TC-Relative Environmental Helicity and Its Impact on Intensity and Development

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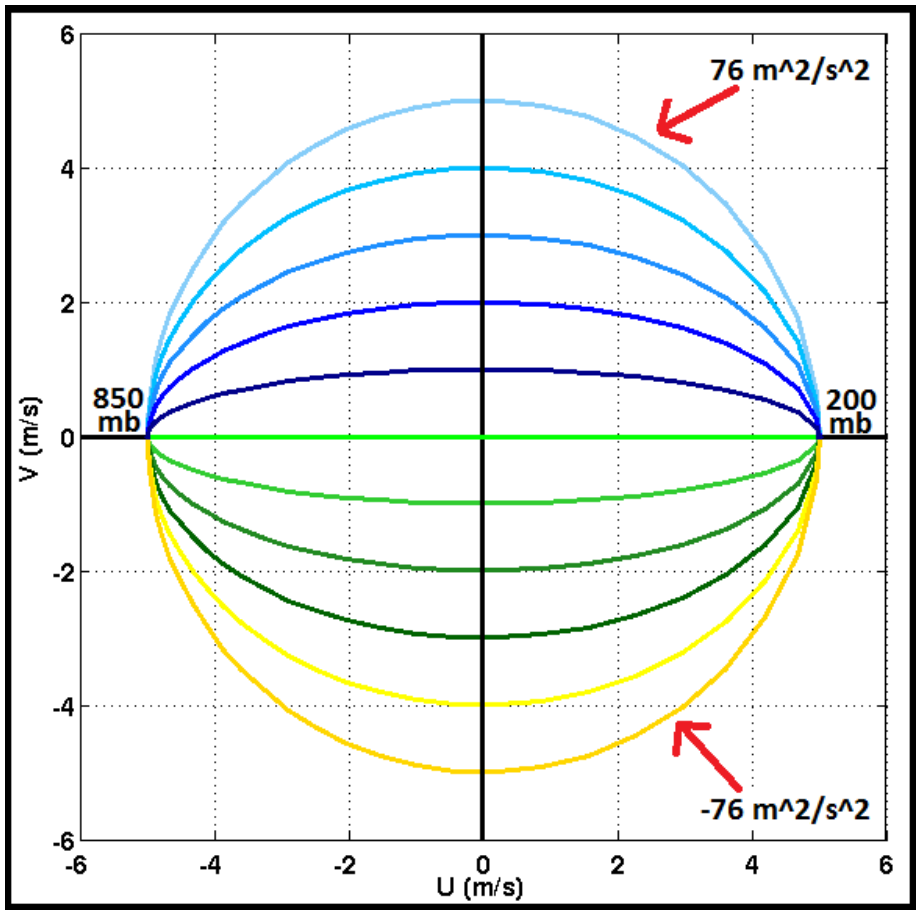
Motivation

- 850-200 mb wind shear is commonly used to diagnose the favorability of TC environments

- For the same value of shear, helicity can change significantly

Environmental Wind Profiles



Research Questions

- What are the implications of different values of environmental helicity?
- Does environmental helicity have as much predictive value as shear?
- How do observational estimates compare to the WRF simulations? i.e., do we see any signal in nature?

Background

- Many studies show vertical wind shear is important for TC intensity change (e.g., DeMaria and Kaplan 1999)
- Nolan (2011) suggests that helicity in the TC environment may be important
- Point-Downscaling (PDS) developed by Nolan (2011) as a framework to control the environment around a TC
- This modification has been used in many idealized studies of mid-latitude convection (e.g., Skamarock et al. 1994; Davis and Weisman 1994; Weisman and Trapp 2003)

Methodology – Model Setup

- 2 modeling techniques are used

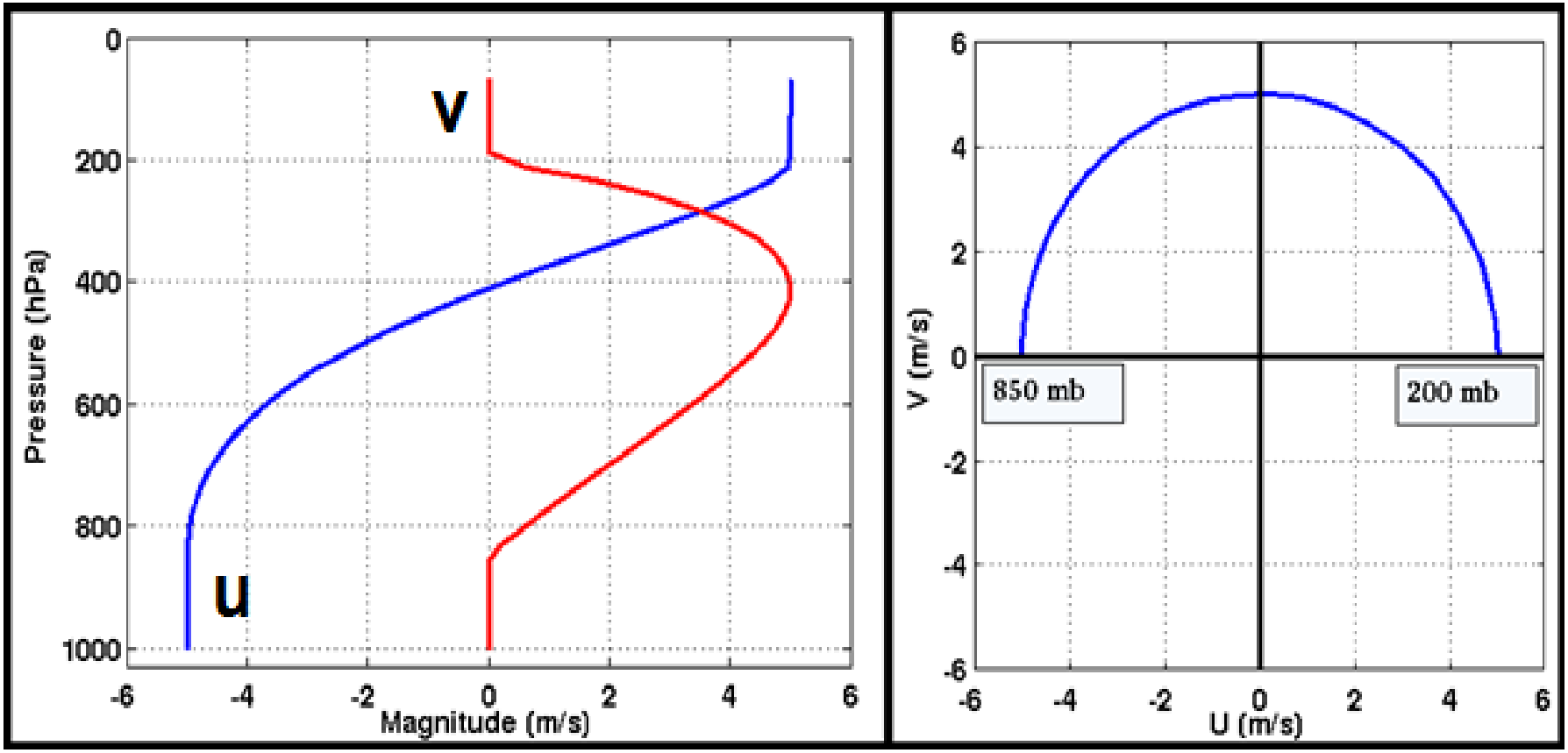
    1) PDS: Allows wind shear without the typically required temperature and pressure gradients (for explanation: see Nolan 2011)

    2) Idealized Nudging: Nudge environment in outermost domain toward the original prescribed sounding to restrict changes to the environment

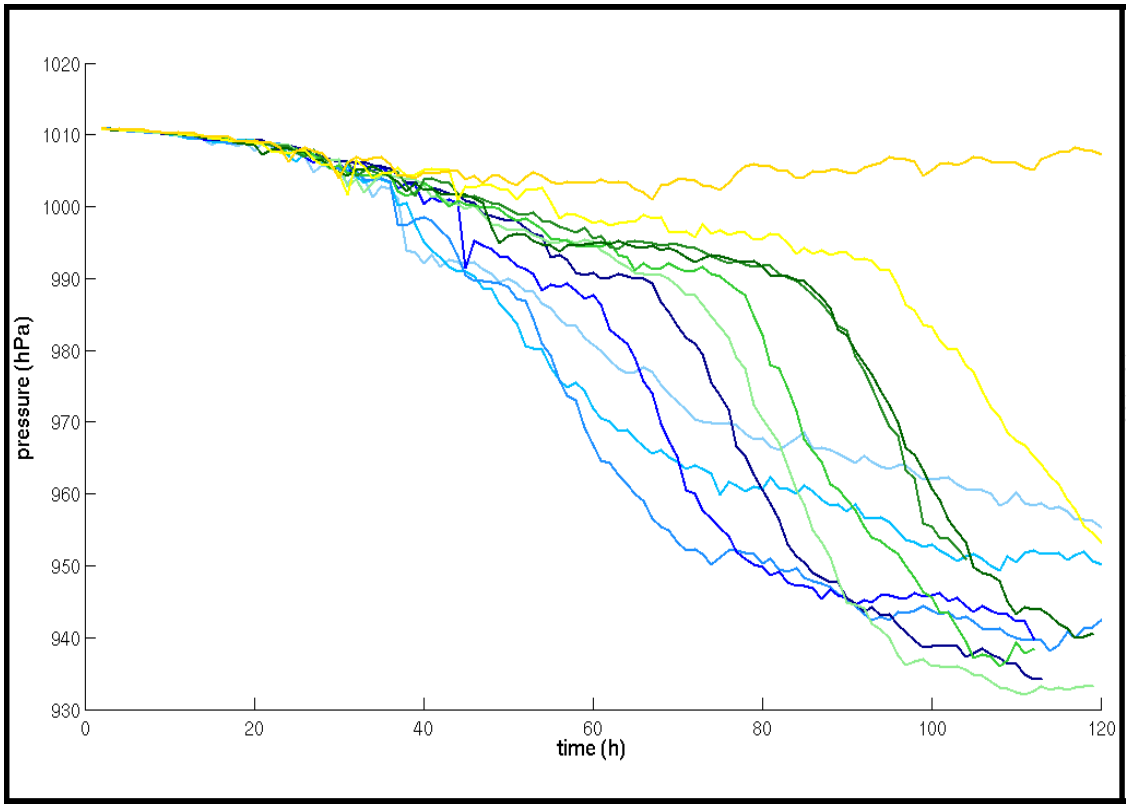
- 3 domains (18, 6, 2 km grid spacing). Doubly periodic BCs on outermost domain.

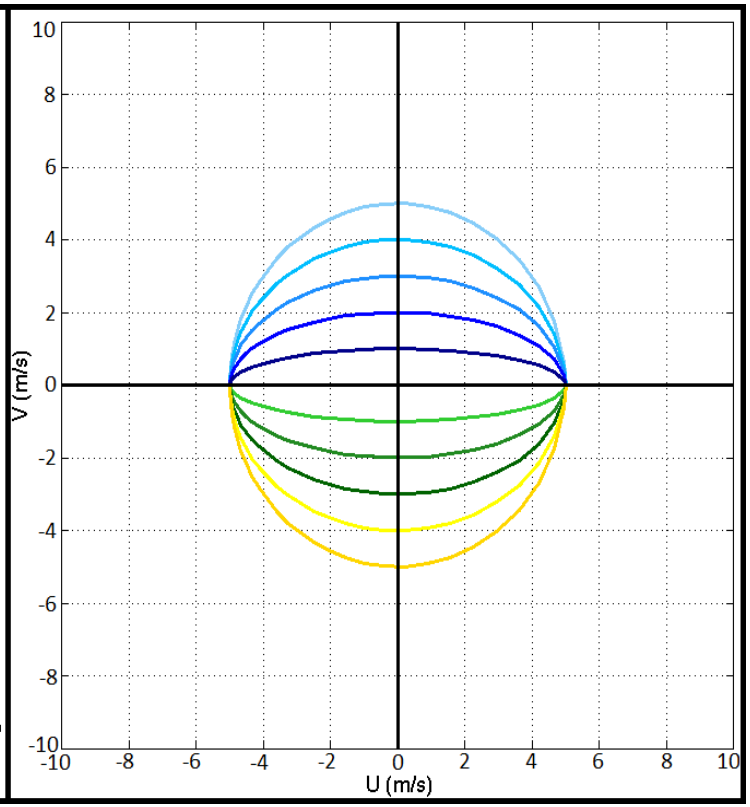
Methodology – Model Setup

- Prescribed environmental wind field



Modeling Results – WRF Simulations



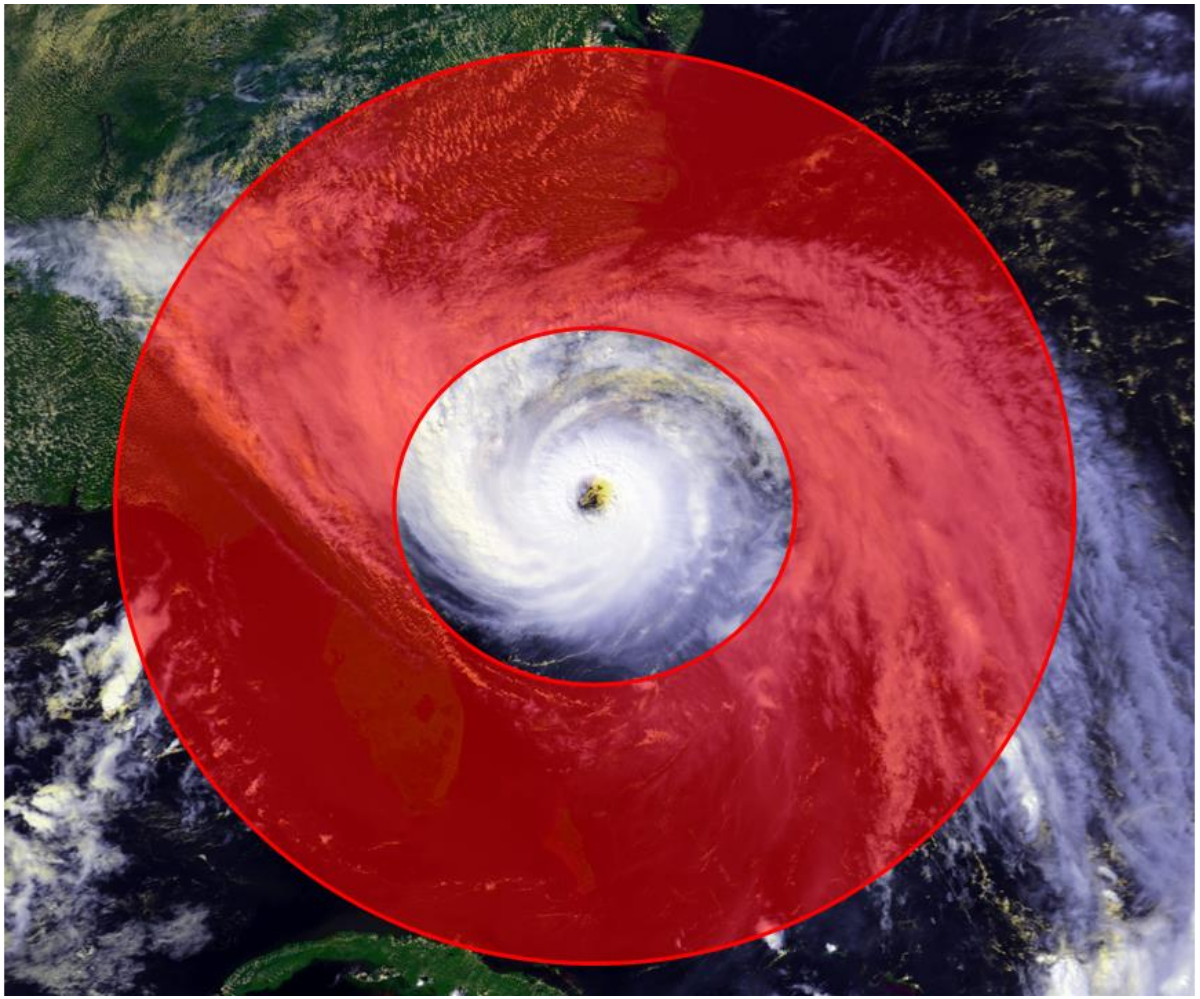


TCs initialized as a modified Rankine vortices with maximum tangential wind speed of 20 ms^{-1} radius of max winds = 90 km.

Methods and Results from Reanalyses

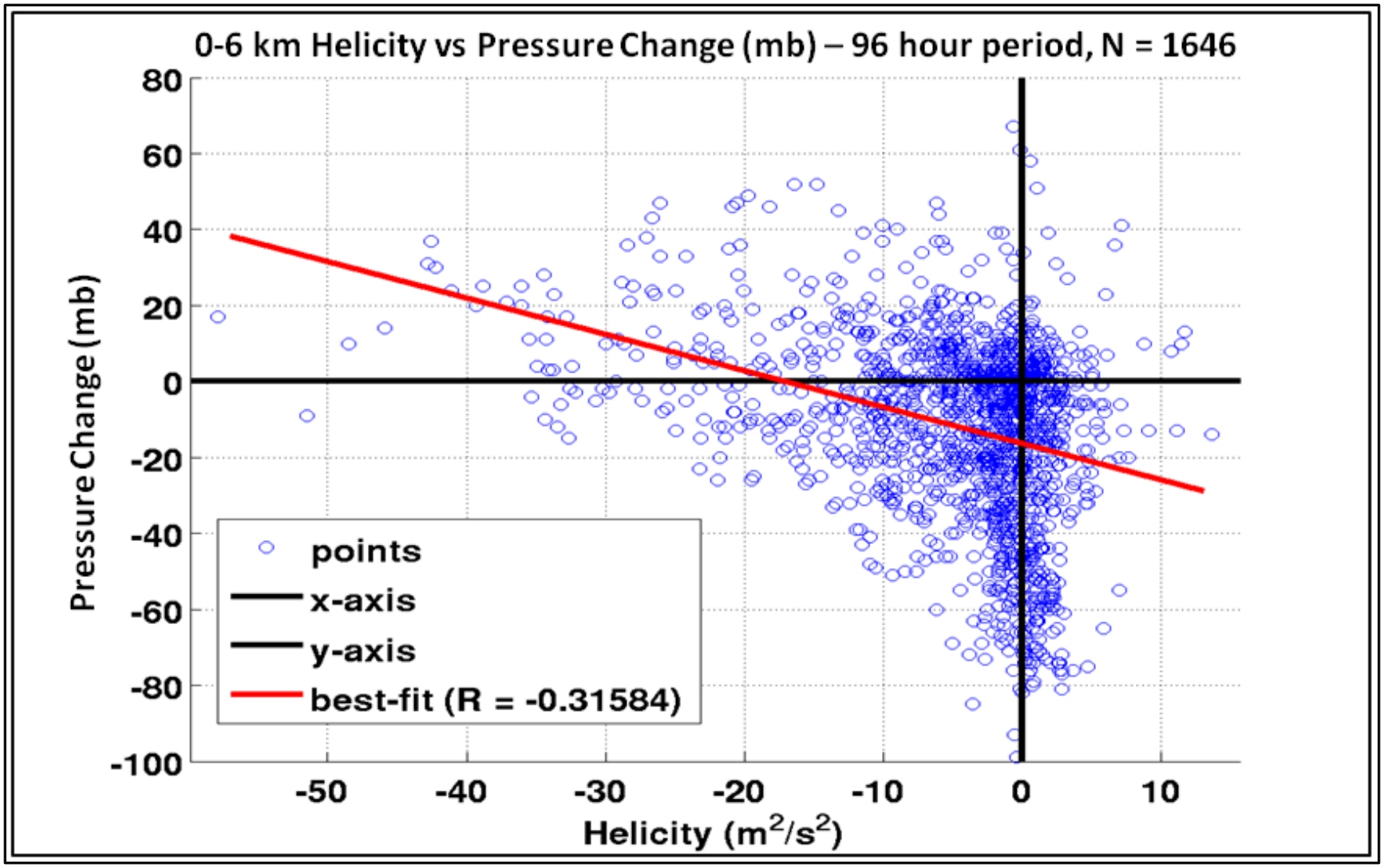
Methodology – Reanalysis Data

- Calculate TC-relative environmental helicity (TCREH) from ERA-Interim reanalyses and GFS analyses
- TCREH computed from the average wind profile in annuli around TCs

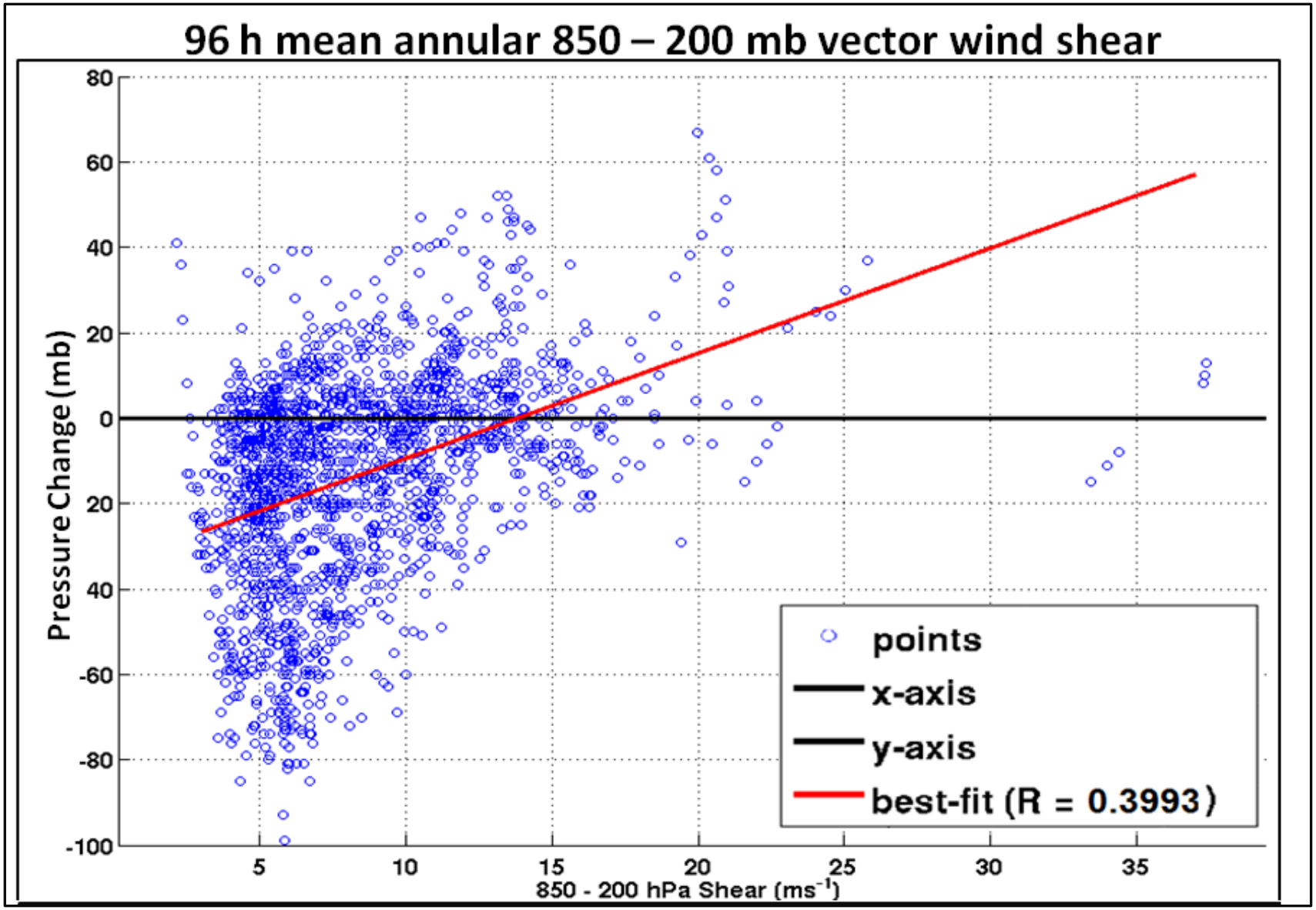


Hugo 1989

Results – ERA-Interim Reanalysis Data

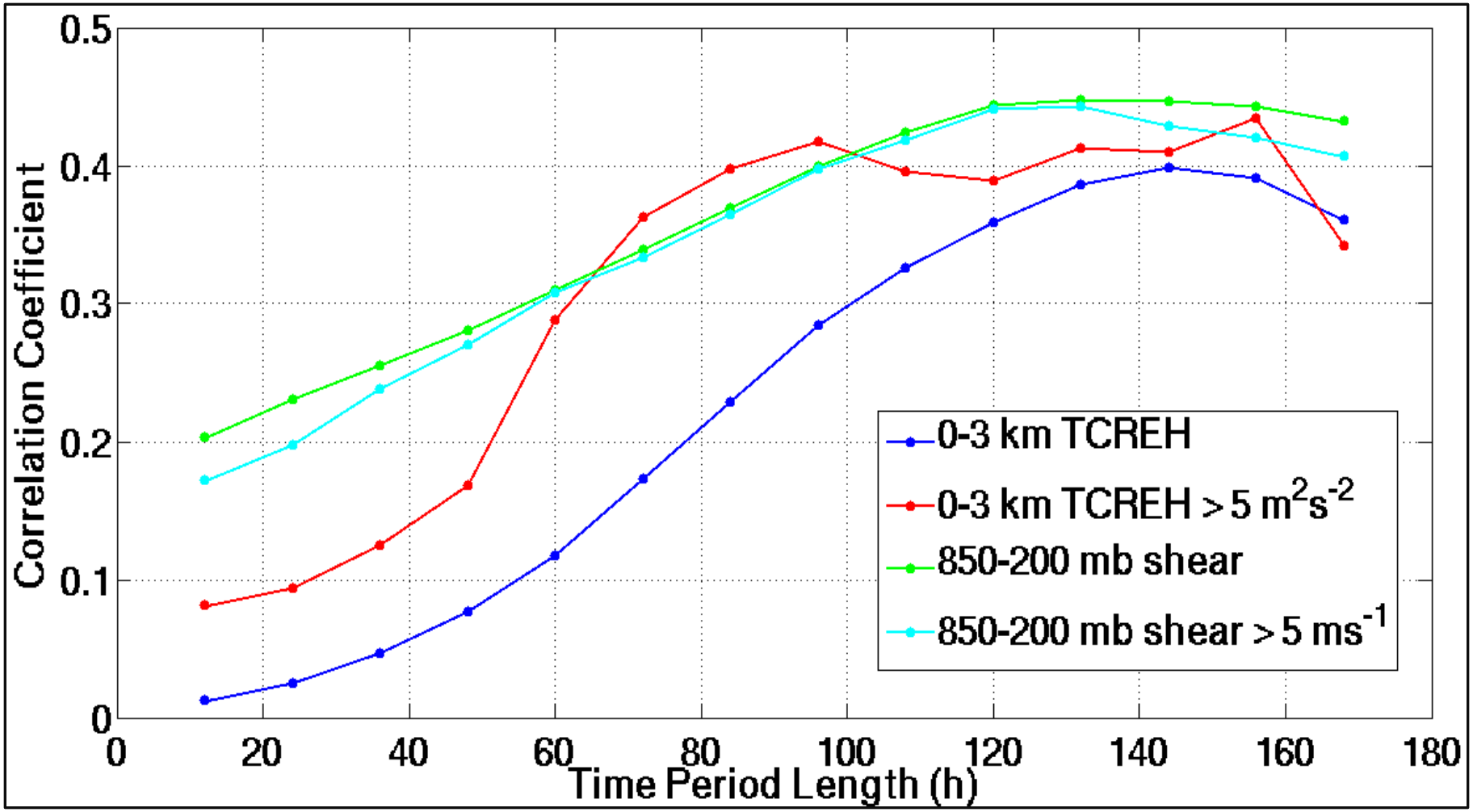


Results – ERA-Interim Reanalysis Data



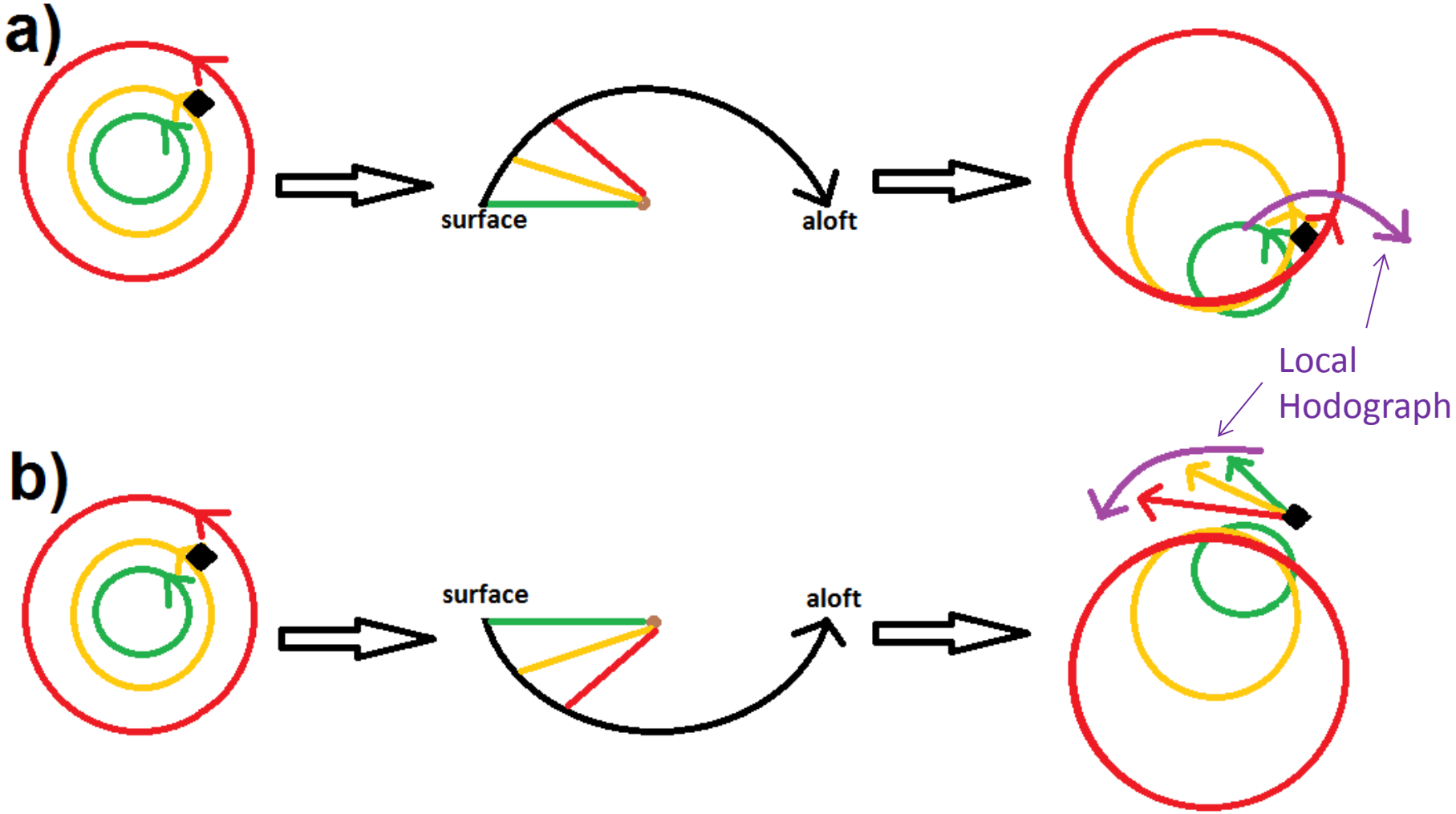
Results – ERA-Interim Reanalysis Data

Correlation coefficient vs. time period length

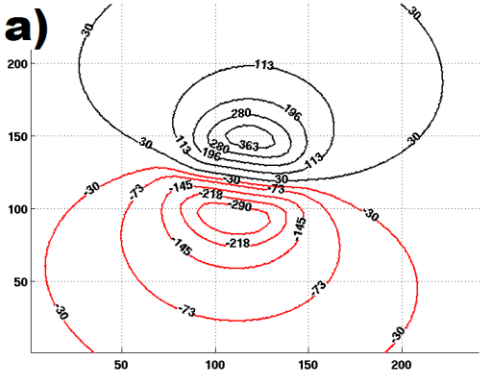


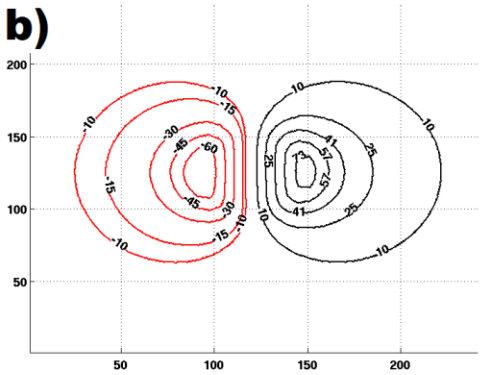
Idealized Framework

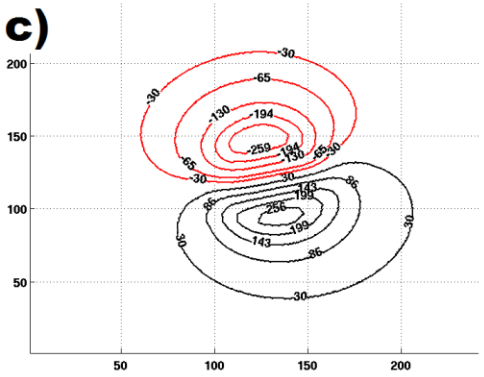
Modulation of local helicity by environmental helicity through TC tilt

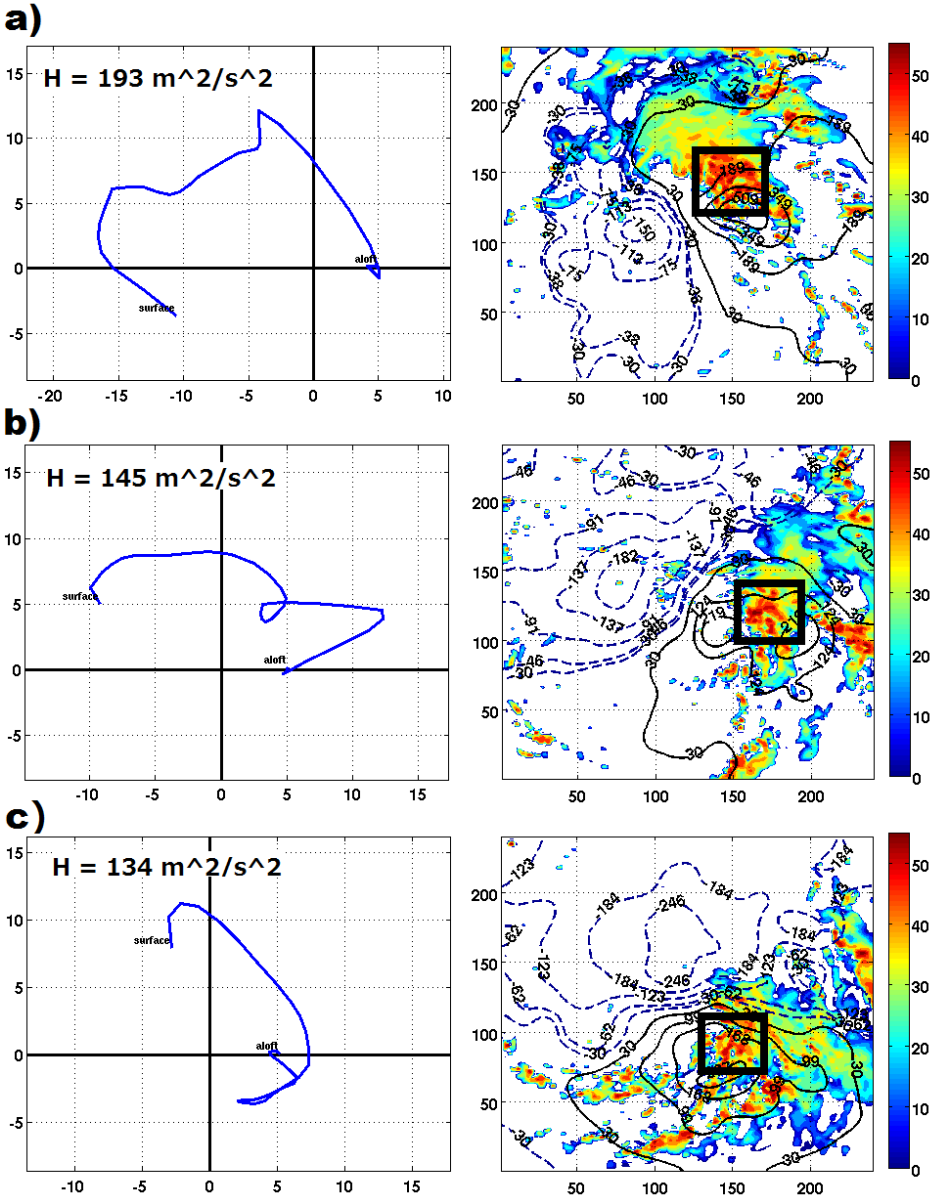


Methodology – Idealized TC Tilt









Summary

- WRF simulations suggest helicity is a useful predictor for TC intensification.

- Reanalysis data suggests that this signal is weak in nature, although the correlations are similar in magnitude to those for 850 – 200 mb shear, particularly for periods longer than 72 h.

- Idealized shifting of wind fields shows how environmental helicity can modulate the impact of local storm helicity.