Tropical Cyclone Interactions Within Central American Gyres
Philippe P. Papin*, Lance F. Bosart, Ryan D. Torn
Department of Atmospheric and Environmental Sciences – University at Albany: SUNY, Albany NY

*Corresponding author e-mail: ppapin@albany.edu

1) Motivation

- TCs occasionally interact with large-scale cyclical circulations, known as Central American gyres (CAGs) in the Atlantic basin (Papin 2014)
- One potential interaction occurred in October 2005 where TC Stan possibly interacted with a CAG, resulting in:
  1. A poor track forecast by the National Hurricane Center (Fig. 1, red) when TC Stan deviated equatorward in the Gulf of Mexico (Fig. 1, green).
  2. Over 1000 fatalities due to catastrophic rainfall associated with both systems (Fig. 1, shaded).

2) CAG Identification

- Pasch and Roberts (2006) attributed track error to a stronger than expected deep-layer anticyclone north of TC Stan
- This study aims to investigate track deviation associated with the previously unidentified CAG.

3) CFSR Analysis Vs. GFS Forecast

- This study investigates TC Stan’s interaction with CAG qualitatively from a vorticity (microscopic) and circulation (macroscopic) perspective
- Using Stokes’ theorem, circulation is equivalent to area average vorticity
- CFSR suggests barotropic interaction between TC Stan and the larger CAG circulation (Fig. 3a – c)
- GFS forecast depicts TC Stan displaced poleward and does not develop a CAG (Fig. 3d – f)
- GFS forecast forms a possible TC in east Pacific

4) Piecwise Vorticity Inversion

- Adapted from Davis et al. (2008), where inverted vorticity and divergence is used to obtain nongdivergent and irrotational winds individually for both the CAG and outside environment
- Steering flow obtained by removal of TC Stan vortex
  1. averaged over TC Stan radius (2.5°)
  2. averaged from 925 – 500-hPa; consistent with expected steering depth of strong tropical storm (Galarneau and Davis 2012)

5) Discussion and Conclusions

- Large cyclical circulation (CAG) interacted with TC Stan, resulting in an unexpected equatorward deviation in track (Fig. 3a – c)
- TC Stan tracked more poleward in GFS forecast, possibly due to failure to develop a CAG (Fig. 3d – f)
- Piecwise vorticity inversion conducted to quantify CAG steering impact of TC Stan relative to the environment (Fig. 4a – c)
  1. Deep-layer anticyclone initially contributes to majority of westward steering flow of TC Stan into Gulf of Mexico (Fig. 5 e – f)
  2. When TC Stan turns equatorward, CAG steering flow dominates over steering flow by deep-layer anticyclone(Fig. 5a – c)
- Piecewise inversion of GFS forecast only has steering flow from deep-layer anticyclone due to lack of CAG (not pictured)

Datasets

- NCEP Climate Forecast System Reanalysis (CFSR)
- GFS forecast initialized at 0000 UTC 1 Oct 2005
- NASA TRMM 3B42 (v7) Rainfall
- NDCD NCEP-NCAR reanalysis

References and Acknowledgments

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