=>Atmospheric Sciences

Formation and rapid intensification of tropical cyclones: Intense convective events vs. large-scale controls

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+many students who should get field experience in 2010

- The central focus of this proposal, continuing the progress made in TCSP and NAMMA, is to *seek the essential differences between developing and non-developing tropical disturbances.*
- More specifically, we seek to make **quantitative distinctions** between the **large-scale properties** of incipient disturbances, and the **nature and strength of the convective and mesoscale events** within those disturbances.
- How to do this??? Requires detailed knowledge of **each**, at frequent time intervals, during several days when genesis is “possible”

- *“....how to differentiate between the many ‘sufficient-appearing’ disturbances that do and do not become tropical cyclones.”* (Nolan, 2007)

- Genesis often proceeds over a period of several days, but with significant events such as convective bursts and VHTs occupying only a few hours. Therefore, observations in a 5-hour time window 24 hours apart are insufficient.
- The large-scale environment evolves differently in low, mid, and high levels over a period of several days, so knowing how the circulation of a wave or embedded mesoscale PV anomaly changes at a single level is insufficient.
- Perfect knowledge of the wind field and temperature field without good knowledge of the 4-dimensional evolution of the water vapor field is insufficient.

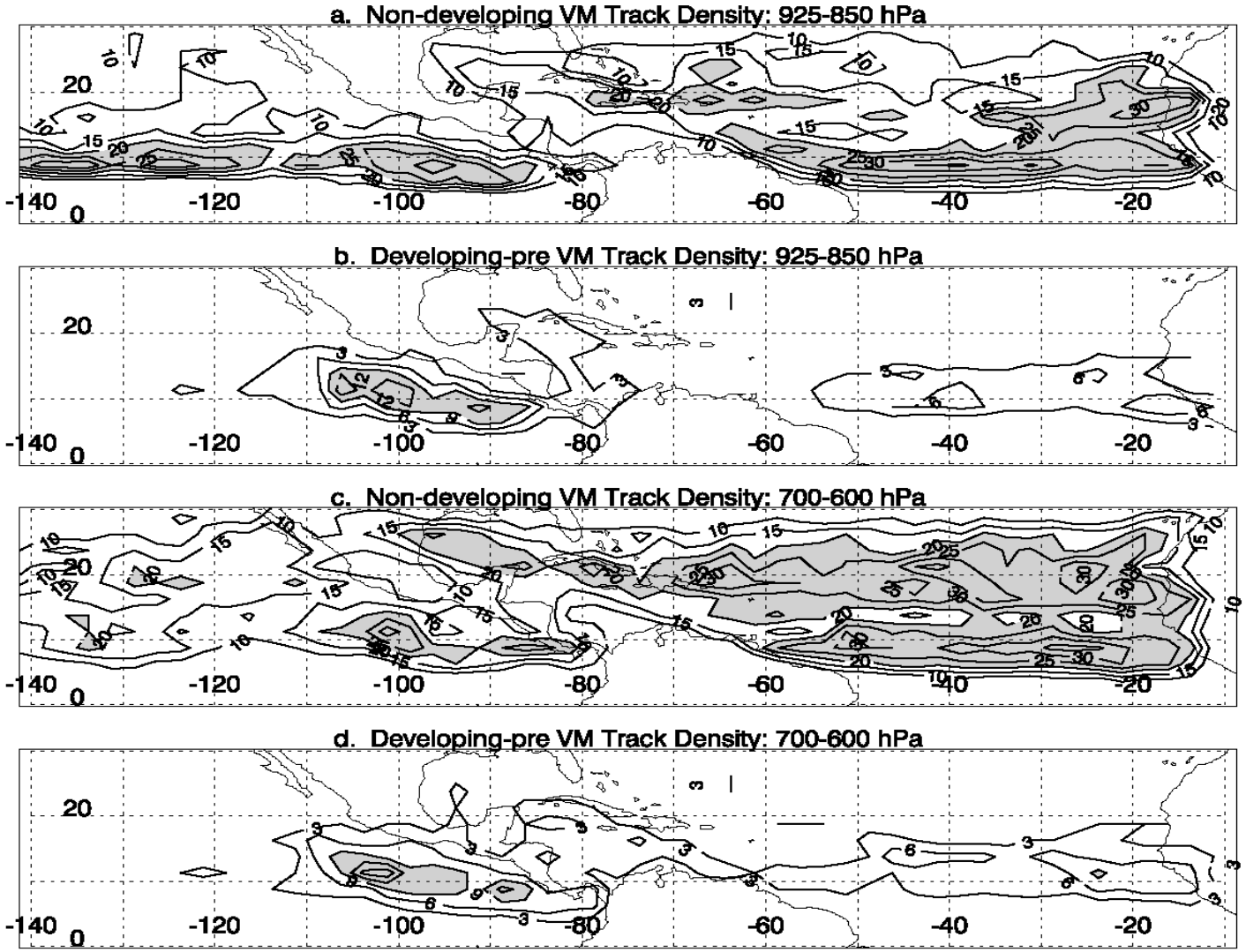


Figure 4.5. The number of VM tracks passing through each 2.5 degree box (track density) for June–October, 1998–2001. For parts a and c the contours are every 5, starting at 10, shaded above 20. For parts b and d the contours are every 3, starting at 3, shaded above 9.

(Courtesy Brandon Kerns)

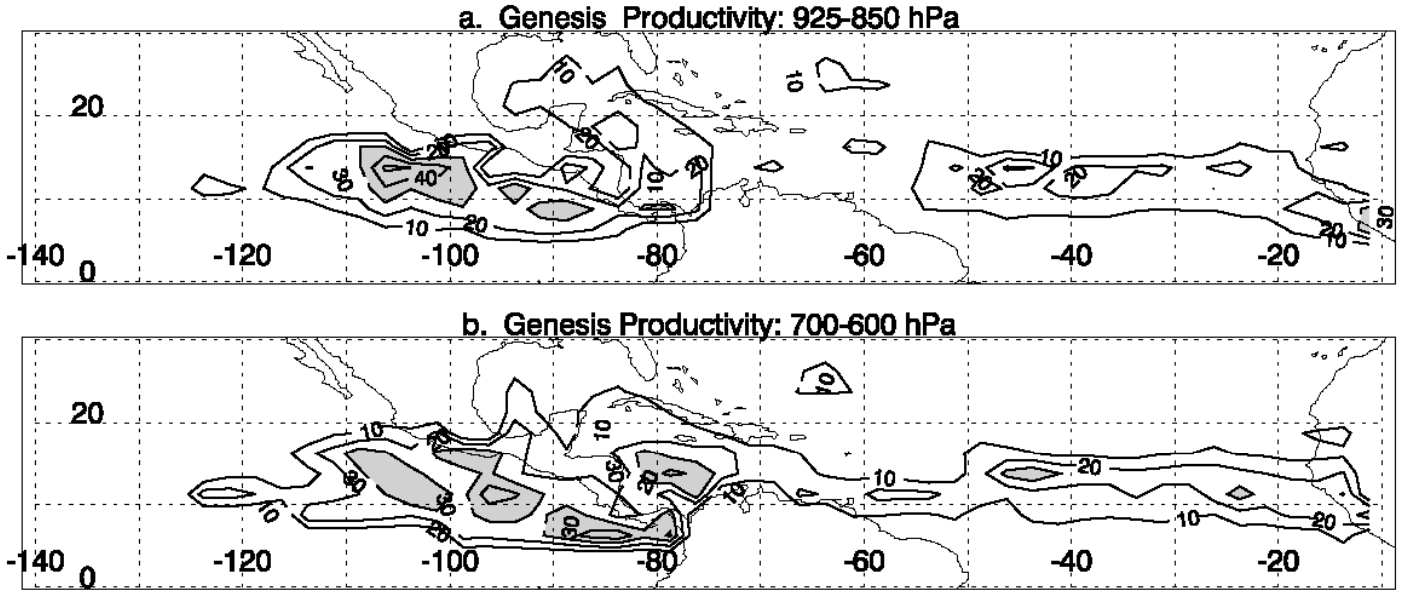
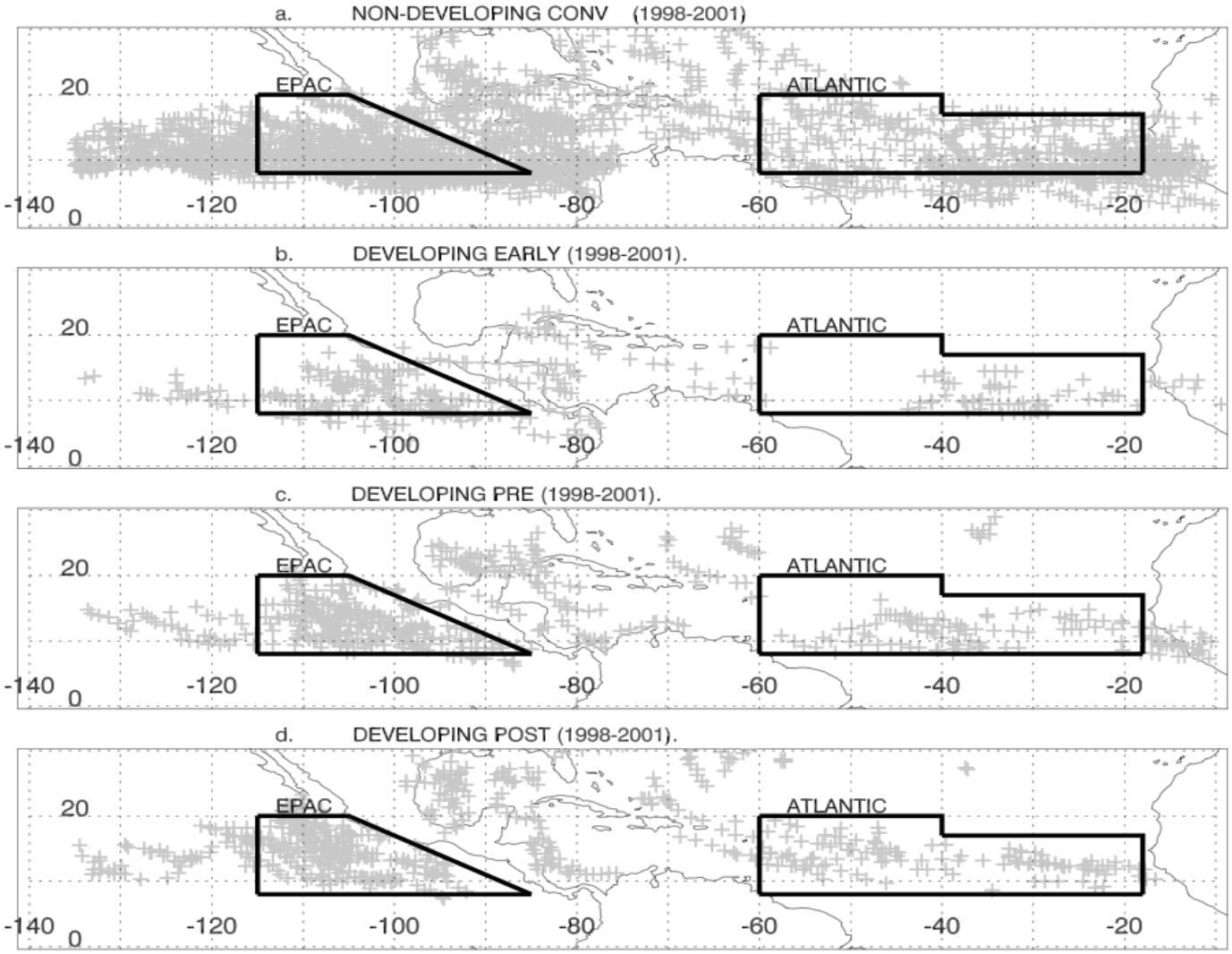


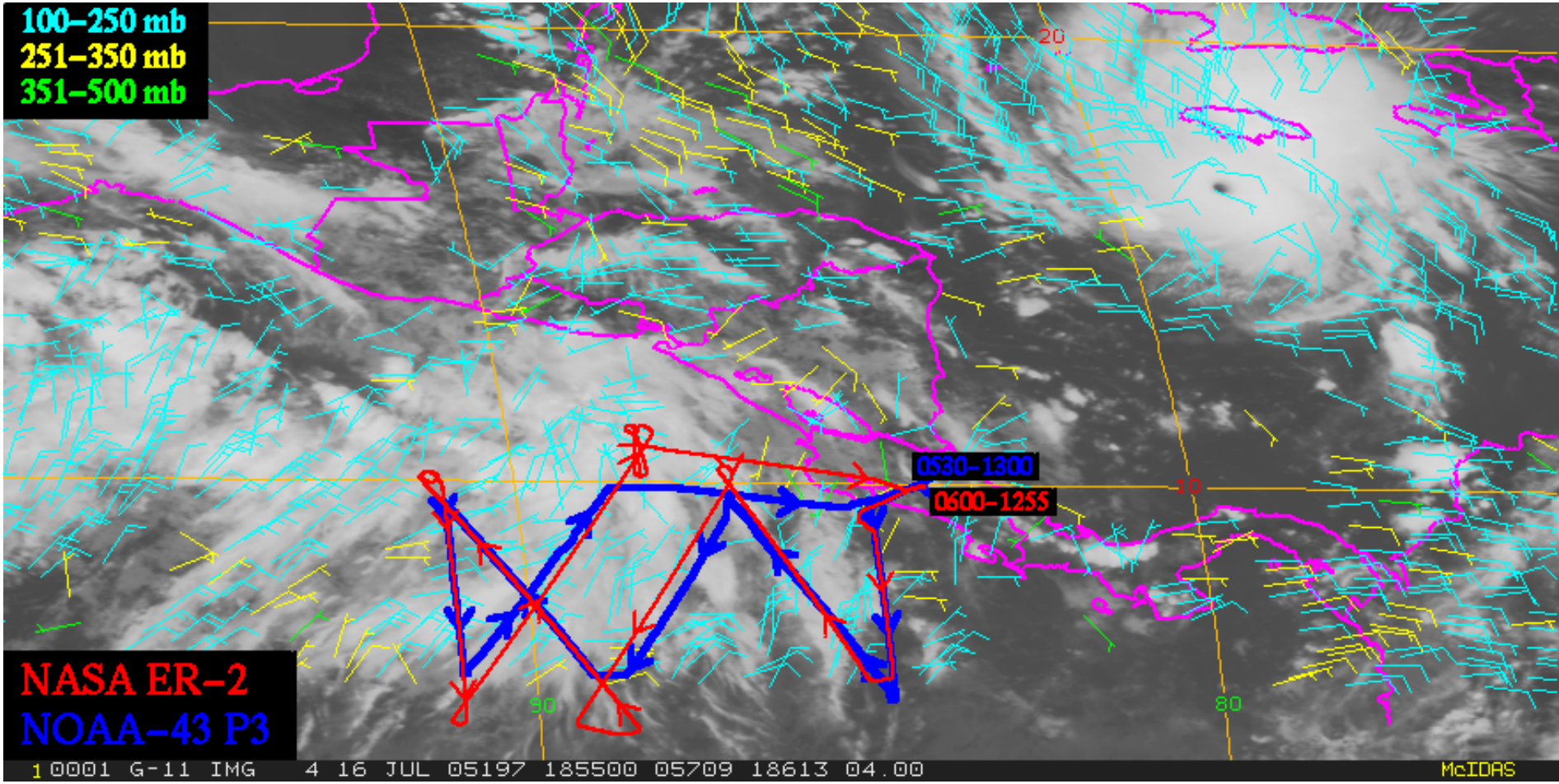
Figure 4.6. The percentage of all non-tropical cyclone VM tracks (non-developing + developing-pre) that eventually become tropical cyclones. The calculation is done for each 2.5 degree box for June-October, 1998–2001. Values are only plotted for boxes for which the total number of non-tropical cyclone VM tracks is at least ten. Contours are every 10%, and values above 30% are shaded.

(Courtesy Brandon Kerns)



Courtesy Brandon Kerns

Message for GRIP: Be prepared for periods without pregnant marsupials



From Halverson et al. (2007): Part of the attempt to observe pre-Eugene. 5 X 10h flights not enough. :-(

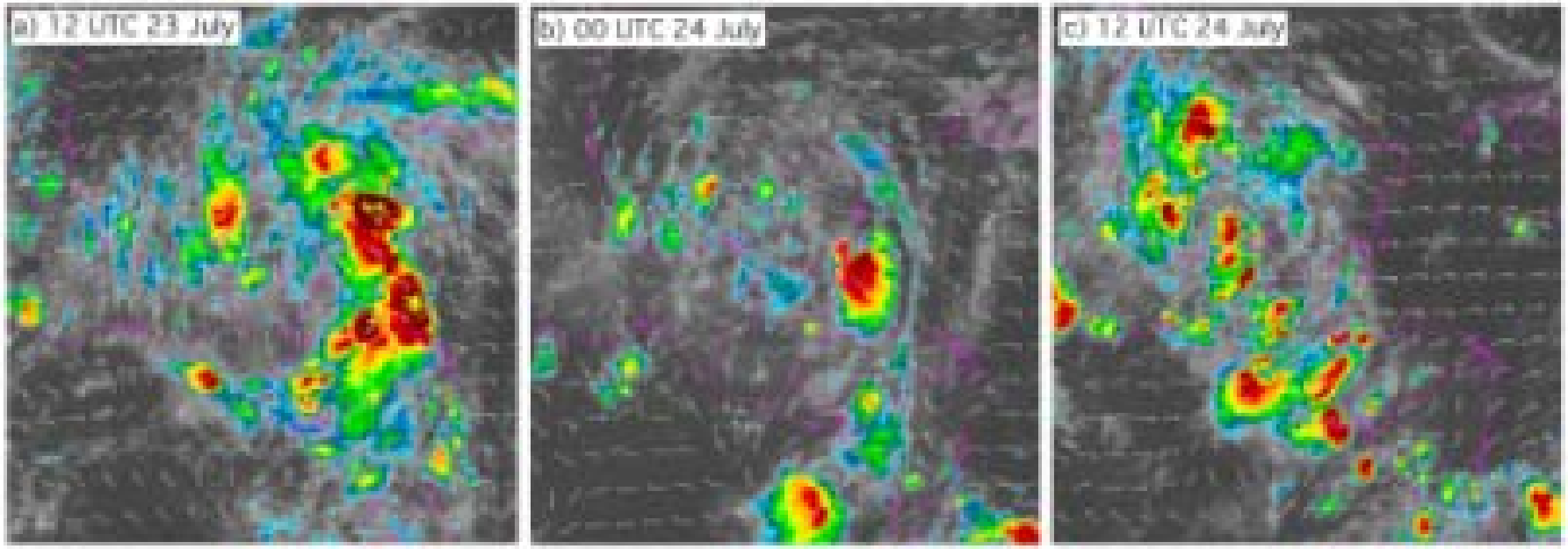
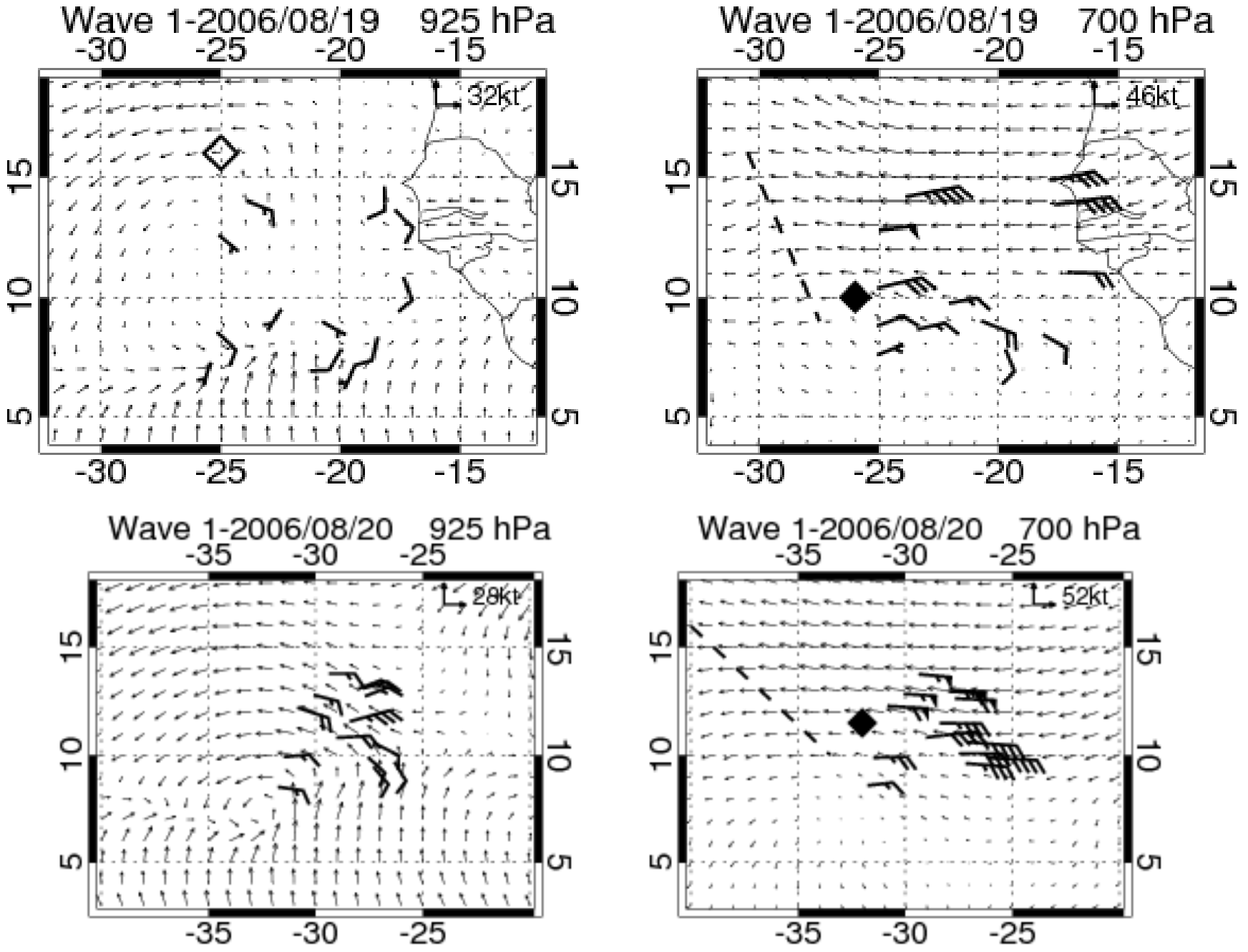
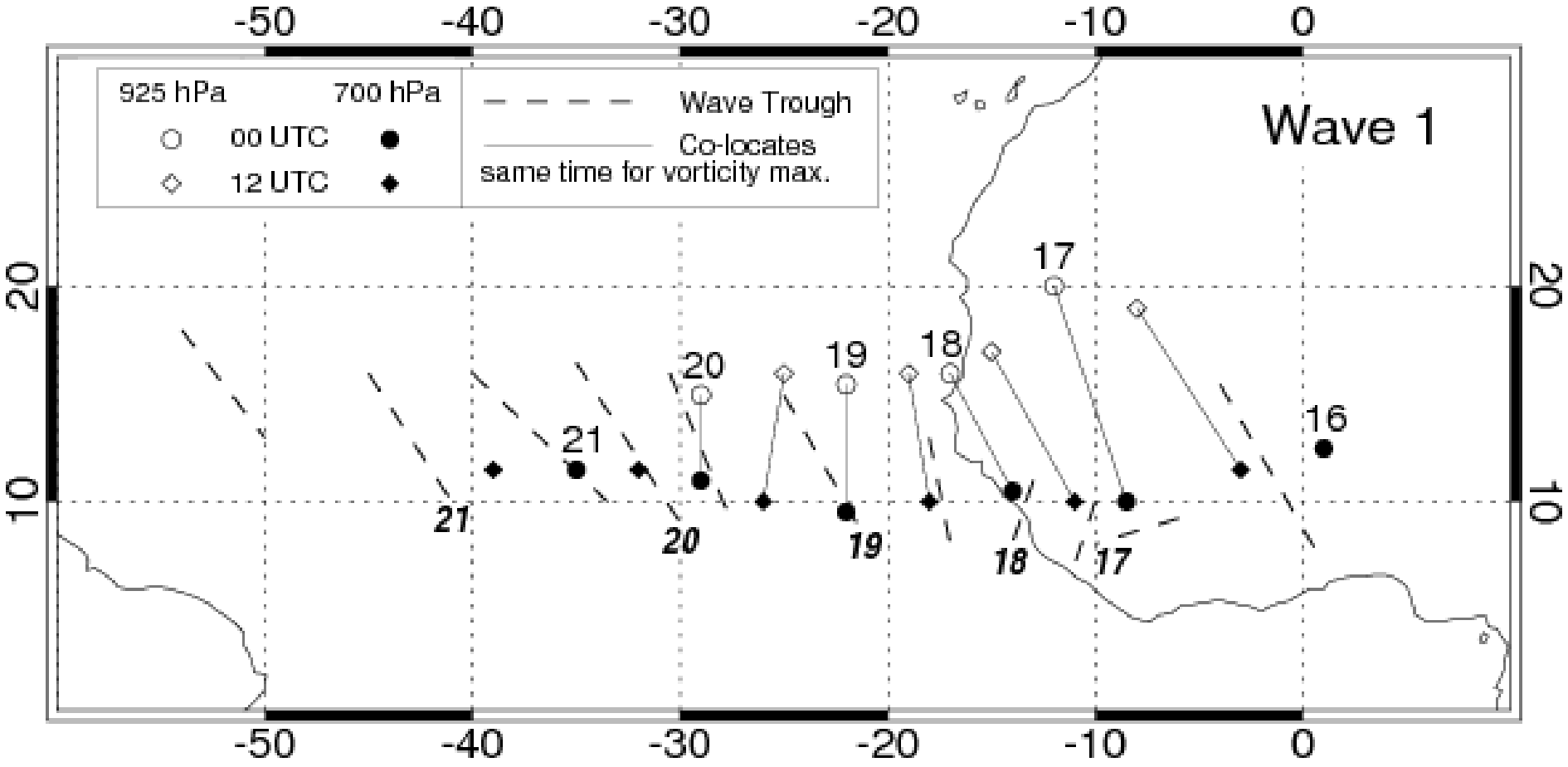


Figure 4. The 1000 hPa winds from NCEP global analyses show the broad scale wave clearly at 0000 UTC 23 July (panel a) as well as two primary regions of convection on each side of the Yucatan peninsula. The only circulation center is found east of the peninsula. By 1200 UTC 23 July (panel b), two distinct circulation centers are present. The eastern center has fallen well behind the wave axis and subsequently weakens. The second circulation center is near the wave axis in the far southern Gulf of Mexico and is also associated with active but not widespread convection. This is the region in which Gert forms. These two images show the complexity that arises as the wave crosses from water to land and back to water. The final image (0000 UTC 24 July, panel c) shows that only one circulation center remains, in the southwestern Gulf, with significant convection occurring within it. Vorticity fields from the NCEP analyses confirm that the center is broad and, like the convection, not clearly focused. The 12 hours before and after this time are most interesting for the diagnosis of how this storm forms within the easterly wave.

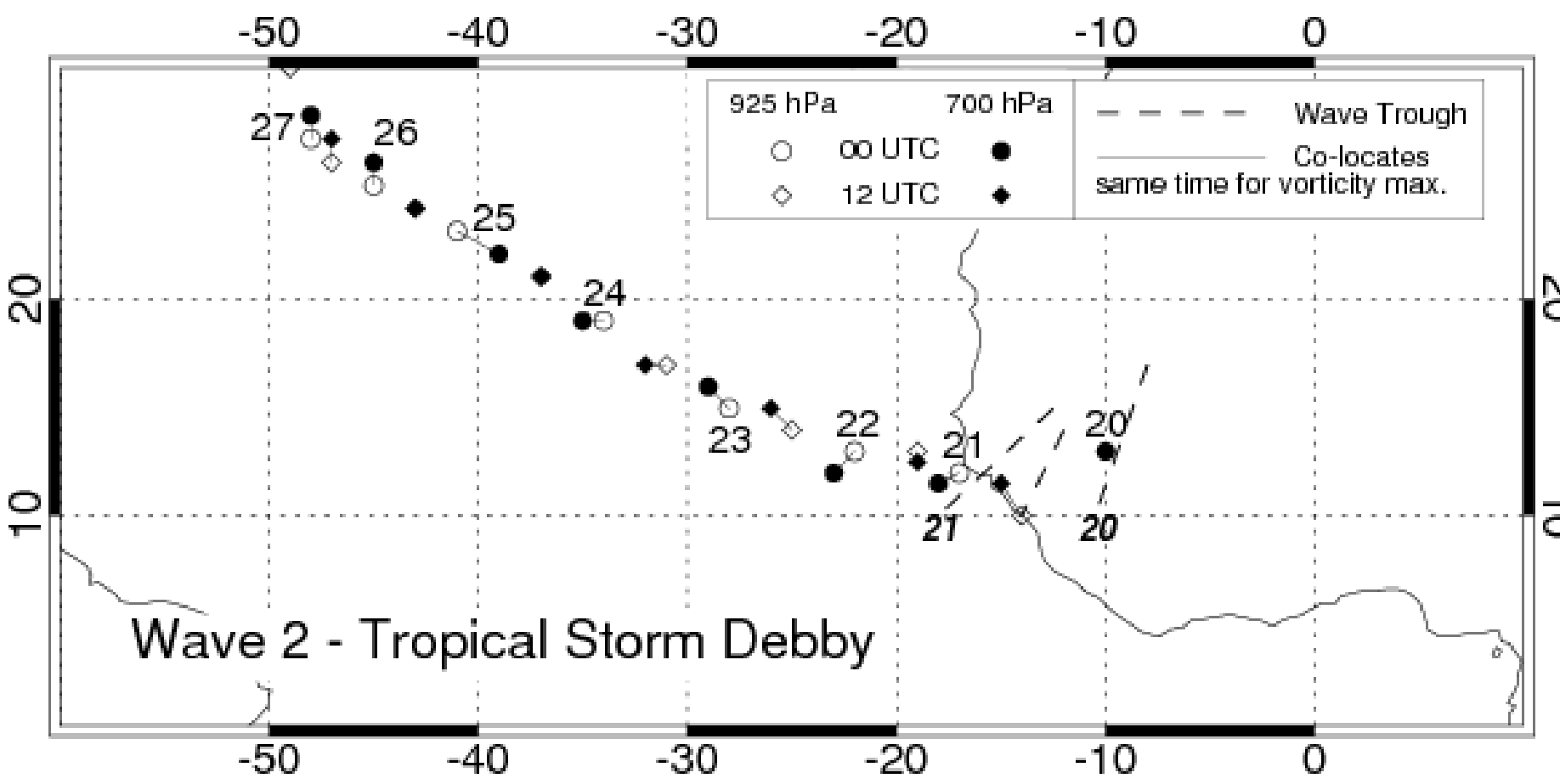
Gert (2005) development (?)

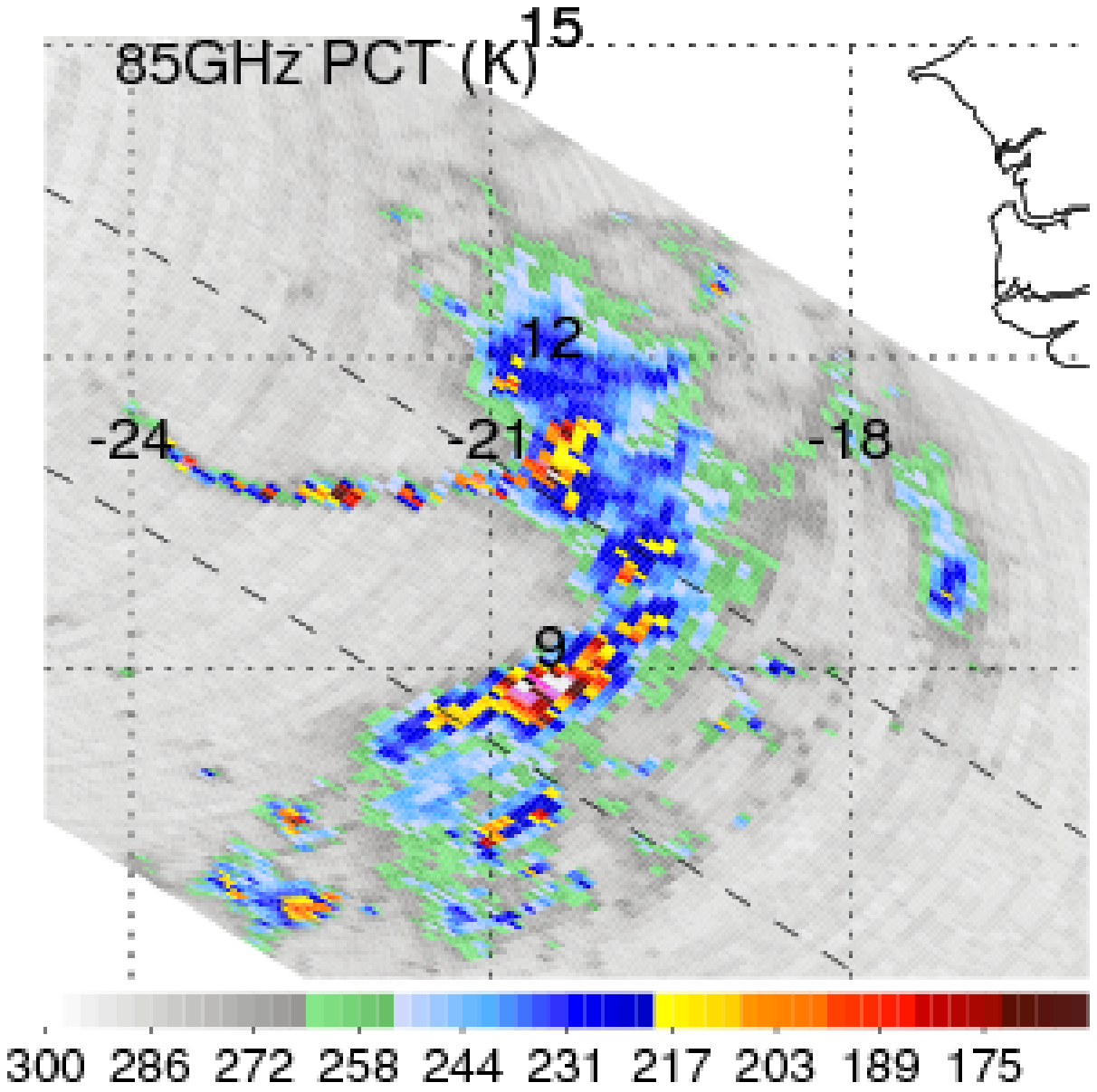


NAMMA Wave 1 (Zawislak et al. 09)

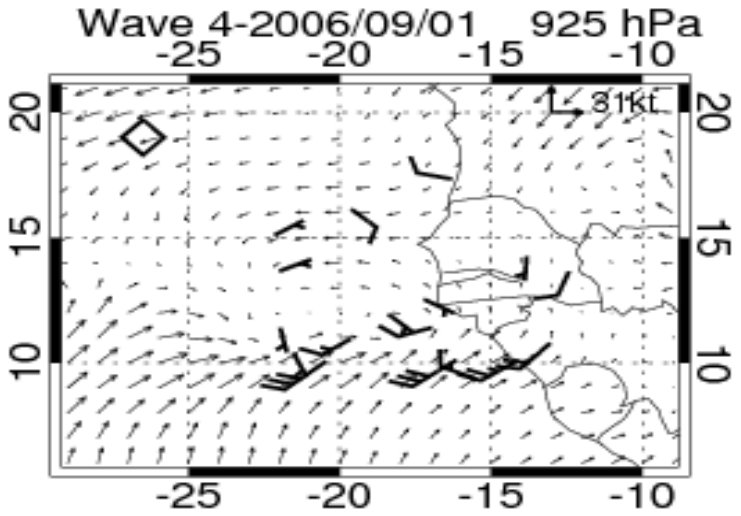


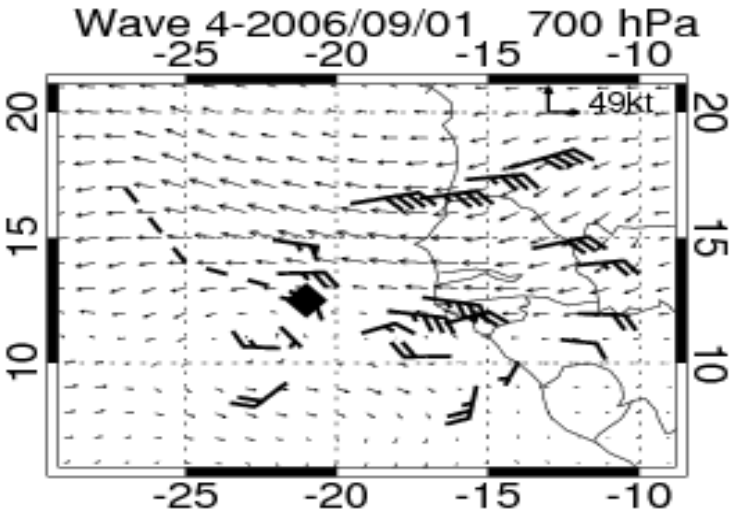
GDAS-analyzed 925 and 700 hPa vorticity maxima and 700 hPa wave trough locations for wave 1 at 0000 and 1200 UTC. Non-italic numbers indicate the day of the month (at 0000 UTC) for the vorticity maxima, italic numbers indicate day of the month for the 700 hPa wave trough (at 0000 UTC). (courtesy Jon Zawislak from Zawislak et al. 09, submitted)


-50
-40
-30
-20
-10
0
20
10
925 hPa
700 hPa
00 UTC
12 UTC
Wave Trough
Co-locates
same time for vorticity max.
27
26
25
24
23
22
21
20
21
20
Wave 2 - Tropical Storm Debby

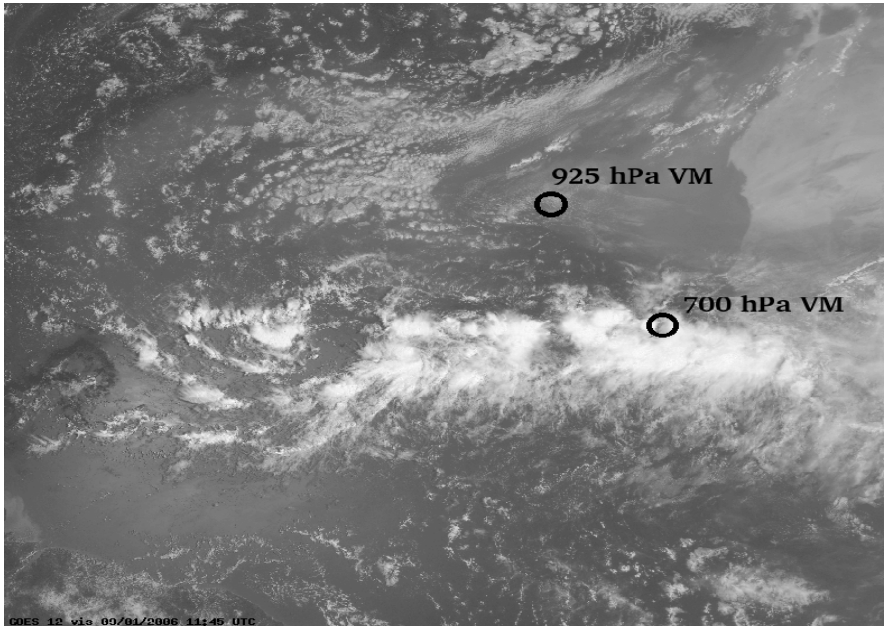


Debby (2006) forms close to Cape Verde (but DC-8 needed a down day after 2 flights into “wave-1”)





925 (left) and 700 hPa (right) dropsonde wind data (wind barbs, kt; full barb is 10 kt) with 1200 UTC GDAS analysis wind vectors overlaid for flight into wave 4 on 1 September 2006. Open diamond (filled) indicates GDAS-analyzed 925 (700) hPa vorticity maximum, while dash is the analyzed 700 hPa wave trough.



Problems: (1) Analysis and observations in very poor agreement; (2) E-W vorticity max at low levels, lots of deep convection, but without continuity will never know if and how this max contributed to cyclogenesis (3) Formation of Florence (2006) 60 h later was in climatological max near 40W that is out of reach of all aircraft

Lessons for GRIP

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