

Tri-Agency Forecast Discussion

29 September 2010

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Current Conditions/Synoptic Overview

Synoptic Overview: The current synoptic-scale flow pattern across the North Atlantic basin is shown using the CIMSS water vapor and upper-level cloud-tracks wind analysis valid at 1015 UTC 29 Sep (**image 1**). Over Central America and the Caribbean, newly named Tropical Storm Nicole (PGI50L) is embedded within broadly diffluent upper-level outflow, organizing deep convection, and a closed circulation at 700 hPa (**image 2**). A deep, nearly stationary trough over the eastern U.S. extends into the southern Gulf of Mexico (note the very dry air over the northern and western Gulf in **image 3**). Strong southerly flow on the forward flank of the trough (**image 2**) is helping to draw tropical moisture from the northern Caribbean poleward along the Eastern Seaboard (**image 3**). Downstream of the eastern U.S. trough, a tropospheric-deep anticyclone is positioned over the western North Atlantic. Southeast of this anticyclone, a positively tilted upper-level trough extends down toward the Lesser Antilles. The eastern flank of this trough helping to enhance outflow over a region of disorganized convection in the western/central tropical Atlantic collocated with a weak tropical wave (PGI51L). PGI51L is in a very moist environment (**image 3**) on the edge of anticyclonic flow aloft (**image 1**) and easterly flow at low levels (**image 2**). Farther east, PGI49L is embedded in strong easterly flow on the southern edge of an anticyclone over the eastern North Atlantic (**image 2**), and is associated with scattered convection.

The pouches being followed today are (from west to east): PGI50L (TS Nicole) over the northwestern Caribbean, PGI51L over the western/central tropical North Atlantic, and PGI49L over the eastern tropical North Atlantic. Discussion of each of these pouches follows below:

Nicole (PGI50L): As of 1500 UTC, T.D. 16 was upgraded to T.S. Nicole. Nicole was located at 22.6 N, 80.6 W with an intensity of 35 kt/996 hPa. This position places Nicole over west-central Cuba with emergence of the cyclone into the Florida Straits expected within the next 6 hr or so. Movement is currently 40 deg (or northeast) at 8 kt. Tropical storm warnings are currently in effect for the Cayman Islands, the northwestern and central Bahamas, and much of the west-central Cuba coastline.

Nicole is currently located in a broad region of upper level diffluence (**image 4, left panel**). The diffluence maximum to its north is associated with flow around the eastern periphery of the eastern U.S. trough while the diffluent flow to its south is associated with the westward extent of an upper tropospheric anticyclone. Substantial dry air and fast upper tropospheric flow are located approximately 1-2 deg north and west of the center of the storm. The surface circulation associated with Nicole is quite broad as highlighted by regional surface observations (**image 4, right panel**) and ASCAT overpasses from the past 24 hr (not shown). Tropical storm-force winds are well-removed from the center of the storm to its southeast and confined mostly over water near eastern Cuba, Jamaica, and Hispaniola. This is reflected by the 300 n. mi. extent to the 34-kt wind radii to the southeast of the storm in the 1500 UTC NHC advisory for Nicole.

The convective structure of Nicole has improved substantially since yesterday. Yesterday, deep convection associated with the storm was removed well to the southwest and southeast of the system. Today, while deep convection is still primarily confined to the south and east of the system, the

banding structure of this convection about the center of circulation has greatly improved (**image 5**). Furthermore, deep convection has recently developed near and just east of the center of circulation. We feel that the improved organization of the convection associated with the storm - and, by extension, the intensity of the storm - is due to a 'scale matching' process described by Hanley et al. (2001, *MWR*). At 1200 UTC yesterday, the scale of the deep trough across the eastern U.S. was much greater than that of Nicole (**image 6, left panel**). At 0600 UTC today, 18 hr later, the scale of this trough has narrowed substantially (**image 6, right panel**). Water vapor satellite imagery (**image 7**) suggests that the wavelength of this feature now closely approximates that of Nicole. The narrowing of the scale of the eastern U.S. trough arises due to two factors: the north-northeastward ejection of the vorticity maximum/shortwave analyzed near 40 N, 80 W at 1200 UTC yesterday and substantial convective-related diabatic heating (e.g. **image 7**) on the eastern side of the trough. These factors have contributed to a temporary reduction in the magnitude of the vertical wind shear atop the cyclone and a potential constructive trough interaction scenario.

PGI51L: As of 1600 UTC 29 Sep, PGI51L was located over the western/central tropical Atlantic at 12.5 N, 55.0 W within a region of disorganized deep convection, cyclonic low-level vorticity, and pronounced upper-level outflow to the northwest (**image 8**). The initial position of the pouch sweet spot is somewhat uncertain based on the large position spread among the dynamical models (bottom panel in **image 8**). This disturbance is experiencing only low to moderate vertical wind shear (~10 kt; not shown), although shear increases substantially to the north in association with strong southwesterly winds on the eastern flank of an upper-level trough (**image 1**). The environment surrounding PGI51L appears generally favorable for development, with considerable moisture present (TPW >55 mm, **image 3**) and high SSTs (30+ C, not shown).

PGI49L: At 16Z, PGI49L was located at 10.8N, 34.5W moving toward the west-northwest. **Image 9** shows the CIMSS wind analyses, IR satellite, and total precipitable water from 15Z. There is scattered convection, primarily in a band to the northeast of the estimated pouch center. Additionally, there is a tongue of lower total precipitable water wrapping around the western flank of the storm. This coincides nicely with an absence of deep convection. The upper-level flow is uniformly from the east, and the vertical wind shear is from the north at about 10-20 knots.

Day 1 Forecast

Nicole (PGI50L): Nicole is expected to accelerate to the east-northeast during this period (**image 10**) as it undergoes extratropical transition, a process that it is expected to complete by F024 (e.g. **image 11**). Though Nicole has remained fairly well insulated from the detrimental effects of the upper trough to date (as described above), this is not expected to continue as it becomes embedded within the mid-latitude westerlies. The substantial degree of baroclinic forcing associated with this trough in a very moist environment (**image 3**) is expected to help the cyclone maintain its intensity through the period as it becomes an extratropical cyclone. In conjunction with this energy and moisture, heavy rainfall is likely to continue for much of Florida, Cuba, and the Bahamas through this period (**image 12**) with localized flooding possible.

The official 0-24 hr NHC forecast for Nicole is as follows:

INITIAL	29/1500Z	22.6N	80.6W	35 KT
12HR VT	30/0000Z	24.7N	79.8W	35 KT
24HR VT	30/1200Z	29.4N	78.4W	35 KT...POST-TROPICAL

PGI51L: The dynamical model forecasts indicate that PGI51L will remain weak (**image 13**) as it moves to the west-northwest (**image 8**). Similar to the last set of model pouch time series, the latest time series indicate high moisture in the pouch, but near-zero Okubo-Weiss values, very low ($\sim 2 \times 10^{-5} \text{ s}^{-1}$) low-level relative vorticity, and moderate deep-layer wind shear (15-20 kt). Due to the position spread at the initial time, the individual model tracks exhibit a fair amount of spread. The ECMWF and UKMET positions are displaced south of consensus through the period, while the GFS and NOGAPS positions are displaced north.

PGI49L: PGI49L is forecast to move toward the west-northwest in the short term (**image 14**). The ECMWF shows a sudden spike in OW and relative vorticity, but this is likely due to a transient mesoscale feature and not representative of the system as a whole. The GFS weakens PGI49L, possibly due to some dry air intrusion into the pouch. One can see this occurring in the dividing streamline analysis in **image 15**, although the dividing streamlines are not plotted. This is not unreasonable given trends in the total precipitable water and moderate amounts of vertical wind shear seen in the initial synoptic analysis. In fact, the GFS has the total precipitable water decreasing to 45-50 mm by the end of day one. The UKMET and NOGAPS develop PGI49L, but the NOGAPS appears to be too robust initially, as it has been during the past couple of runs. Shear is forecasted to remain around 6-10 m/s during the short term.

Day 2 Forecast

Nicole (PGI50L): By F024, Nicole is expected to have transitioned into an extratropical cyclone in response to substantial baroclinic forcing ahead of the intense eastern U.S. upper tropospheric trough (e.g. **image 11**). Between F024-F048, Nicole is expected to dissipate as a secondary extratropical cyclone develops in the right entrance region of the upper tropospheric jet streak east of the eastern U.S. upper trough. Nicole (or the remnant thereof) is expected to track north-northeastward through this period (**image 10**) from the northern Bahamas toward the NC/SC coastline. As upper jet dynamics couple with lower tropospheric lift along an in situ coastal front in an abnormally moist environment, widespread heavy rainfall is likely across the coastal Carolinas during this period (**image 12**).

The official 24-48 hr NHC forecast for Nicole is as follows:

24HR VT 30/1200Z 29.4N 78.4W 35 KT...POST-TROPICAL
36HR VT 01/0000Z...DISSIPATED

PGI51L: Between 1200 UTC 30 Sep and 1200 UTC 1 Oct, the ECMWF indicates slow development of this system, whereas the GFS and UKMET forecasts do not. The ECMWF deterministic pouch time series show a slight uptick in relative vorticity and Okubo-Weiss values near the end of the period, while the GFS and UKMET show steady state conditions (**image 13**). A comparison of the GFS and ECMWF ensembles valid at 1200 UTC 30 Sep shows disagreement between the models, with comparatively more of the ECMWF members hinting at development (**image 16**). Ryan Torn's EnKF-based WRF ensemble (**image 17**) is similar to the ECMWF in that many members indicate slow development on 30 Sep.

PGI49L: PGI49L is forecast to continue moving toward the west-northwest or northwest (**image 14**). The ECMWF and GFS remain quite weak through the period with OW values near zero, whereas the UKMET and NOGAPS intensify PGI49L. The GFS does show a gradual recovery of the TPW as the dry air

is moistened in situ or mixed with moister air surrounding the pouch. The vertical wind shear is forecasted to remain in the moderate range around 8 m/s. The high values of shear seen in the NOGAPS is likely due to PGI49L's stronger vortex and is not representative of the environment.

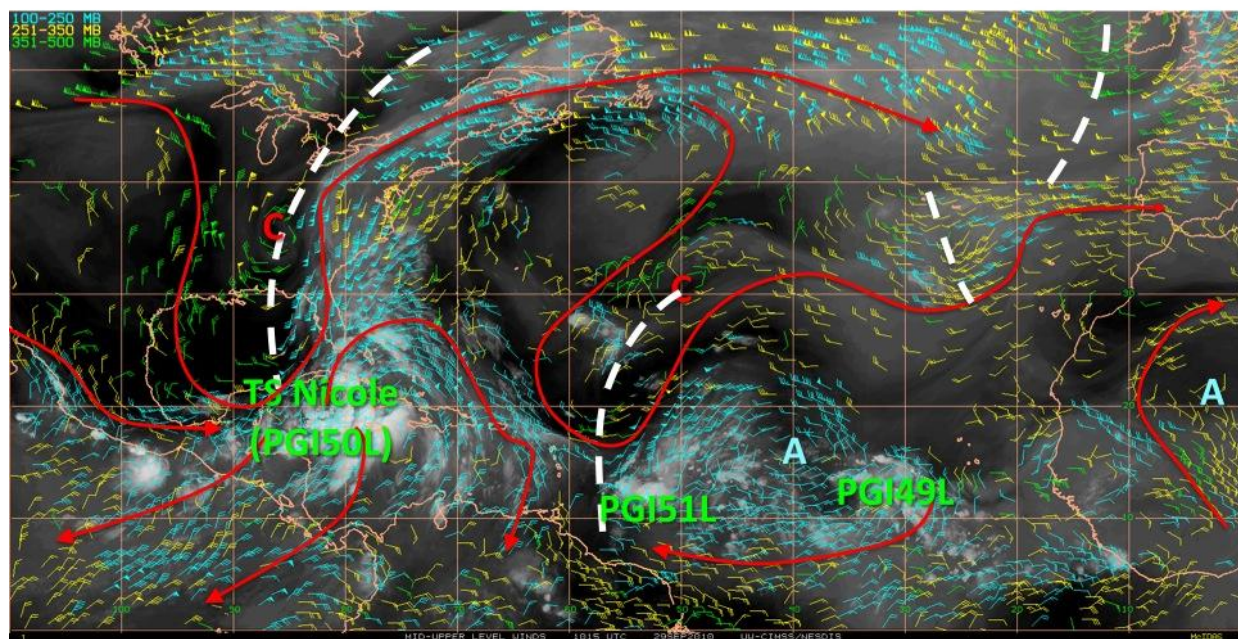
Extended-Range Forecast

Nicole (PGI50L): Nicole is expected to have dissipated prior to F048 in response to secondary extratropical cyclogenesis along the GA/SC coastline. Despite this forecast of dissipation, the substantial tropical moisture associated with Nicole - approaching 4 standard deviations above normal for this time of year (not shown) - is expected to continue to be pulled northward ahead of the secondary extratropical cyclone along the east coast of the United States. Coupled with upper tropospheric jet dynamics focusing lift to the north and west of the extratropical cyclone, this moisture is expected to help contribute to widespread heavy rainfall across the Mid-Atlantic and northeast U.S. over the next 2-3 days (**image 12**).

The GFS and ECMWF suggest that another tropical cyclone may form in the northwestern Caribbean Sea after F072 along the tail end of the baroclinic zone associated with Nicole/the secondary extratropical cyclone. A slow east to northeastward movement ahead of the persistent eastern U.S. upper tropospheric trough is anticipated for any disturbance that may develop in this region.

PGI51L: PGI51L is forecast by the consensus of the models to move toward the northwest and be in the vicinity of the Leeward Islands in the extended range (**image 13**). The ECMWF and UKMET both lose PGI51L after 72 hours. The low-level vorticity appears to become more linear in appearance, possibly due to some background deformation (not shown). The GFS maintains a weak feature, but like the ECMWF and UKMET, shows high amounts of vertical wind shear at the beginning of day 3. Such an unfavorable environment will likely stifle development. Complicating matters is that there may be some interaction of PGI51L with PGI49L behind it. Despite the insistence of the global models for no development, the mesoscale ensembles are quite robust in strengthening PGI51L in the extended range (see ensemble mesoscale discussion).

PGI49L: PGI49L is forecast to continue tracking toward the northwest during the extended range (**image 14**). The ECMWF loses PGI49L in the extended period, although some of its ensemble members suggest otherwise. Although the GFS doesn't have increasing OW values, the relative vorticity and total precipitable water do gradually increase after day 3. However, one detriment to development may be the increase in vertical wind shear seen in the models as PGI49L approaches an upper-level trough of cutoff low in the central Atlantic. Additionally, the conglomeration of wave energy with PGI51L and ex-PGI48L will have to be watched.



1015 UTC 29 Sep

A = Upper-level anticyclone

C = Upper-level cyclone



Representative streamline



Upper-level trough axis

Image 1

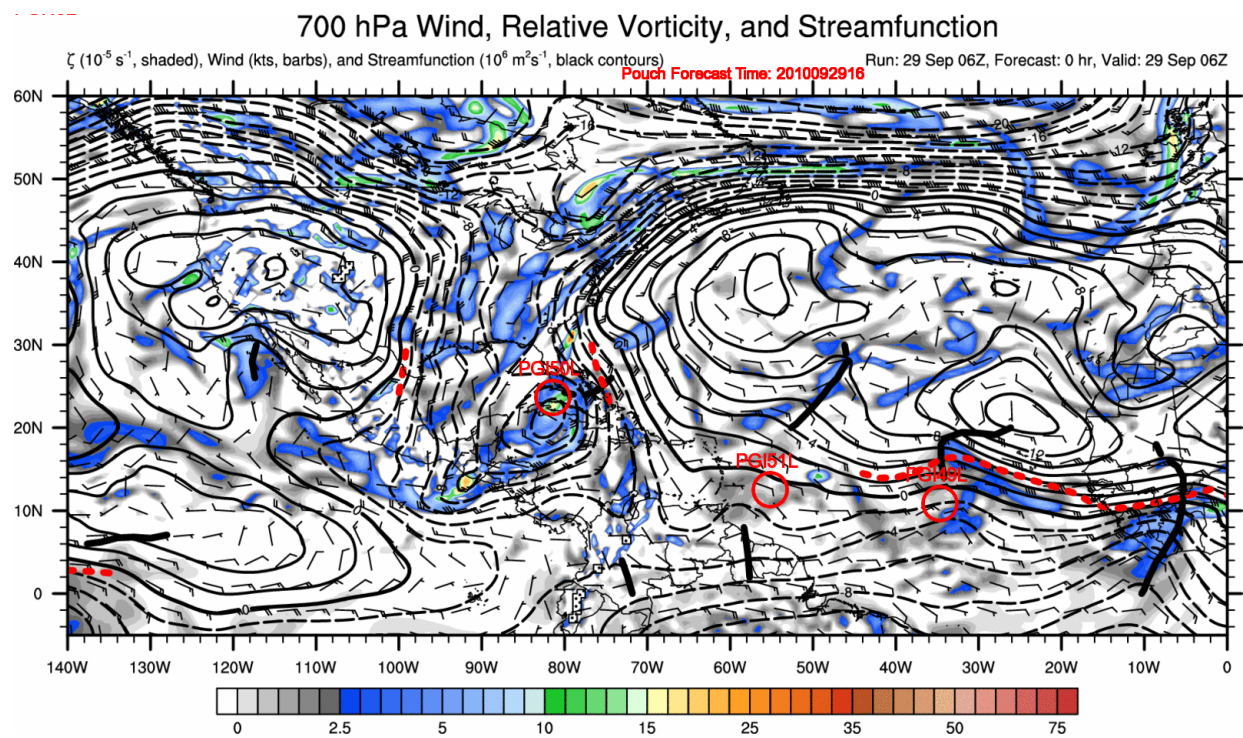


Image 2

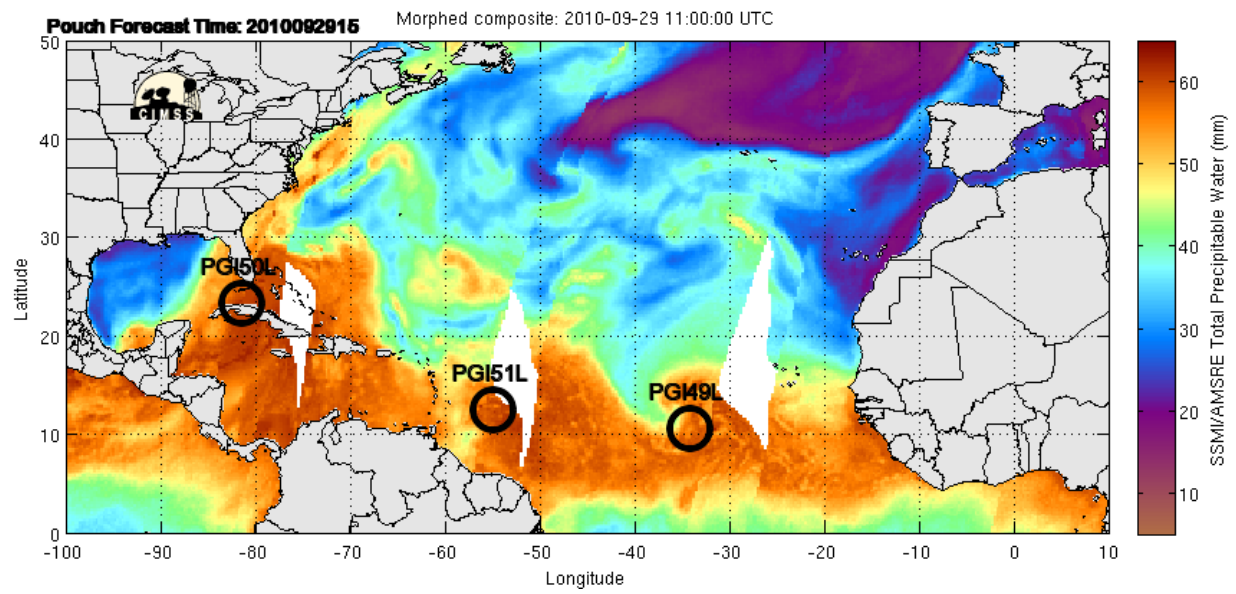


Image 3

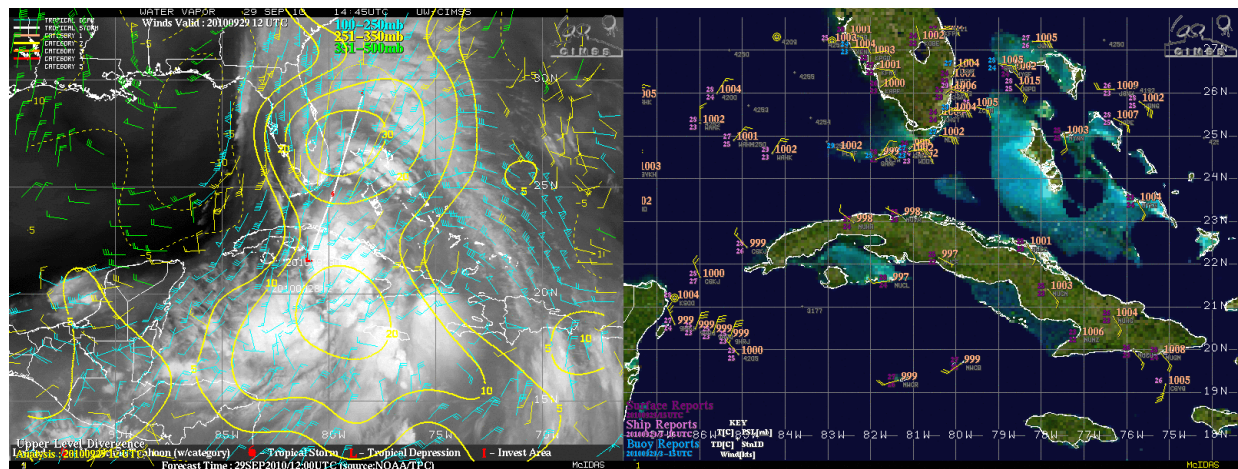


Image 4

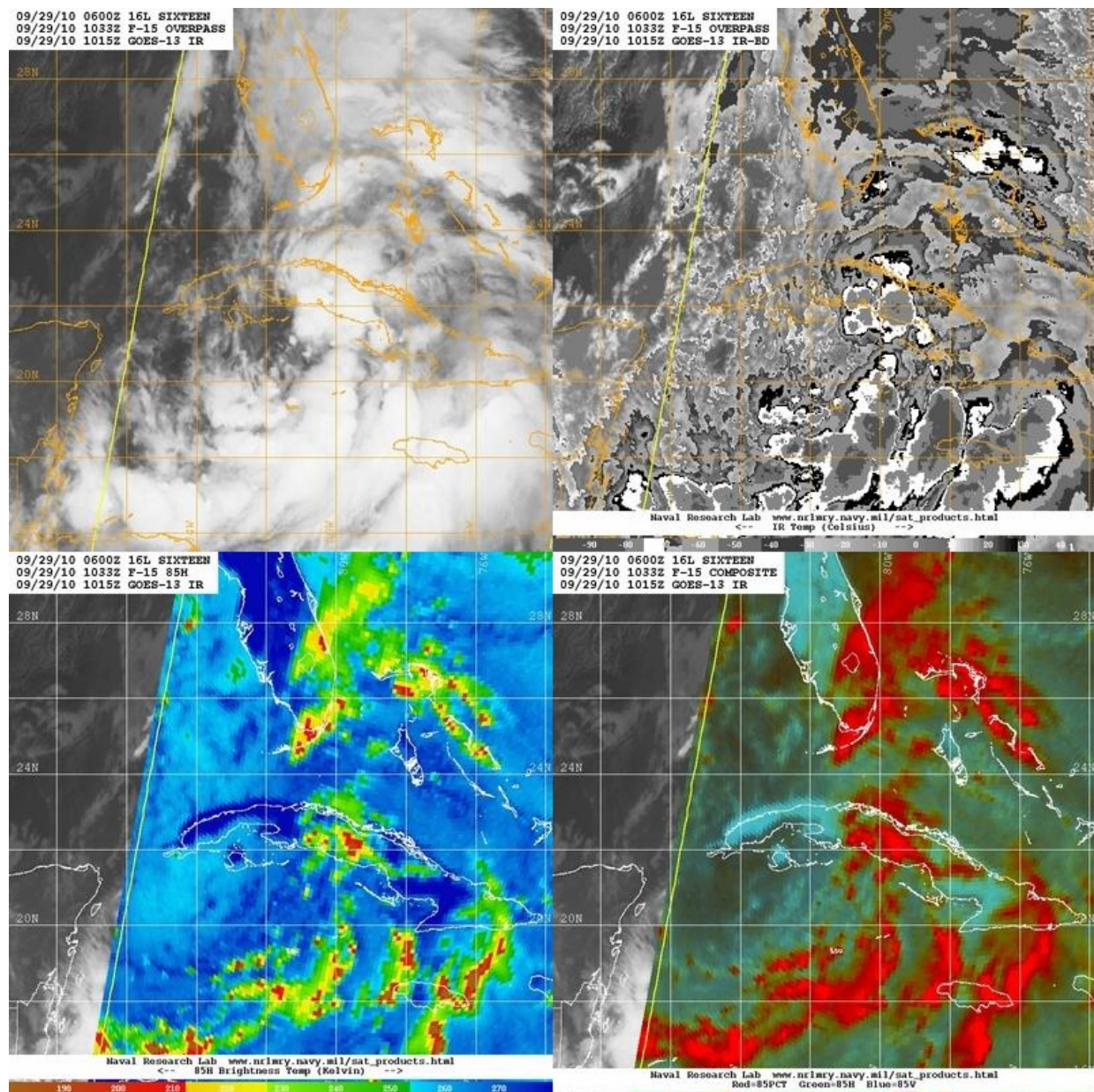


Image 5

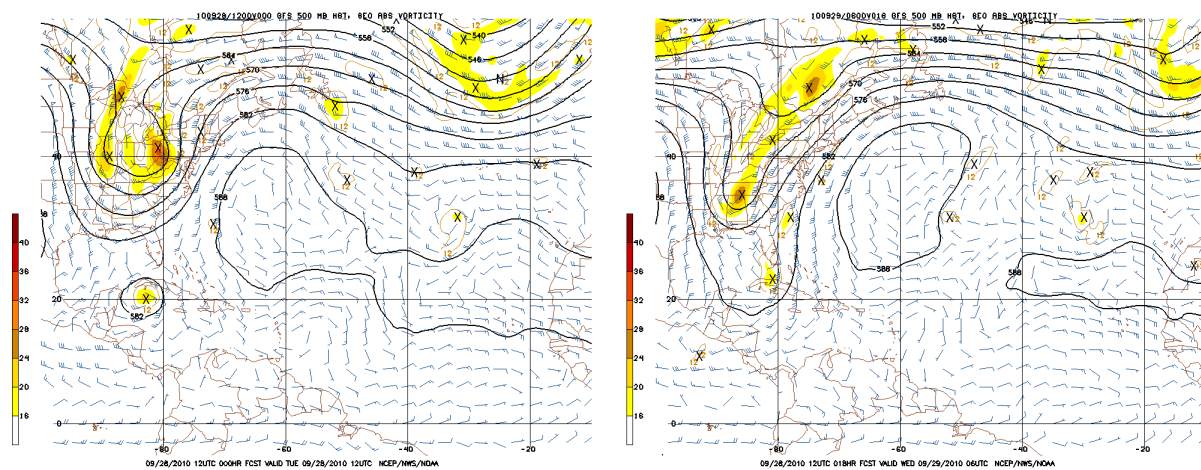


Image 6

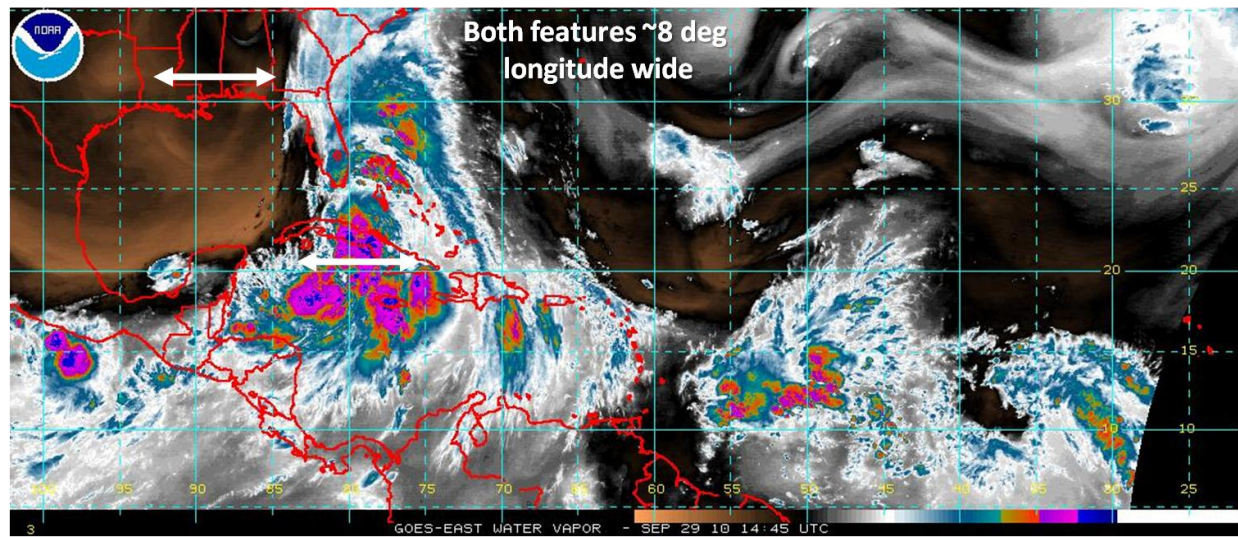


Image 7

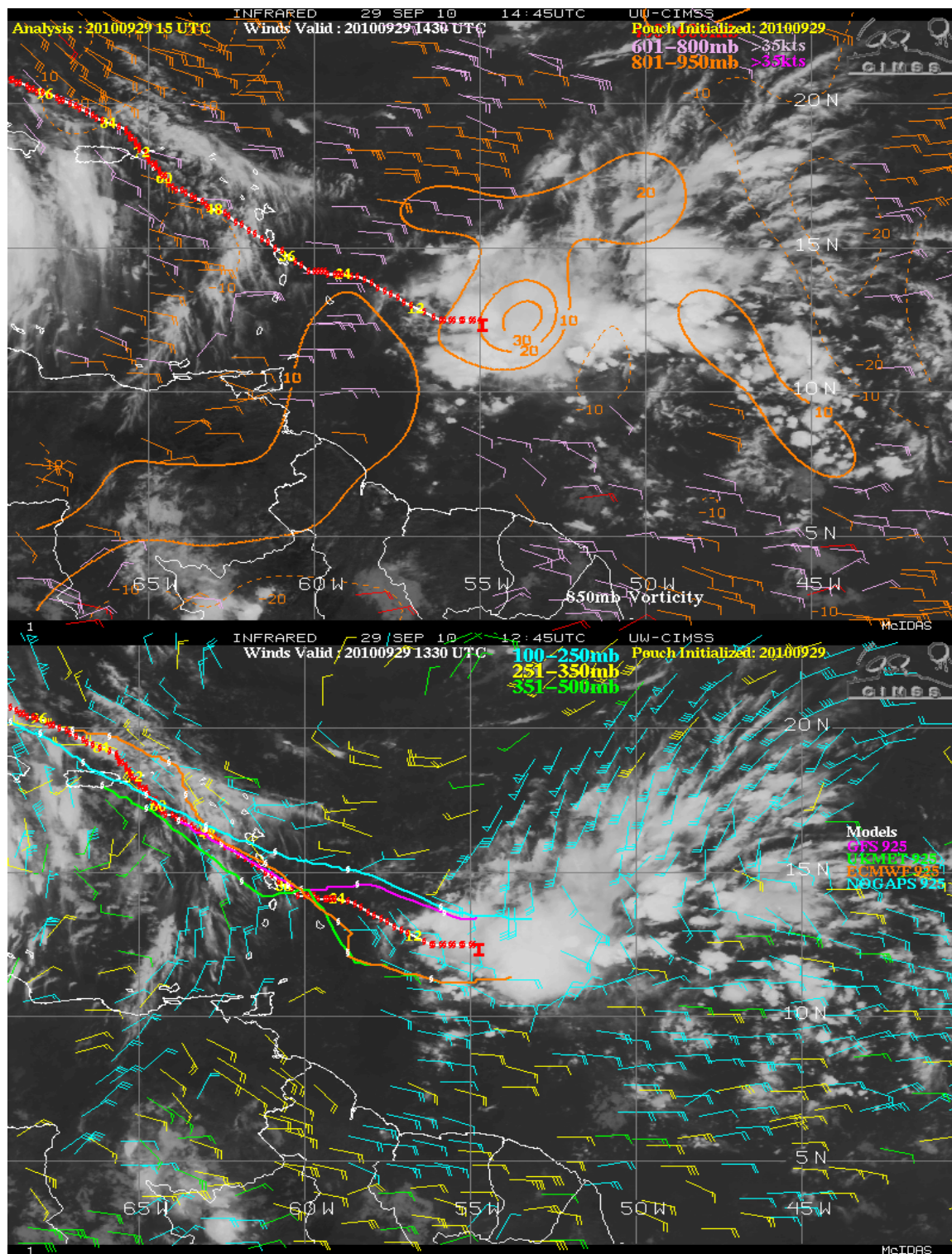


Image 8

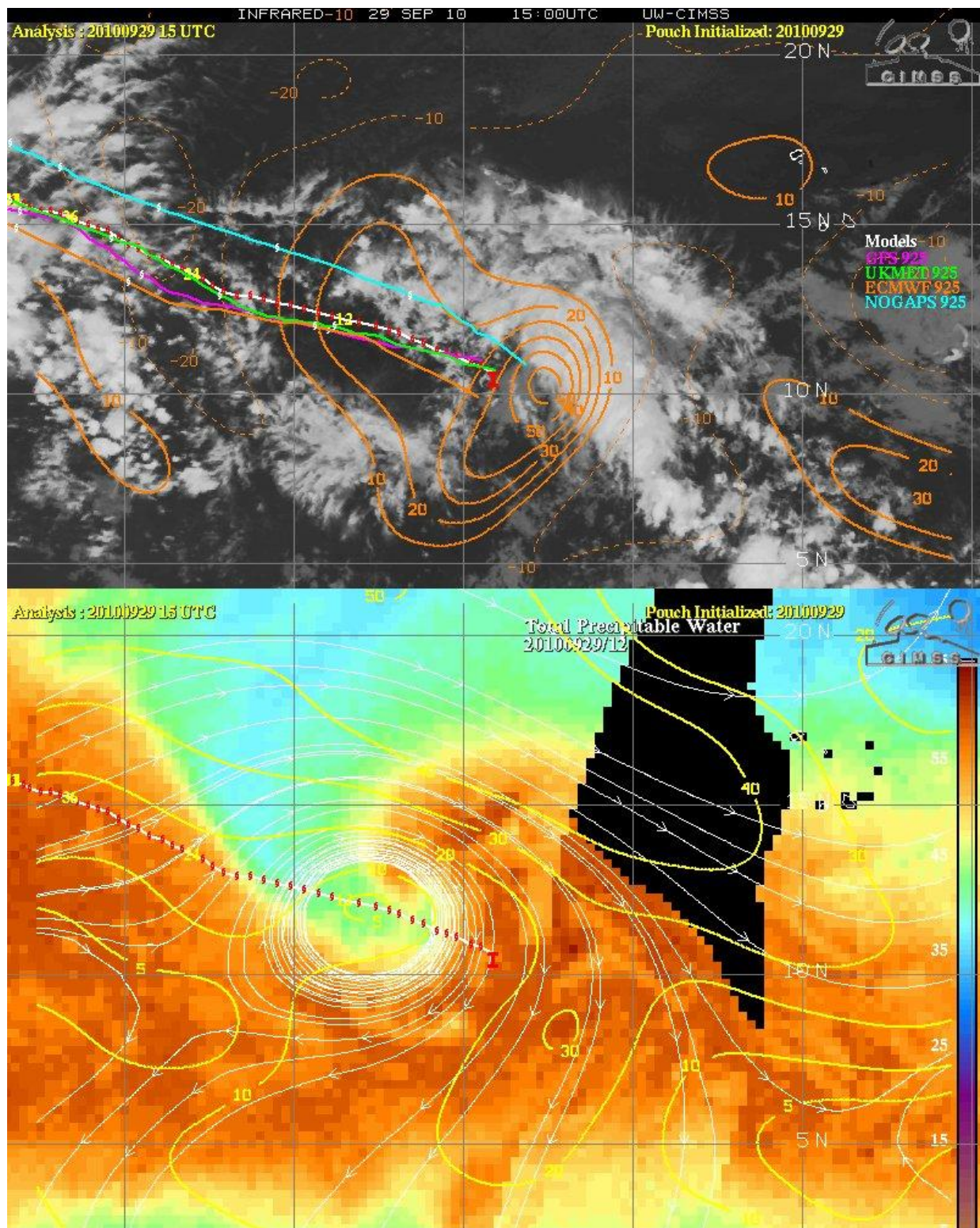
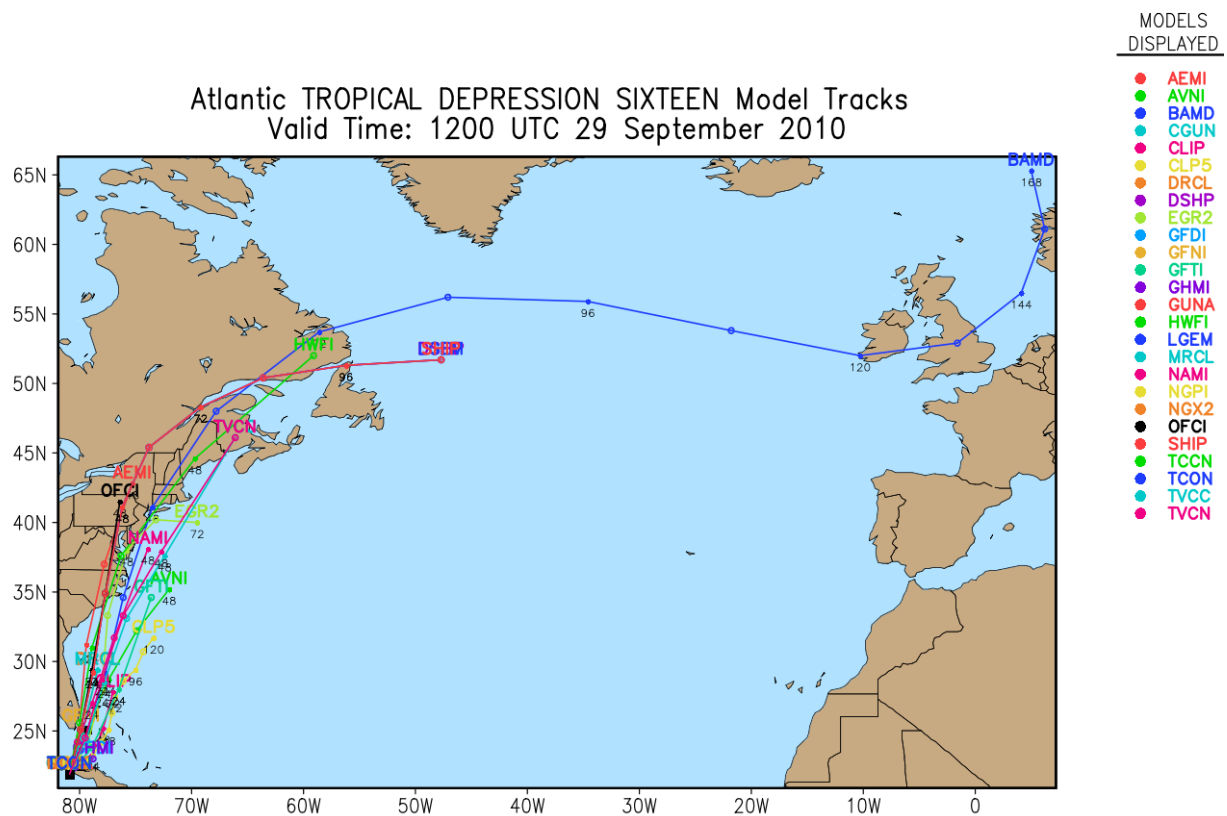


Image 9



Tropical Cyclone Model Plots
<http://moe.met.fsu.edu/~acevans/models/>
 Redistribution of these images is prohibited.

DISCLAIMER: Do not use this image in place of official sources!
 The official NHC forecast is always available at <http://www.nhc.noaa.gov>.
 Forecast points above are shown in 12 hr increments. Initial points denoted by black squares.

Image 10

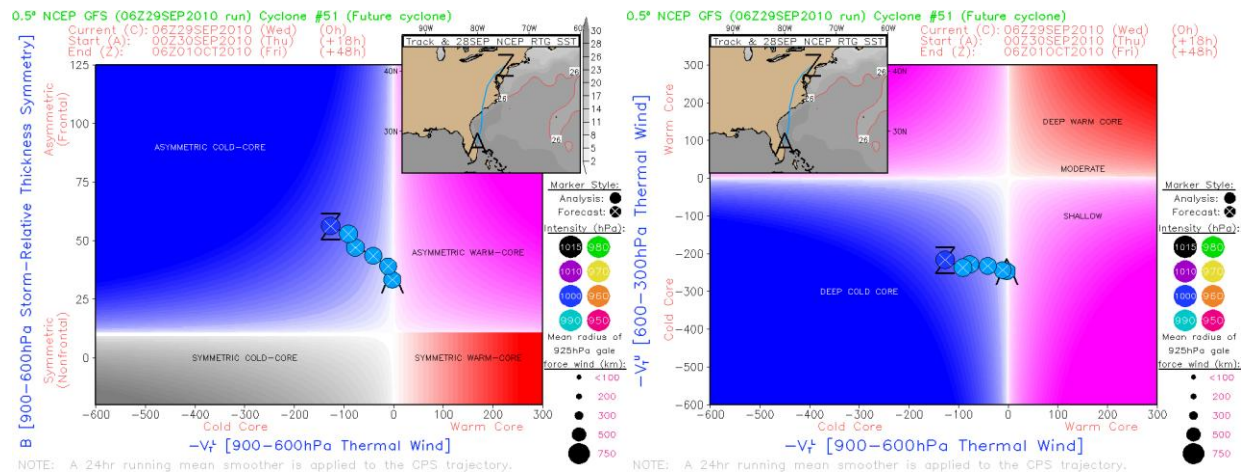


Image 11

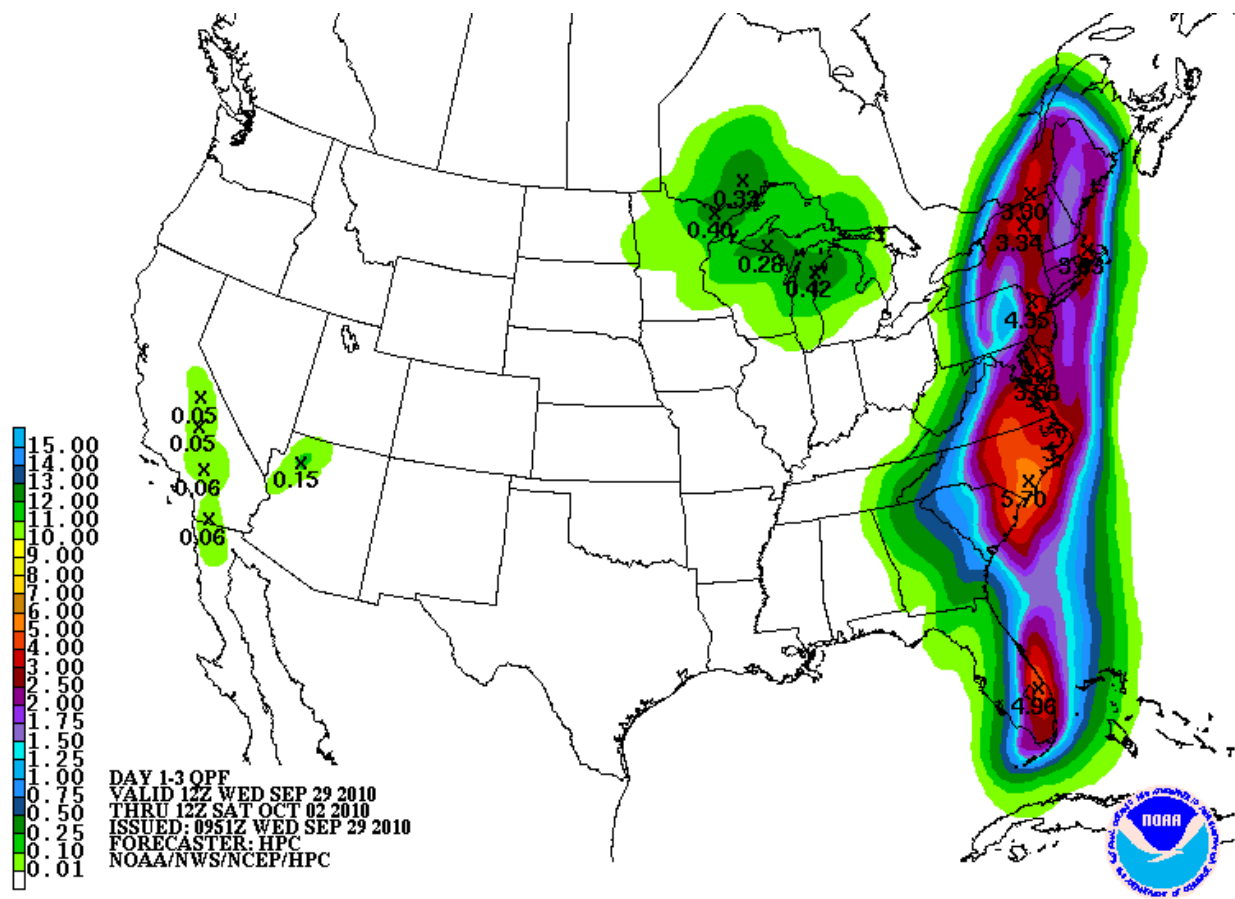


Image 12

PGI51L

↓ = 1200 UTC 30 Sep

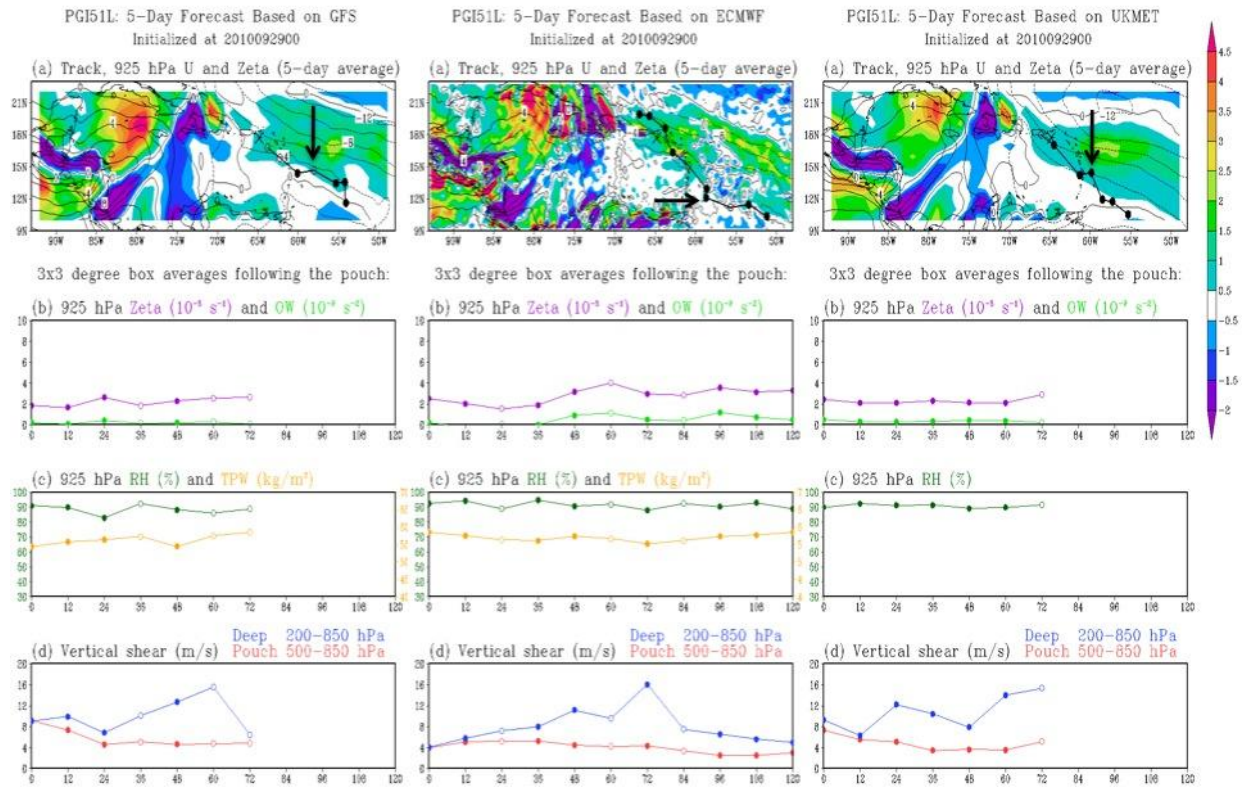


Image 13

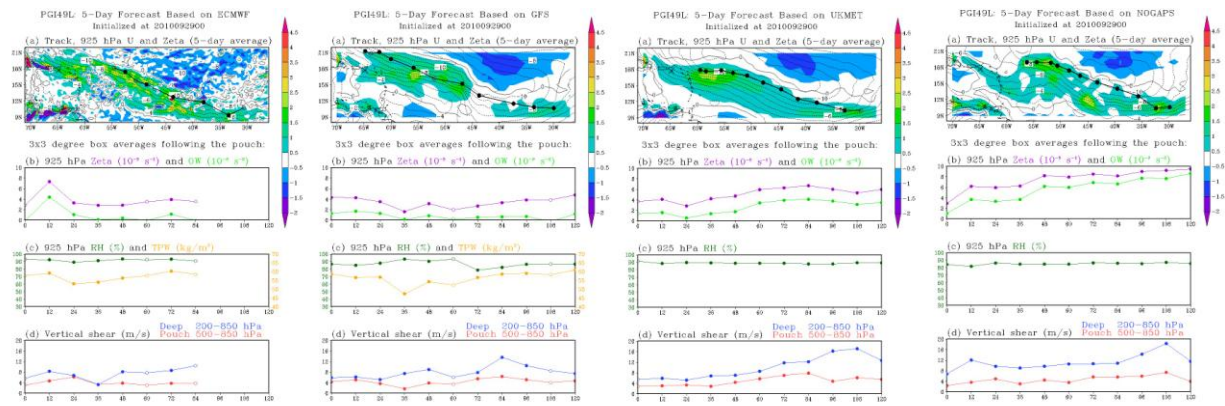


Image 14

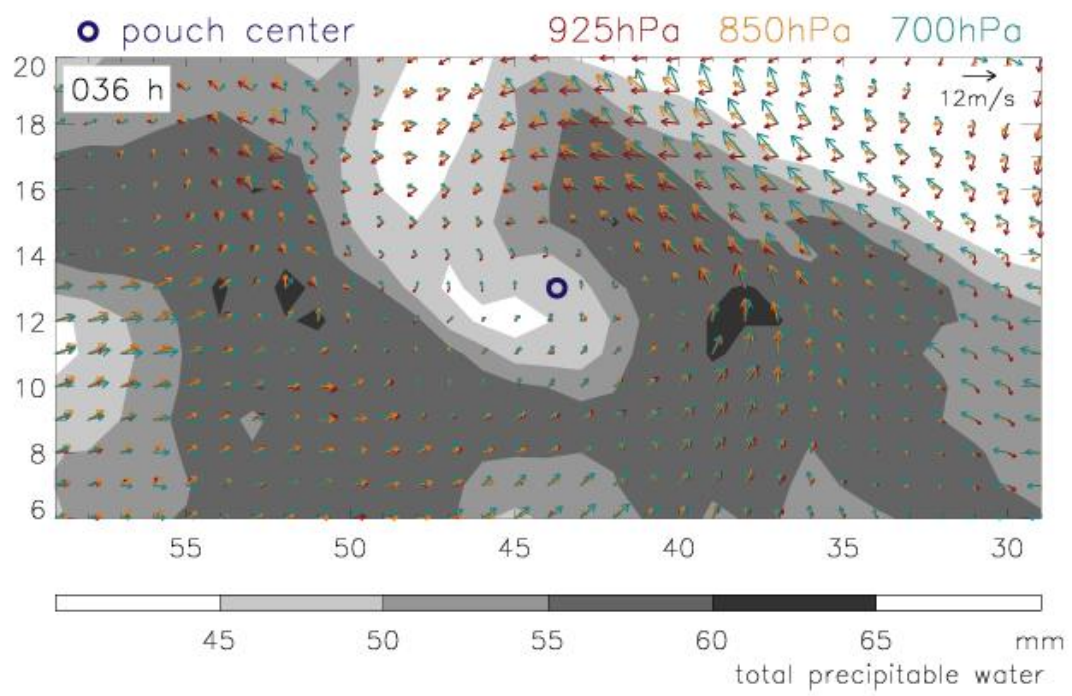


Image 15

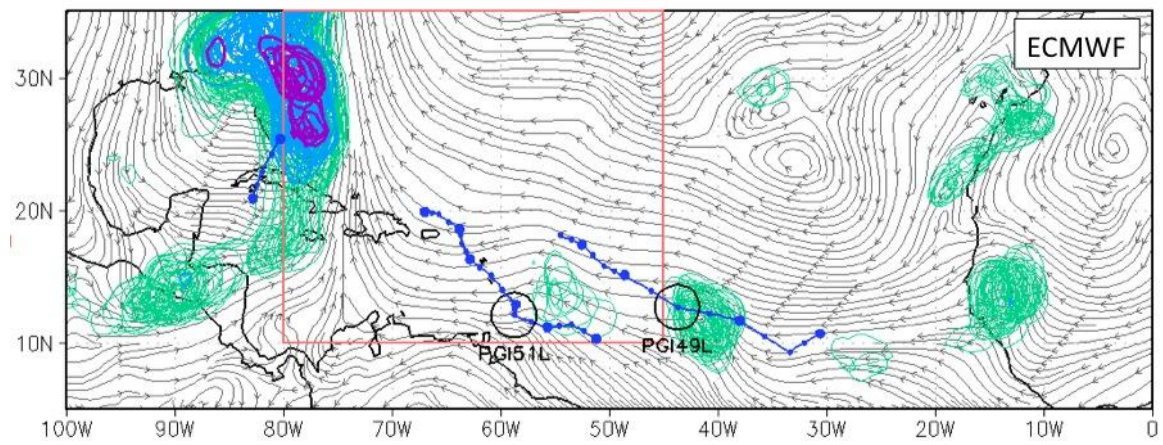
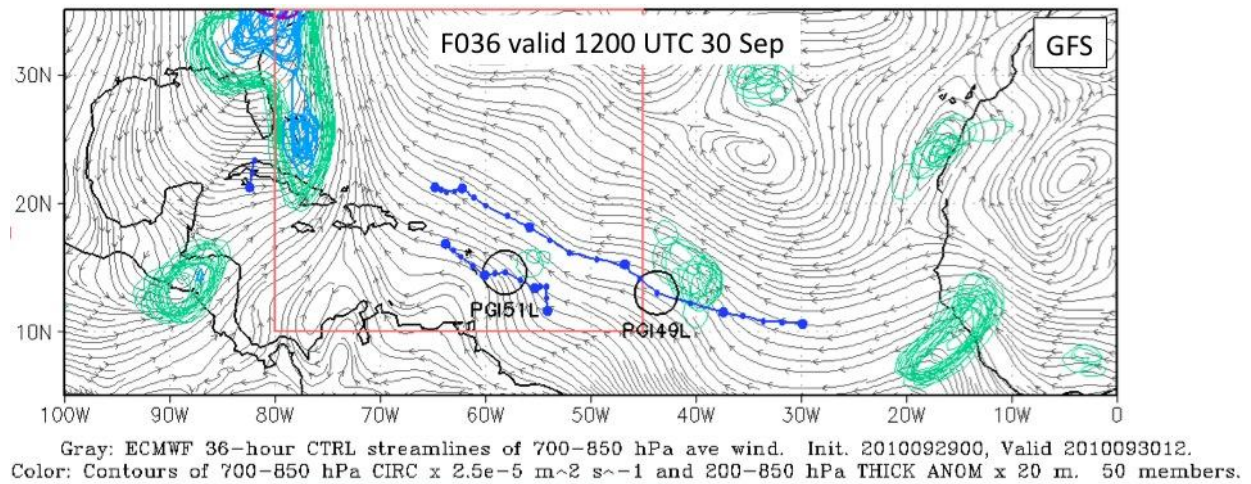


Image 16

Ryan Torn's 12-km
WRF ensemble

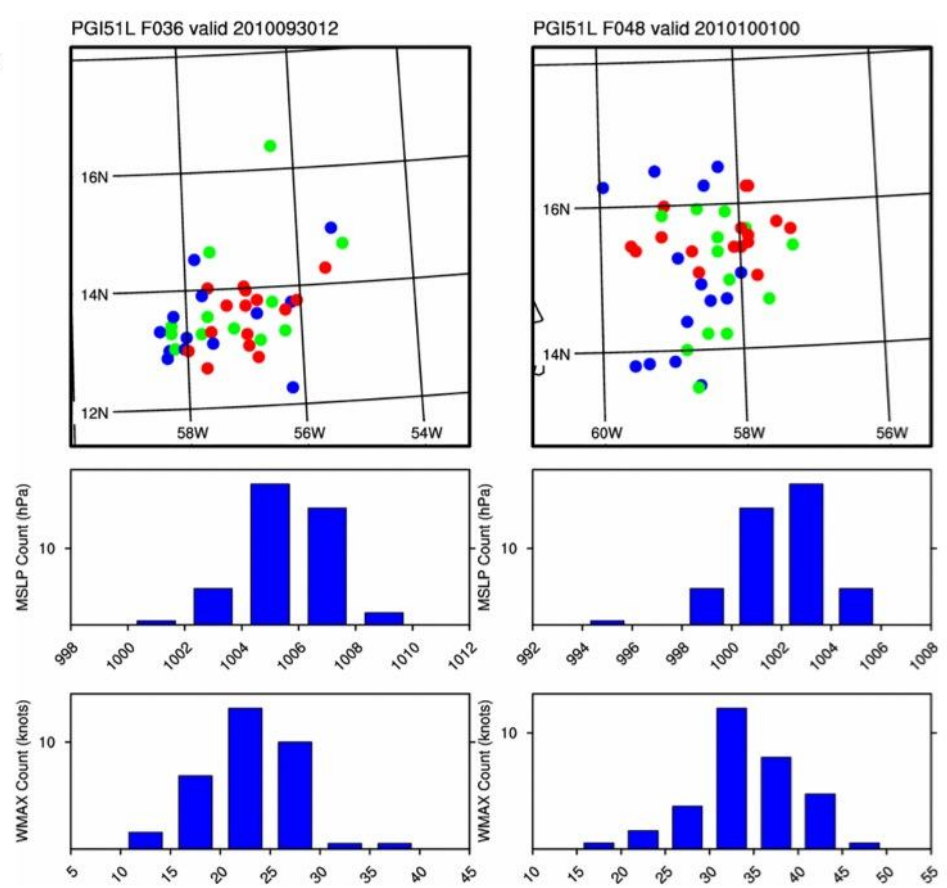


Image 17