The Forecast Funnel

Streamlining the Though Process
and
Objective Weather Forecasting Techniques

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WPC International Desks

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Rules

- Your participation is required
  - Partake of the poll questions to assess your understanding of the material

- Questions??
  - Use the chat box to send a text message(s)
  - Bernie, Jose and Kathy will be monitoring
    - They will answer and/or identify questions of common interest.

Distribution

- The presentation is available on our ftp server at:
  - https://ftp.wpc.ncep.noaa.gov/mike
    - **Title**: COVID19-Forecast Funnel.ppt
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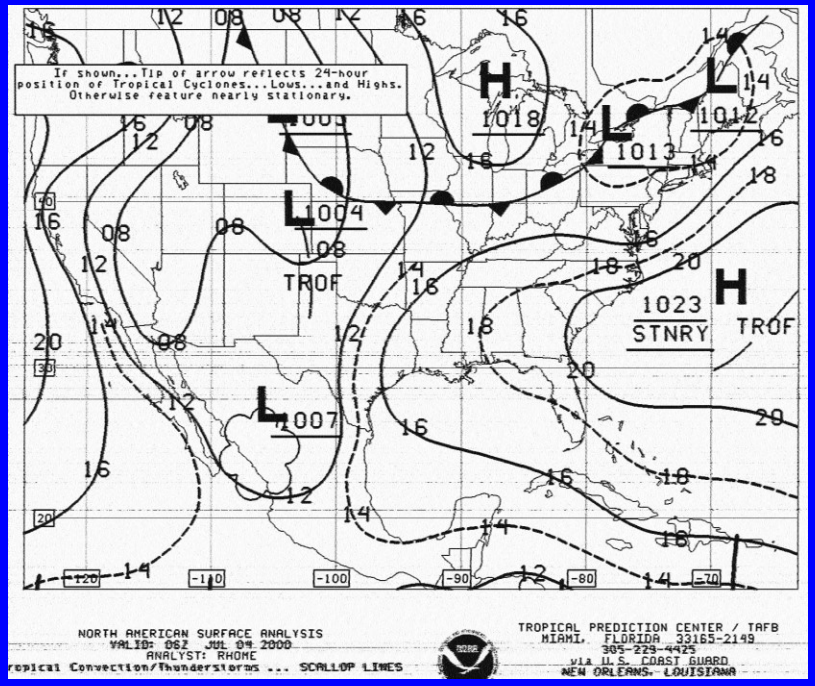
Subjective vs. Objective Weather Forecasting



- Weather Facsimile (WEFAX) Charts?
  - Subjective Analysis
    - That was the norm in the tropics
  - Mid 90's Internet Revolution
    - Analog to Digital

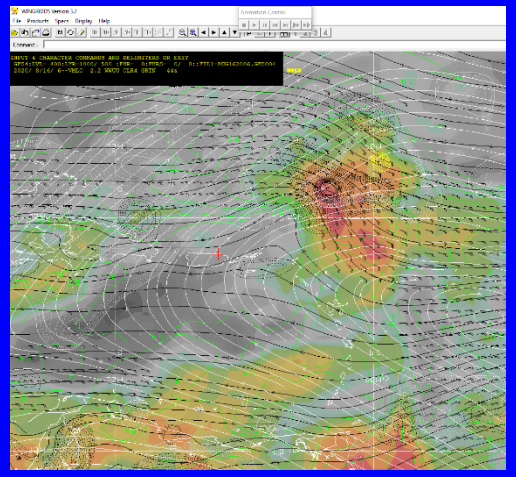
Subjective vs. Objective Weather Forecasting

- Problem with the analog charts was/is that meteorologists would make subjective forecasts
  - Old hands knew how to read the pattern
    - ***The Art of Meteorology***

  - Newer/less experienced forecasters often went for worst case scenario rather than under forecast

Subjective vs. Objective Weather Forecasting

- This changed in the mid/late 90's
  - Model output in Grid Binary (GRIB) format
    - Early 90's the AVN (now the GFS) resolution was 200Km
    - It is now 27Km
  - Telecommunications
    - TTY at baud rate of 75
    - 12-25Mbps
- Software became available for us to process and display the model data
  - Ralph Petersen's PCGridDS
  - Jeff Krobb's WinGridDS



Training

- In the 90's most in RA-III/IV went from 1950-60's technology to an era of exponential growth in data and capabilities.
- U.S. NWS Director, ***Dr. Joe Friday***, recognized the importance of training the users of the new technology – Train the Trainer
- The NWS International Desks
  - South America Desk 1989
  - Tropical Desk 1992
  - Training strategy
    - In-residence training
    - On-site training through NWP workshops
    - Online training, the WMO's VISIT Program

What's the Challenge? Streamlining Though Process

- Station manager needs to make sure all follow the same procedure to make a weather forecast.
  - An "equalizer" is required
- **The Forecast Funnel**, although somewhat simplistic, helps meteorologists streamline the thought process, and gives due consideration to the atmospheric dynamics.
- Ideally, every forecaster, independent of their level of experience, should reach similar conclusions.
  - Follows the steps of a ***"decision tree"***

How the forecast funnel works?

Mix a pinch of observations

Add one cup of satellite images

16 ounces of Numerical Models

Forecast

If forecasting the weather were this easy….

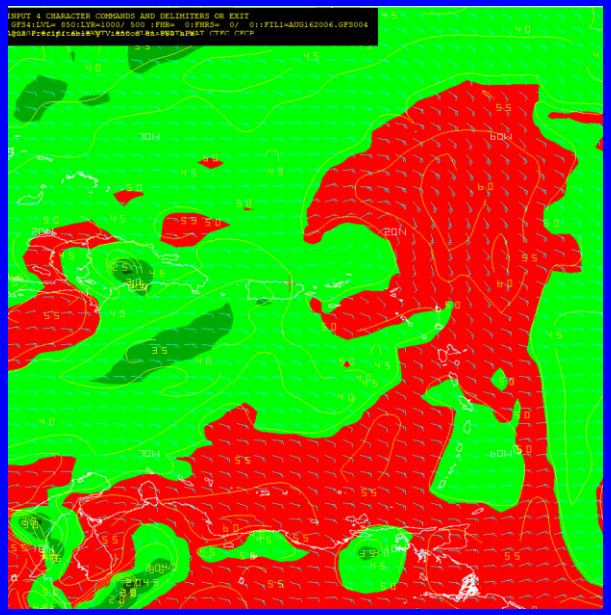
Forecast Funnel Approach
Evaluation of Atmospheric Dynamics

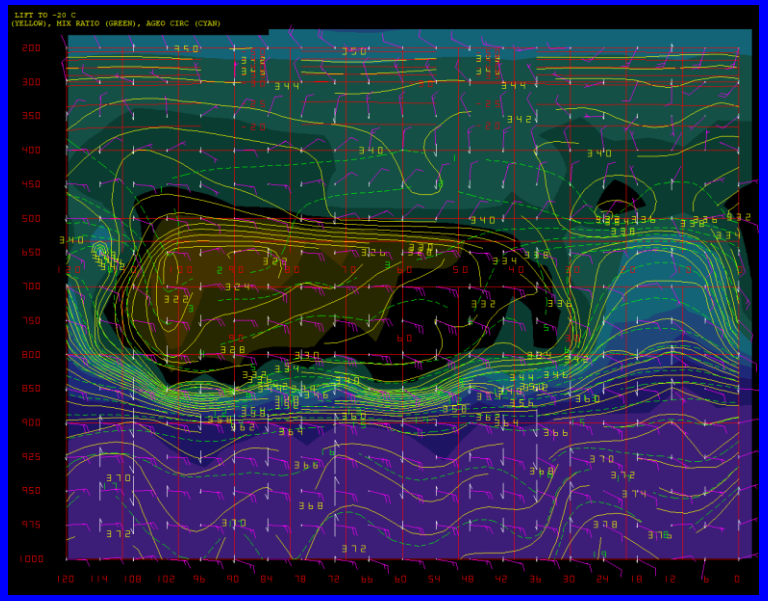
- Divergence or Convergence Aloft?
- Column, stable or unstable?
  - Traditional Indices
    - LI, KI, SSI, TTI
  - Thermodynamic Indices
    - CAPE/CINS
    - GDI
- Trigger?

- Divergence or Convergence at Low Levels?
- **MOISTURE Content!!!!!**
  - Mix. Ratio
  - Td
  - PW
  - RH?
    - Does not quantify moisture content, only saturation.

Forecast Funnel Approach

- Allows the user to properly take a four-dimensional look at the atmospheric dynamics
  - Vertical/horizontal dynamics and time
    - X, Y, Z axis

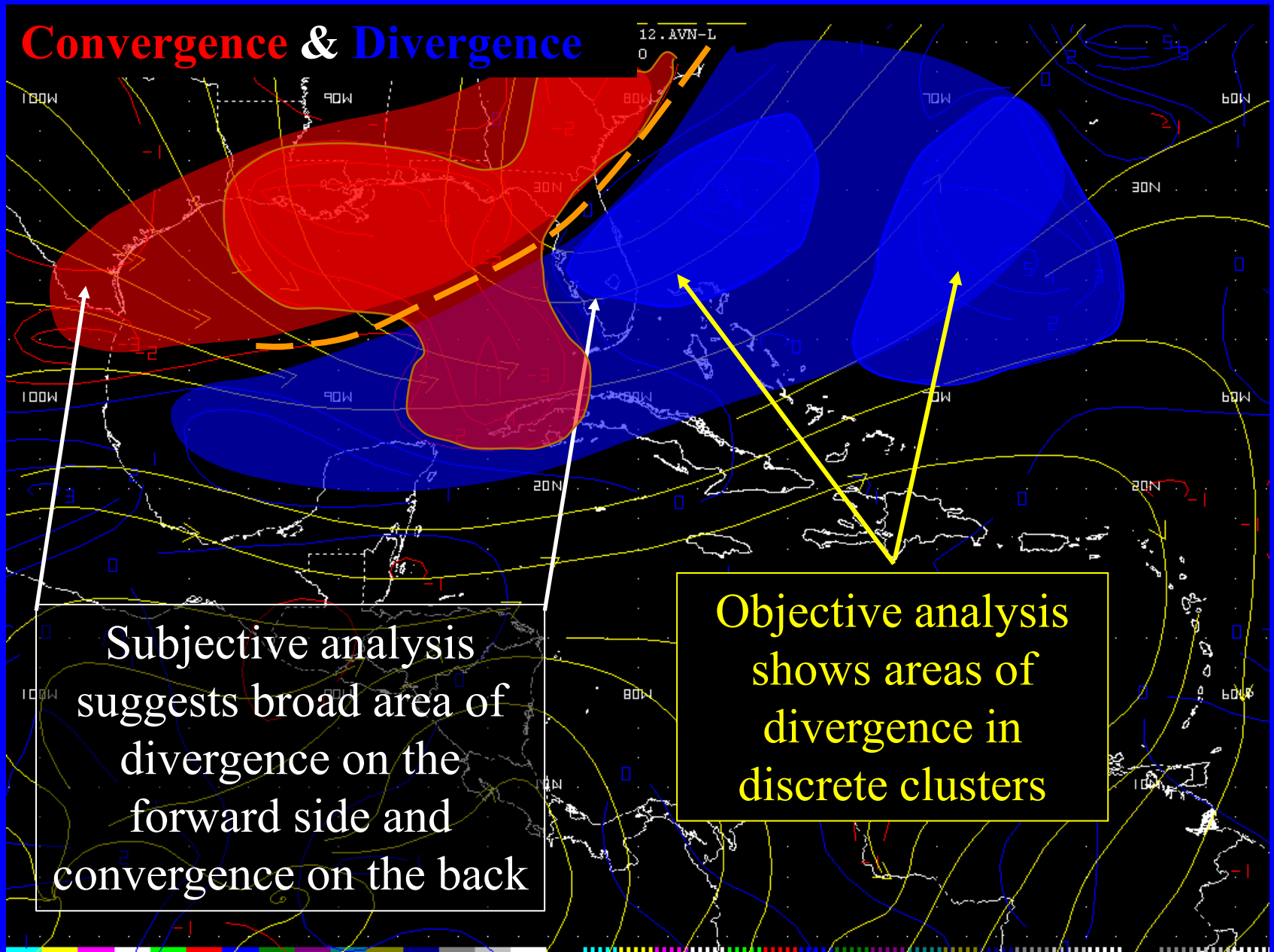




Divergence Aloft

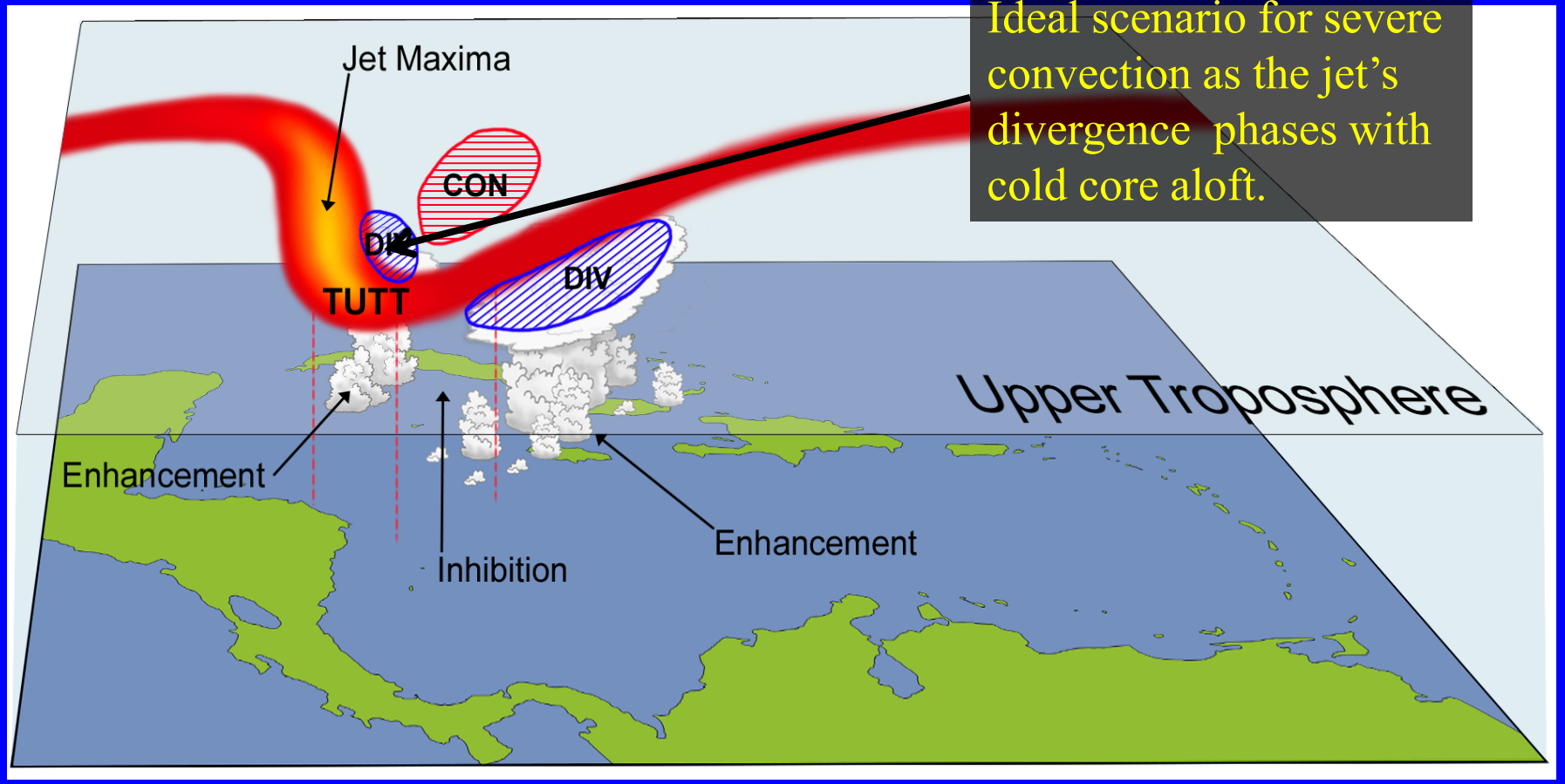
- Forecaster needs to consider sources of ventilation aloft.
  - Determine if the conditions are favorable for deep vs. shallow convection.
  - Sources aloft: Troughs, ridges, jet maxima
- Also don't forget to consider the negative influence of convergence aloft!!!

Analysis of Upper Divergence



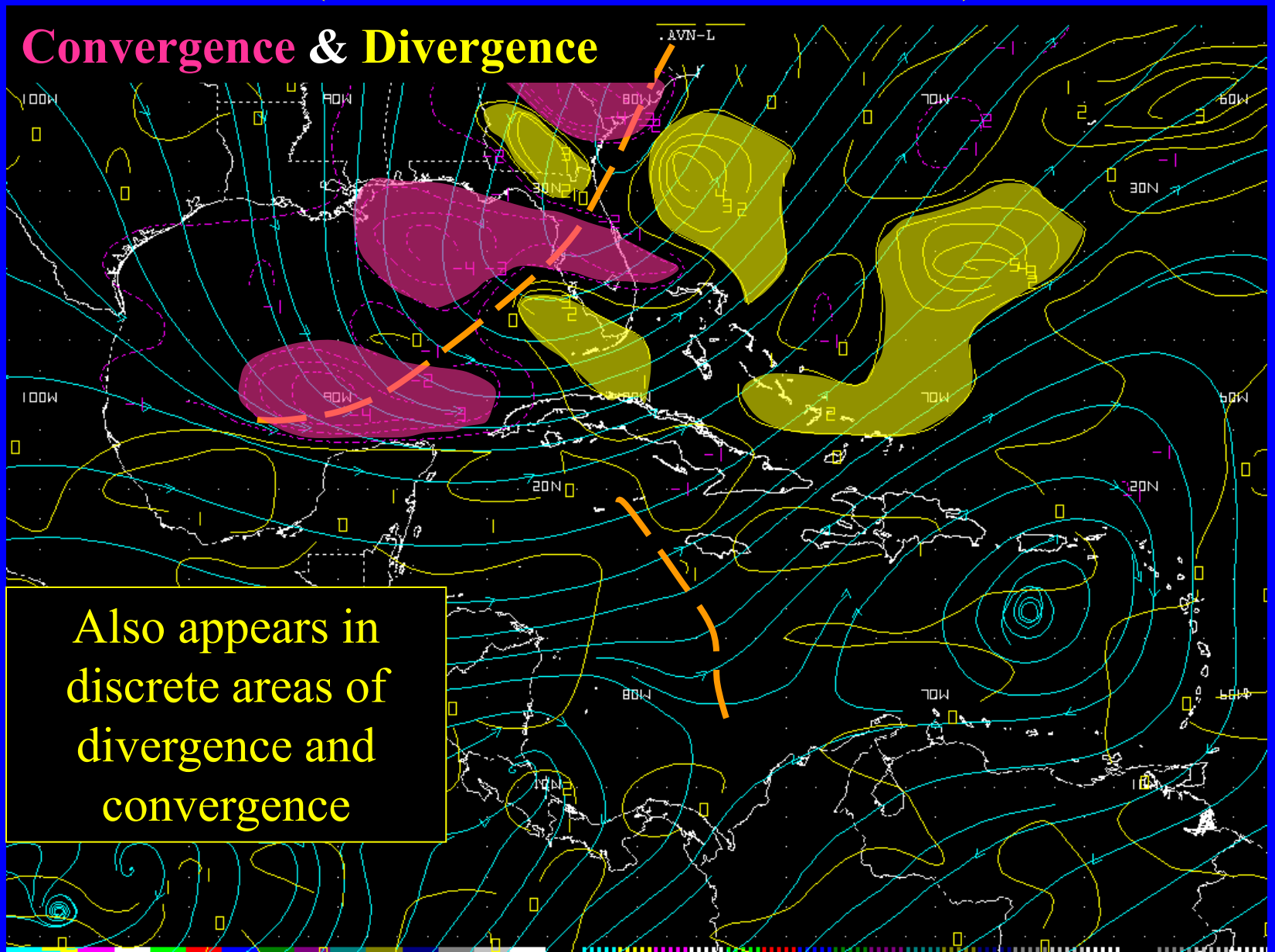
Jet Dynamics
Jet Rounding a TUTT

-Best upper divergence to the southeast of TUTT.
-Some upper divergence on upper jet's left exit.
-Upper convergence along TUTT's axis.



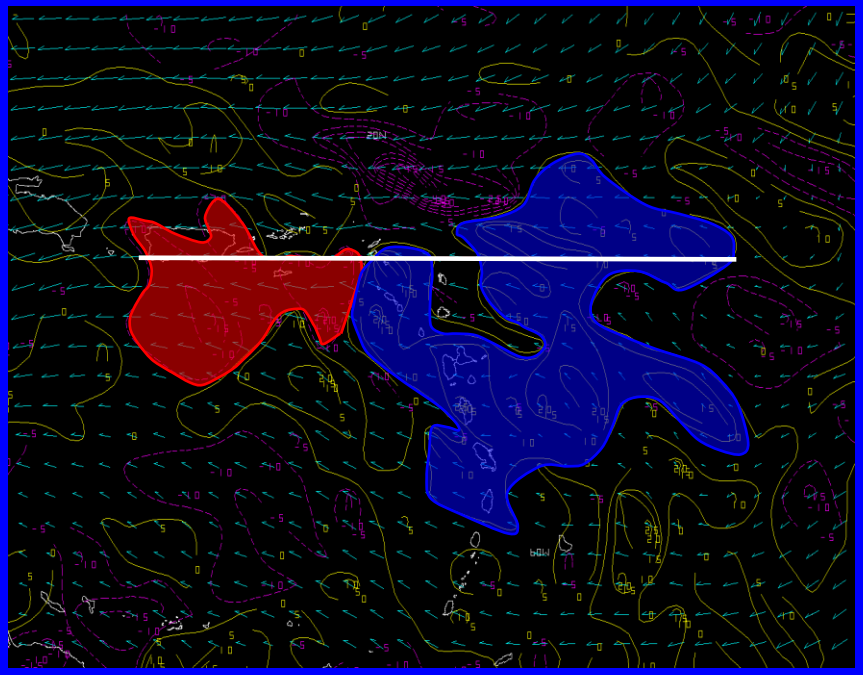
Layer Divergence and Mean Flow

(500-250 hPa, Macro LD52.)

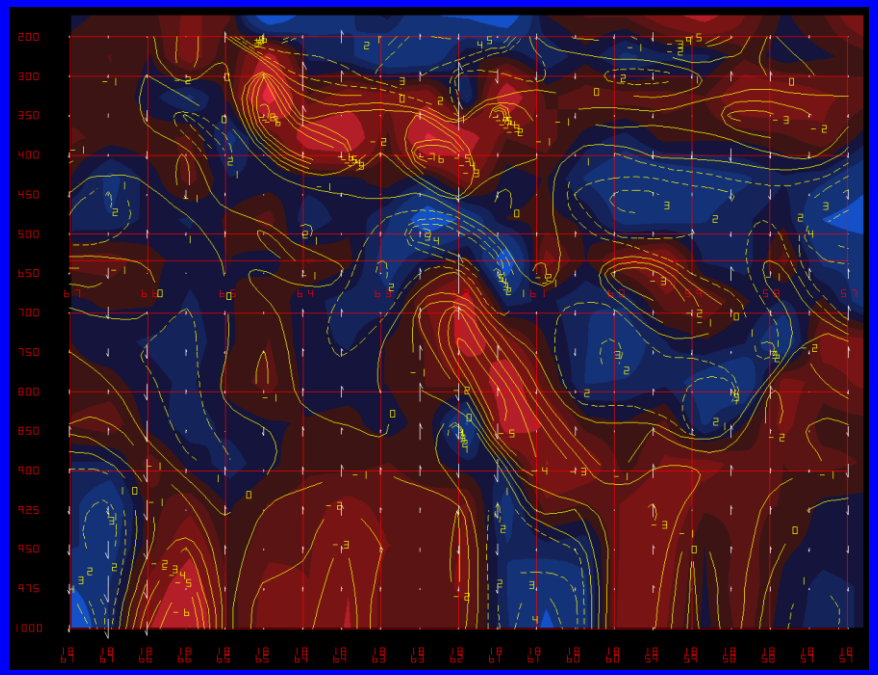


Why use Mean Upper Layer Divergence?

- Atmosphere is a tridimensional fluid.
  - Looking at a single height can/could be misleading
  - Layer divergence gives perspective of what's happening in a column.



Layer divergence 500-250hPa
Divergence & **Convergence**

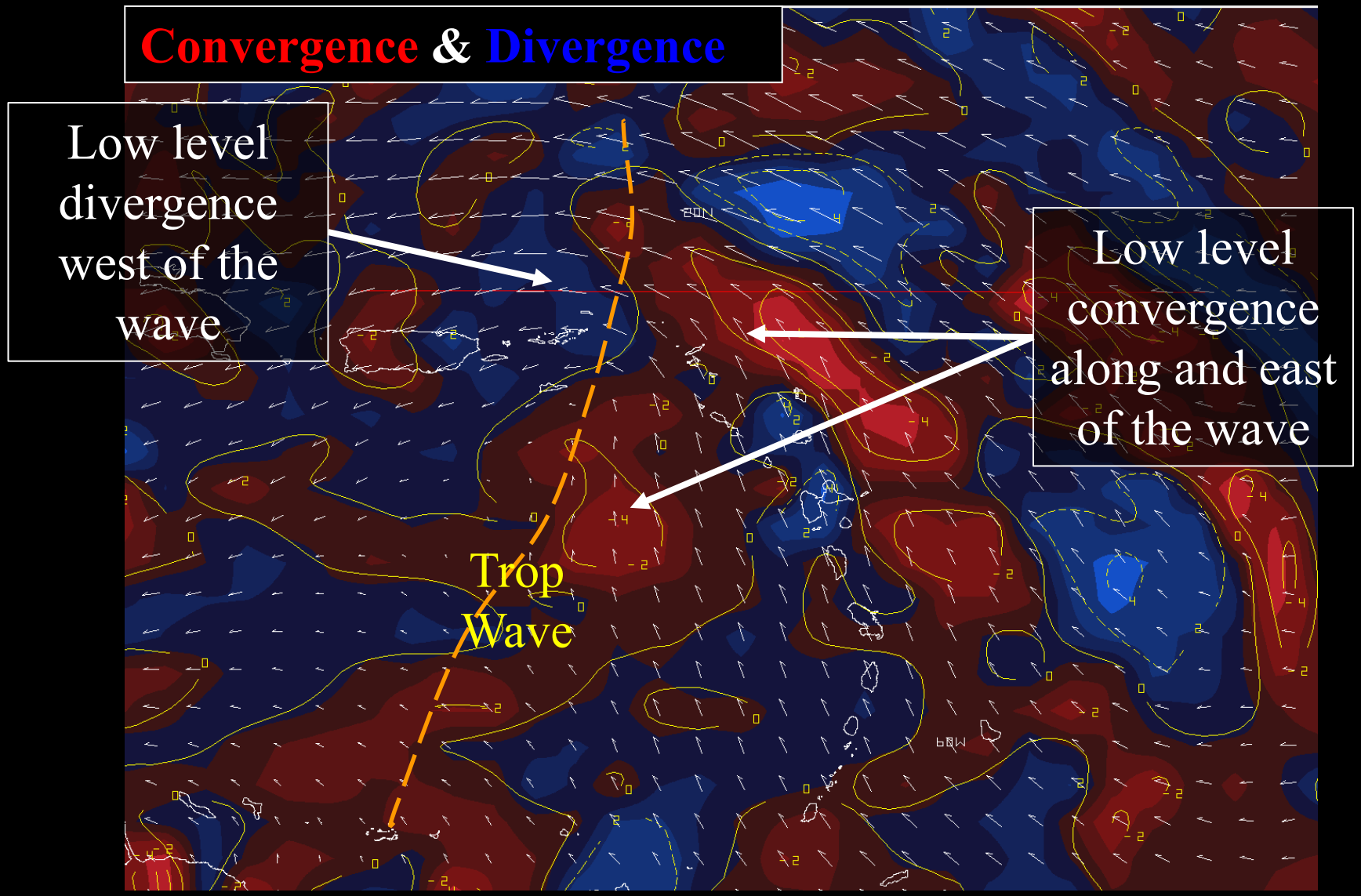


Cross Section of Divergence
Diverg., Converg & VVEL

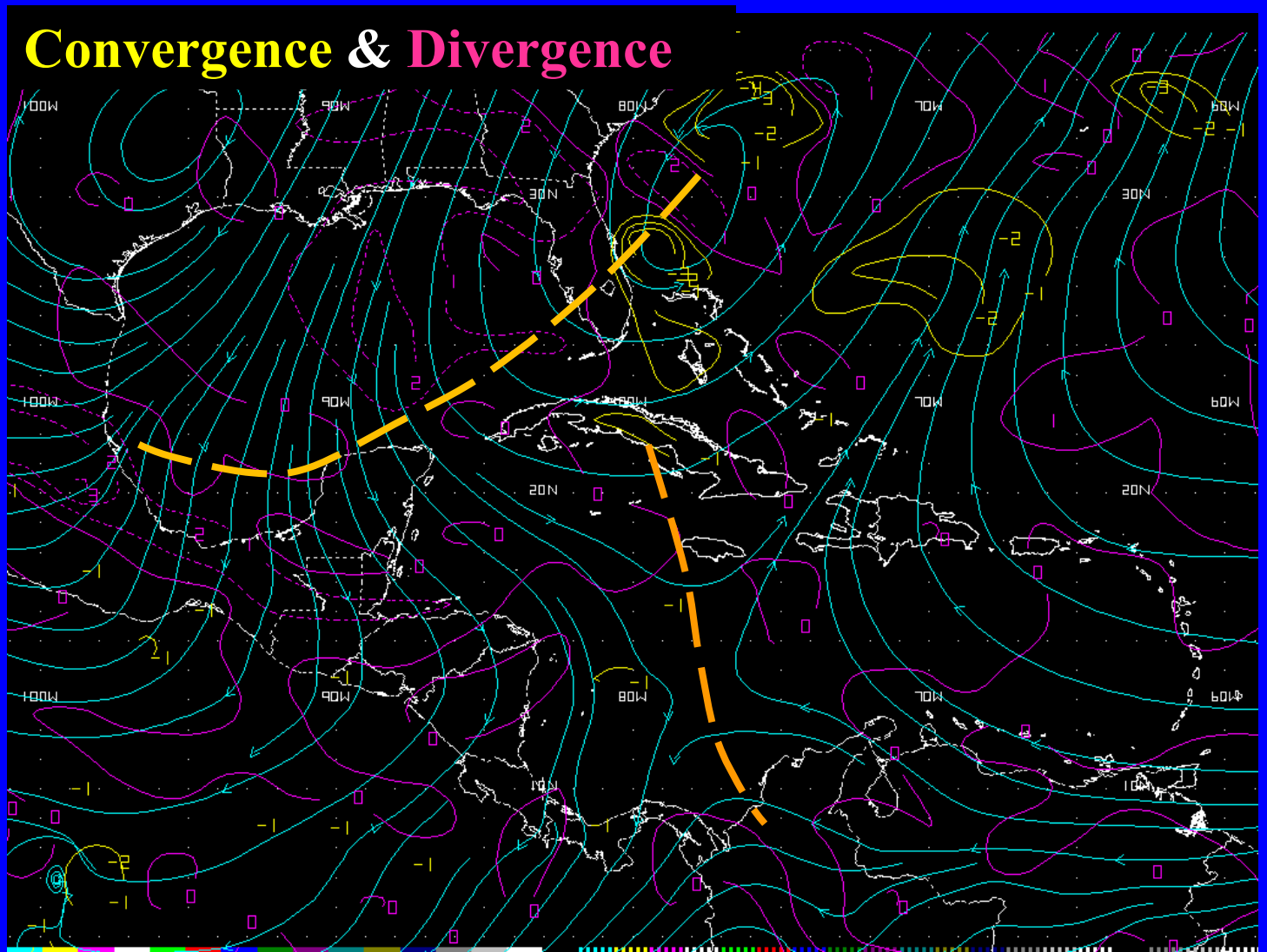
Low Level Convergence

- Low level convergence is desired to get parcels of air rising above the LCL/CCL.
  - Low level perturbations, such as tropical waves, are good sources of low level convergence.
  - Also consider fronts and prefrontal shear lines.

850 hPa Winds and Divergence



SFC-500 Mean Flow and Layer Divergence



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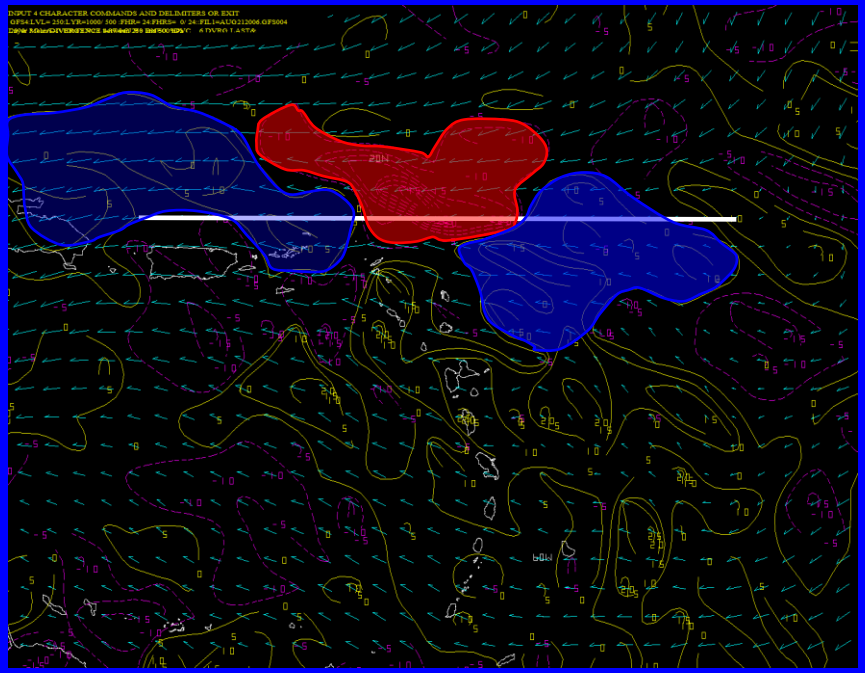

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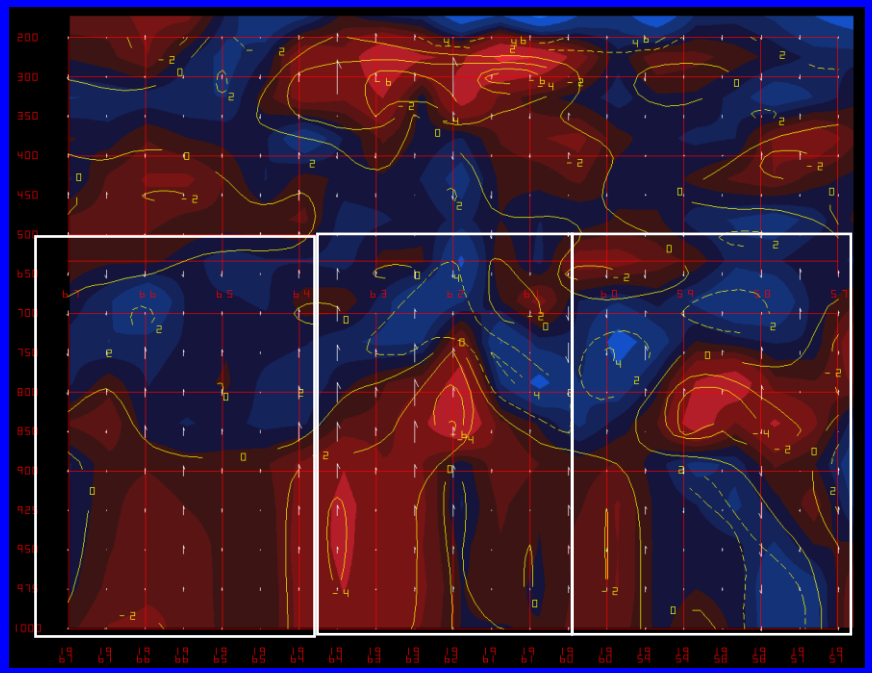
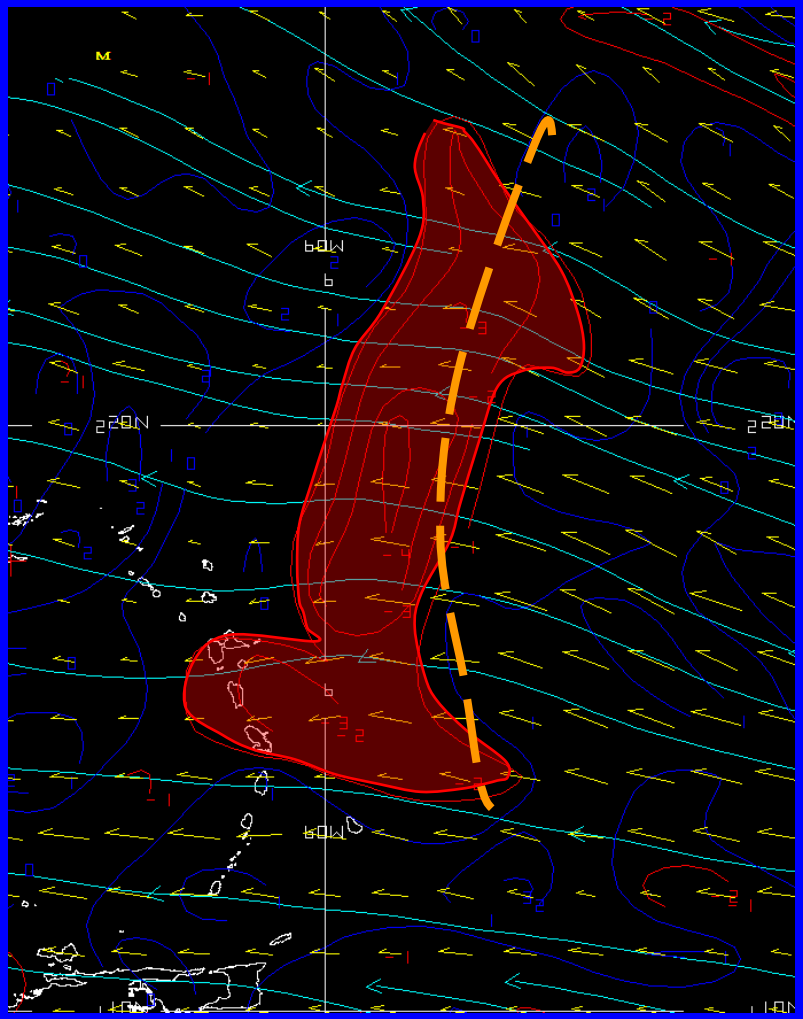
Divergence & **Convergence**



Cross Section of Divergence
Diverg., Converg & VVEL

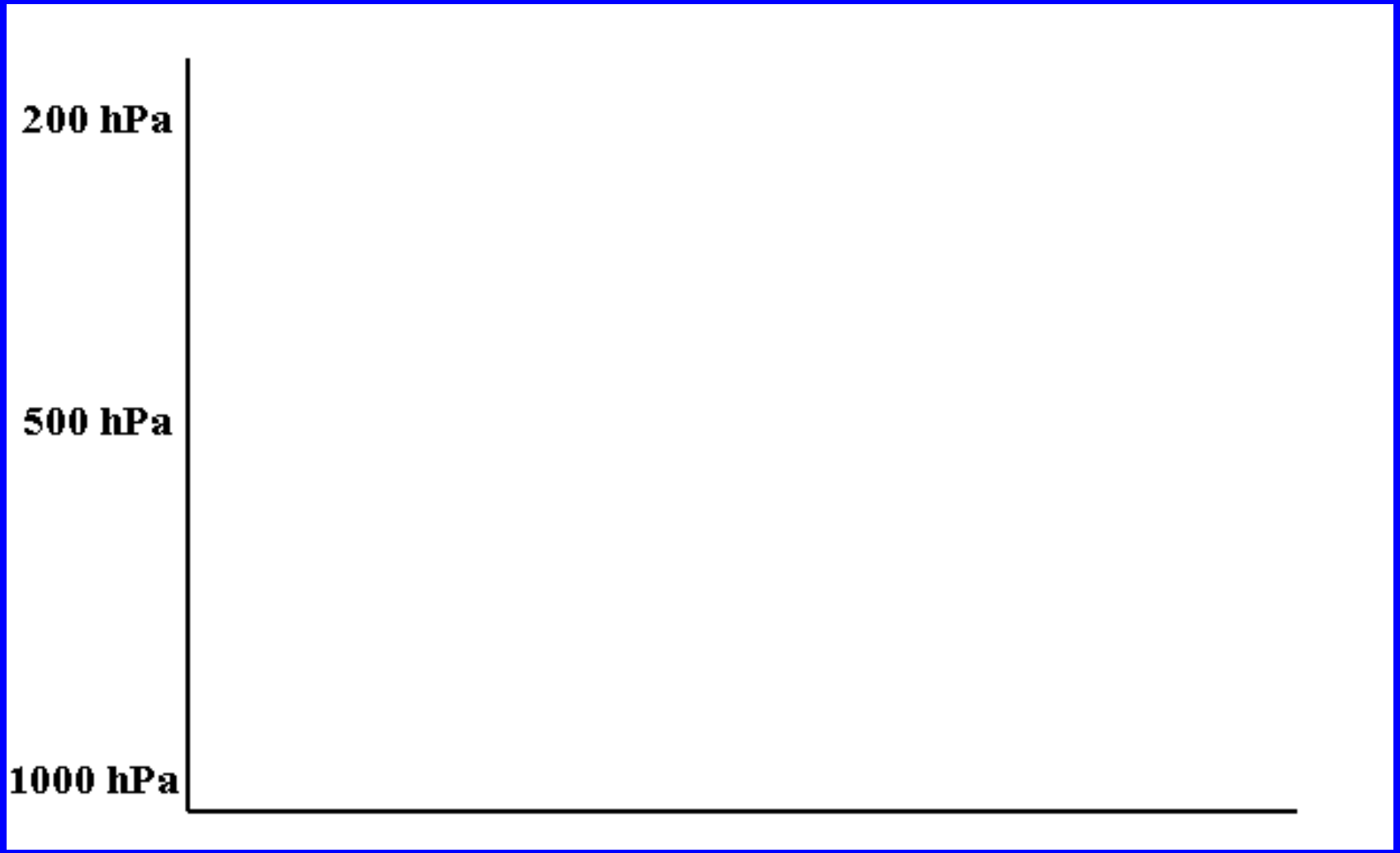
850 hPa Moist Flux Divergence (Convergence Red)



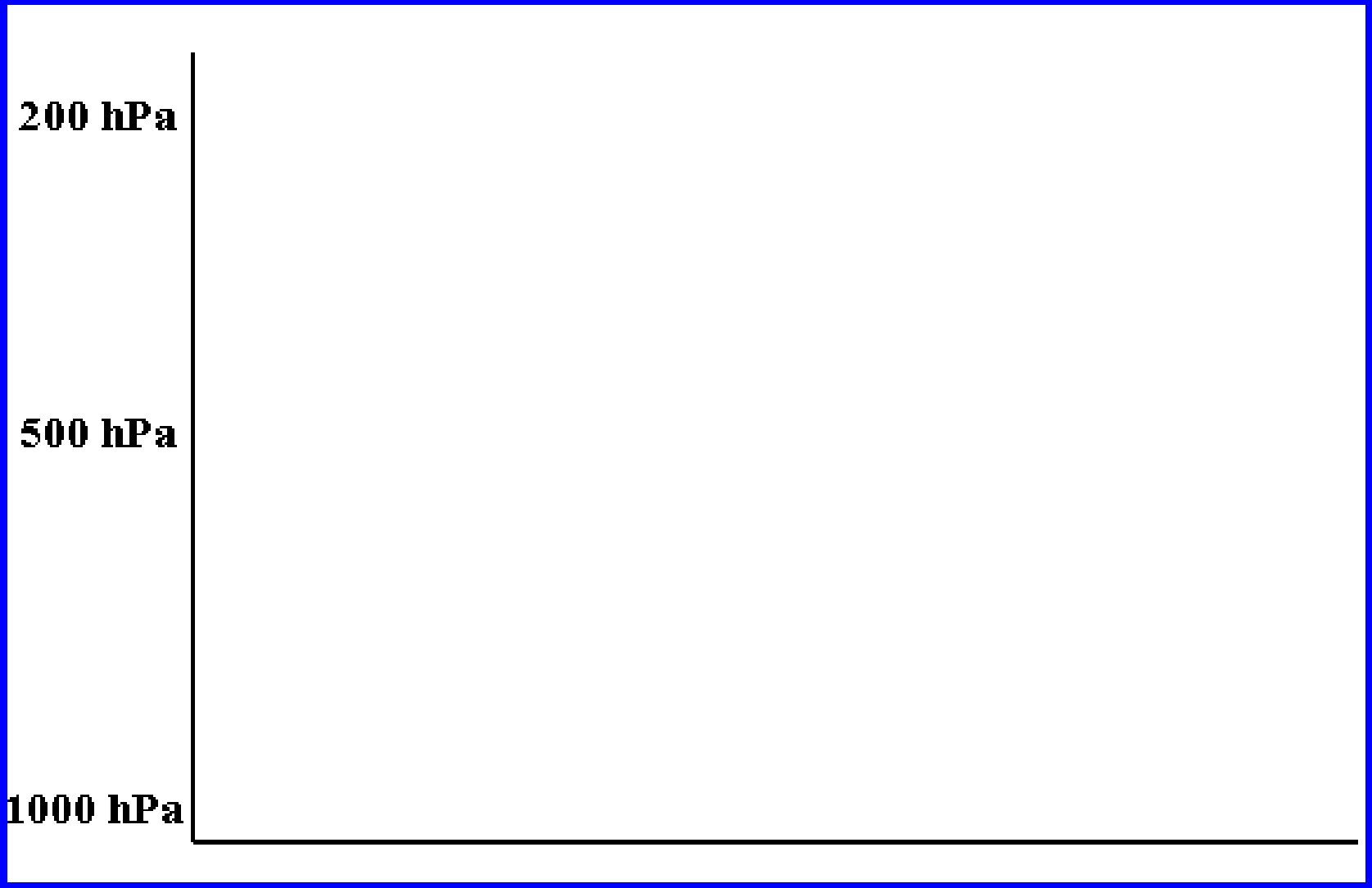
- The length of the flux vectors are proportional to the intensity of the transport
- Moist flux convergence can have a destabilizing effect in the atmosphere
  - Mass convergence between surfaces leads to an increase in static instability

Convergence/Divergence Impact on Deep and Shallow Convection

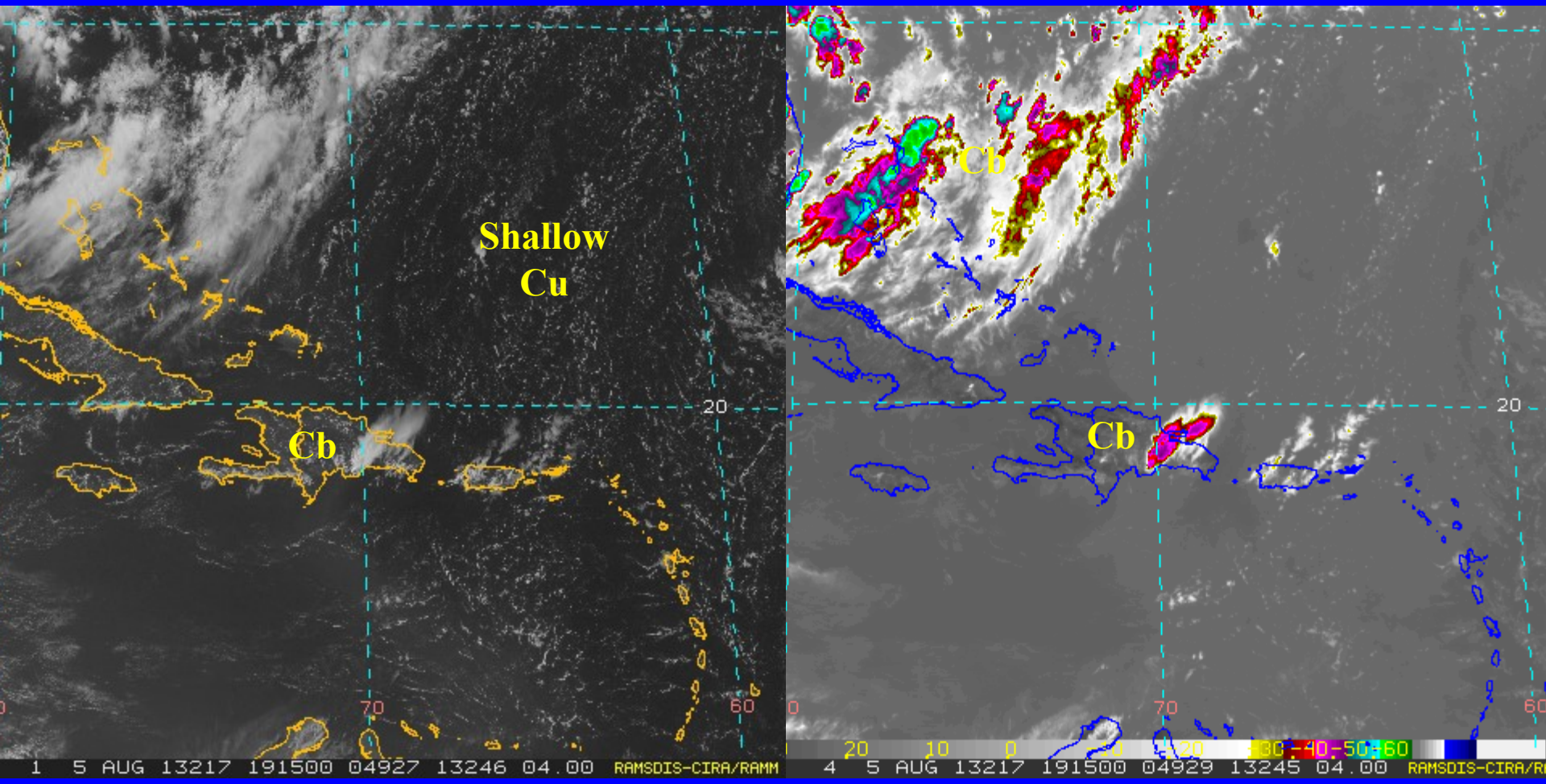
Deep Layer Upward Motion



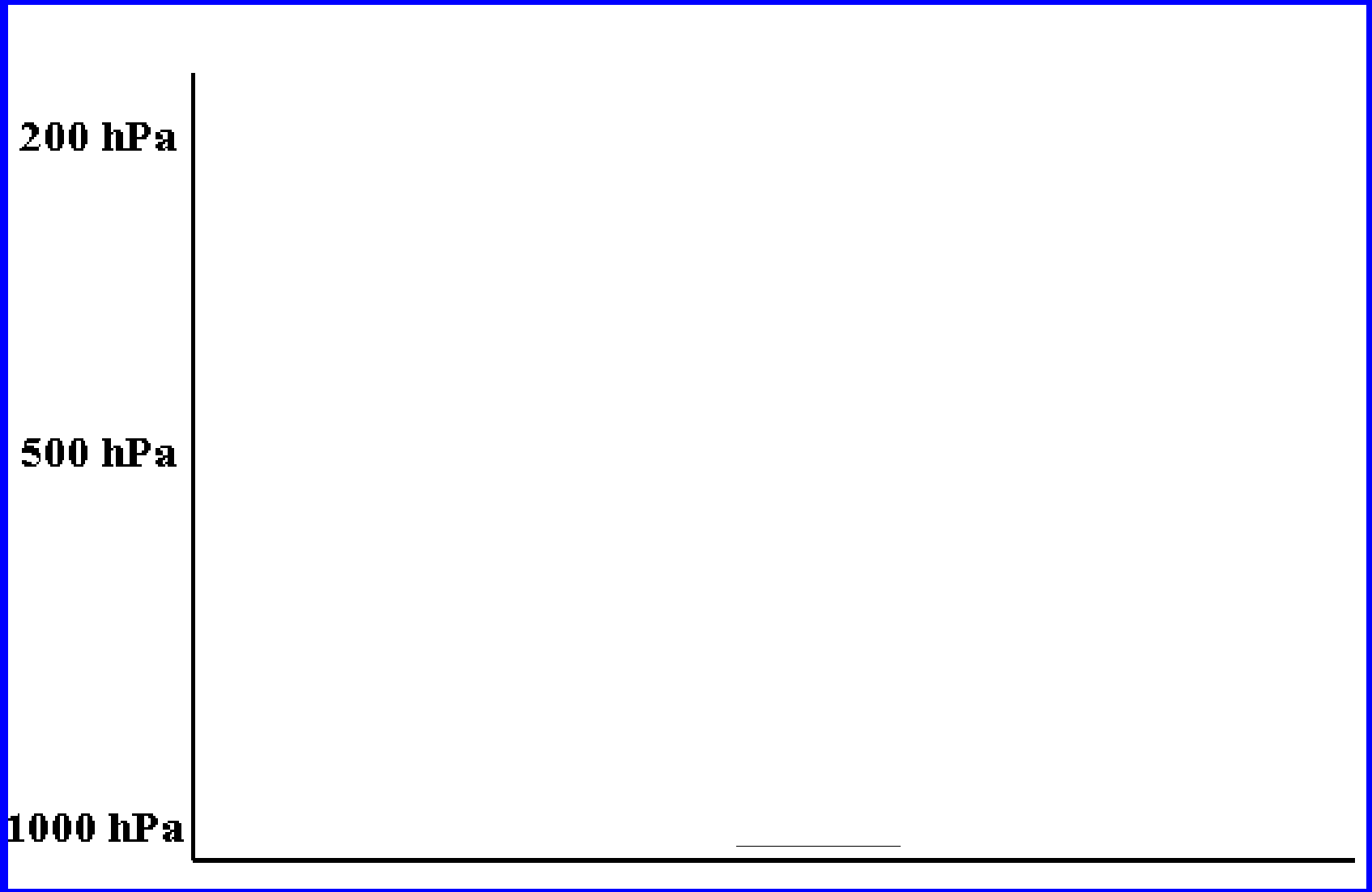
Deep Layer Downward Motion



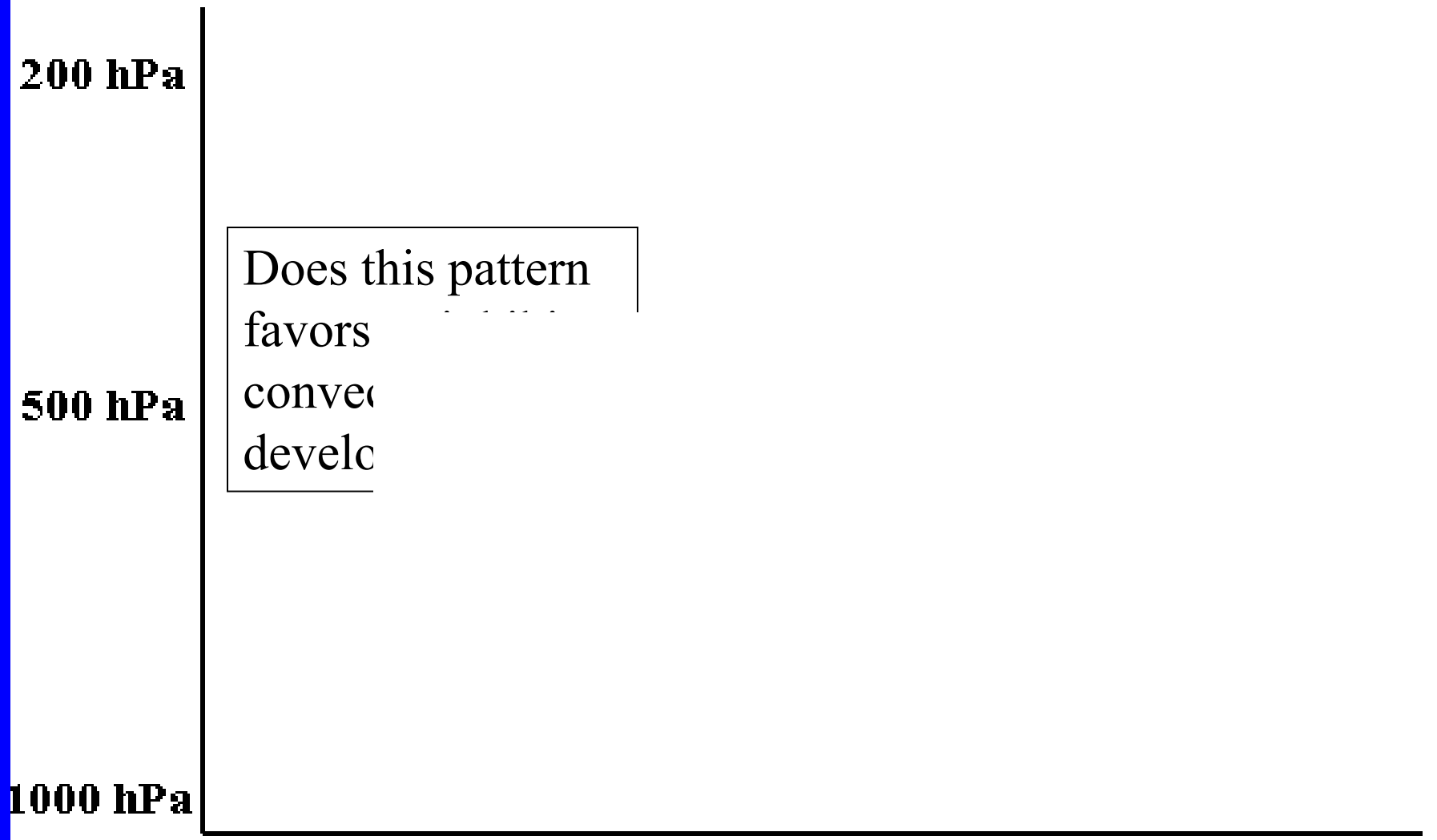
Vis/IR Image


Shallow
Cu
Cb
Cb
Cb
20
70
60
1 5 AUG 13217 191500 04927 13246 04.00 RAMSDIS-CIRA/RAMM
4 5 AUG 13217 191500 04929 13245 04.00

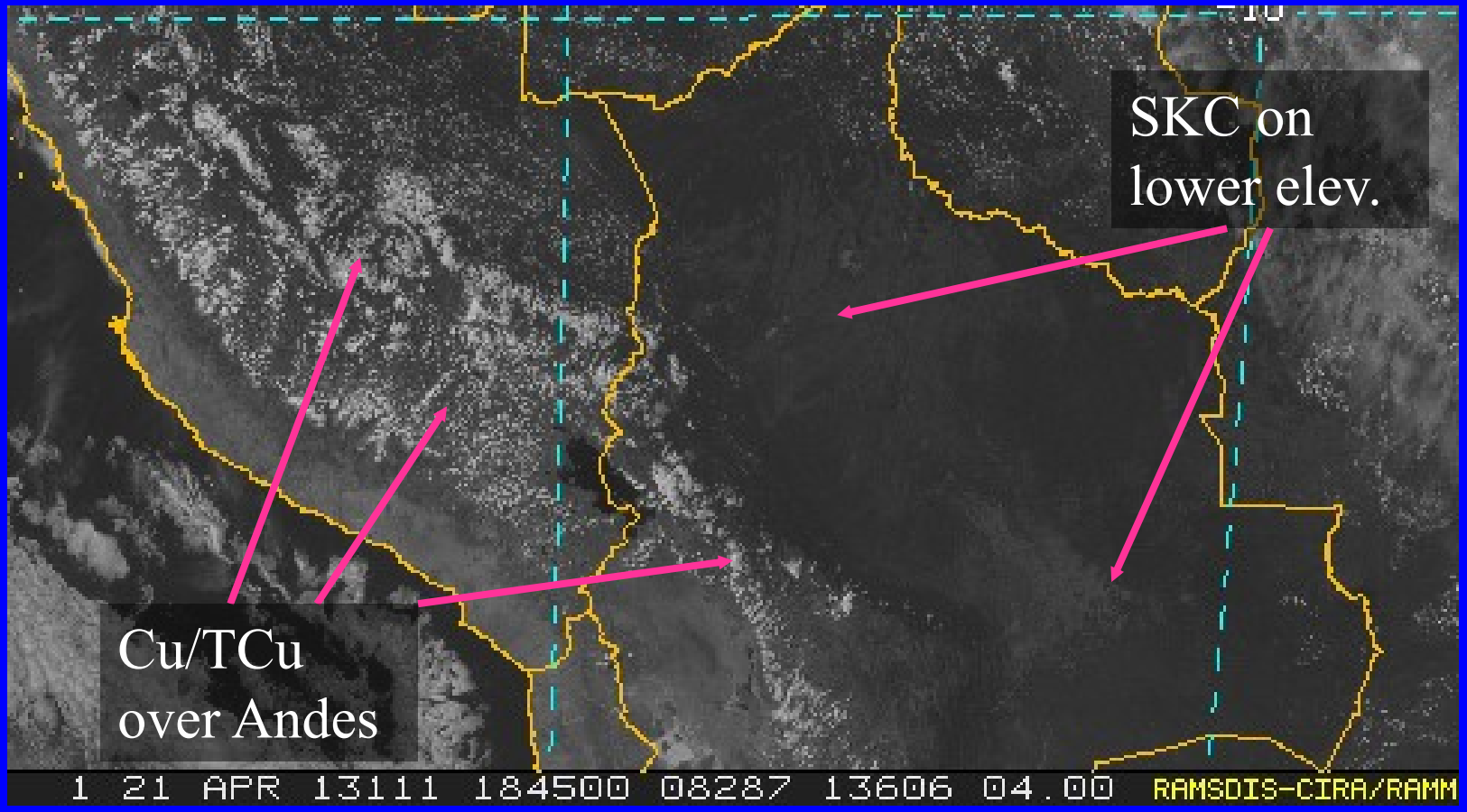
Shallow Vertical Development



Mid Level Subsidence



Vis Image – Cu over Mountains and Clear on the Valleys

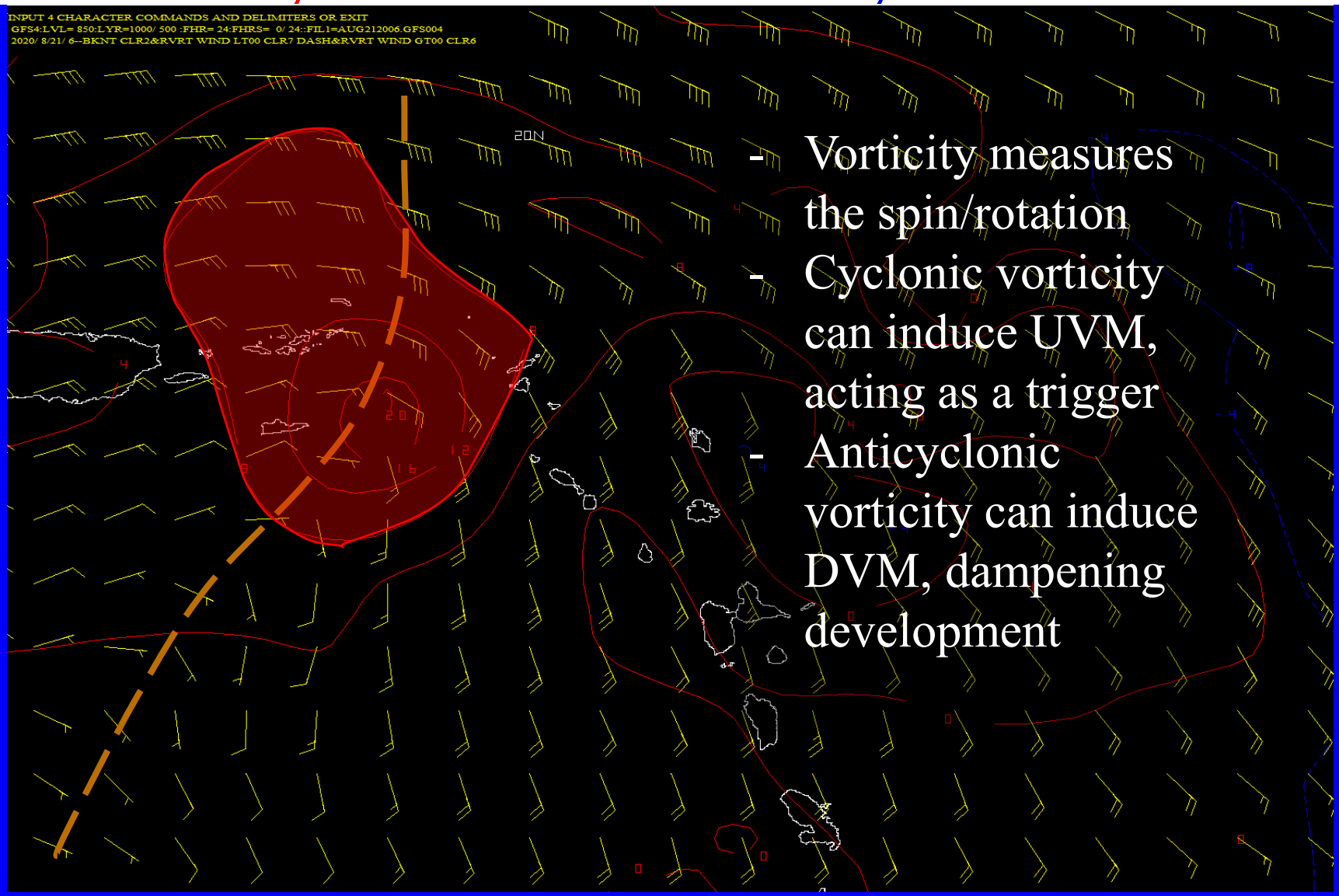


Trigger

- Mechanism that can ***incite*** the release of energy
  - "A butterfly flapping its wings triggers a tornado"
  - Mid level perturbations/vorticity maxima
  - Tropical Waves
  - Fronts and Frontal Shear Lines
  - Sea/Land Breeze Convergence
  - Diurnal Heating
  - Topographical forcing

850 hPa Winds and RVRT

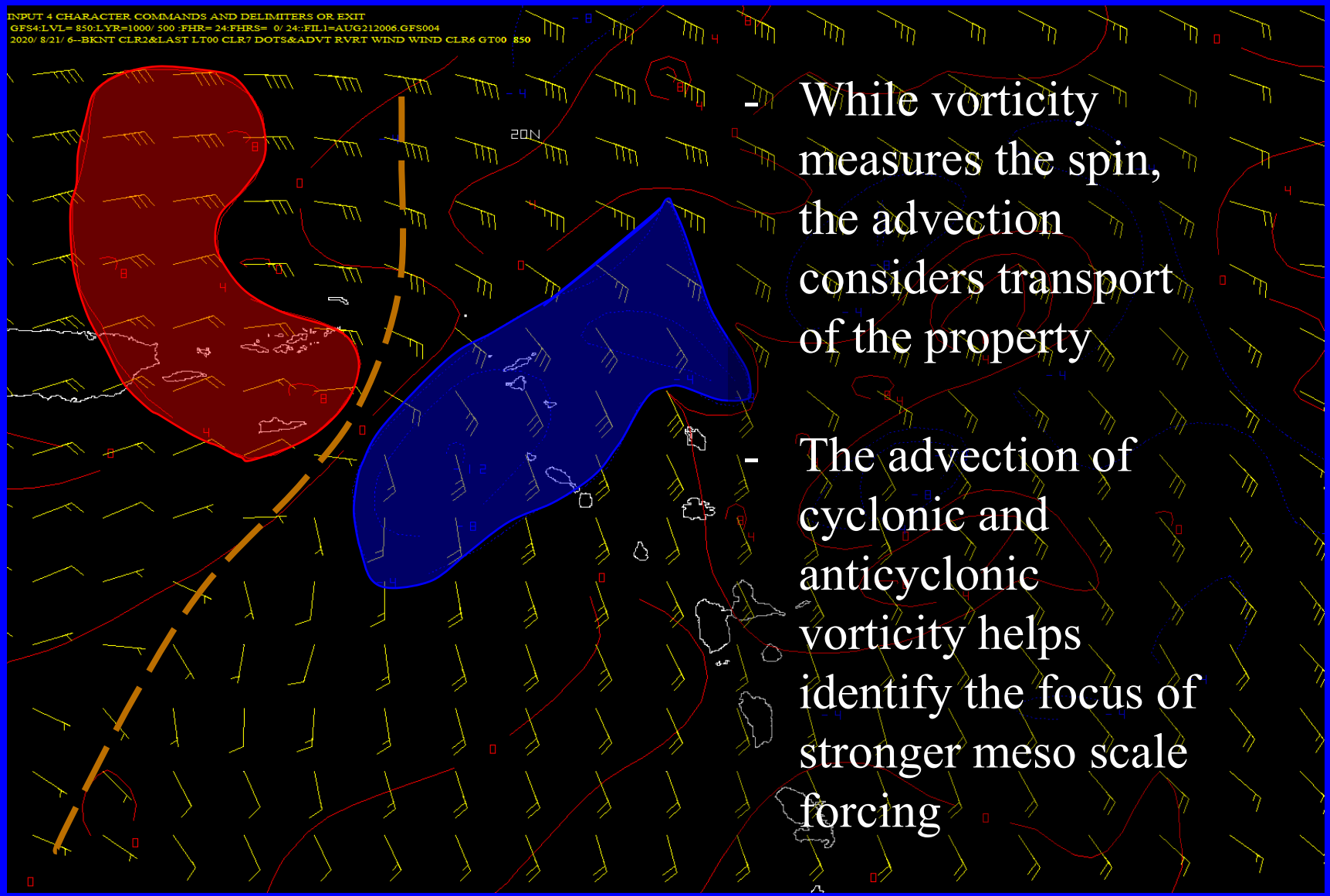
Cyclonic & Anticyclonic



- Vorticity measures the spin/rotation
- Cyclonic vorticity can induce UVM, acting as a trigger
- Anticyclonic vorticity can induce DVM, dampening development

850 hPa Winds and Advection of RVRT

Cyclonic & Anticyclonic



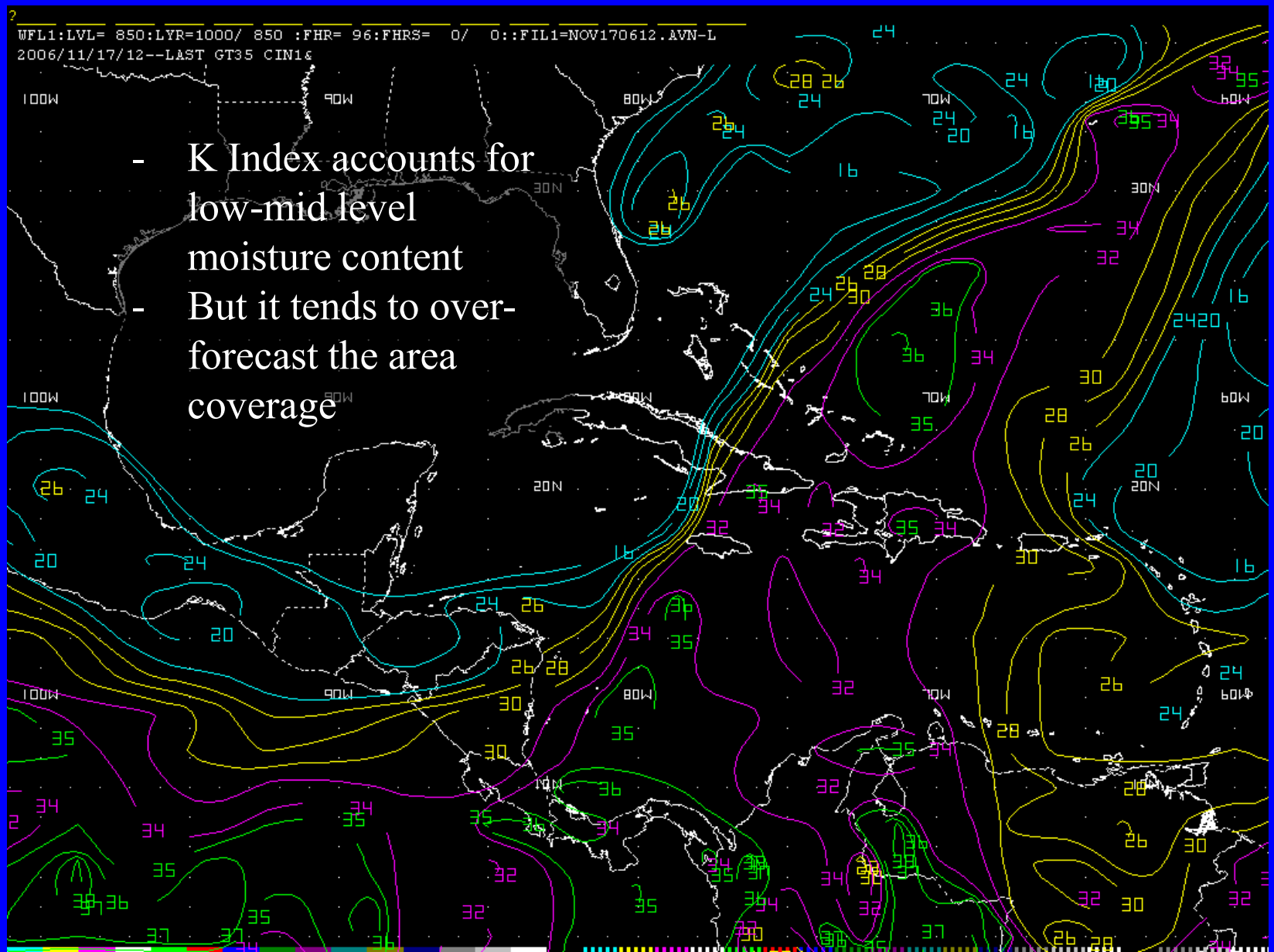
- While vorticity measures the spin, the advection considers transport of the property

- The advection of cyclonic and anticyclonic vorticity helps identify the focus of stronger meso scale forcing

Stability Indices

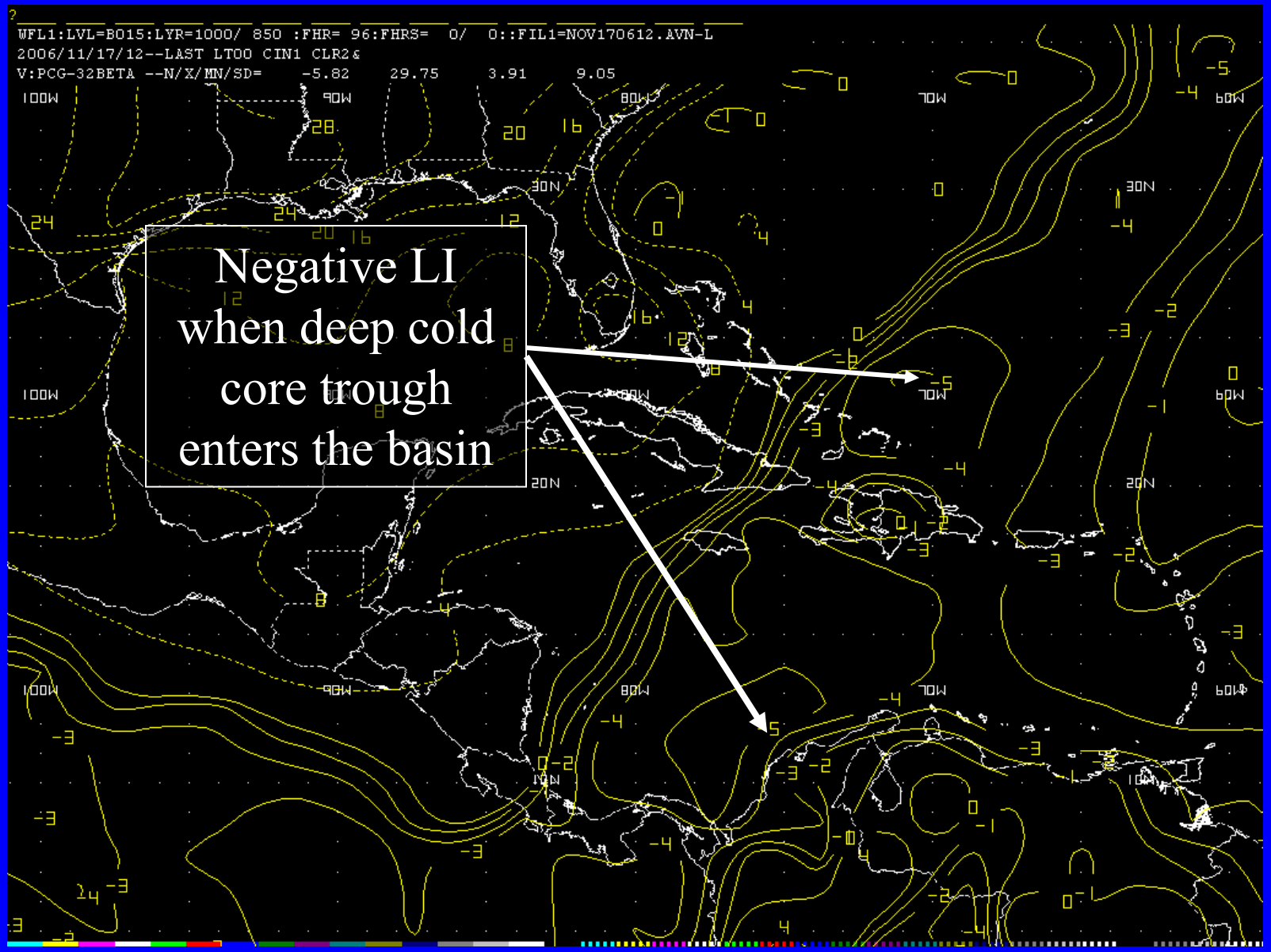
- Traditional stability indices were developed for mid latitudes
  - How easy it is for the atmosphere to release energy
- **Parcel Theory**
  - The SSI, TTI and LI only "work" in the tropics when there is a cold core trough aloft (TUTT)
  - KI was developed for the tropics
    - $K=(T_{850} - T_{500}) + Td_{850} - (T_{700} - Td_{700})$
    - But tends to over-forecast area coverage
  - Limitations: Only look at particular levels, does not consider the column

K Index

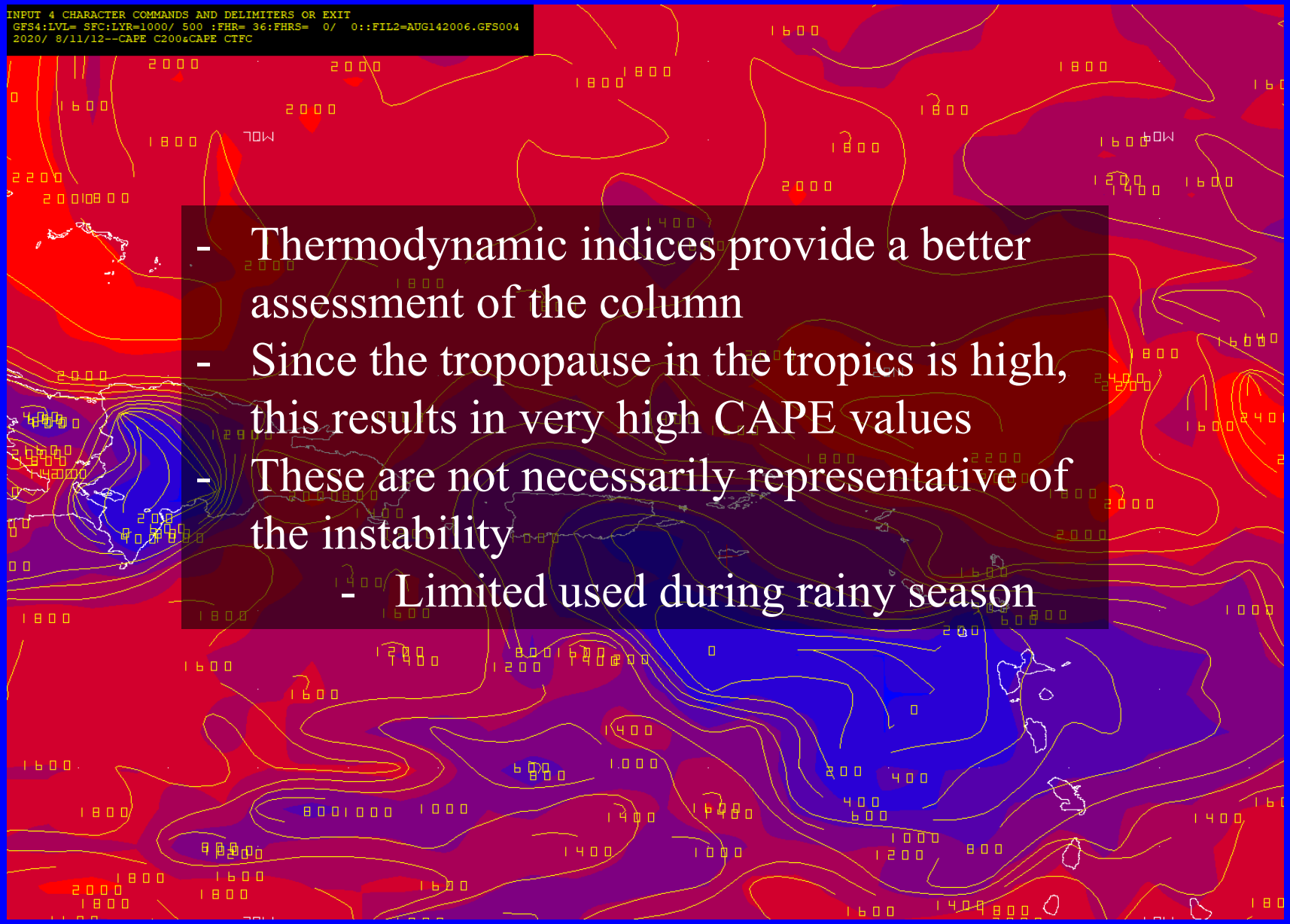

WFL1:LVL= 850:LYR=1000/ 850 :FHR= 96:FHRS= 0/ 0::FIL1=NOV170612.AVN-L
2006/11/17/12--LAST GT35 CIN1&
- K Index accounts for low-mid level moisture content
- But it tends to over-forecast the area coverage

Lifted Index and SSI

Most Useful with TUTTs



Thermodynamic Index: CAPE



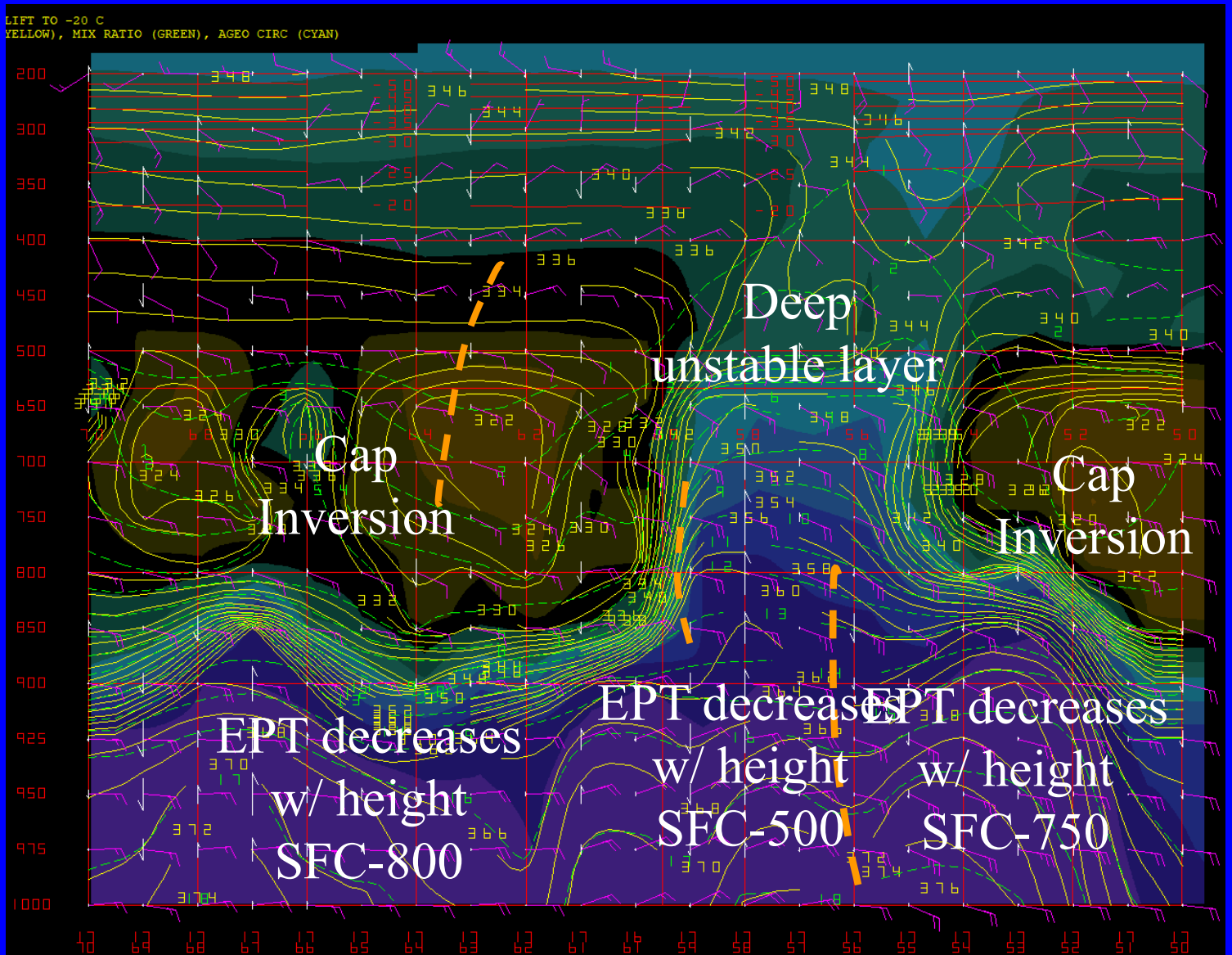
- Thermodynamic indices provide a better assessment of the column
- Since the tropopause in the tropics is high, this results in very high CAPE values
- These are not necessarily representative of the instability
    - Limited used during rainy season

Stability of the Column

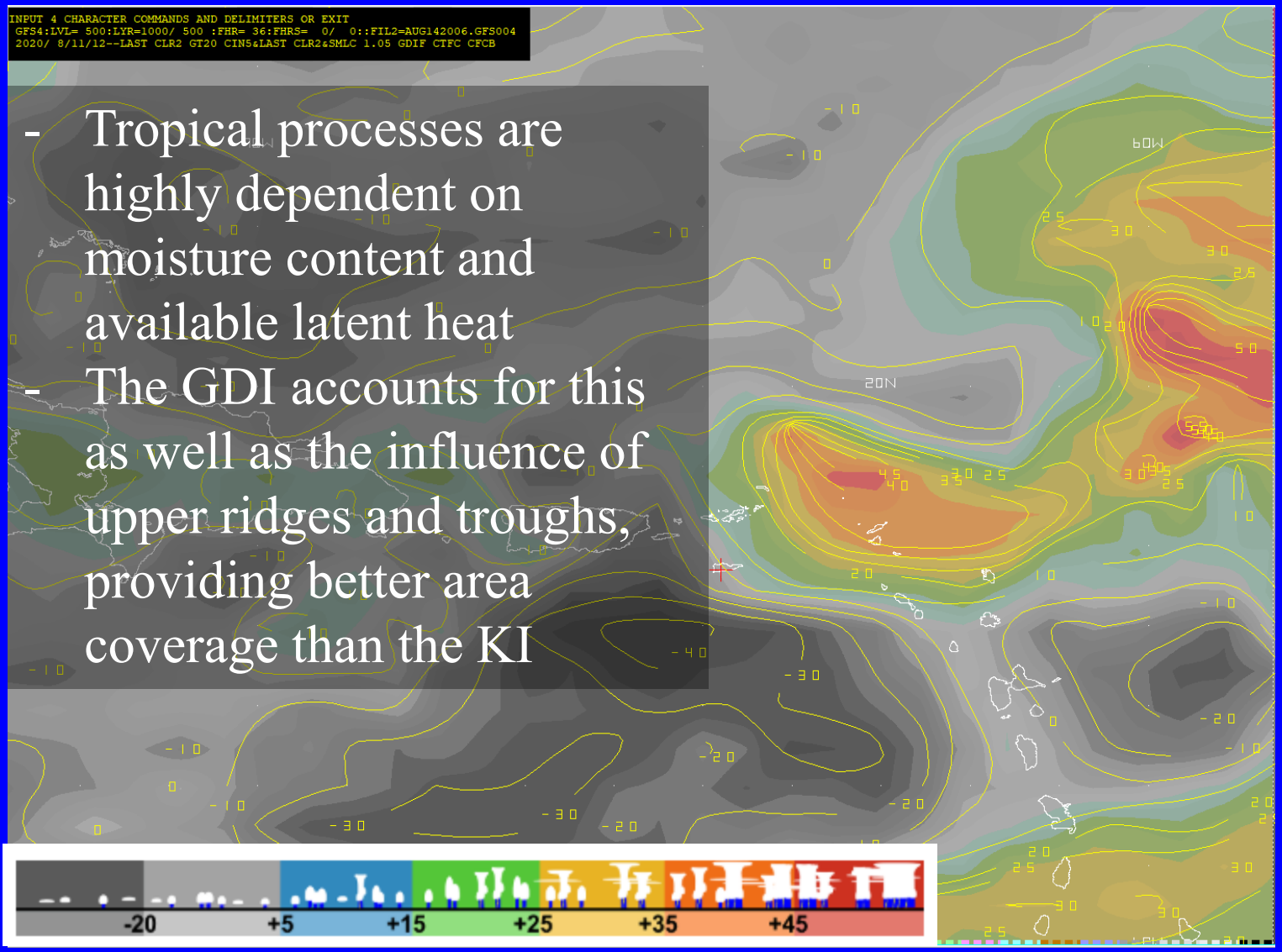
- **<u>Challenge in the Tropics</u>**
  - In the tropics it is better to consider vertical profiles of ***equivalent potential temperature*** (EPT)
    - Stable = EPT increases with height
    - Unstable = EPT decreases with height
  - Convectively stable/unstable processes are the primary drivers for tropical convection
    - Air mass becomes more unstable following convection
    - Why? Due to the release of latent heat

Vertical Cross Section

EPT, Winds and VVEL



Galvez-Davison Index (GDI)



- Tropical processes are highly dependent on moisture content and available latent heat
- The GDI accounts for this as well as the influence of upper ridges and troughs, providing better area coverage than the KI

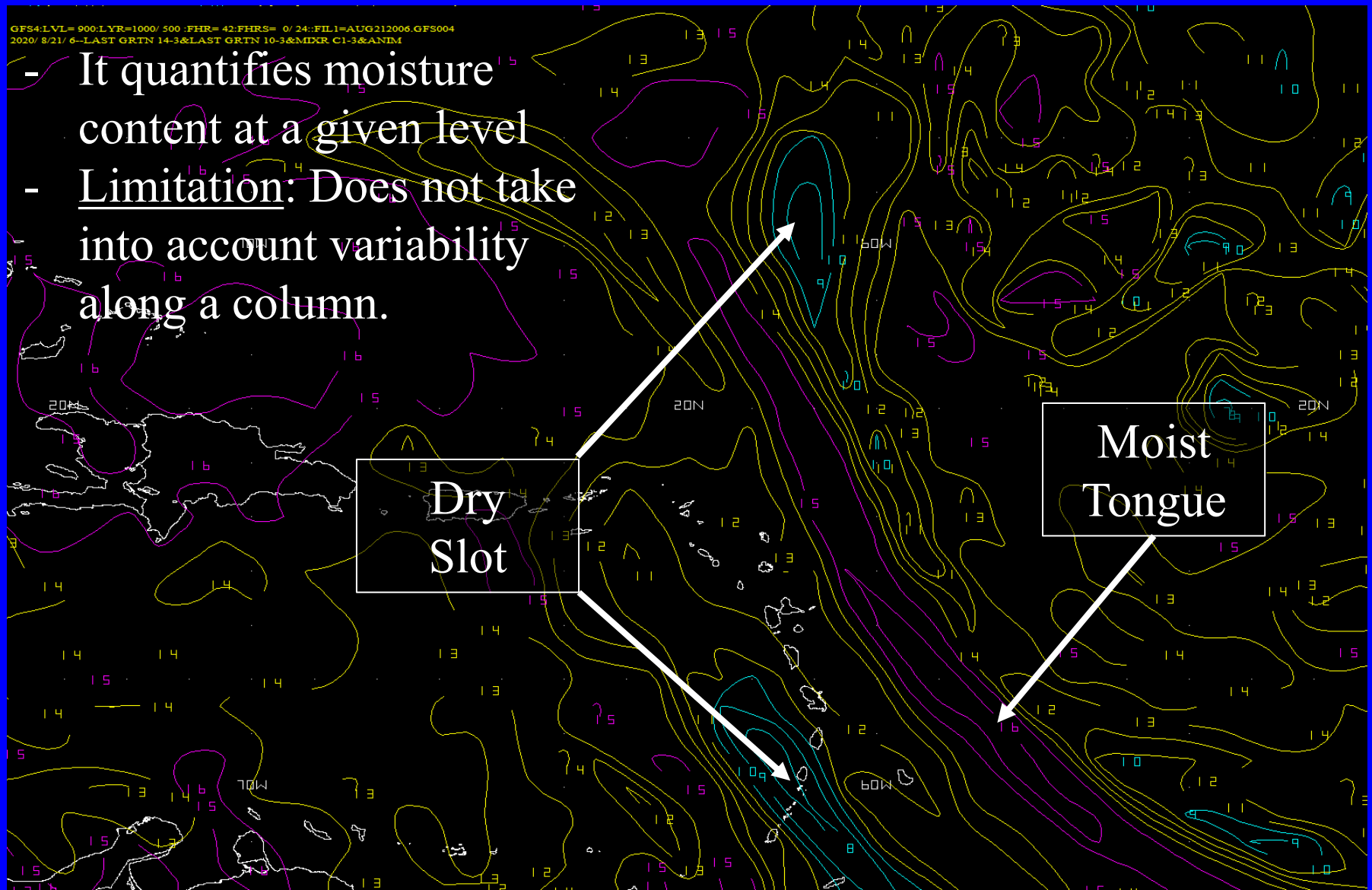
WATER Content

- High RH does not constitute high water content
  - RH only tells you how close to saturation the parcels are!!!
- In order to assess potential for rainfall from a given system, meteorologist must:
  - Determine sources of moisture/water
  - Evaluate water content (Quantify).
    - Dew Point (Td), Mixing Ratio and PW
- No Water; No Weather

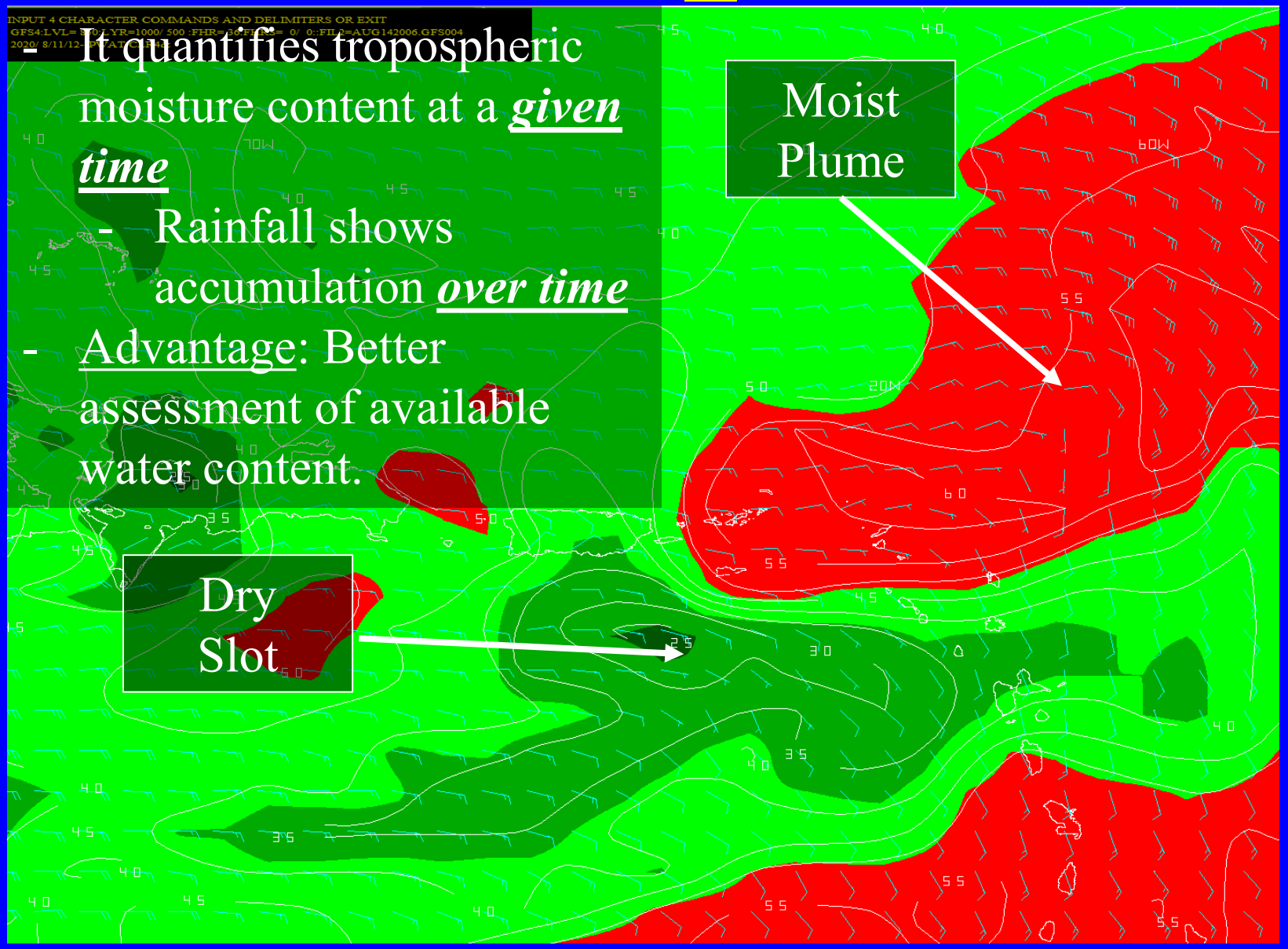
Why do we bother with RH?

- RH does not quantify water content
- RH quantifies how close the parcels are to saturation
  - Can be used to estimate cloud coverage
  - Aviation support

850 hPa Mixing Ratio



PWAT Content ≥ 50mm Red



Poll 1
Upper Level Trough's Function in the Forecast Funnel

Select all that apply

- Upper level divergence
- Low level convergence
- Trigger
- Stability
- Quantifies Moisture Content

Poll 2
Sea Breeze's Function in the Funnel

Select all that apply

- Upper level divergence
- Low level convergence
- Trigger
- Stability
- Quantifies Moisture Content

Poll 3
Dew Point Temperature's Function

Select all that apply

- Upper level divergence
- Low level convergence
- Trigger
- Stability
- Quantifies Moisture Content

Poll 4
Radiational Heating's Function

Select all that apply

- Upper level divergence
- Low level convergence
- Trigger
- Stability
- Quantifies Moisture Content

Poll 5
Relative Humidity's Function

Select all that apply

- Upper level divergence
- Low level convergence
- Trigger
- Stability
- Quantifies Moisture Content

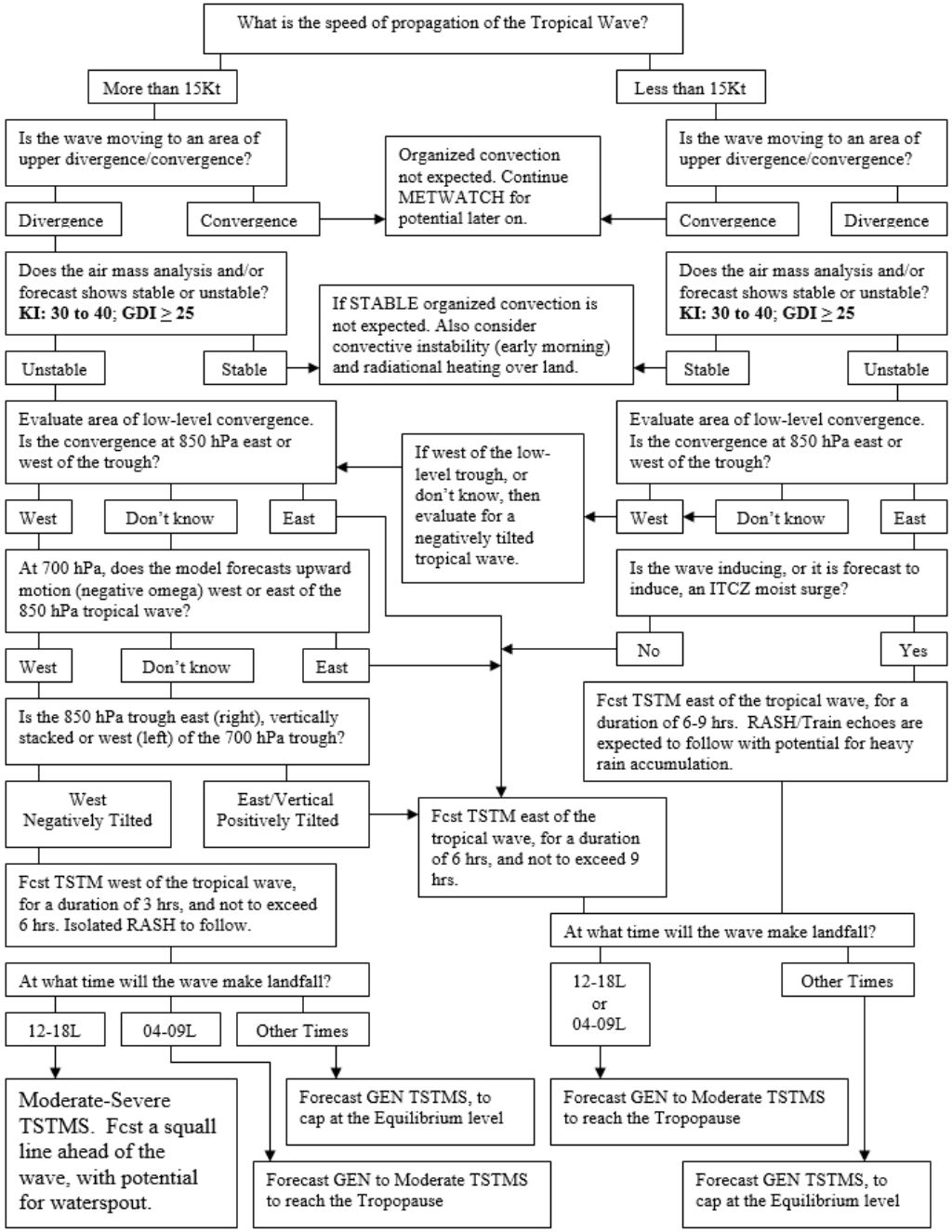
Sorry, none of the above is correct!

Operational Application of the Forecast Funnel

- Forecaster's Worksheet
  - **Decision Tree**

- Example: Positive vs. Negative tilted Tropical Waves

Tropical Waves
Caribbean Basin-Central America
Hurricane Season



Possible Problems with the Forecast Funnel

- It follows a cookbook approach for evaluating atmospheric dynamics
  - Add the ingredients and you get weather
- Atmosphere is a non-lineal medium
- Might appear to be too simplistic
- But at least it establishes a methodology and discipline for the meteorologists

Occam's Razor
(Ockham's Razor)

- Occam's Razor
  - Suppose there are two explanations for an occurrence.
    - The one that requires the smallest number of assumptions is usually correct.
    - The more assumptions you have to make, the more unlikely an explanation.
  - How likely to find a zebra in Central America?

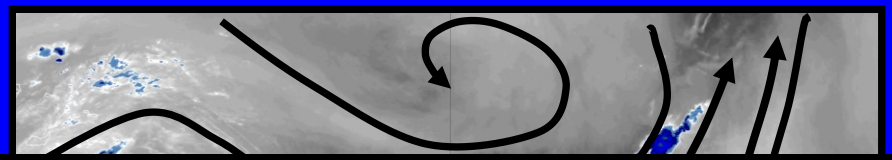
Example
Evaluation of a Tropical Wave Over the Eastern Caribbean

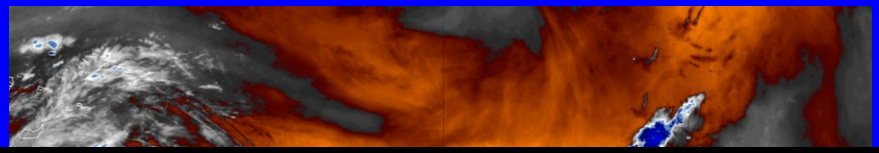
August 11-12, 2020

Initial Conditions

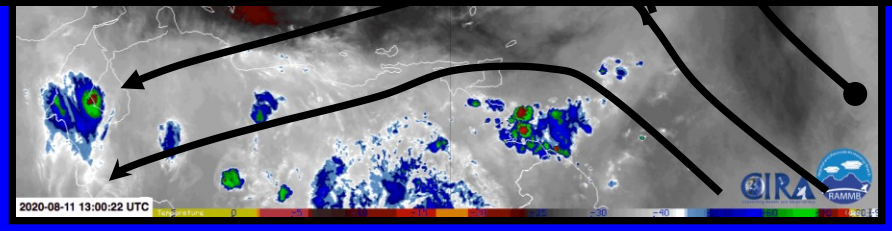
Water Vapor Images

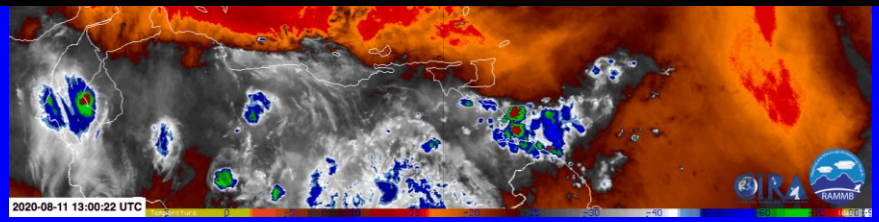
- The WV analysis shows an upper level ridge over the eastern Caribbean with a trough to the east.





Identify Possible Sources of Upper Divergence

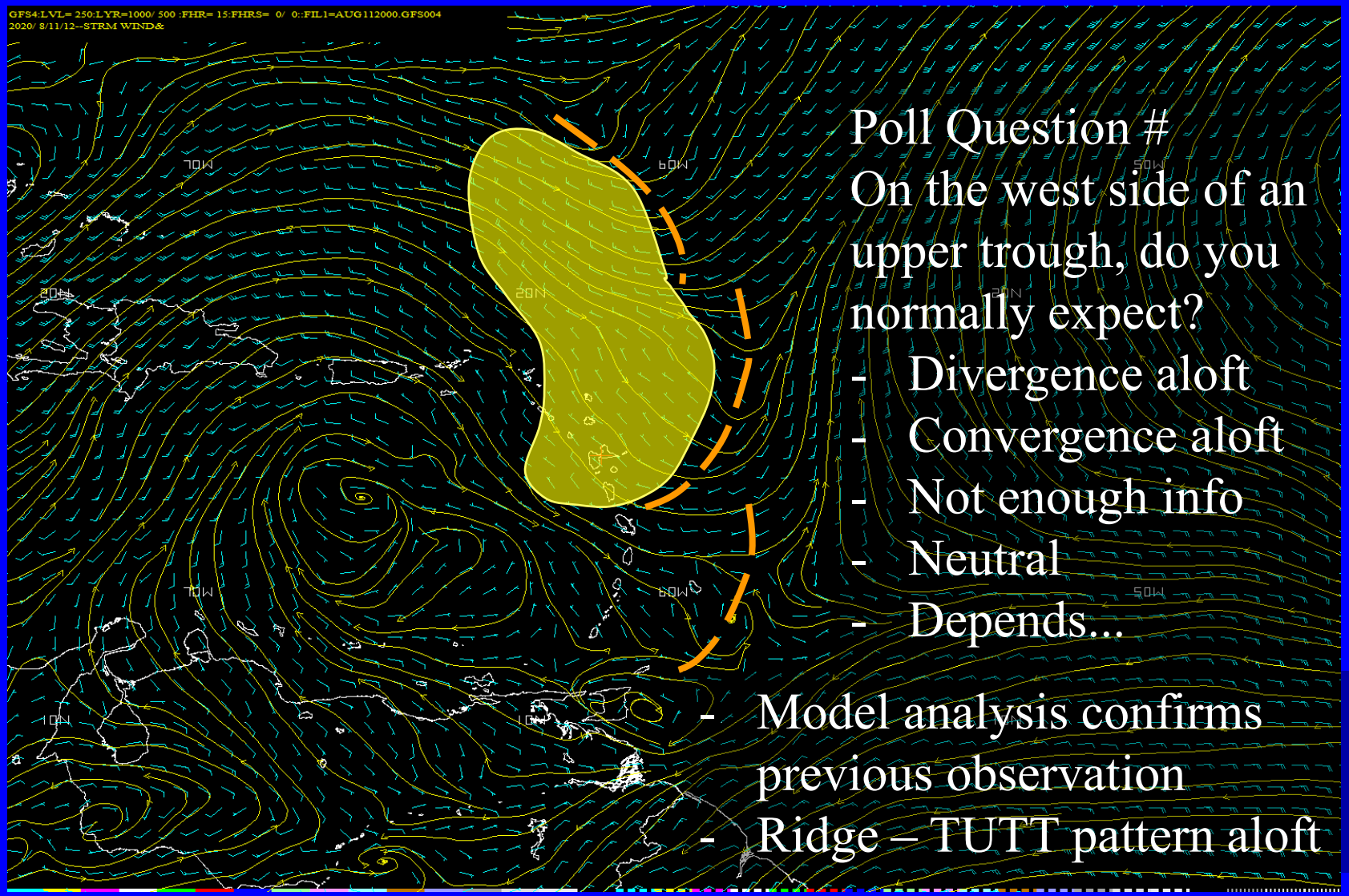




6.2um

6.9um

Model Analysis
250 hPa Winds and Streamlines



Poll Question #

On the west side of an upper trough, do you normally expect?

- Divergence aloft
- Convergence aloft
- Not enough info
- Neutral
- Depends...

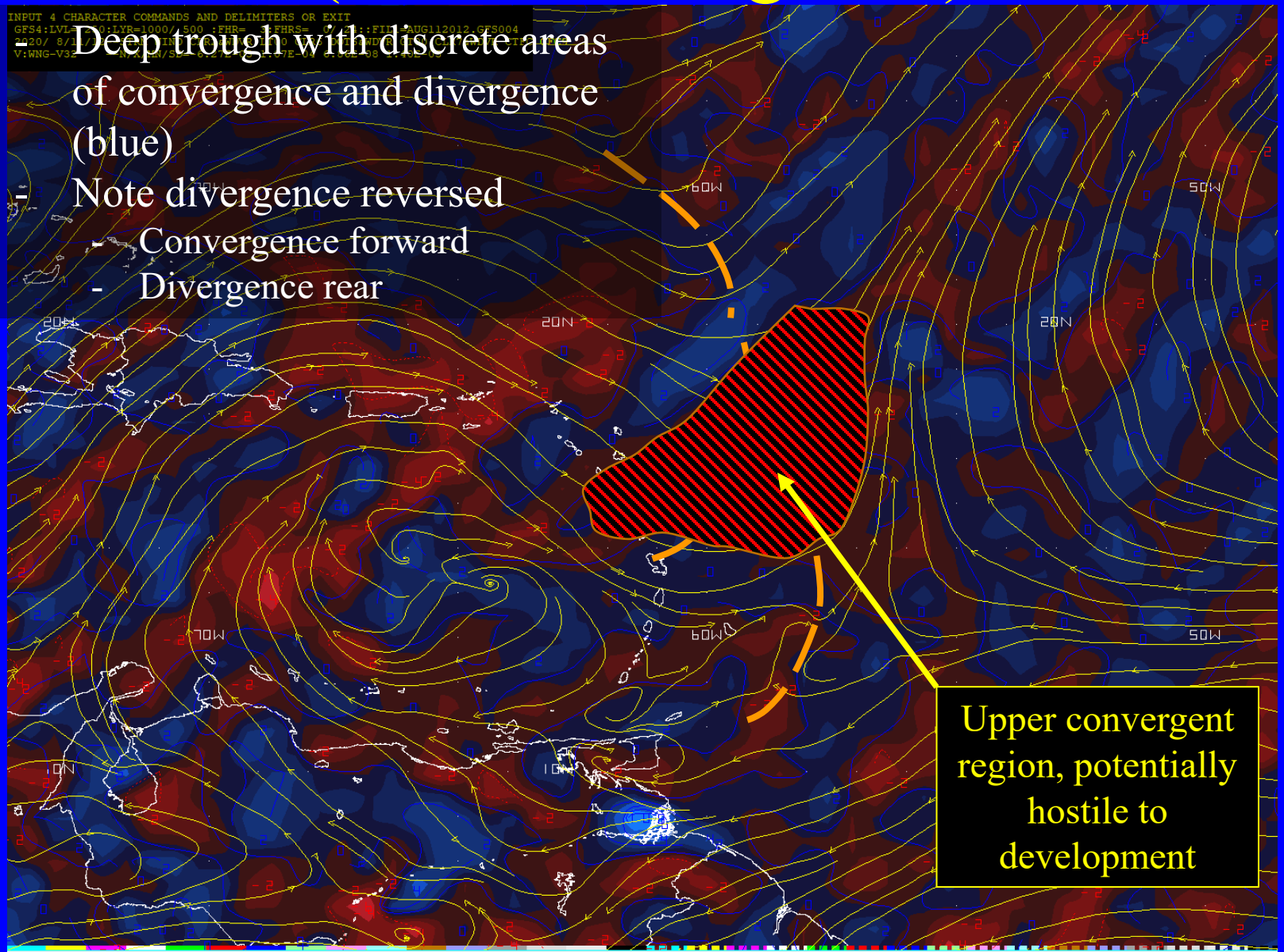
- Model analysis confirms previous observation
- Ridge – TUTT pattern aloft

Poll Question 6
On the backside (west) of an upper trough, you normally expect:

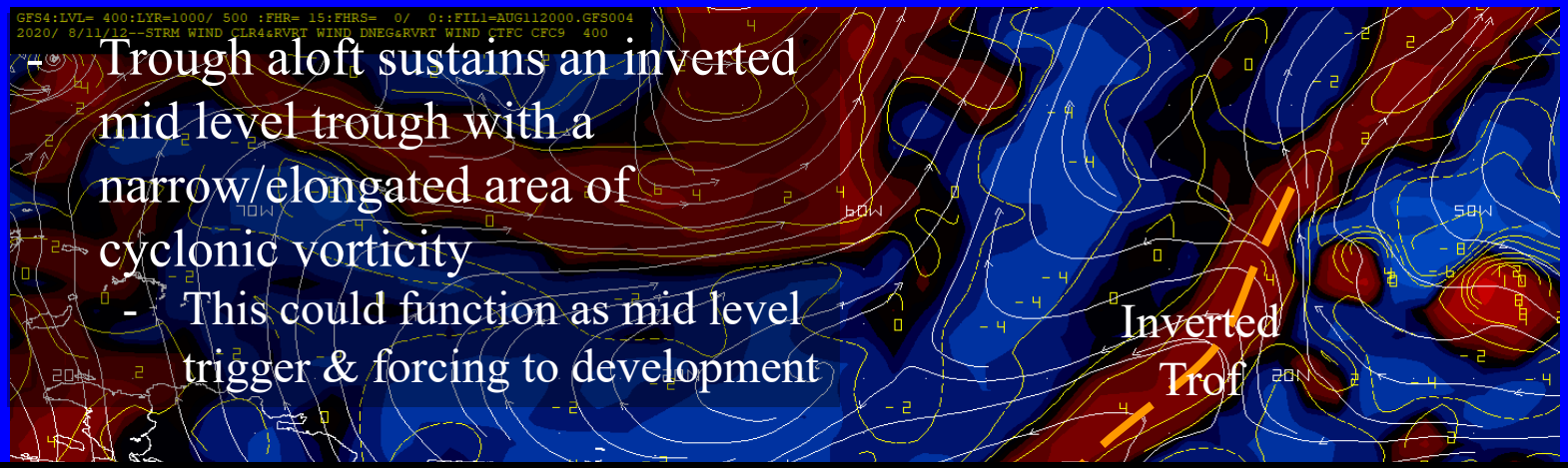
(Select All that Apply)

- Divergence aloft
- Convergence aloft
- Not enough information to determine
- Neutral
- Depends...
  - Positive or Negative tilted
  - Retrogressing, stationary, moving east

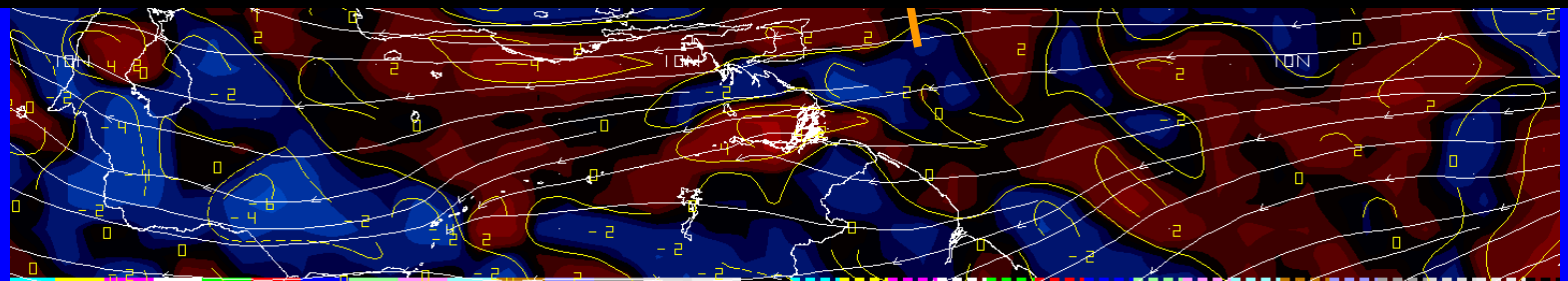
250 hPa Streamlines/Divergence (Red Convergence)



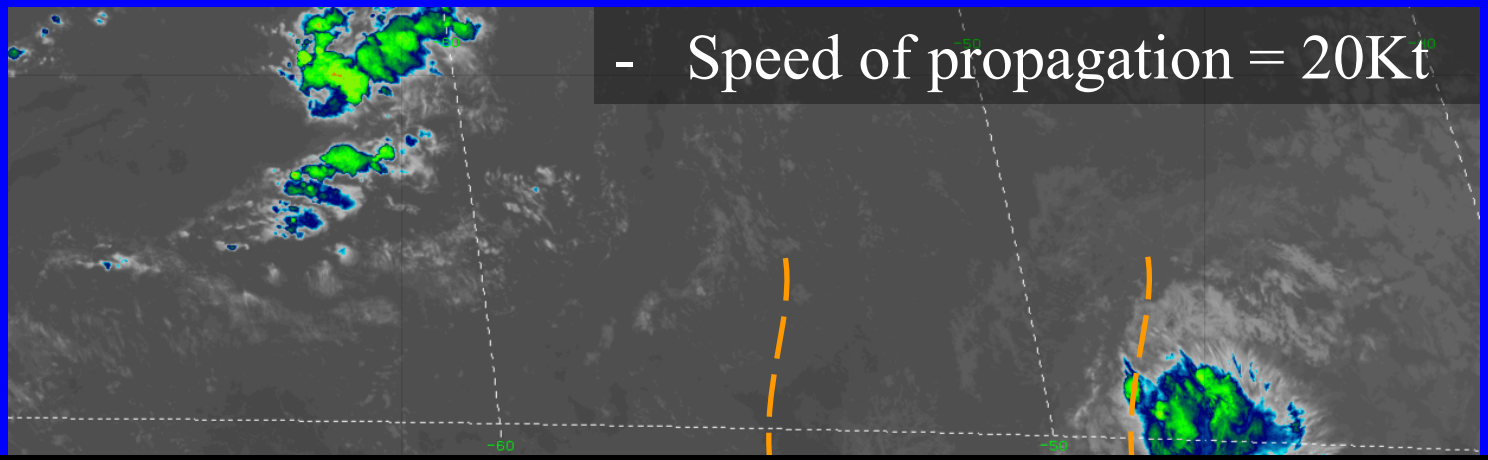
400 hPa Streamlines and Vorticity (Red Cyclonic)



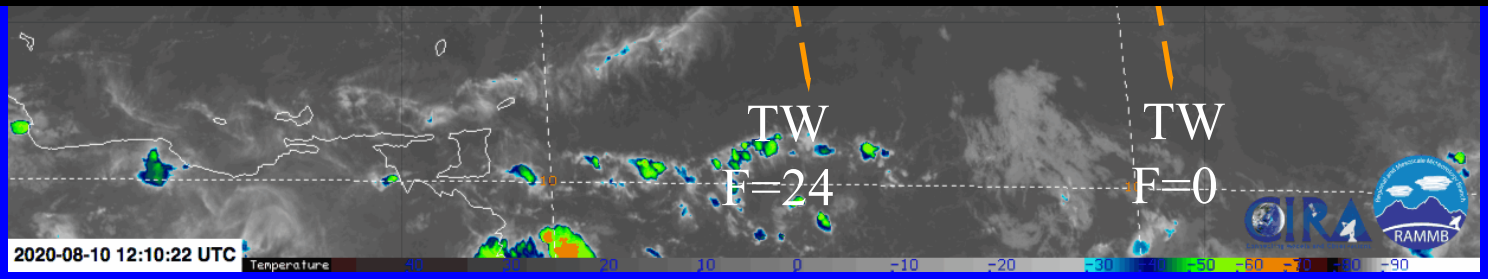
Identify Possible Sources of Mid Level Forcing (Trigger)



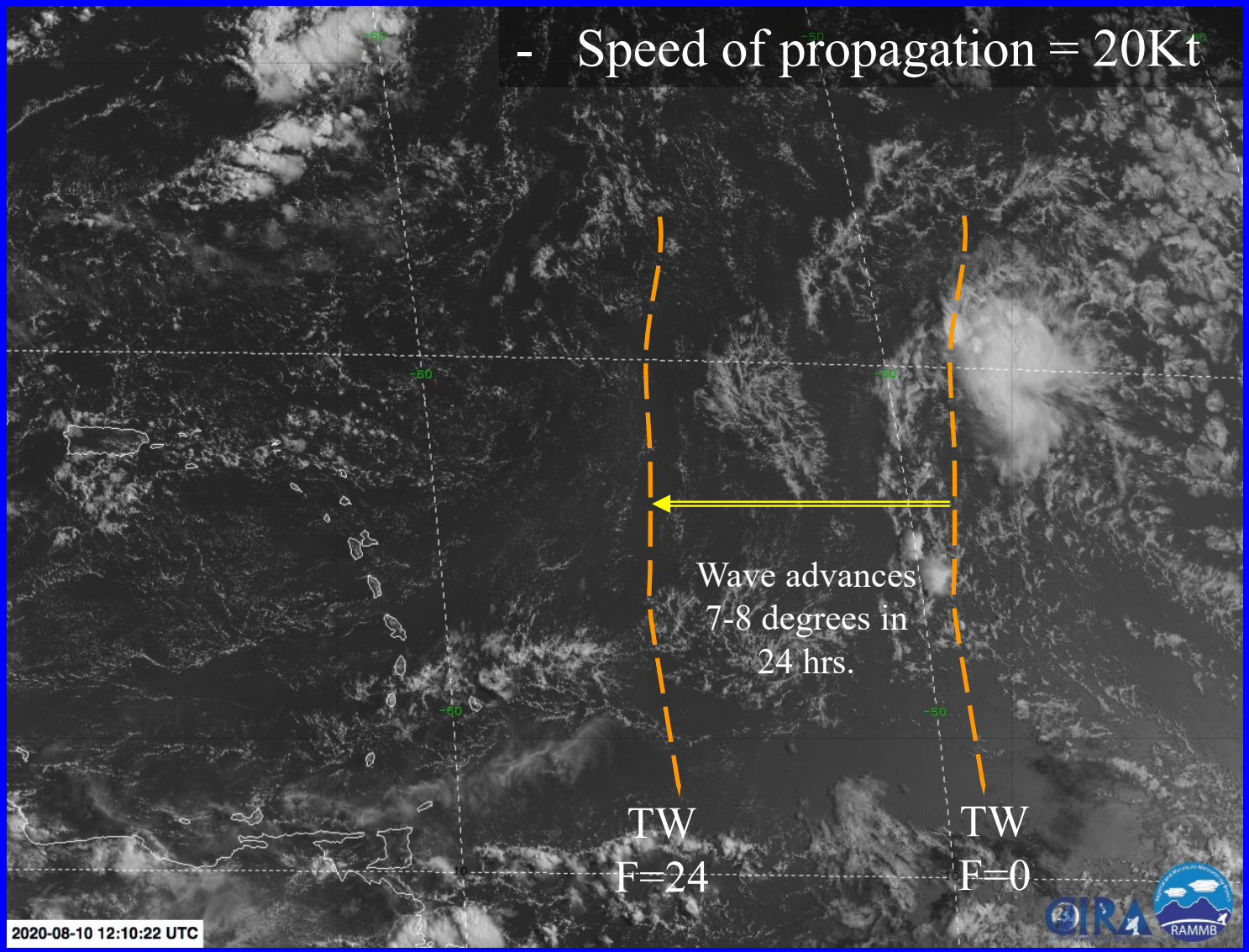
10.3um 08-10/12Z – 08-11/12Z



Identify Possible Sources of Low Level Forcing
(Trigger and Convergence)



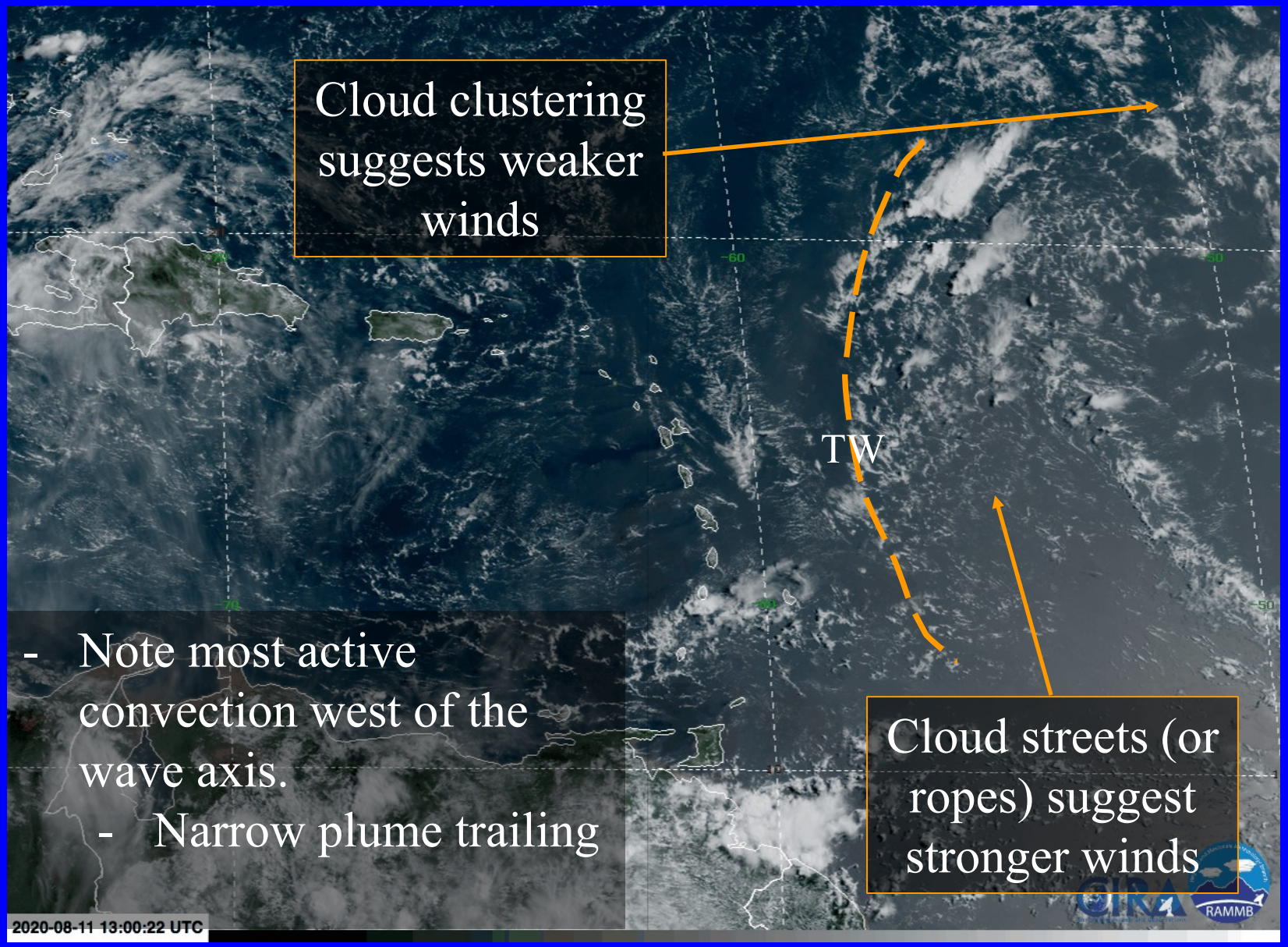
Visible Proxy 08-10/12Z-08-11/12Z



Characteristic of a Fast Moving Tropical Wave

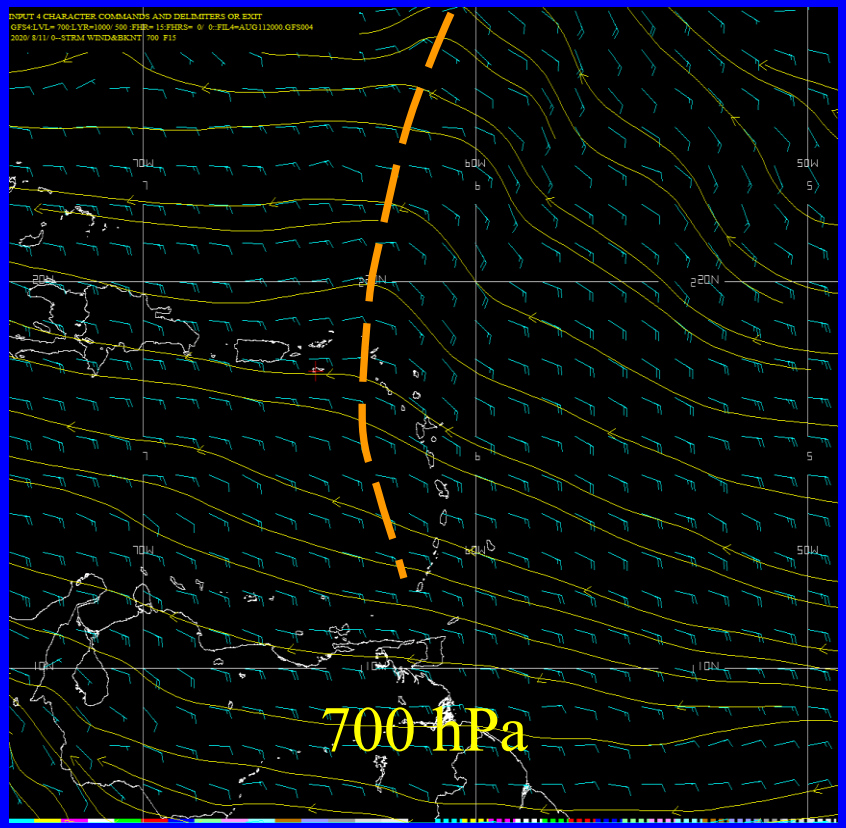
- Weather often precedes wave passage
- Shorter duration
- Could sustain squally weather
- Wind surge with wave passage and afterwards

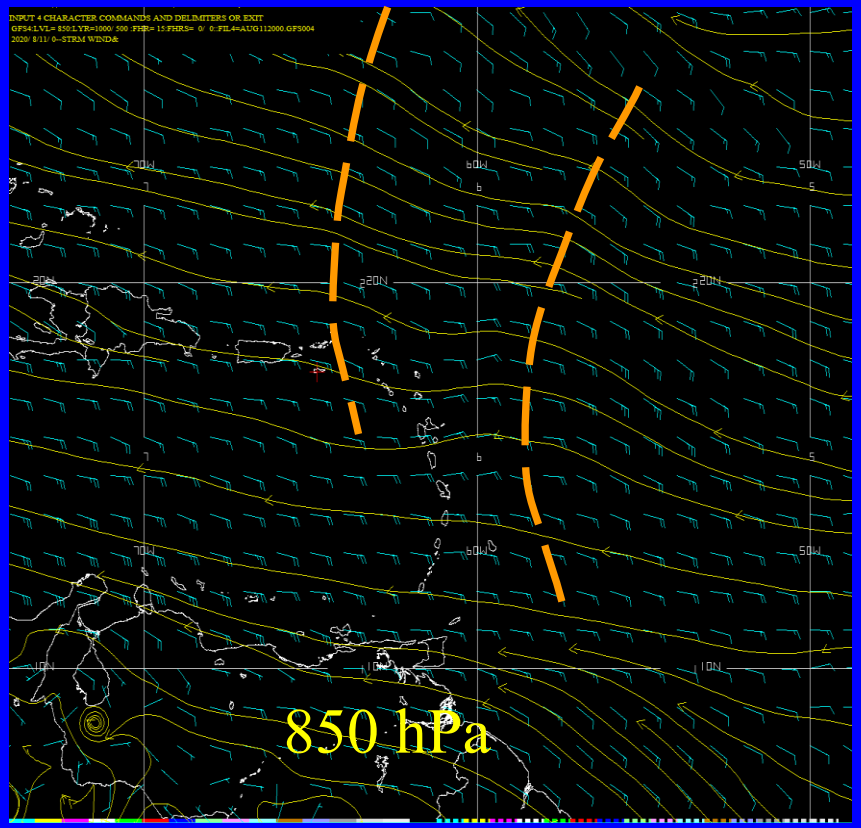
GeoColor – Low Level Feature



Analysis
700 & 850 hPa Winds

Total Wind and Stream Line

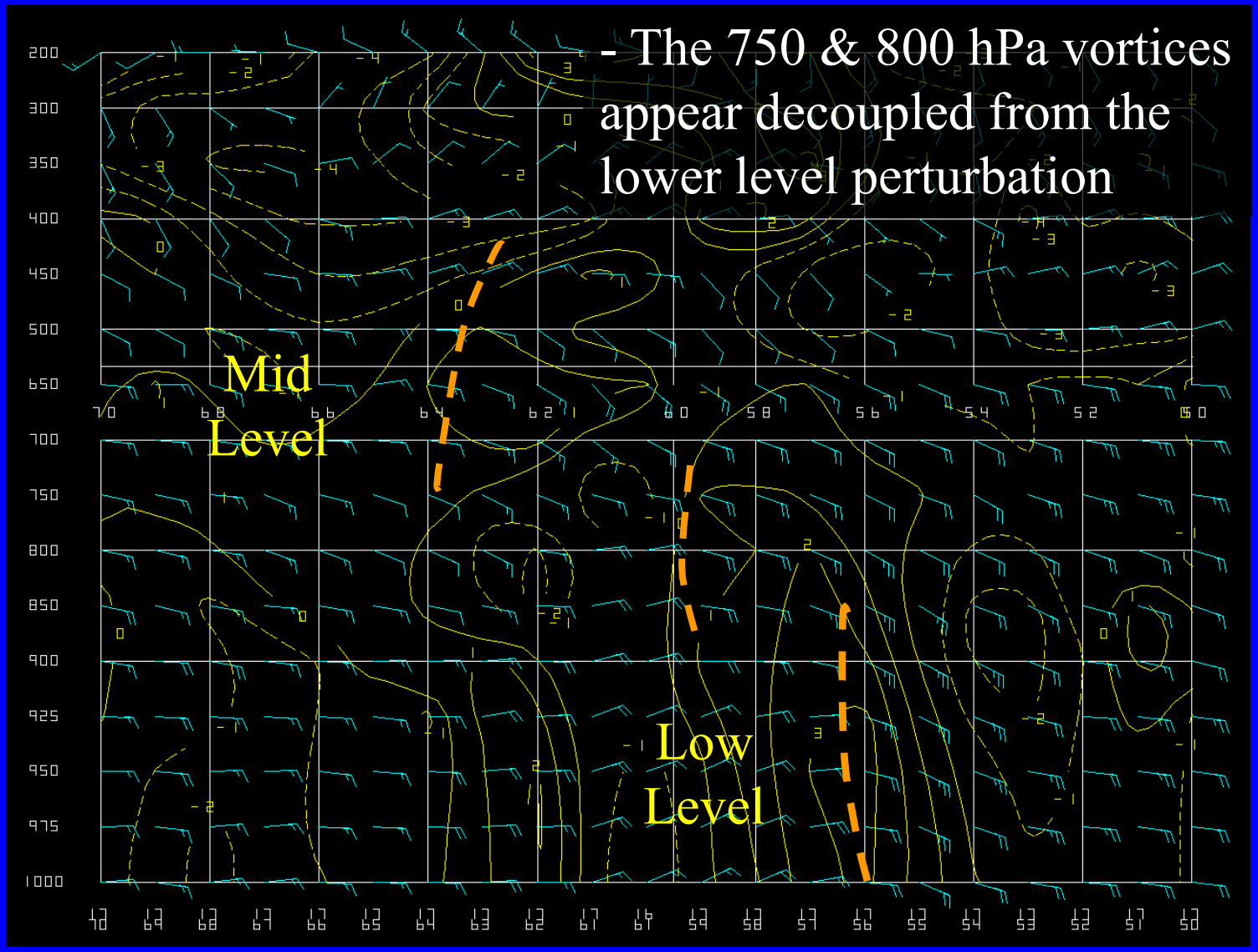




Trough at 700 hPa lies west of the 850 hPa perturbation, suggesting positively tilted wave

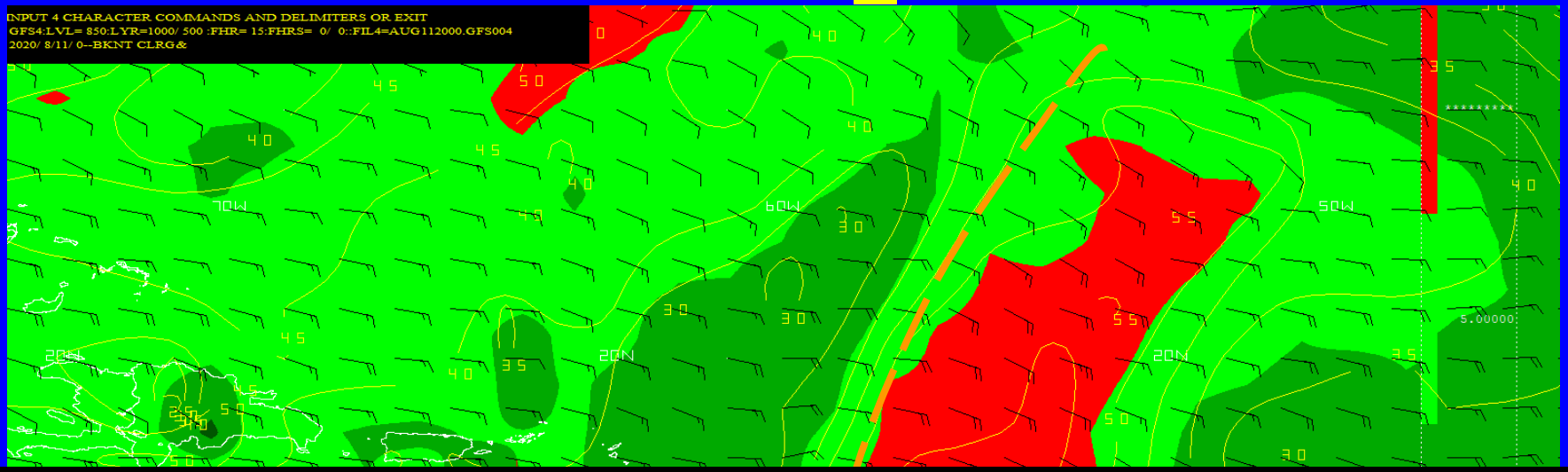
Vertical Cross Section

Total wind and relative vorticity, cyclonic solid contour, AC dashed

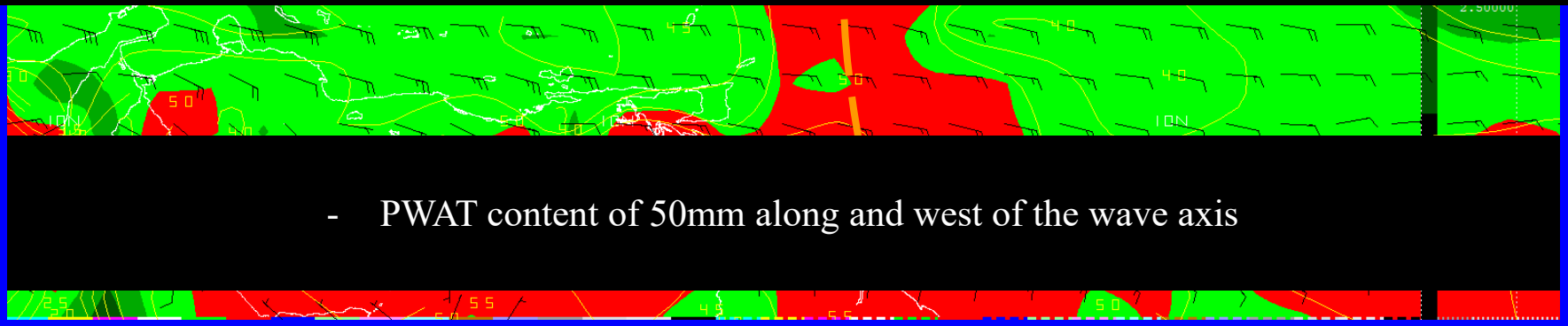


GFS PWAT Content and 850 Winds

Red = PWAT ≥ 50mm

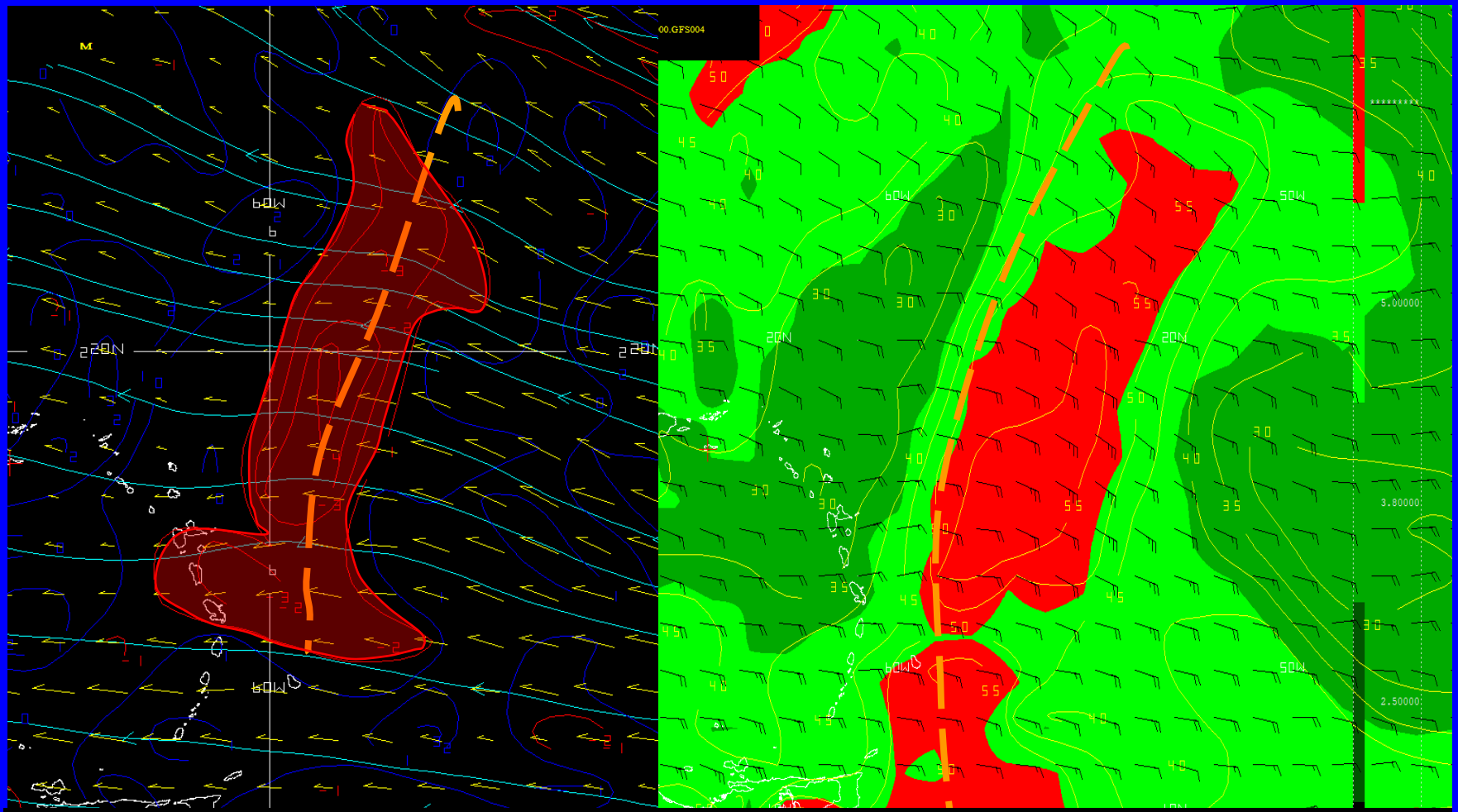


Quantify Moisture Content



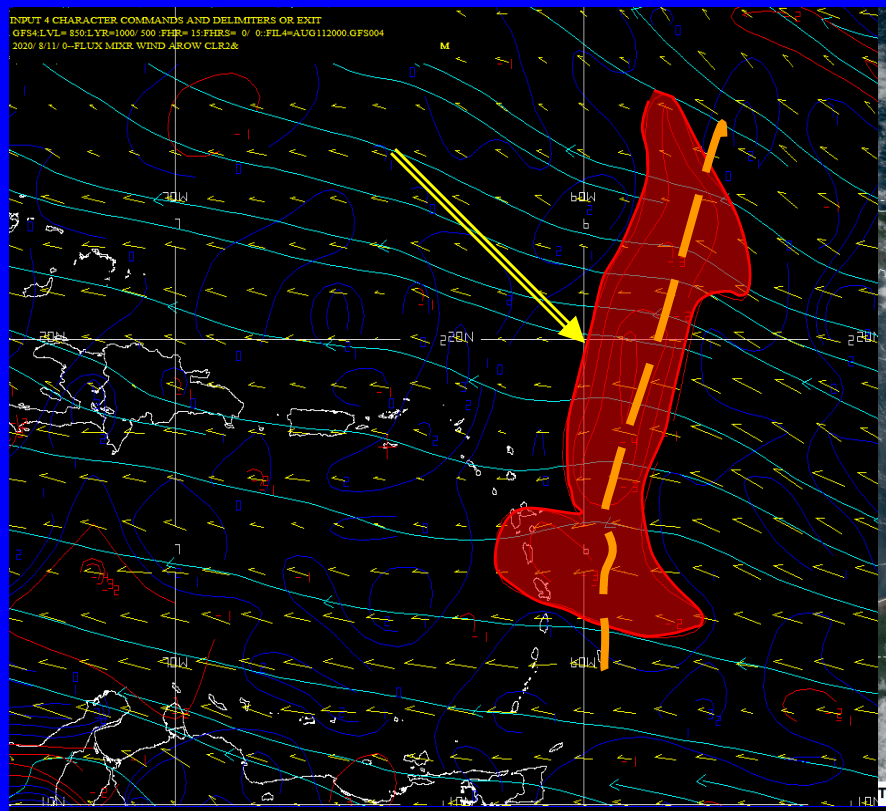
- PWAT content of 50mm along and west of the wave axis

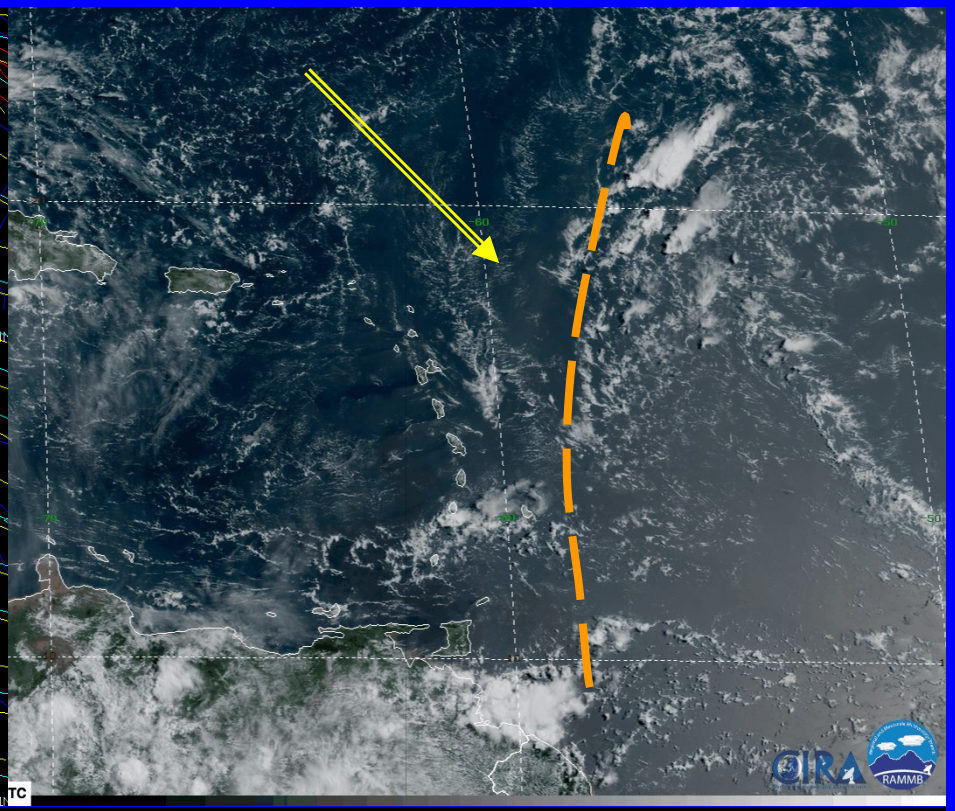
850 hPa Moist Flux Divergence and PWAT



- PWAT content of 50mm along and east of the wave axis
  - Best moisture convergence along and to the west

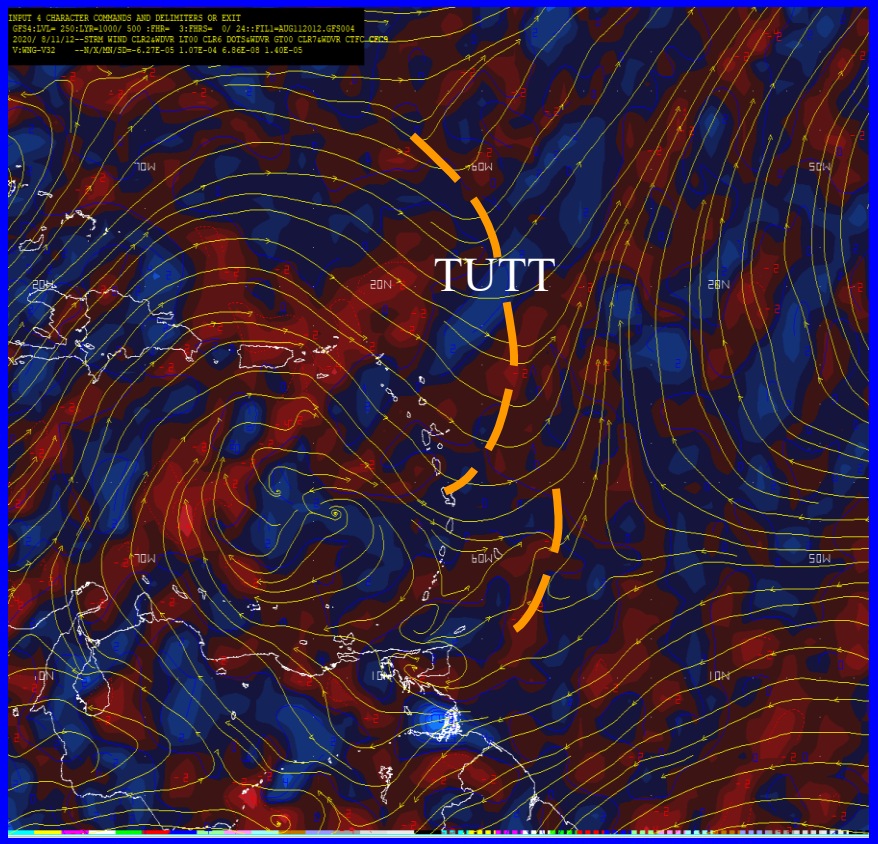
850 hPa Moisture Flux Divergence (Convergence Red)

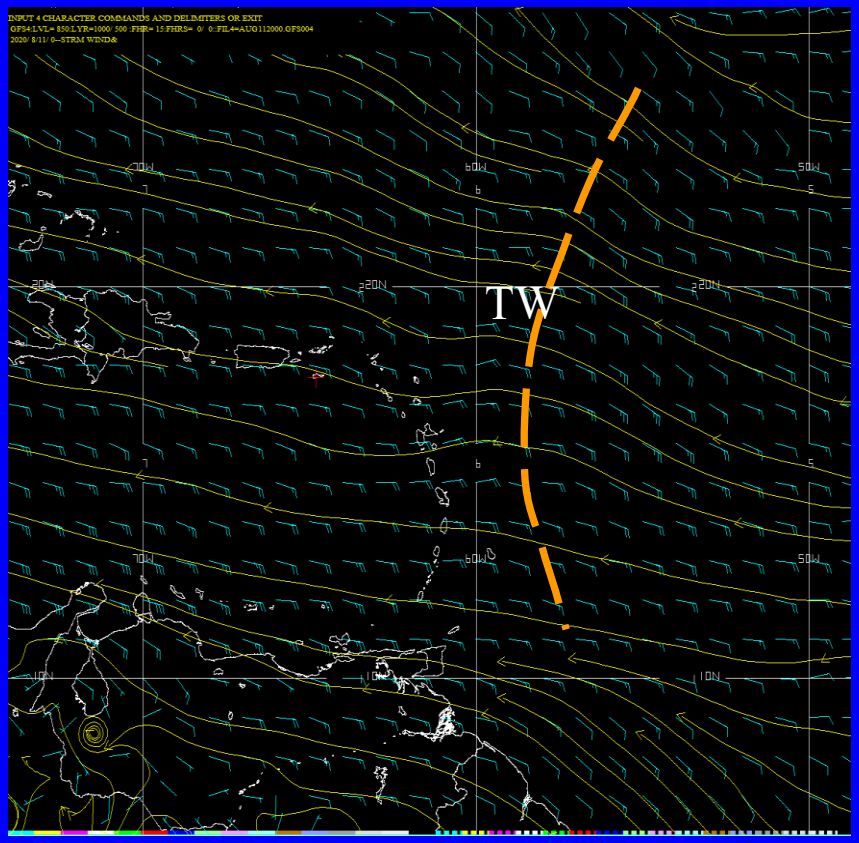




- Note best moisture convergence and convection west of the wave

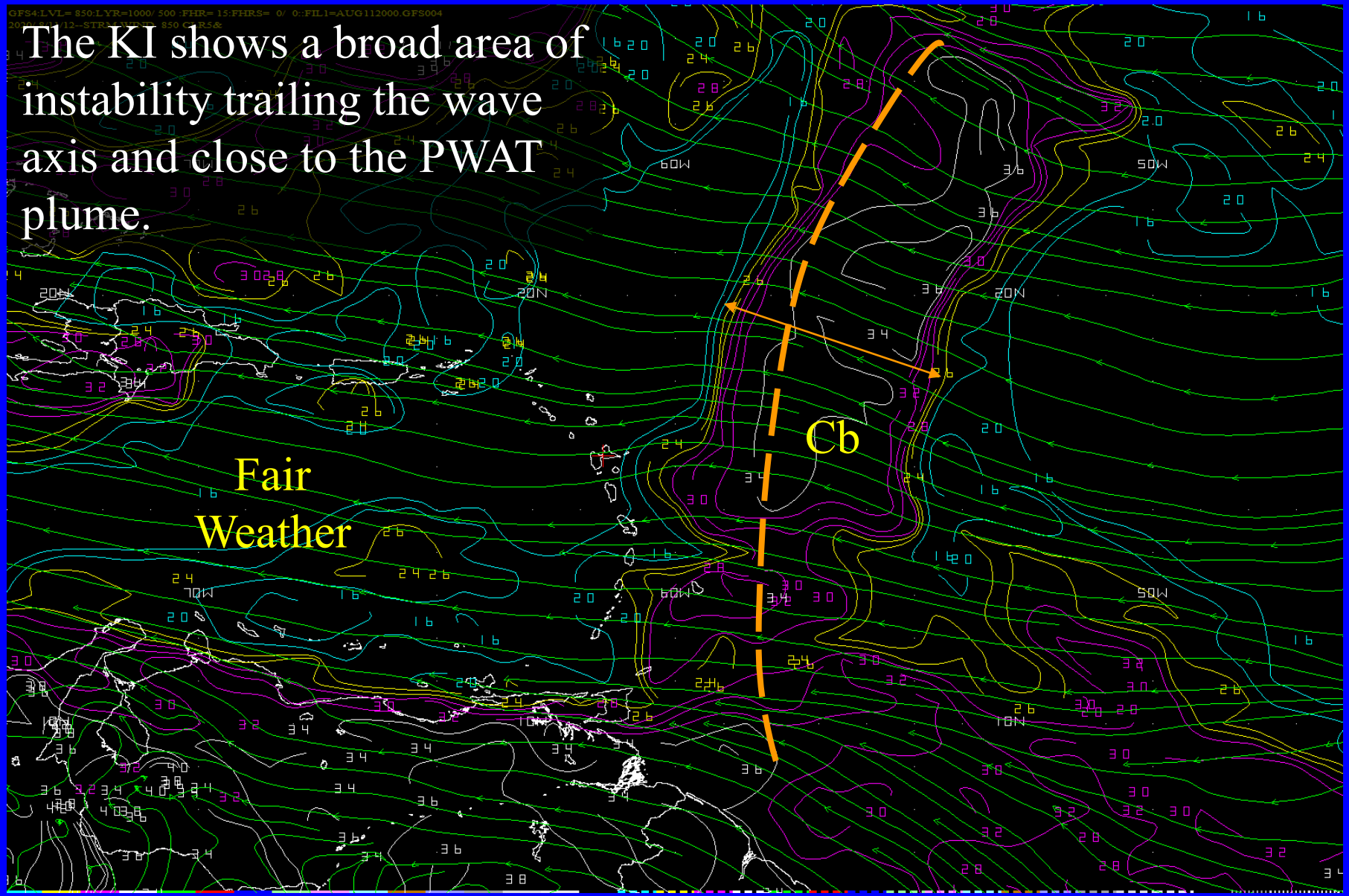
250 Flow/Div. & 850 hPa Wave



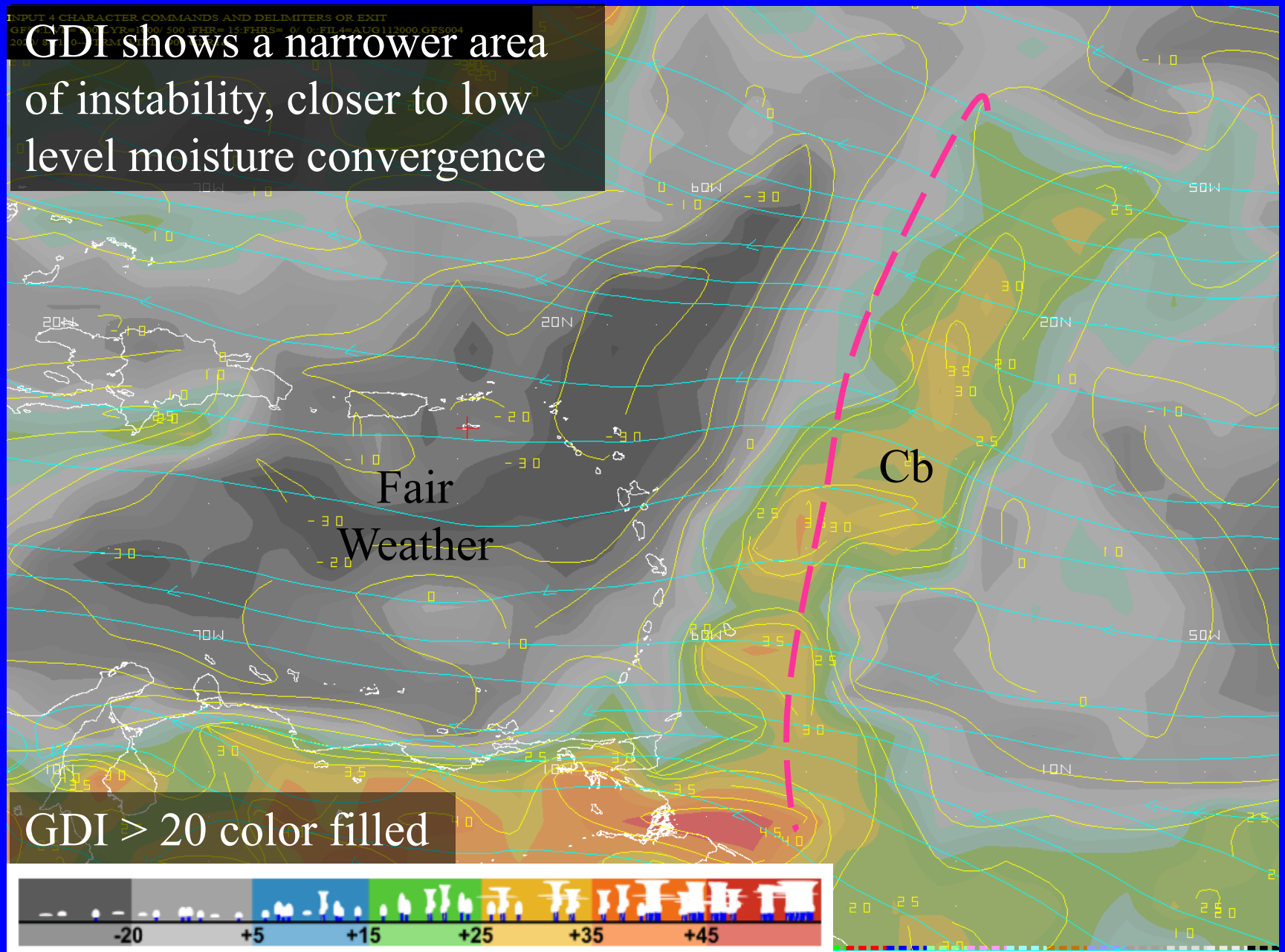


- As the wave slides under the TUTT aloft, entering an area of upper convergence
  - What impact would this have on the wave and associated convection?
    - It is likely to dampen development

KI and 850 Streamlines



GFS GDI and 850 Streamlines



Initial Assessment

- Tropical wave in the easterly trades racing towards the Leeward/French Islands

- Negative interaction is probable as the wave moves to the convergent side of the upper level trough.

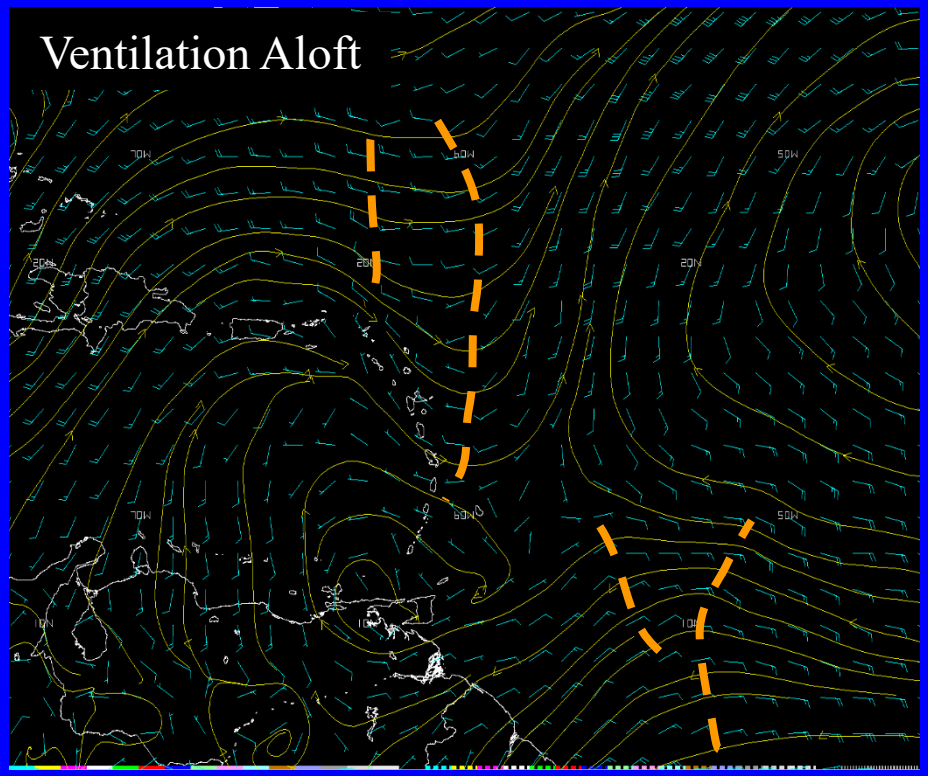
Day 1 Forecast

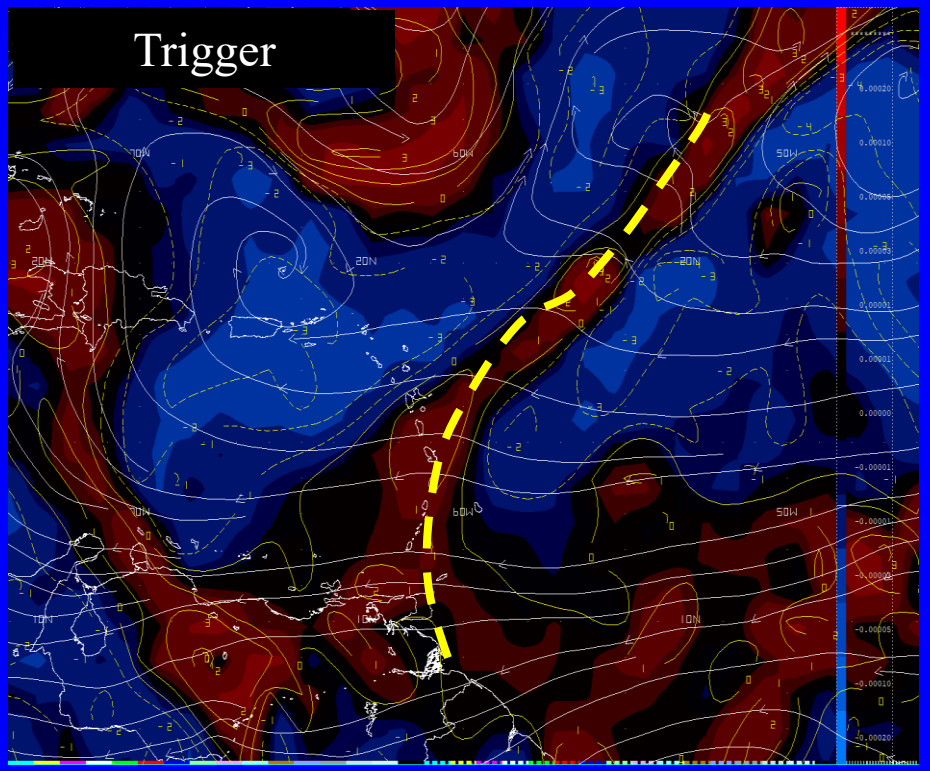
August 11/12Z – August 12/12Z

The Wave enters the Leeward-French Islands

250 hPa Winds/400 hPa Stream Lines Relative Vorticity: VT Aug 12/00Z

Cyclonic Vorticity in Red



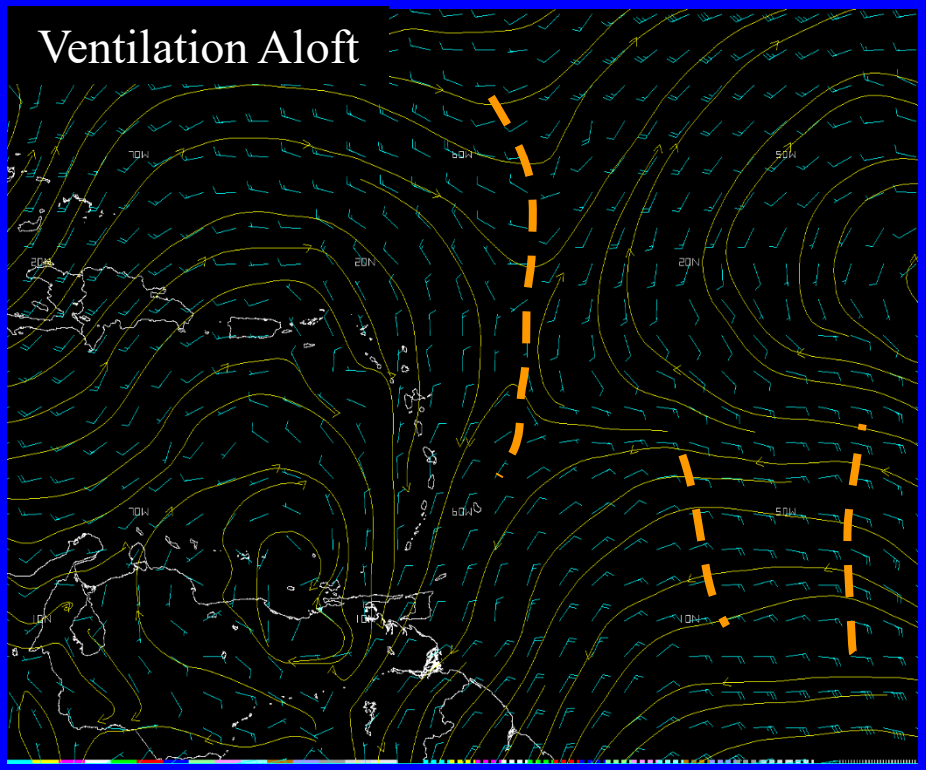


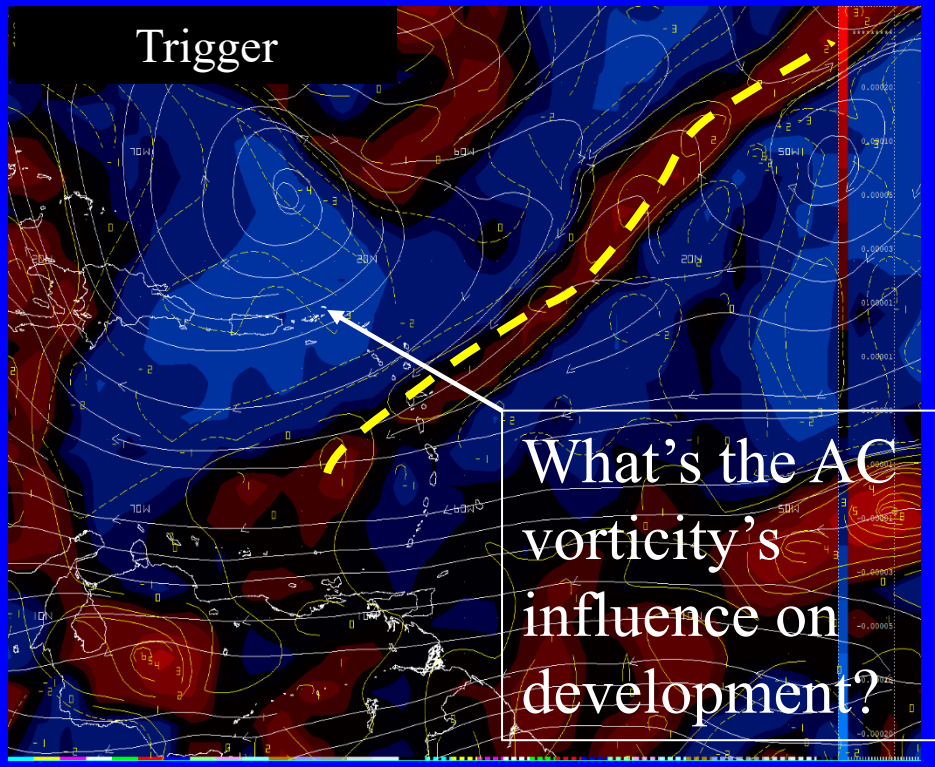
The 250 hPa trough holds its ground

The 400 hPa inverted trough moves over the French Islands

250 hPa Winds/400 hPa Stream Lines Relative Vorticity: VT Aug 12/12Z

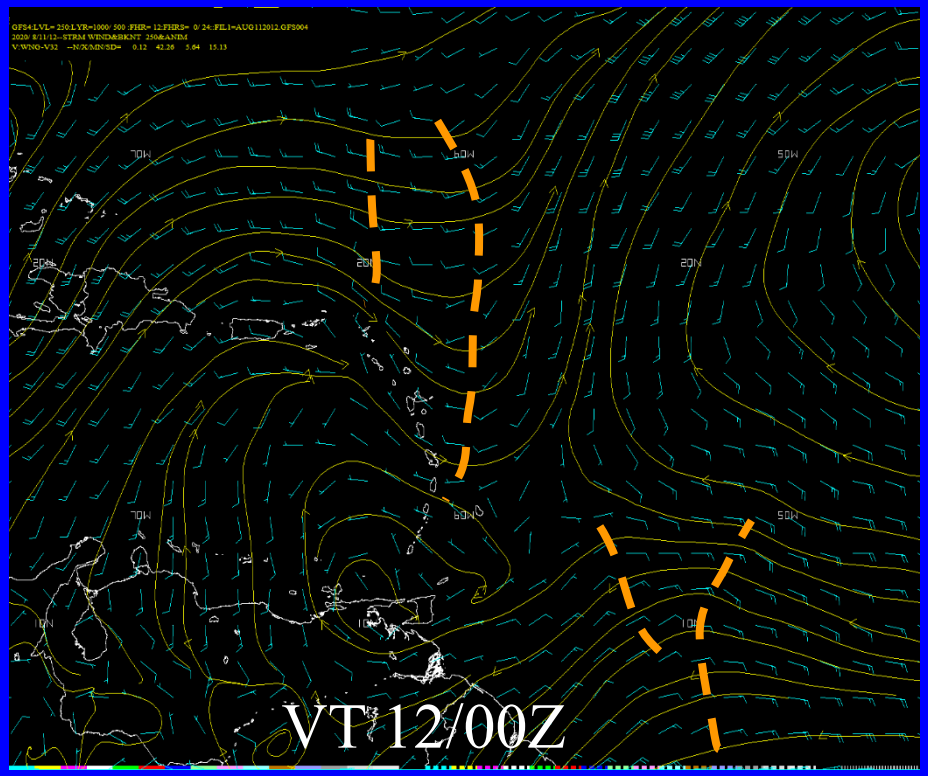
Cyclonic Vorticity in Red

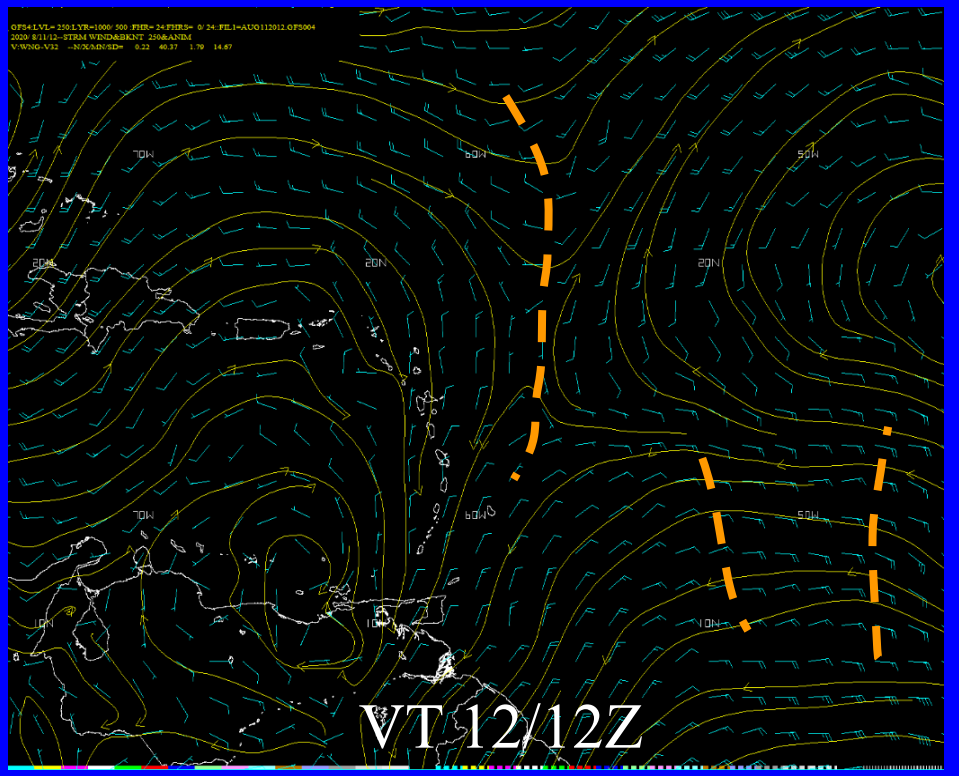




TUTT weakening while simultaneously a mid/upper level ridge builds over the NE Caribbean between 12/00Z and 12/12Z

Comparison 250 hPa Winds at 12/00Z vs 12/12Z



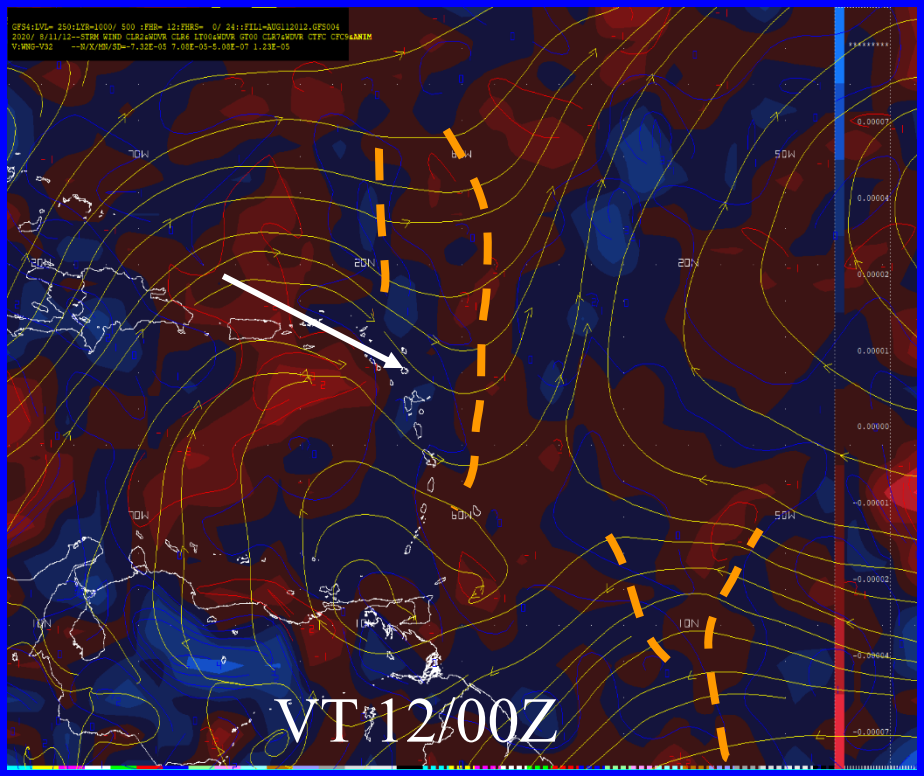


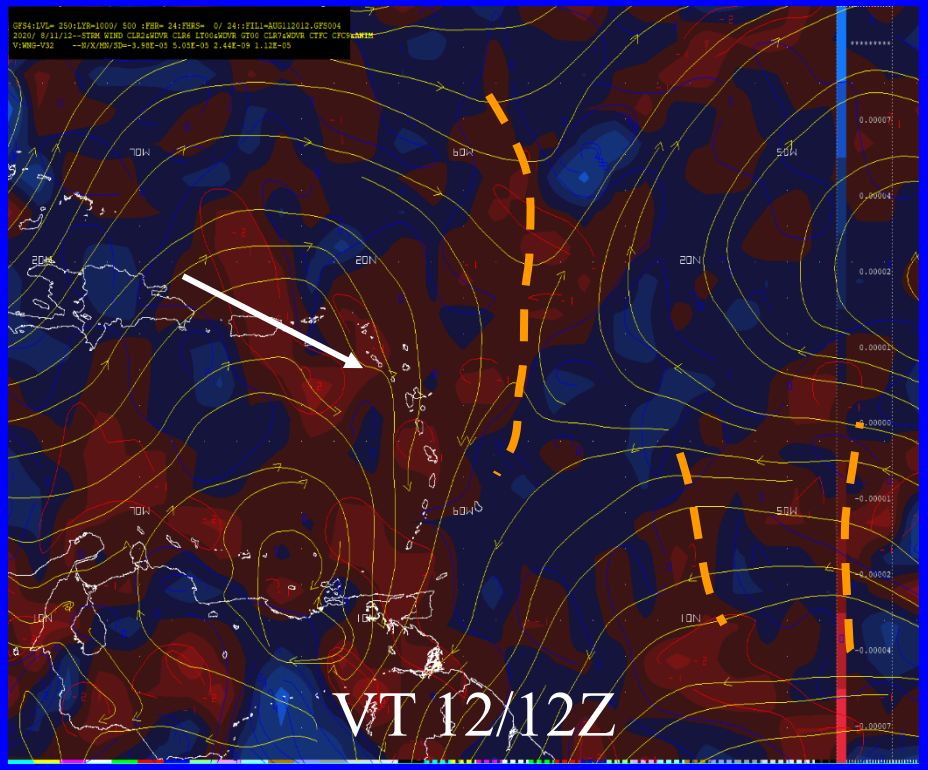
Is the upper level ridge building?

Do you expect an upper convergent or divergent pattern over the Leeward Isles?

Tendency 250 hPa Winds and Divergence Aug 12/00Z & 12/12Z

Convergence in Red/Divergence in Blue

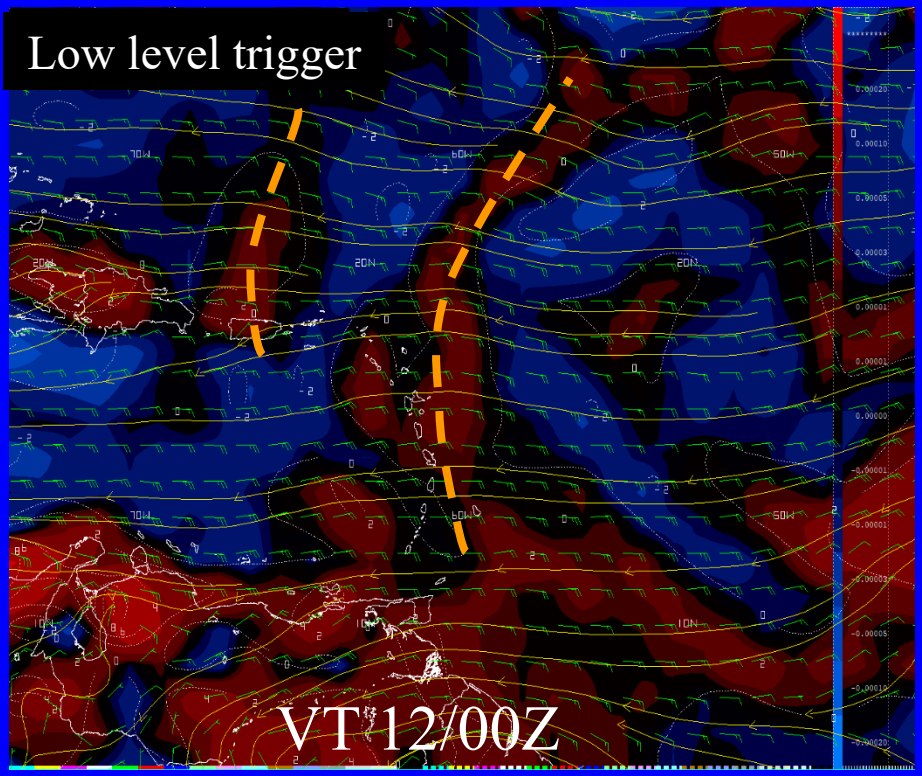


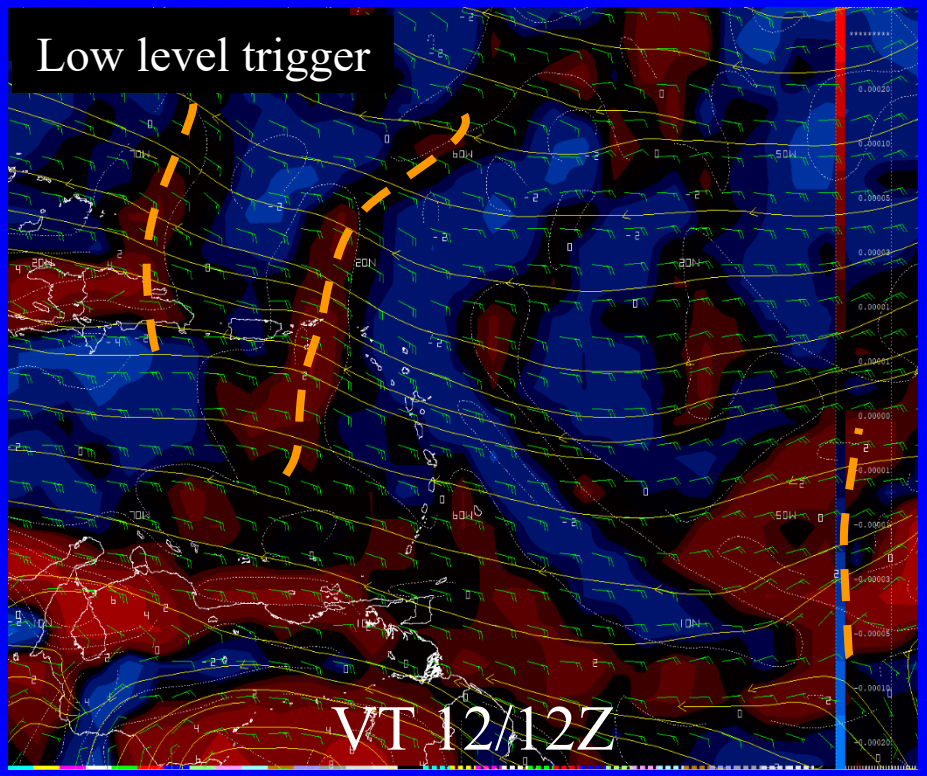


The base of the TUTT pulls and the upper ridge builds, leading to an increase in upper convergence during the evening to morning hours.

850 hPa Winds and RVRT Aug 12/00Z & 12/12Z

Cyclonic Vorticity in Red



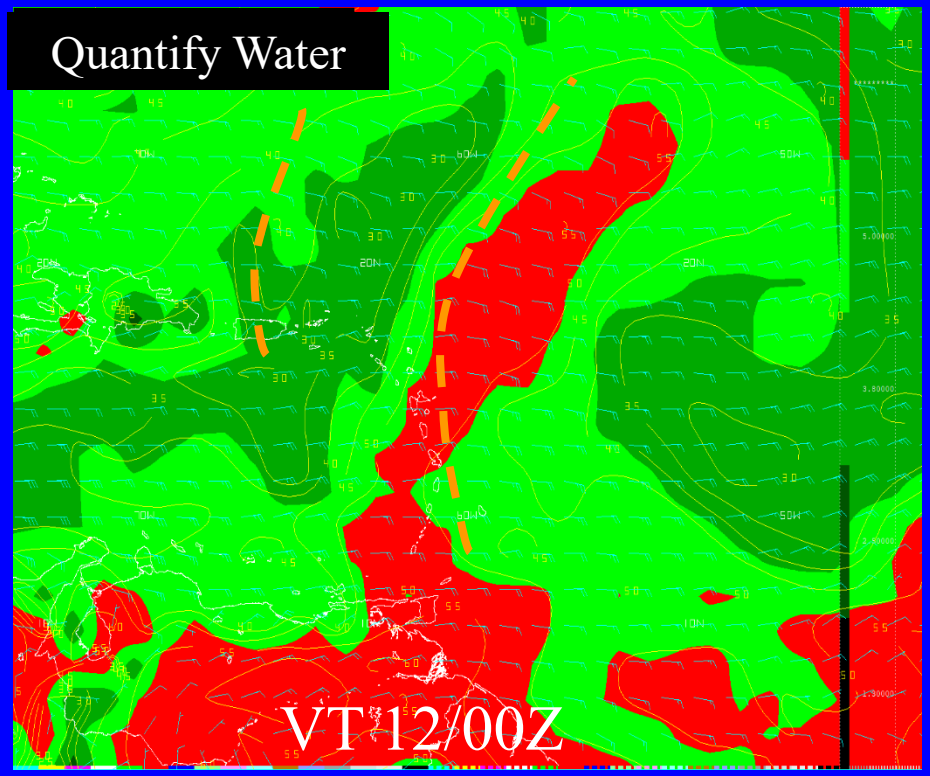


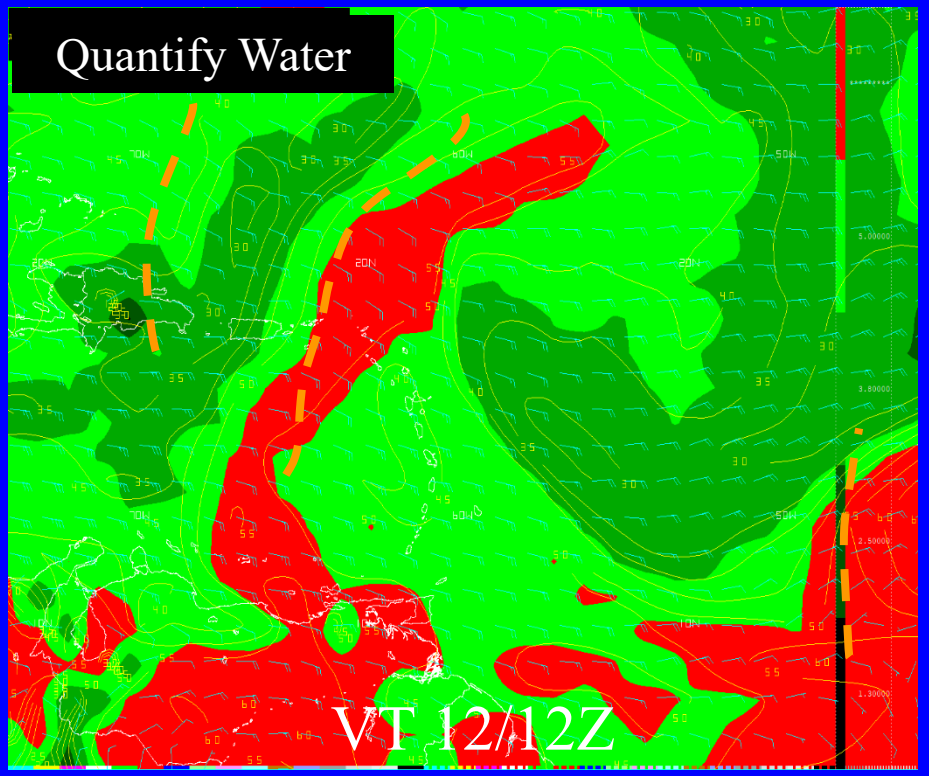
Between 12/00Z and 12/12Z the tropical wave crosses the islands. This is to coincide with intensification of upper convergent pattern.

Do you expect positive or a negative scale interaction?

850 hPa Winds and PWAT Aug 12/00Z & 12/12Z

PWAT ≥ 50mm in Red

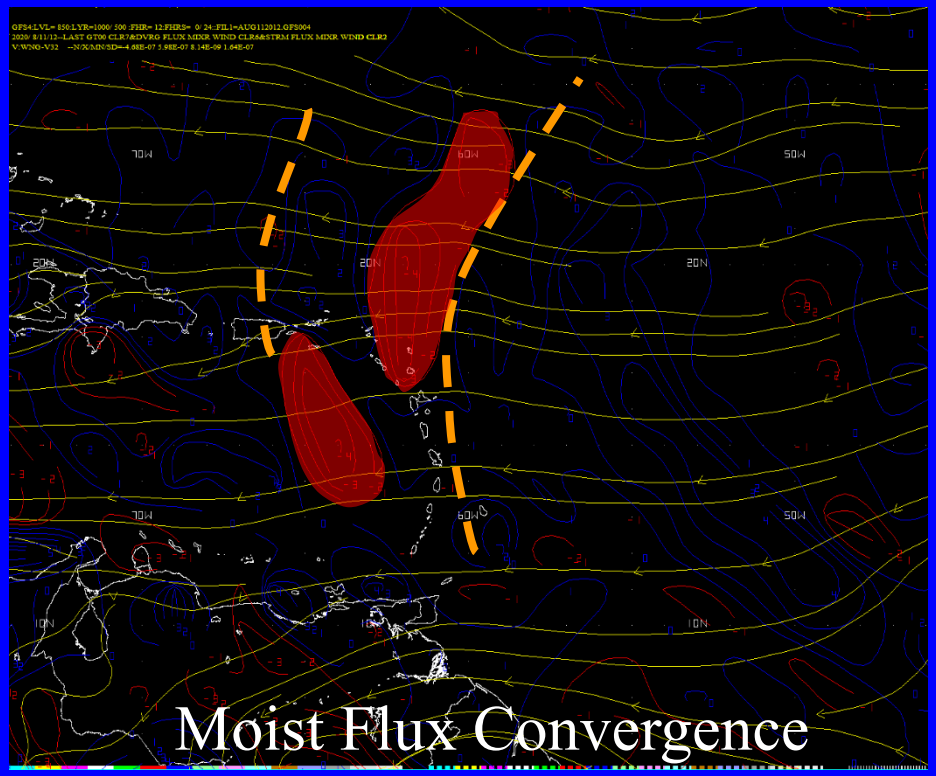


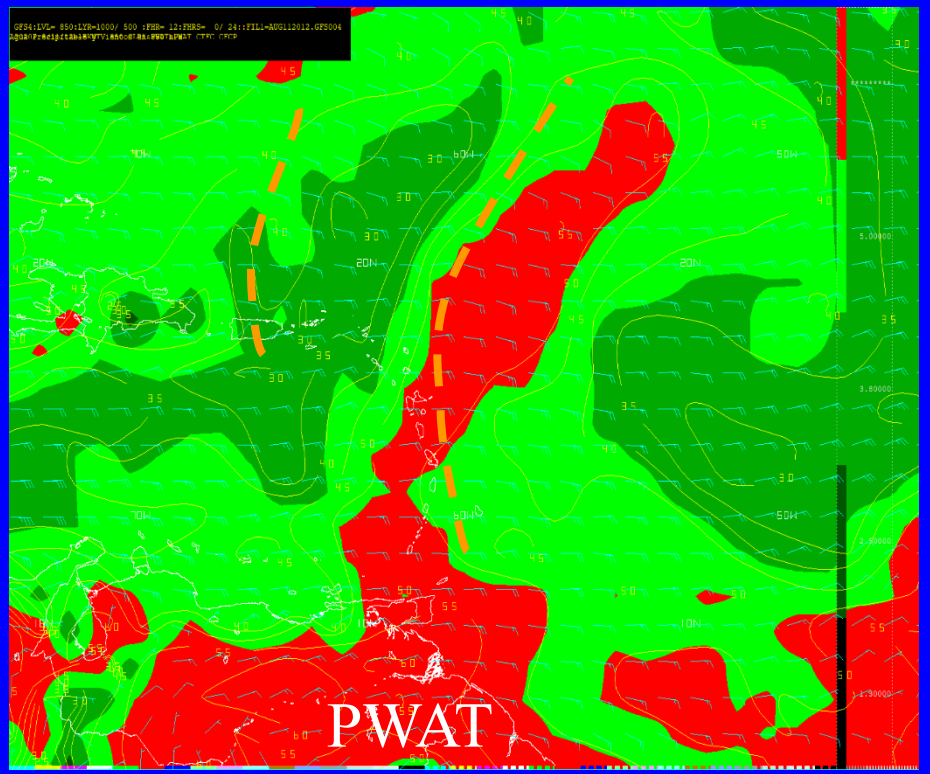


Between 12/00Z and 12/12Z PWAT plume lifts across the French to the VI , with slight modulation of moisture content

850 hPa Flow/Moisture Conv.-PWAT Aug 12/00Z

Moisture Convergence in Red & PWAT ≥ 50mm in Red

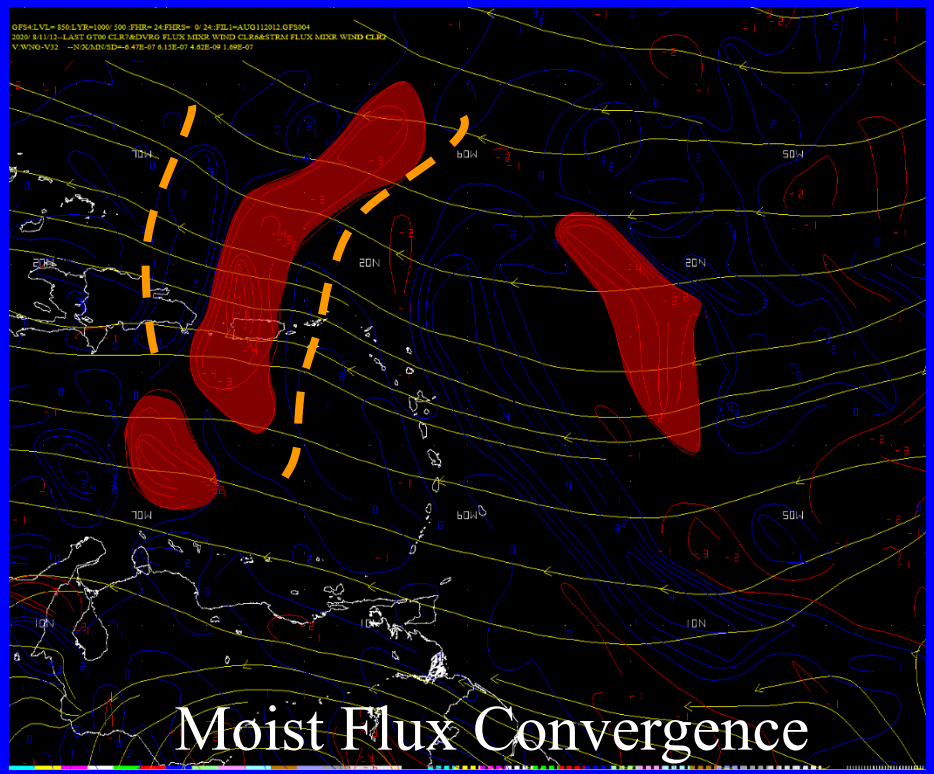


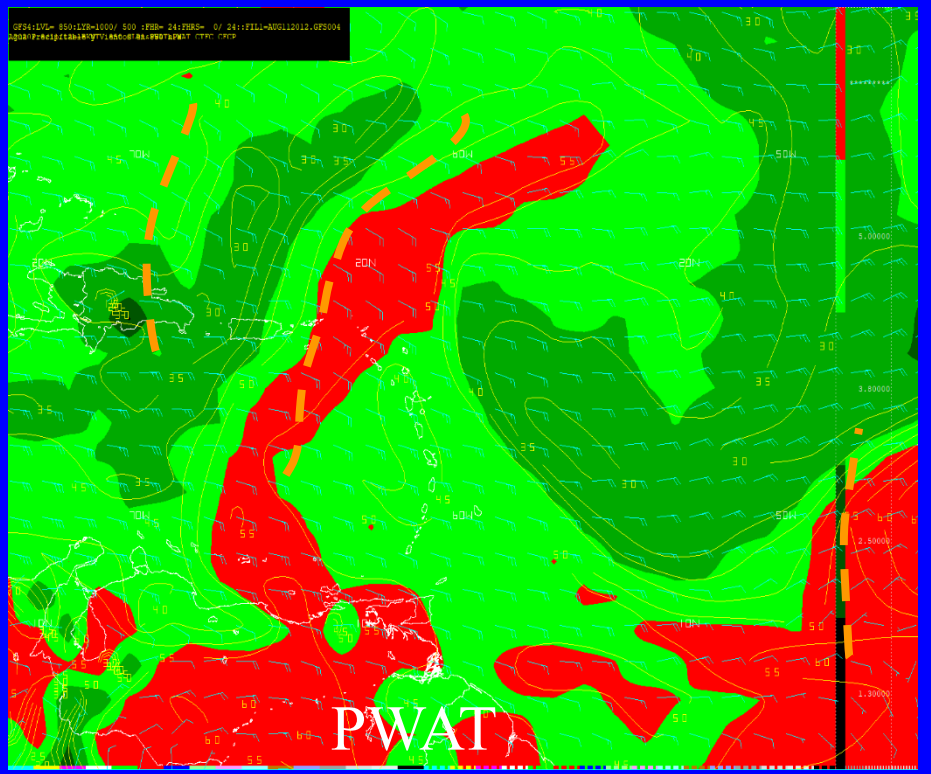


On the 12/00Z best moisture convergence leads the wave axis, while the PWAT plume trails

850 hPa Flow/Moisture Conv.-PWAT
Aug 12/12Z

Moisture Convergence in Red & PWAT ≥ 50mm in Red

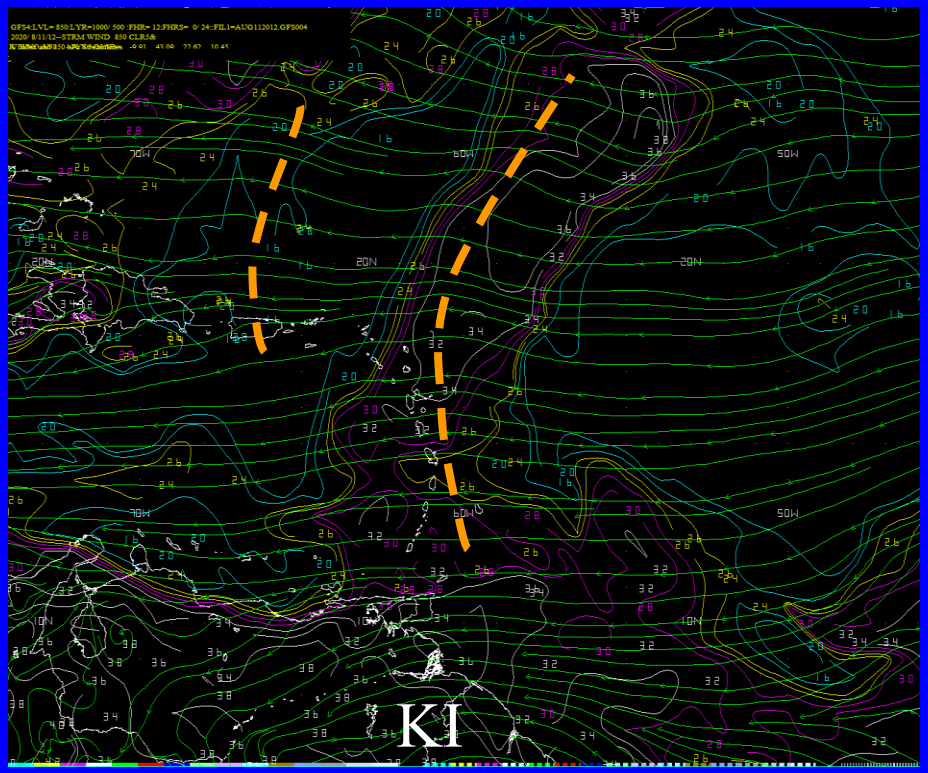


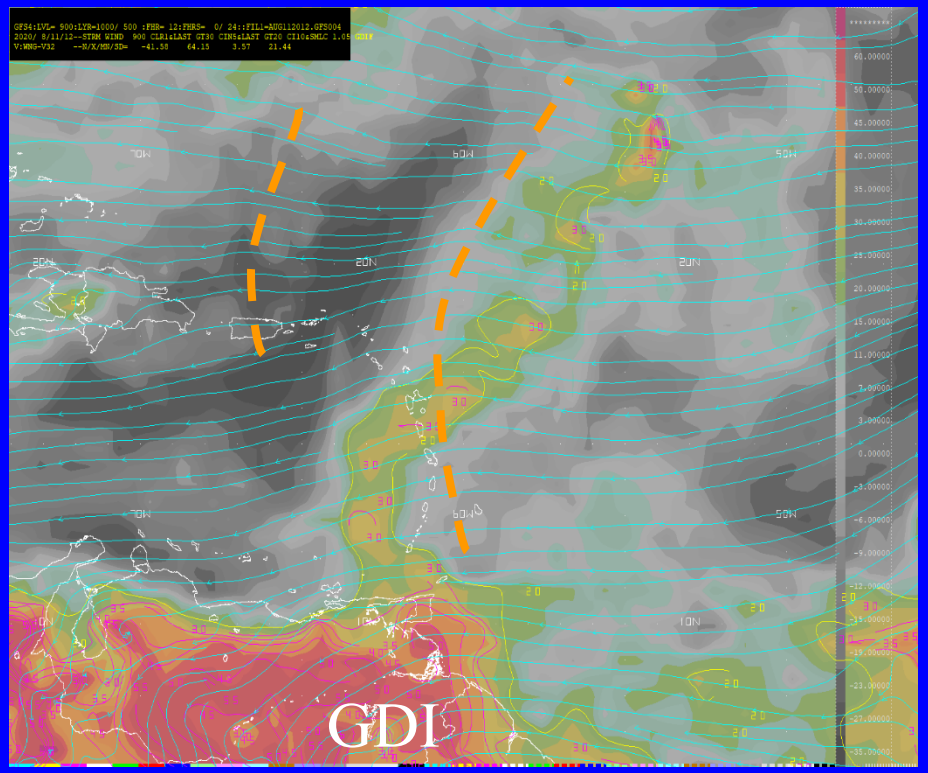


On the 12/12Z best moisture convergence continues to lead the wave axis, while the PWAT plume trails

KI and GDI
Aug 12/00Z

KI ≥ 24 and GDI ≥ 20 Color filled

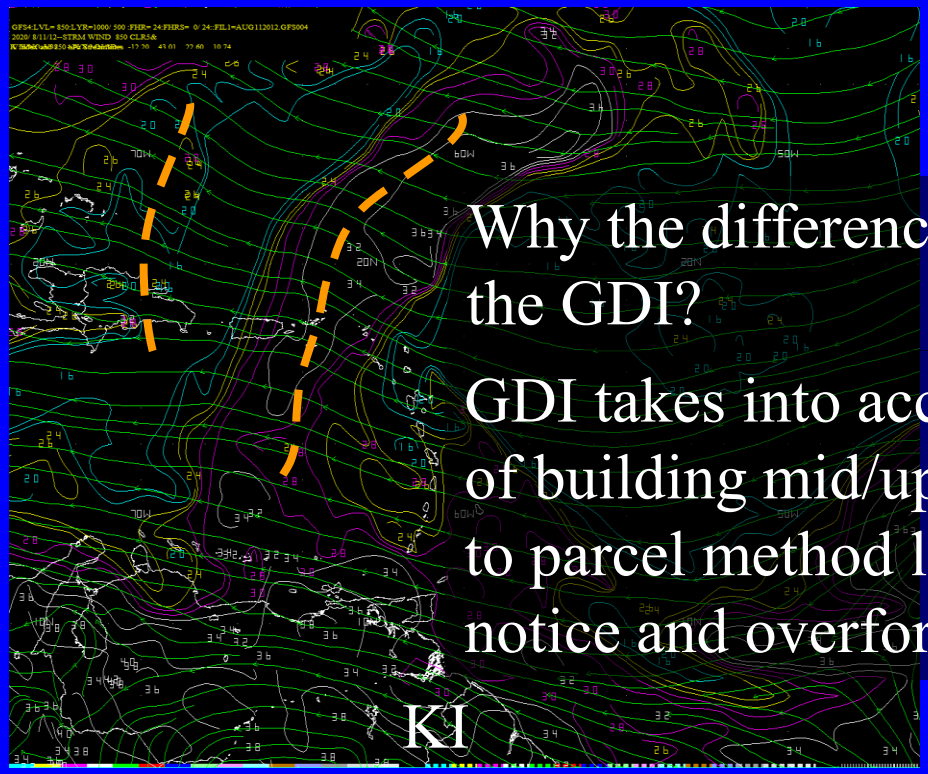




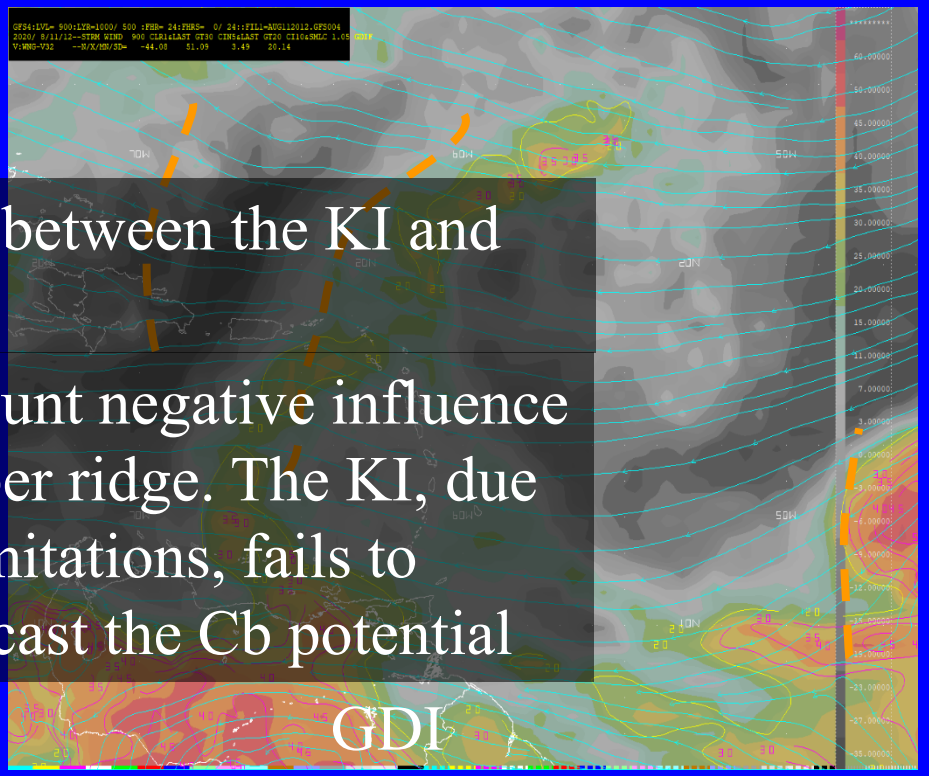
KI of 34 and GDI of 30 show potential for thunderstorms over the French Islands.

KI and GDI
Aug 12/12Z

KI ≥ 24 and GDI ≥ 20 Color filled



KI



GDI

Why the difference between the KI and the GDI?

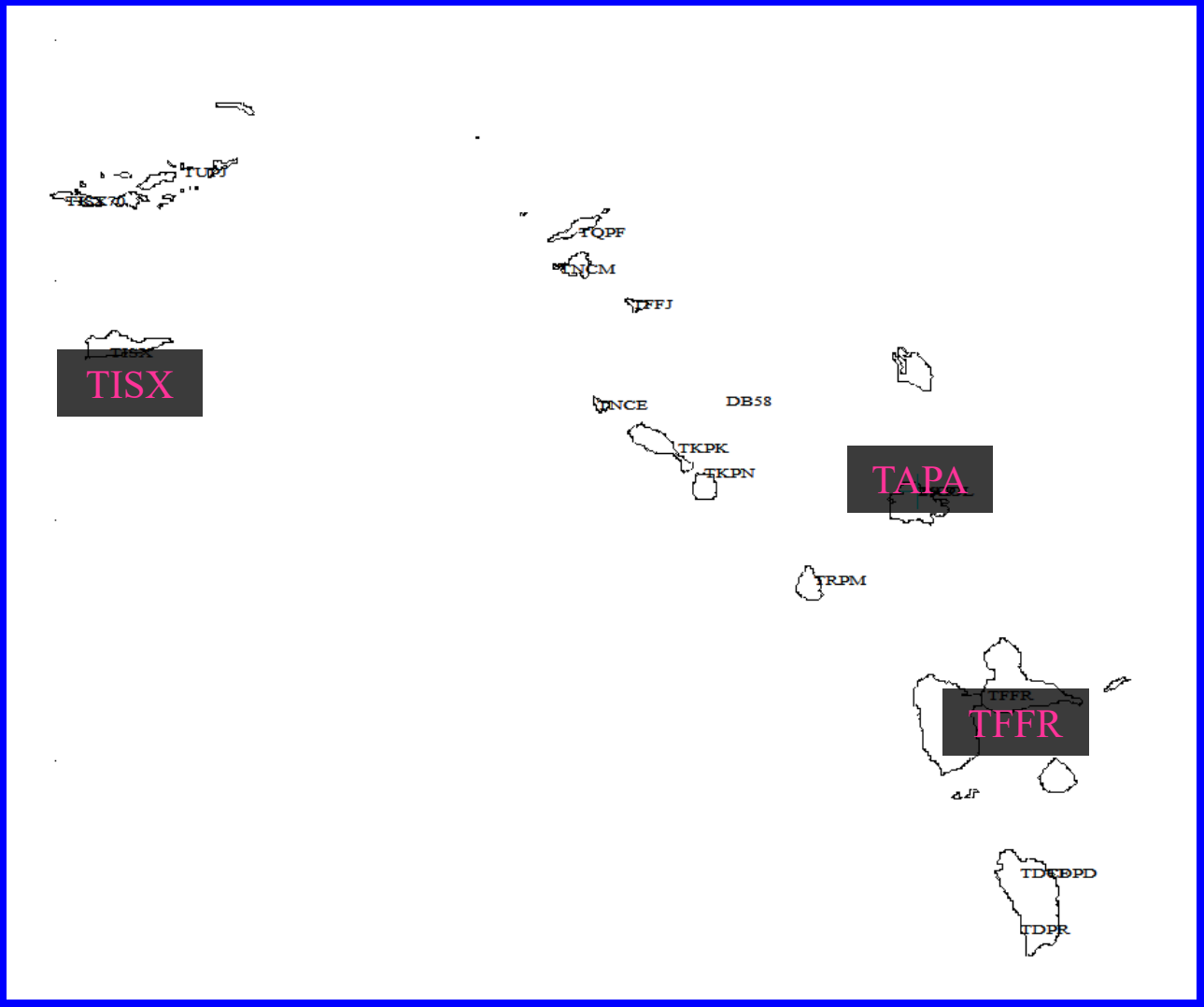
GDI takes into account negative influence of building mid/upper ridge. The KI, due to parcel method limitations, fails to notice and overforecast the Cb potential

On the 12/12z the KI continues to show potential for scattered thunderstorms, while the GDI suggest isolated development, with mostly rain showers along the wave axis.

Time Sections

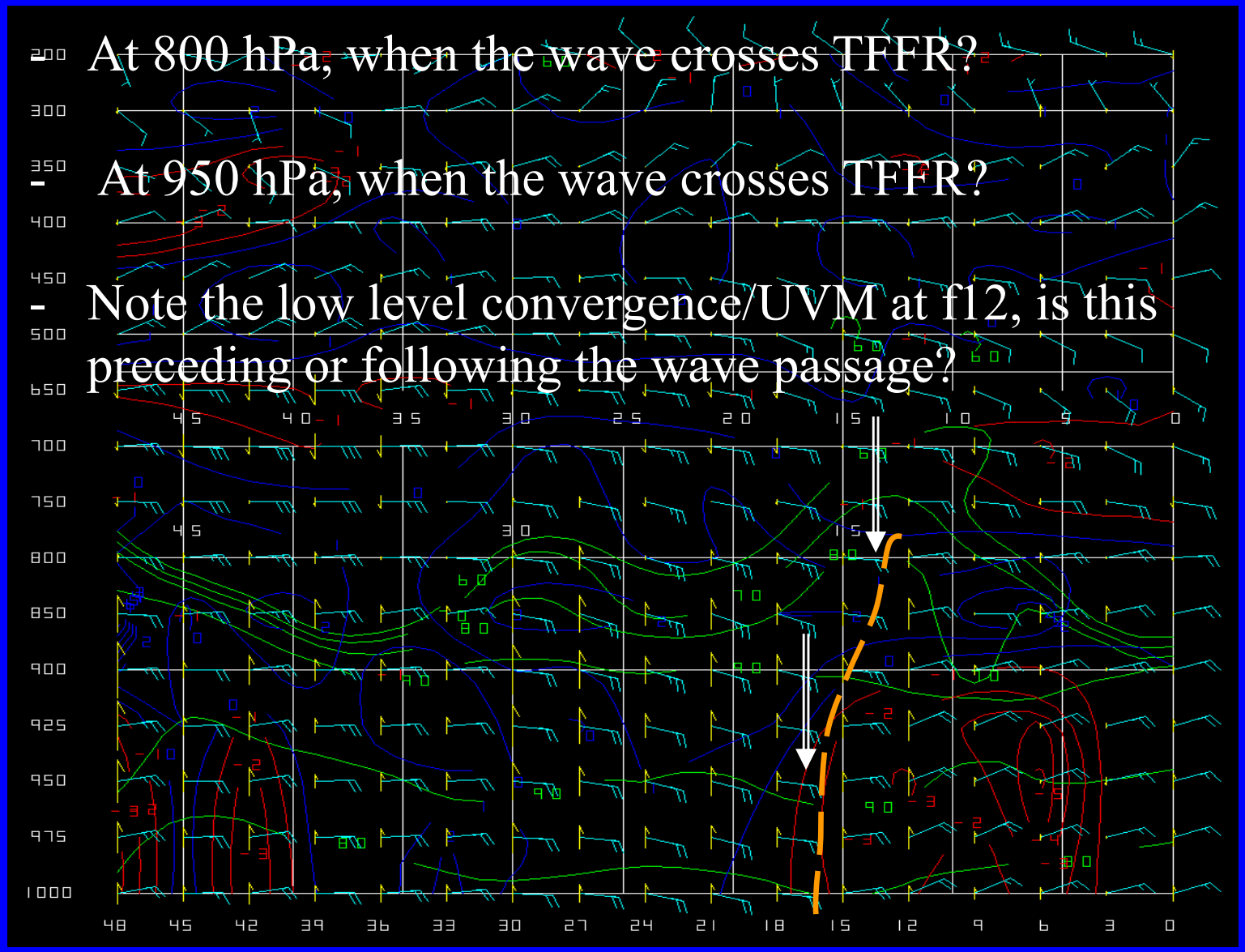
- Evaluation of vertical time sections allows the meteorologist to take a quick glance at the vertical dynamics.
  - Helps to diagnose periods of shallow vs. deep convection
  - Most helpful with synoptic driven systems

Quick View Locations



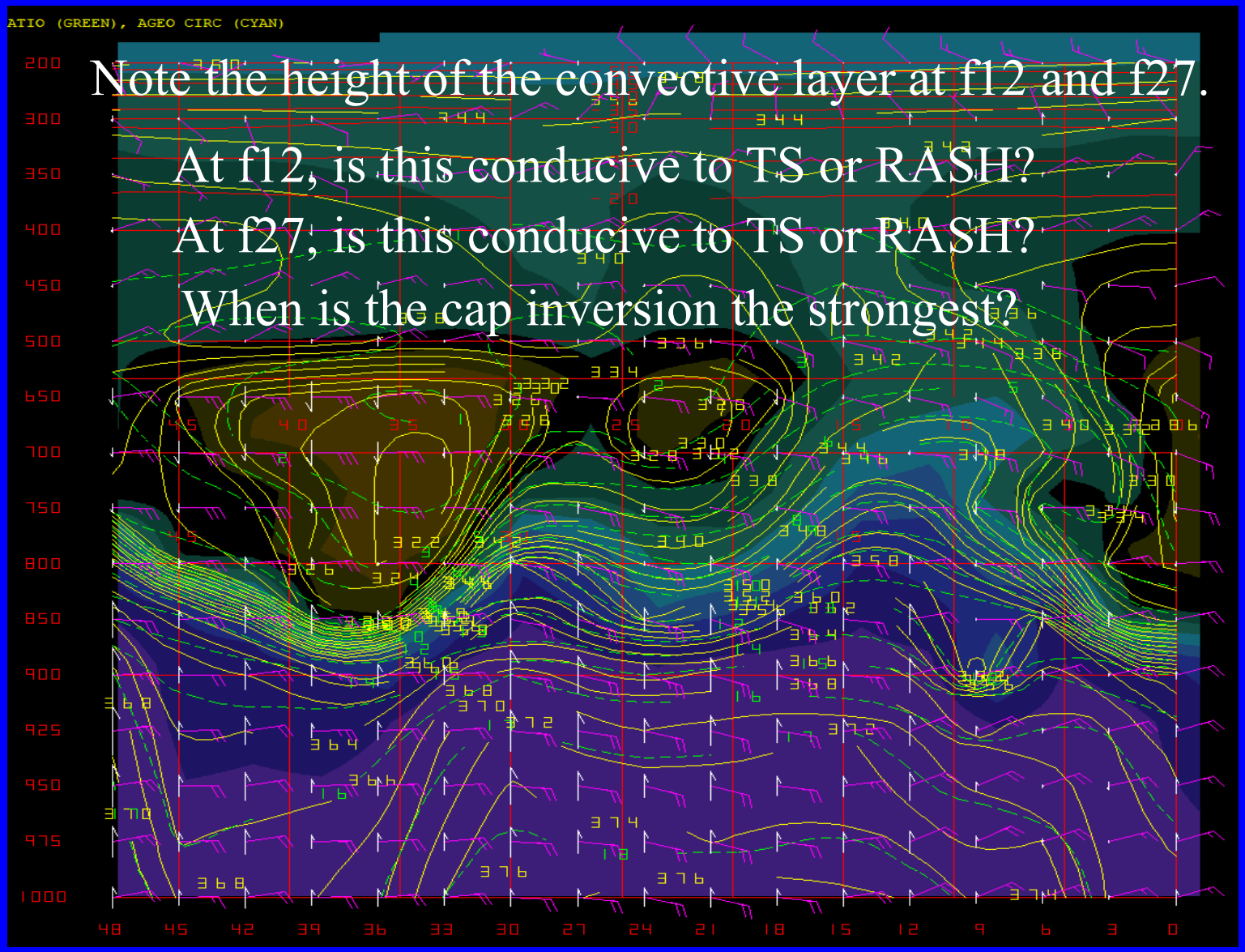
Quick View Time Section - TFFR

Green=RH > 60, Cyan=Total Wind, Yellow=Omega, Red=Convergence



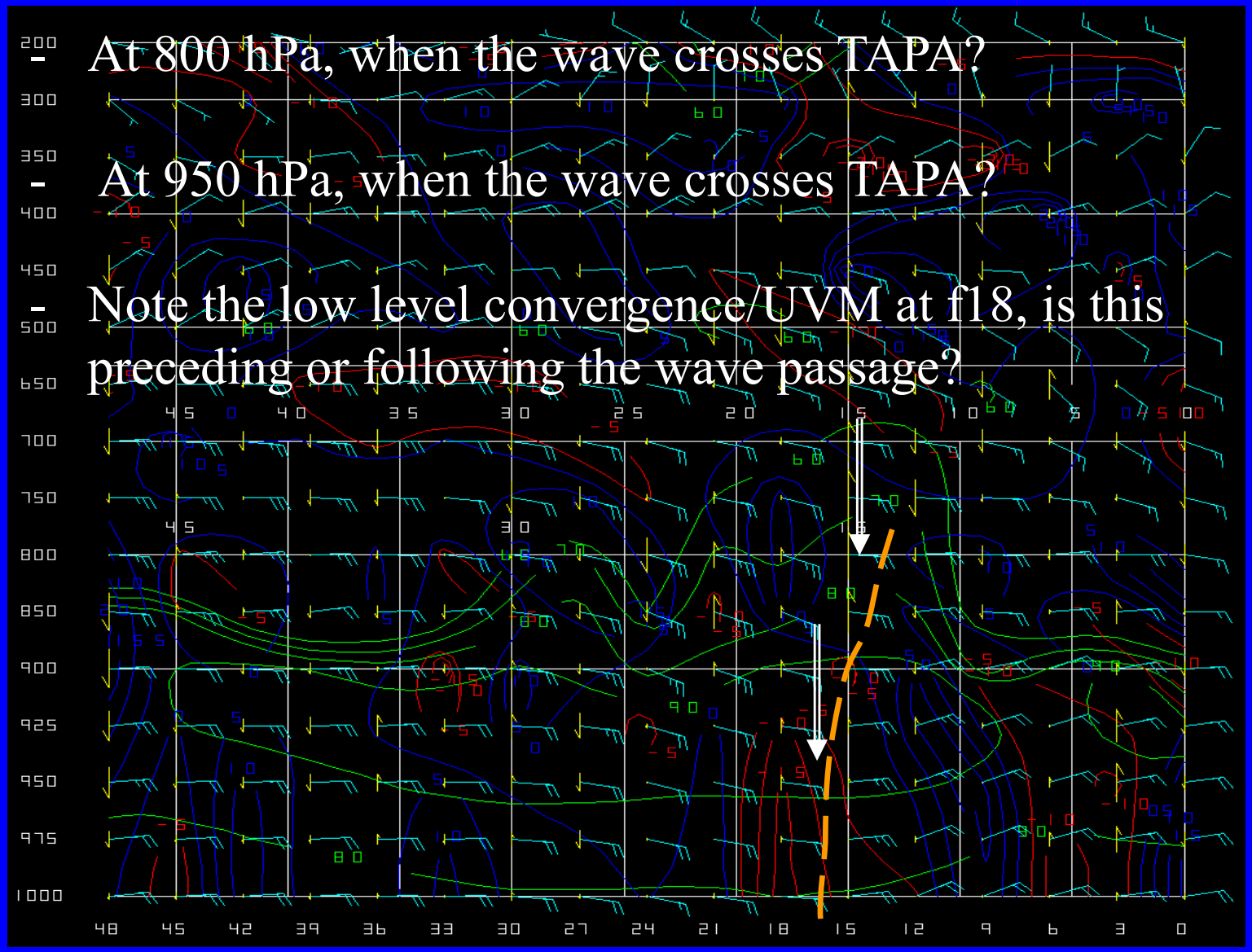
Quick View Time Section - TFFR

Yellow/Color Filled=EPT, White=Omega, Red=T ≤ -20C



Quick View Time Section - TAPA

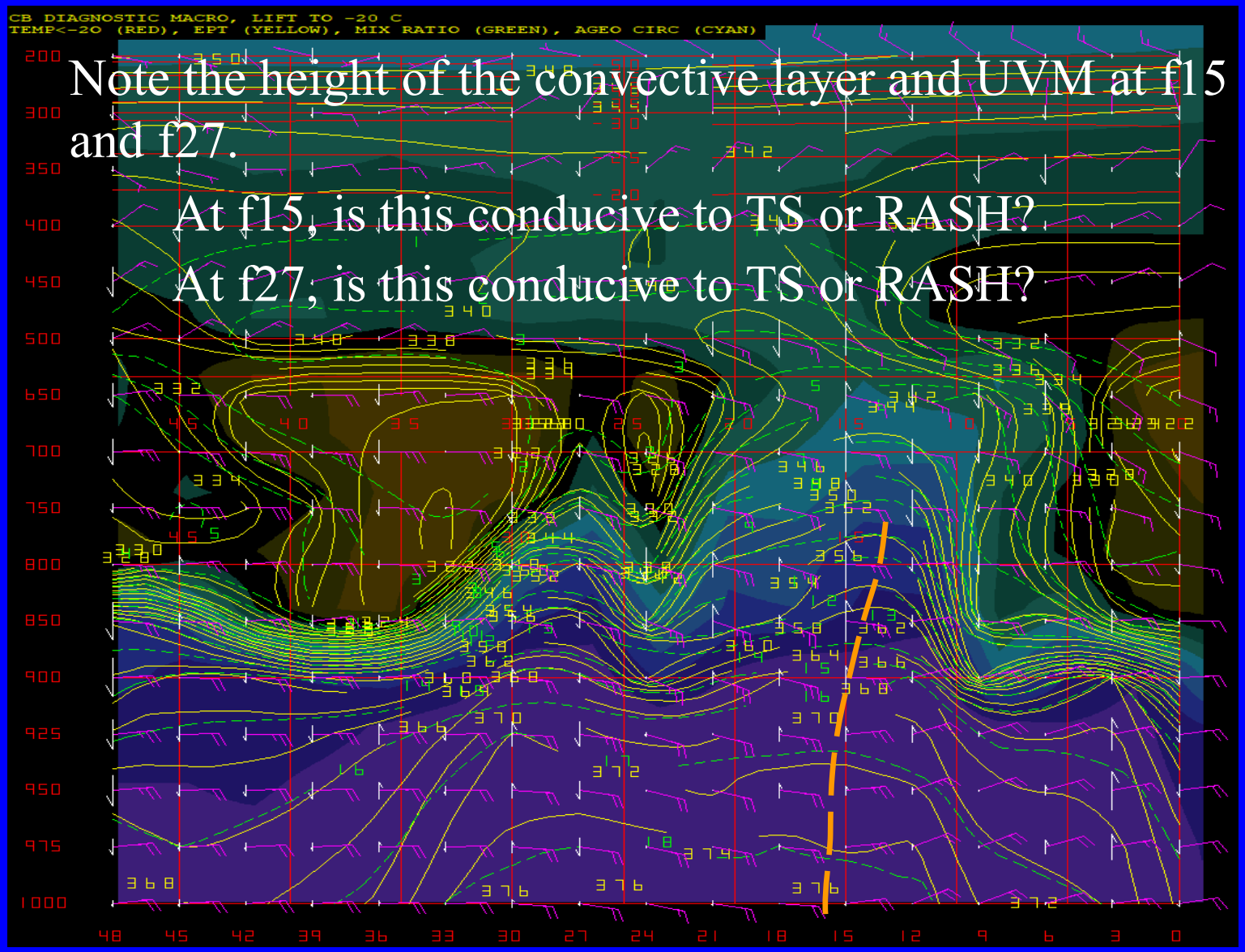
Green=RH > 60, Cyan=Total Wind, Yellow=Omega, Red=Convergence



- At 800 hPa, when the wave crosses TAPA?
- At 950 hPa, when the wave crosses TAPA?
- Note the low level convergence/UVM at f18, is this preceding or following the wave passage?

Quick View Time Section - TAPA

Yellow/Color Filled=EPT, White=Omega, Red=T $\leq$ -20C

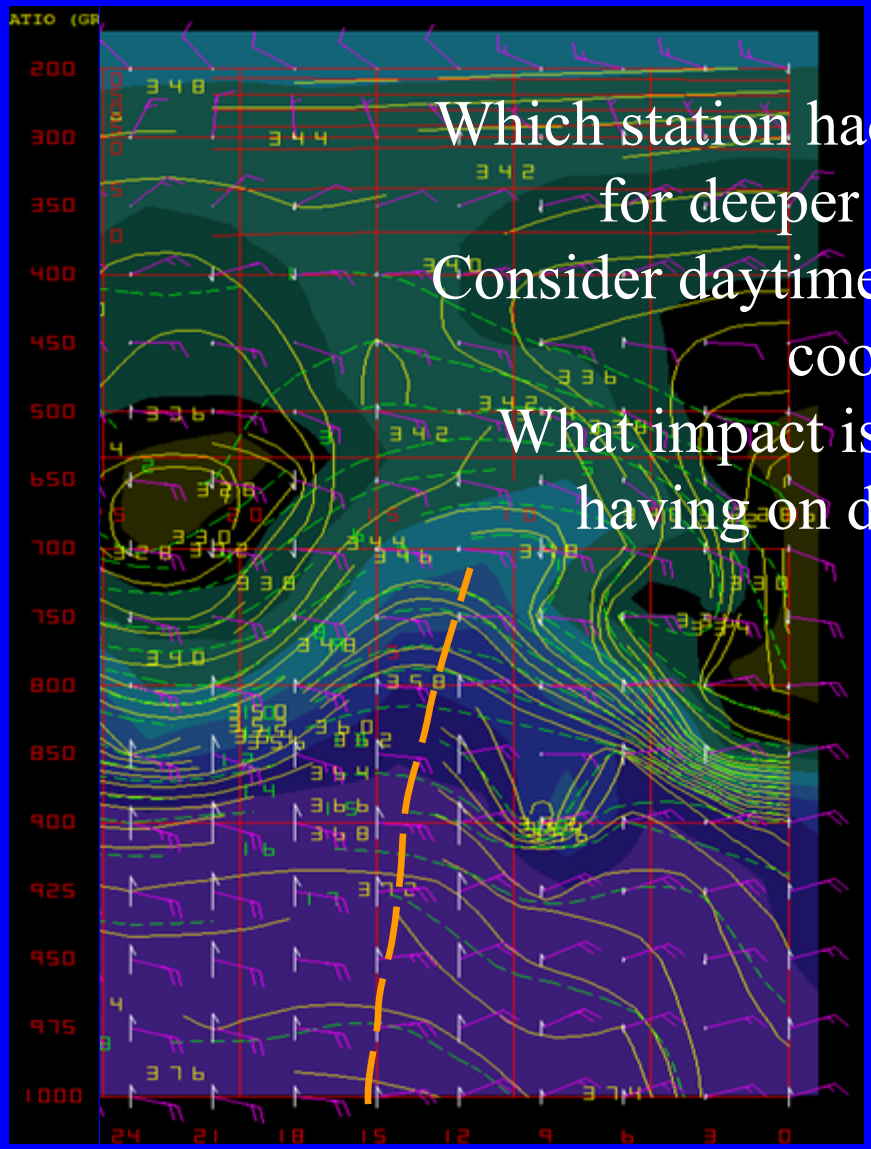


Note the height of the convective layer and UVM at f15 and f27.

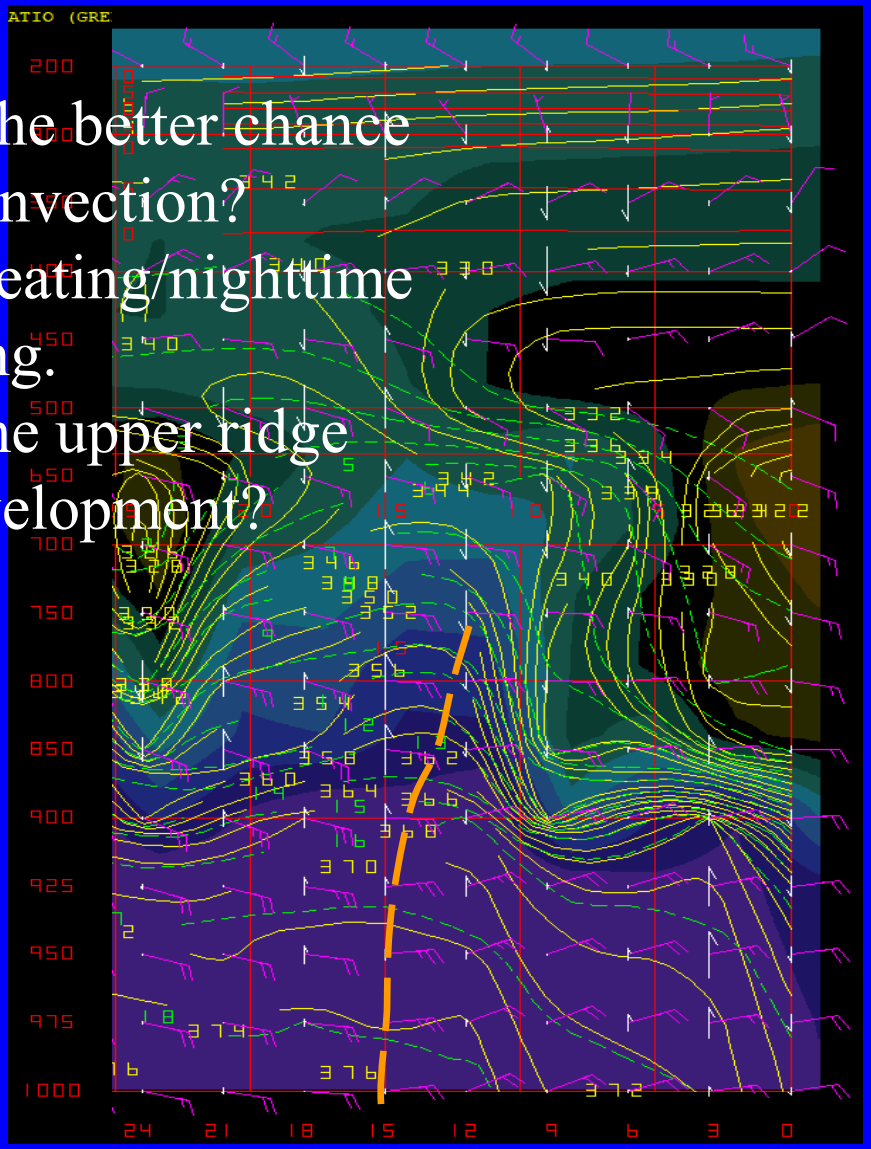
At f15, is this conducive to TS or RASH?

At f27, is this conducive to TS or RASH?

Quick View Time Section – TTFR vs. TAPA
Equivalent Potential Temperature



Which station had the better chance for deeper convection? Consider daytime heating/nighttime cooling. What impact is the upper ridge having on development?



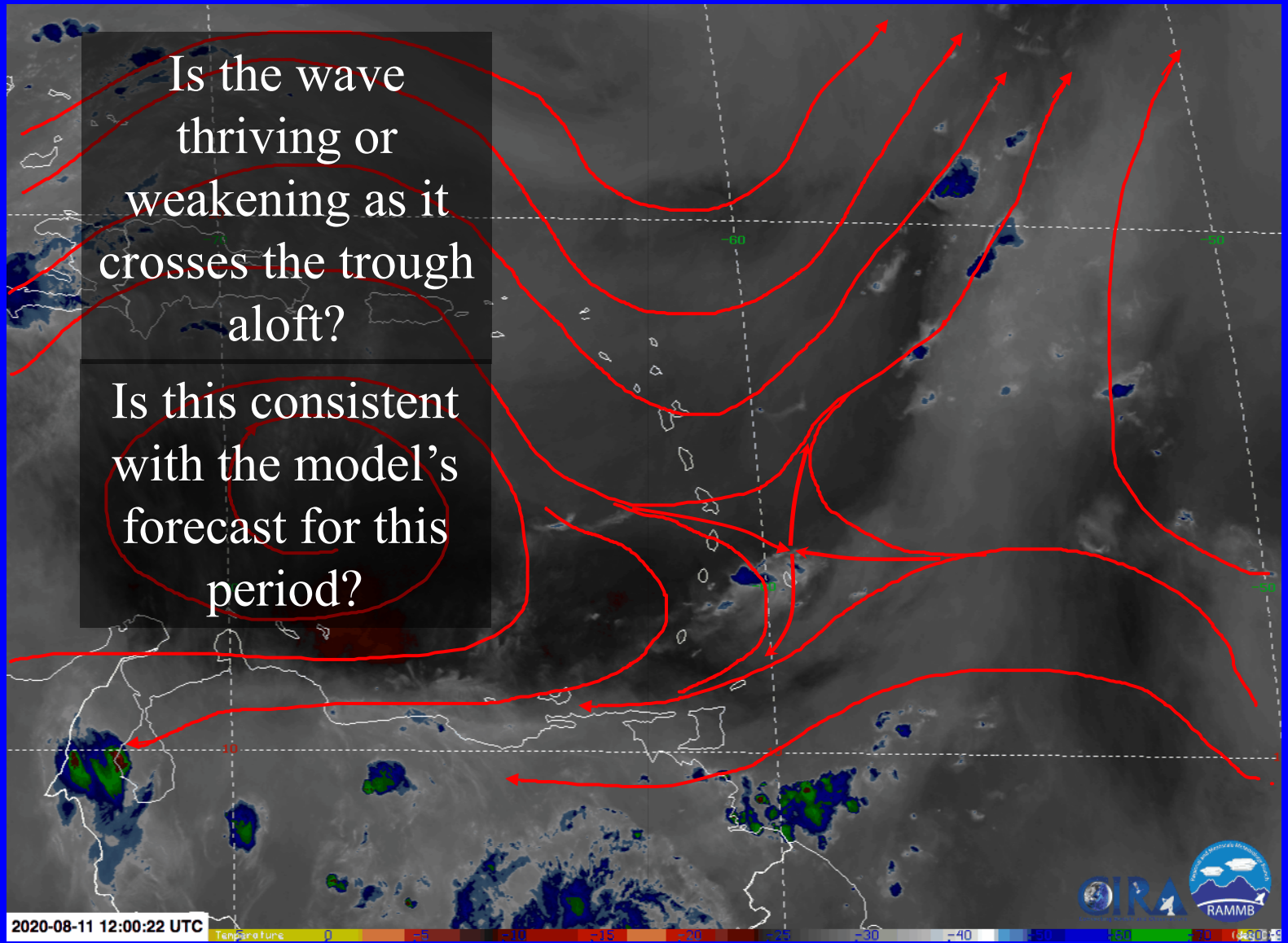
TFFR

TAPA

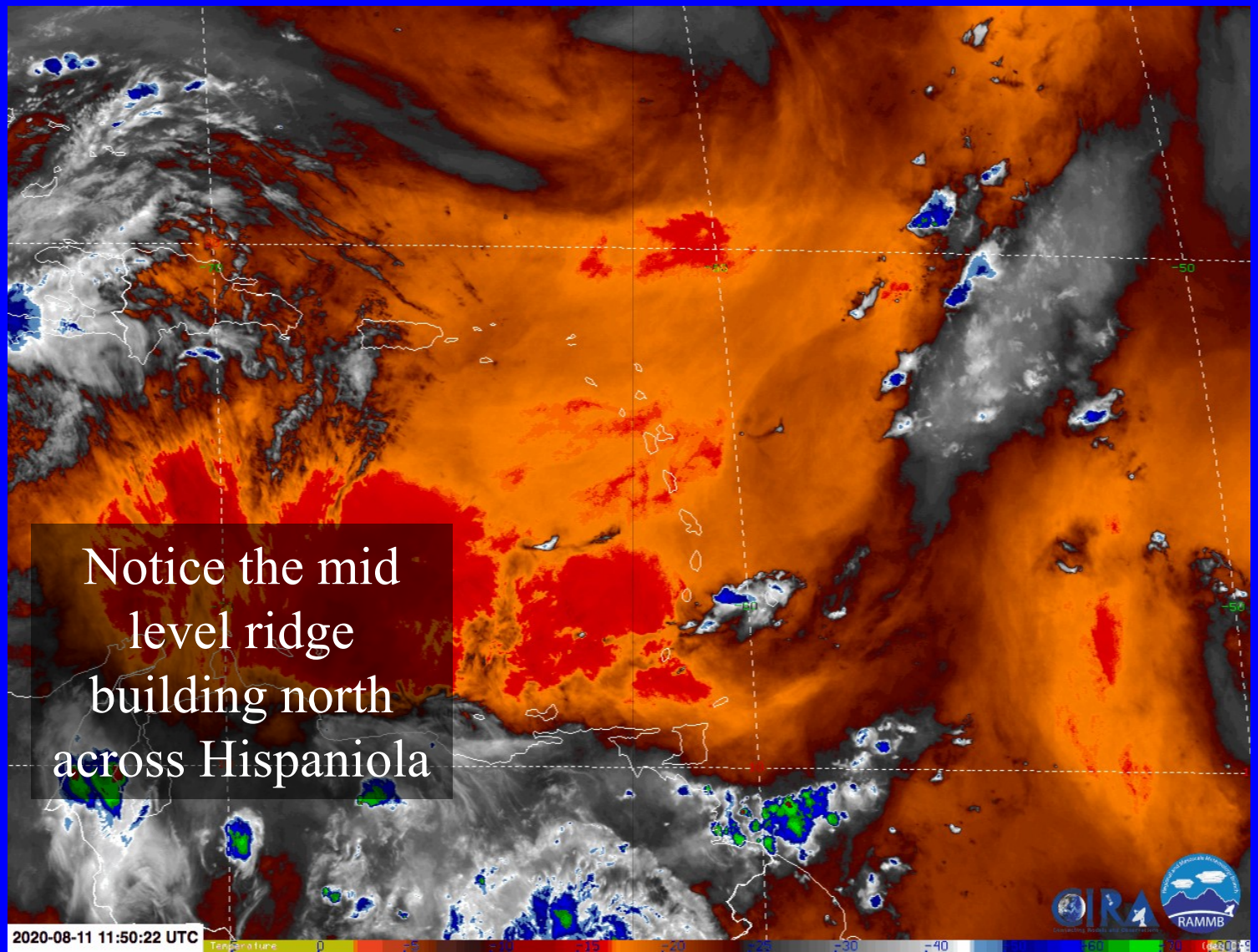
Day 1 Summary

- As the wave enters the Leeward/French Islands:
  - It moves to the convergent/subsident side of the TUTT
    - Negative interaction between the upper trough and lower level perturbation
    - Unfavorable environment for development
  - Convective instability
    - Early evening hours the instability wanes

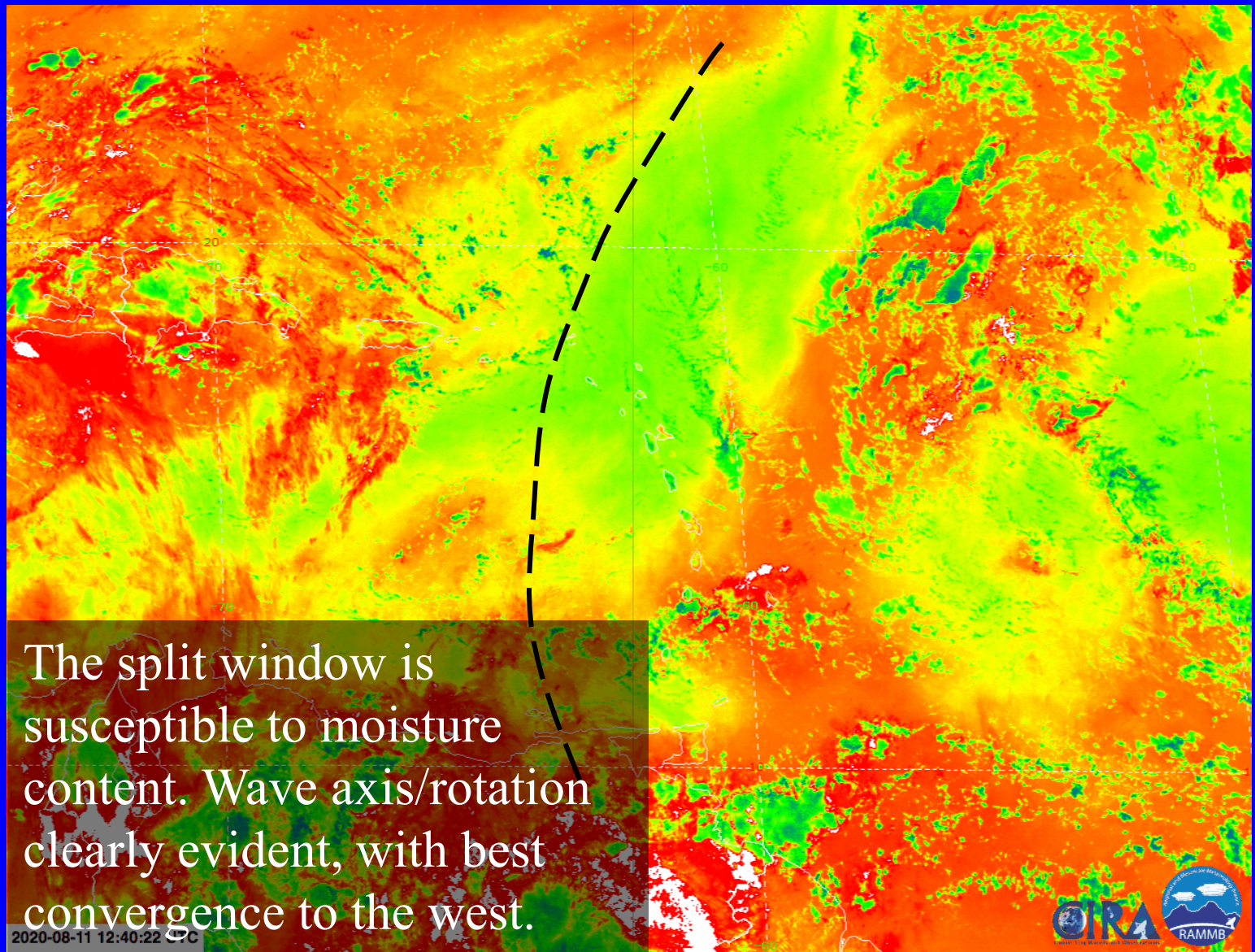
Verification Day 1
6.2um (Ending at 12/12Z)



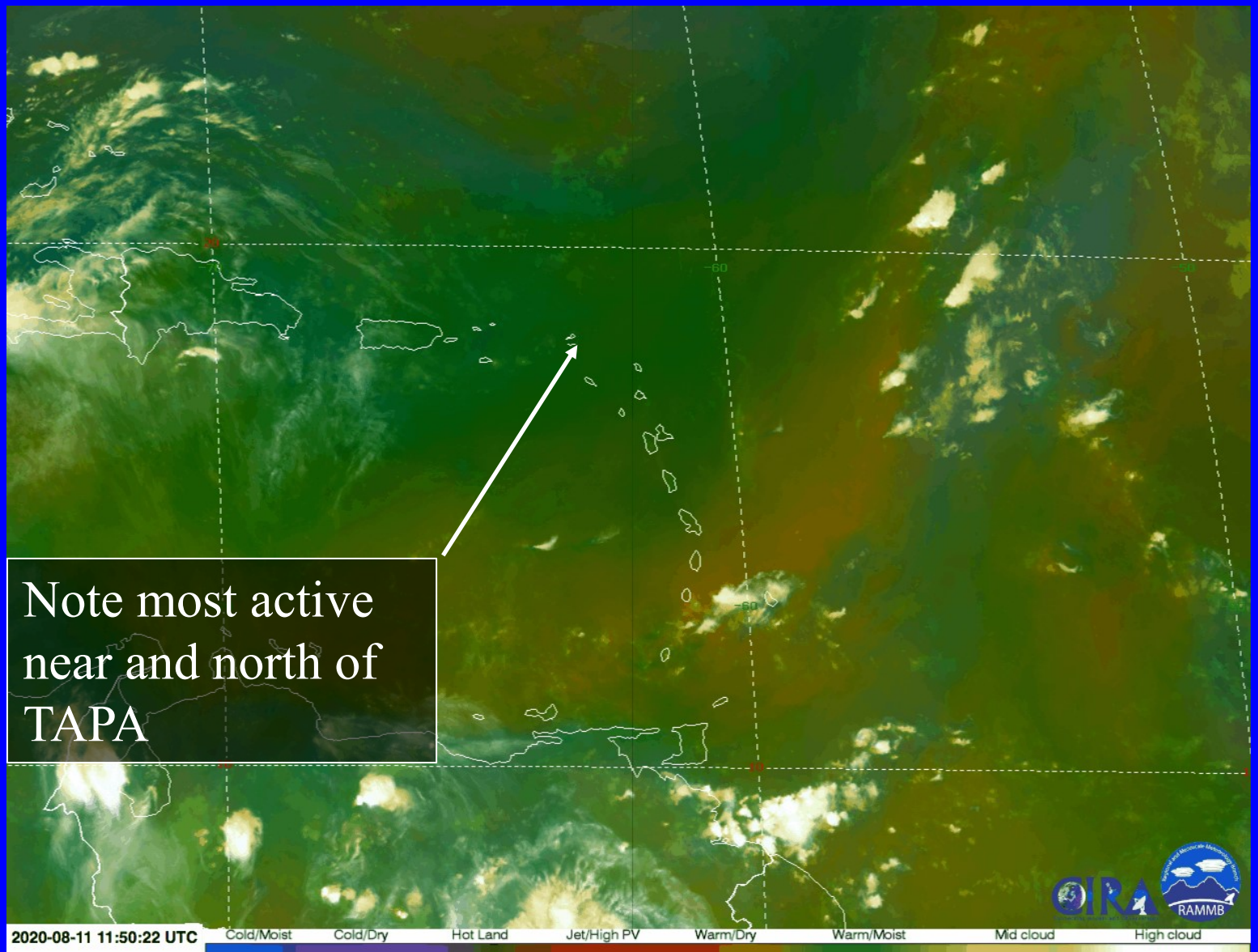
Verification Day 1
6.9um (Ending at 12/12Z)



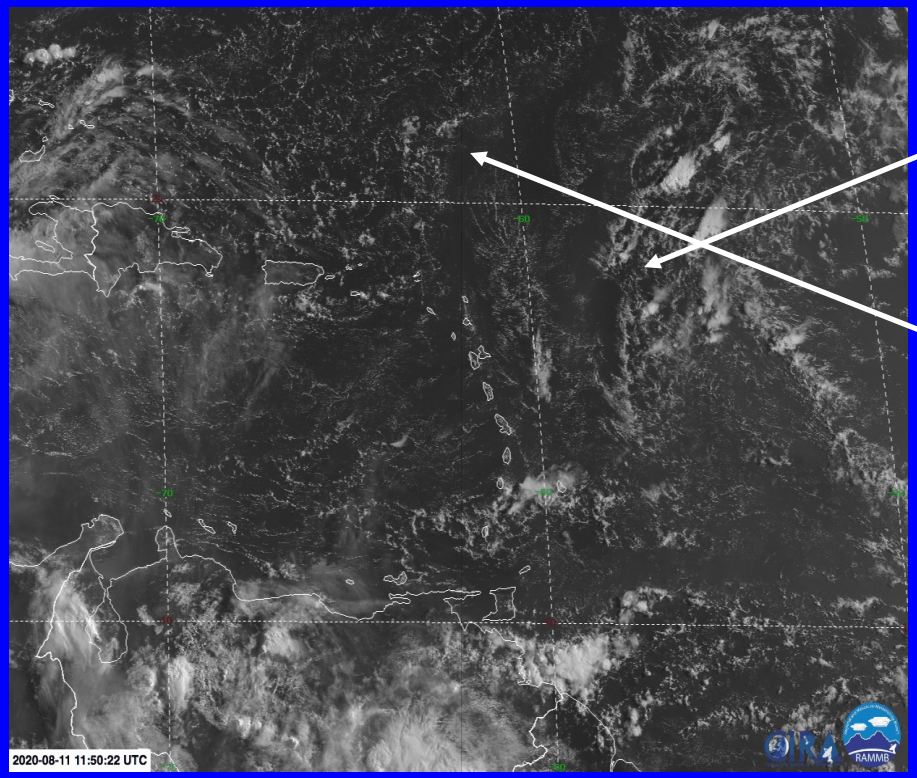
Verification Day 1
Split Window (Ending at 12/12Z)

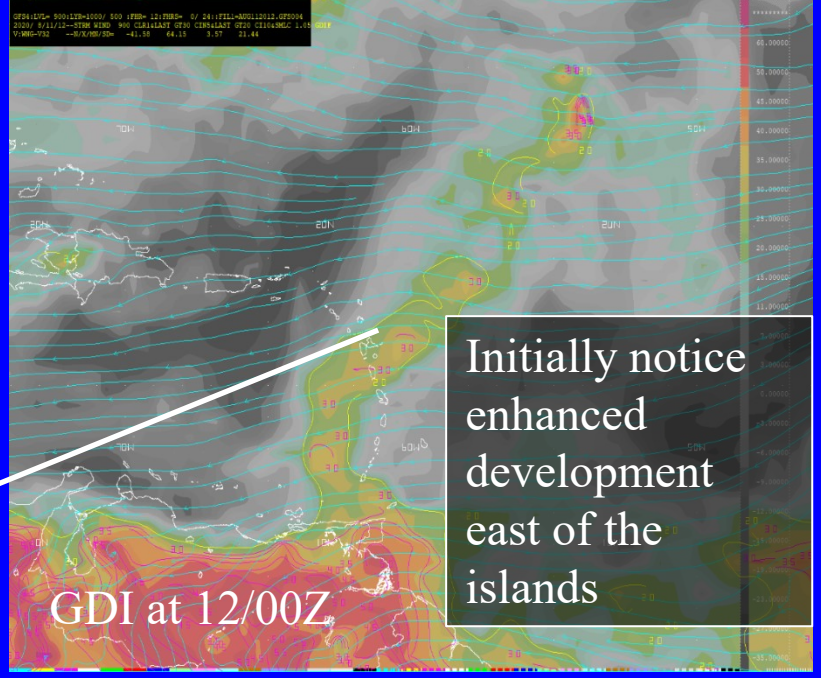


Verification Day 1
Air Mass (Ending at 12/12Z)

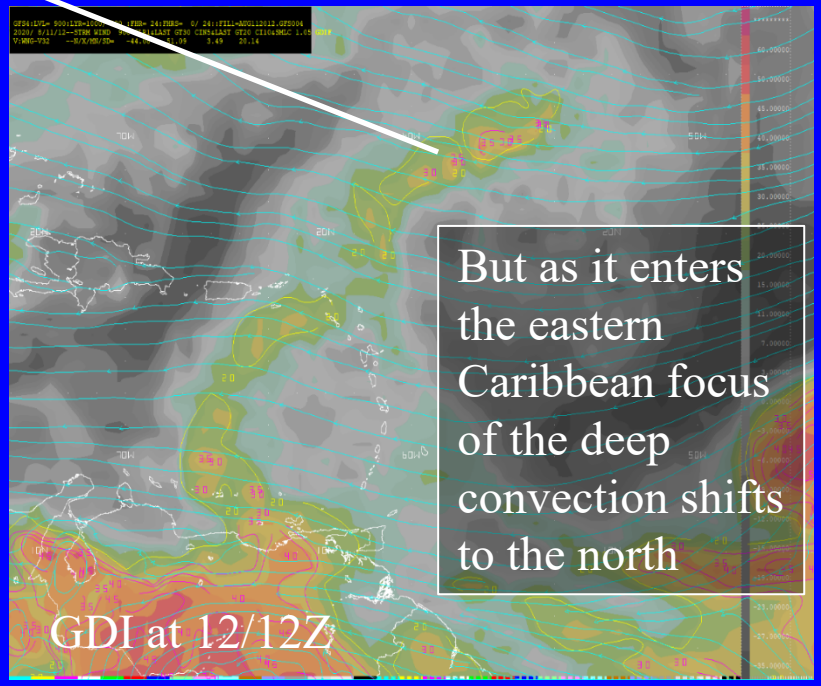


Verification Day 1 Proxy





Initially notice enhanced development east of the islands



But as it enters the eastern Caribbean focus of the deep convection shifts to the north

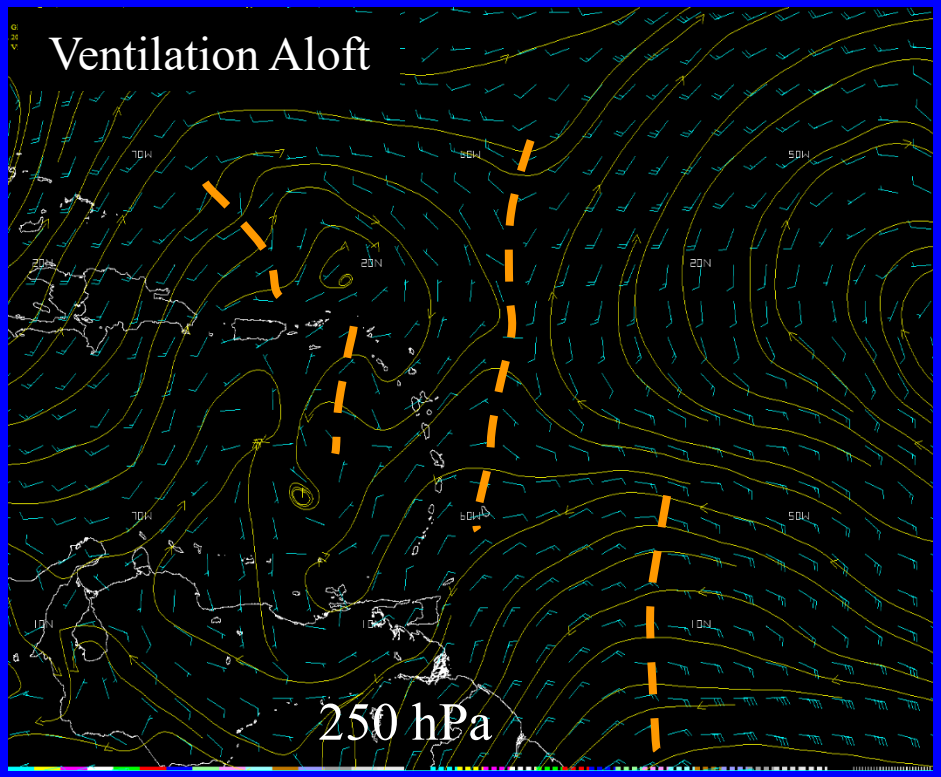
Day 2 Forecast

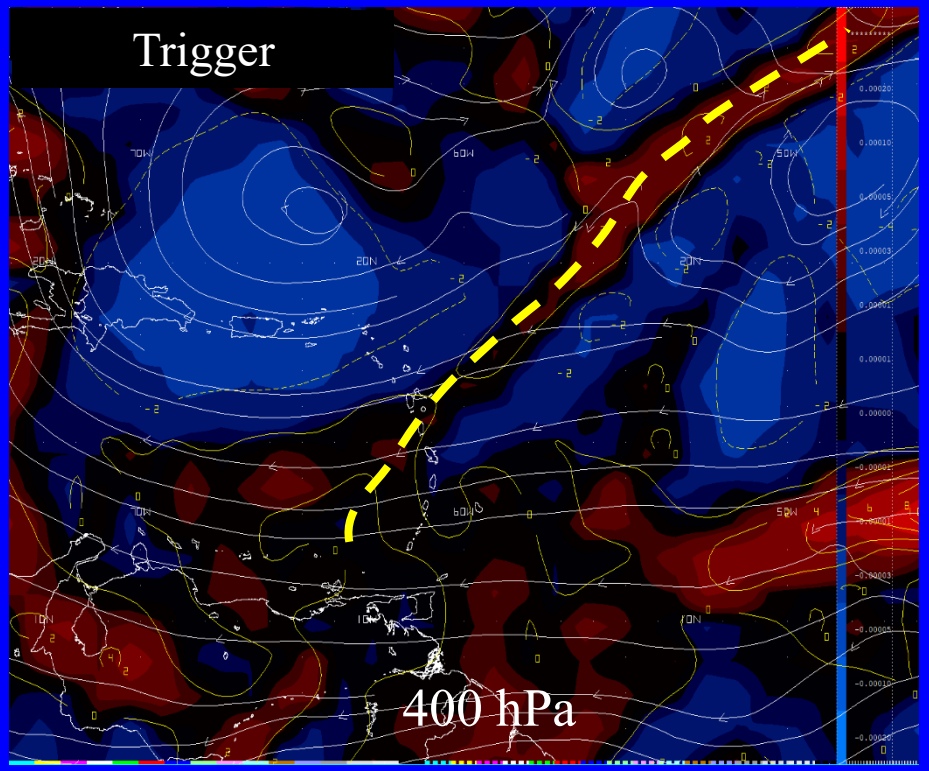
August 12/18Z – August 13/00Z

The wave enters the Virgin Isles-Puerto Rico

250 hPa Winds/400 hPa Stream Lines Relative Vorticity: VT Aug 12/18Z

Cyclonic Vorticity in Red

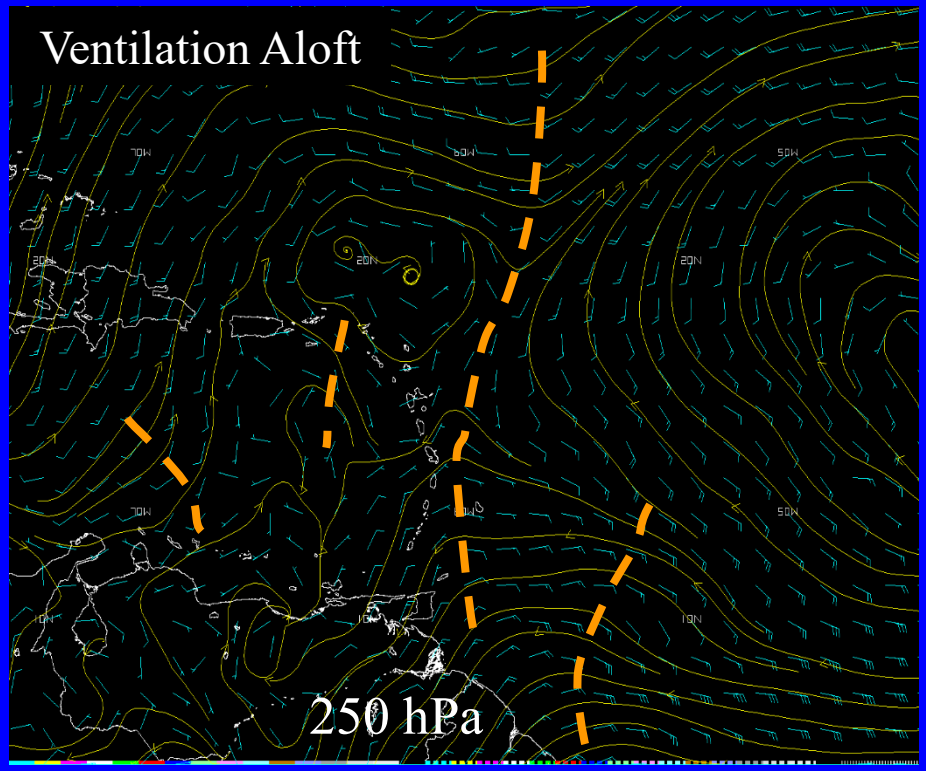


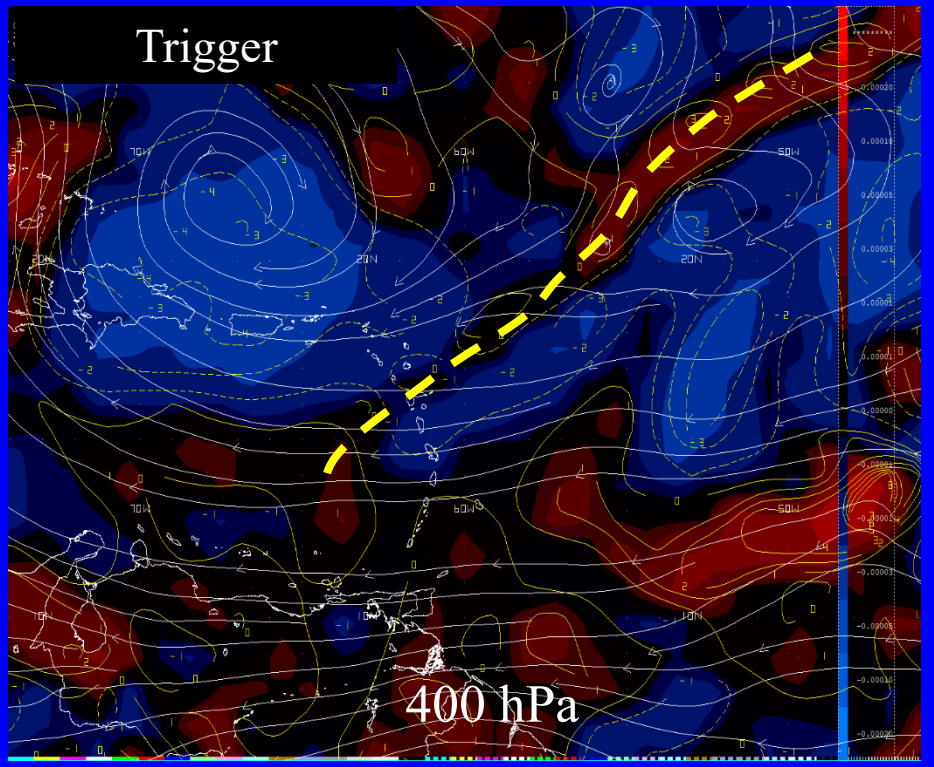


Retrogressing TUTT inducing a weakness in the mid/upper level ridge pattern

250 hPa Winds/400 hPa Stream Lines Relative Vorticity: VT Aug 13/00Z

Cyclonic Vorticity in Red

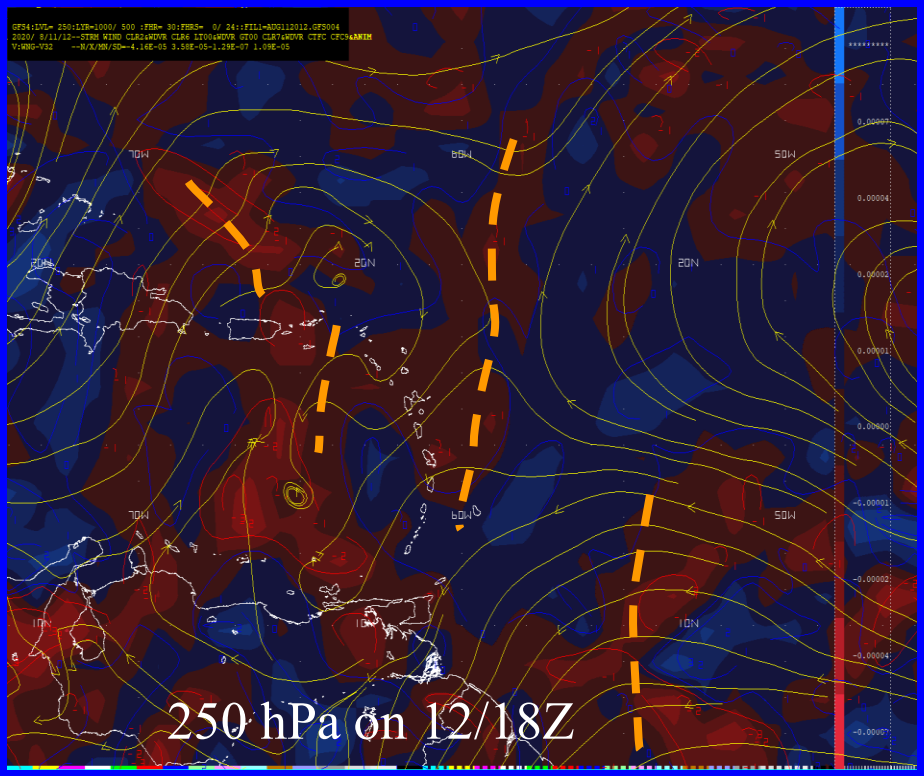


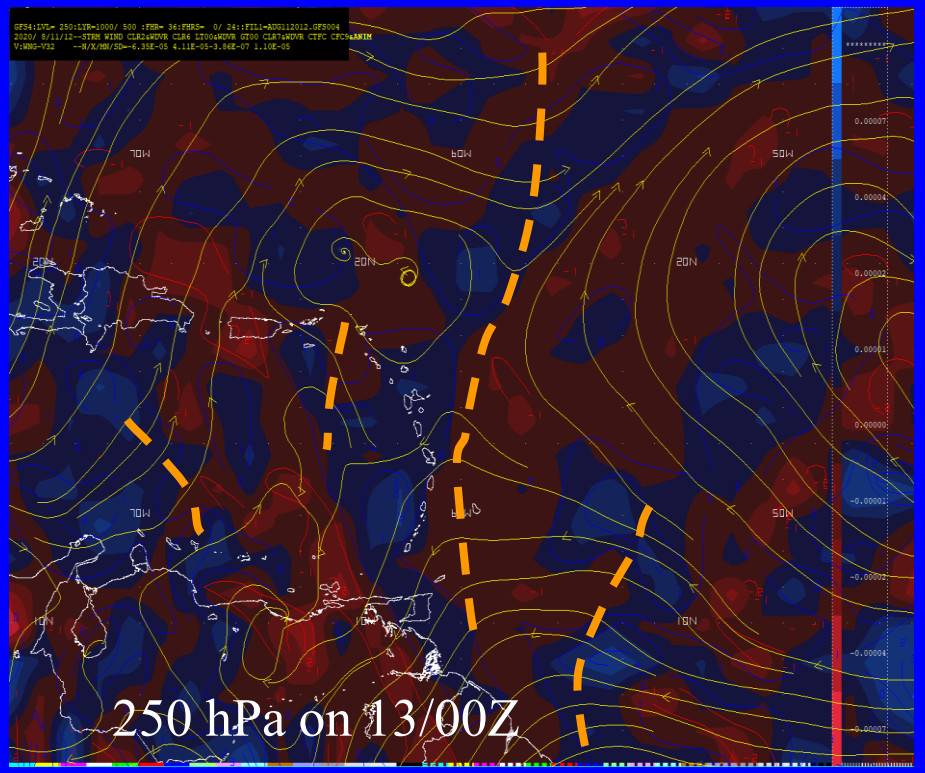


Retrogressing TUTT inducing a weakness in the mid/upper level ridge pattern

Tendency 250 hPa Winds and Divergence Aug 12/18Z & 13/00Z

Convergence in Red/Divergence in Blue

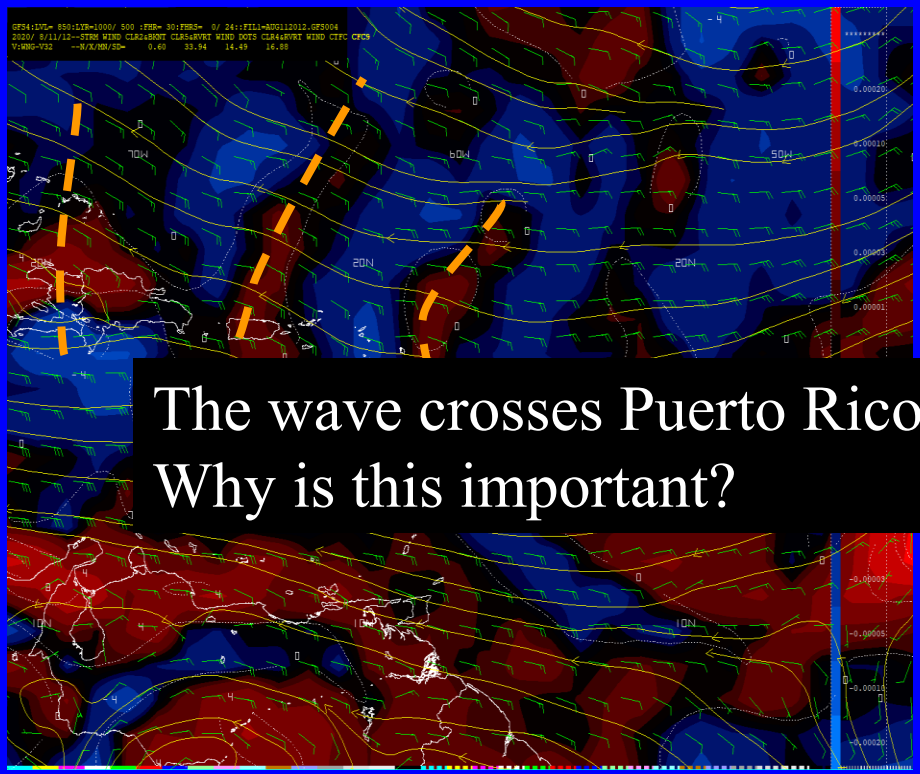


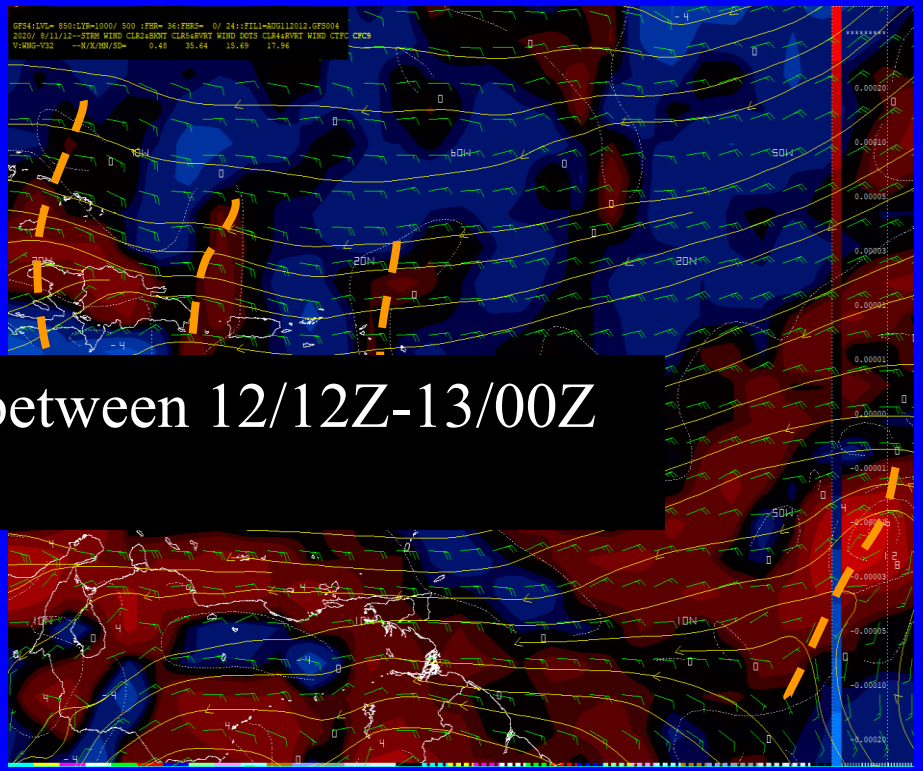


In response to the TUTT aloft, upper convergence weakening over Puerto Rico and the Virgin Islands.

850 hPa Winds and RVRT Aug 12/18Z & 13/00Z

Cyclonic Vorticity in Red



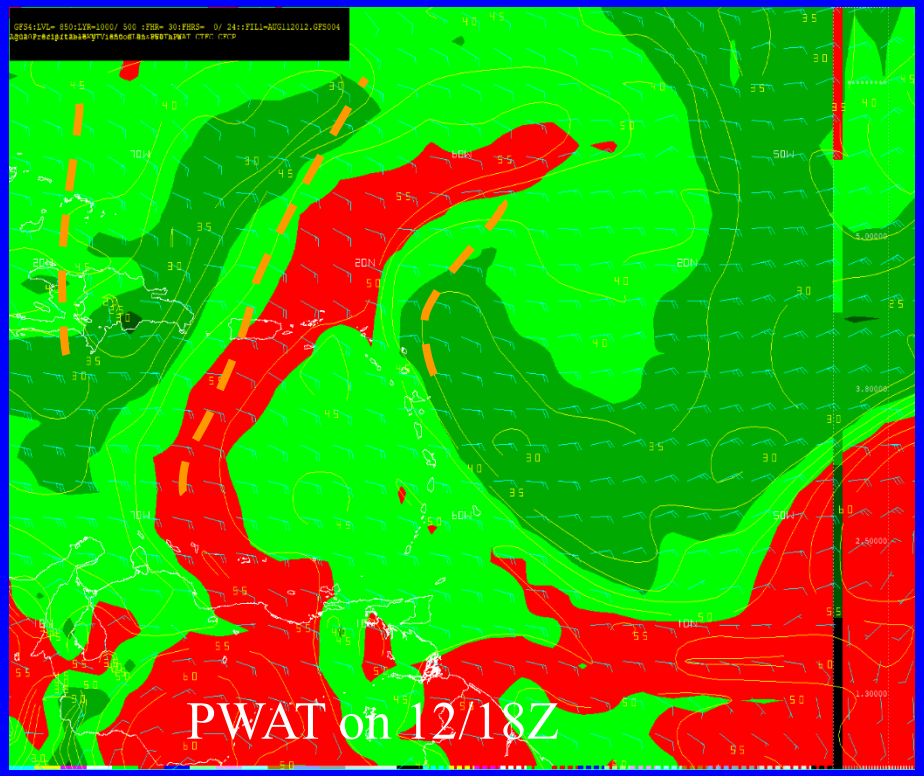


The wave crosses Puerto Rico between 12/12Z-13/00Z
Why is this important?

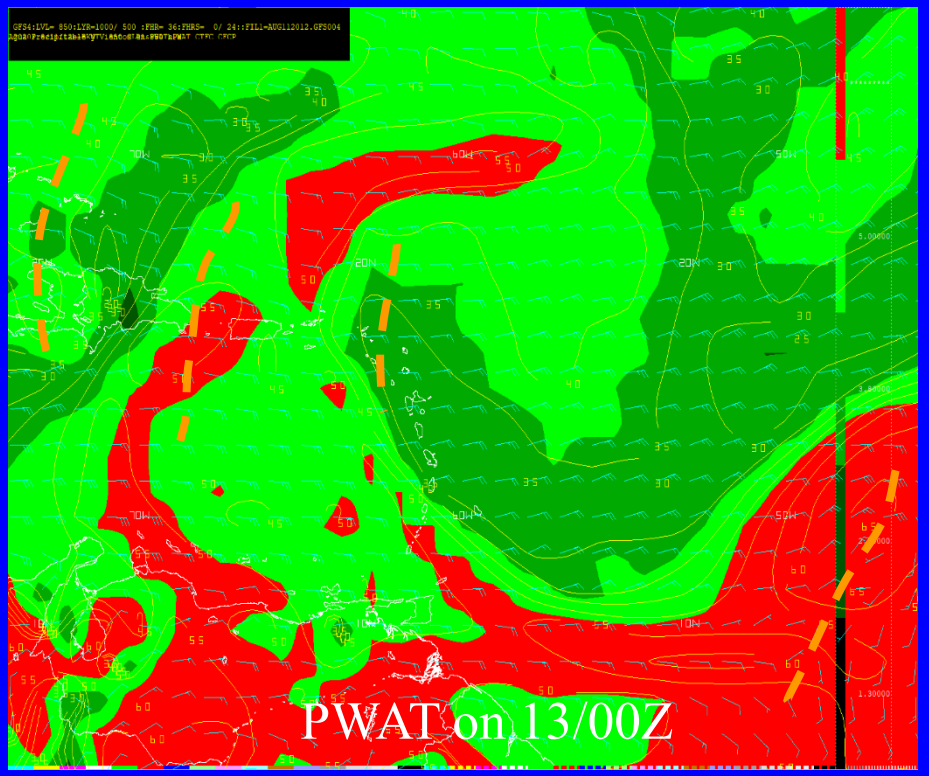
Between 12/12Z and 13/00Z the tropical wave and secondary vortices move across the northeast Caribbean, focusing its energy over the VI-Puerto Rico

850 hPa Winds and PWAT Aug 12/18Z & 13/00Z

PWAT $\geq$ 50mm in Red



PWAT on 12/18Z

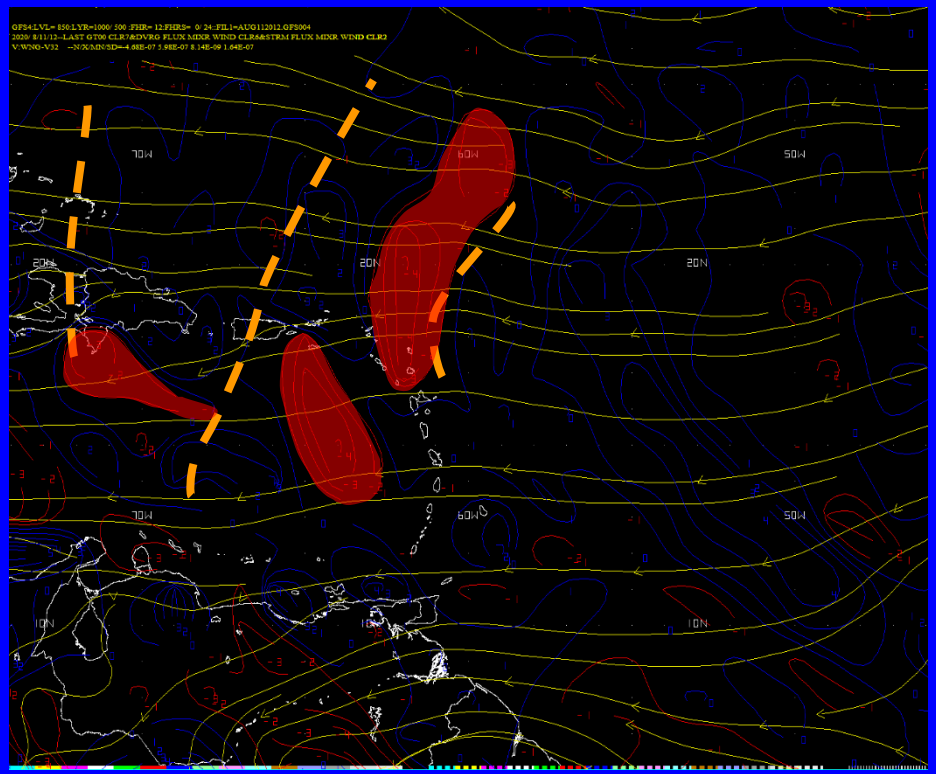


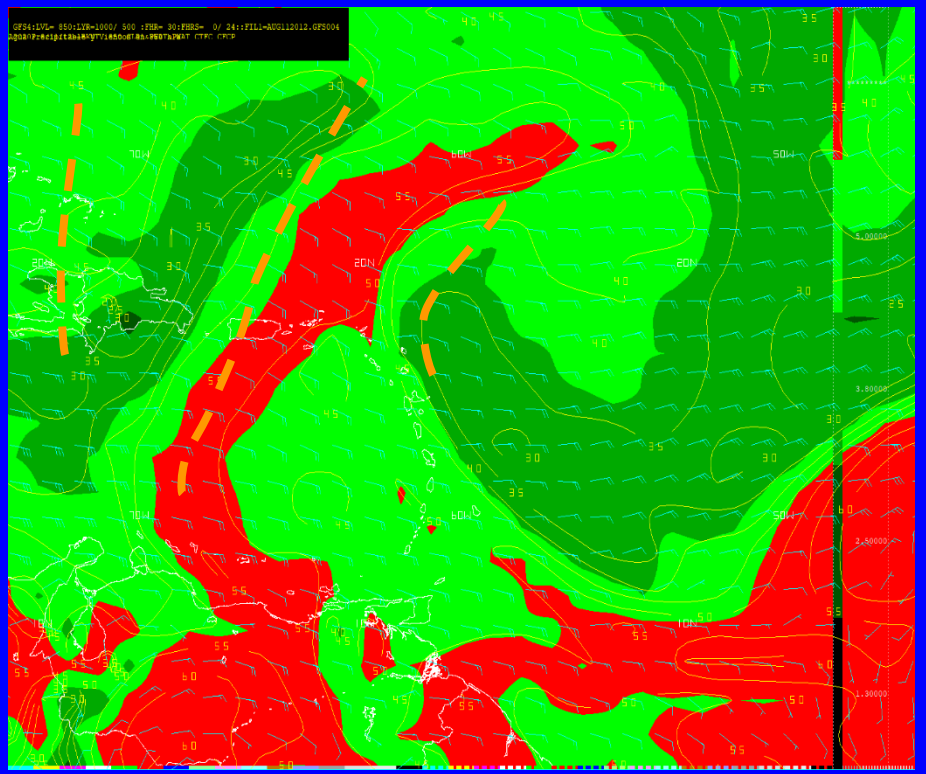
PWAT on 13/00Z

Between 12/18Z and 13/00Z PWAT plume lifts across the VI to Puerto Rico

850 hPa Flow/Moisture Conv.-PWAT Aug 12/18Z

Moisture Convergence in Red & PWAT ≥ 50mm in Red

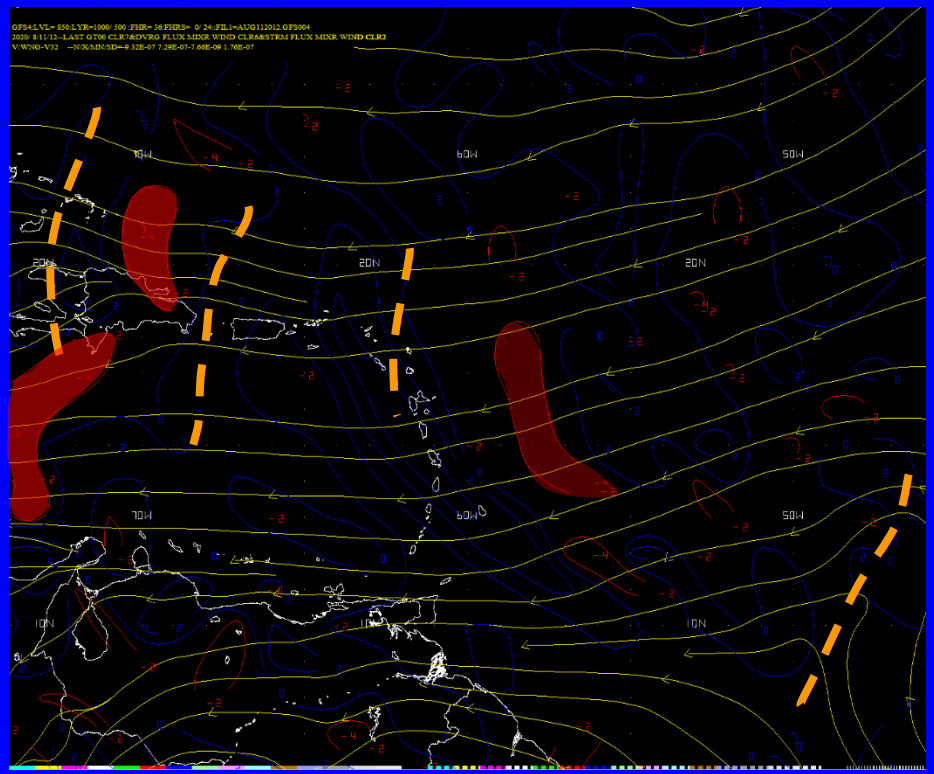


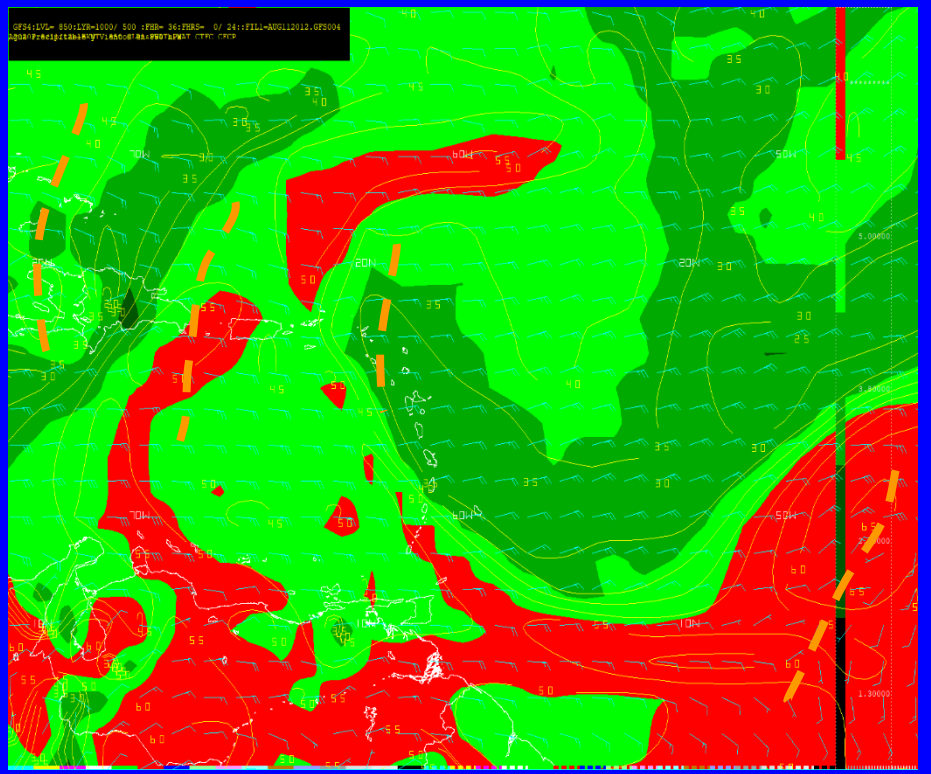


On the 12/18Z best moisture convergence trails the wave

850 hPa Flow/Moisture Conv.-PWAT
Aug 13/00Z

Moisture Convergence in Red & PWAT ≥ 50mm in Red

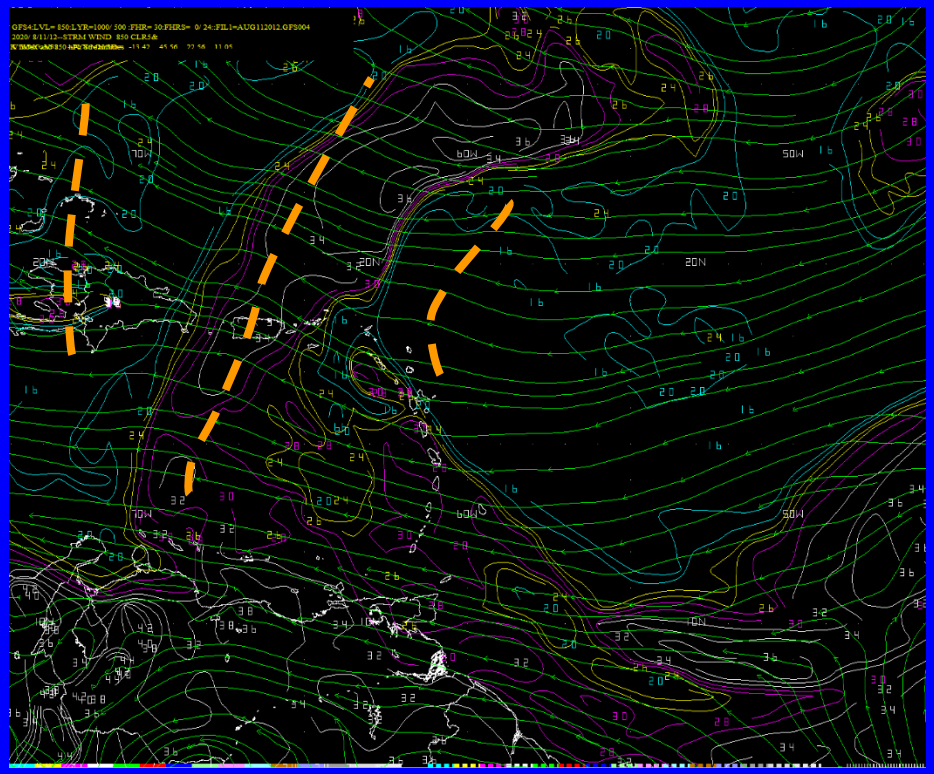


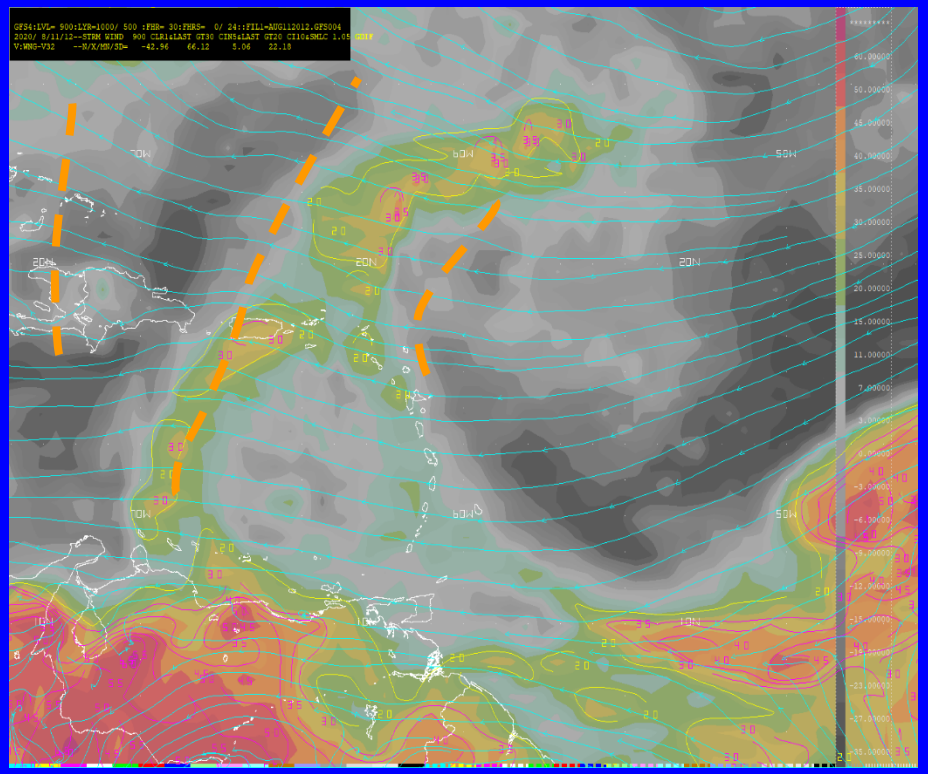


By the 13/00Z this quickly moves across Puerto Rico to the Dominican Republic

KI and GDI
Aug 12/18Z

KI and GDI ≥ 20 Color filled

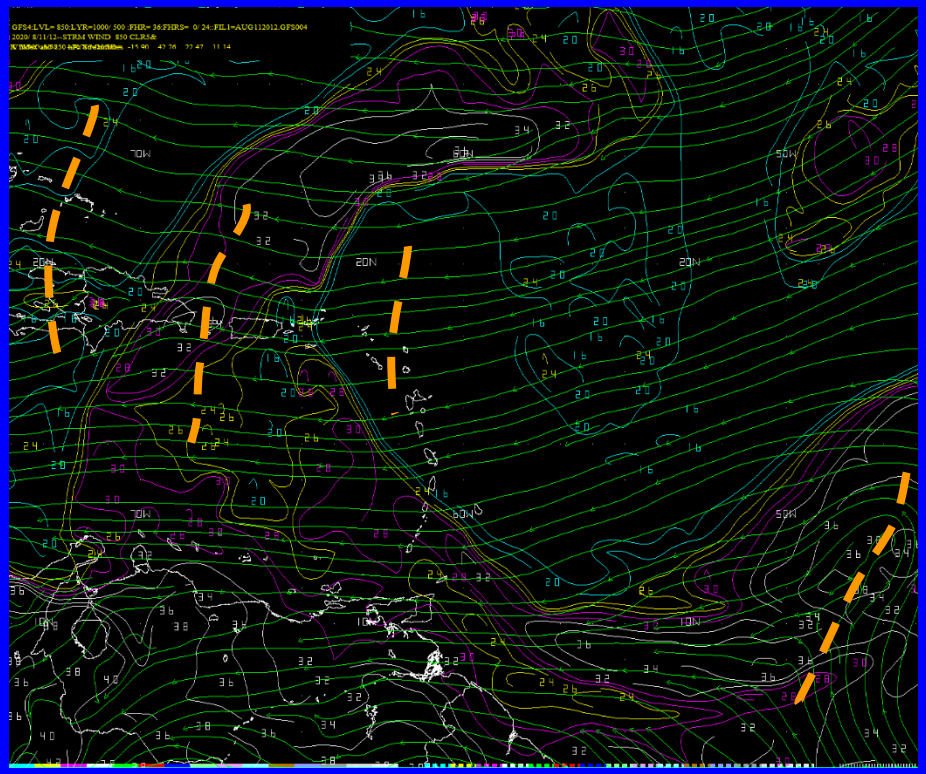


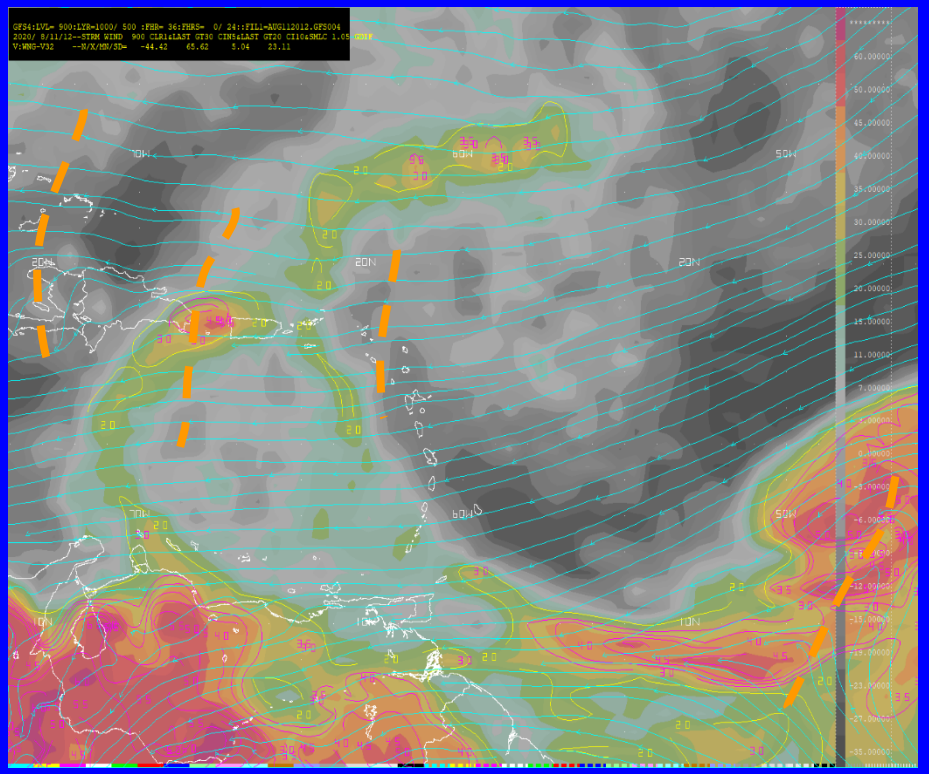


KI holding steady between 30-34, while the GDI increases to 30 as mid/upper level conditions become more favorable for development.

KI and GDI
Aug 13/00Z

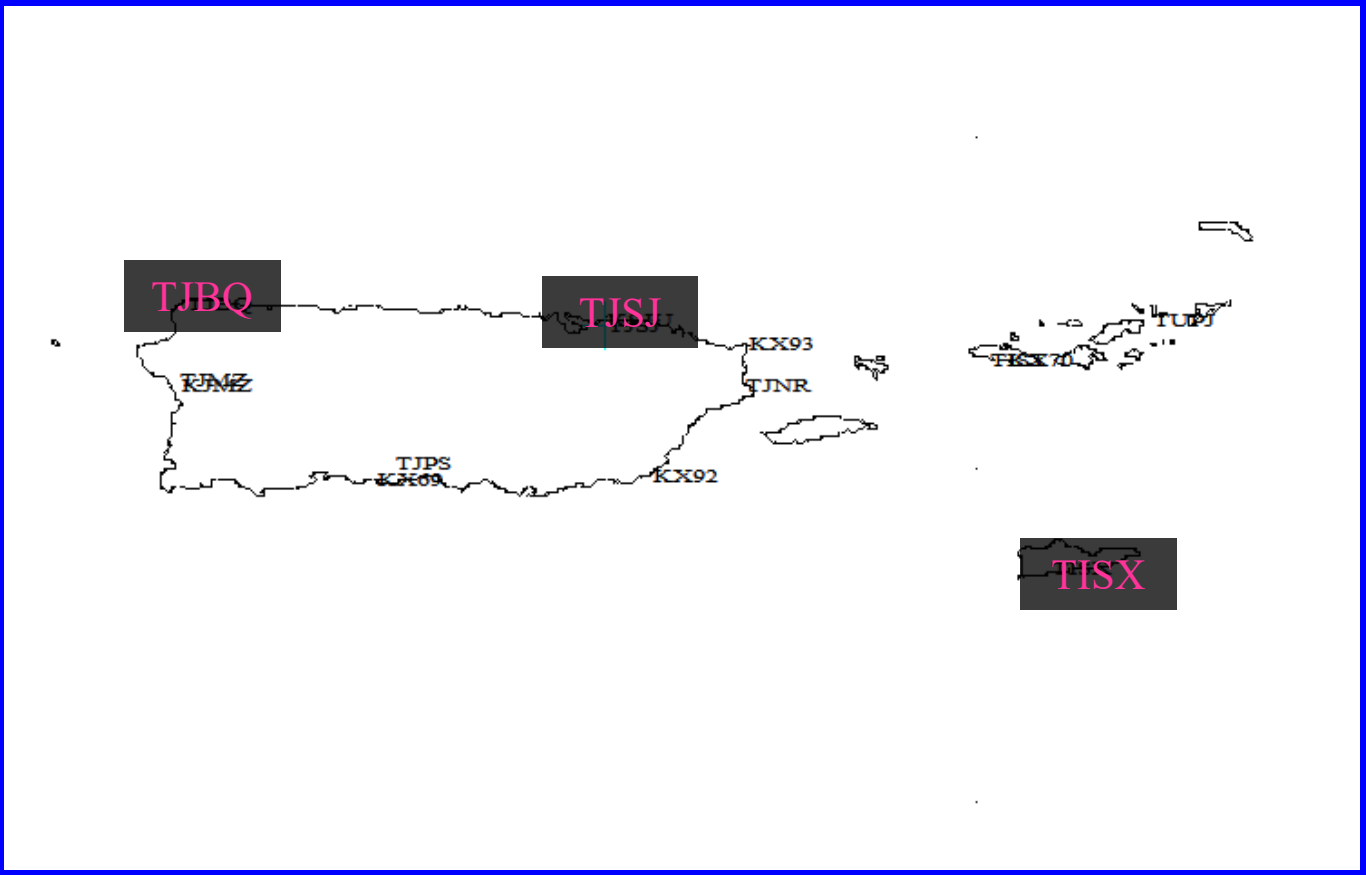
KI and GDI ≥ 20 Color filled





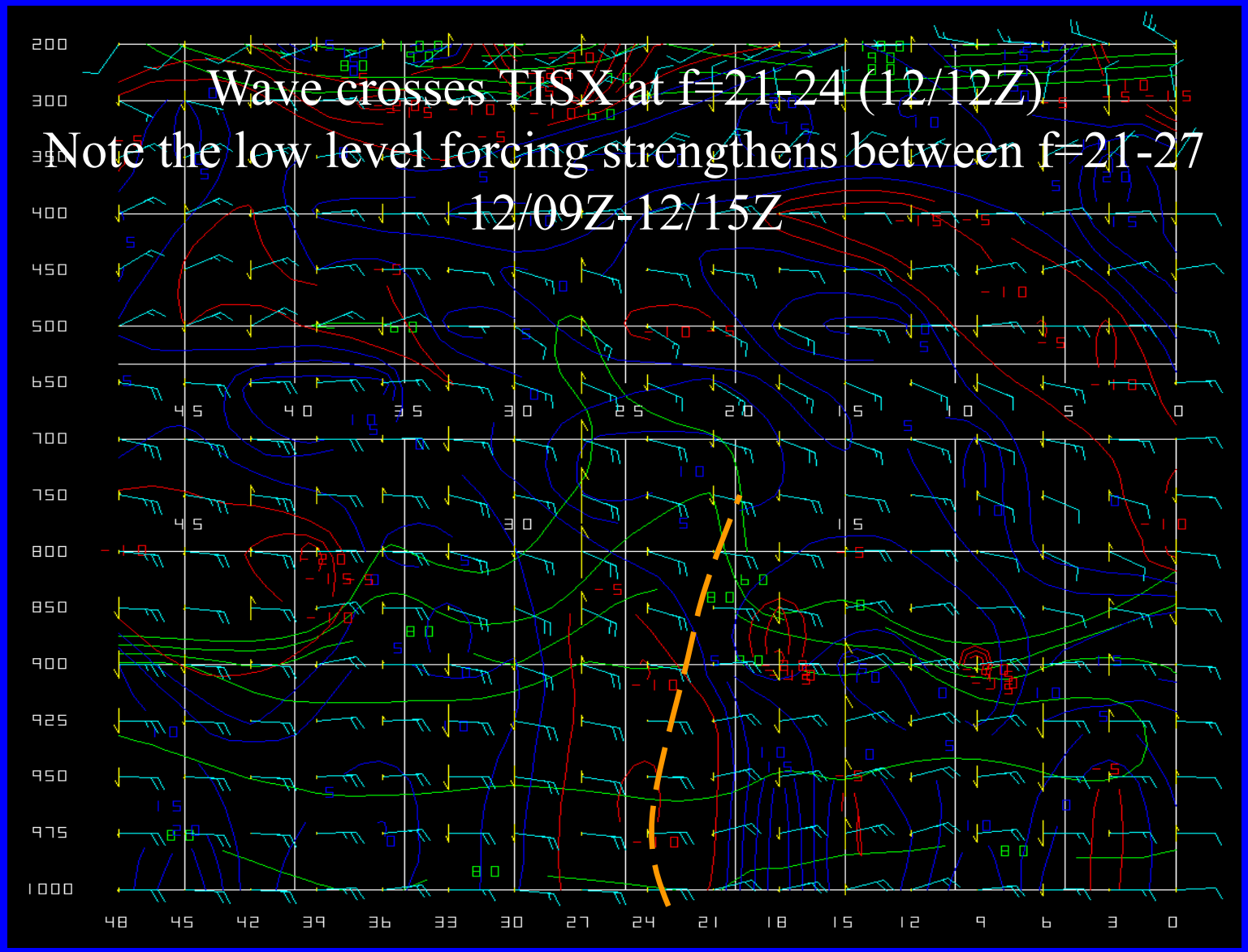
No changes on the KI, while the GDI increases to 35 over NW Puerto Rico as enhanced by diurnal heating.

Quick View Locations



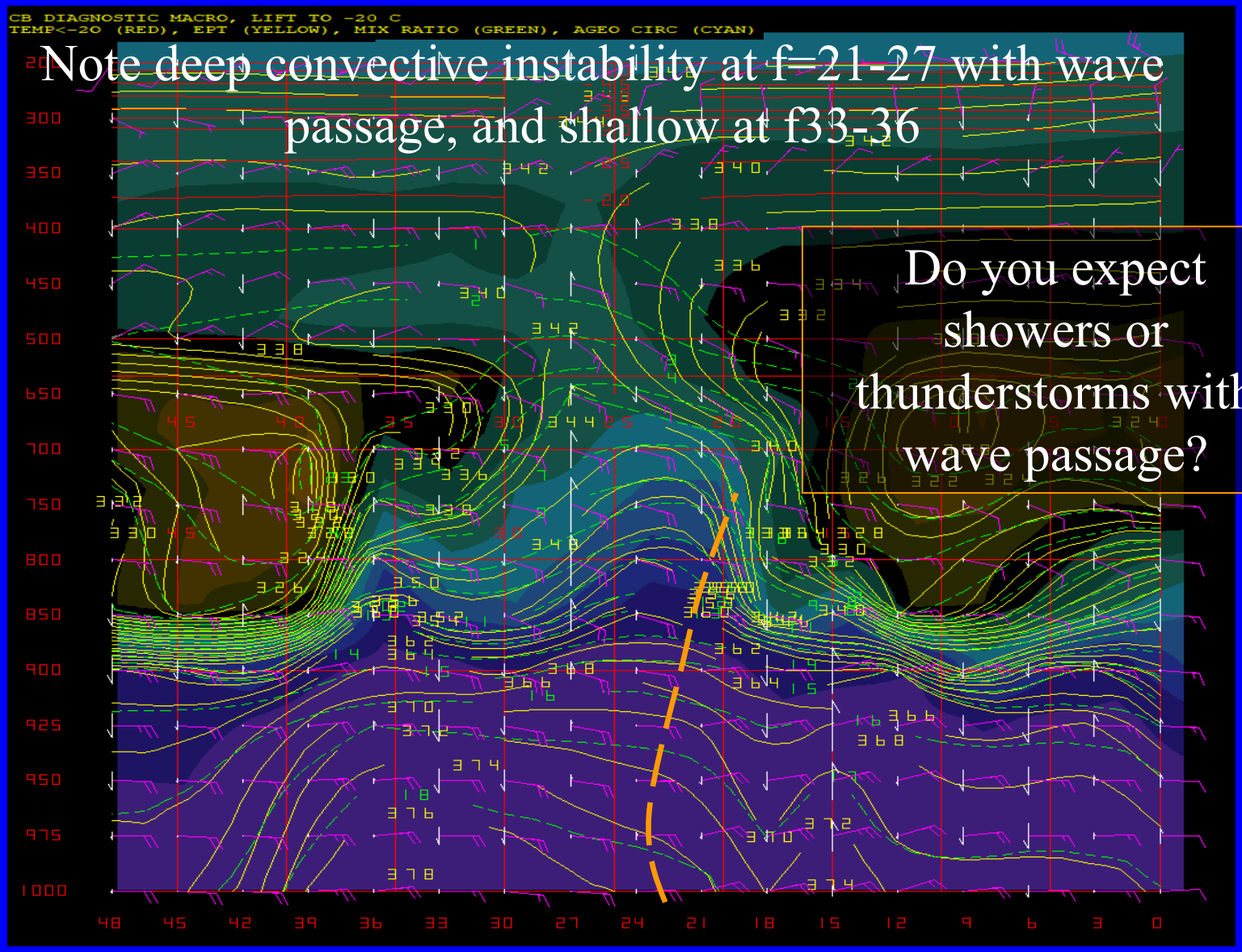
Quick View Time Section - TISX

Green=RH > 60, Cyan=Total Wind, Yellow=Omega, Red=Convergence



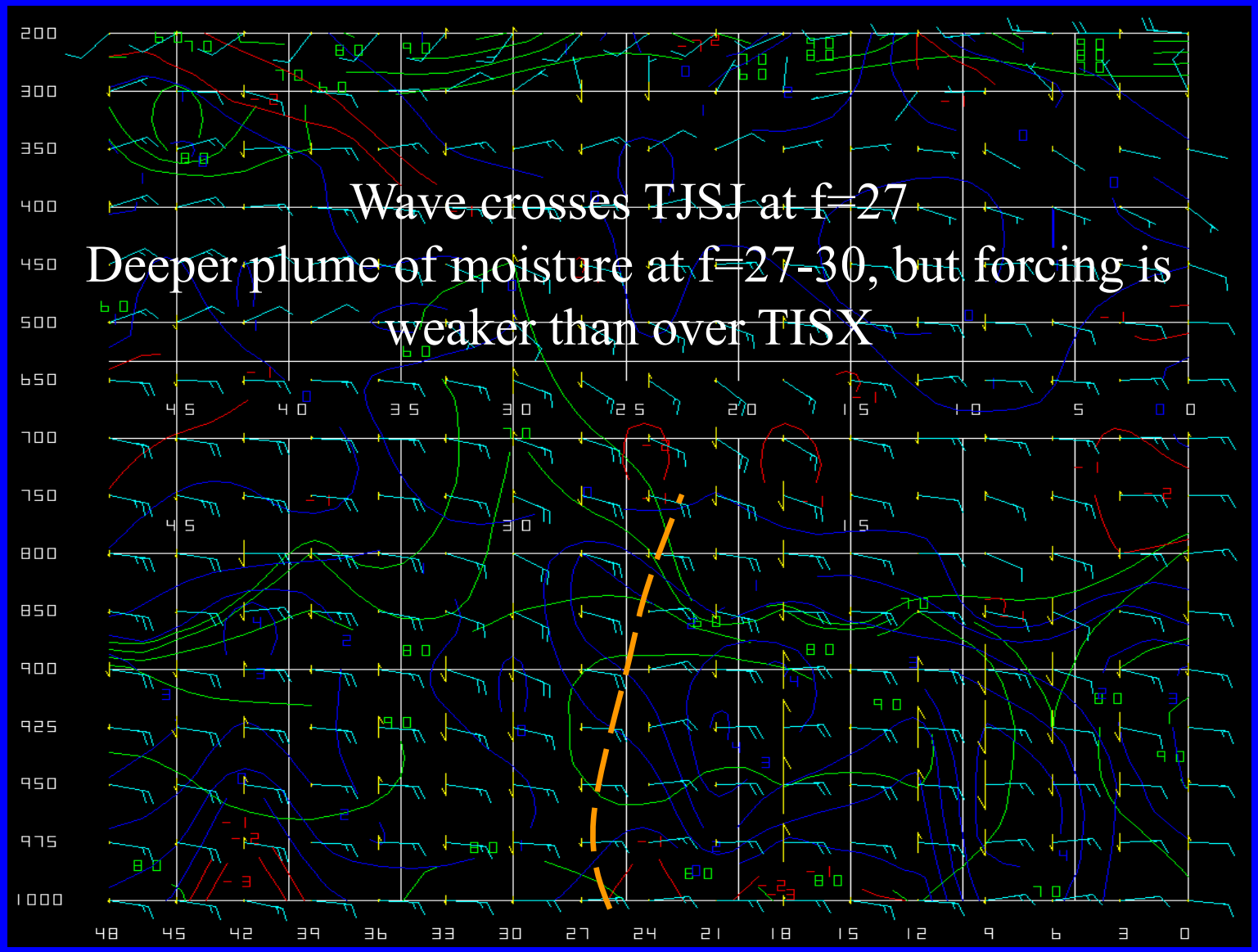
Quick View Time Section - TISX

Yellow/Color Filled=EPT, White=Omega, Red=T ≤ -20C



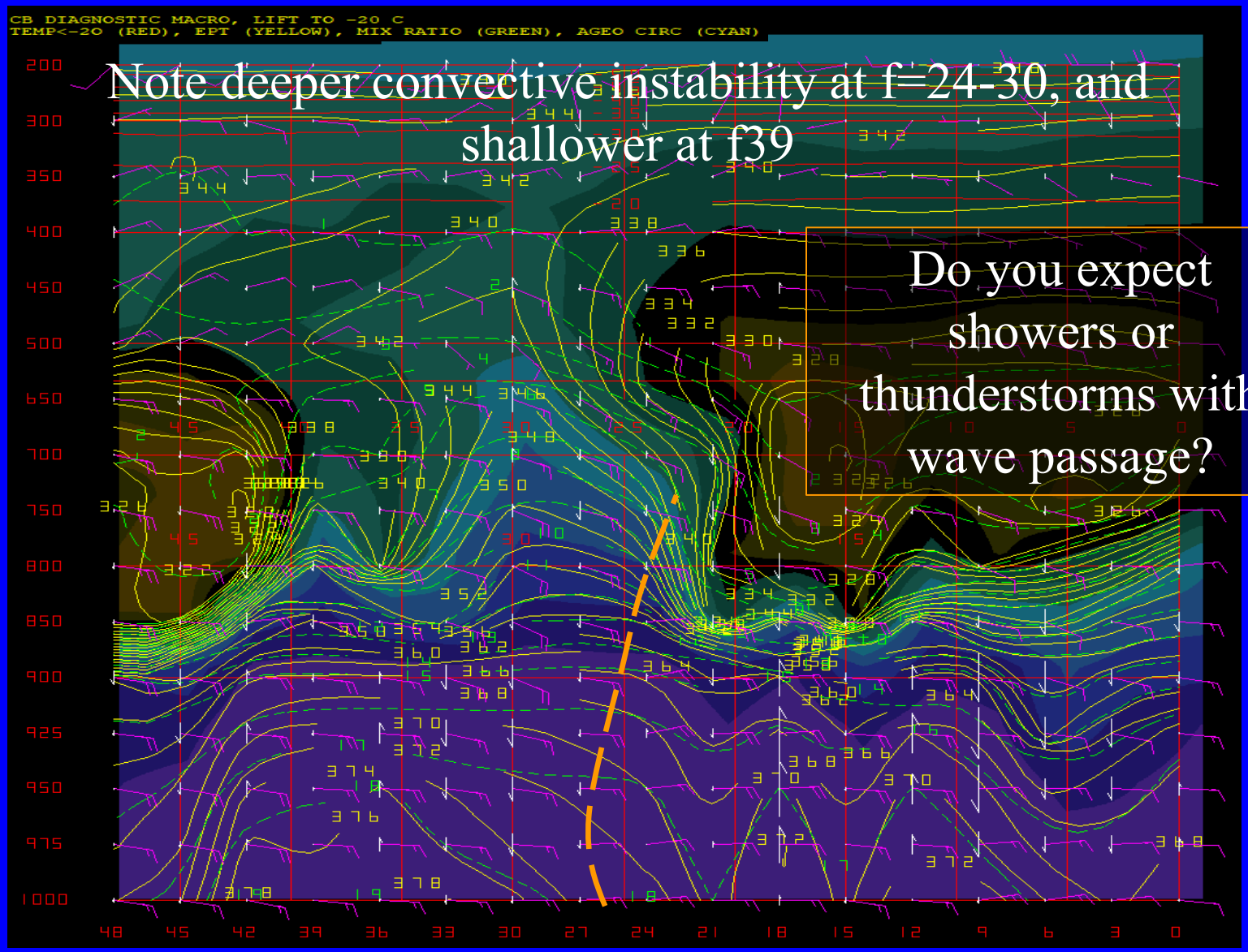
Time Section - TJSJ

Green=RH > 60, Cyan=Total Wind, Yellow=Omega, Red=Convergence



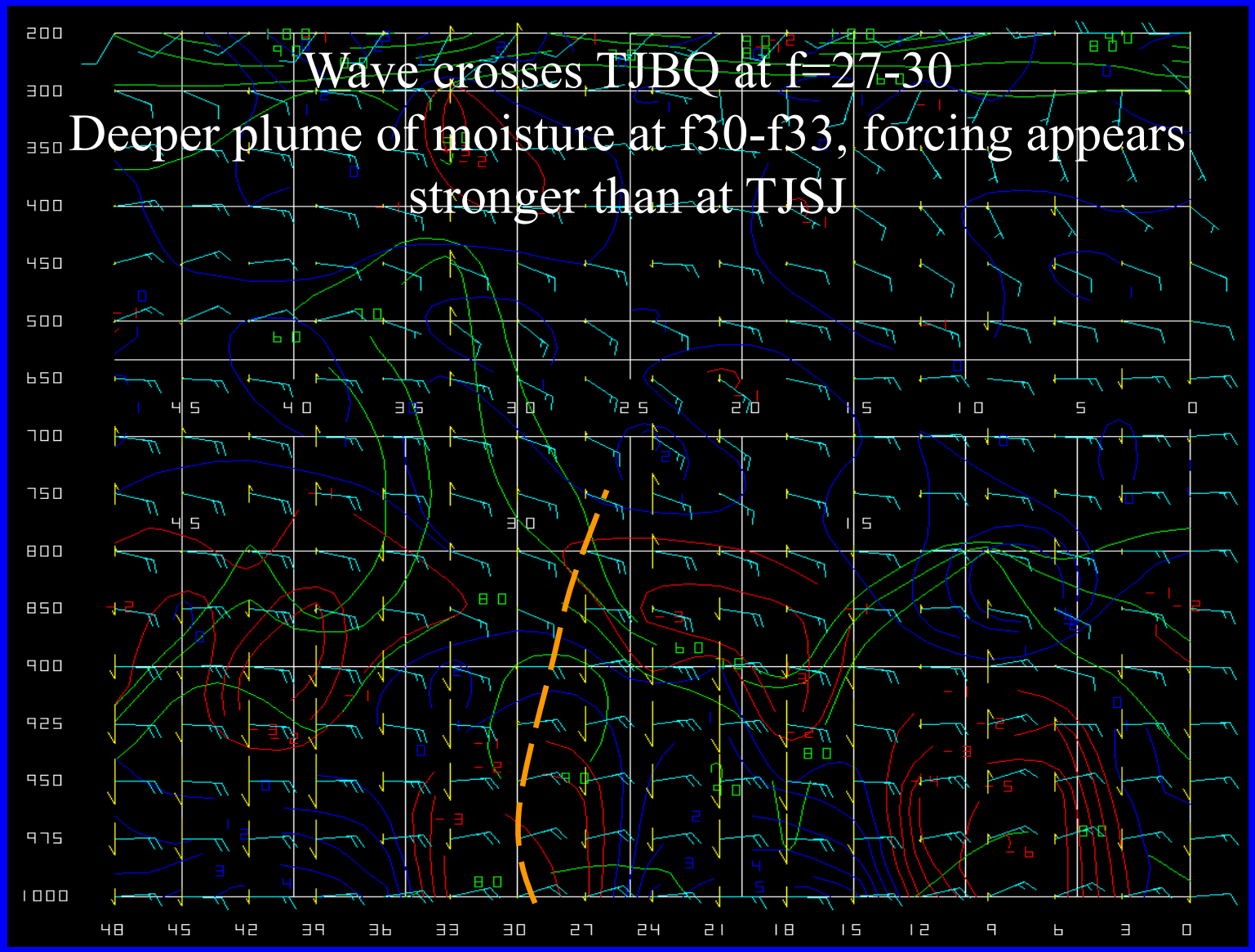
Quick View Time Section - TJSJ

Yellow/Color Filled=EPT, White=Omega, Red=T ≤ -20C



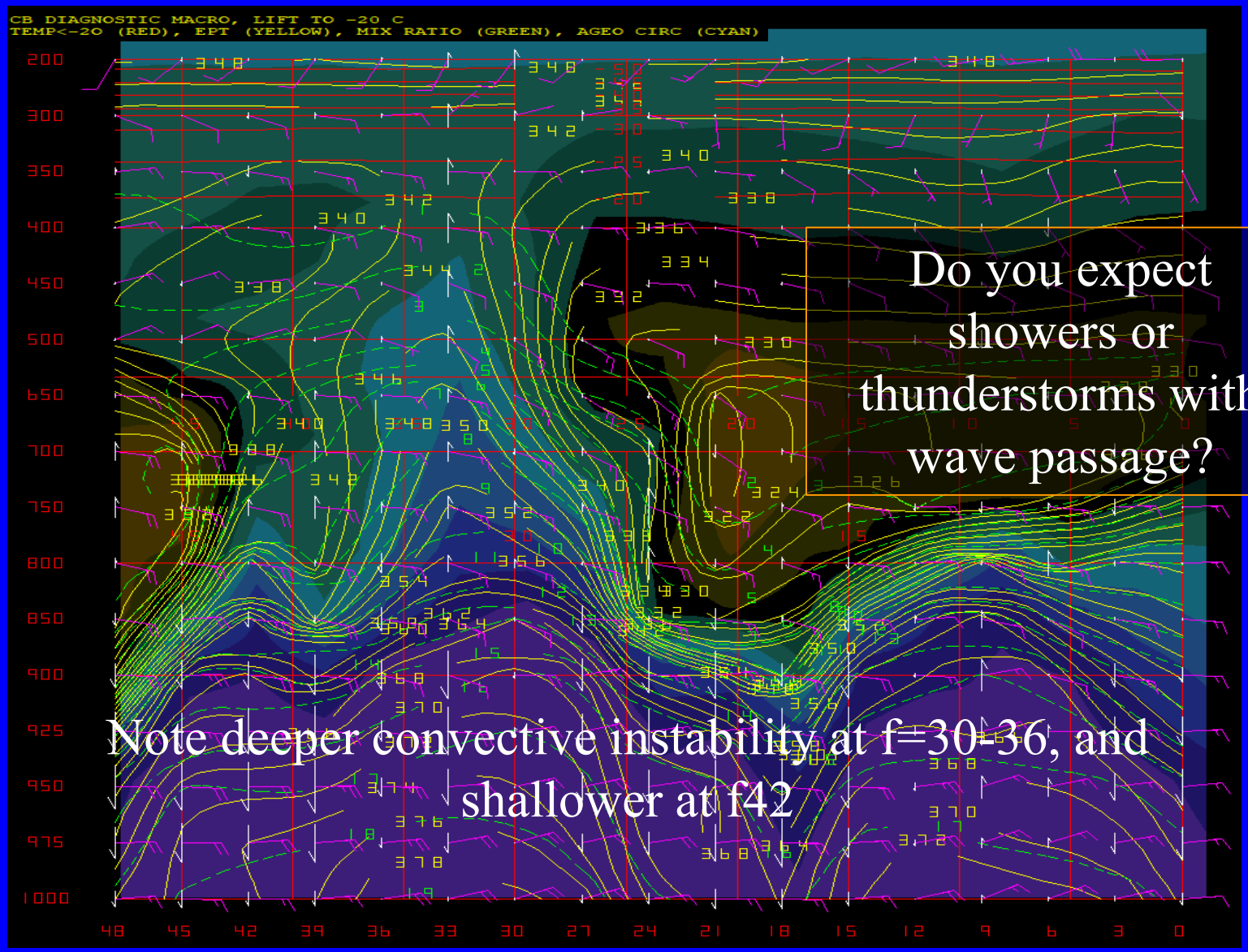
Quick View Time Section - TJBQ

Green=RH > 60, Cyan=Total Wind, Yellow=Omega, Red=Convergence

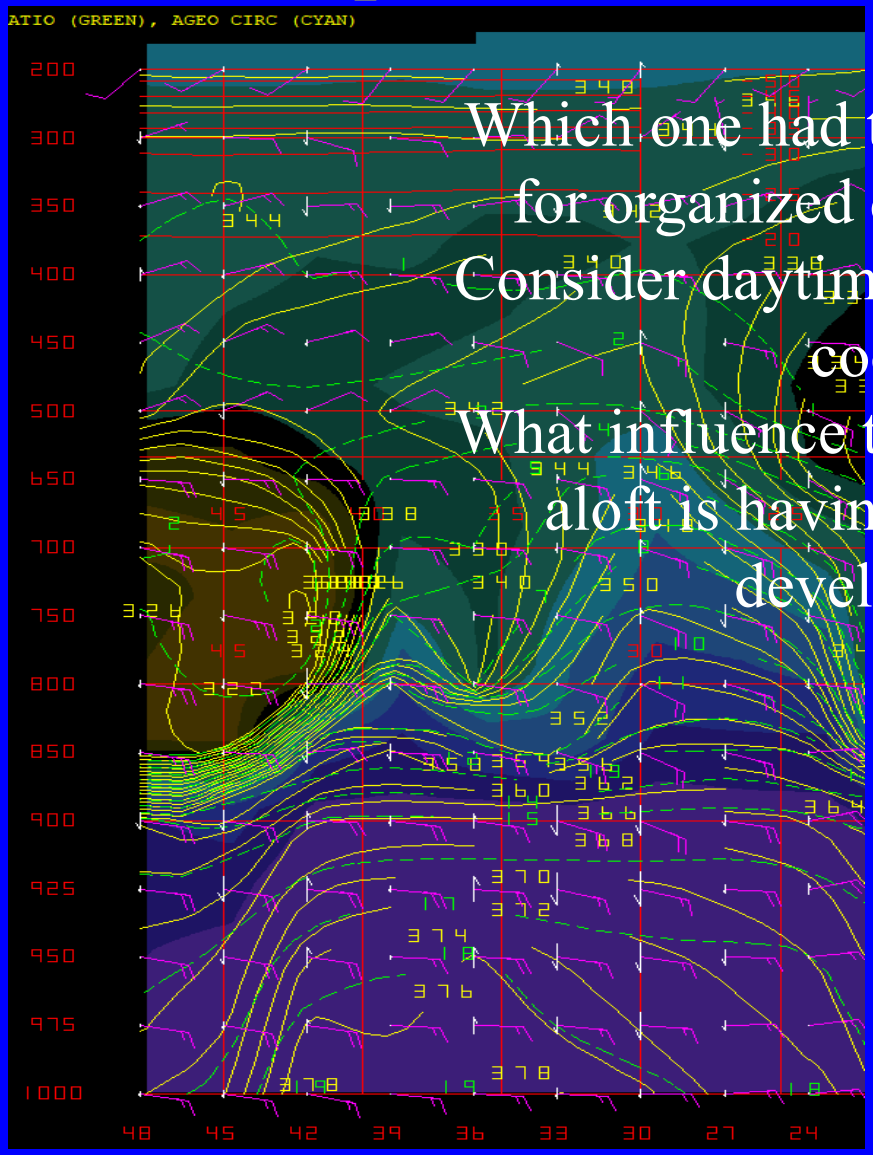


Quick View Time Section - TJBQ

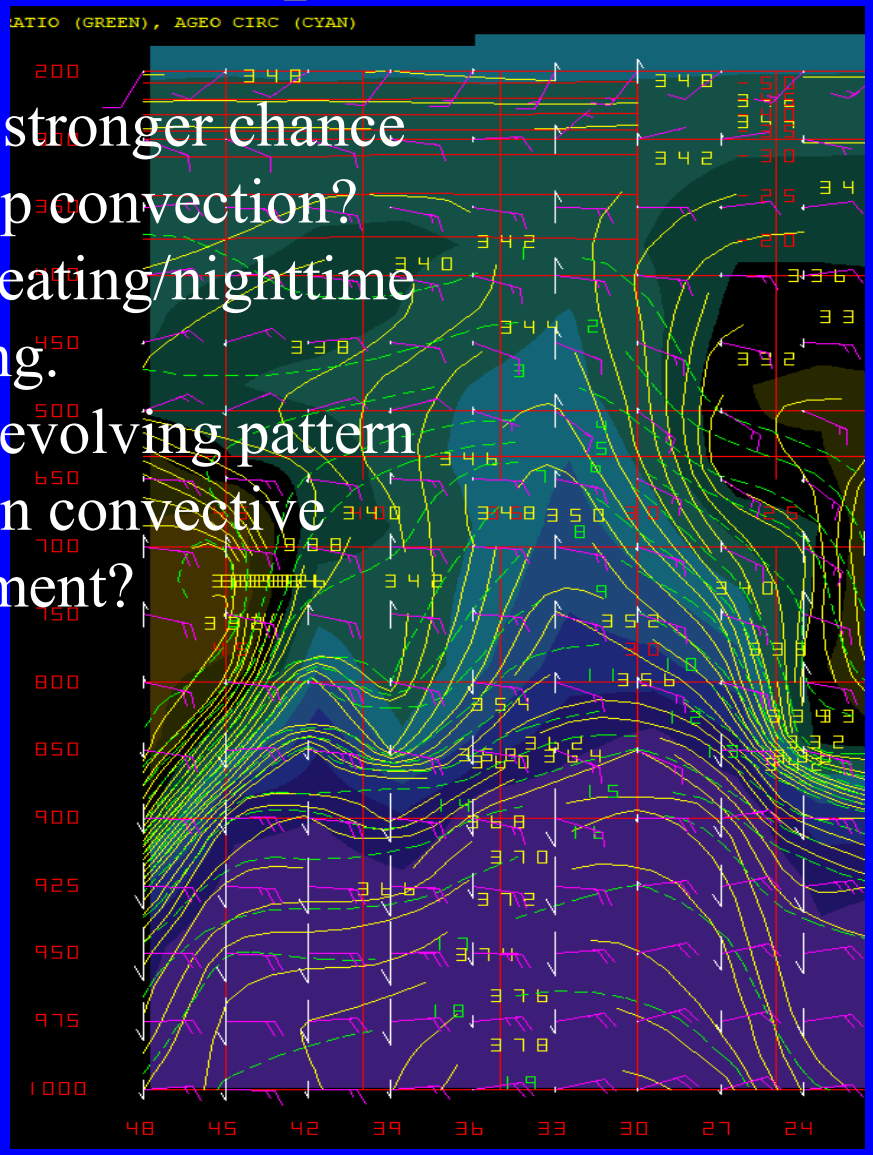
Yellow/Color Filled=EPT, White=Omega, Red=T ≤ -20C



Quick View Time Section – TJSJ vs. TJBQ
Equivalent Potential Temperature



TJSJ



TJBQ

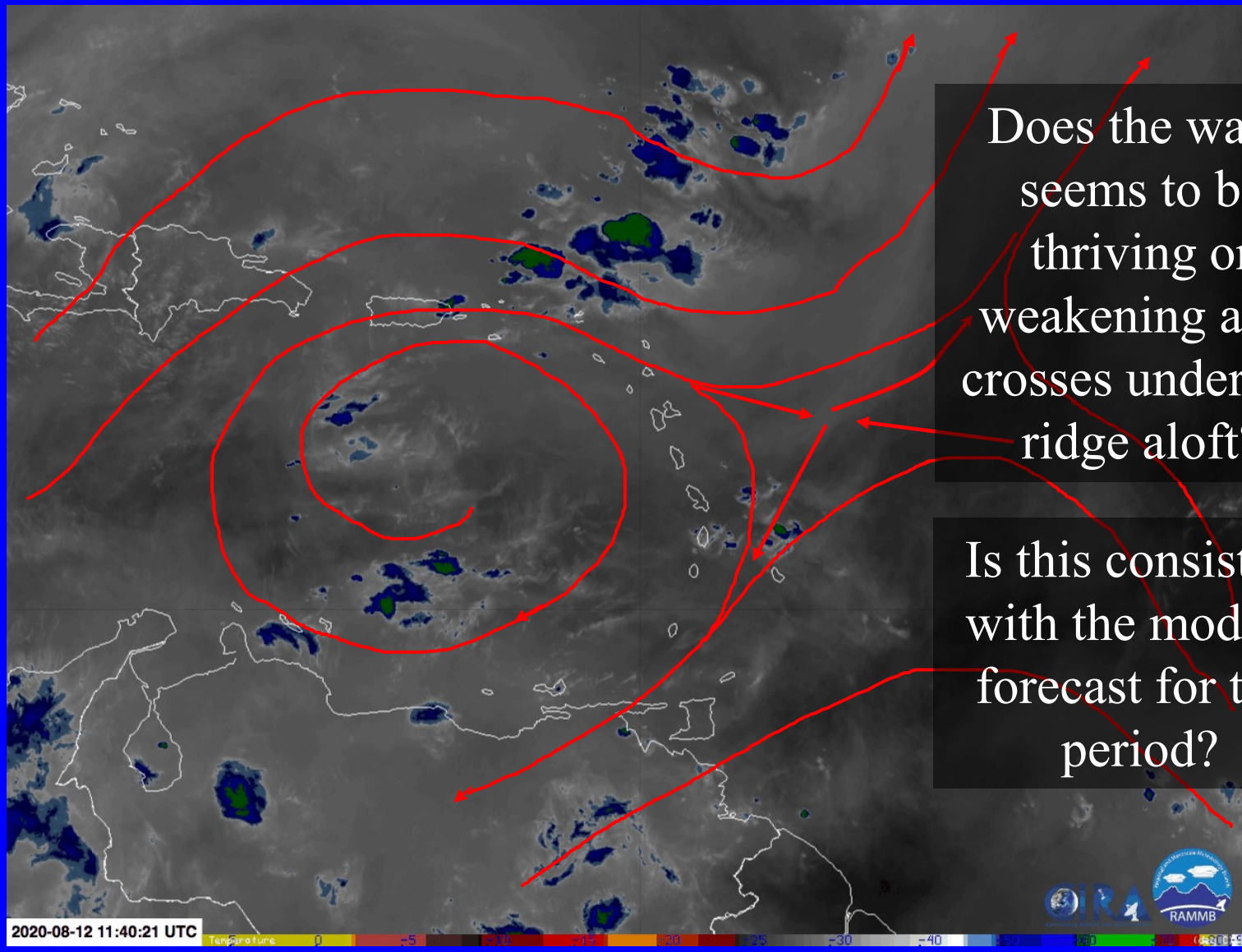
Which one had the stronger chance for organized deep convection? Consider daytime heating/nighttime cooling.

What influence the evolving pattern aloft is having on convective development?

Day 2 Summary

- Environmental conditions appear more favorable as the wave crosses Puerto Rico
  - Daytime heating having an effect on development as trailing plume of moisture crosses the island
  - GDI reflects an increase in instability as it accounts for diurnal heating

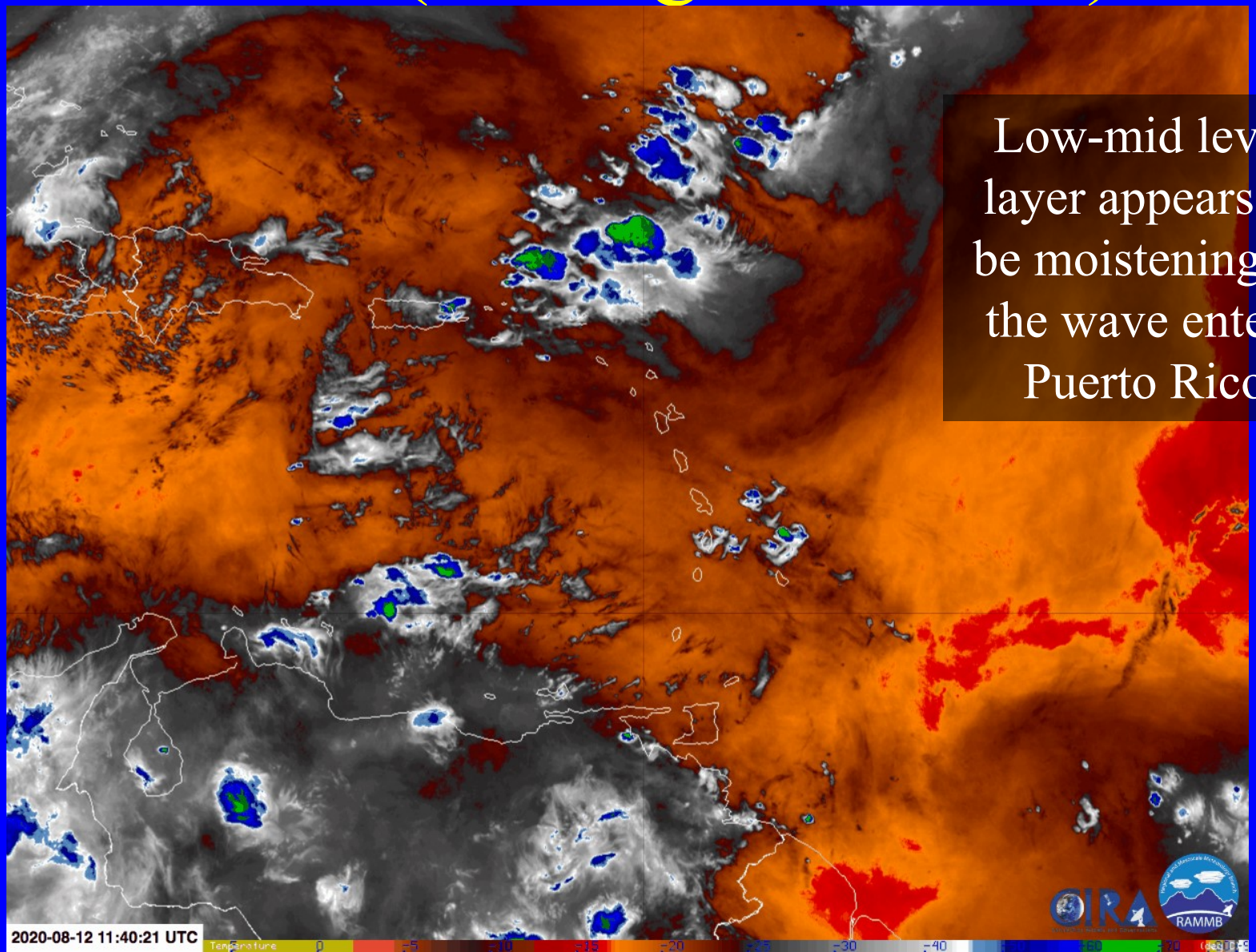
Verification Day 2
6.2um (Ending at 13/12Z)



Does the wave seems to be thriving or weakening as it crosses under the ridge aloft?

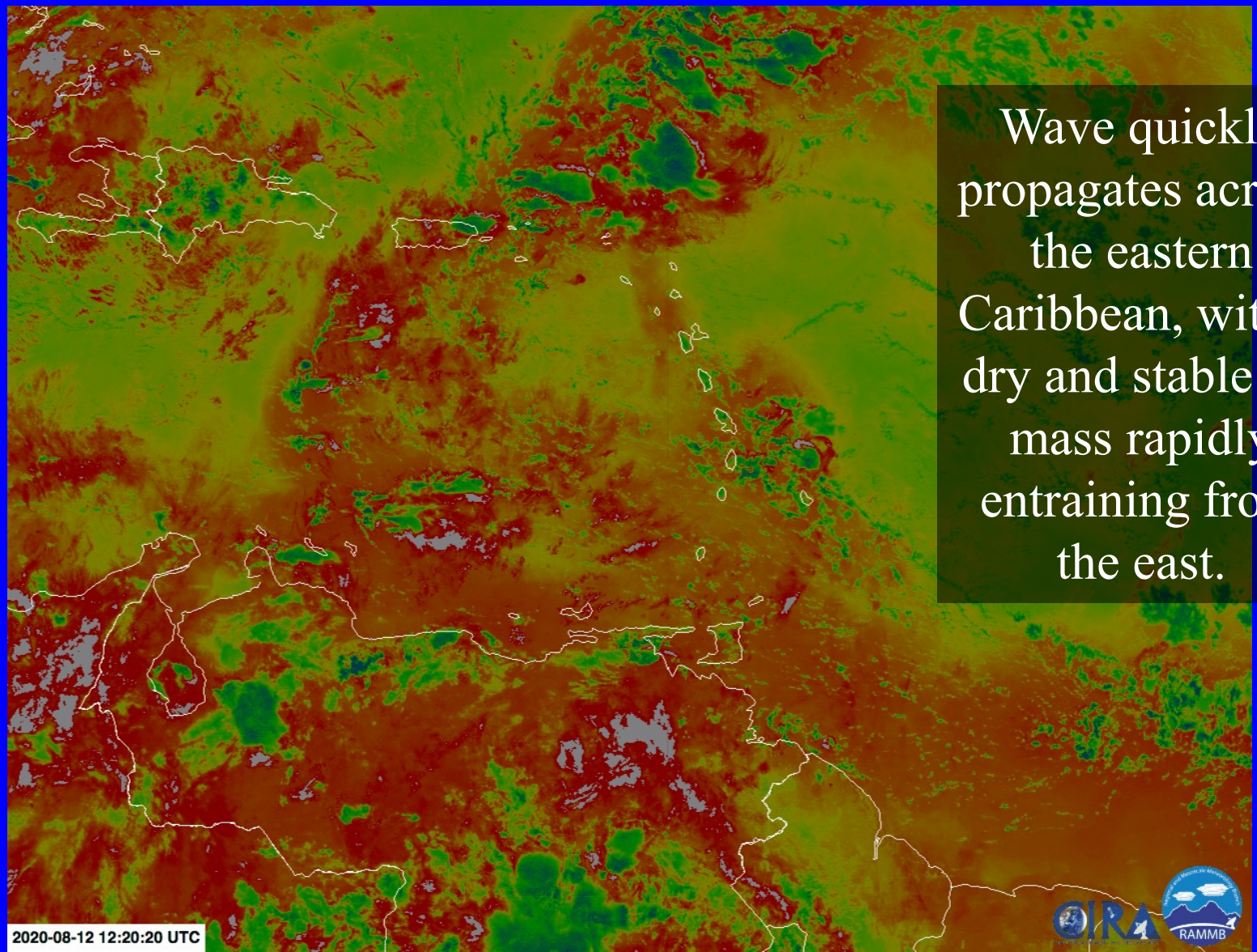
Is this consistent with the model's forecast for this period?

Verification Day 2
6.9um (Ending at 13/12Z)



Low-mid level layer appears to be moistening as the wave enters Puerto Rico

Verification Day 2
Split Window (Ending at 13/12Z)

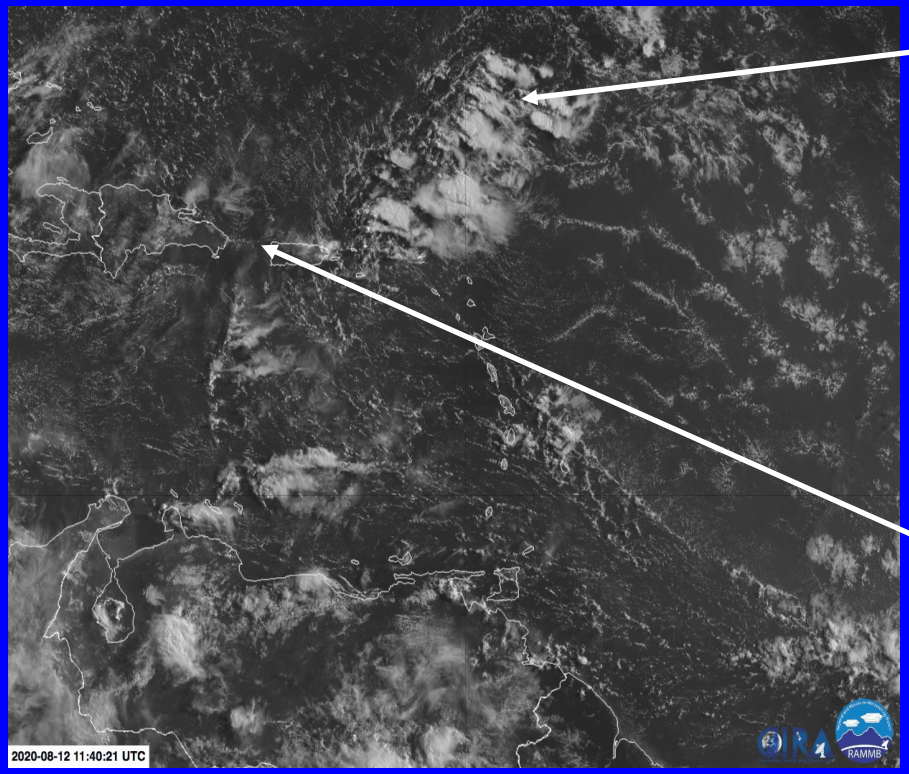


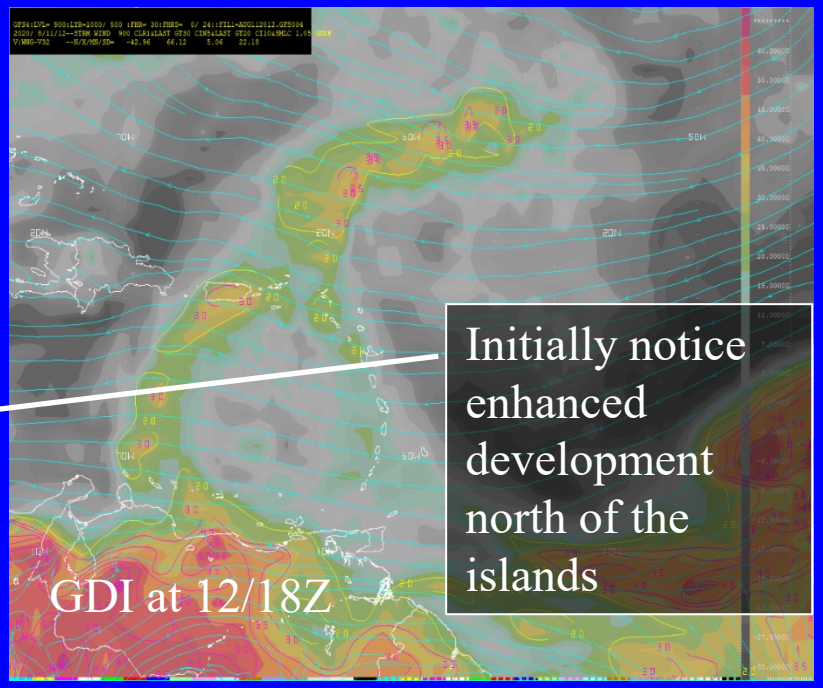
Wave quickly propagates across the eastern Caribbean, with a dry and stable air mass rapidly entraining from the east.

Verification Day 2
Air Mass (Ending at 13/12Z)

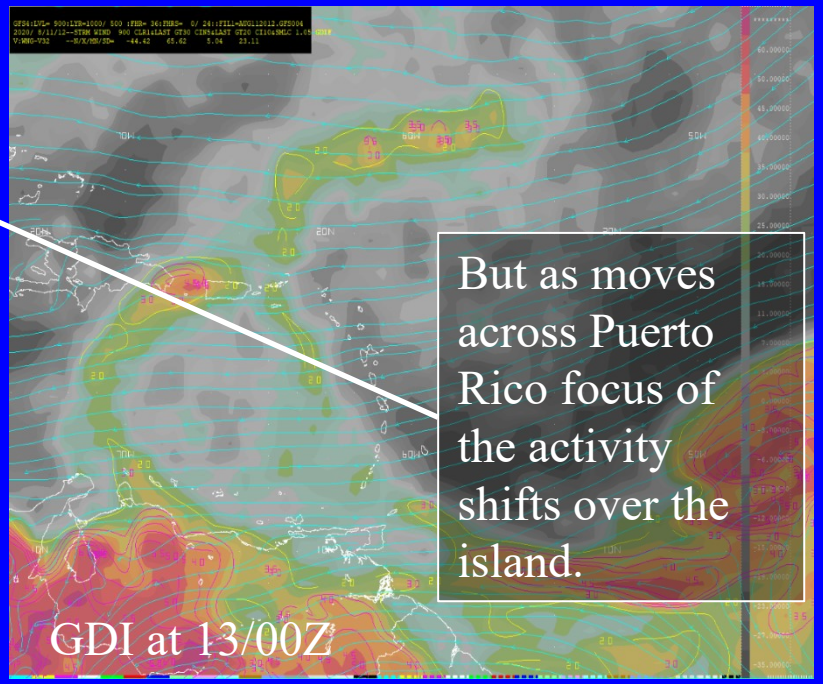
Most intense convection developed over Puerto Rico as enhanced by diurnal heating

Verification Day 2 Proxy





Initially notice enhanced development north of the islands



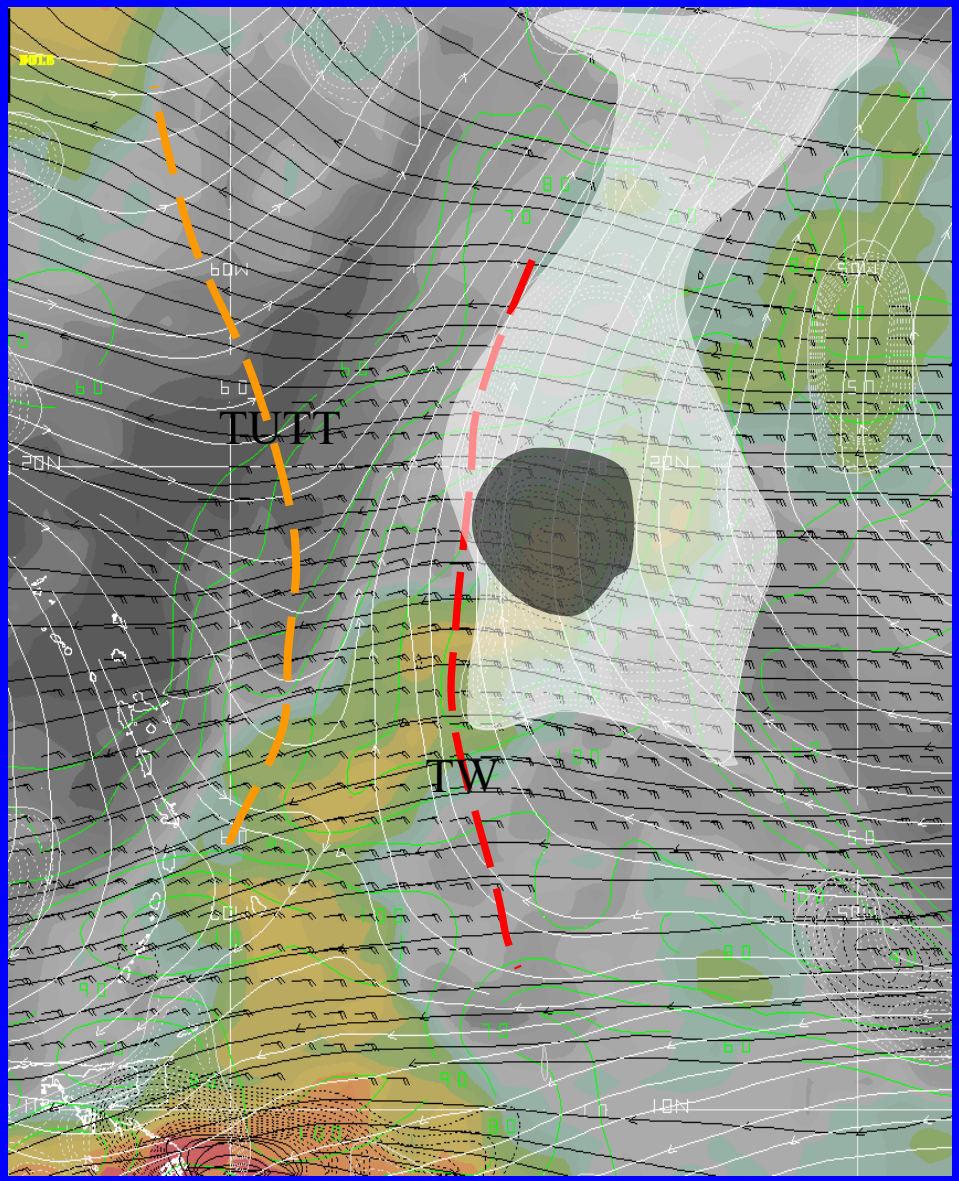
But as moves across Puerto Rico focus of the activity shifts over the island.

What to do when you are in a hurry?

- Combining:
  - Upper Level Dynamics
  - Lower Level Forcing
  - Convective Instability

- GDI2. Macro on WinGridDS

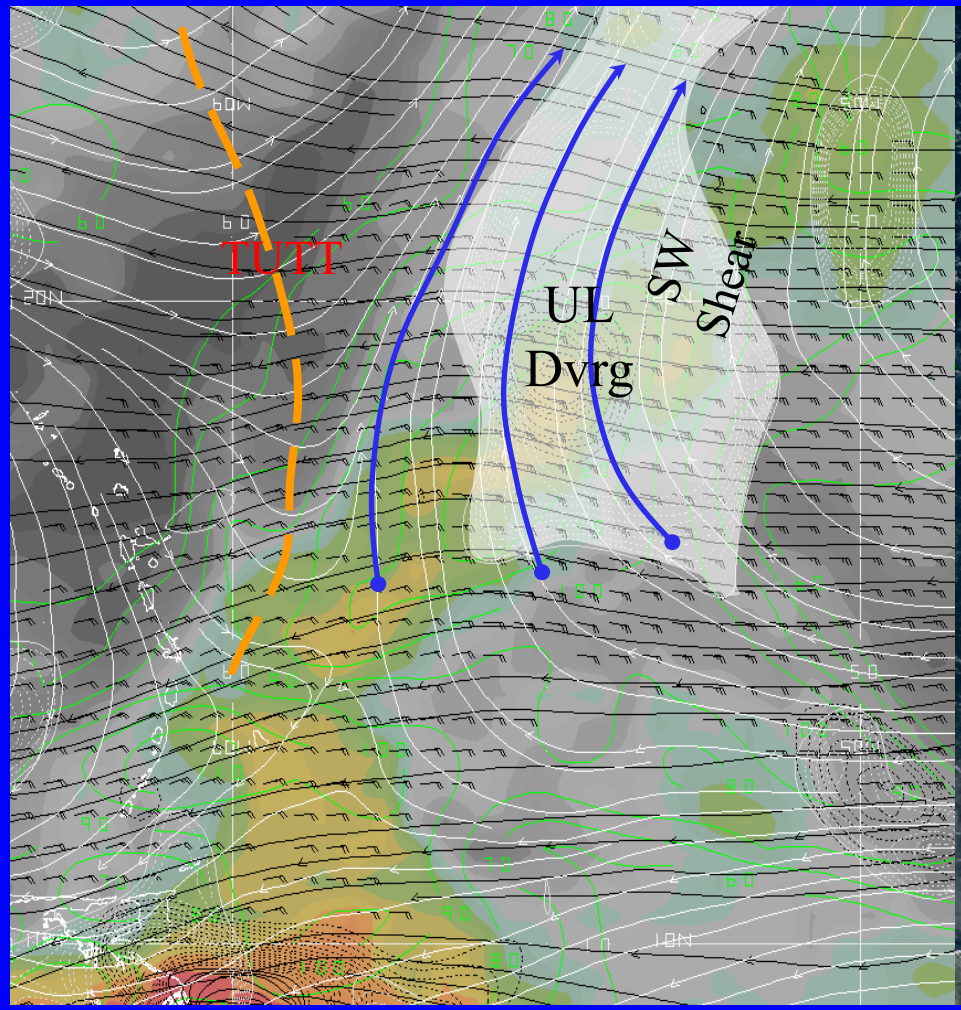
GDI2 Macro



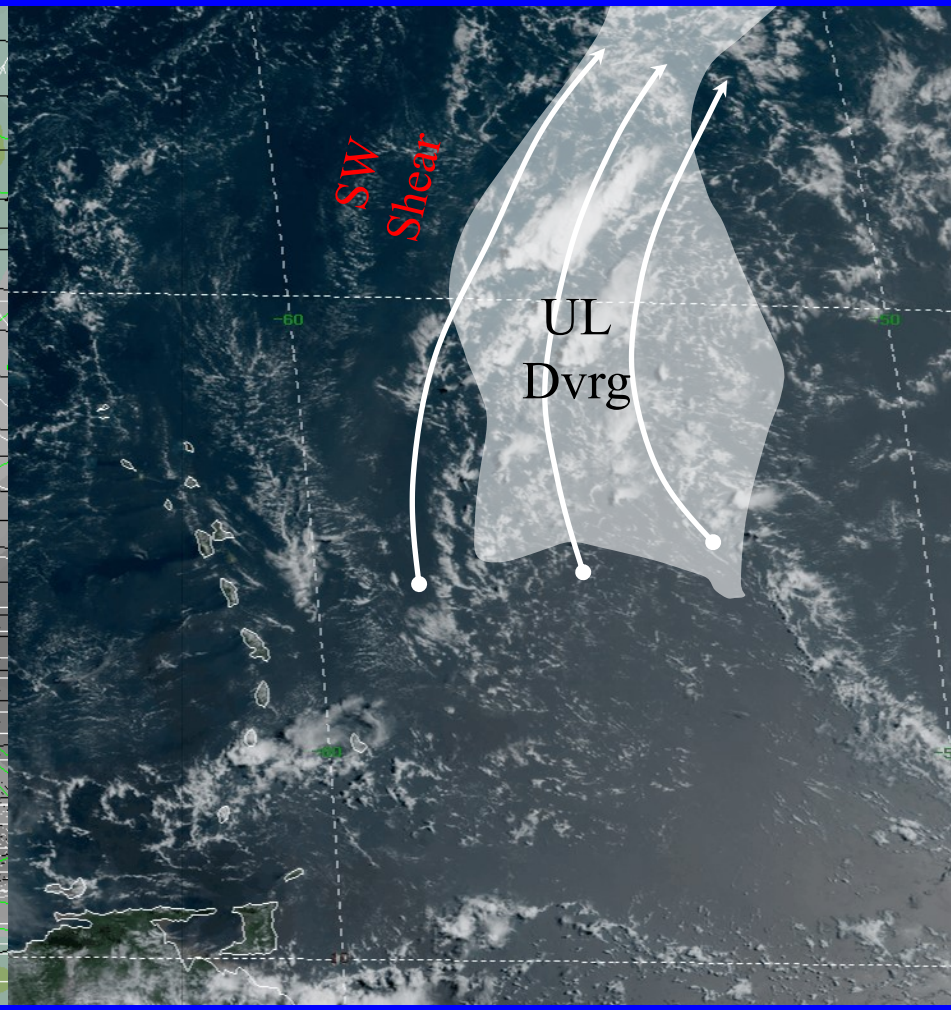
- Upper Level Flow
  - White streamlines
- Upper Divergence
  - White dashed
  - Yellow Solid
- Low Level Flow
  - Black streamline
  - Barbs $\geq$ 25kt
- Low Level Convergence
  - Black dashed
- RH
  - Green isohumes
- GDI

GDI2 Macro Operational Application

Evaluation of Upper Level Features and Divergence Aloft



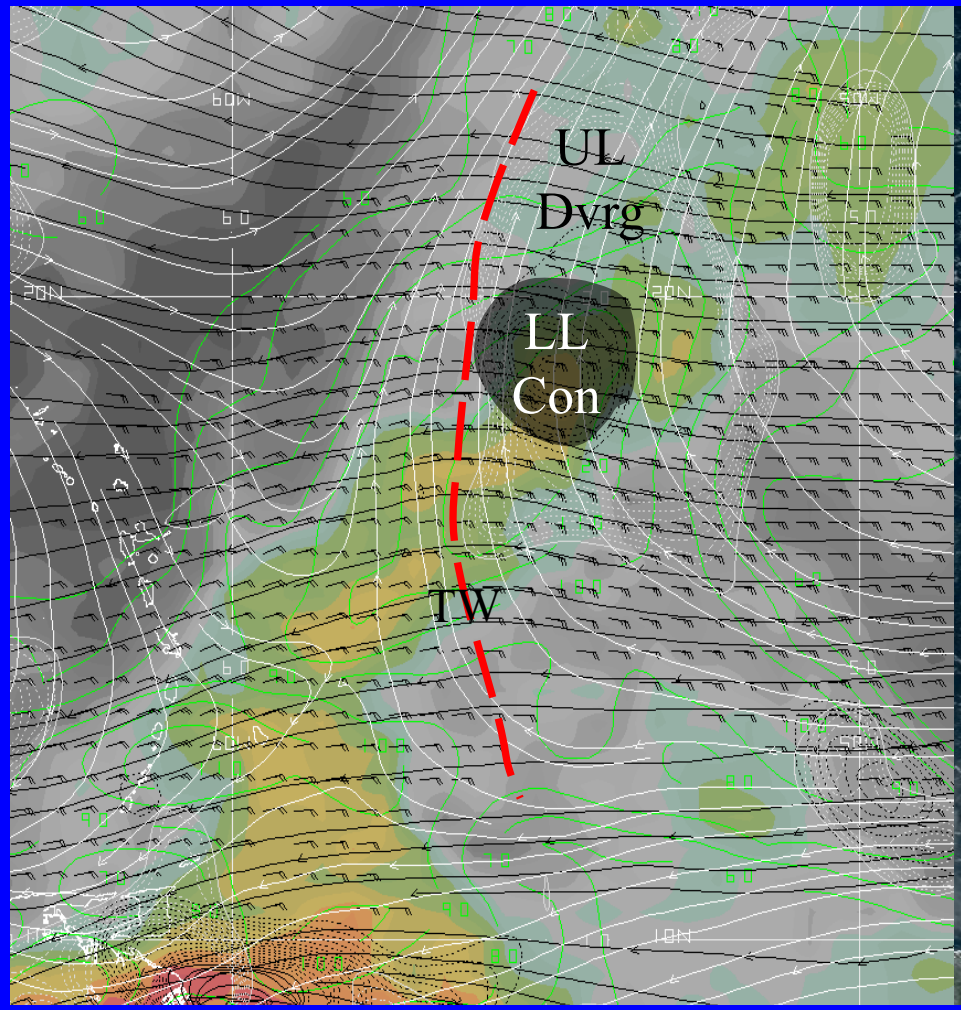
GDI2



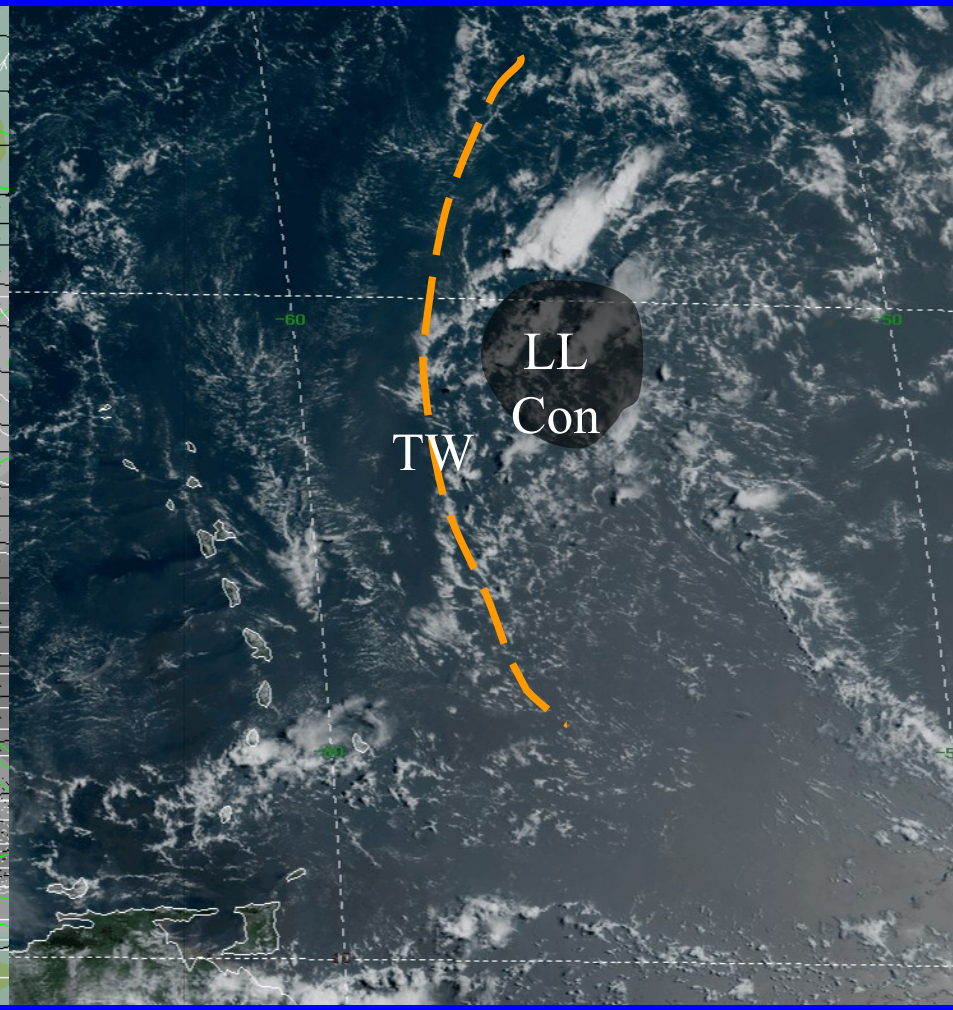
GeoColor

GDI2 Macro Operational Application

Evaluation of Low Level Features and Convergence



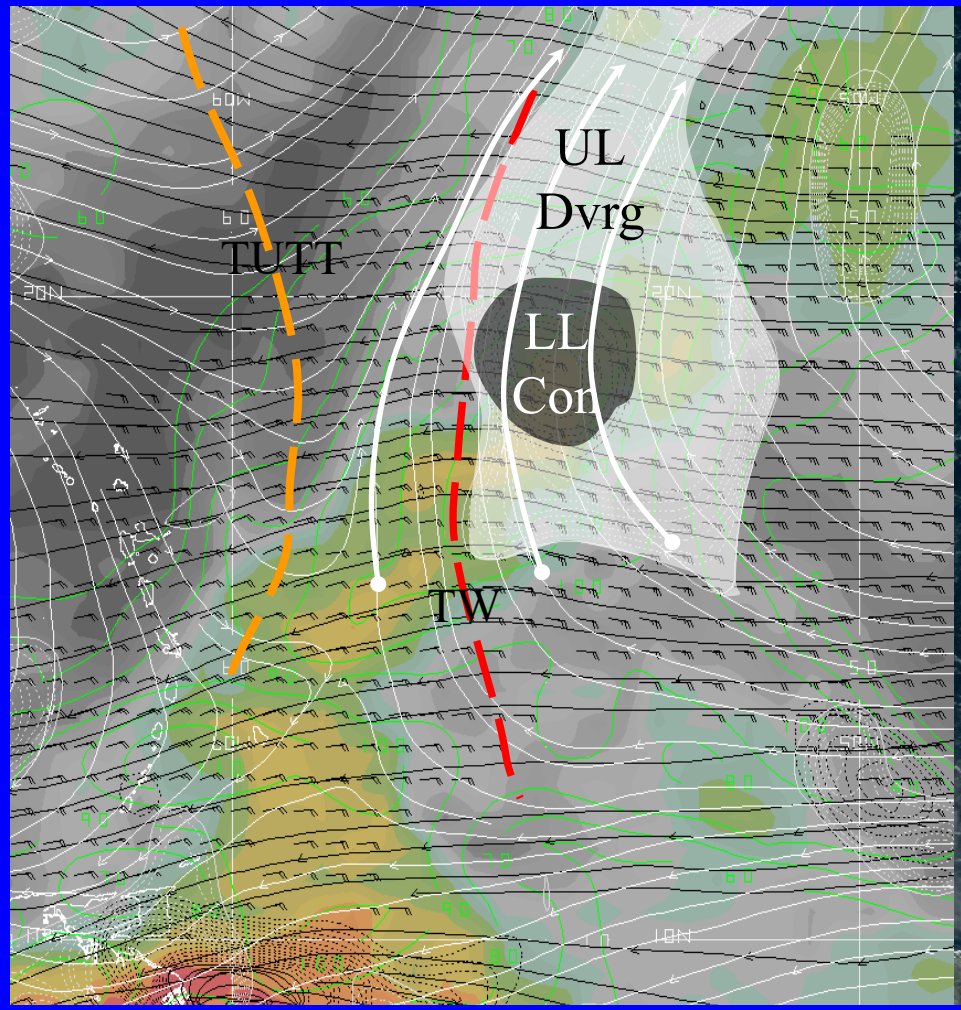
GDI2



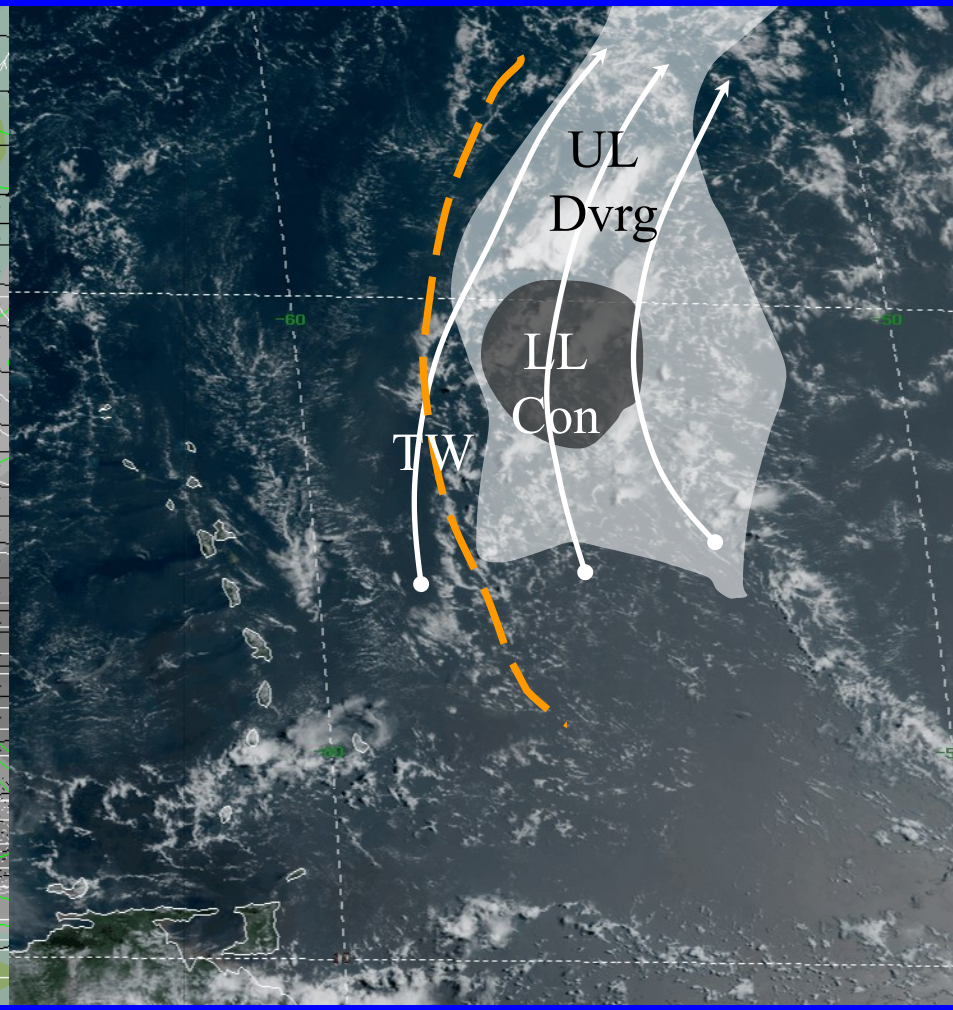
GeoColor

GDI2 Macro Operational Application

Coupling of Atmospheric Dynamics



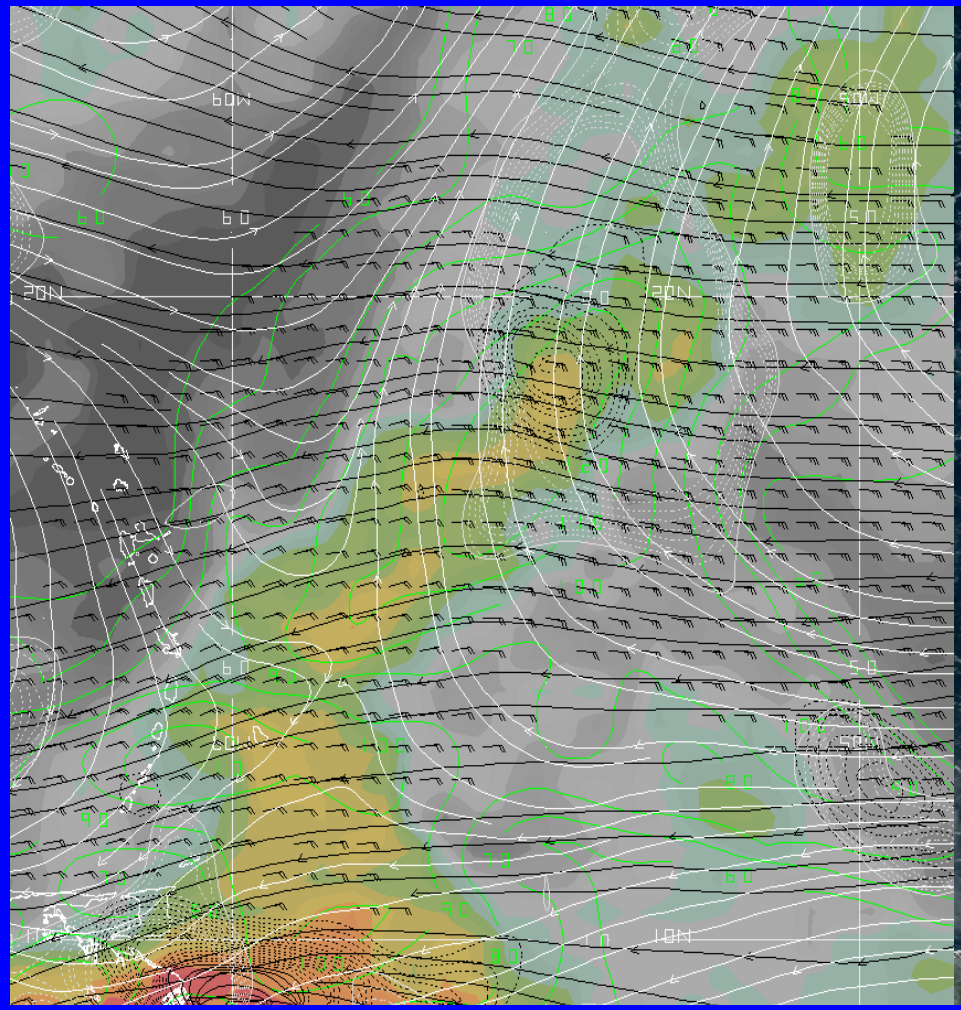
GDI2



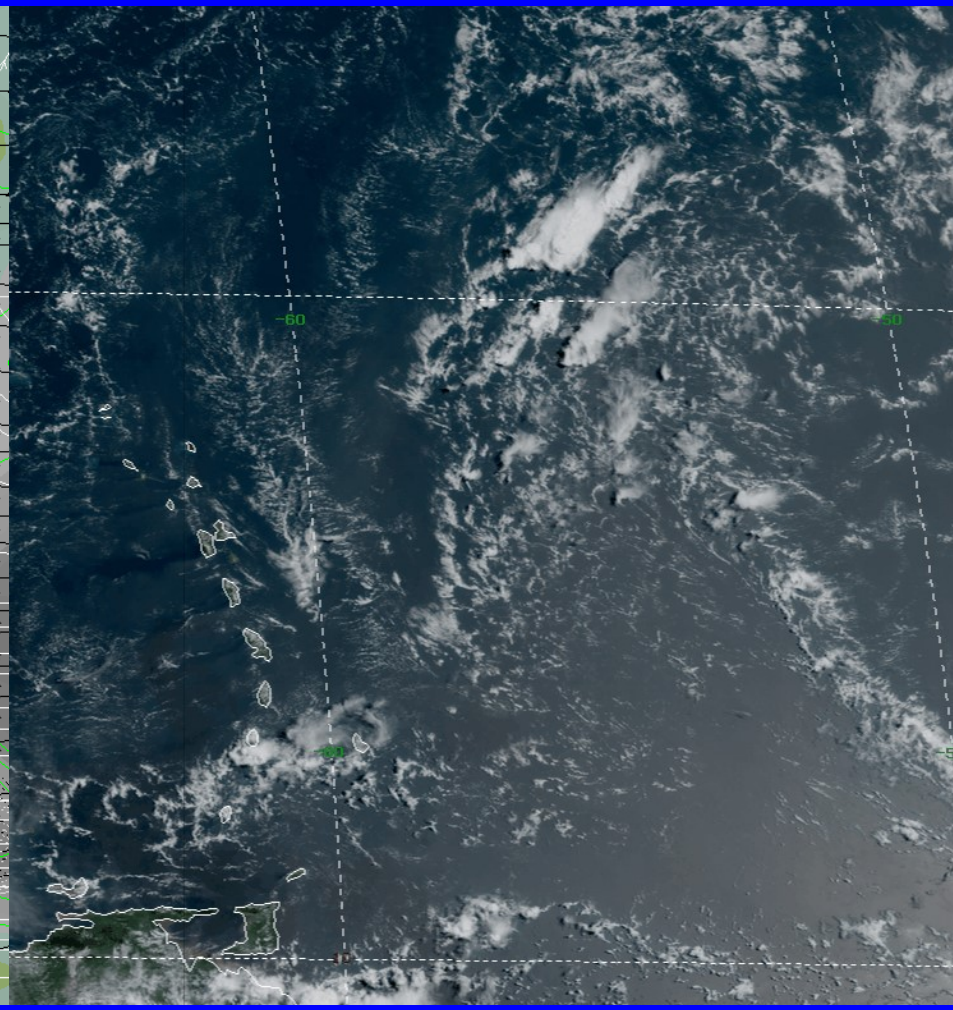
GeoColor

GDI2 Macro Operational Application

In a hurry, this is a time saver, as it helps you identify areas and time periods you need to pay particular attention.



GDI2



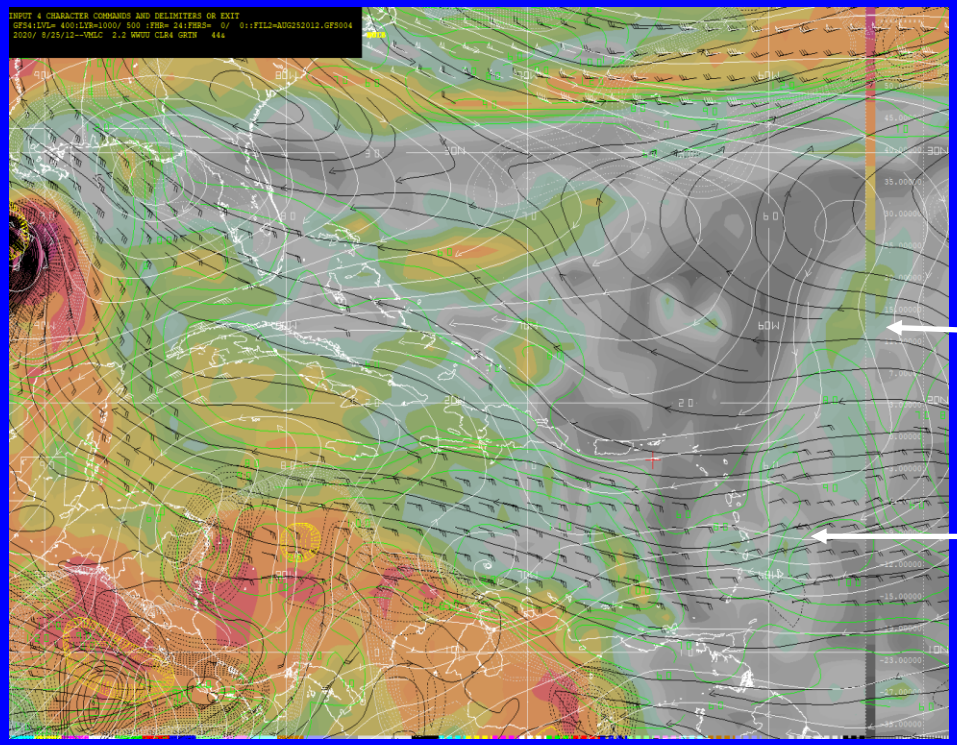
GeoColor

Can we do better?

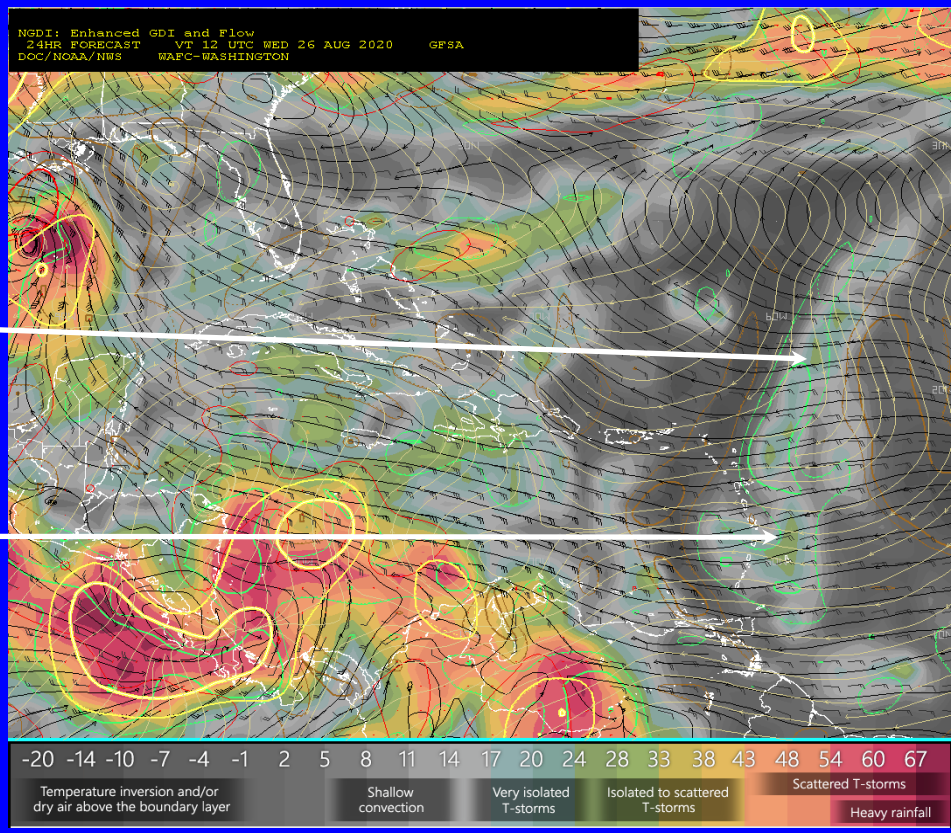
Enhanced Galvez-Davison Index (EGDI)

Enhanced GDI

- EGDI accounts for the effects of moisture convergence/divergence



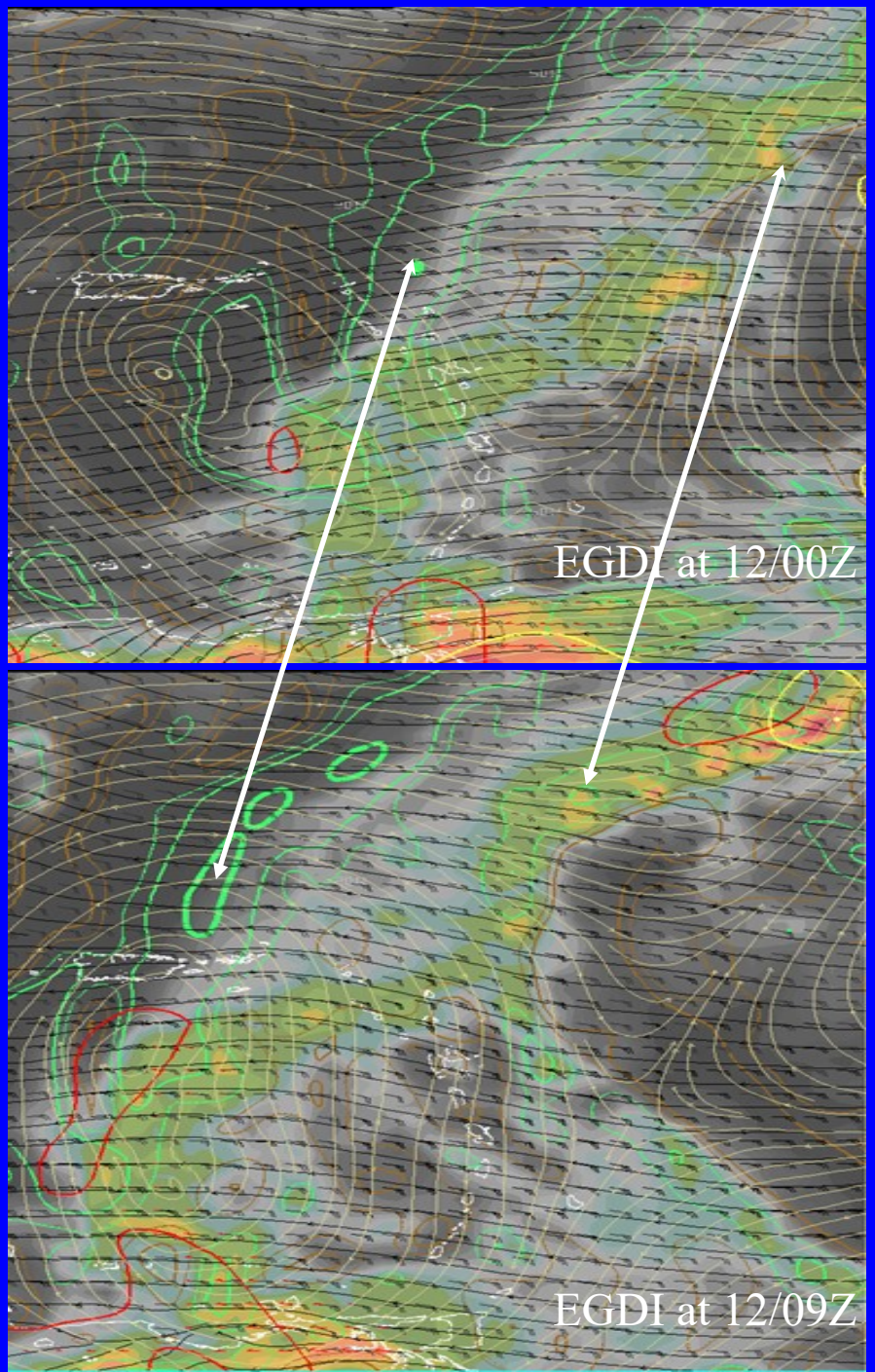
GDI2



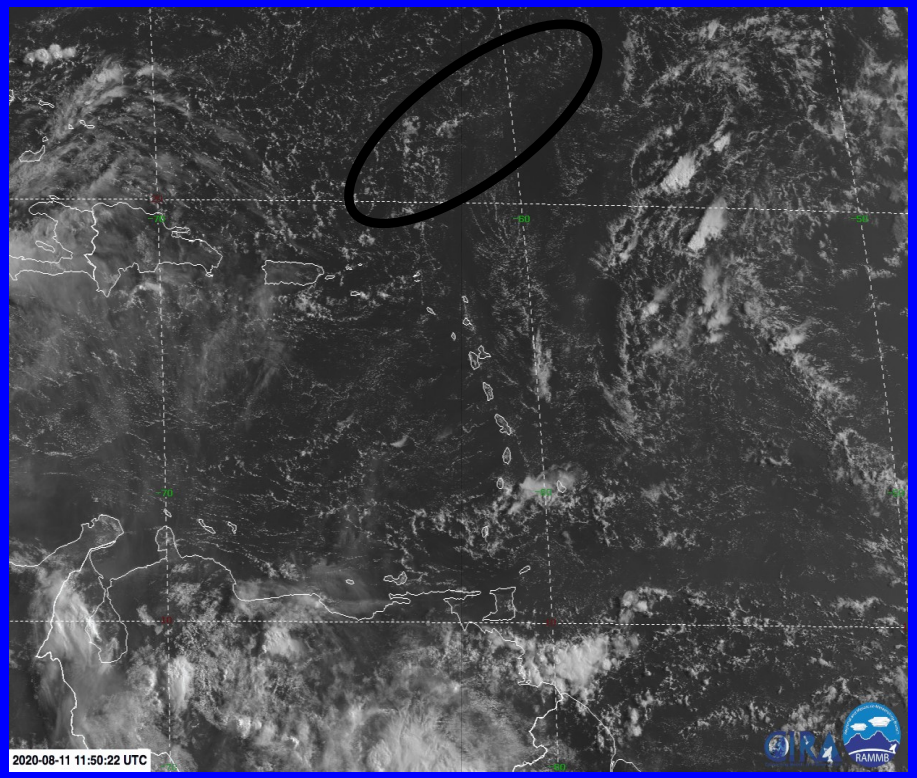
EGDI

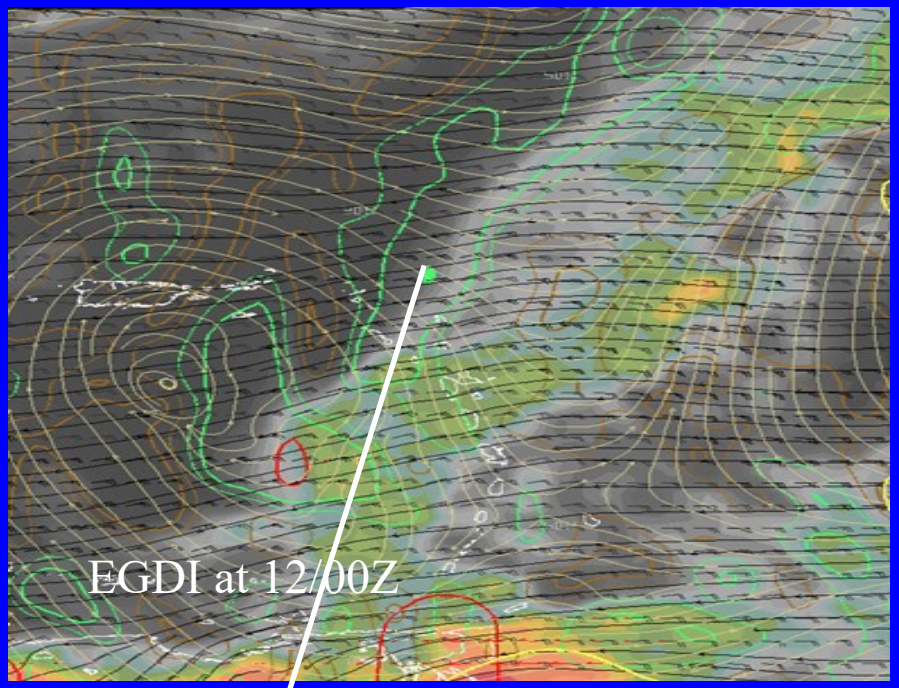
EGDI

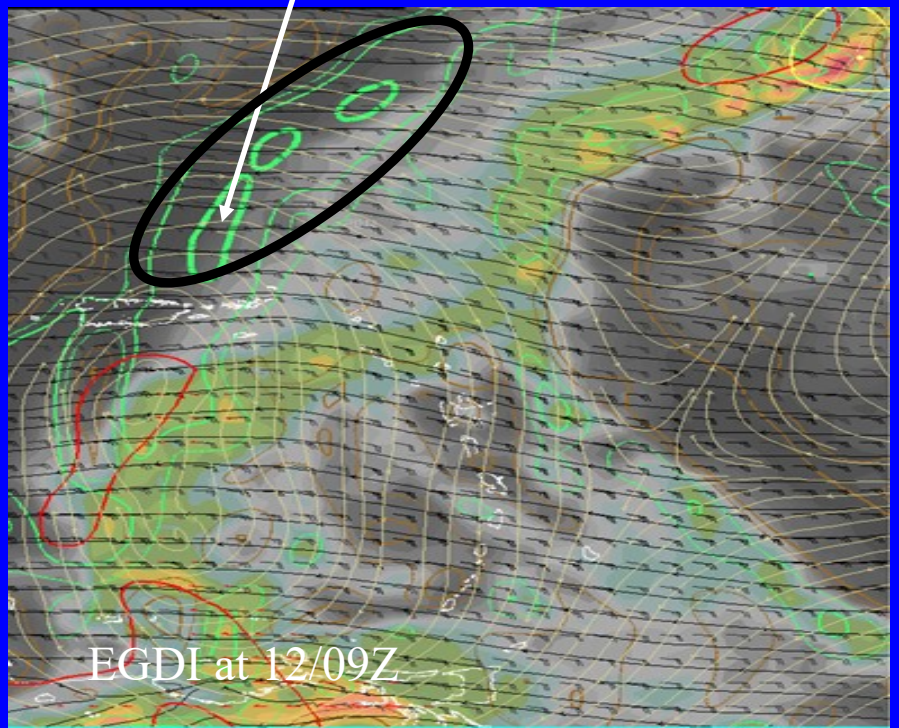
- Low level moisture convergence west of the wave increases between 12/00Z and 12/09Z
- Trailing instability to the east persists



Vis Proxy & EGDI







Questions?