An Assessment of the Impact of Tropical Cyclones on Their Large Scale Environment

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Previous Work on Reanalysis TC Fidelity

- In interest of full disclosure, evaluation of reanalysis TC position and intensity has shown:
 - 1. Significant discrepancies between reanalysis and Best-Track TC position
 - 2. Underestimation of reanalysis TC intensity beyond what can be *solely* attributed to the coarse resolution of reanalyses
 - 3. Substantial differences in the timing of TC intensity changes between the Best-Track and reanalysis TCs
 - 4. Several examples of nonphysical reanalysis TC structure
- Schenkel, B.A. and R.E. Hart, 2012: An Examination of Tropical Cyclone Position, Intensity, and Intensity Life Cycle within Atmospheric Reanalysis Datasets. *J. Climate*, MERRA Special Collection, in press.
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Assessing the Large Scale Impact of TCs

Atmospheric Response to TC Passage



Methodology: Quantifying the Large Scale Response to TC Passage

- Objective: To analyze the response of the tropical atmospheric environment to TC passage
- Evaluation of mean environmental response will occur using four-dimensional stormrelative composites of normalized anomalies
- Composites are constructed using the NCEP Climate Forecast System Reanalysis (Saha et al. 2011) for category 3 to 5 Best-Track TCs in the Western North Pacific from 1982-2009 (N=257 TCs)
- CFSR chosen for this study given it has strongest reanalysis TC intensities and smallest differences between reanalysis and Best-Track TC positions
- Reanalyses are *crucial* for this analysis since they provide the only means of evaluating the mean large scale environmental response for historical TC cases

Assessing the Large Scale Impact of TCs

Introduction

Large Scale Pressure Anomalies in the Tropics Following TC Passage



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Large Scale Pressure Anomalies in the Tropics Following TC Passage



- Large scale response similar to TC Tip with significant anomalies through day 11
- Anomalies are significant (≥0.2σ) over an area extending over one-quarter of the circumference of the globe
- 22% reduction in meridional pressure gradient

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Assessing the Large Scale Impact of TCs

Methodology

Vertical Structure of Moisture Anomalies



Methodology

Vertical Structure of Temperature Anomalies



Physical Processes Responsible for Cooling and Drying of Equator

Normalized Meridional-Vertical Wind Vector and Temperature Anomalies (σ) for Major Western North Pacific Tropical Cyclones at Day 5



• Weakening of Hadley cell following TC passage

Physical Processes Responsible for Cooling and Drying of Equator

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Methodology

Vertical Structure of Zonal Wind Anomalies



Modulation of Upper Level Jet Stream Circulations by TCs



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Concluding Thoughts



Assessing the Large Scale Impact of TCs

Variability of Large Scale Pressure Anomalies Among Reanalyses



Variability of Large Scale Pressure Anomalies Among Reanalyses



Normalized Mean Sea-Level Pressure Anomalies (σ) for Major Western North Pacific Tropical Cyclones at Day 14 Before Major TC Passage

- **Red:** Anomalies in *CFSR* more strongly positive
- **Blue:** Anomalies in *ERA-Interim* more strongly positive
- CFSR shows stronger positive anomalies in western portion of domain with differences of 10-15%
 - Northward shift of positive anomalies in CFSR relative to ERA-

Response in large scale pressure anomalies appears consistent among reanalyses...

Assessing the TC Climate Footprint

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