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A Climatology of Central American Gyres

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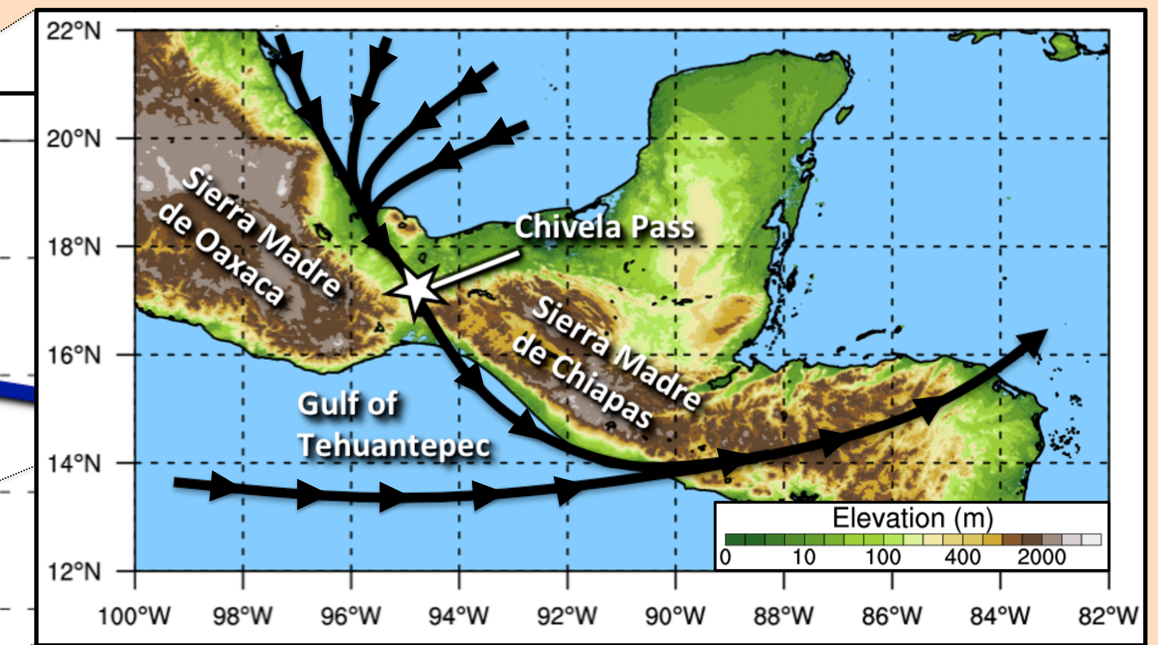
1. Motivation

- September 2010 large scale cyclonic circulation (gyre) was well observed
- Gyre contributed to a series of major rainfall events in Mexico, Jamaica, and the eastern U.S.
- No previous gyre studies over Atlantic basin
- Role of tropical cyclones (TCs)
  1. TC Matthew as gyre generator
  2. TC Nicole as product of gyre

2. Gyre Definition

Northwest Pacific Basin	Central American Gyres
Low-level cyclonic vortex (~ 2500 km)	Low-Level cyclonic vortex (~ 1400 km)
Deep convection on southern and eastern sides of circulation	Deep convection on southern and eastern sides of circulation
Mesoscale vorticies downstream of convective band (Possible TCs)	Mesoscale vorticies downstream of convective band (e.g. TC Nicole)
Multiweek lifespan	2-5 Day Lifespan

Fig 1b. Topography map of Central America with low-level streamlines sketched



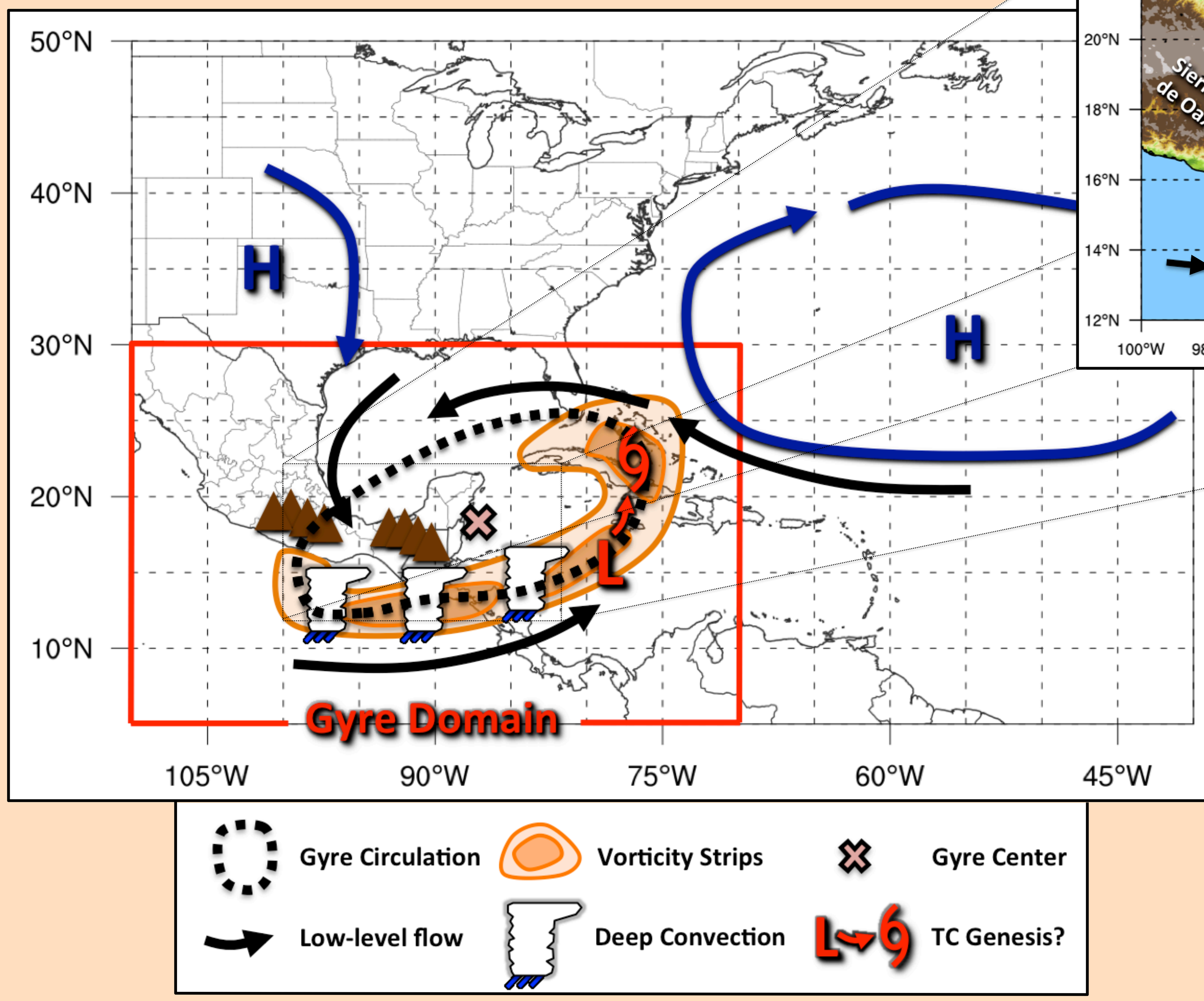


Fig 1. Schematic outlining major features associated with Central American gyres.

4. Gap Wind Origins

- Enhanced Azores-Bermuda high necessary for gap winds in Chivela Pass during summer.
- Strengthened cold surges enable gap winds in Fall/Winter (Schultz et al. 1998)
- Equatorward displaced flow by Central American mountains results in low-level, jet-producing vorticity maxima that propagate downstream (Fig 1b)
- Acted as source region for vorticity in developing gyre

6. Gyre Characteristics

- Gyres more common in La Nina regime (Fig 4a)
- Gyres more likely to occur in late Spring and Early Fall (Fig 4b)

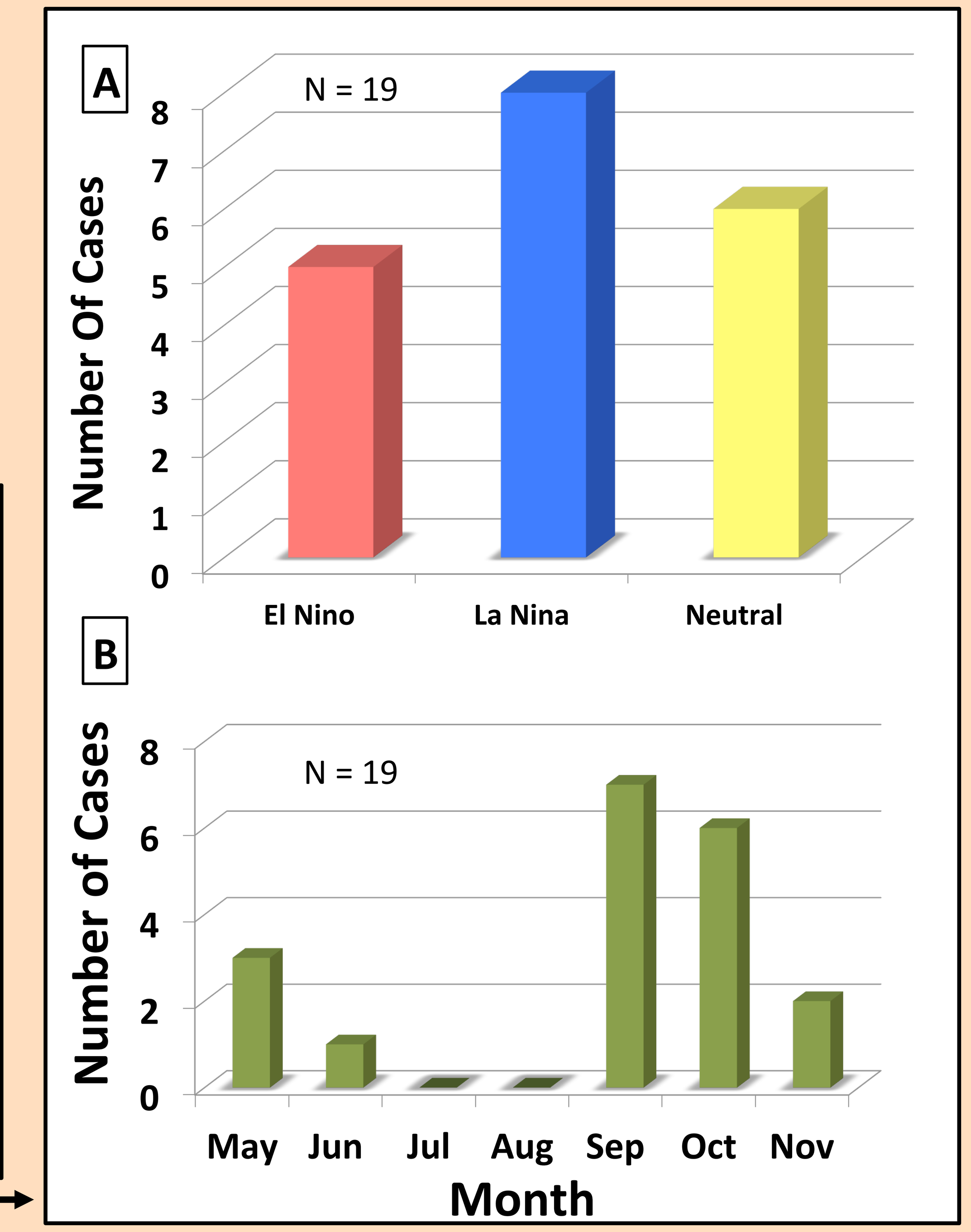


Fig 4. Distribution of gyre cases by (A) ENSO state and (B) Month.

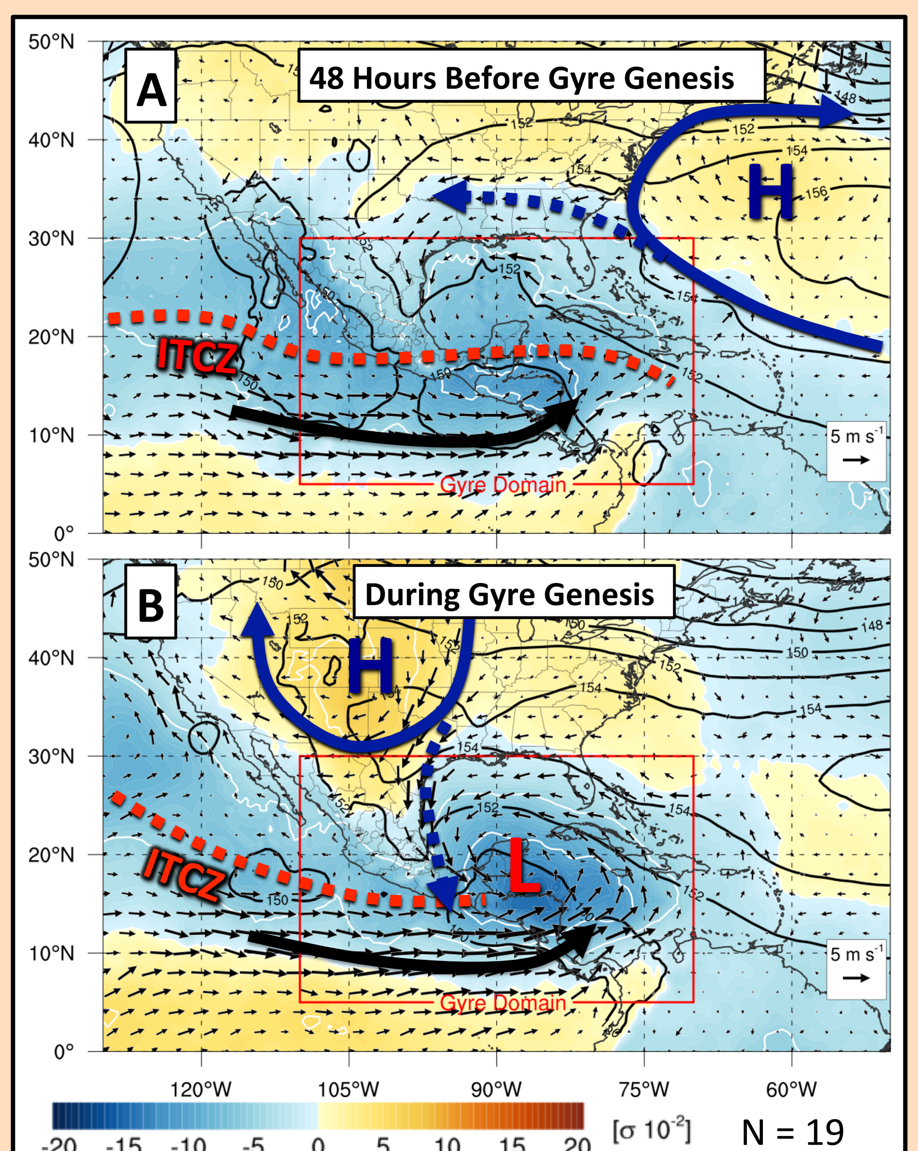


Fig 2. Gyre composite 850 hPa height (black contours), standardized height anomalies (shaded), and anomalous wind (vectors).

3. Gyre-Related Synoptic Features

- Northward displacement of the Intertropical Convergence Zone (ITCZ) over Central America (Fig 2)
  - Leading to anomalous westerly flow in East Pacific (Fig 2a,b)
  - Most common in late Spring /early Fall (Romero-Centeno 2007)
- Enhanced ridging over West Atlantic drives anomalous easterly flow in Atlantic (Fig 2a)
- Enhanced ridging over North America drives gap wind flow (Chivela Pass) during gyre genesis. (Fig 2b)
- Gyre vorticity sources:
  a) Terrain induced vorticity (Fig 3a)
  b) Upper-level trough interaction (Fig 3b)
  c) Predecessor TC (Fig 3c)

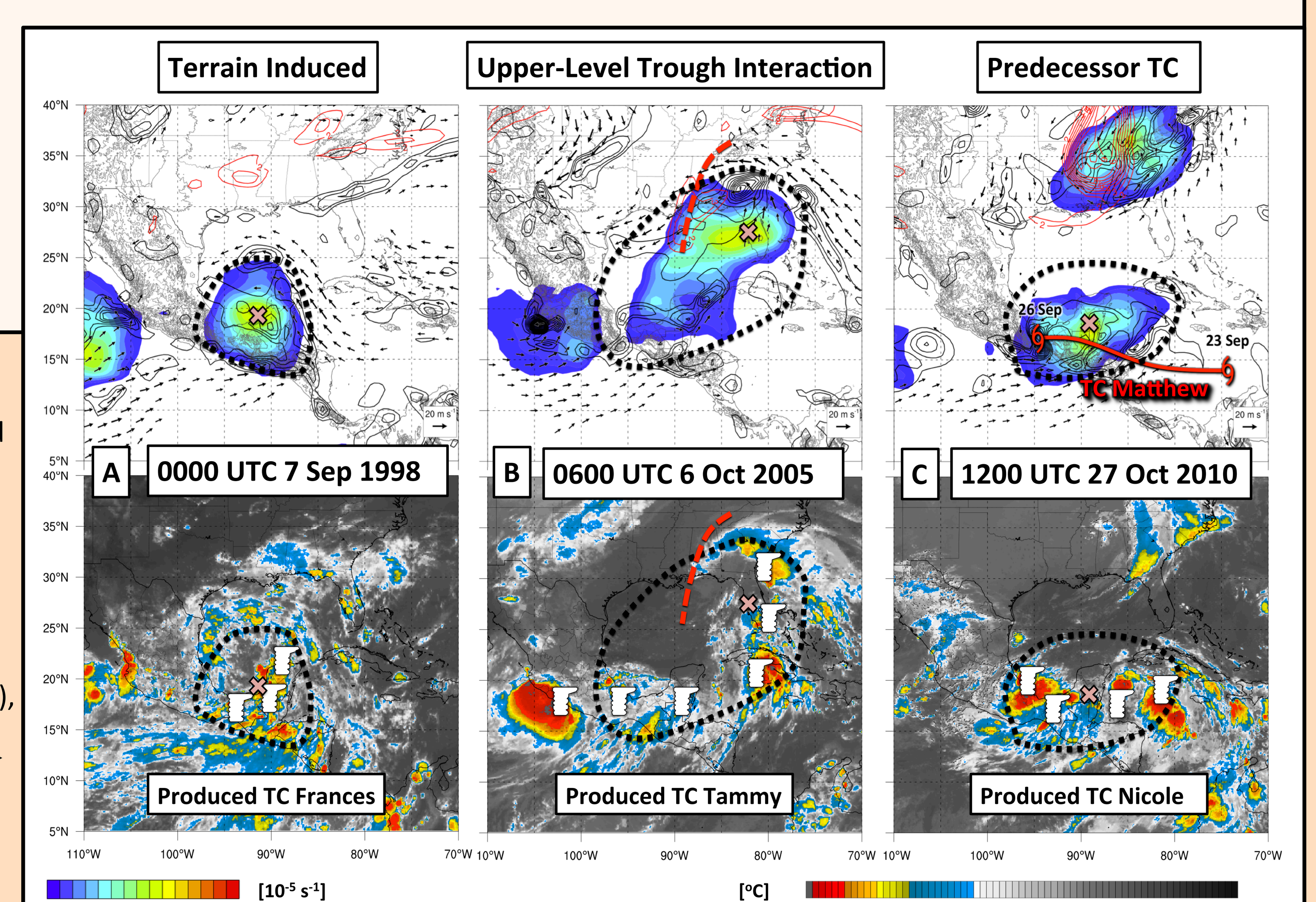


Fig 3. Gyre Case Studies:
Top:
850 hPa Circulation at 700 km radius(color shading), relative vorticity (black contours) and winds (vectors), 200-300 hPa layer mean potential vorticity (red contours), topography every 500 m (gray contours)
Bottom:
Infrared Brightness Temperature (color shading)

5. Gyre Identification Process

1. Objective identification – Identify persistent circulation
   a) Magnitude circulation threshold: > $2X10^{-5}$ s^{-1} at 700 km radius
   b) Longevity threshold: ≥ 48 hours
   c) Area threshold: between 5-30°N and 70-110°W
   d) Period of Climatology: 1980-2010 (May-November)
2. Subjective identification – Identify gyre distinctive features
   a) Deep convection on south and eastern flank of circulation
   b) Multiple mesoscale vortices downstream of convective band with no dominant vortex
3. Future work
   - Automate all identifying techniques for more objective classification

Datasets

- NCEP Gridded Climate Forecast System Reanalysis (CFSR) 0.5° resolution (Maps and Climatology)
- NASA Merged IR Brightness Temperature (BT)
- NCDC Gridsat Satellite Data

References and Acknowledgements

◆ This work was supported by NSF grant AGS-0935830

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