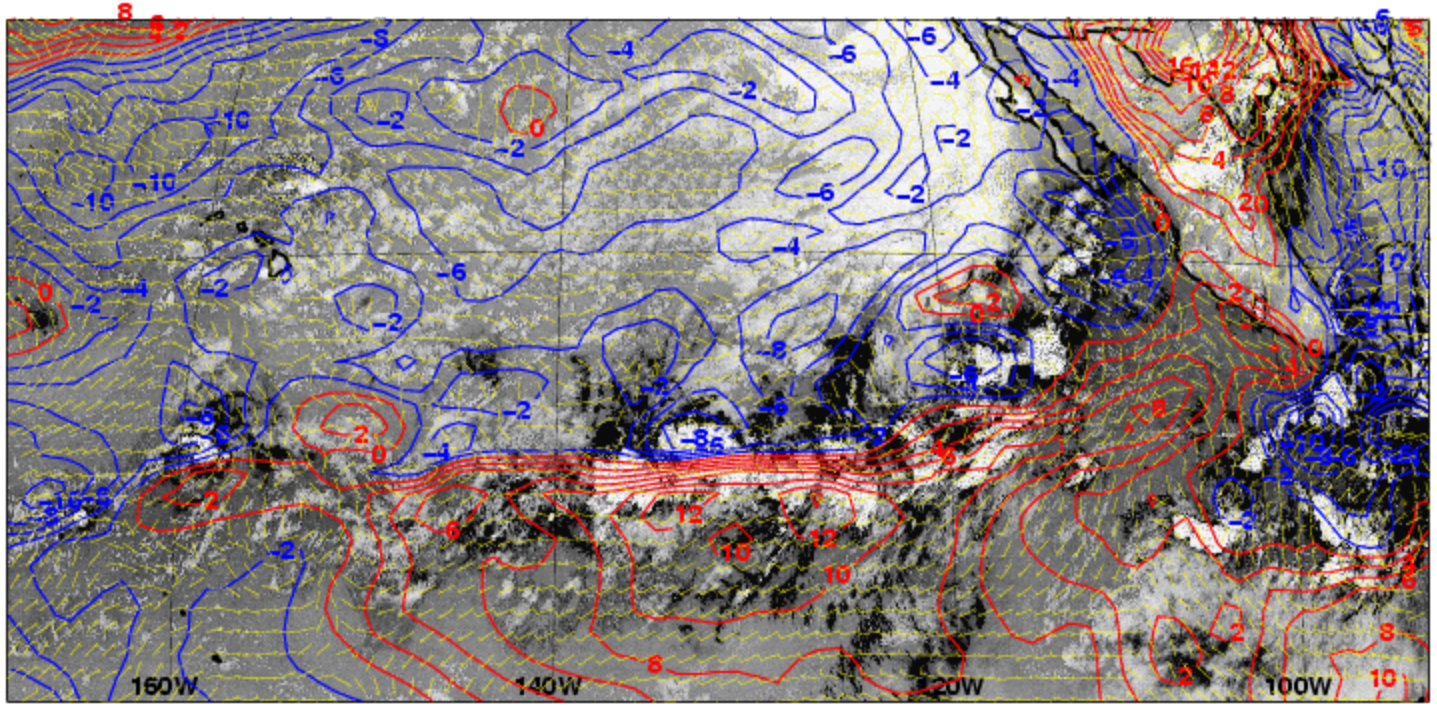
Note: Westerly anomalies dominated the whole eastern tropical Pacific. Convection was active along the northern edge of the westerly anomalies, including the eastern partion of the east Pacific where it was subdued just two days earlier. Easterly anomalies started moving across the dateline.

1200UTC Sep 17, 2011



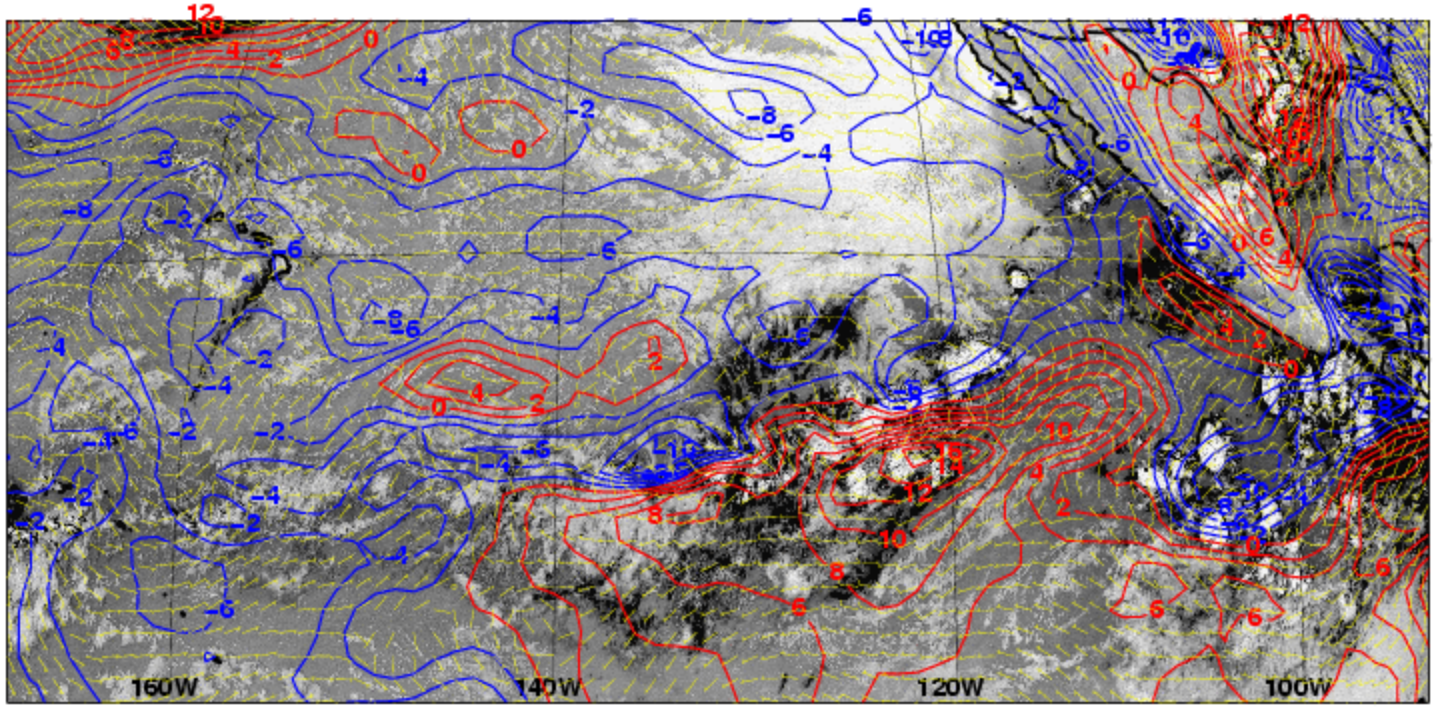
110917/1200V000 850 MB WIND (KTS) ANOMALIES FROM 20–DAY MEAN (110901–110920)

1200UTC Sep 18, 2011



110918/1200V000 850 MB WIND (KTS) ANOMALIES FROM 20–DAY MEAN (110901–110920)

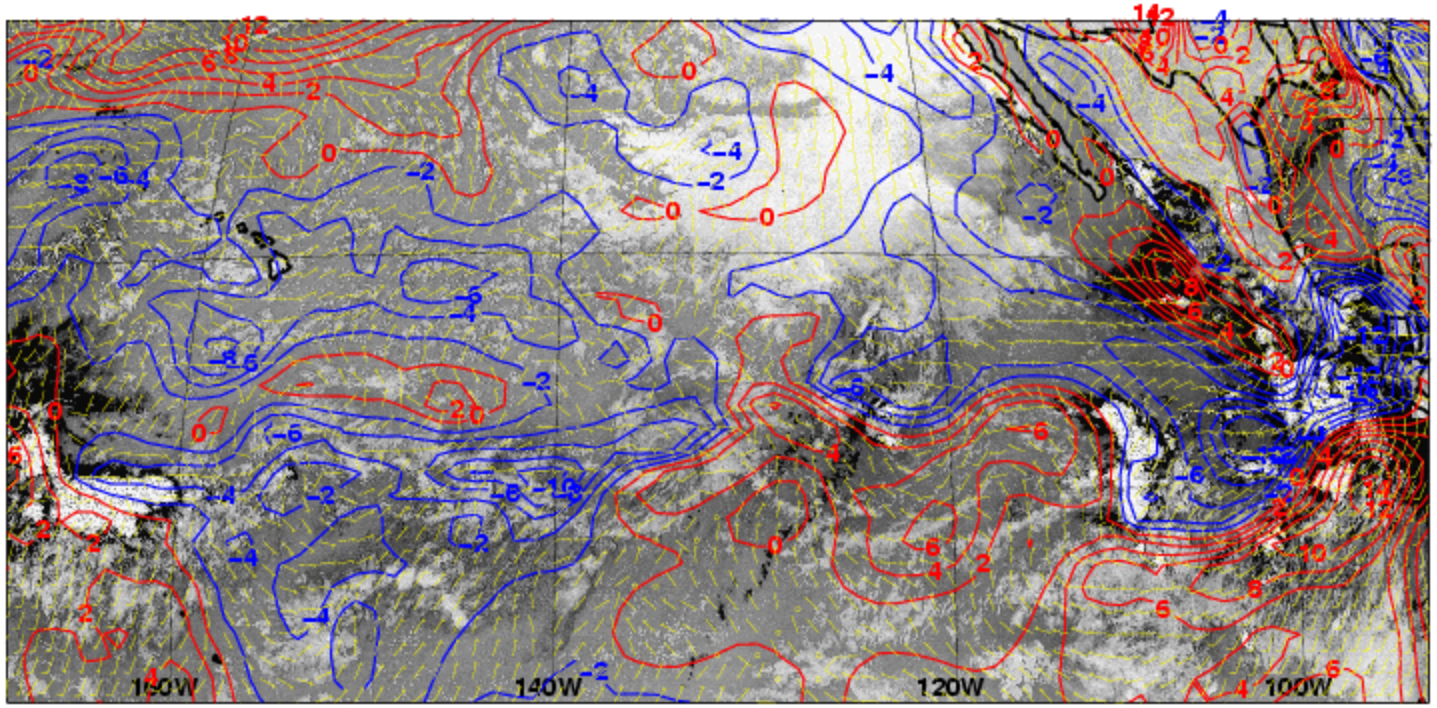
1200UTC Sep 19, 2011



110919/1200V000 850 MB WIND (KTS) ANOMALIES FROM 20–DAY MEAN (110901–110920)

Note: Easterly anomalies from the west continued to extend eastward. Convection in the easterly anomalies was inactive.

1200UTC Sep 20, 2011



110920/1200V000 850 MB WIND (KTS) ANOMALIES FROM 20–DAY MEAN (110901–110920)

East Pacific tropical cyclones formed from easterly waves moving westward across the Caribbean and the central America