Quantifying the Environmental Memory of Tropical Cyclones: Lingering Footprint or Climate Amnesia?

Benjamin Schenkel (bschenkel@fsu.edu) and Robert Hart

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The Florida State University

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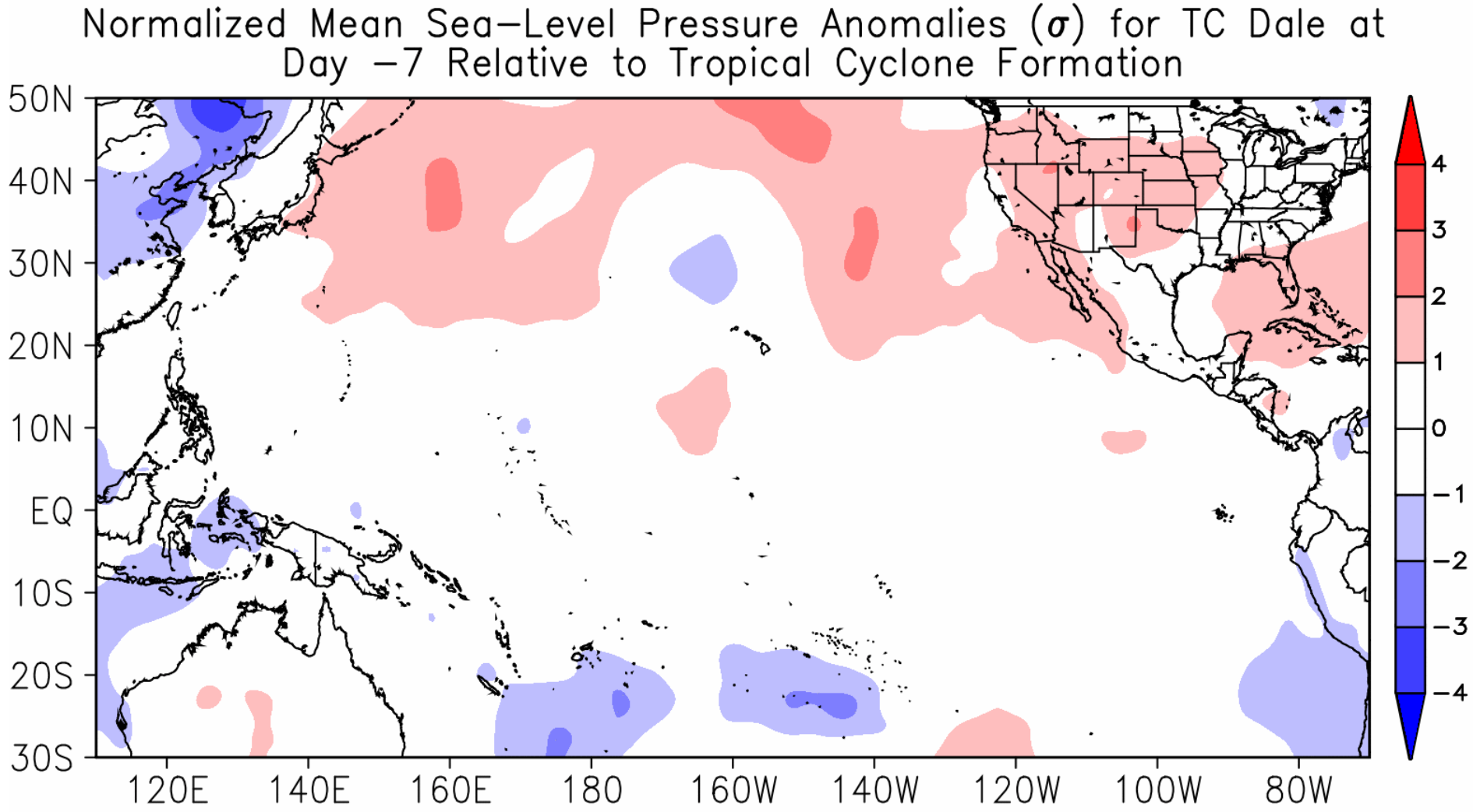
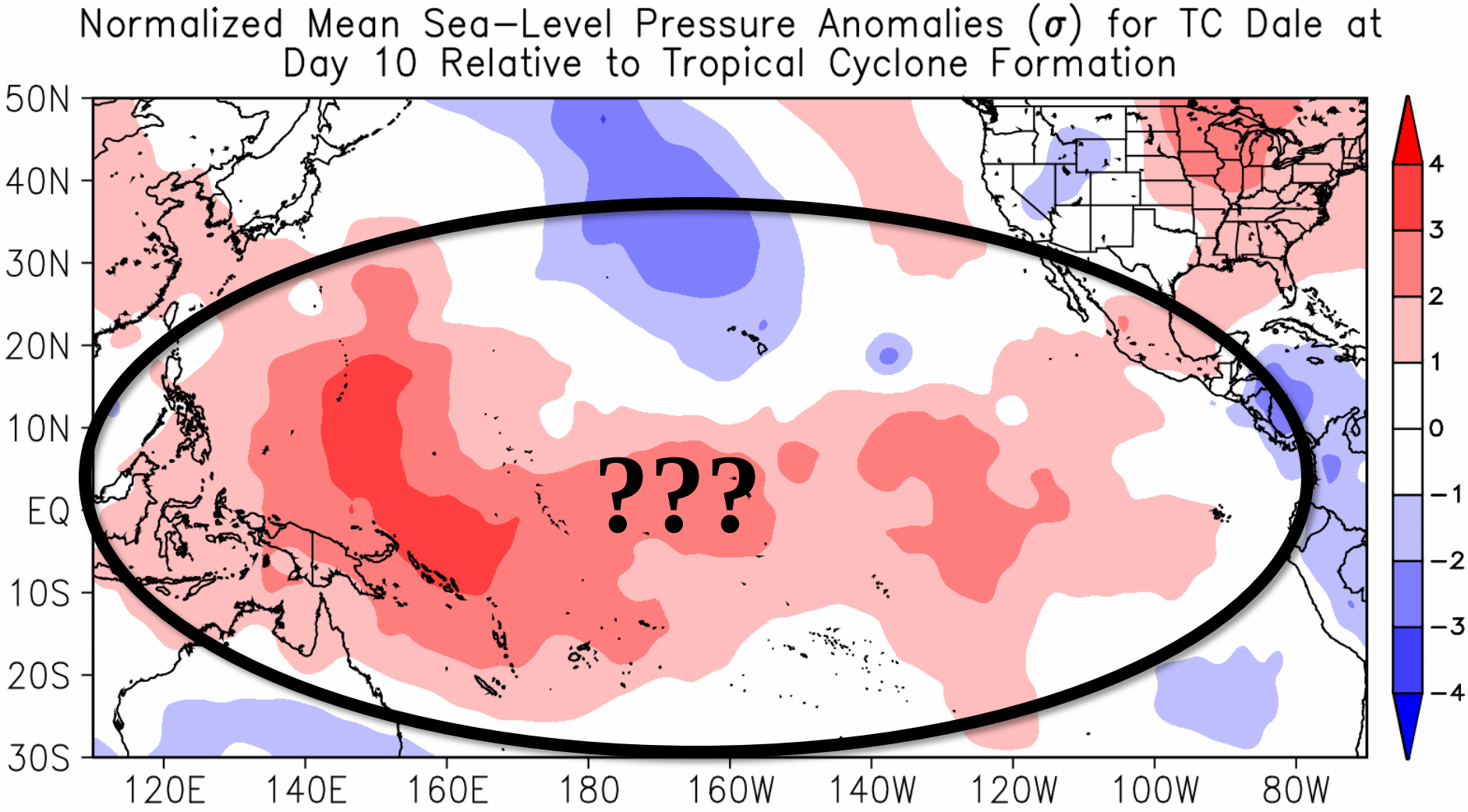
Motivation

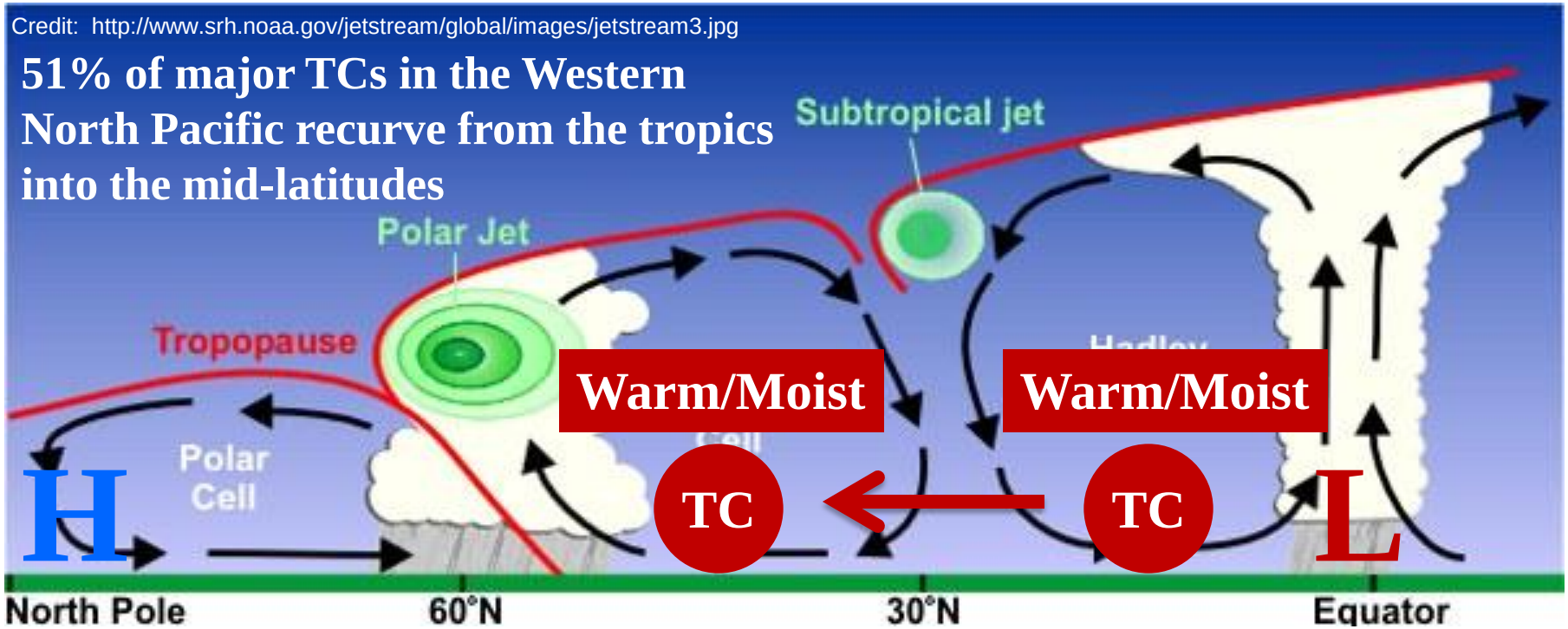

Normalized Mean Sea–Level Pressure Anomalies (σ) for TC Dale at
Day –7 Relative to Tropical Cyclone Formation
50N
40N
30N
20N
10N
EQ
10S
20S
30S
120E
140E
160E
180
160W
140W
120W
100W
80W
4
3
2
1
0
−1
−2
−3
−4

Motivation



How does the poleward movement of tropical cyclones (TCs) impact the large scale circulation?

Questions Raised



Cold/Dry: High Surface Pressure **Warm/Moist: Low Surface Pressure**

- **Do TCs transport *significant* quantities of moisture and heat polewards?**
- **Is the strength of the Hadley Cell substantially modulated by TCs?**
- **Do TCs significantly modulate the strength of the jet streams?**
- **Do the impacts of recurving TCs extend far beyond the time scales of the TC itself?**

Methodology

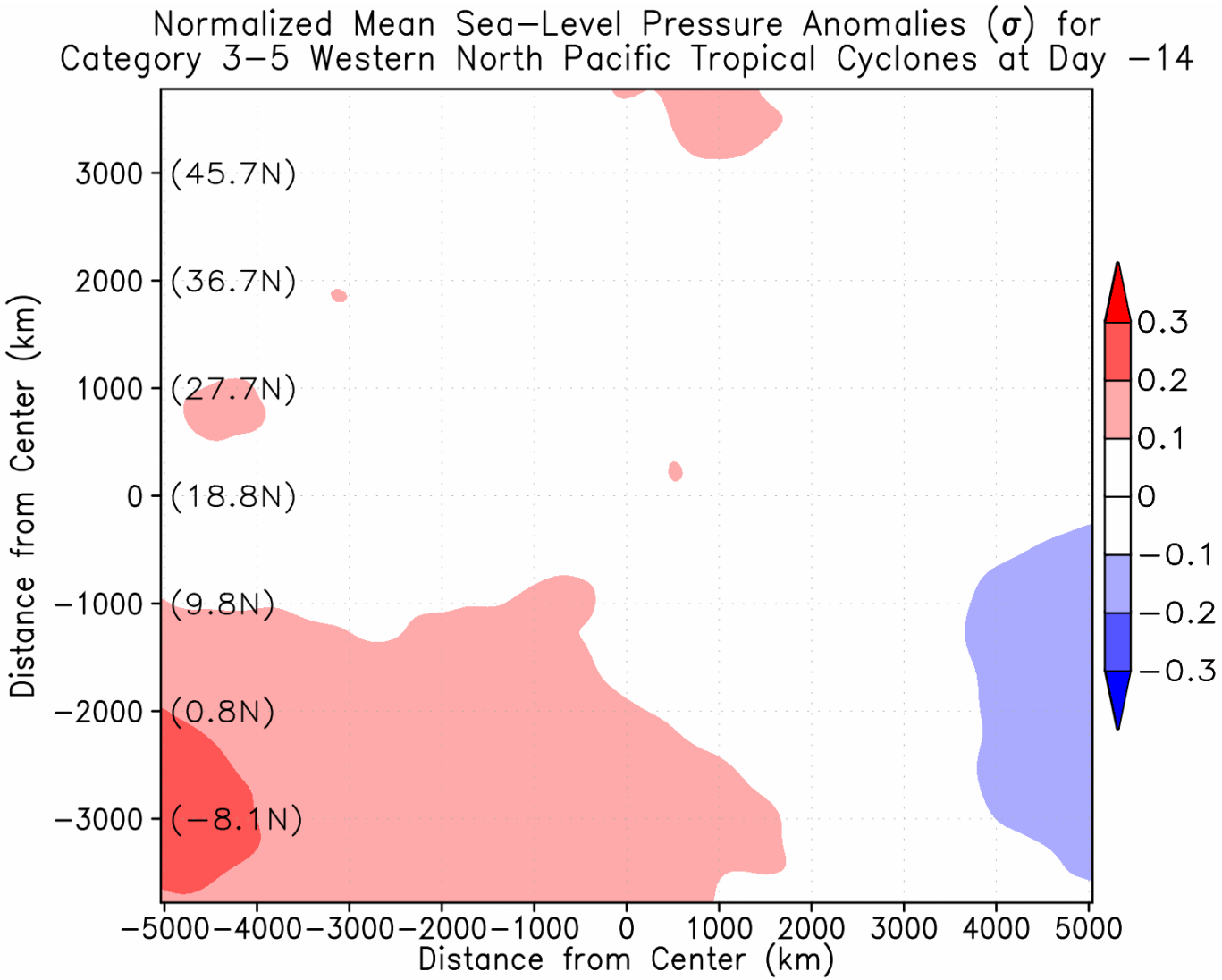
- **Objective: To analyze the response of the atmospheric environment to TC passage**

- **Evaluation of mean environmental response will occur using four-dimensional storm-relative composites of raw variables, raw anomalies, and normalized anomalies for 14 days prior to 14 days after TC passage at 6 hr intervals**

- **Reanalysis: A past model simulation that assimilates historical observations providing the most likely atmospheric state at a given time (Thorne and Vose 2010)**

- **Composites are constructed using the NCEP Climate Forecast System Reanalysis (Saha et al. 2011) for TCs in the historical record (e.g. best-track) with intensities of Saffir-Simpson category 3-5 in the Western North Pacific basin from 1982-2009 (N=257 TCs)**

Evidence of Hadley Cell Modulation by TCs



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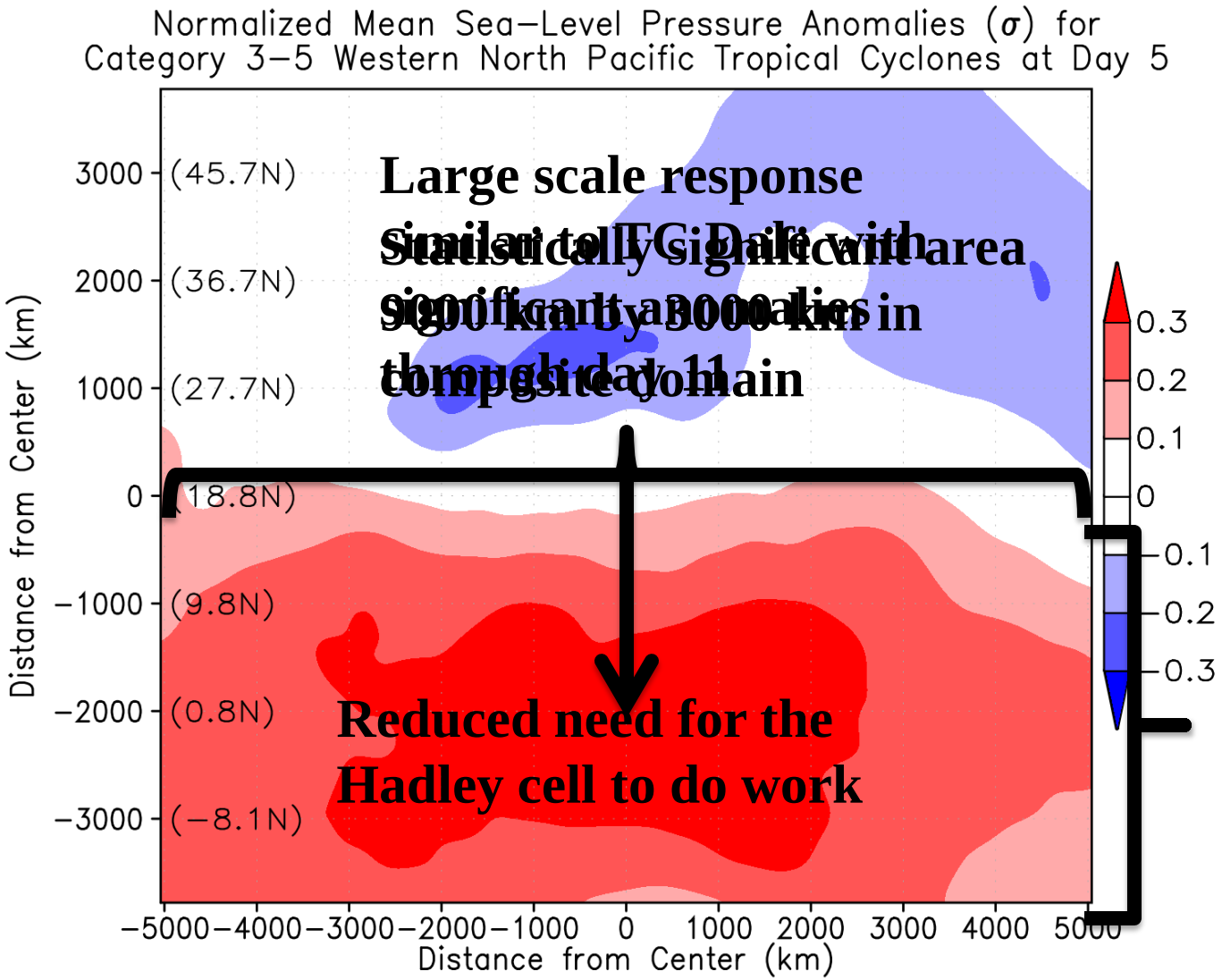
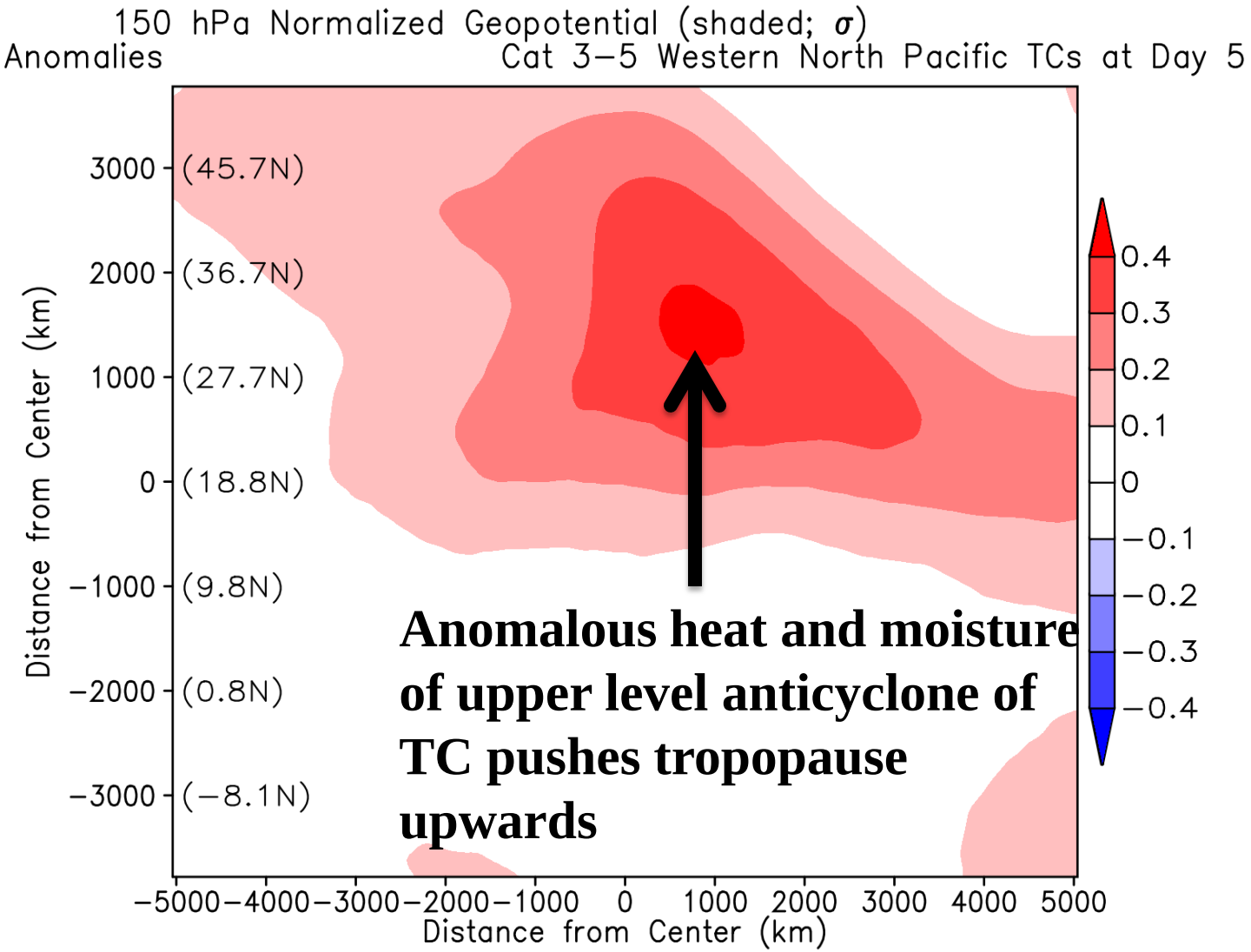


Modulation of Upper Level Jet Stream Circulations by TCs



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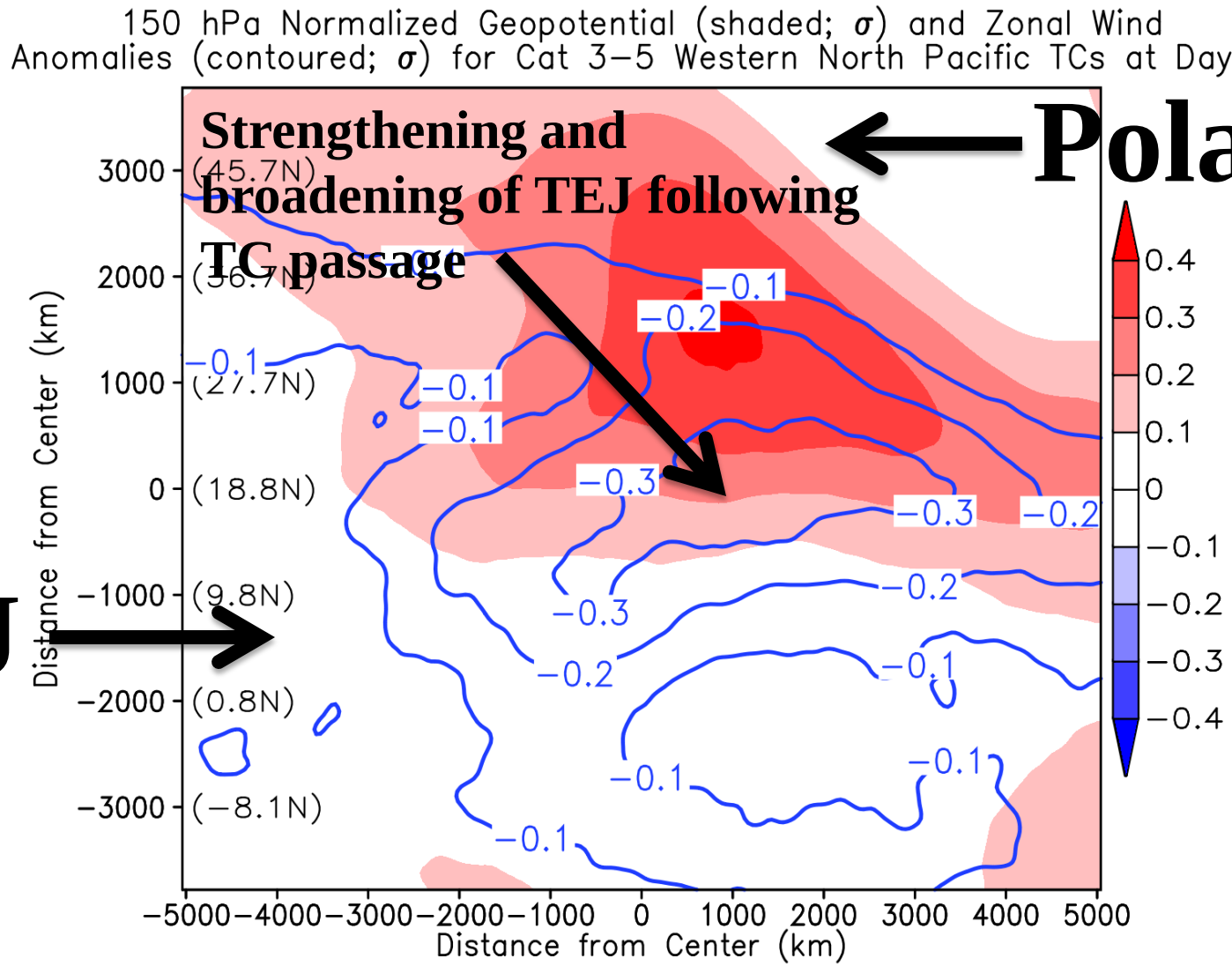

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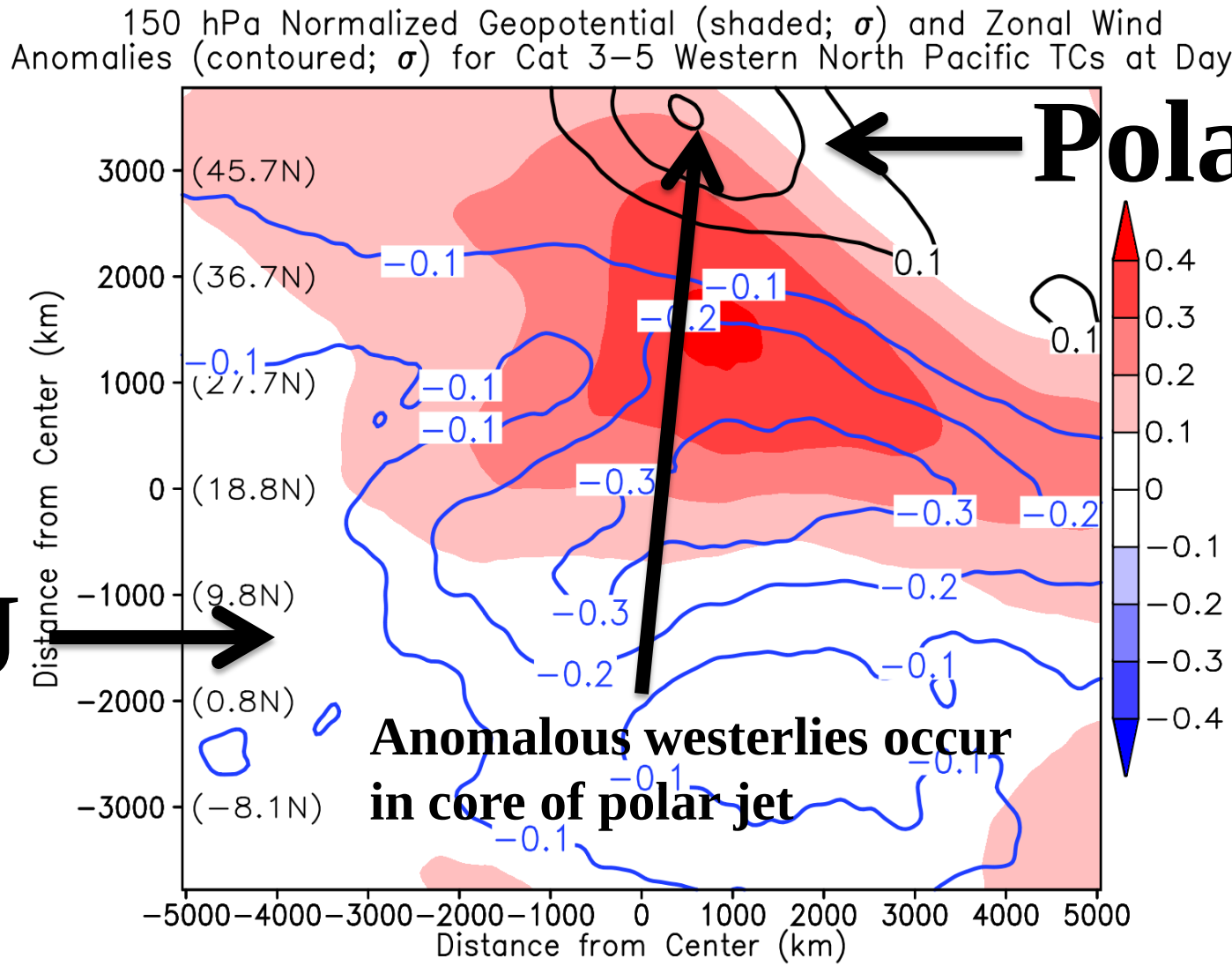
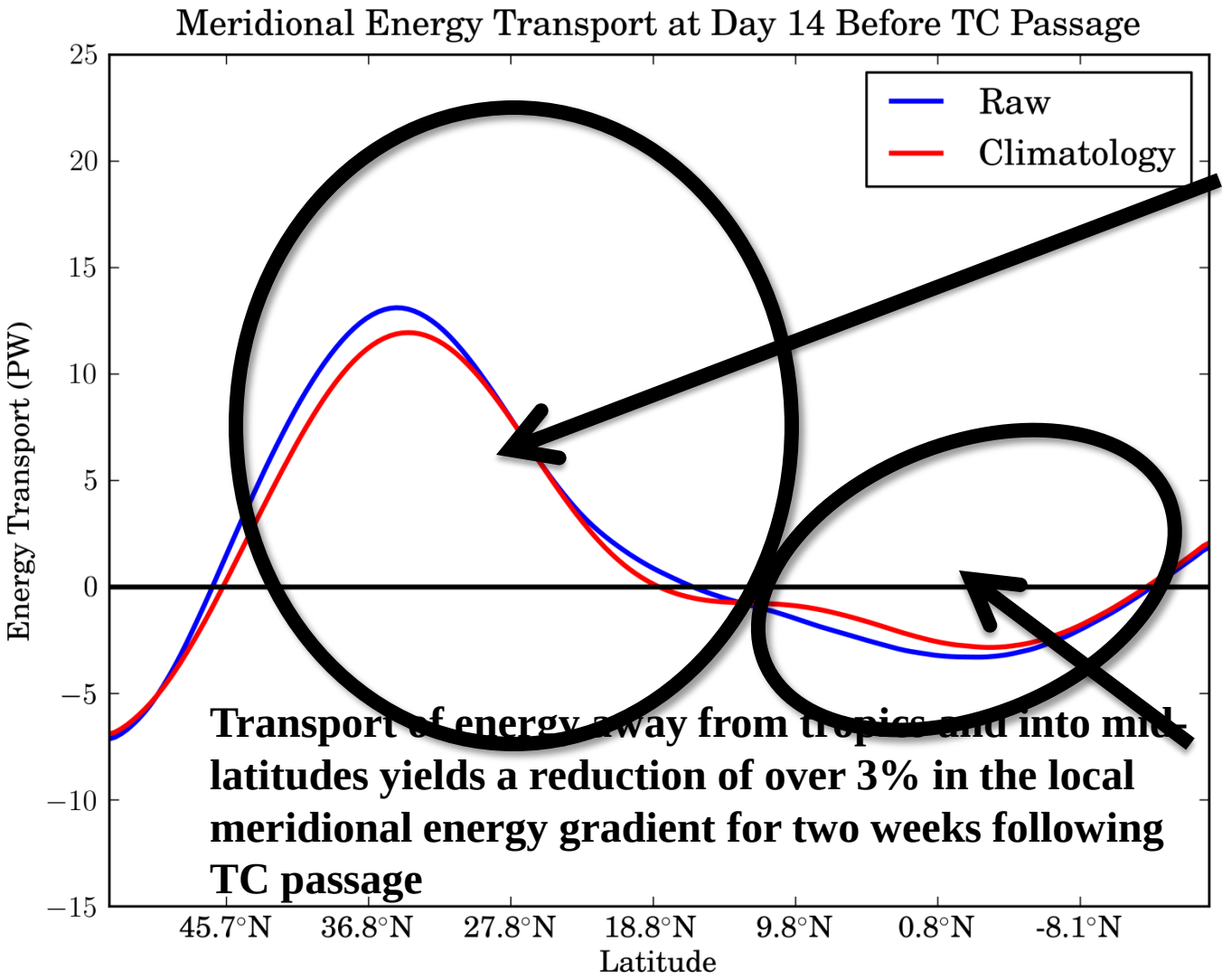


Potential strengthening or weakening of jet streams depending on how far north TC moves

Quantifying Poleward Energy Transport by TCs



Upwards of 33% increase in peak northward energy transport due to TC at time when contribution from extratropical cyclones is relatively small

Transport of energy away from tropics and into mid-latitudes yields a reduction of over 3% in the local meridional energy gradient for two weeks following TC passage

Strong increase in southward transport of energy away from tropics in region with relatively marginal climatological transport

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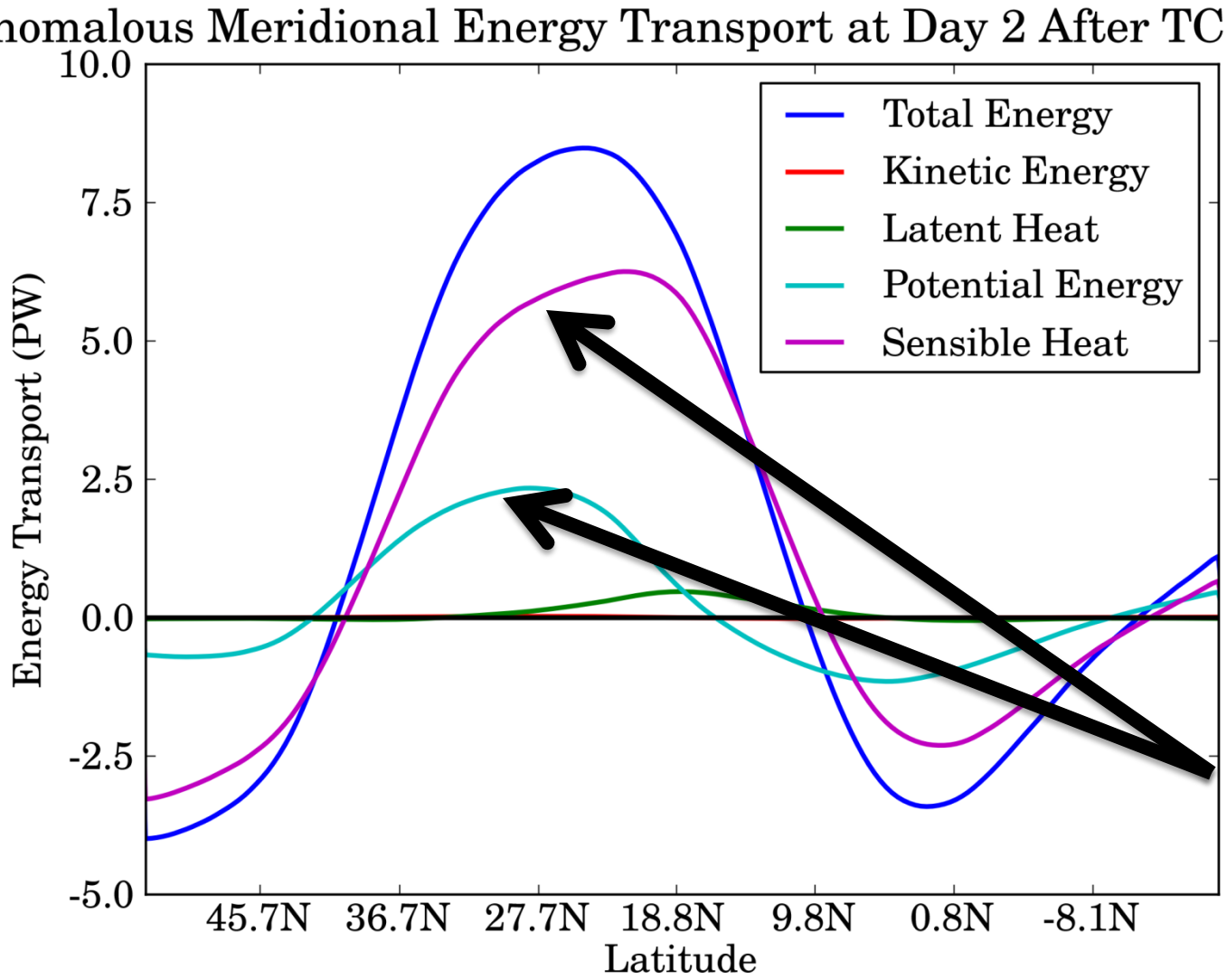
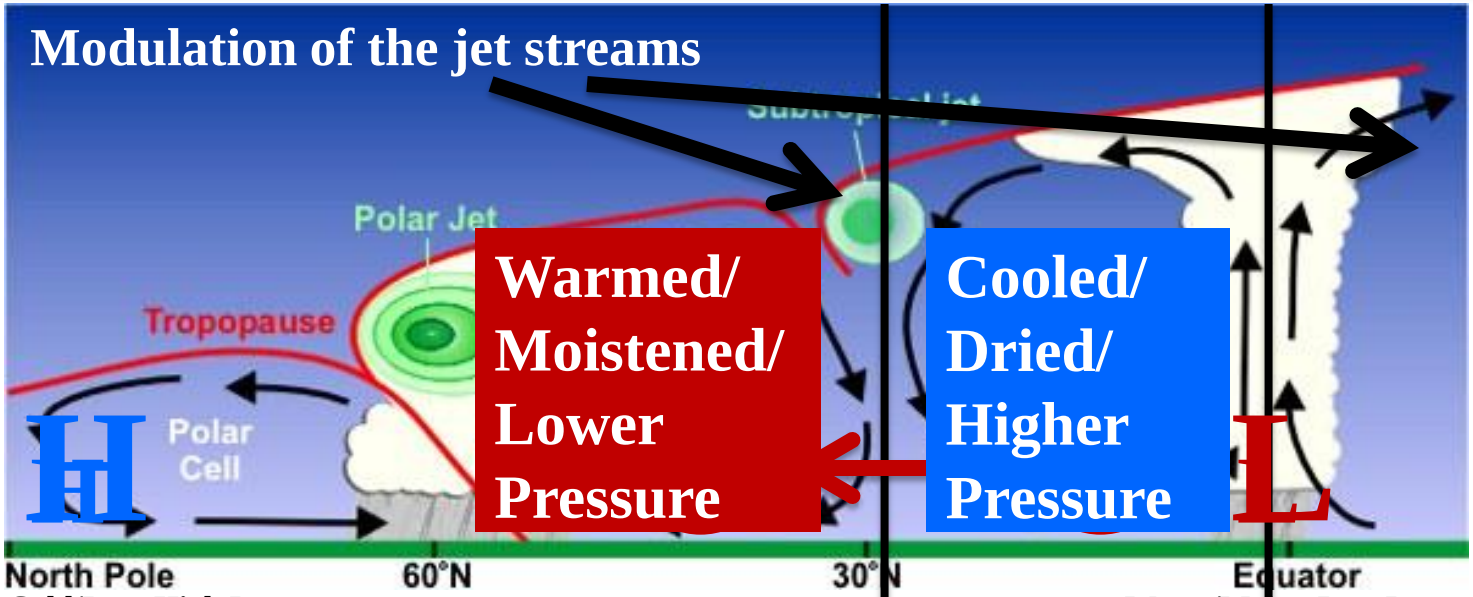


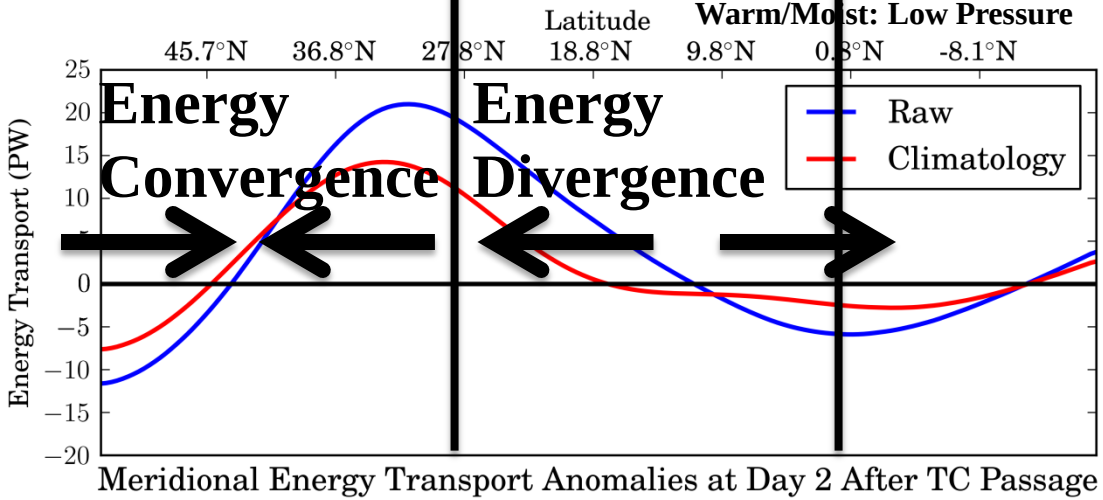
0.1%
2.5%
21.7%
75.7%

Percentage of total energy anomaly

Majority of anomalous meridional energy transport is sensible heat and potential energy

Broader Implications





How long does the aggregate impact of all TCs from one season last? Weeks? Months?