# PREDICT

PRE-Depression Investigation of Cloud systems in the Tropics

# Overview of PREDICT Science Opportunities

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**Support provided by NSF grant AGS-0935830**

Photo Credit: Carlye Calvin (UCAR)

# Events of Interest

**Vortex Interaction Near Genesis**
- Danielle
- Earl

**Dry Air "Troubles"**
- Earl
- "Gaston"

**"The South American Connection"**
- Karl
- Matthew

**Late September W. Caribbean Gyre**
- Matthew
- Nicole

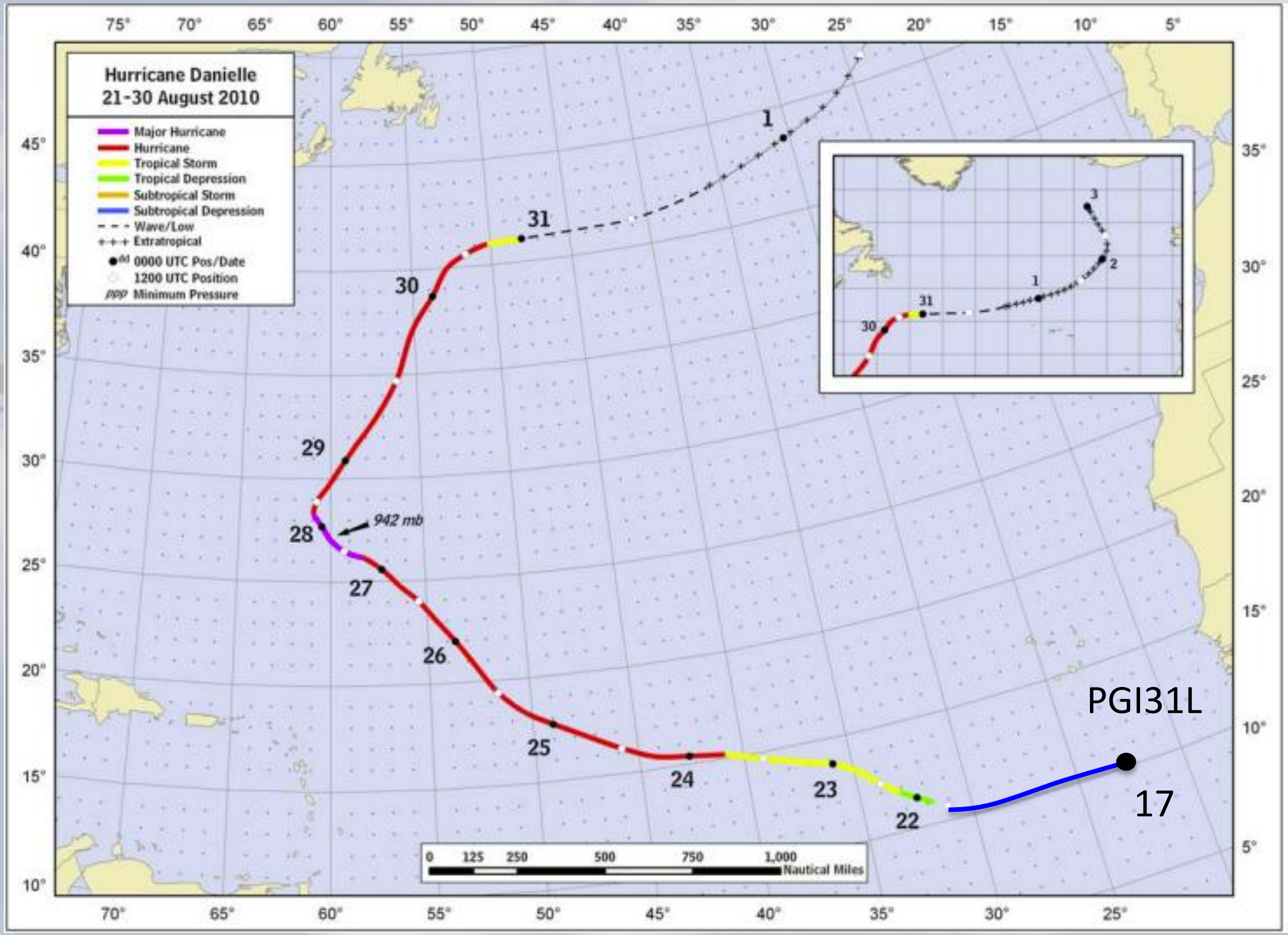
**Gridded data presented here created via operational ECMWF analyses and 6-h forecasts, 0.28125˚ resolution**

# Vortex Interactions

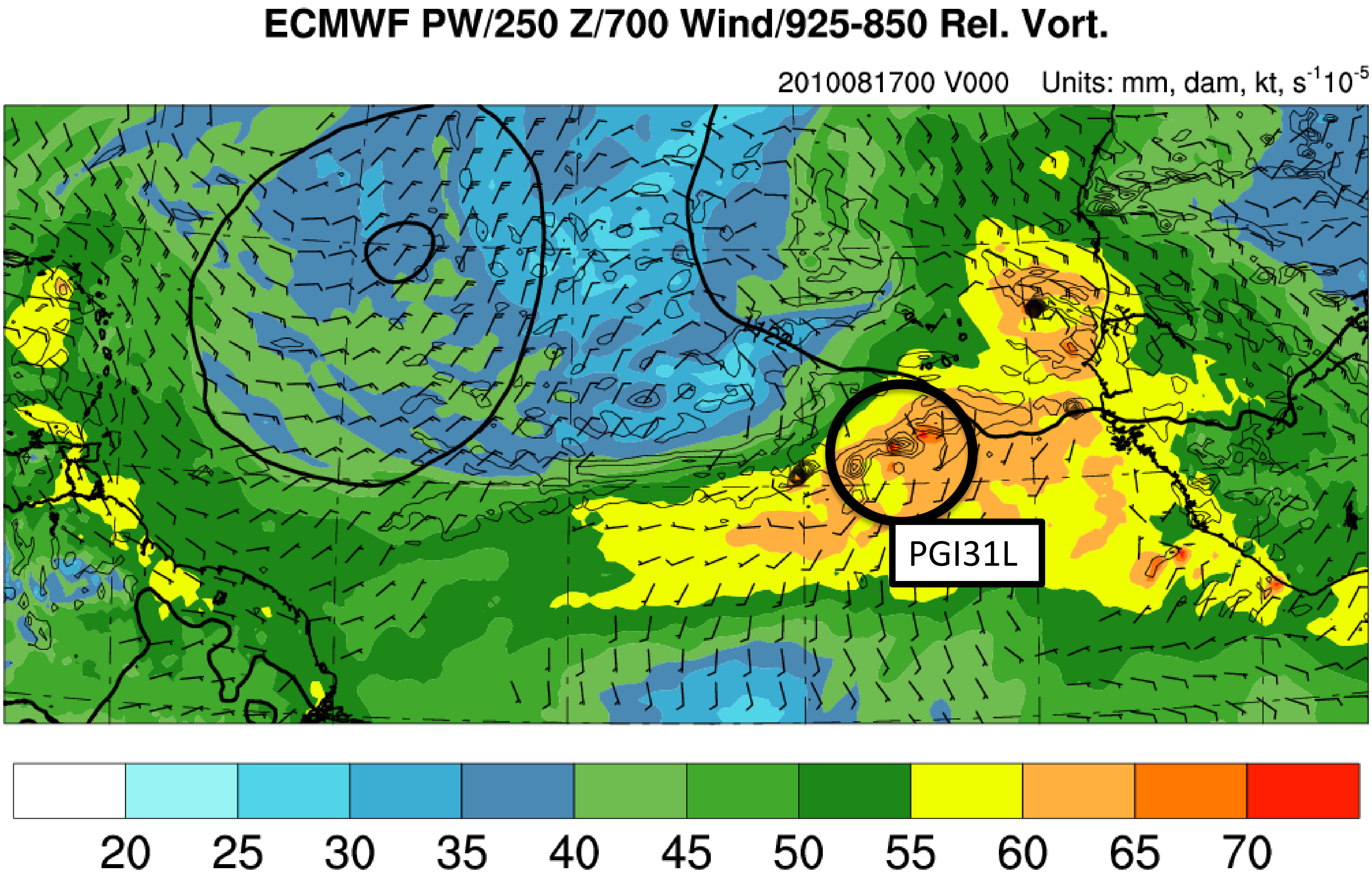
**Danielle vs. PGI 34L**

**Earl and a non-pouch northern vortex**

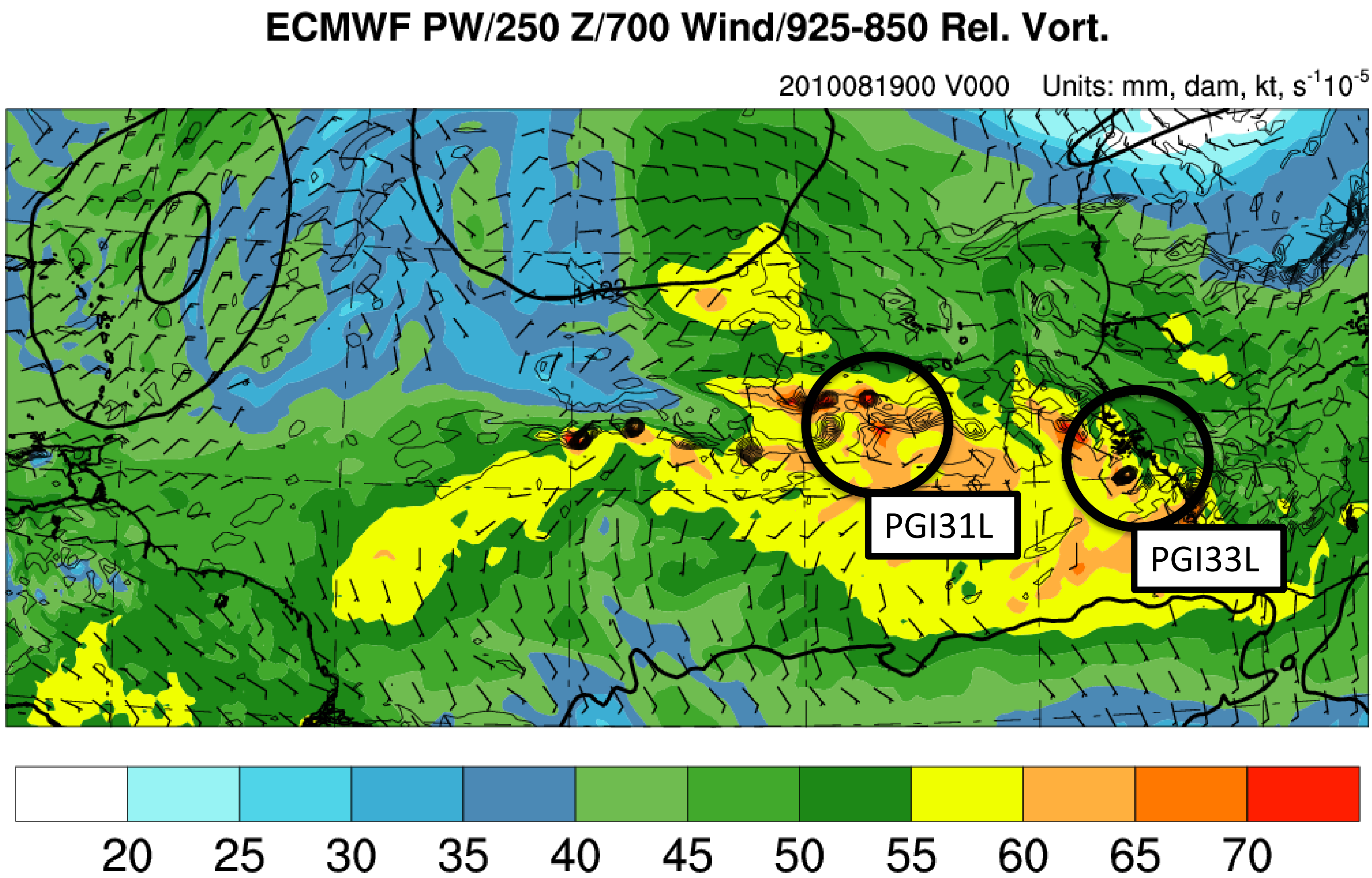
# Pouch Interaction: Danielle



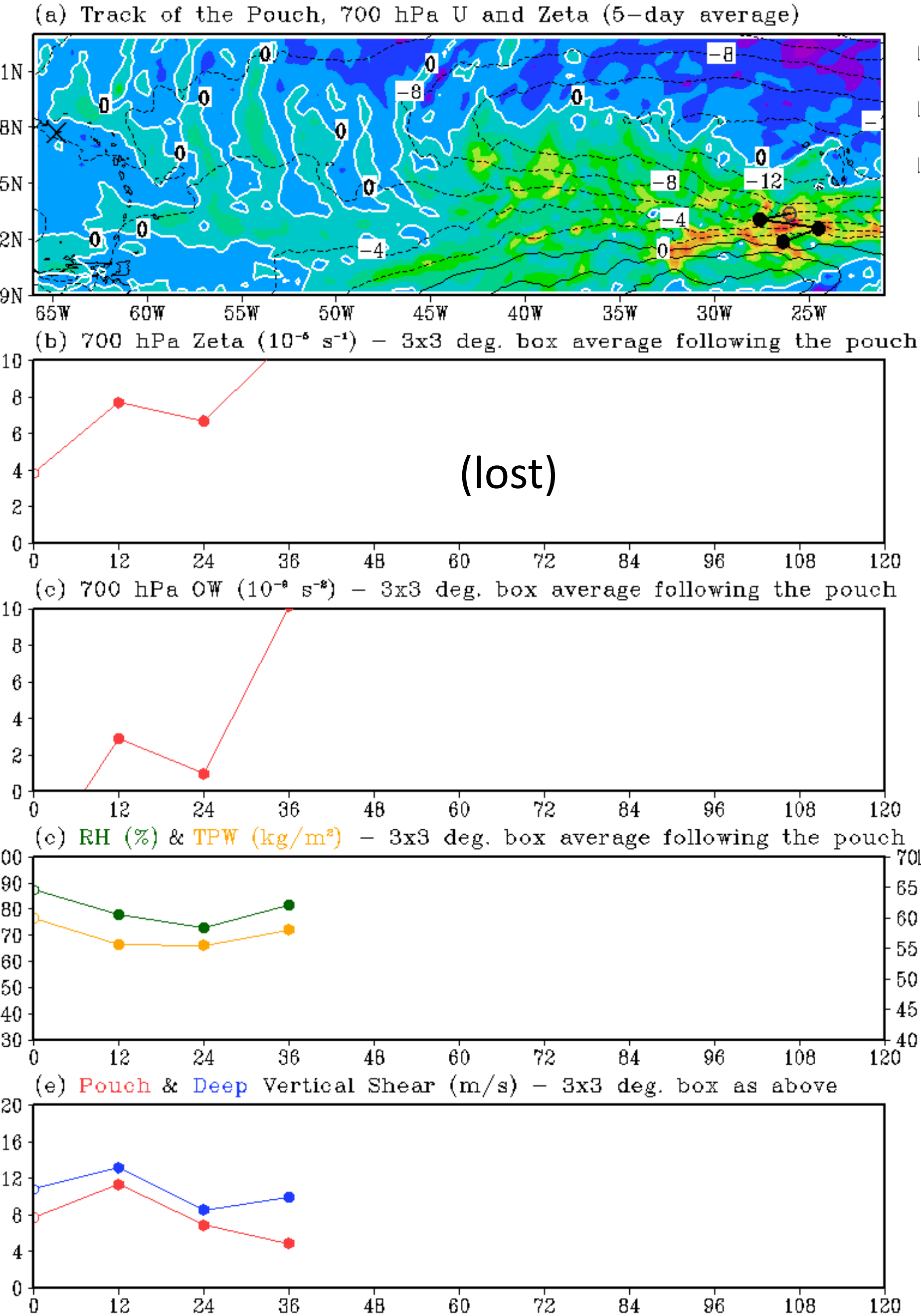
# Pre-Danielle: 0000 UTC 17 August

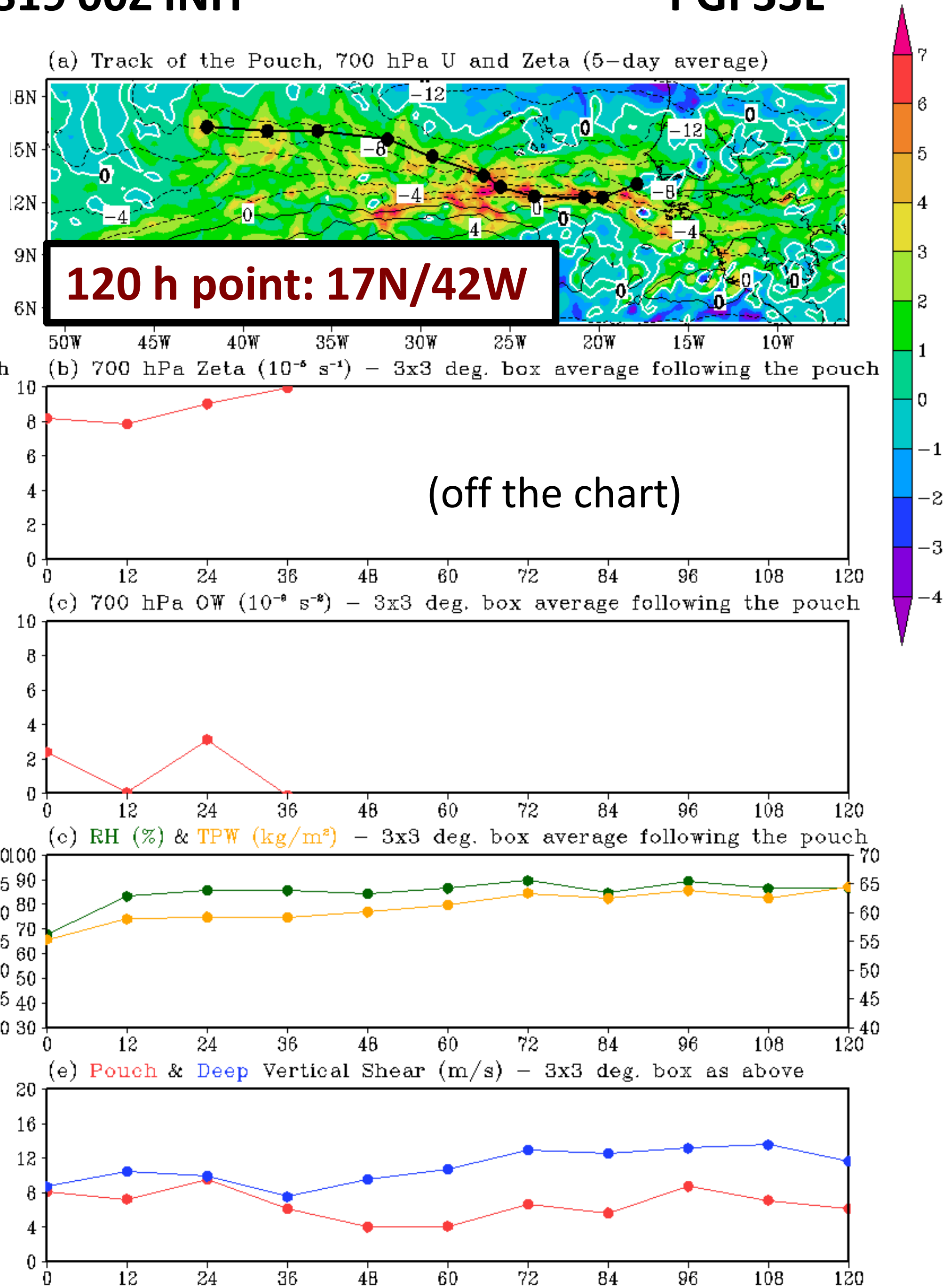


# Pre-Danielle: 0000 UTC 19 August

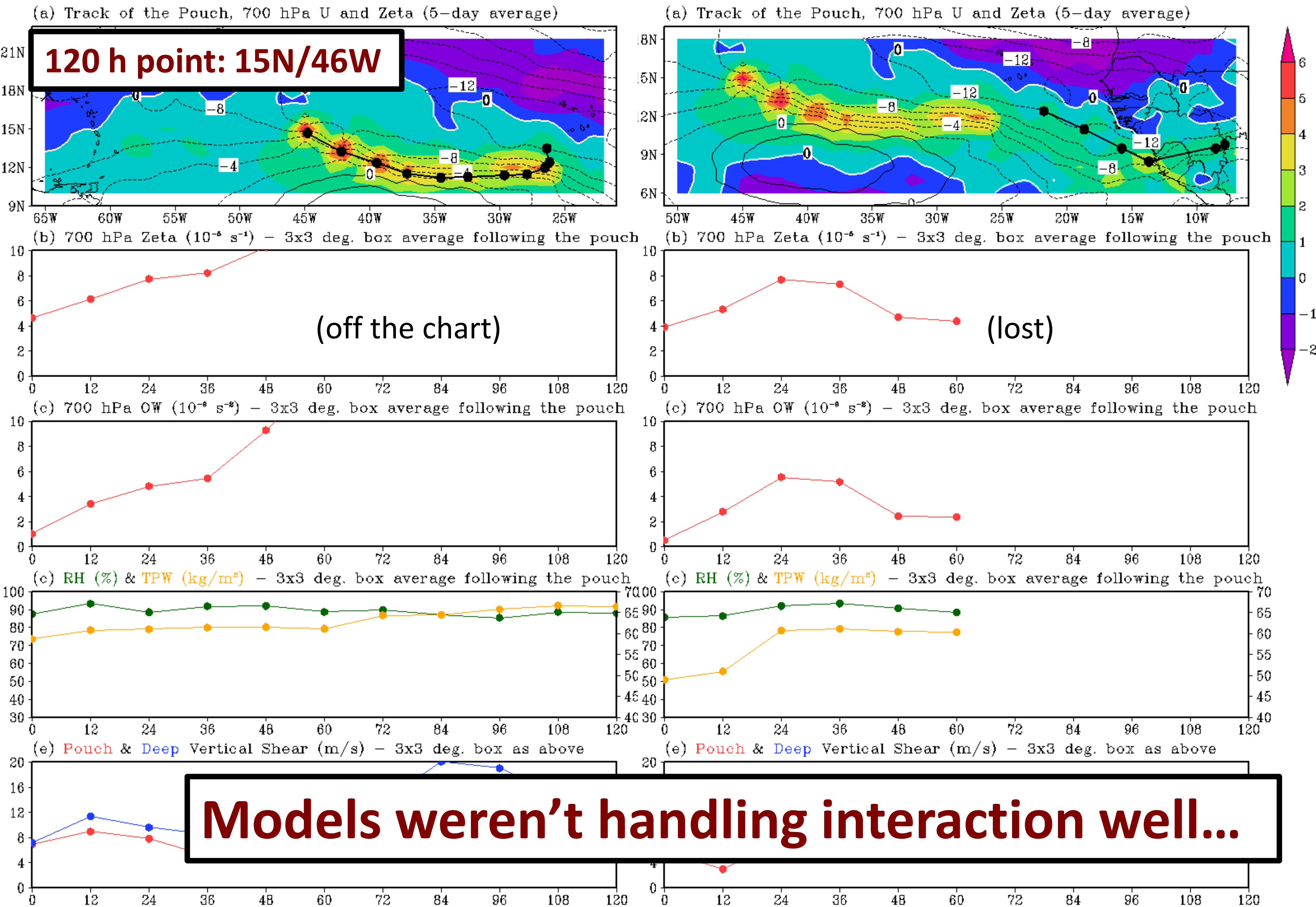


**PGI 31L** (future Danielle) **ECMWF: 20100819 00Z INIT** **PGI 33L**

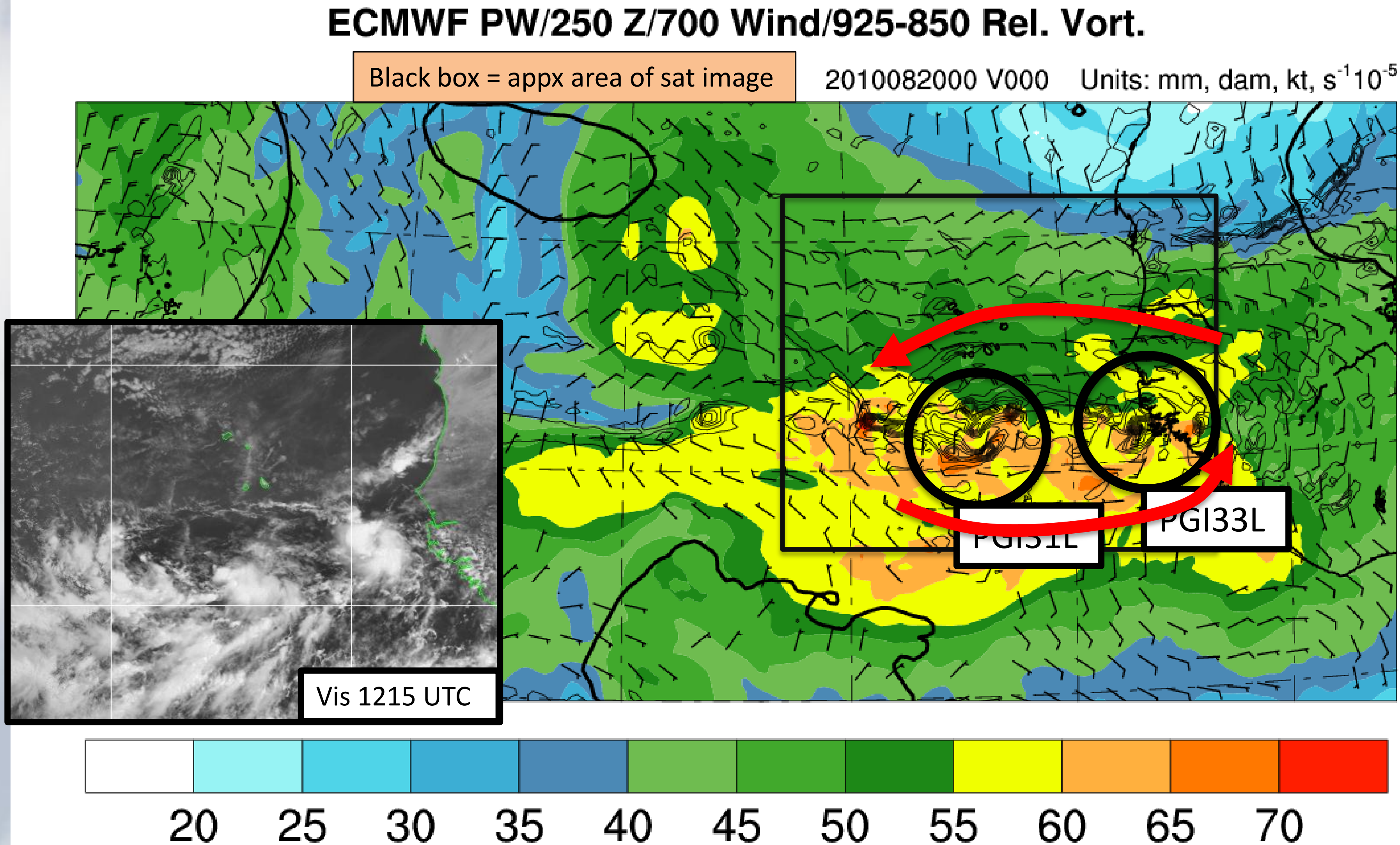


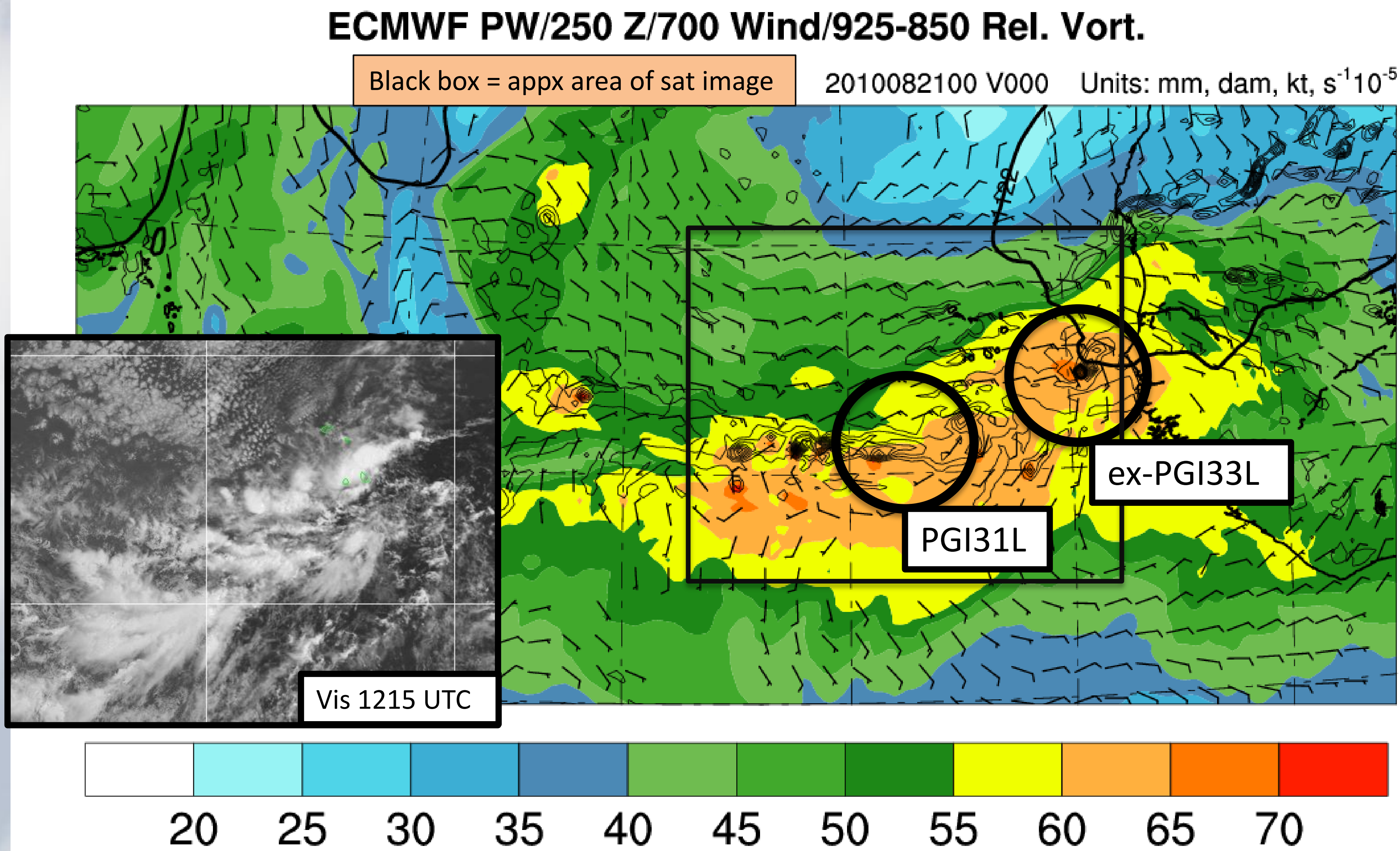
PGI 31L (future Danielle) **GFS: 20100819 00Z INIT** **PGI 33L**



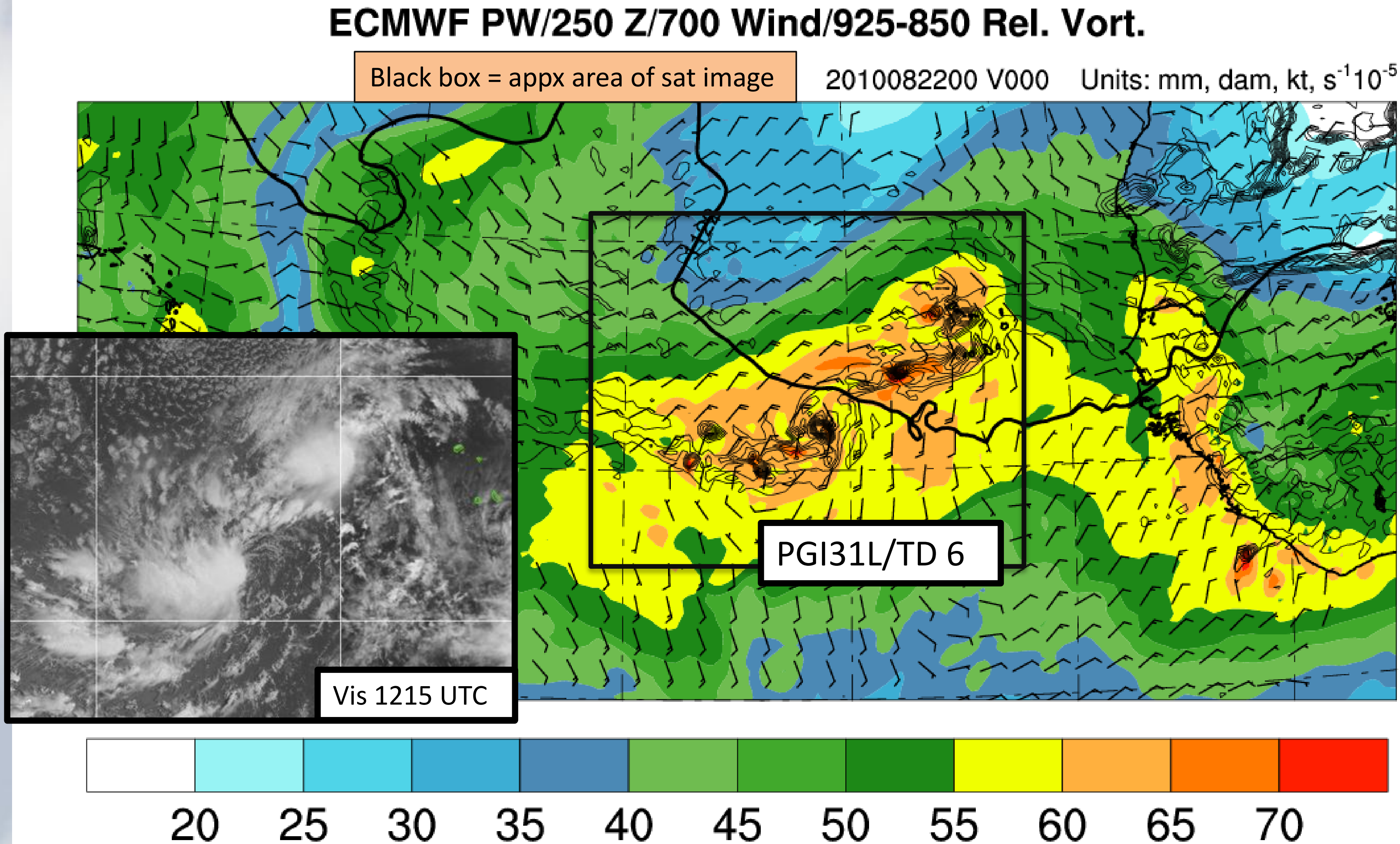
# Pre-Danielle: 0000 UTC 20 August



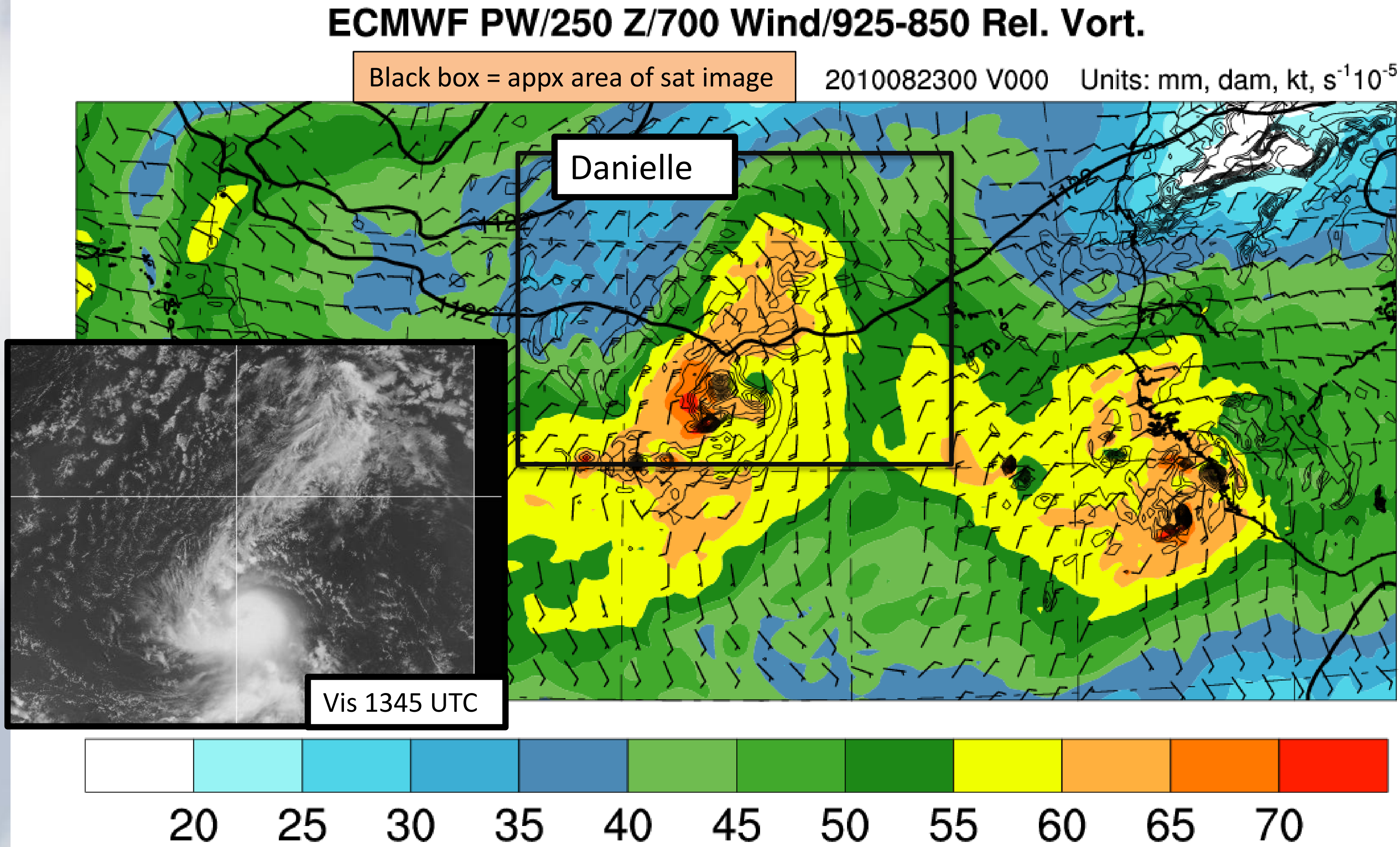
# Pre-Danielle: 0000 UTC 21 August



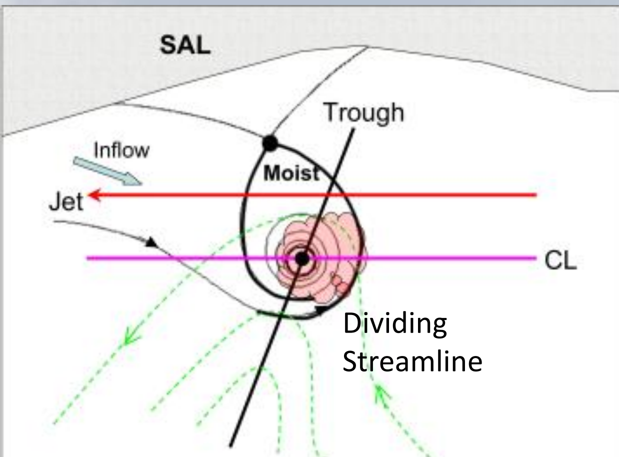
# TD 6: 0000 UTC 22 August



# TS Danielle: 0000 UTC 23 August



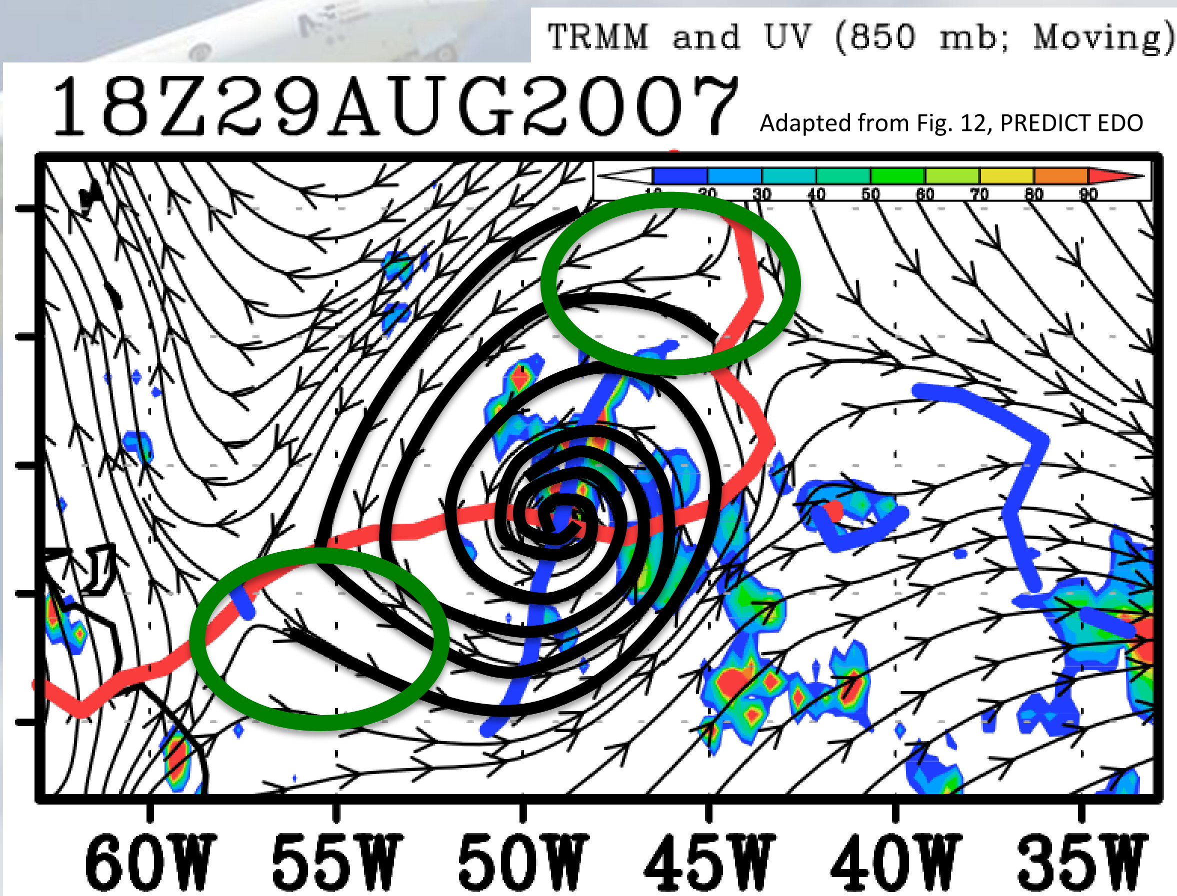
# Dividing Streamlines



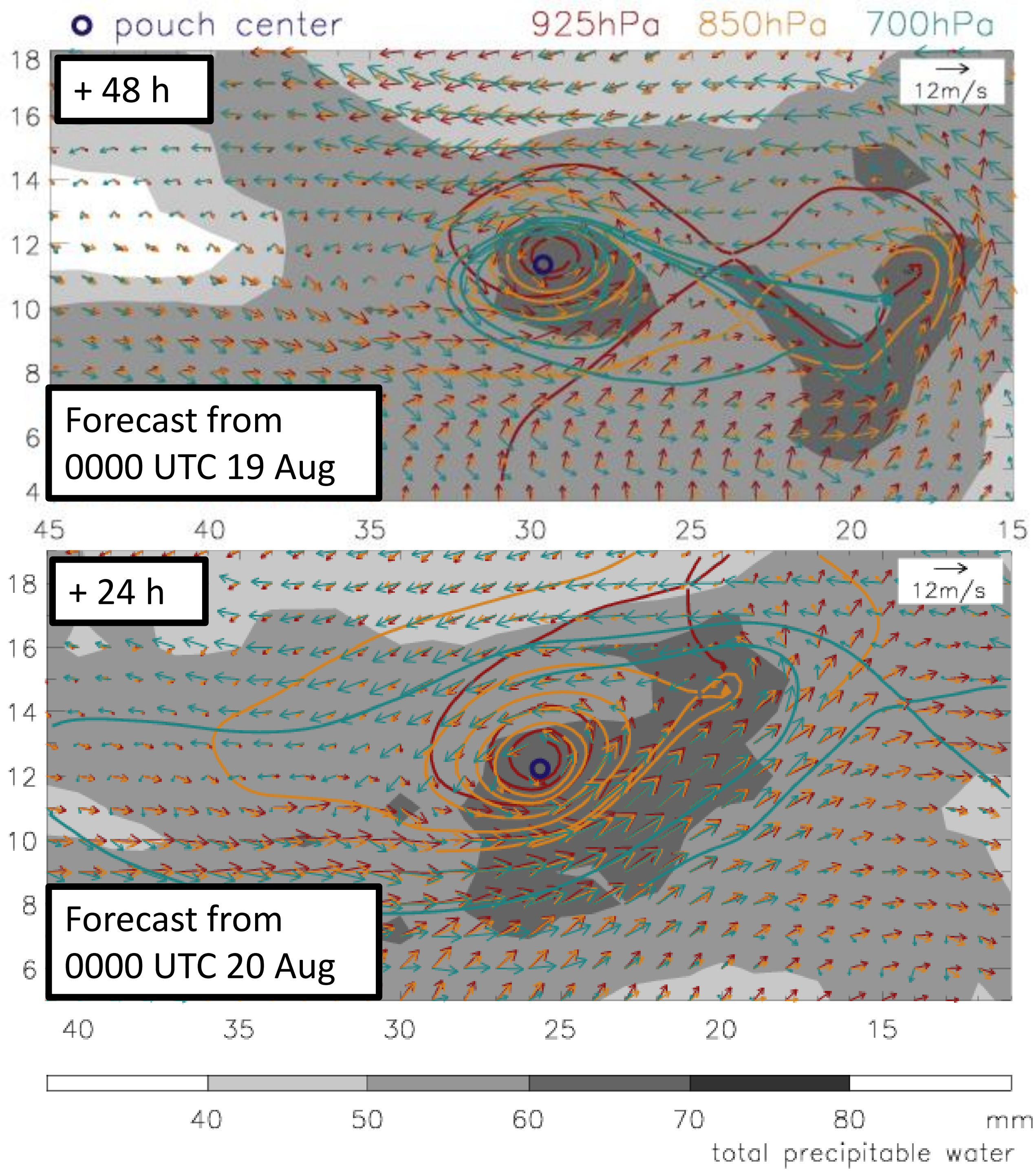
Adapted from Wang, Montgomery, and Dunkerton 2009

**Indicate boundaries between flow regimes, generally the pouch and its environment**

**Broken or disconnected streamlines can indicate the possibility of air mass confluence (i.e. they are not completely divided), allowing air from the environment into the pouch** (green circles)



Adapted from Fig. 12, PREDICT EDO

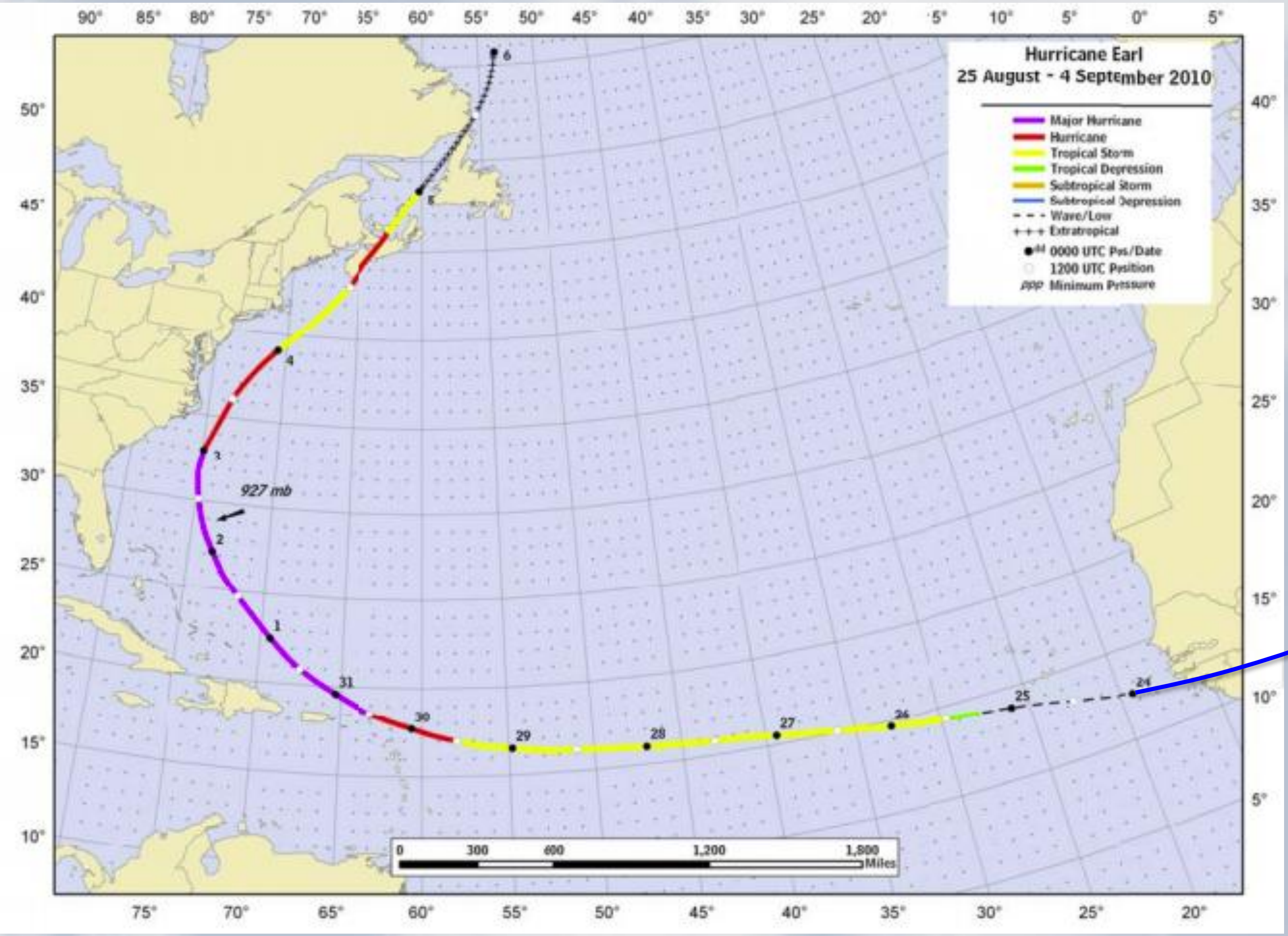



**Dividing Streamline forecasts valid 0000 UTC 21 Aug**

**All levels include additional circulation to the east of pre-Danielle**

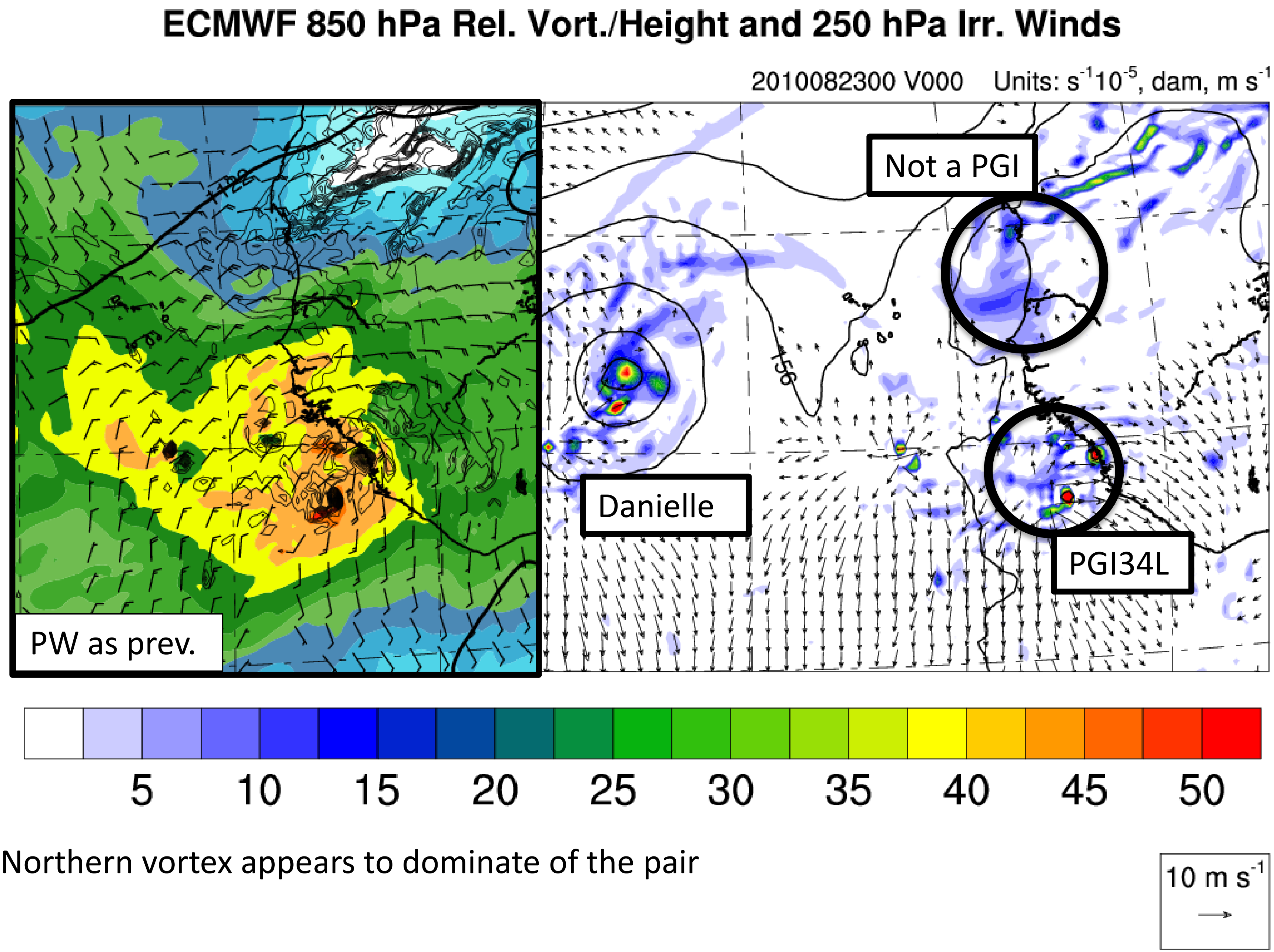
**Interaction occurs when dividing streamlines begin to cross/pinch? Opening up of streamlines signals mixing of pouches?**

# Vortex Interaction: Earl



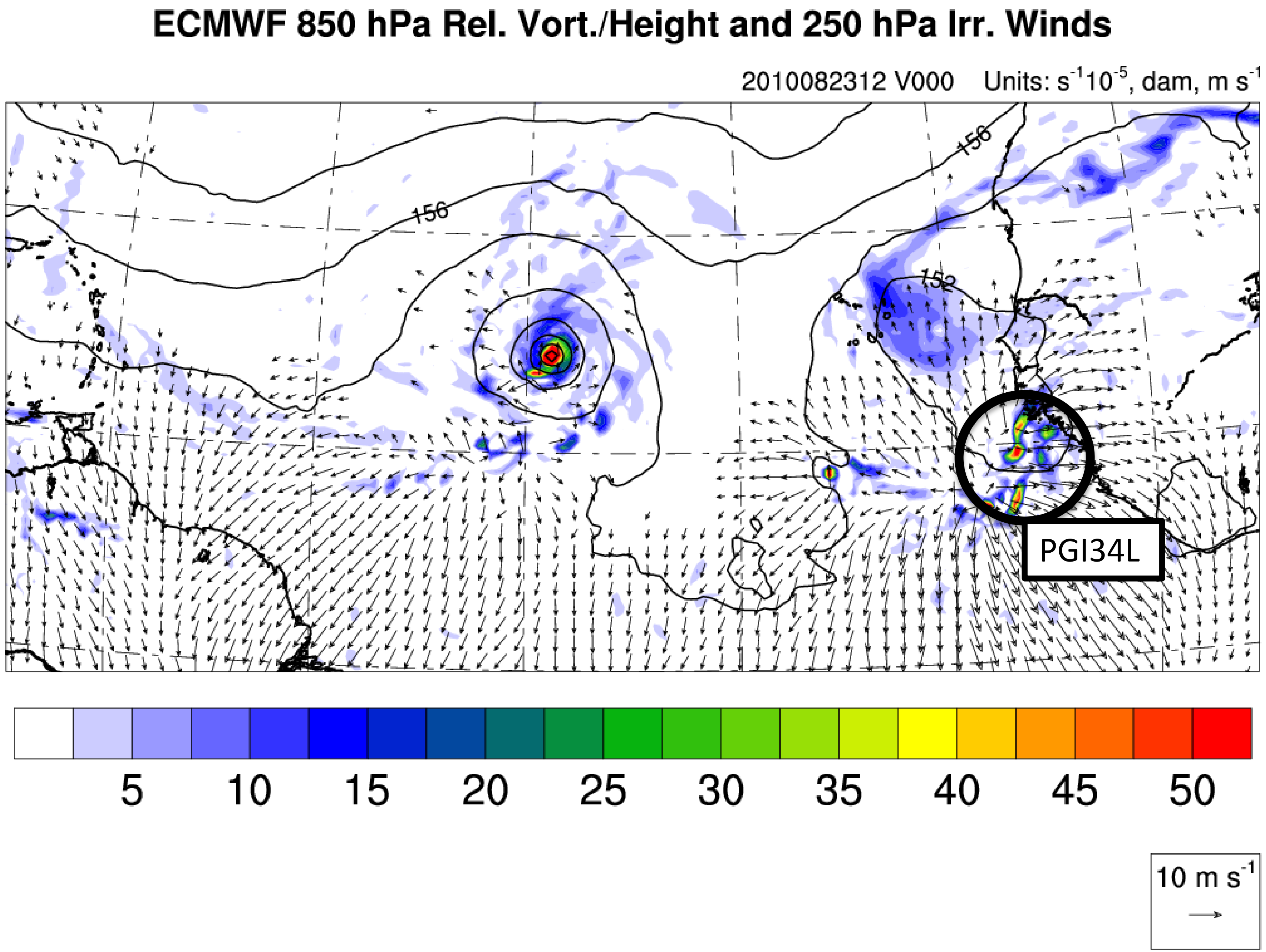

To 10˚E
21 Aug

# Pre-Earl: 0000 UTC 23 August

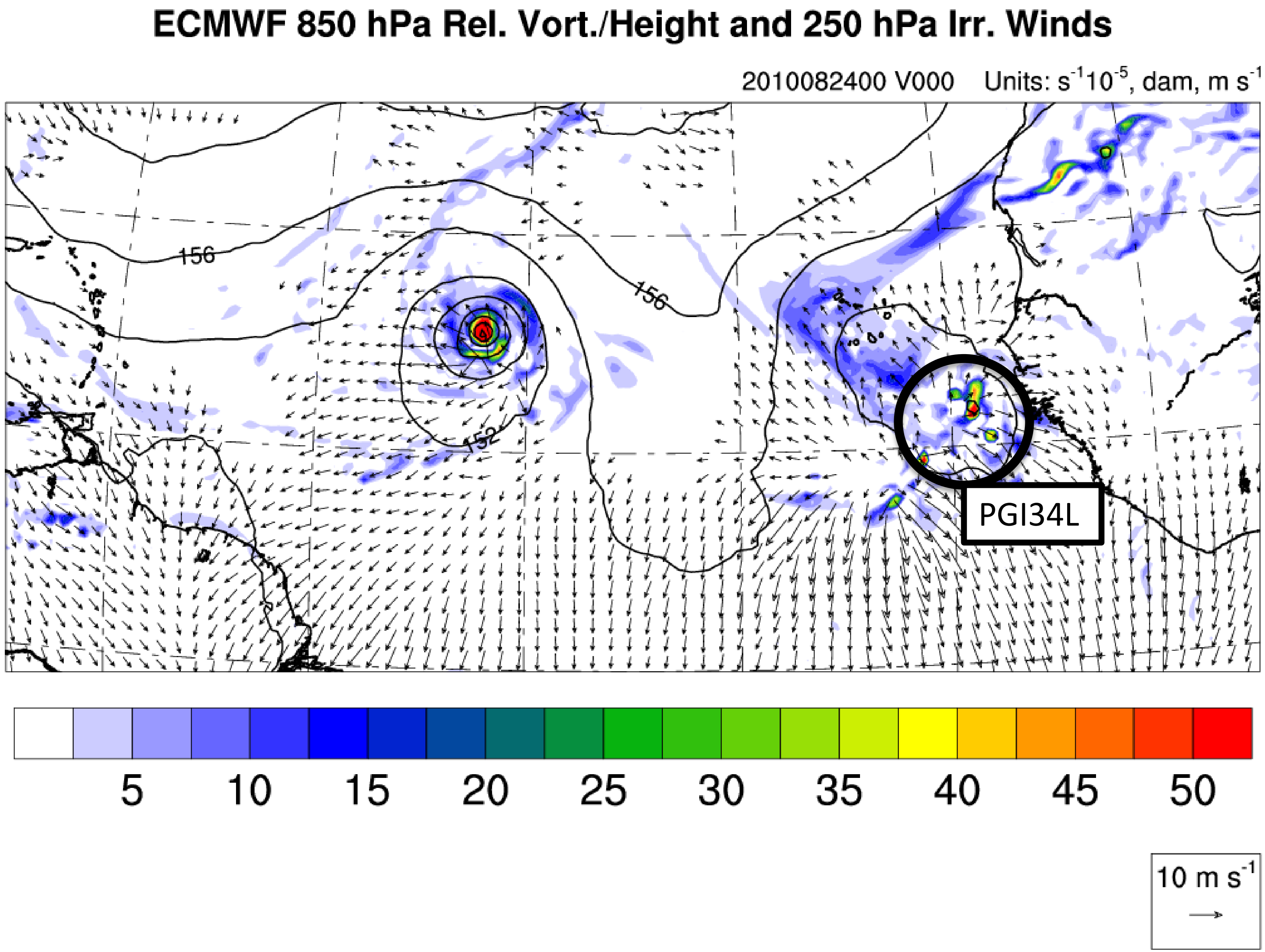



Northern vortex appears to dominate of the pair

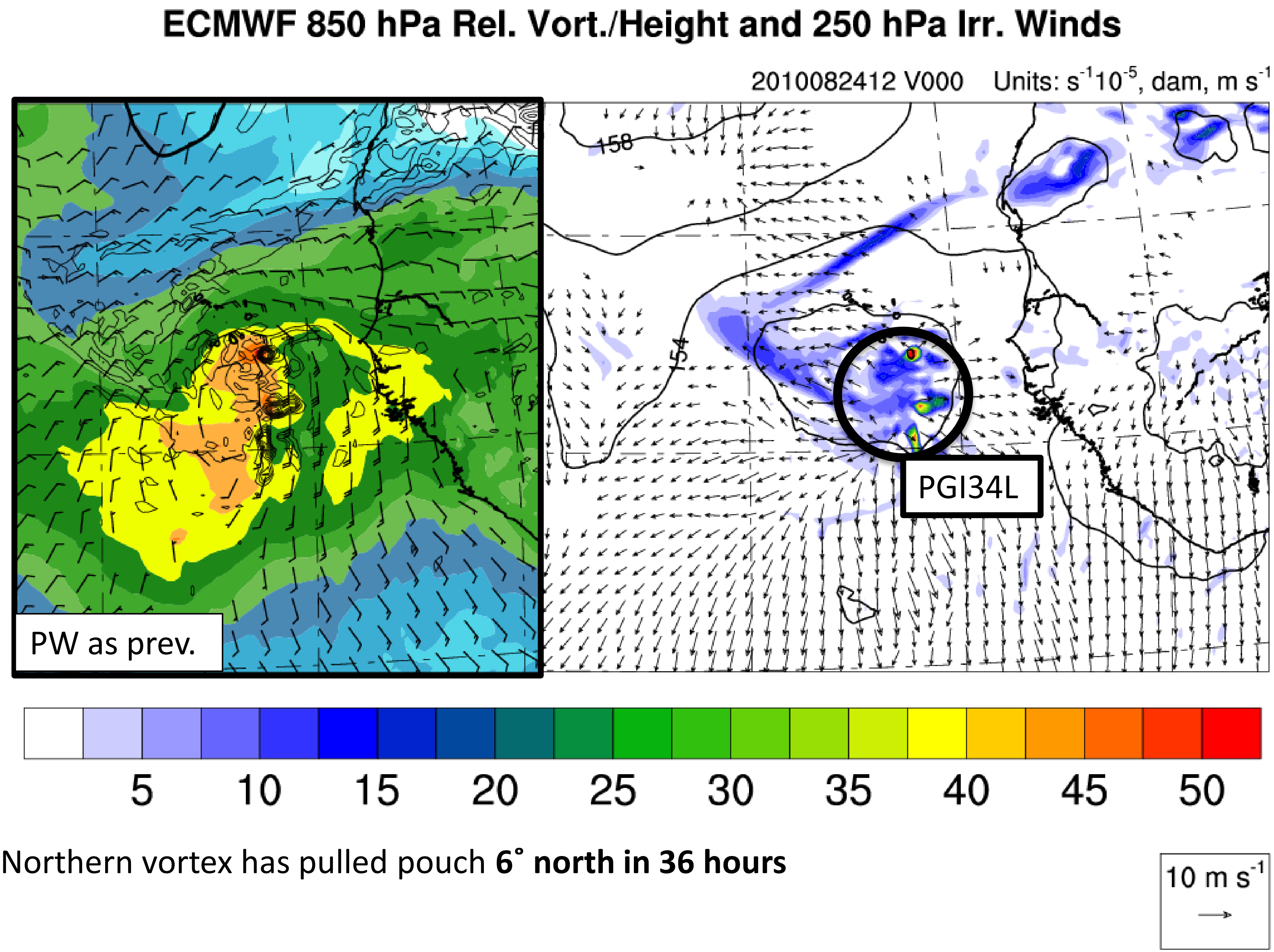
# Pre-Earl: 1200 UTC 23 August



# Pre-Earl: 0000 UTC 24 August

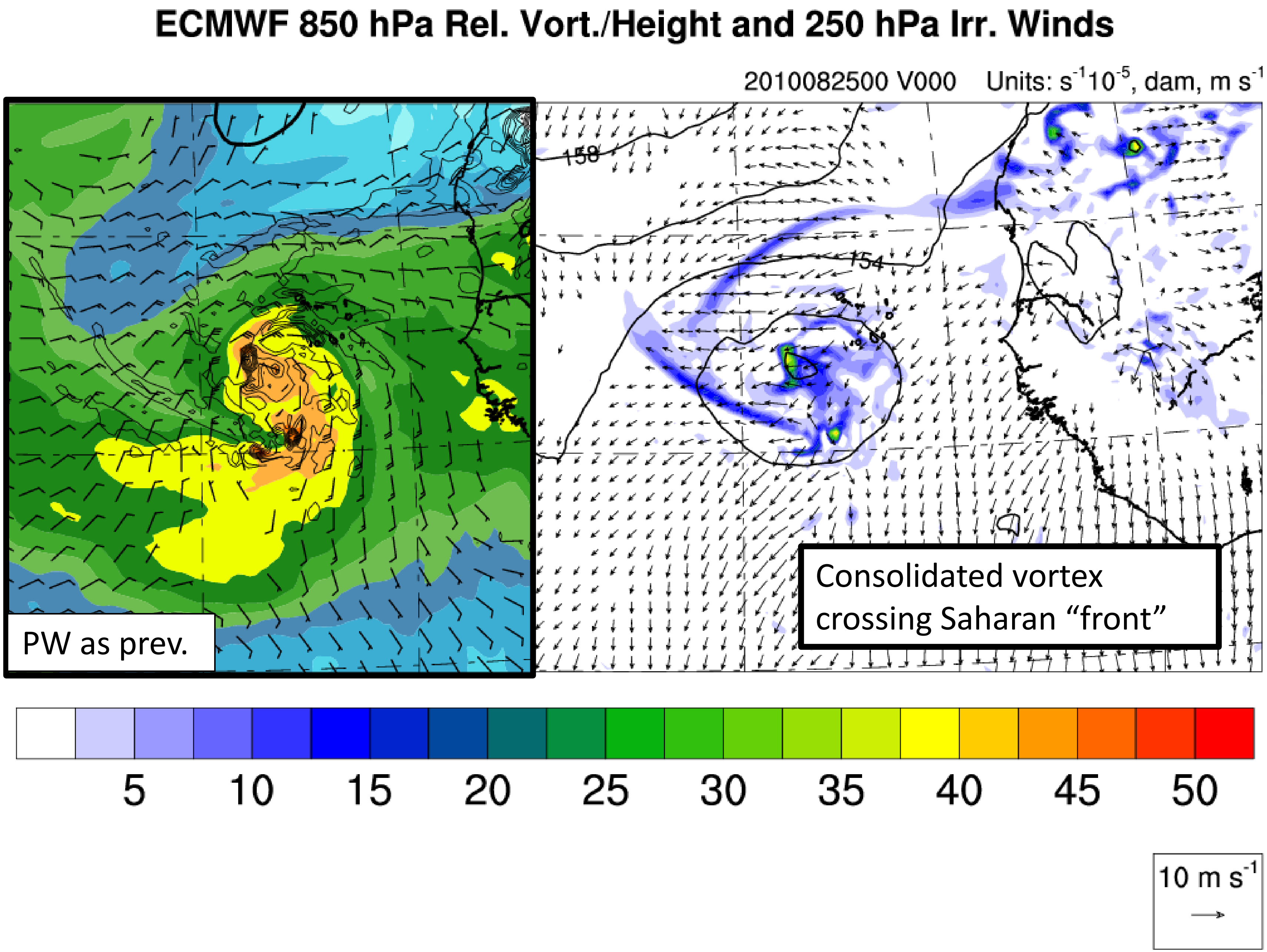


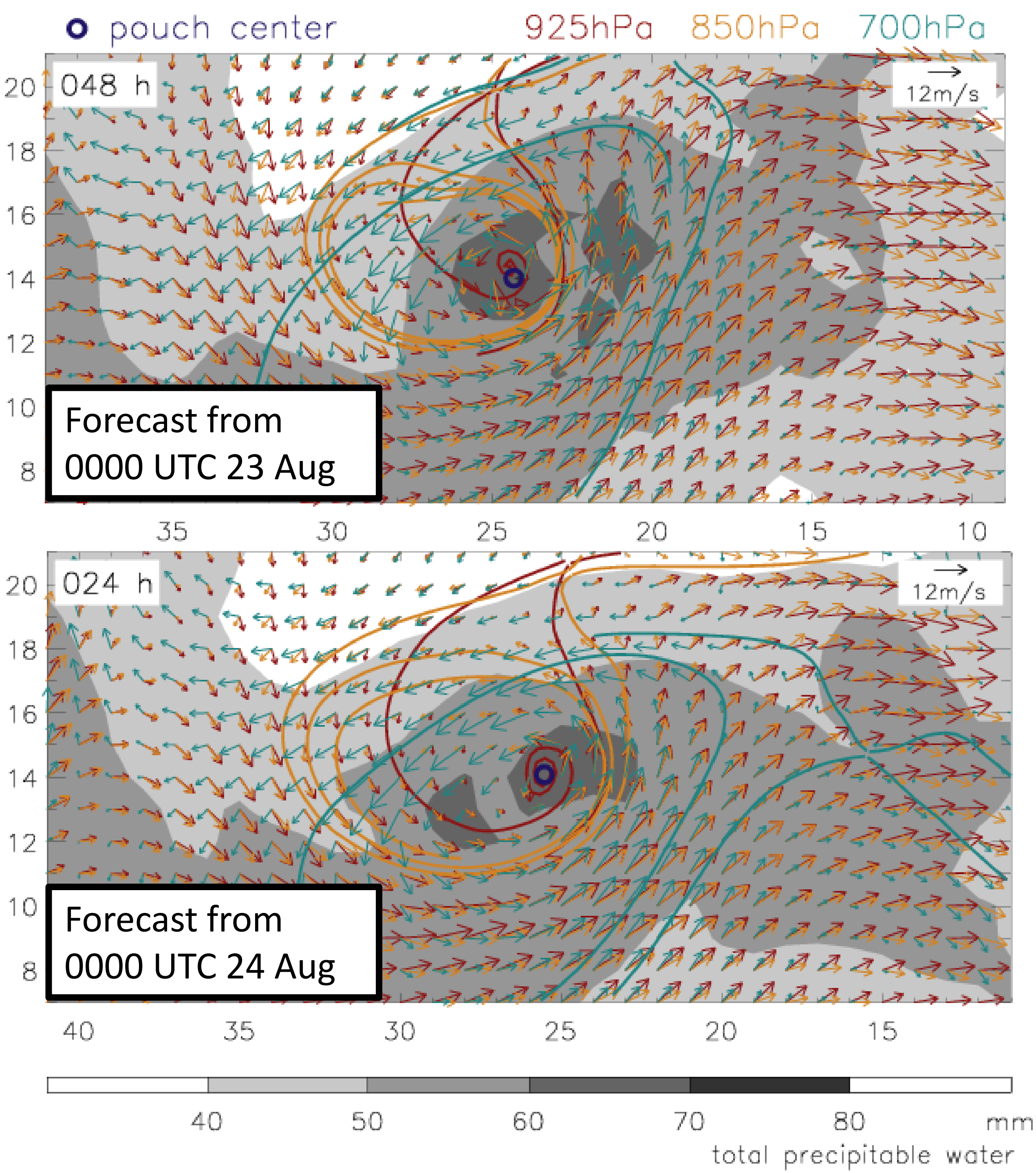
# Pre-Earl: 1200 UTC 24 August




Northern vortex has pulled pouch **6˚ north in 36 hours**

# Pre-Earl: 0000 UTC 25 August






**Dividing Streamline forecasts valid 0000 UTC 25 Aug**

**Lower-level streamlines larger to NW, encompass dry (lower PW) air and low-level vorticity remnants**

# So…

## How can we better forecast pouch/vortex interactions?

**Will dividing streamlines prove to be a useful tool to forecast/analyze these interactions?**

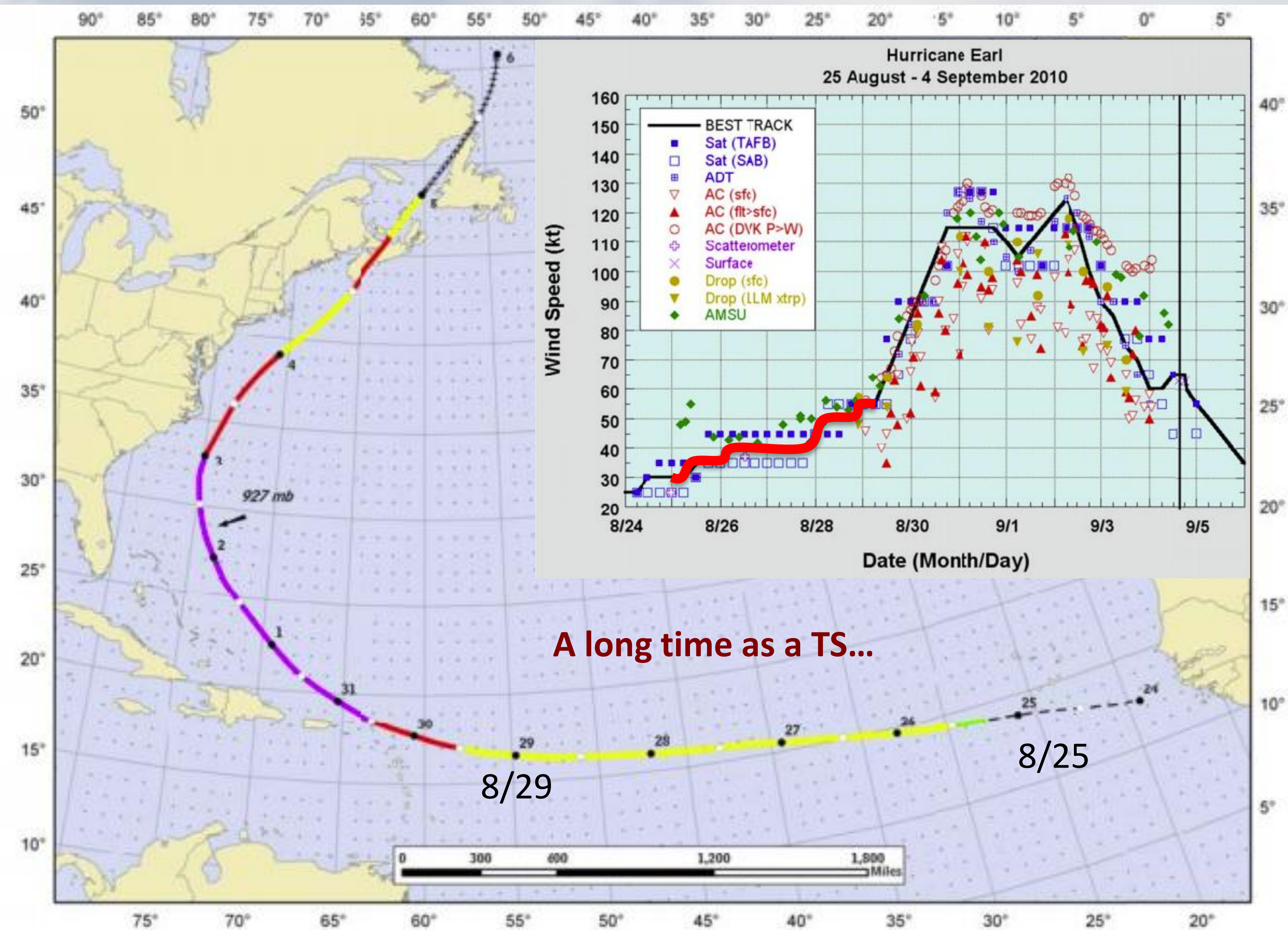
**Do these interactions have a noticeable influence on the genesis potential of the resulting pouches?**

# Dry Air “Troubles”

Earl, in its early stages

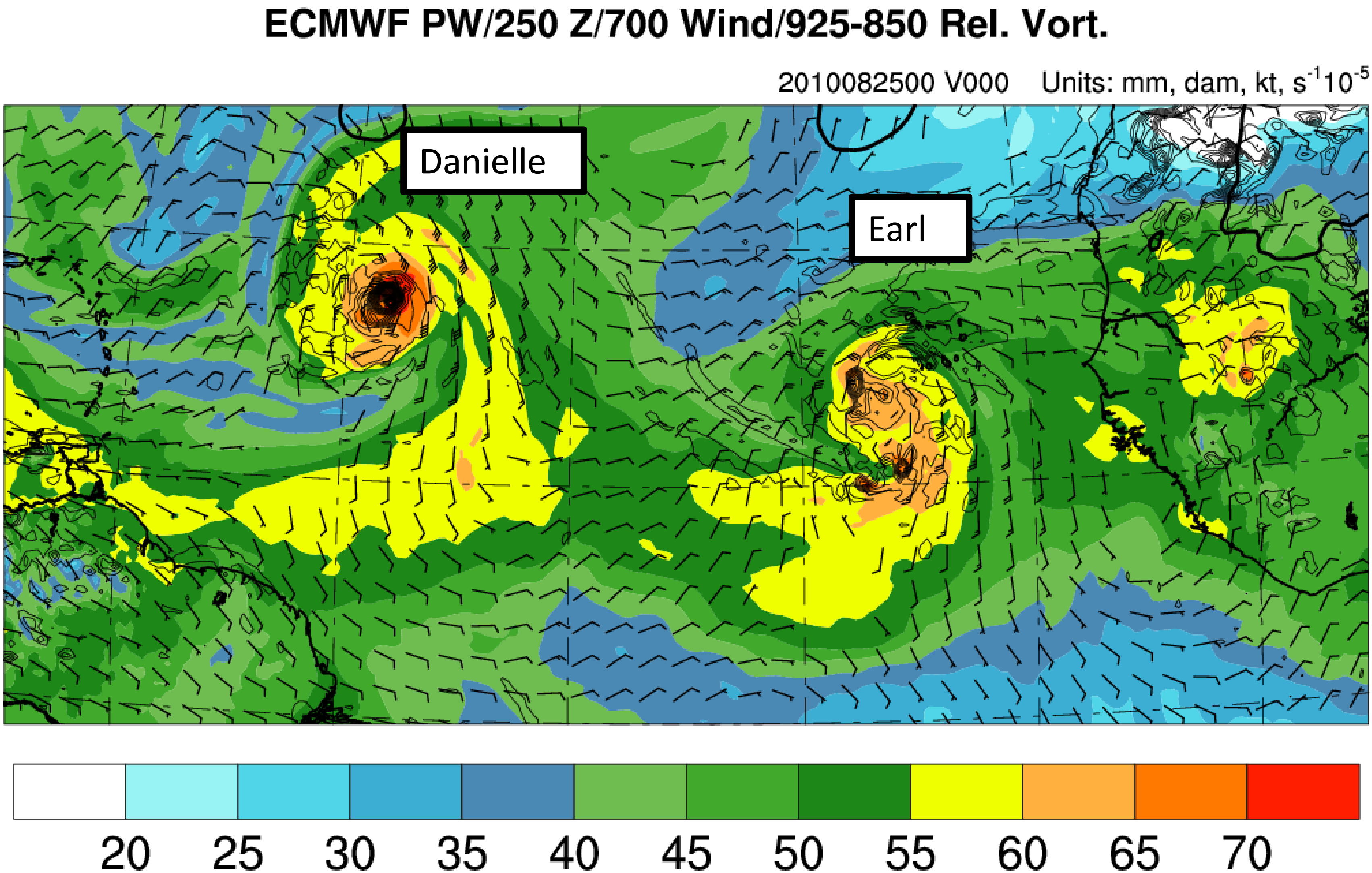
Gaston, at the bookends of its life

# Dry Air: Earl

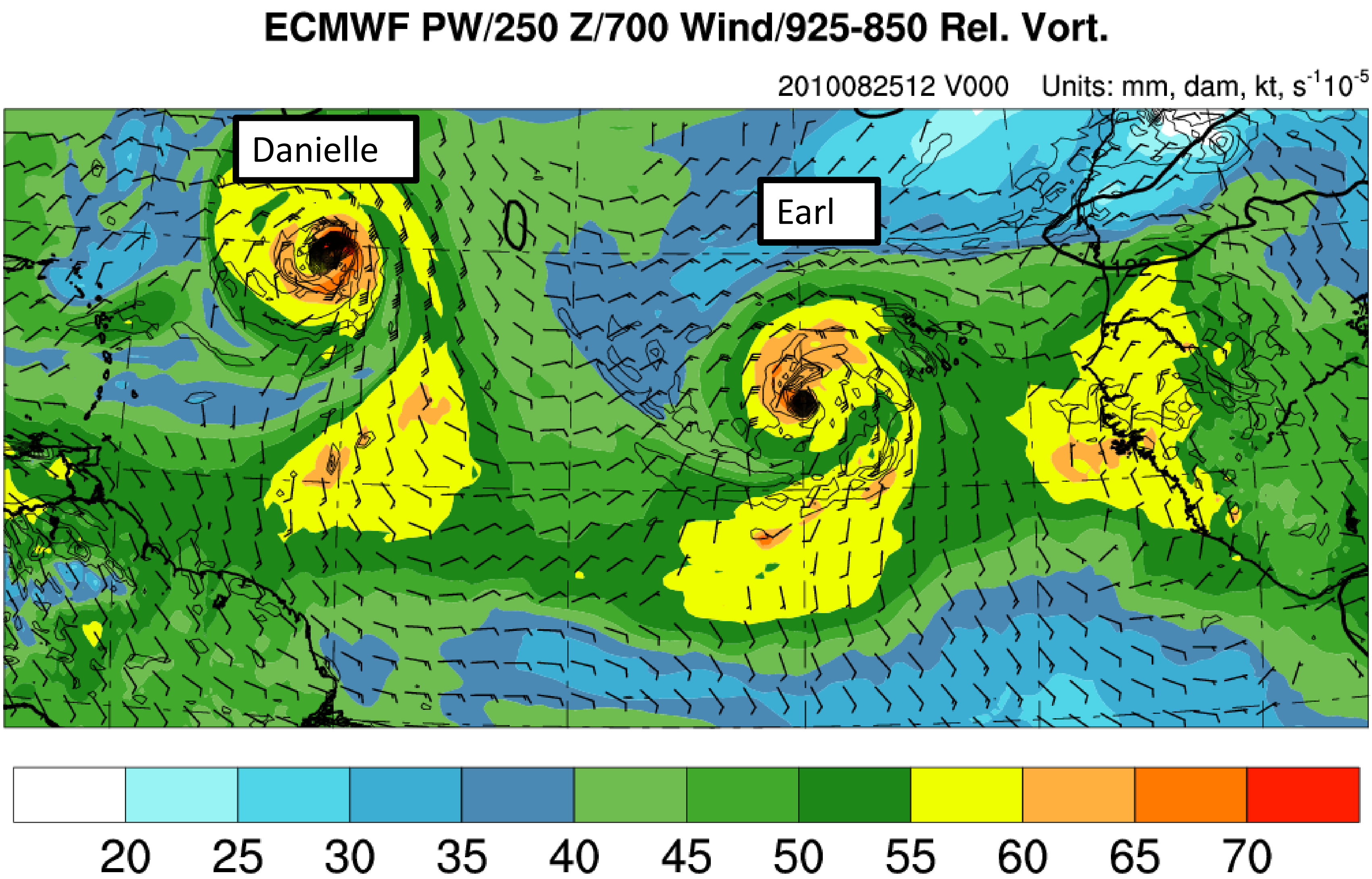


Hurricane Earl
25 August - 4 September 2010
Wind Speed (kt)
Date (Month/Day)
BEST TRACK
Sat (TAFB)
Sat (SAB)
ADT
AC (sfc)
AC (flt>sfc)
AC (DVK P>W)
Scatterometer
Surface
Drop (sfc)
Drop (LLM xtrp)
AMSU
8/24
8/26
8/28
8/30
9/1
9/3
9/5
927 mb
A long time as a TS…
8/29
8/25
Miles

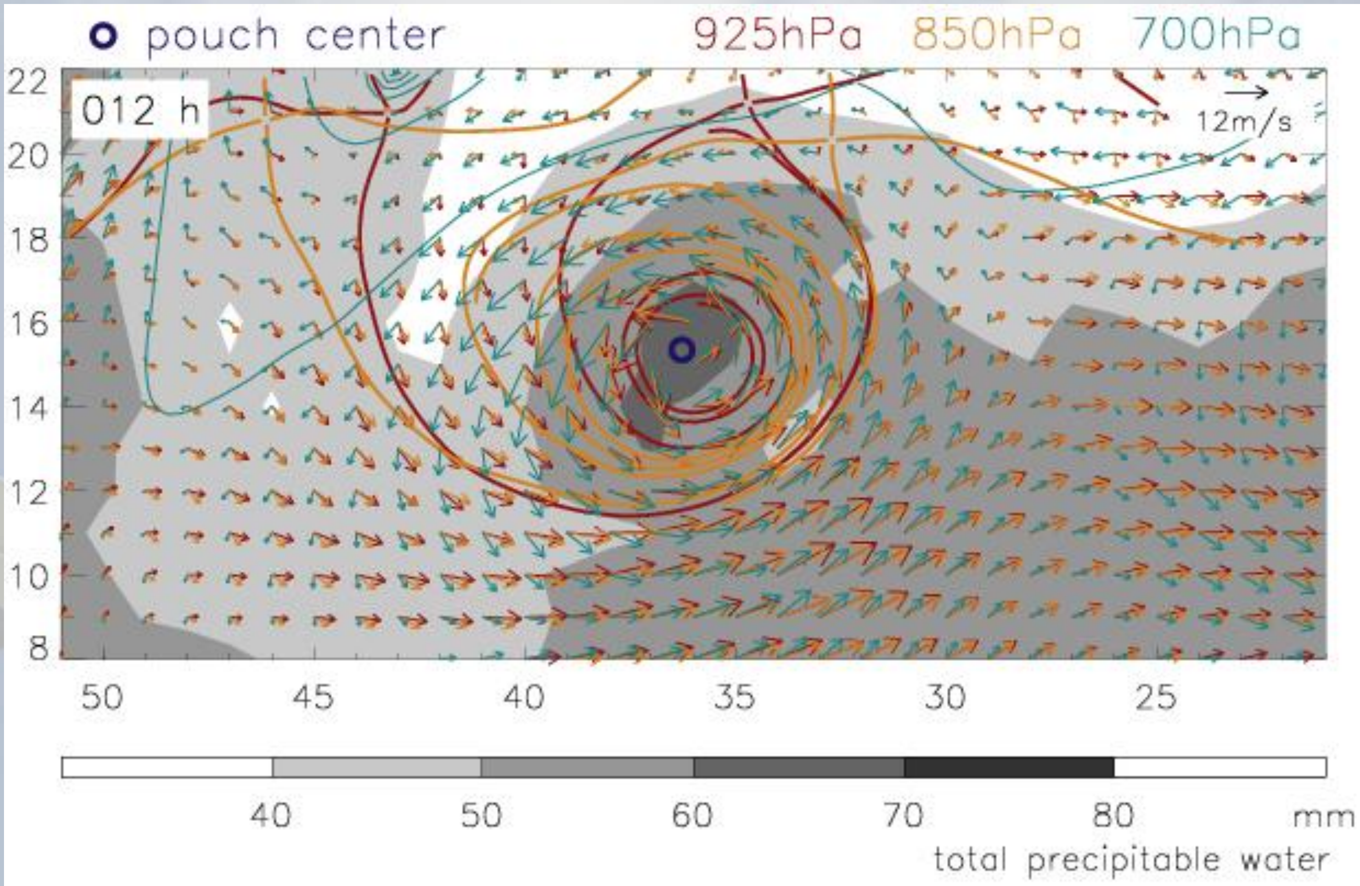
# TS Earl: 0000 UTC 25 August



# TS Earl: 1200 UTC 25 August



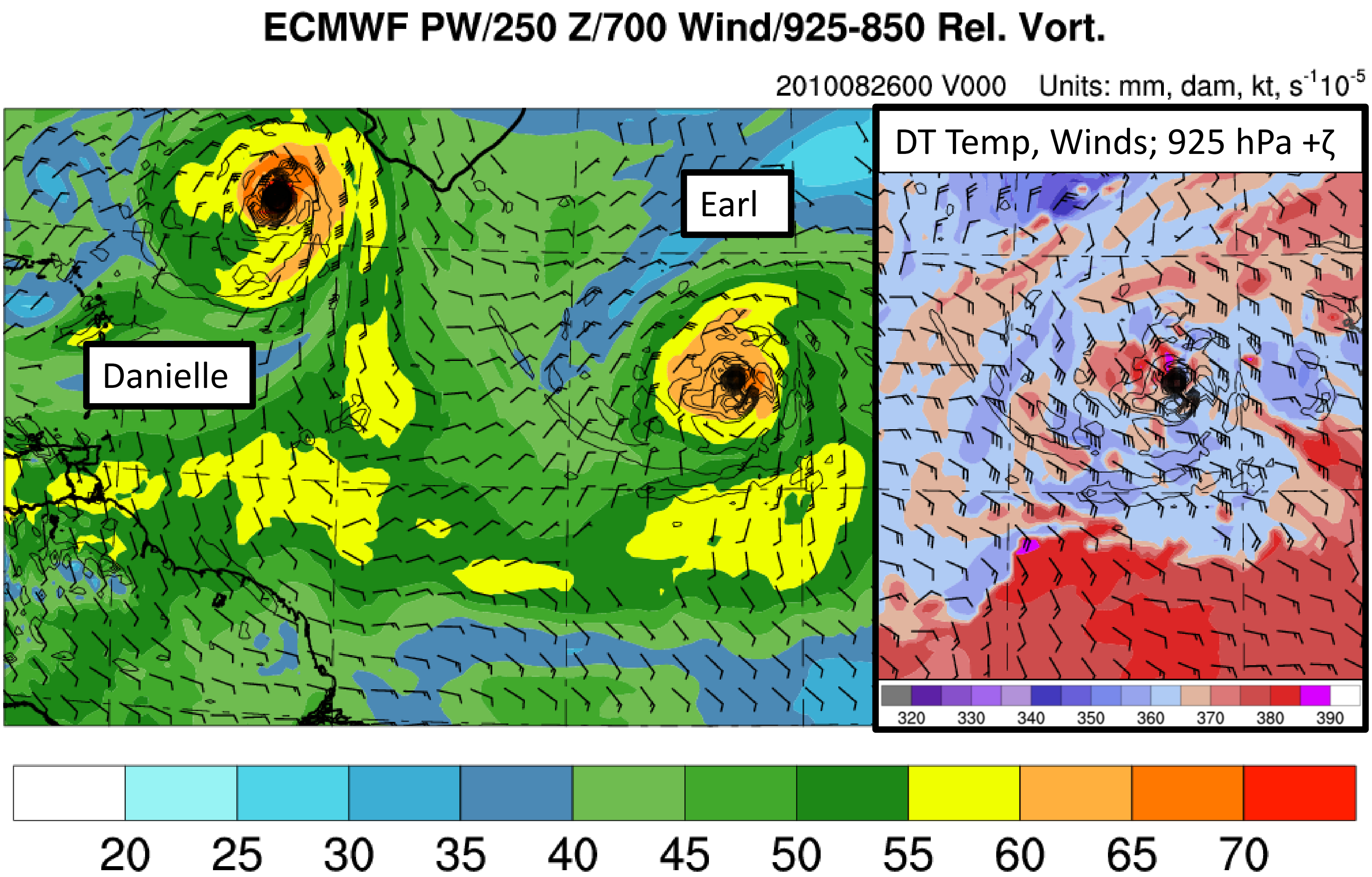
**Dividing Streamline forecast valid 1200 UTC 25 Aug**



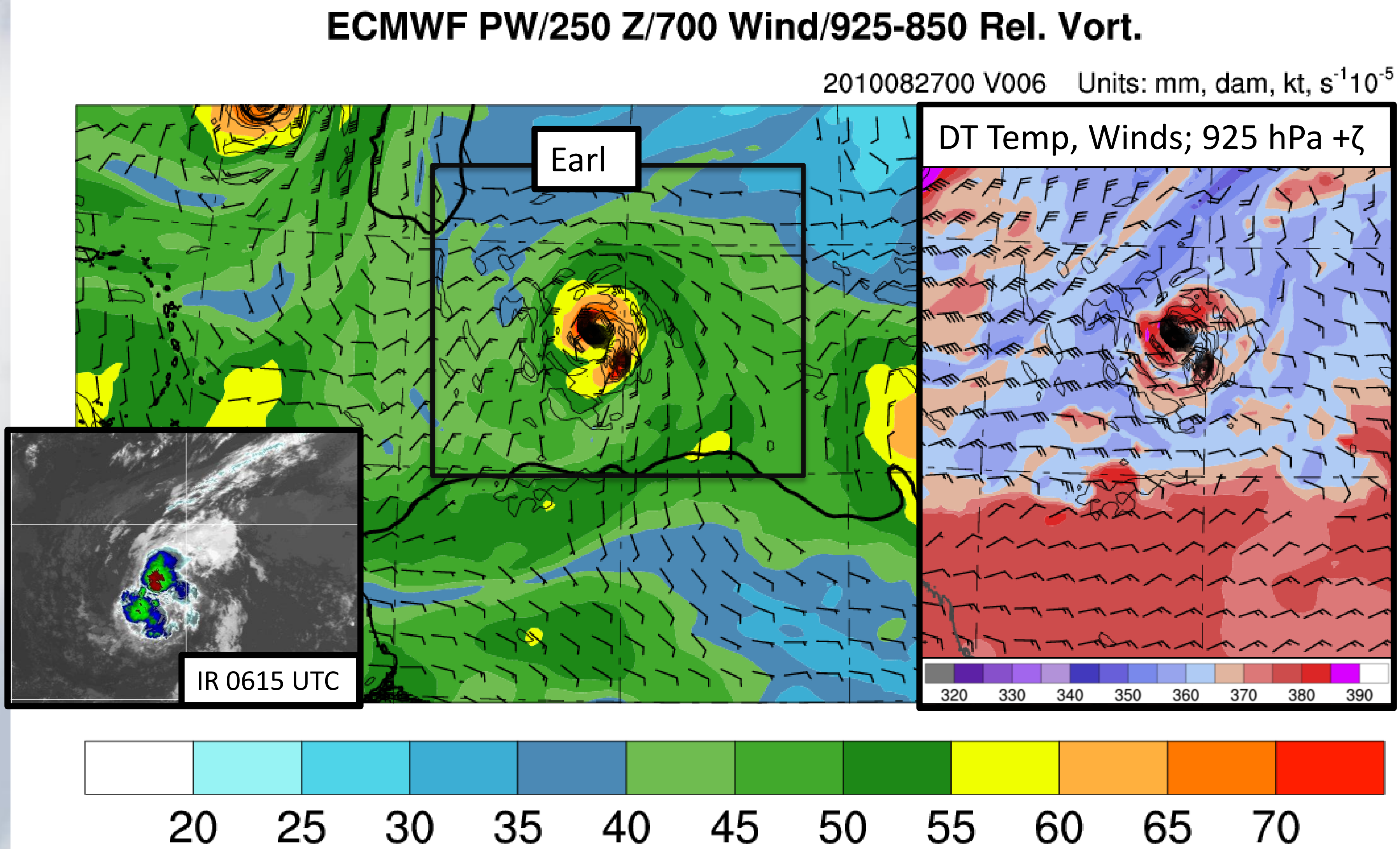

**Strong circulation in the low levels, but streamlines open to northwest throughout all levels**

**No closed pouch at 700 hPa – significantly easier dry air entrainment?**

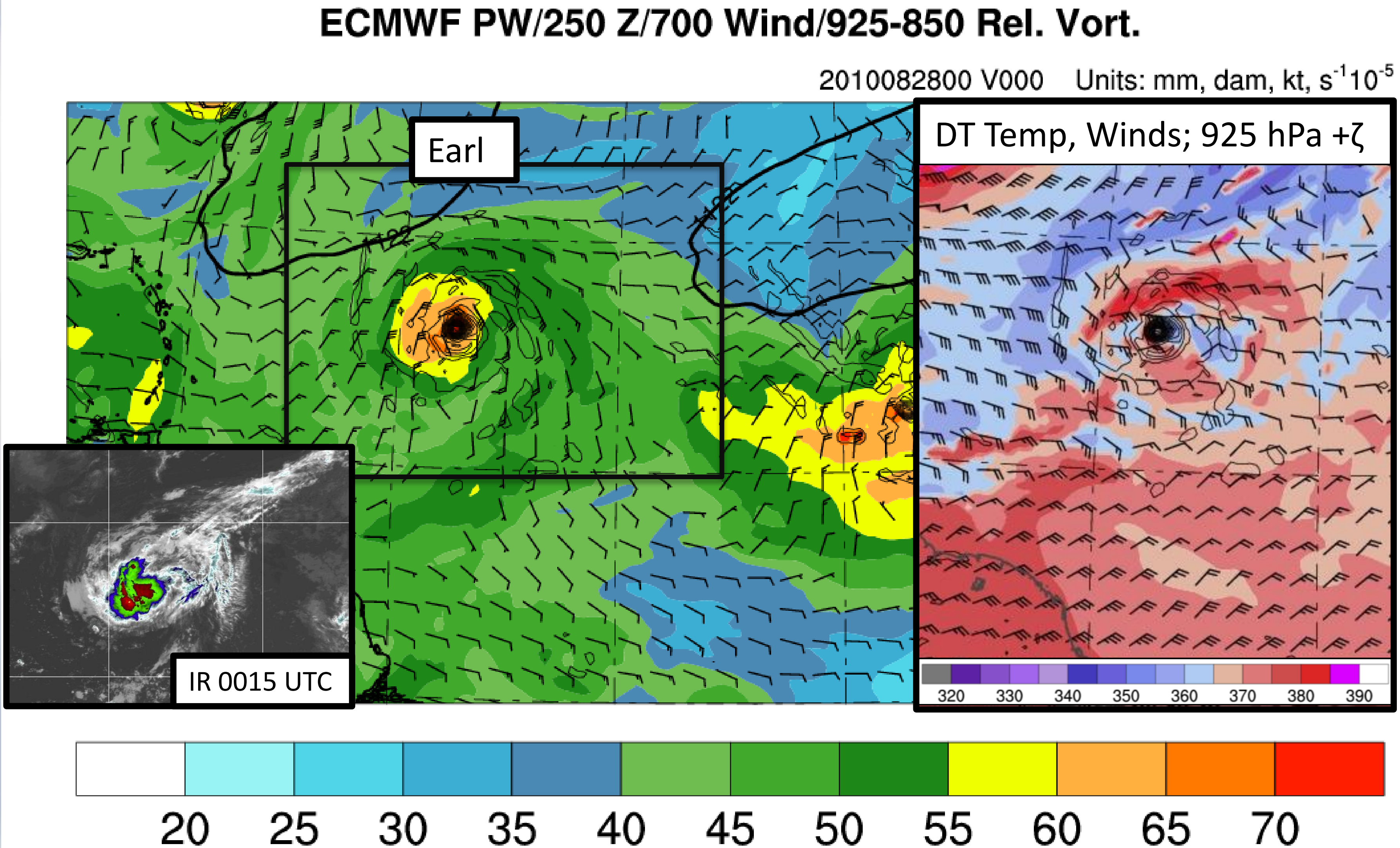
# TS Earl: 0000 UTC 26 August



# TS Earl: 0600 UTC 27 August

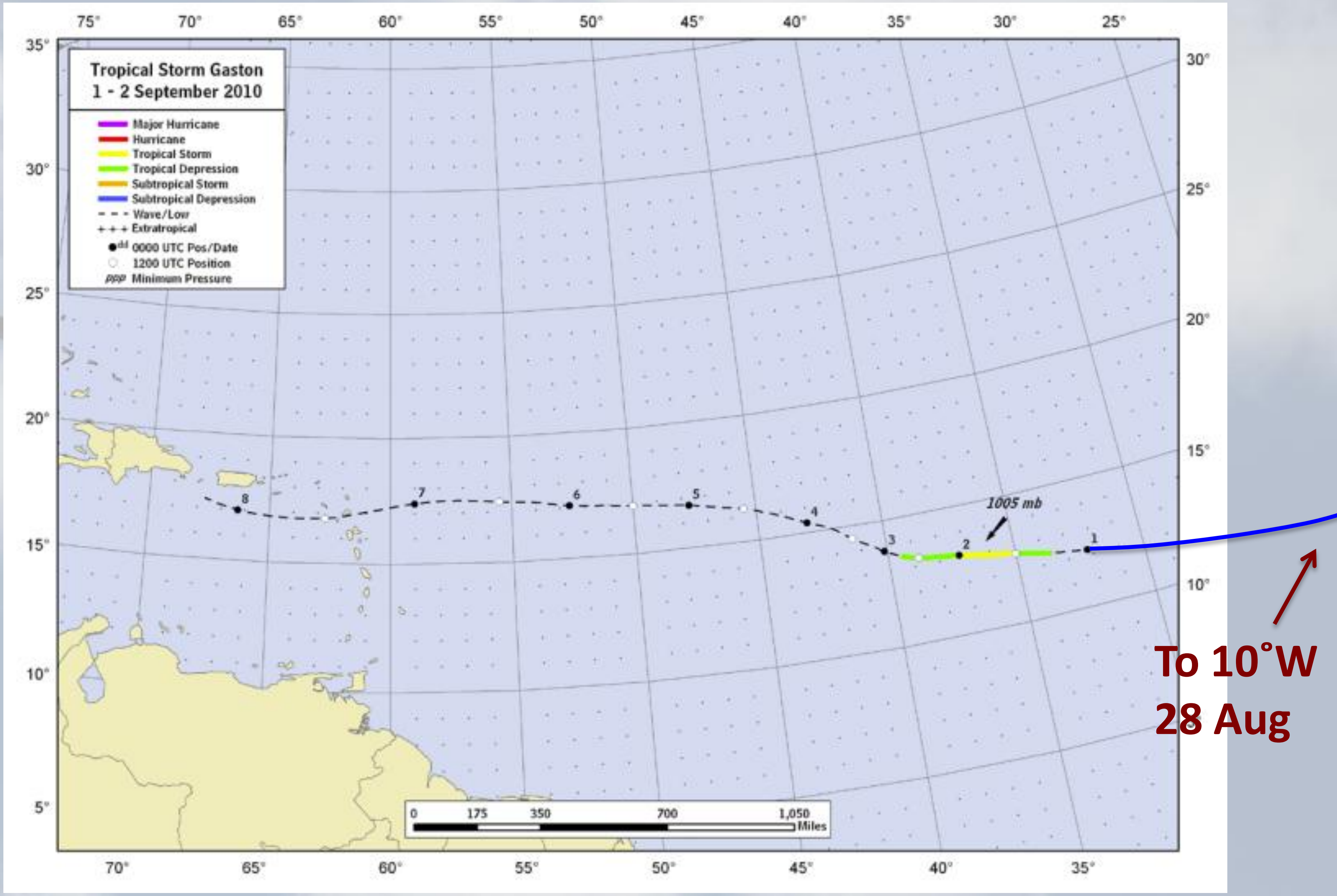


# TS Earl: 0000 UTC 28 August



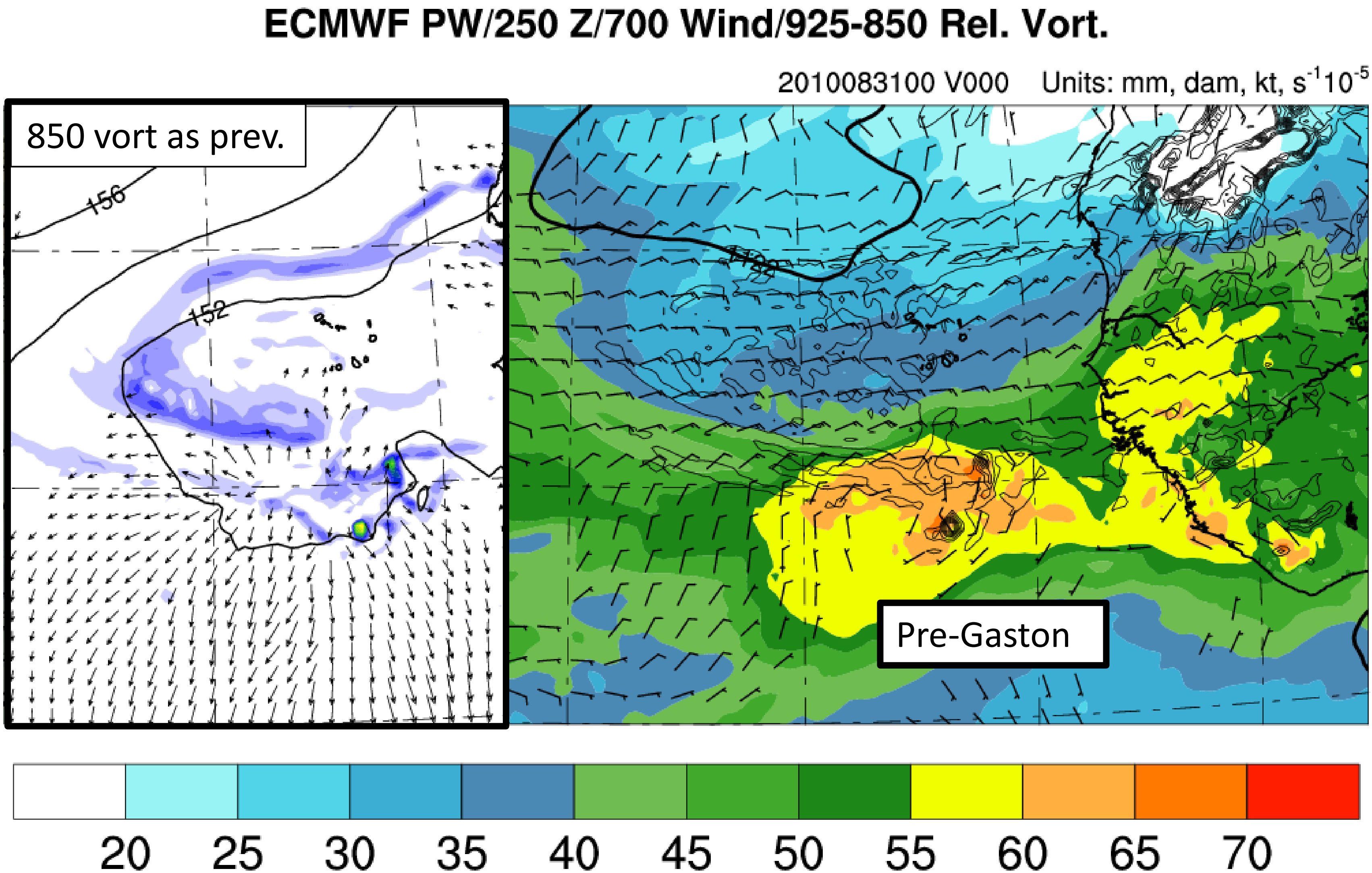

Remains tropical storm for additional 36 h; totals 96 h as a TS

# Dry Air: "Gaston"

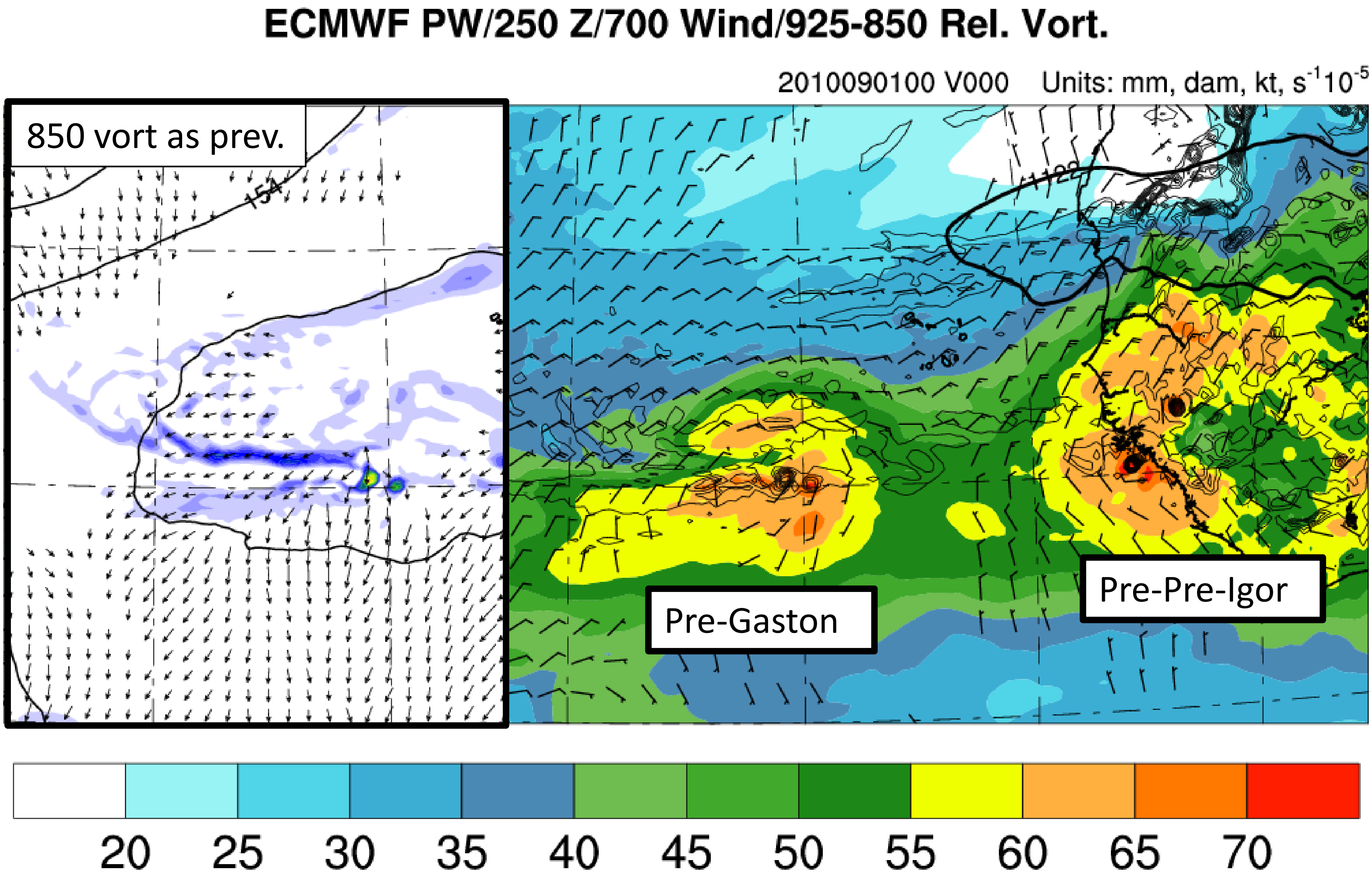



To 10˚W
28 Aug

# Pre-Gaston: 0000 UTC 31 August

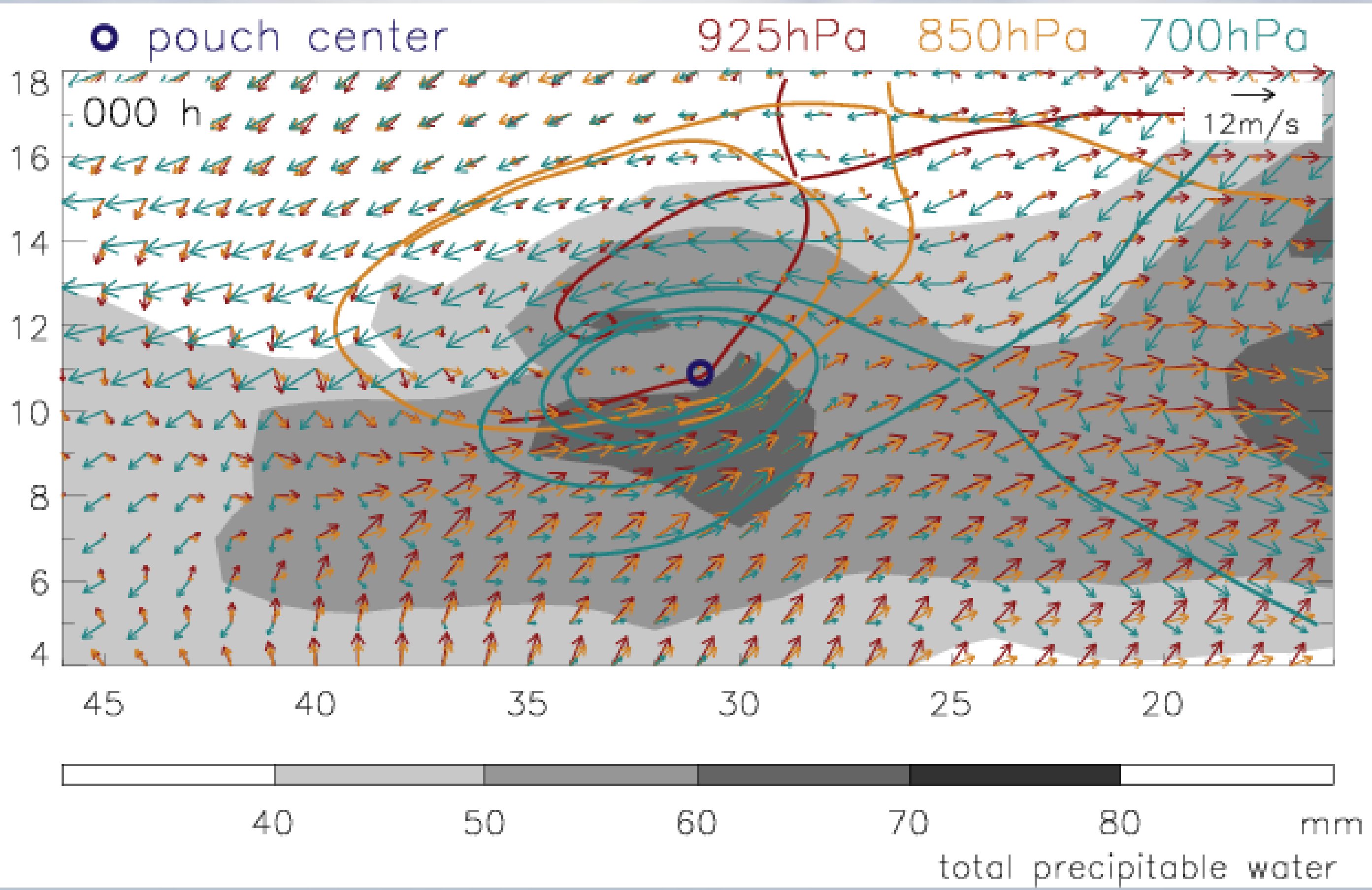


# Pre-Gaston: 0000 UTC 1 September




Declared a TD

# Dividing Streamline analysis valid **0000 UTC 1 Sep**

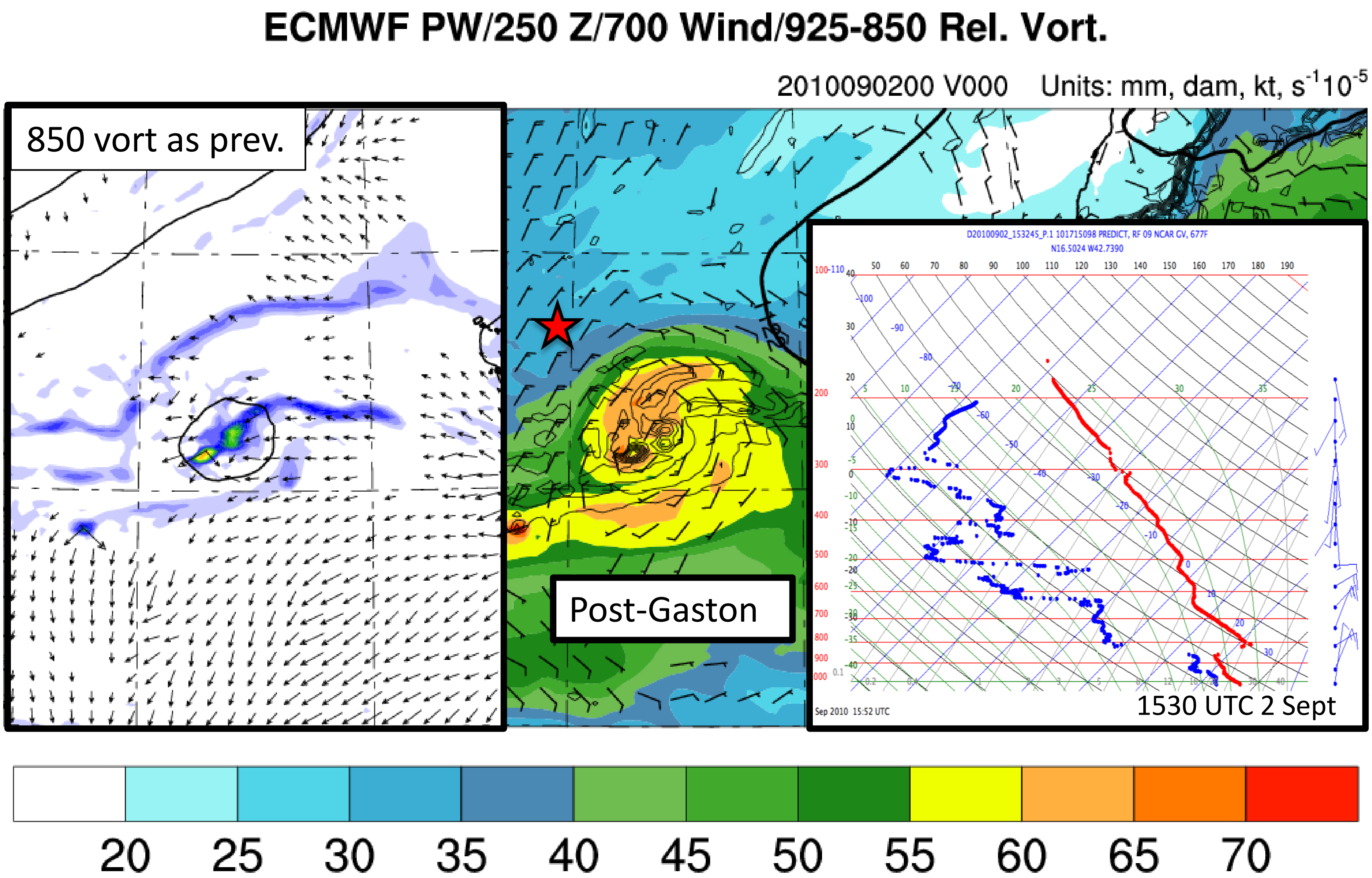



**Pouch is not vertically stacked**

**Lower levels centered beneath dry air/dust layer**

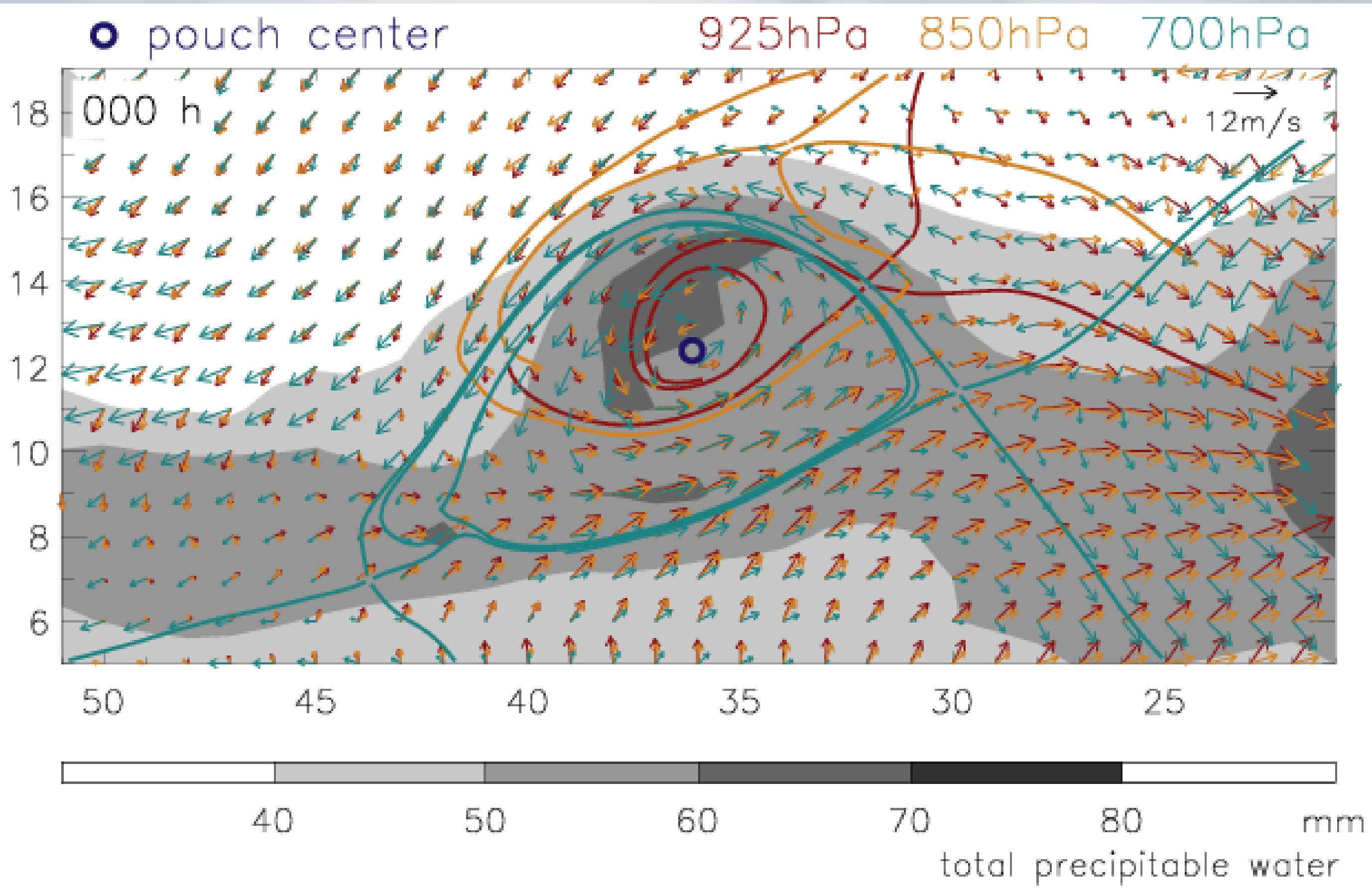
**700 hPa pouch is farther SE, closer to moisture/free of dust**

# Post-Gaston: 0000 UTC 2 September




Downgraded from TS to TD as NHC received G-V dropsonde data

# Dividing Streamline analysis valid 0000 UTC 2 Sep

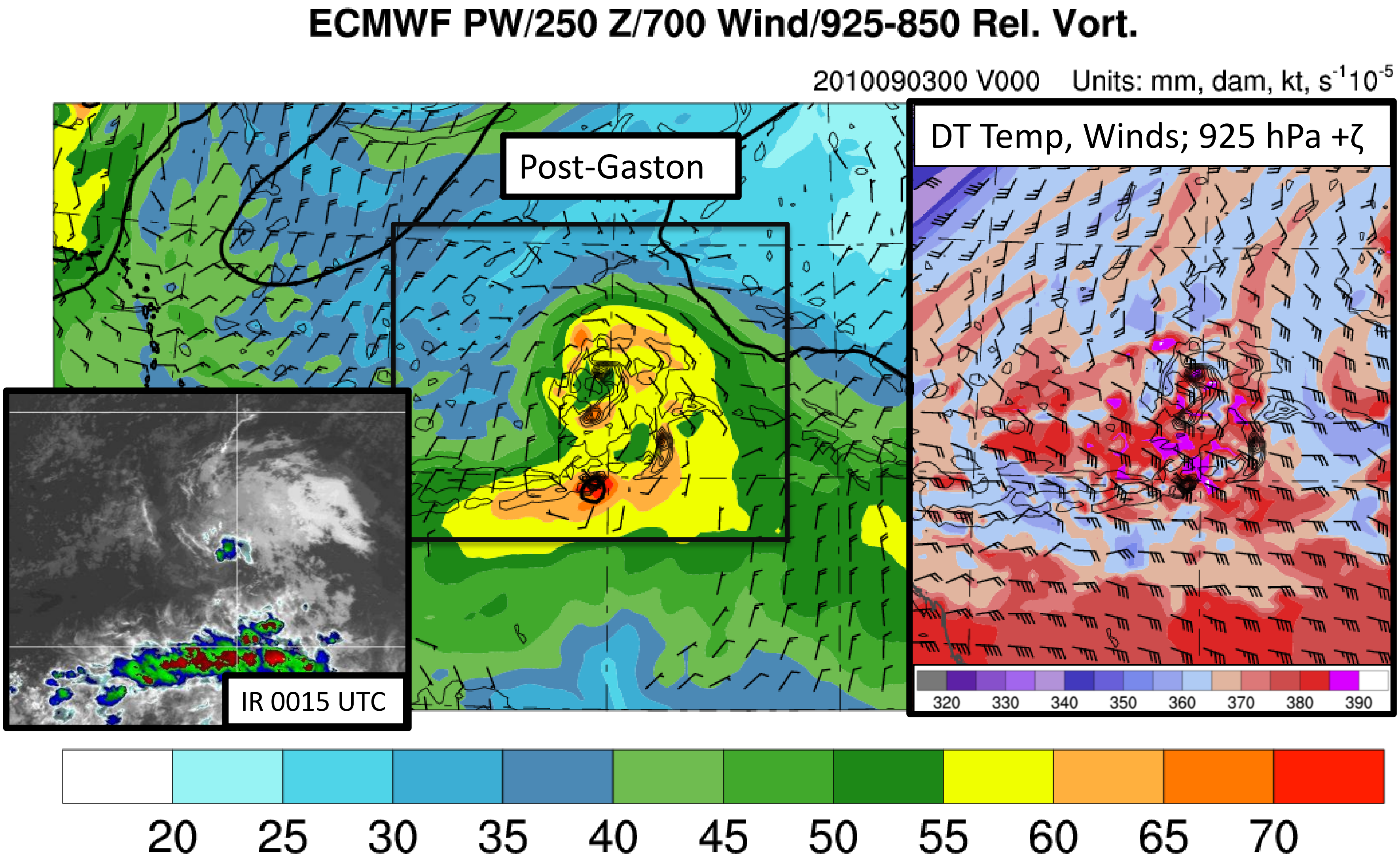



**Vertical structure improved**

**700 hPa streamlines now include dust regions**

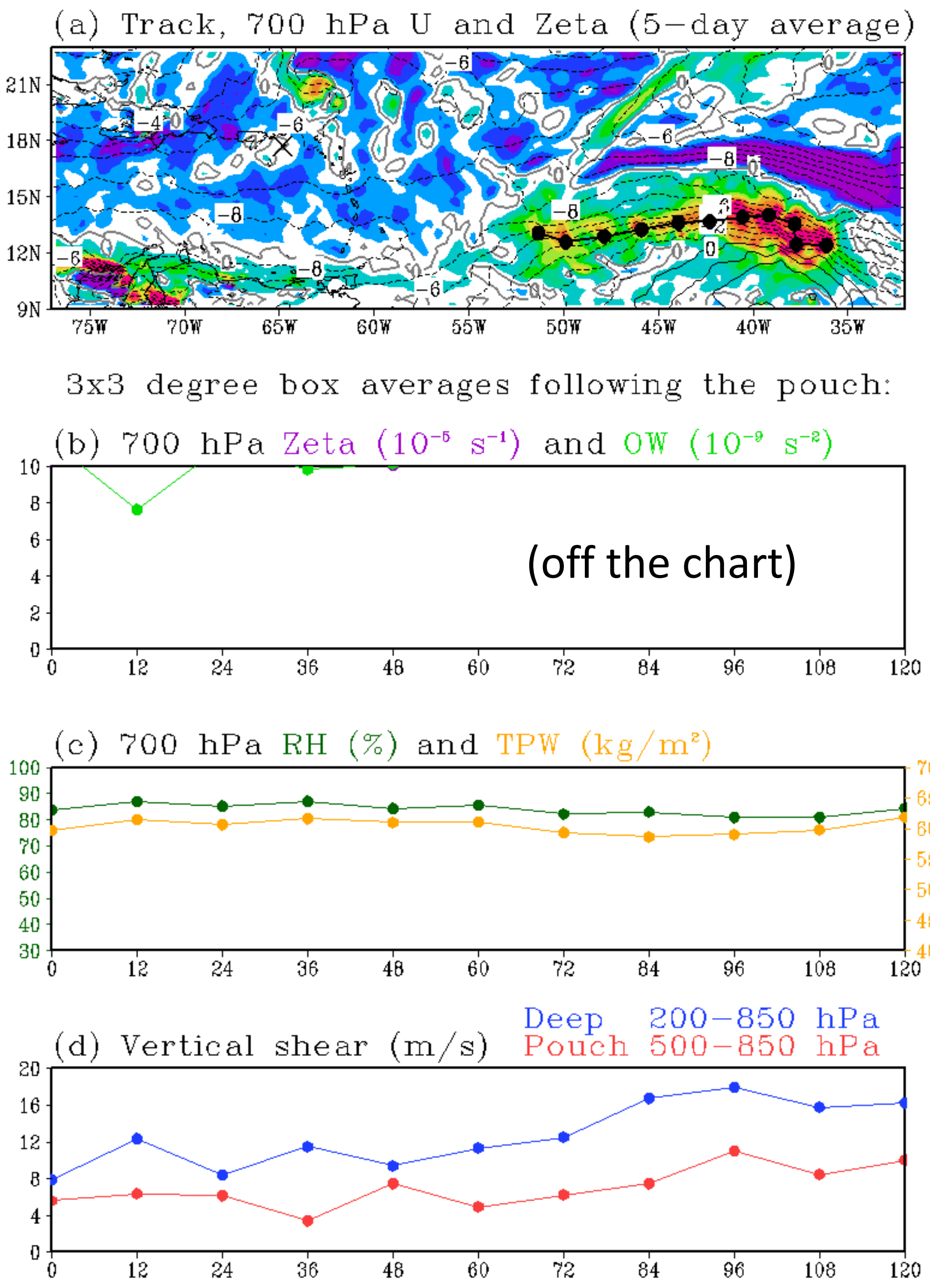
**Dust can now be entrained throughout column**

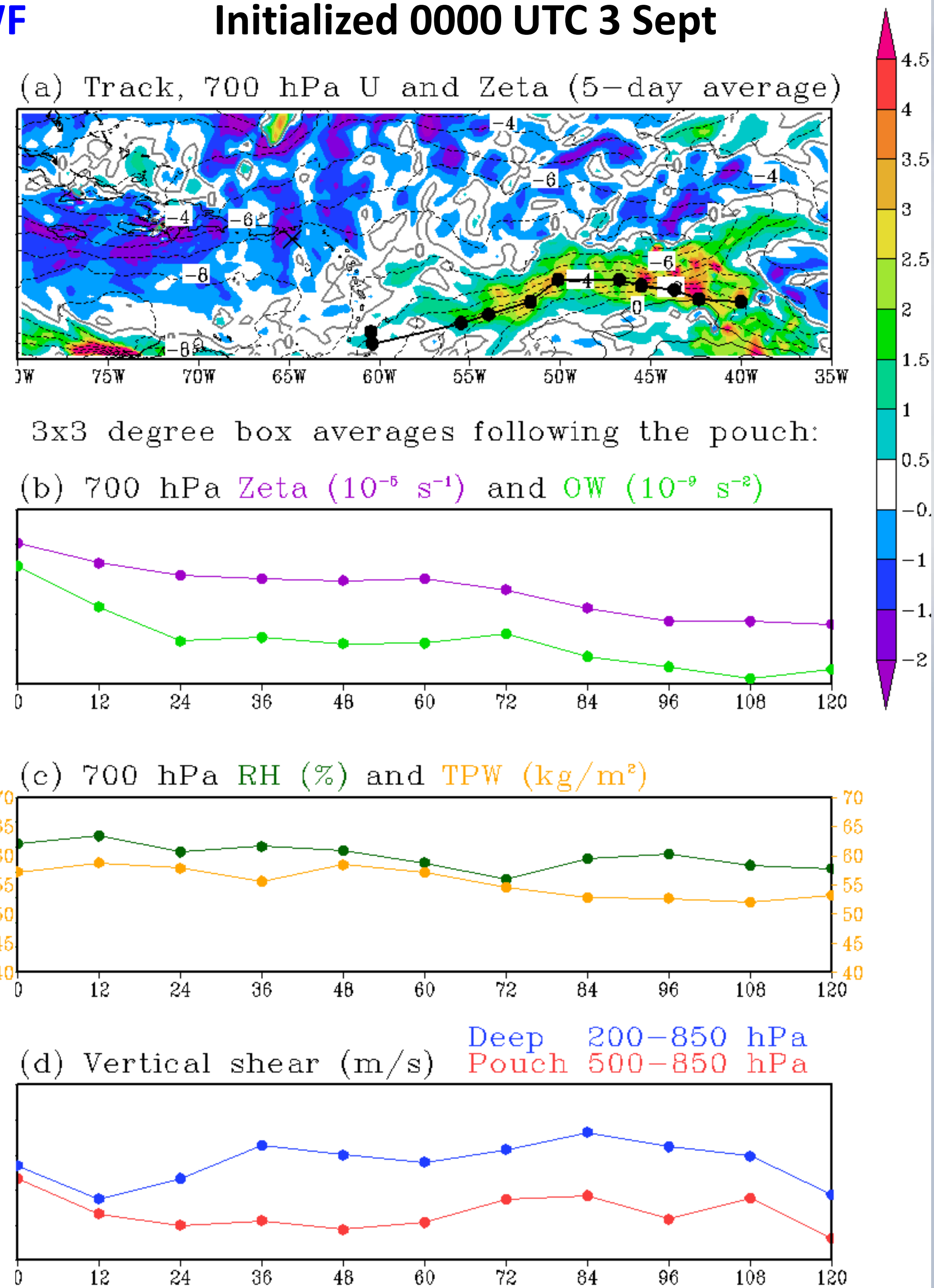
# Post-Gaston: 0000 UTC 3 September



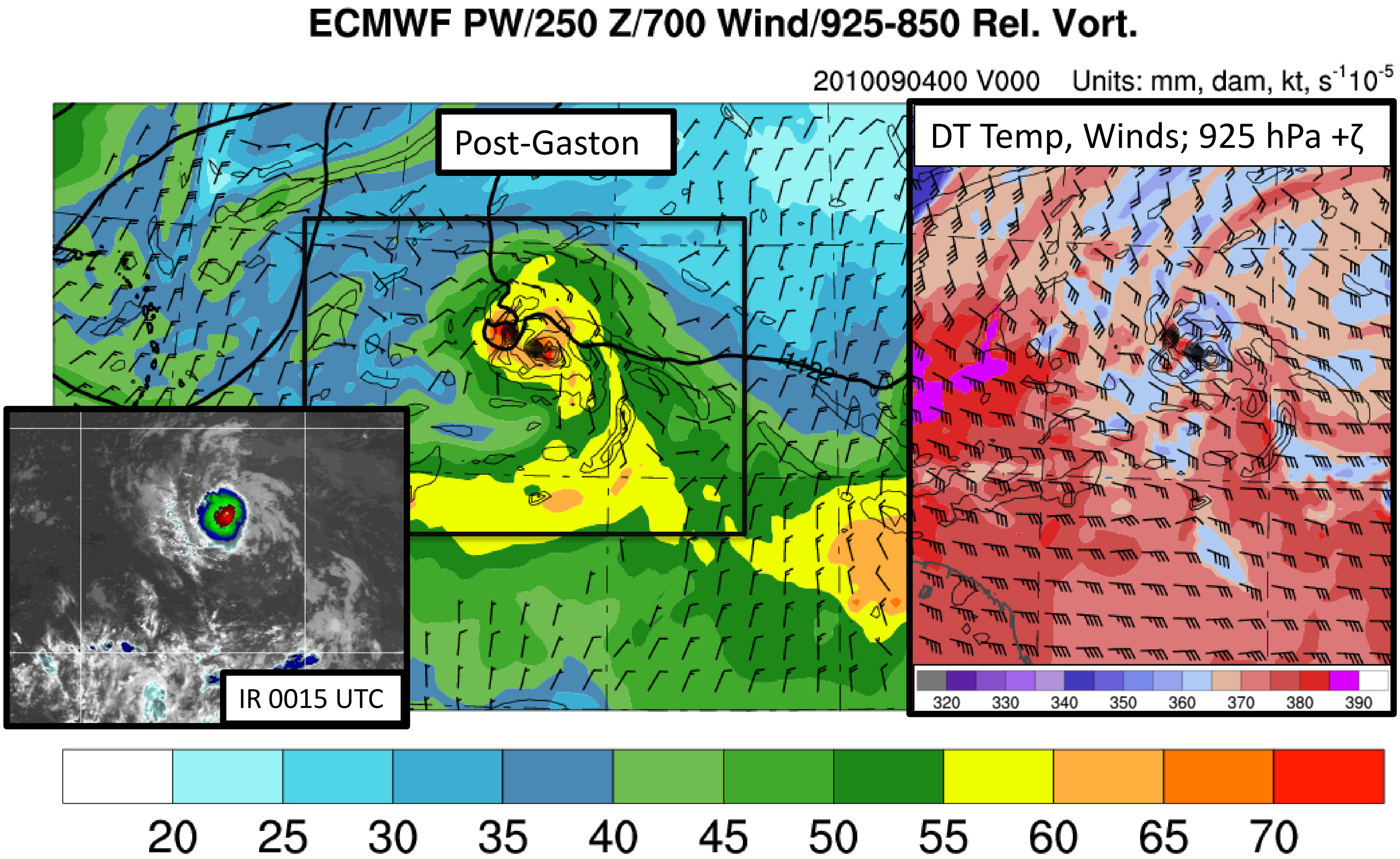

Convection not sufficiently strong to maintain moisture in pouch

**Initialized 0000 UTC 2 Sept** **ECMWF** **Initialized 0000 UTC 3 Sept**

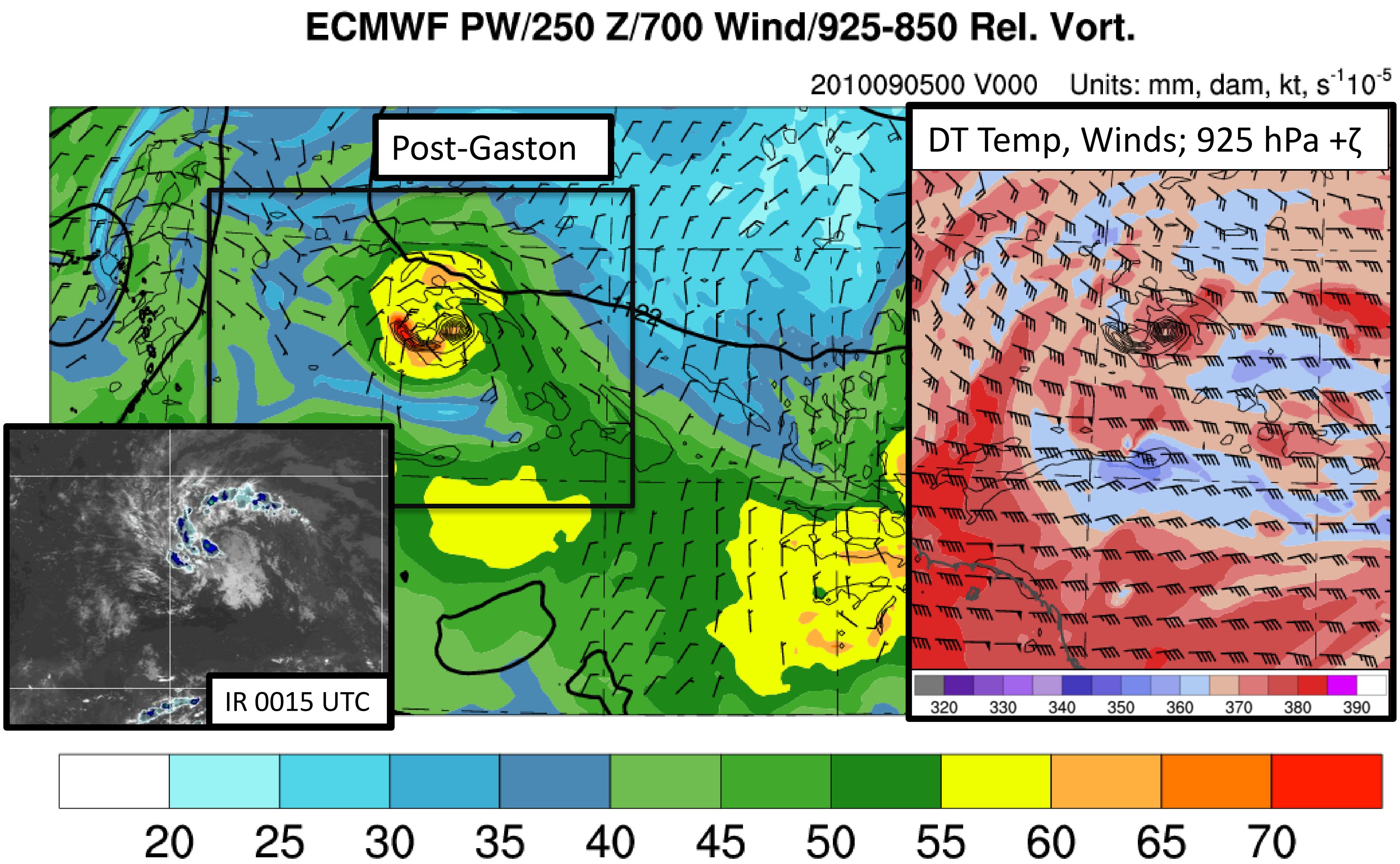


# Post-Gaston: 0000 UTC 4 September



# Post-Gaston: 0000 UTC 5 September



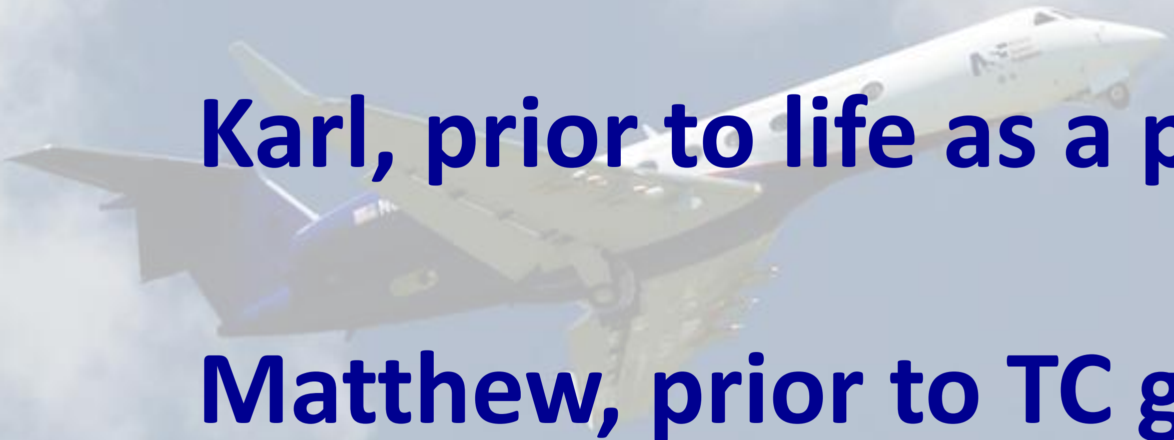
# So…

## Can we accurately forecast the effects of dry air vs. convection on TC evolution?

## Why is the pouch not always a sufficient mechanism to protect the disturbance?

## What factors lead to this insufficiency?

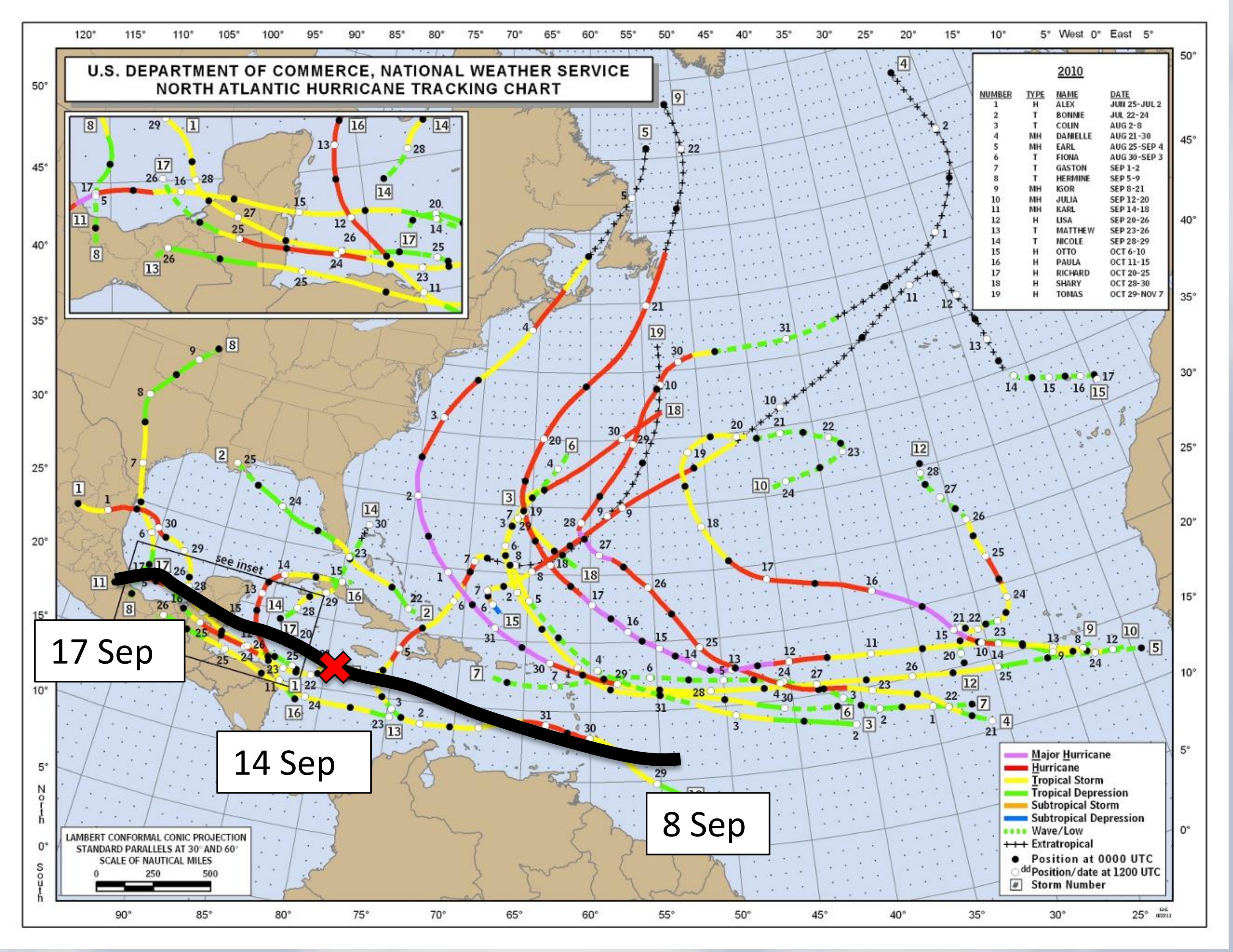
# “The South American Connection”



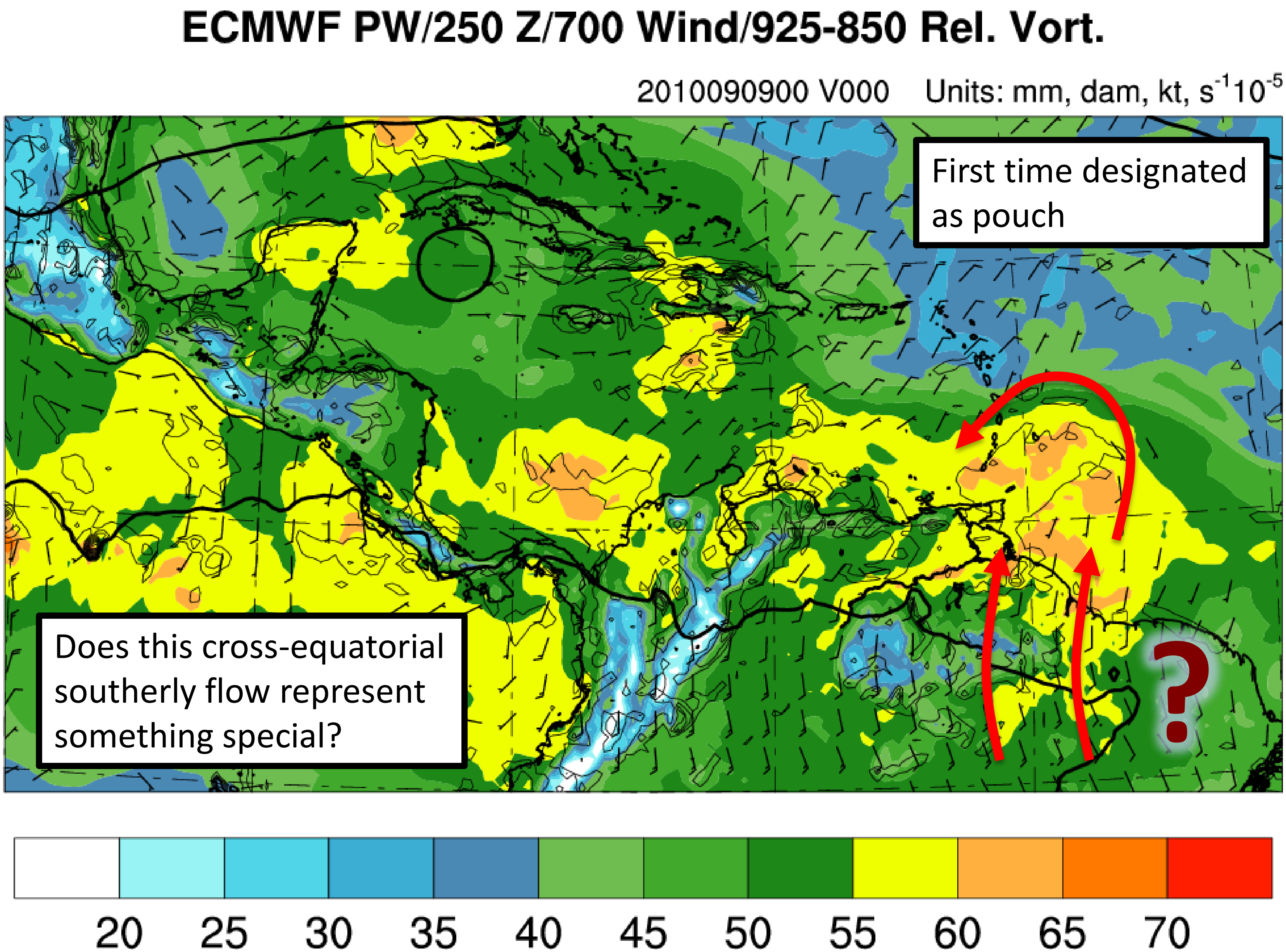
**Karl, prior to life as a pouch**

**Matthew, prior to TC genesis**

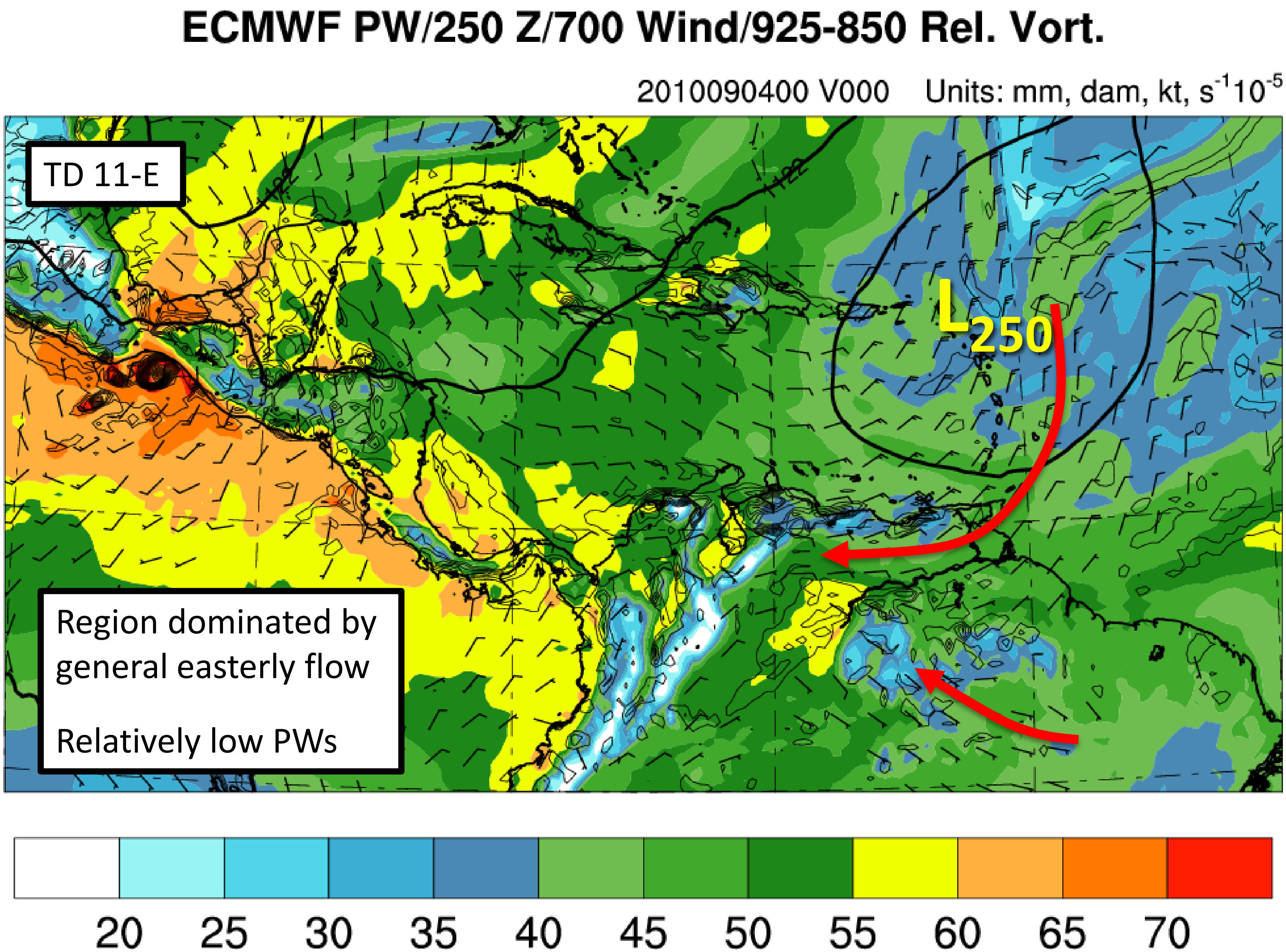
# “South American Connection”: Karl



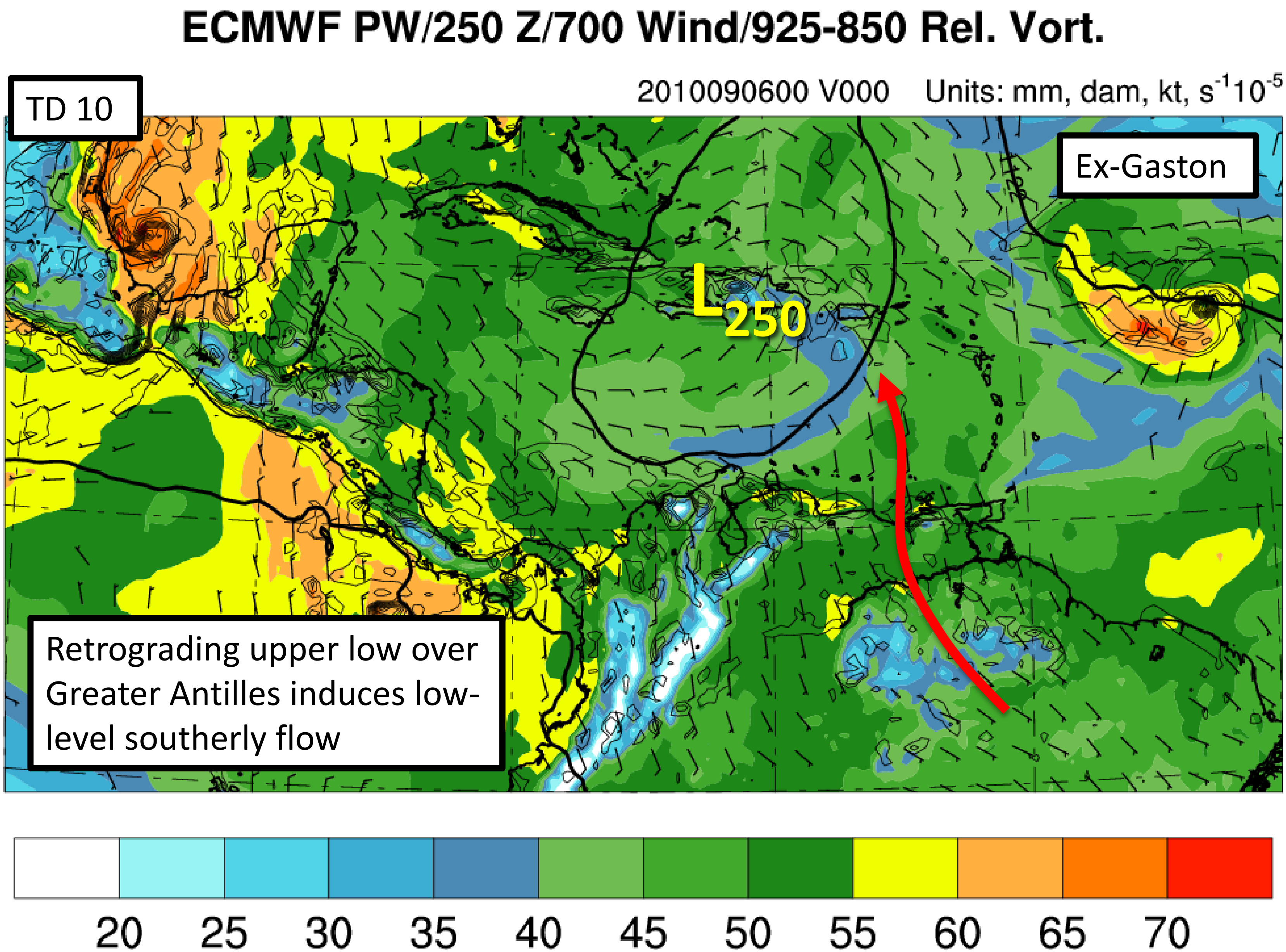
# Pre-Karl: 0000 UTC 9 September



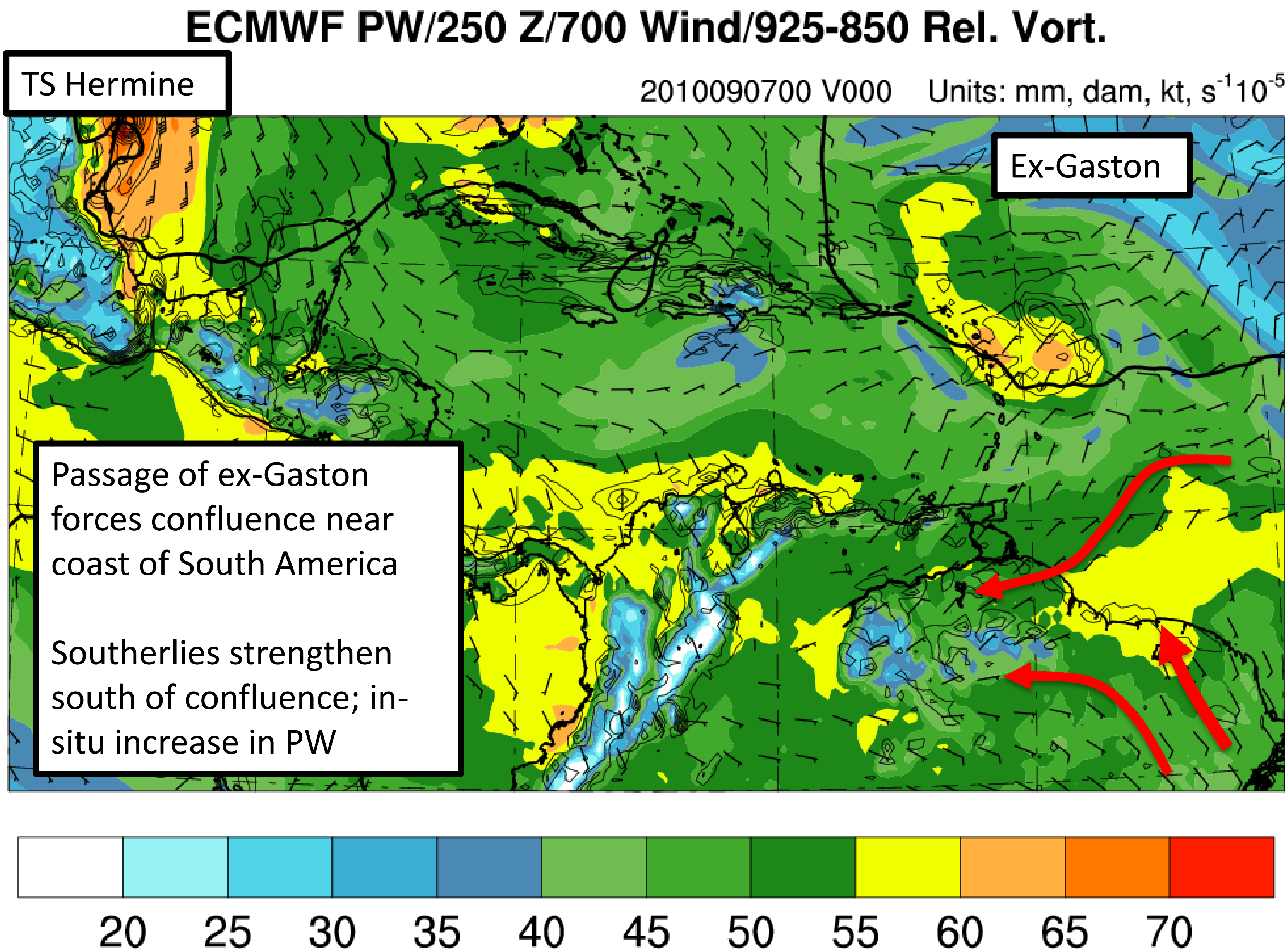
# Pre-Pre-Karl: 0000 UTC 4 September



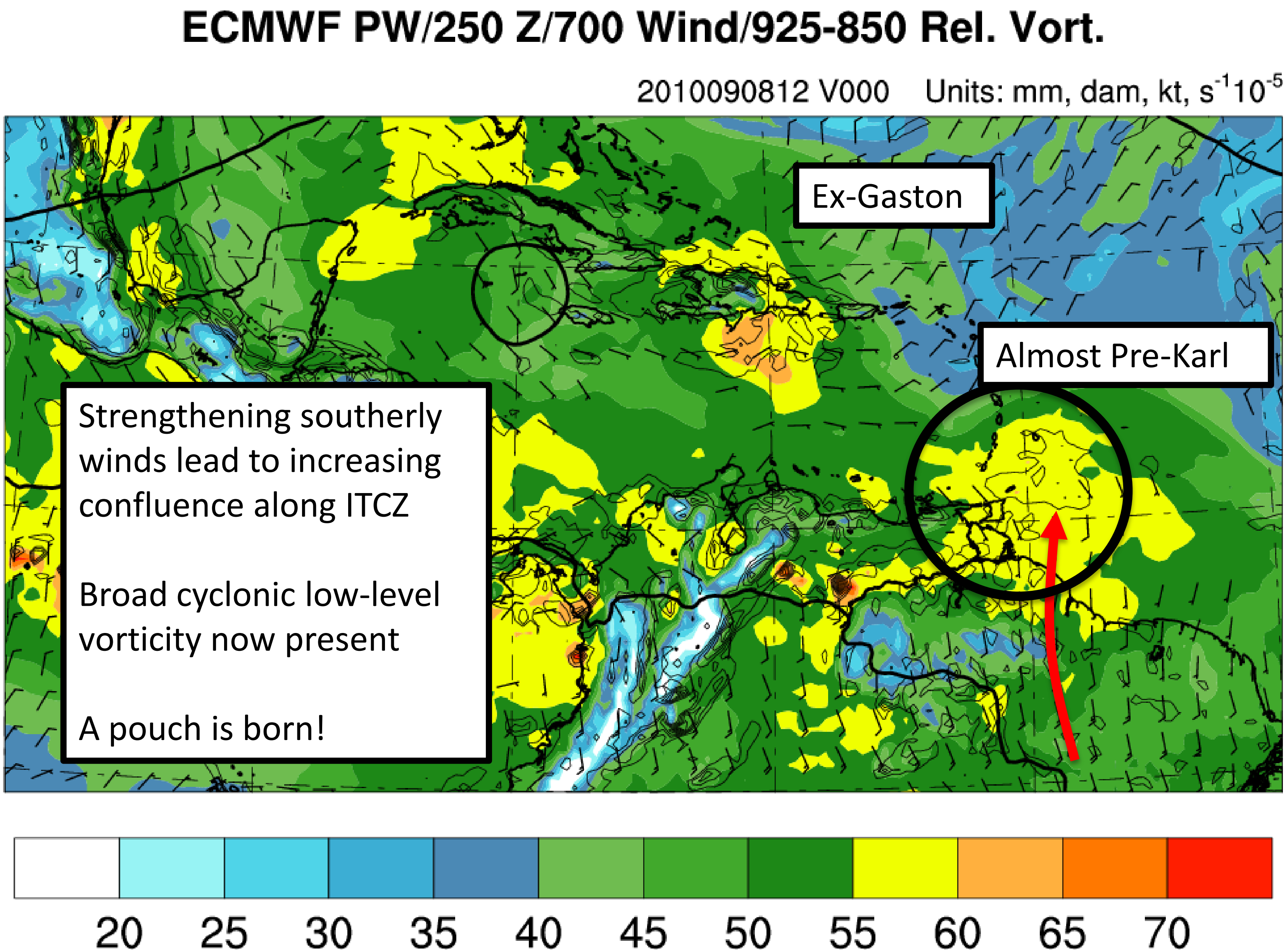
# Pre-Pre-Karl: 0000 UTC 6 September

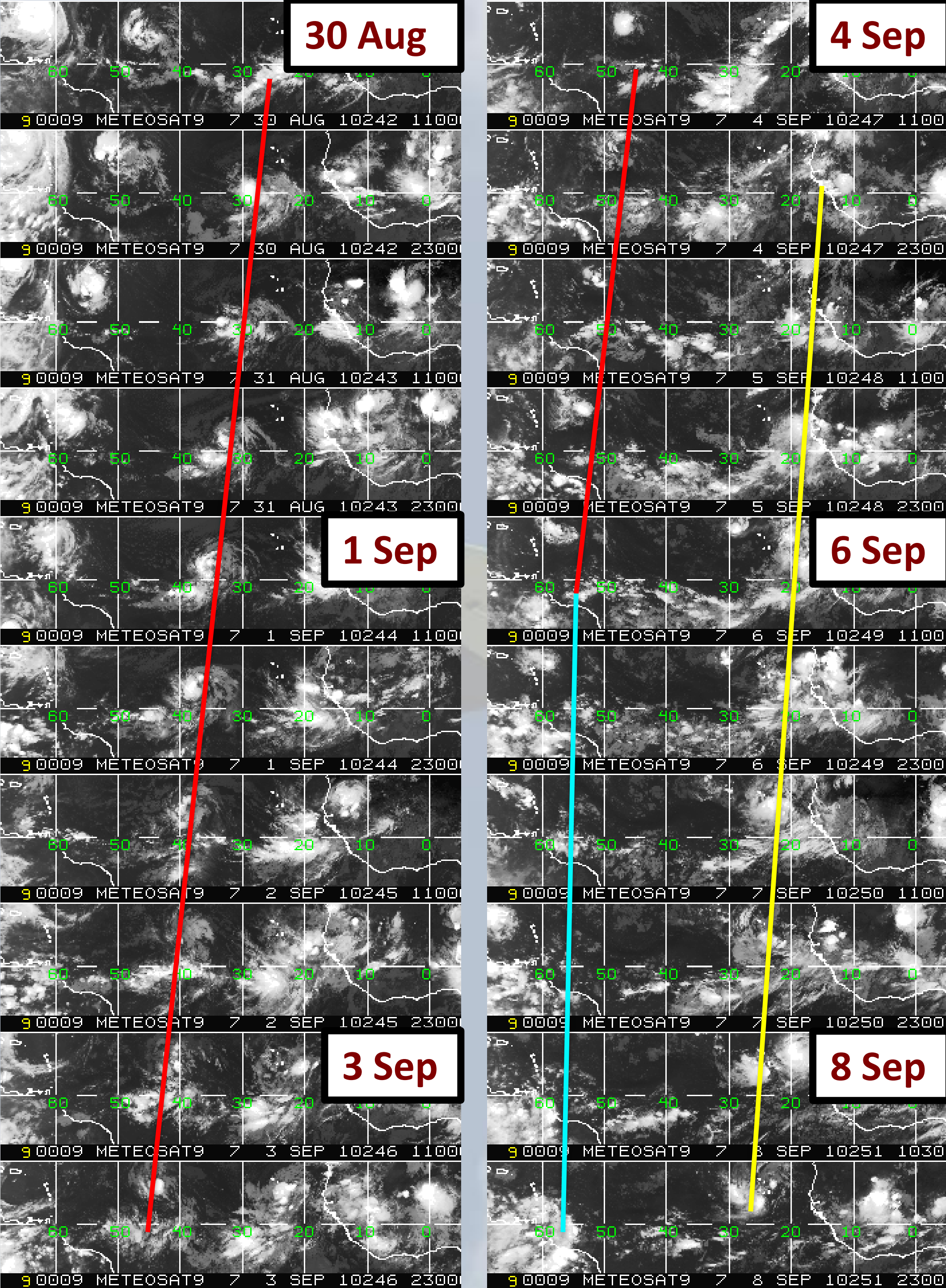


# Pre-Pre-Karl: 0000 UTC 7 September



# Pre-Pre-Karl: 1200 UTC 8 September

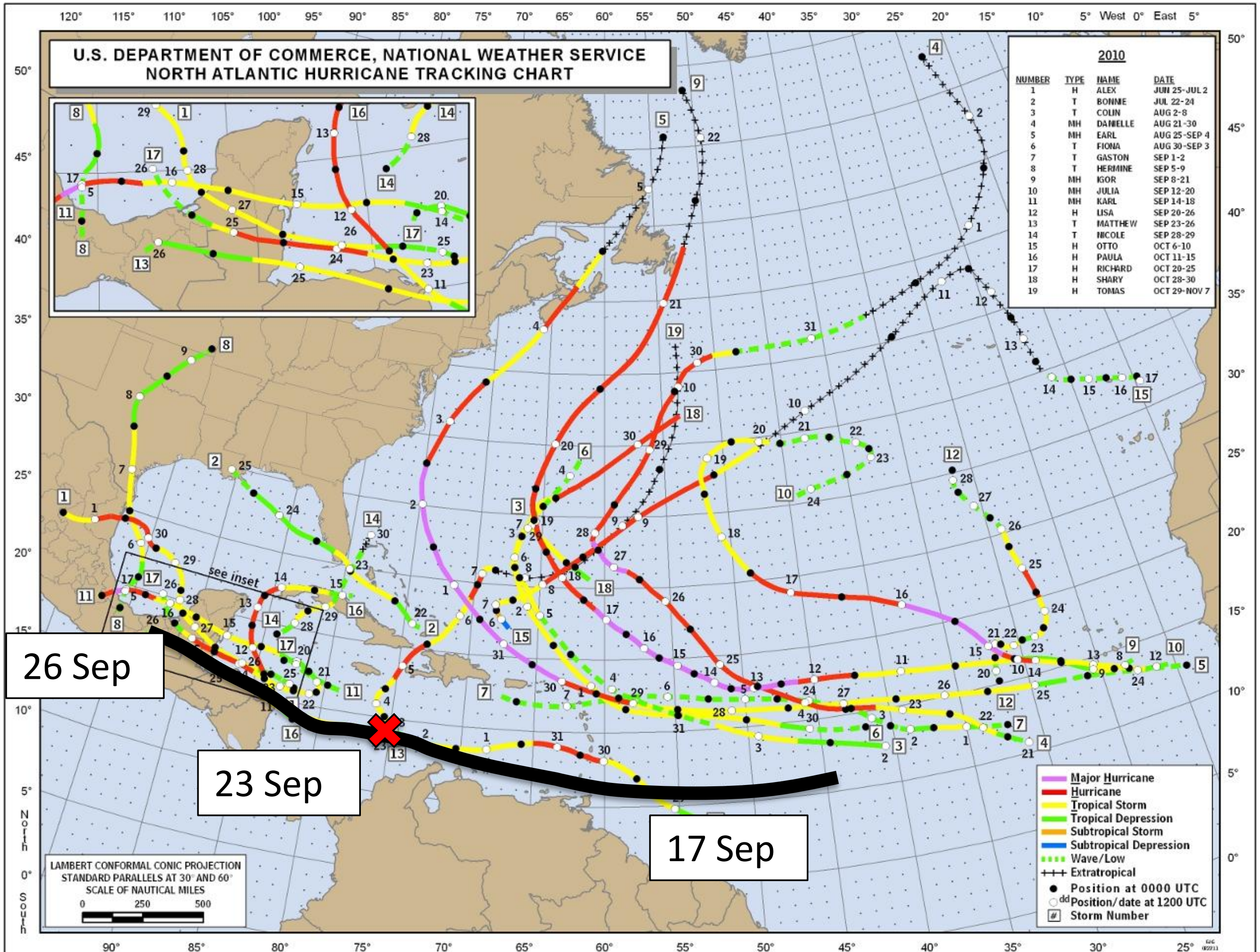




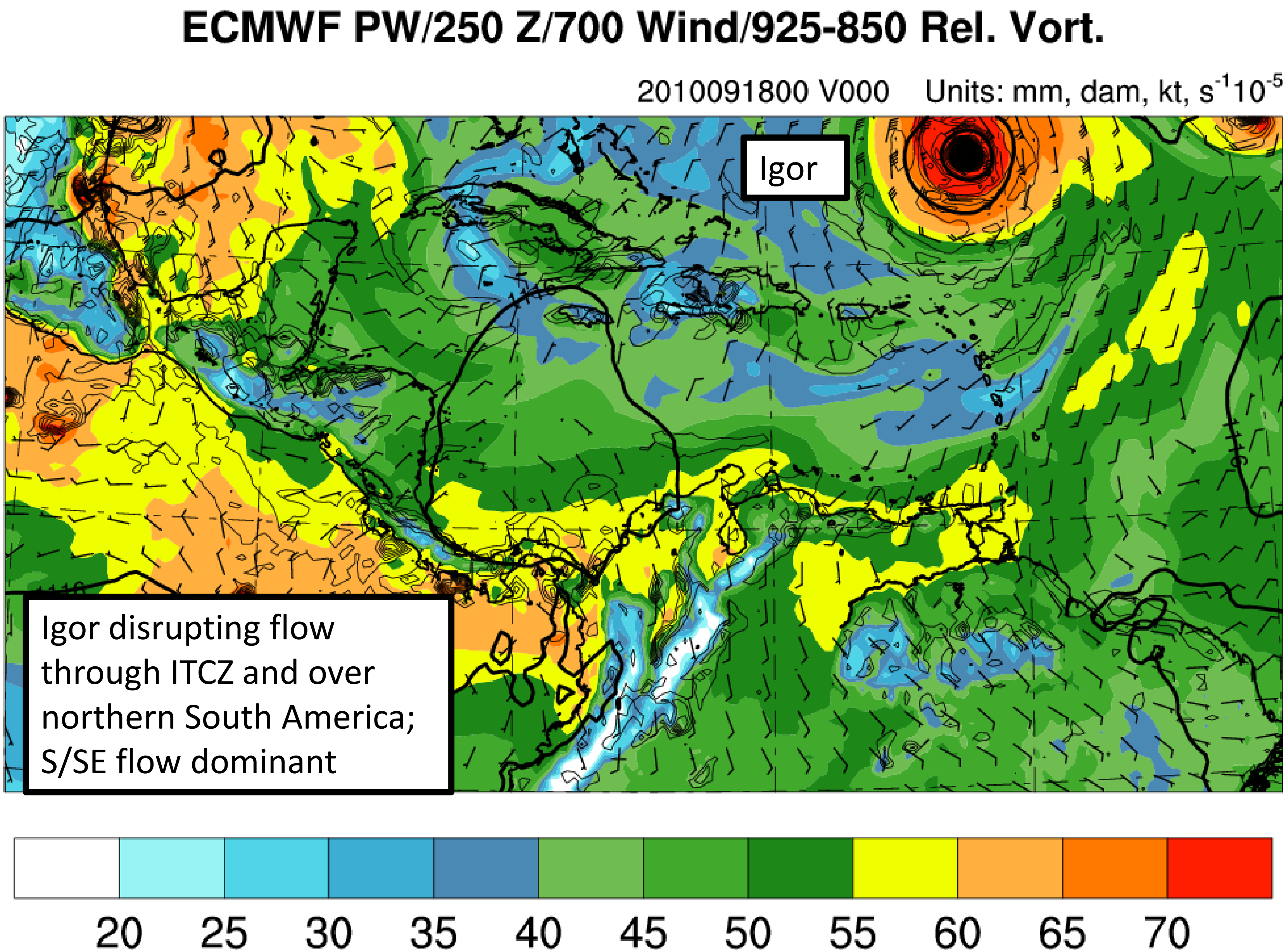

# But did Karl form from a "standard" Easterly Wave?

- Gaston/ITCZ wave
- Quasi-Stationary ITCZ disturbance
- Igor

# “South American Connection”: Matthew

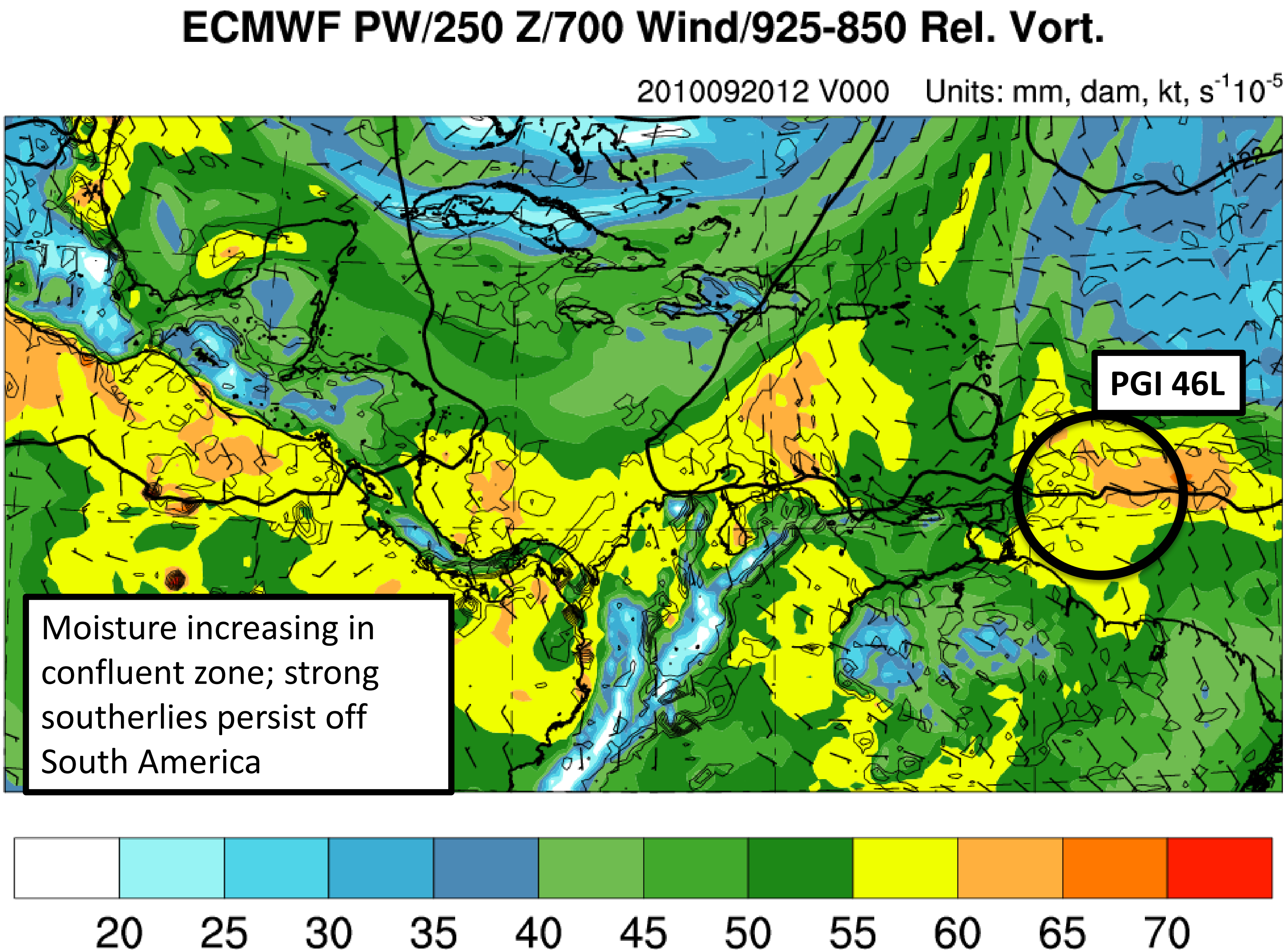


# Pre-Matthew: 0000 UTC 18 September

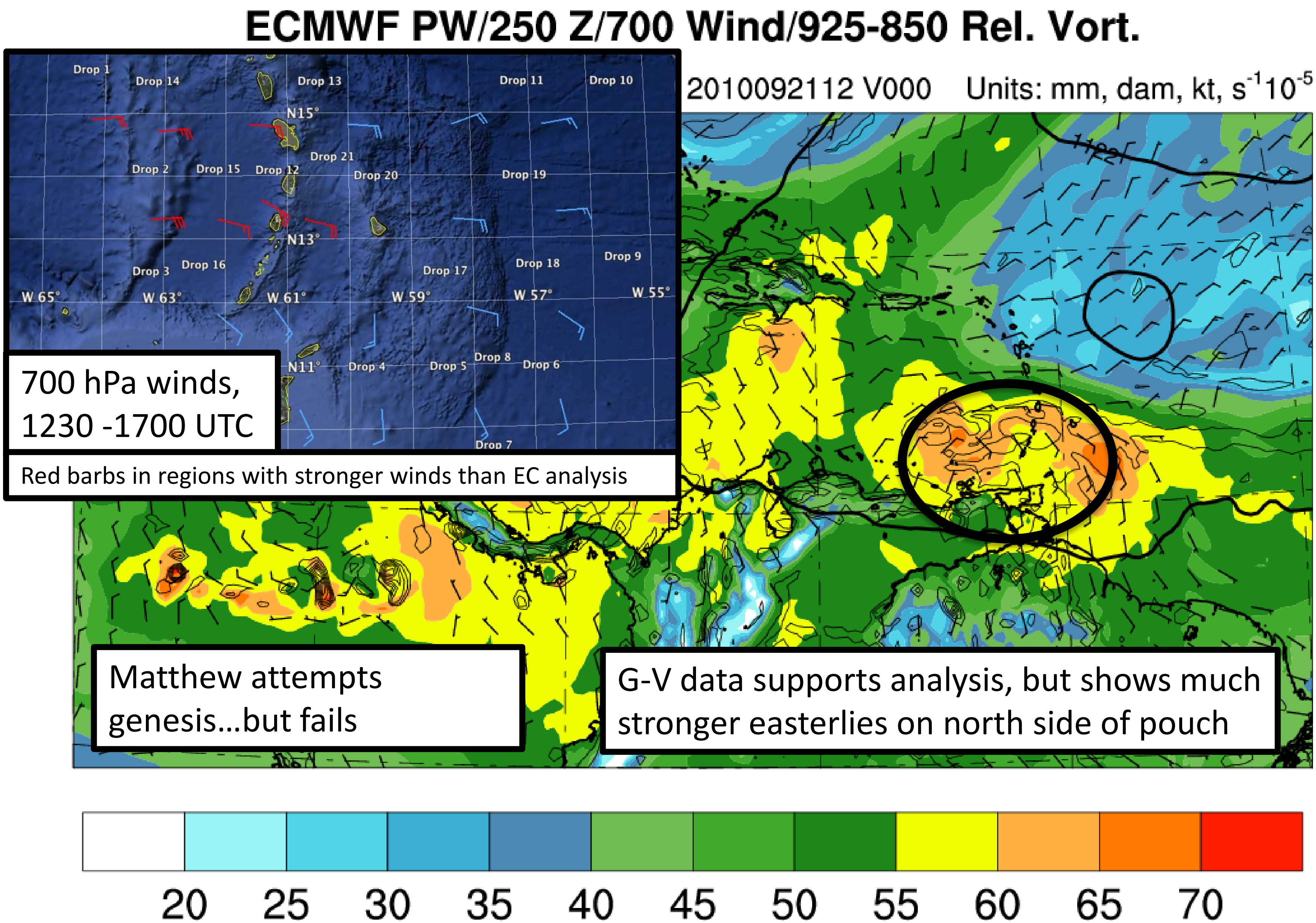



2.5 days later…

# Pre-Matthew: 1200 UTC 20 September

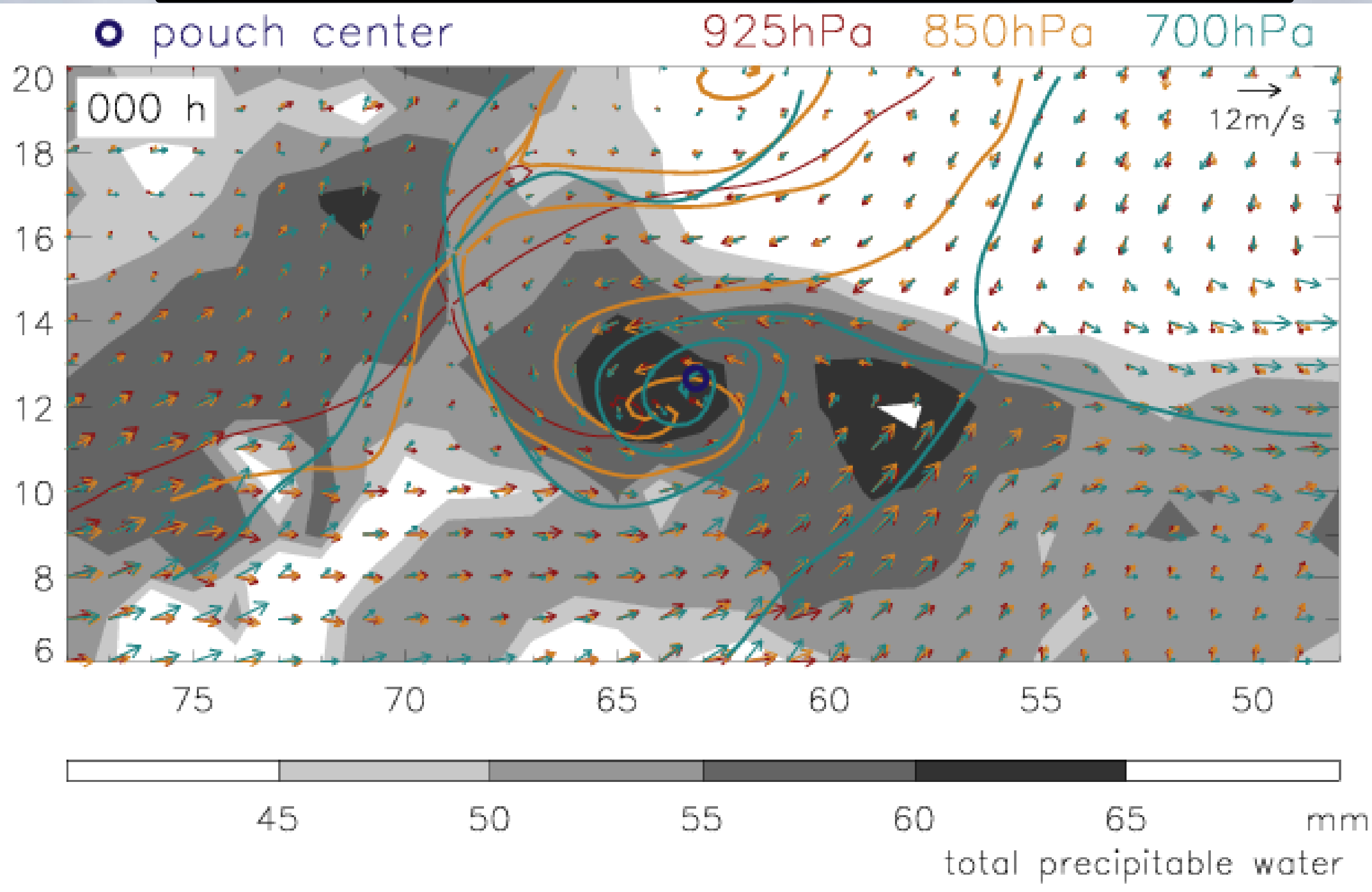


# Pre-Matthew: 1200 UTC 21 September



# Dividing Streamline analysis valid 1200 UTC 21 Sep

Stronger winds (from G-V) on north side of system possibly leads to advection of drier air into system faster than forecast?

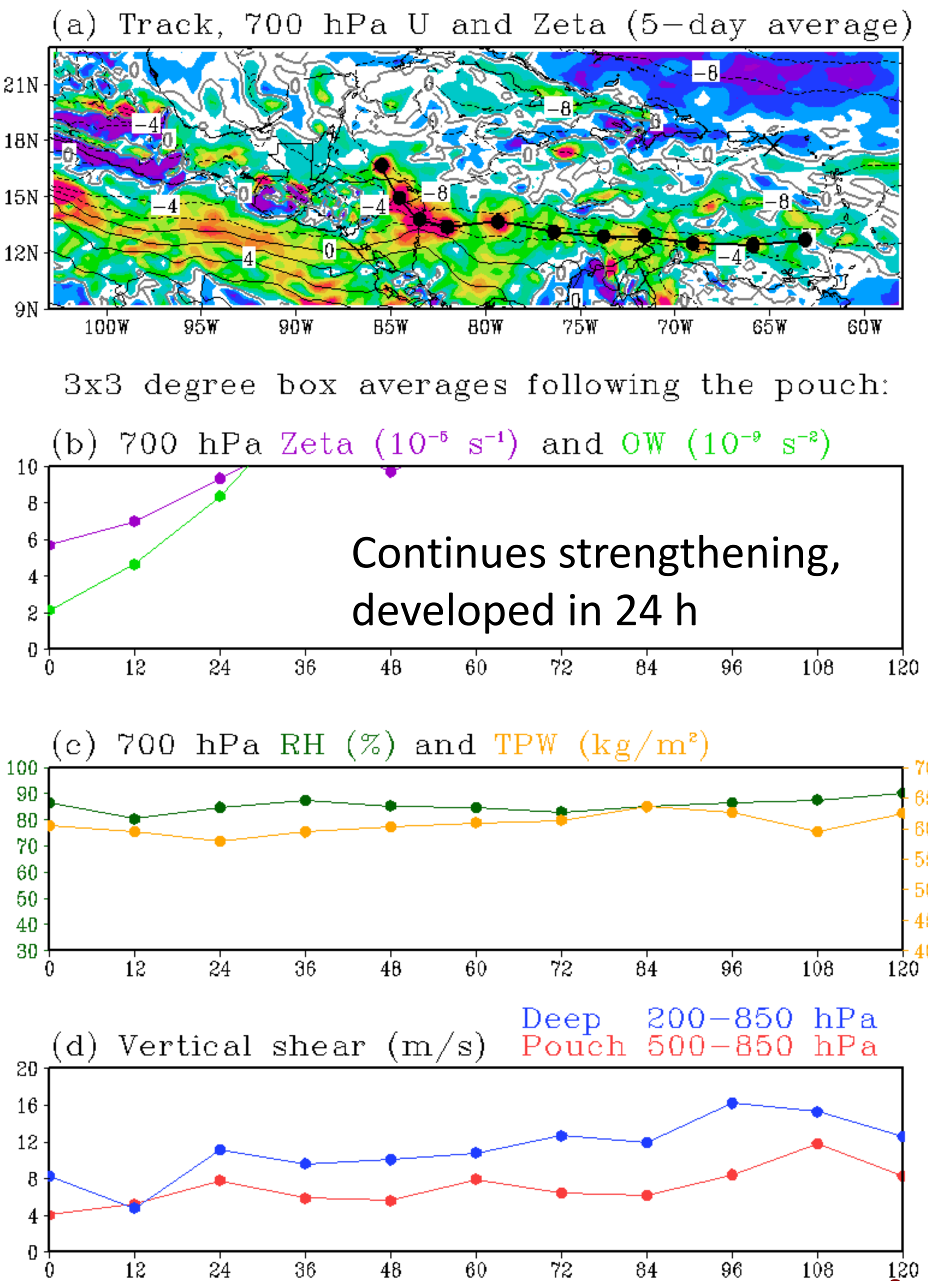


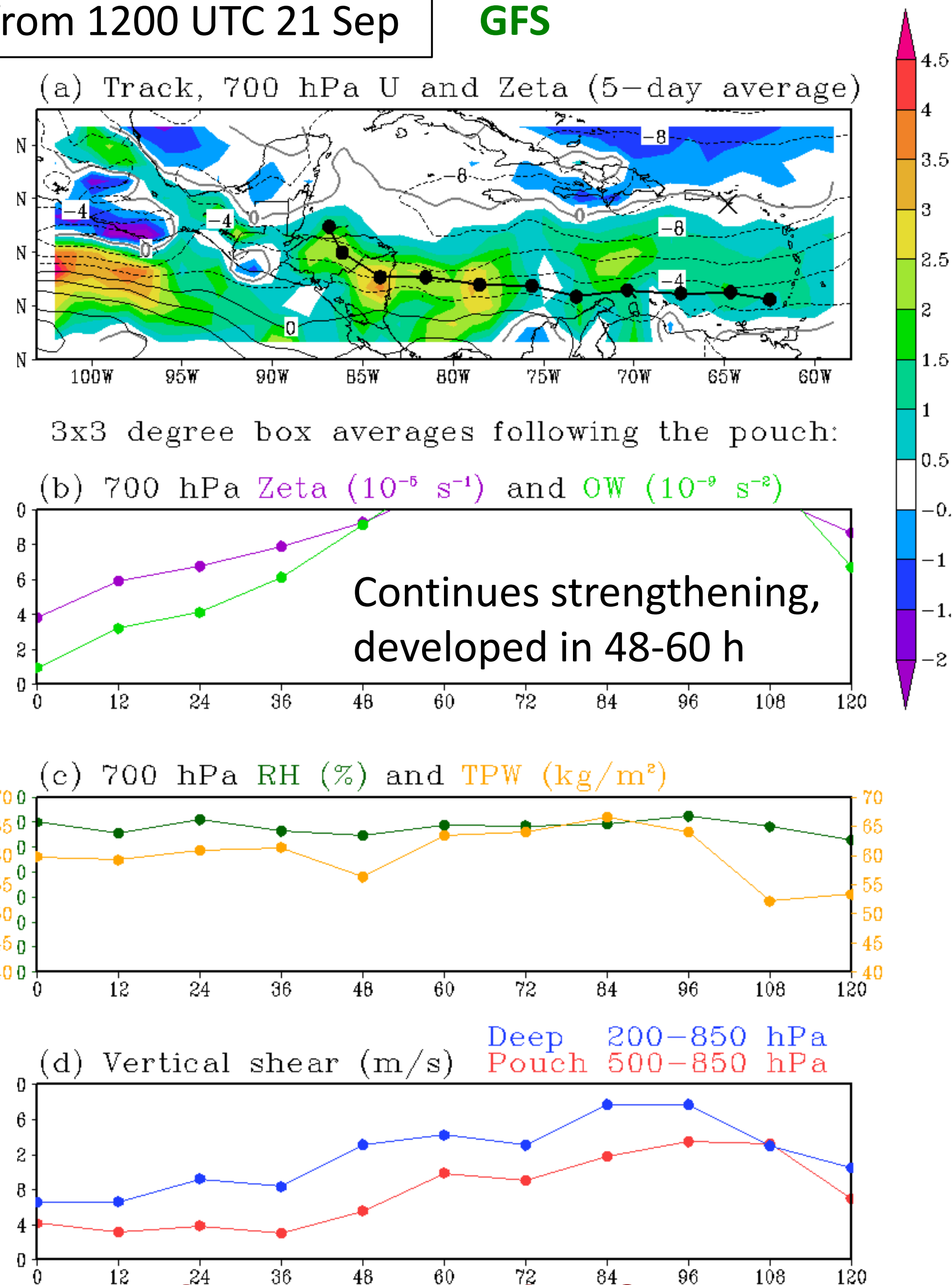

**Moisture forced toward inflow region in streamlines on east side of pouch**

**Vertical structure remains slightly sheared**

**Although genesis "failed", forecast issues remained…**

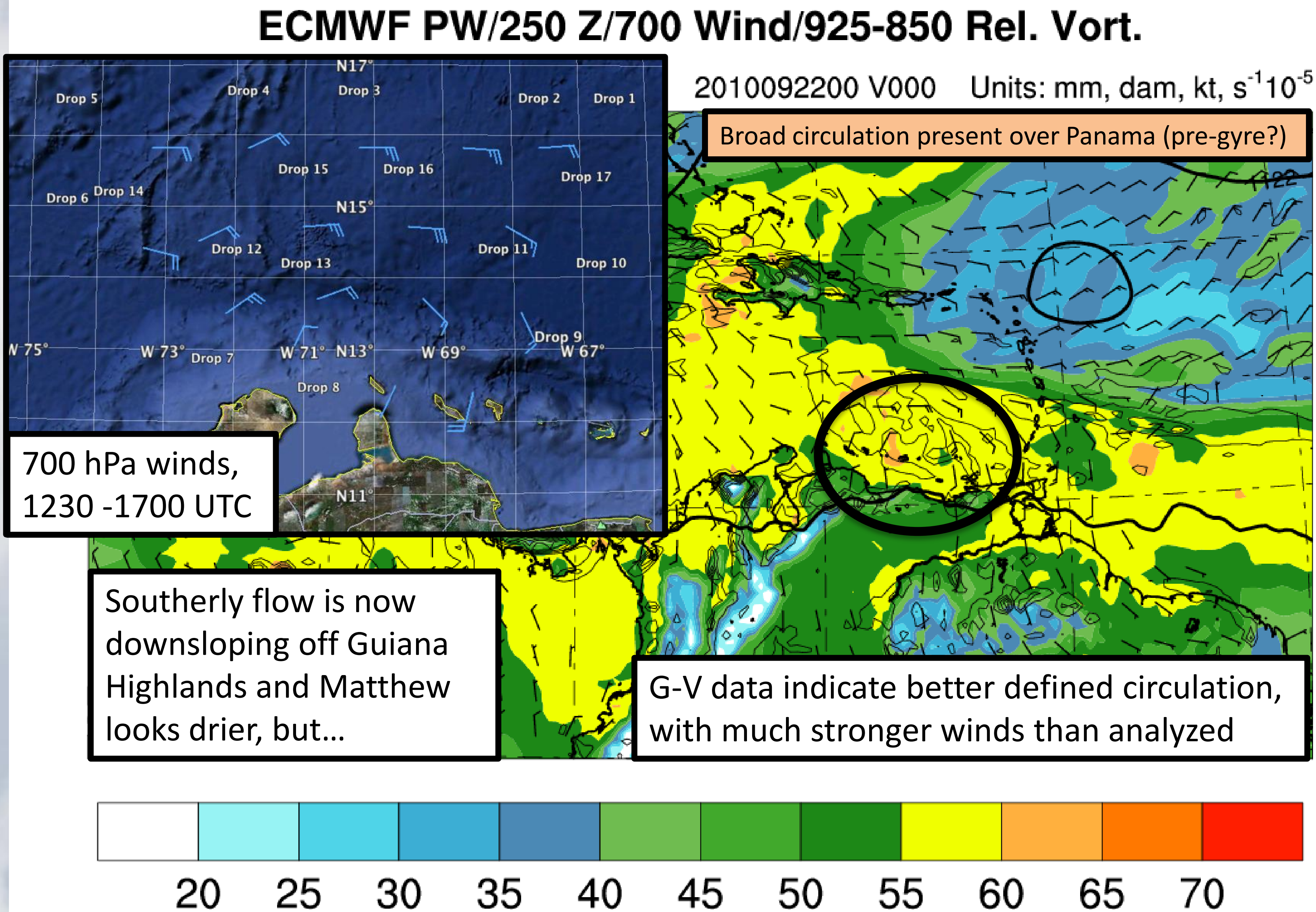
**ECMWF** | **PGI 46L forecast from 1200 UTC 21 Sep** | **GFS**



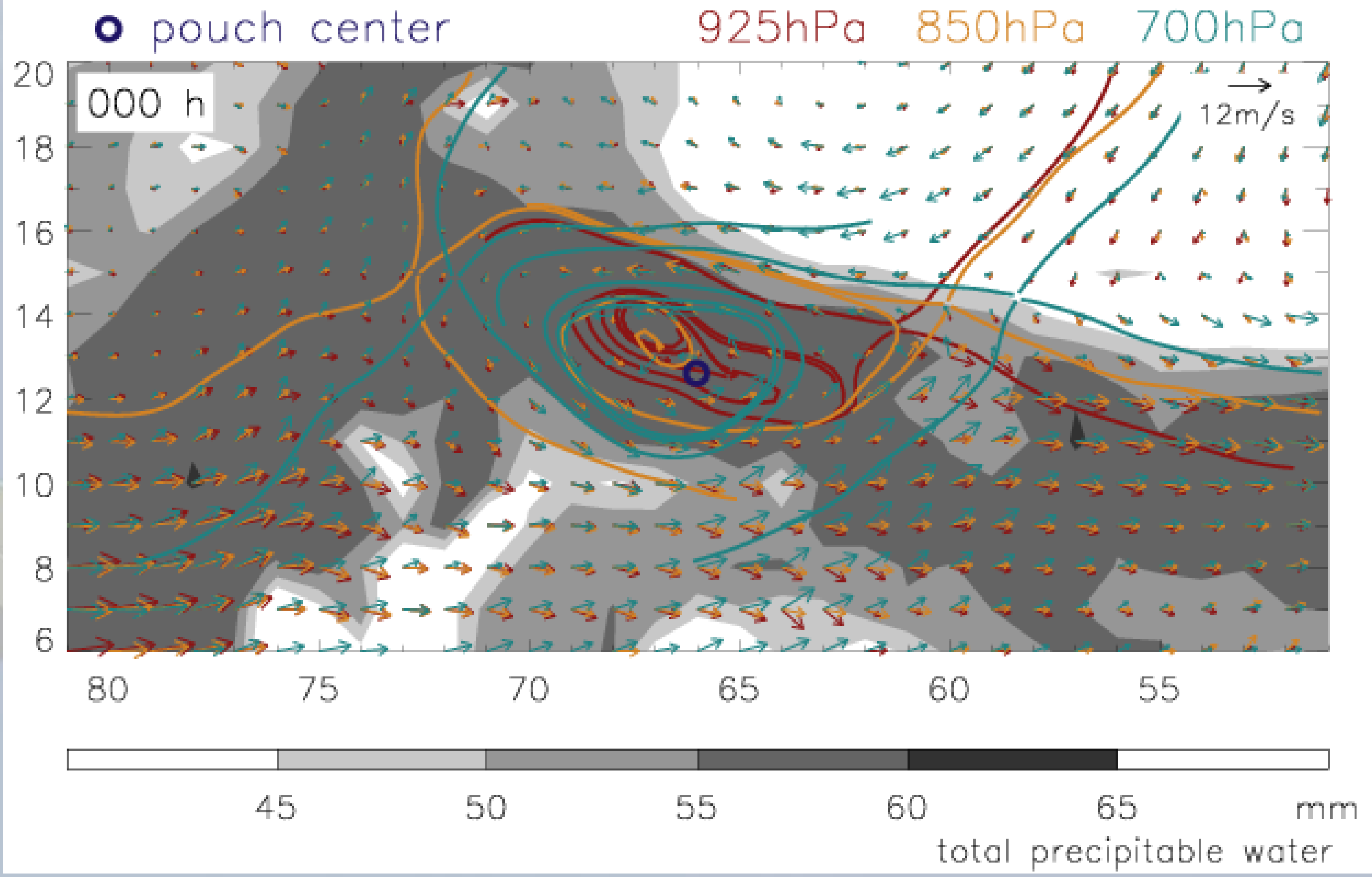




**But just 12 hours into the forecast…**

# Pre-Matthew: 0000 UTC 22 September



# Dividing Streamline analysis valid **0000 UTC 22 Sep**

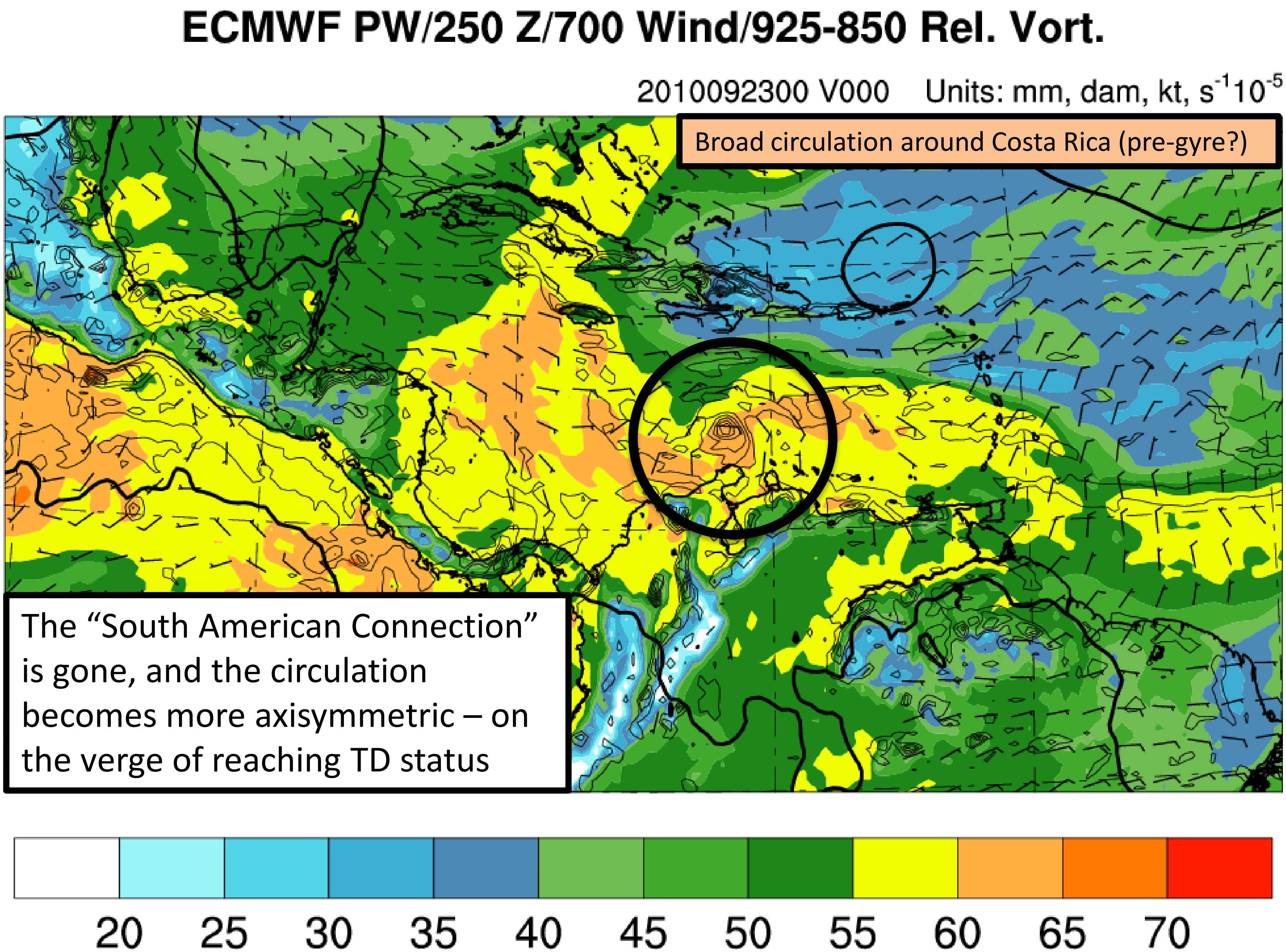



**Streamlines generally tighter, more closed than before**

**Horizontal dry air entrainment possibilities lessened**

**Greatest openings now in southern quadrant**

# Pre-Matthew: 0000 UTC 23 September



# So…

## How common/rare are these South American influences?

## What is the primary cause of these southerly wind events, especially the cross-equator flow?

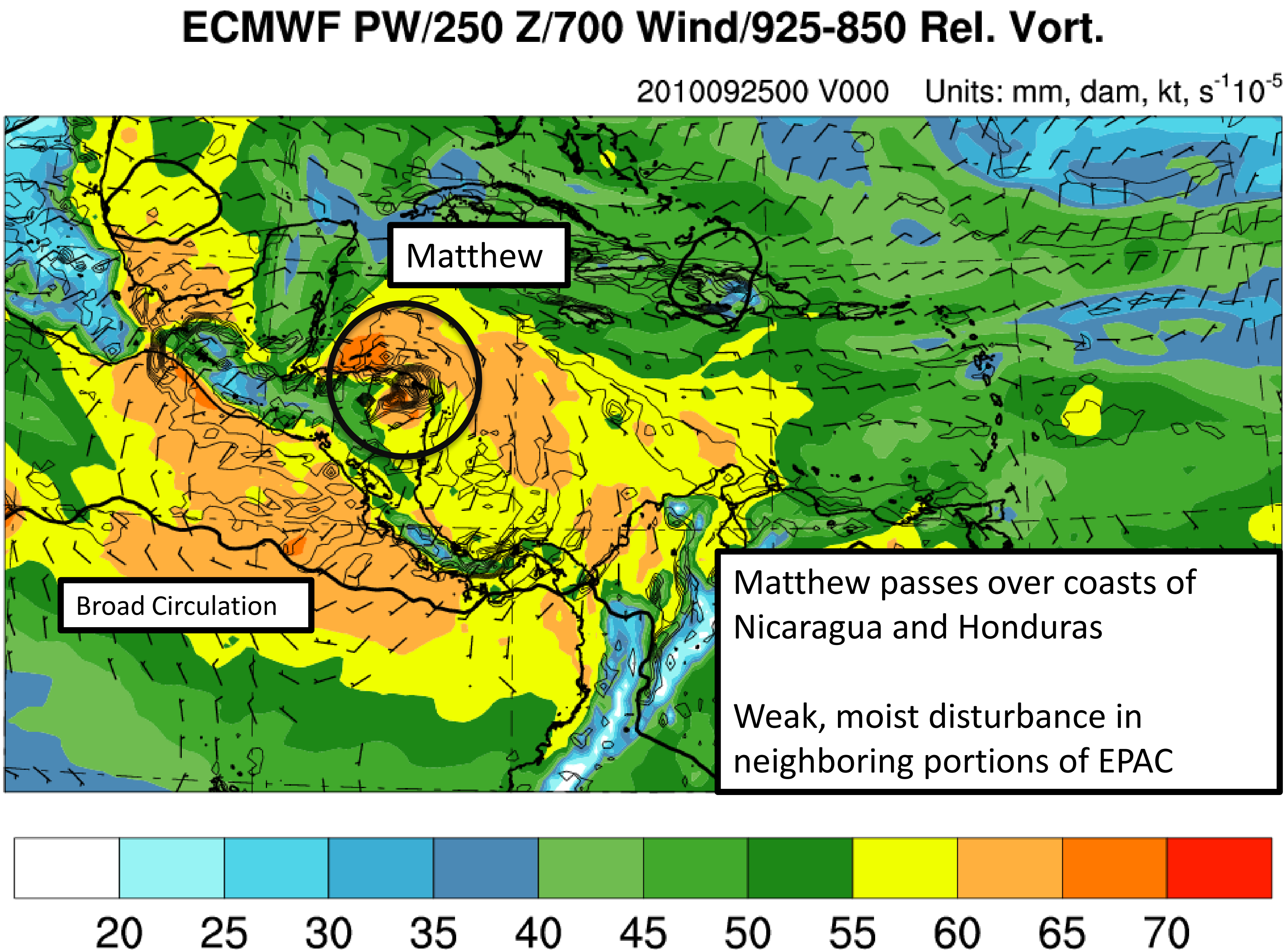
## Do interactions with dry air and terrain over northern South America serve to delay genesis of Matthew?

# Late Season W. Caribbean Gyre

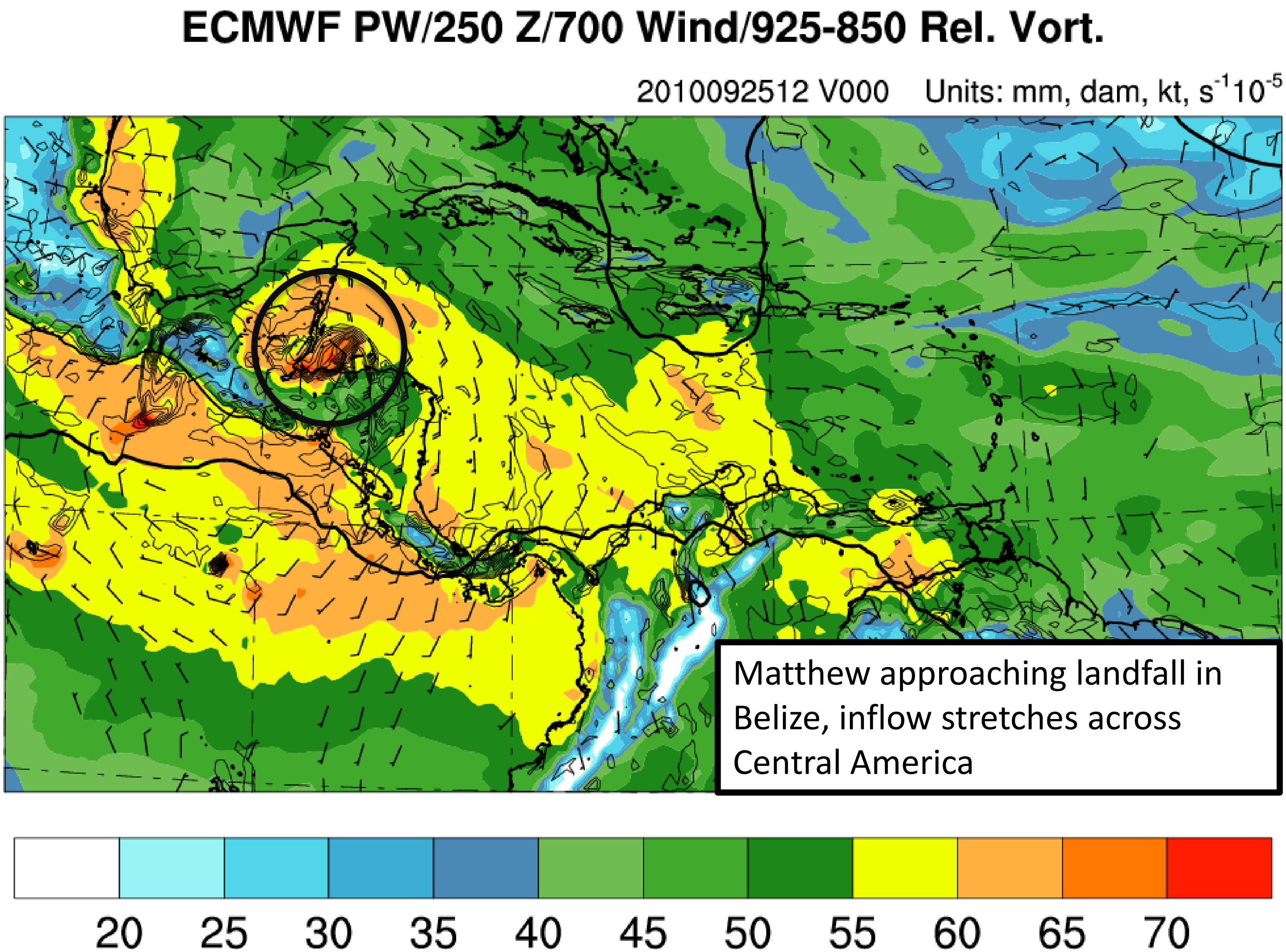
**Matthew, as a precursor to the gyre**

**Nicole, as a result of the gyre**

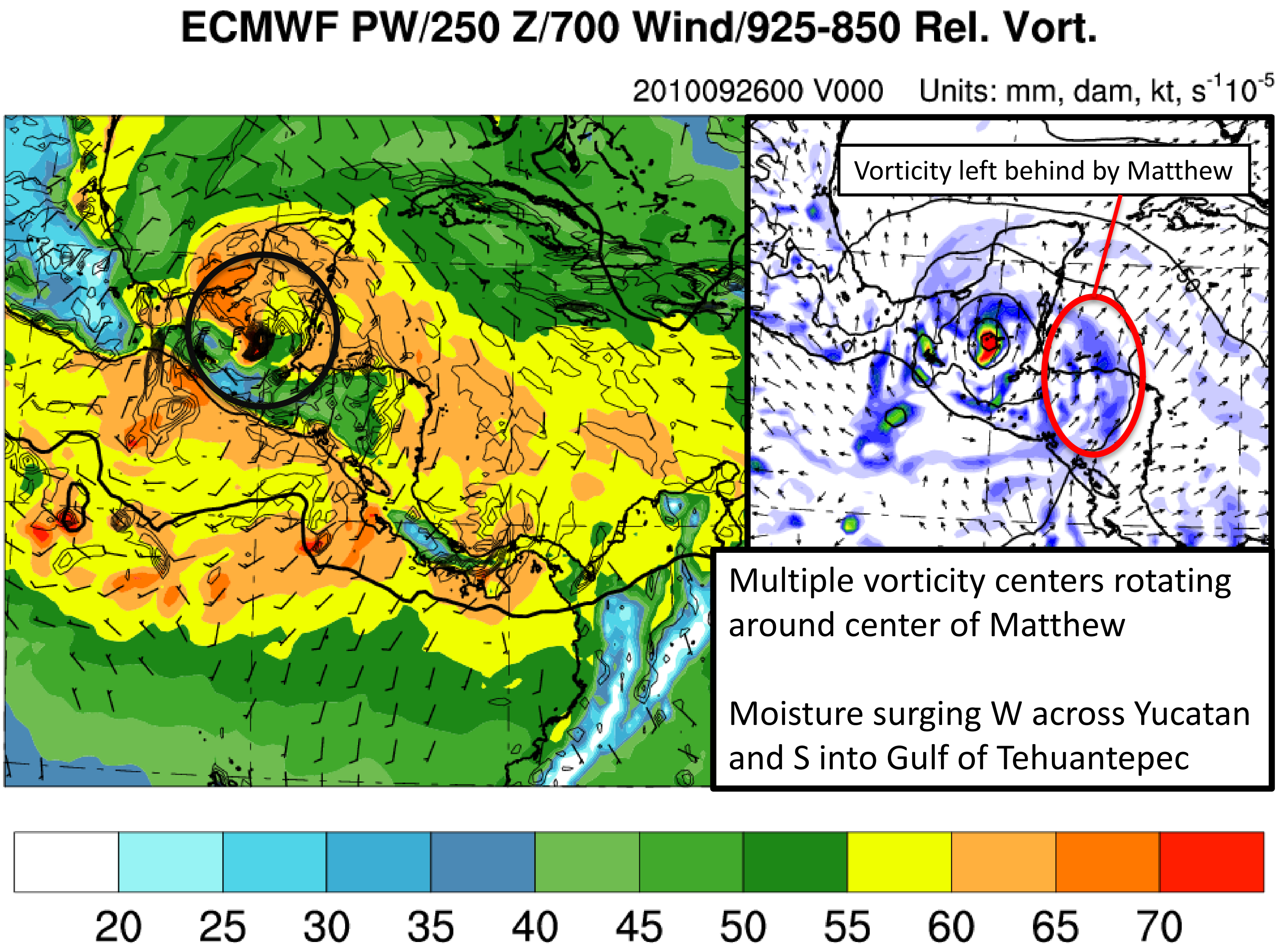
# Matthew/Pre-Gyre: 0000 UTC 25 September



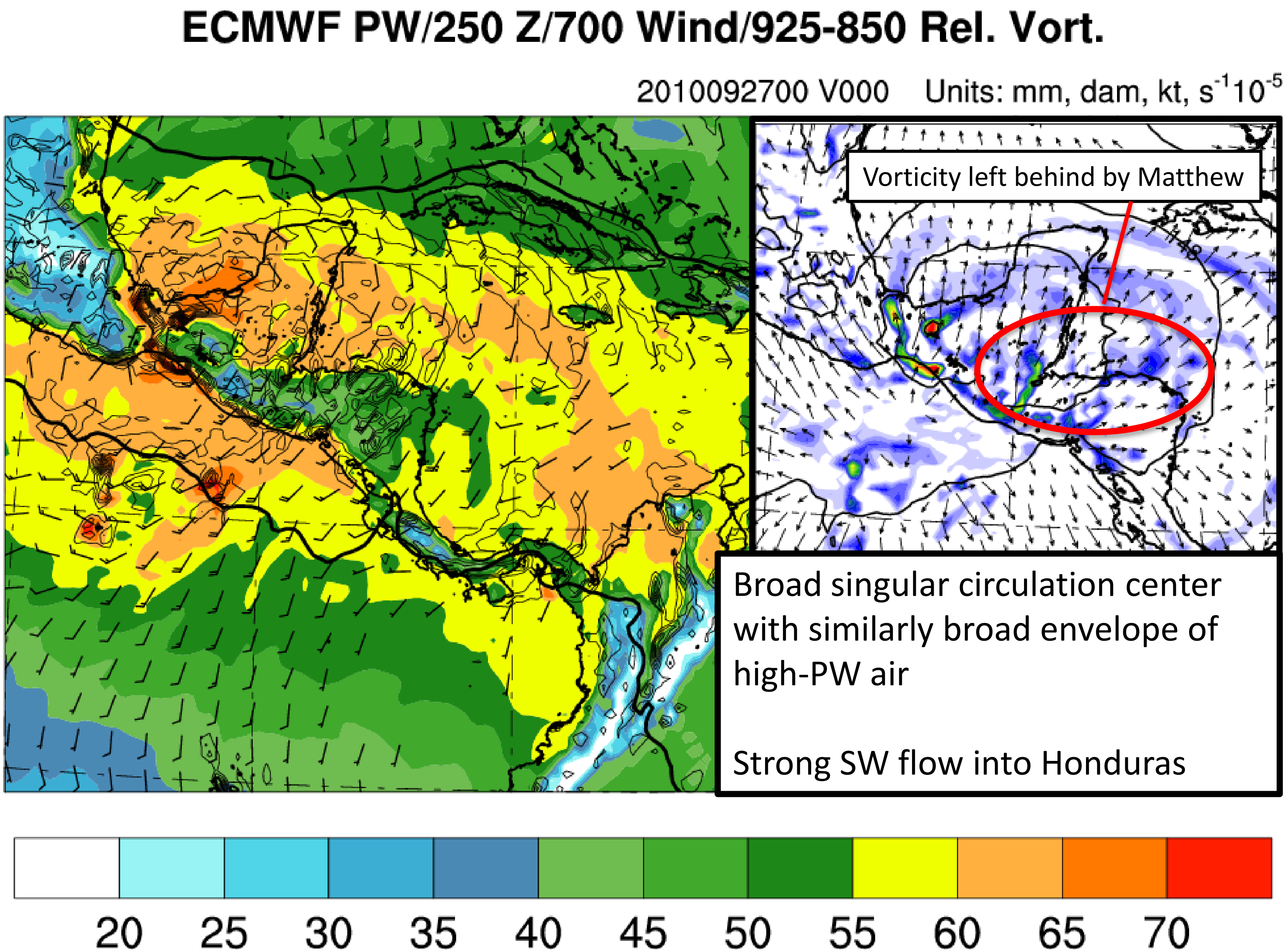
# Matthew/Pre-Gyre: 1200 UTC 25 September



# Matthew/Pre-Gyre: 0000 UTC 26 September



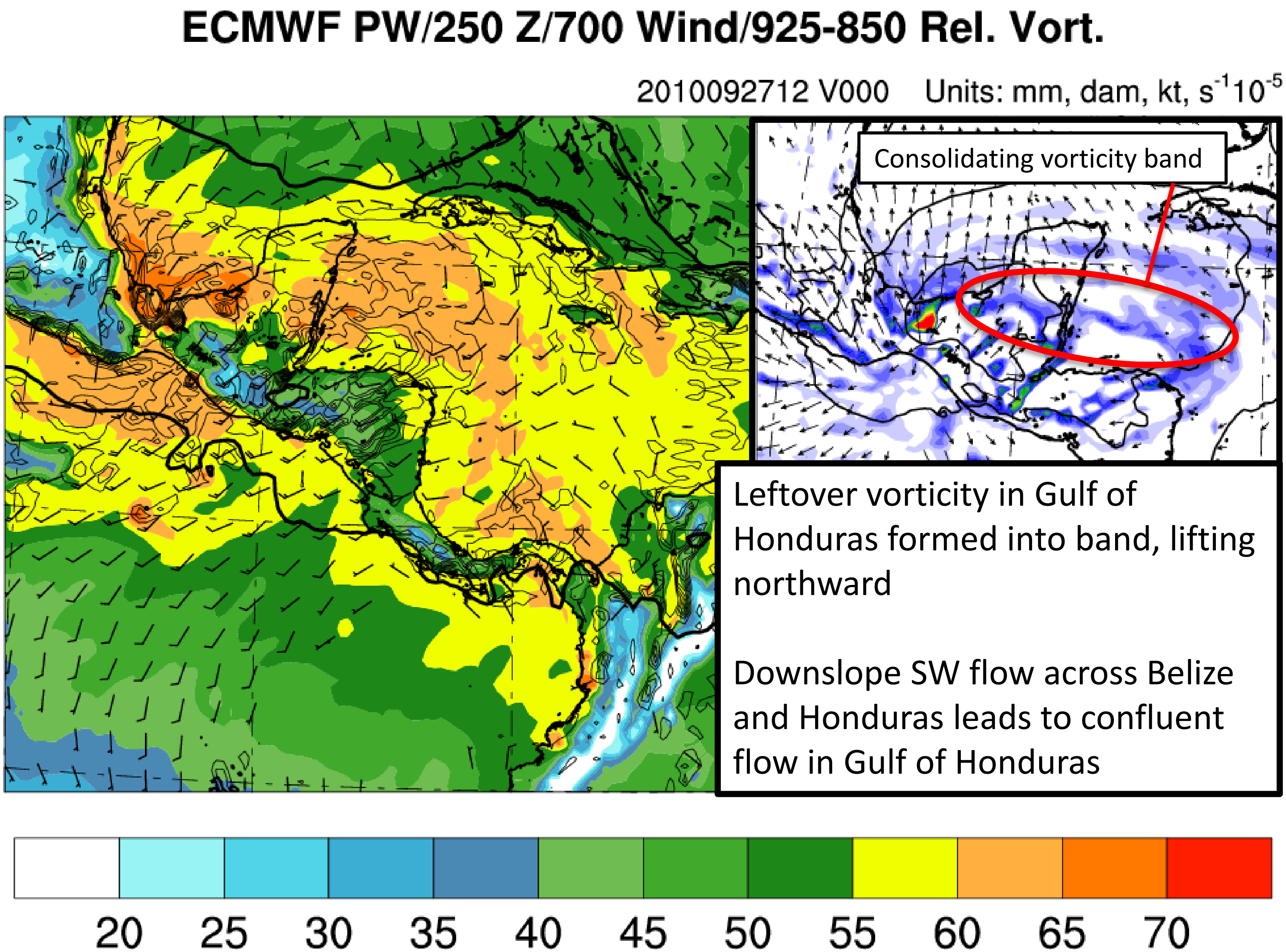
# Gyre: 0000 UTC 27 September




Broad singular circulation center with similarly broad envelope of high-PW air

Strong SW flow into Honduras

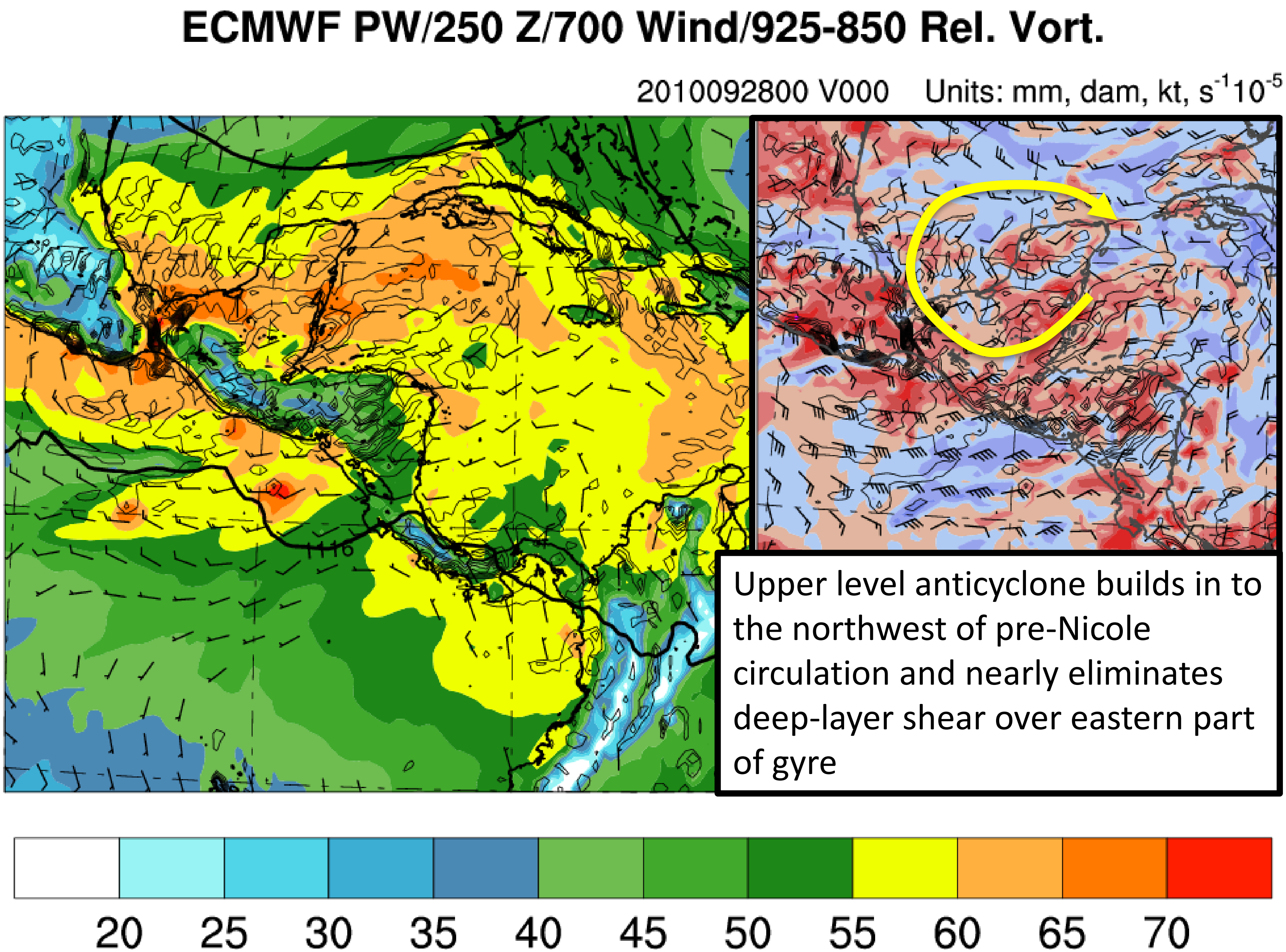
# Gyre: 1200 UTC 27 September




Leftover vorticity in Gulf of Honduras formed into band, lifting northward

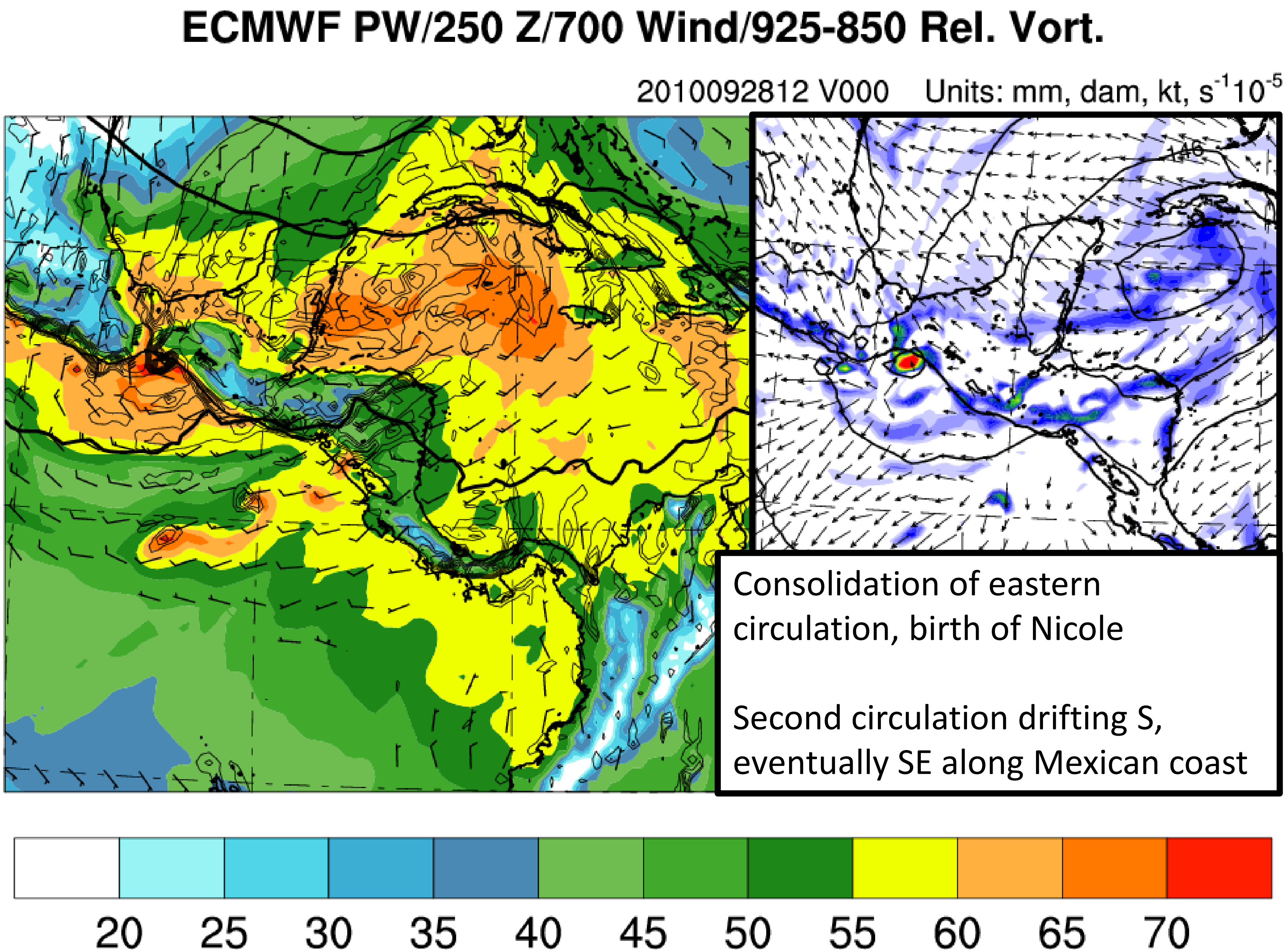
Downslope SW flow across Belize and Honduras leads to confluent flow in Gulf of Honduras

# Gyre/Pre-Nicole: 0000 UTC 28 September




Upper level anticyclone builds in to the northwest of pre-Nicole circulation and nearly eliminates deep-layer shear over eastern part of gyre

# Post-Gyre/Nicole: 1200 UTC 28 September




Consolidation of eastern circulation, birth of Nicole

Second circulation drifting S, eventually SE along Mexican coast

# So… What causes this gyre to form, and why is this (apparently) not as common in the Caribbean compared to the WPAC?

What, if any, are the differences between this gyre and a pouch?

Is it possible that a pouch could "birth" twin vortices and eventually TCs?