

Composite hurricanes affecting Puerto Rico, Hispaniola & Cuba

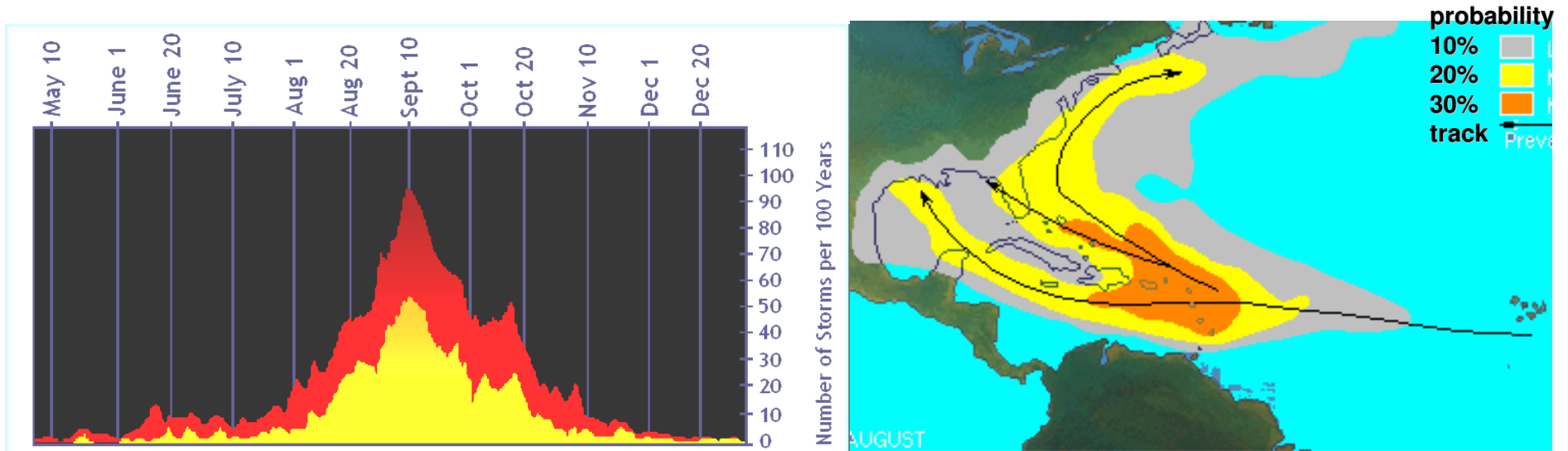
Mark R. Jury



Physics Department
University of Puerto Rico
Mayagüez Campus

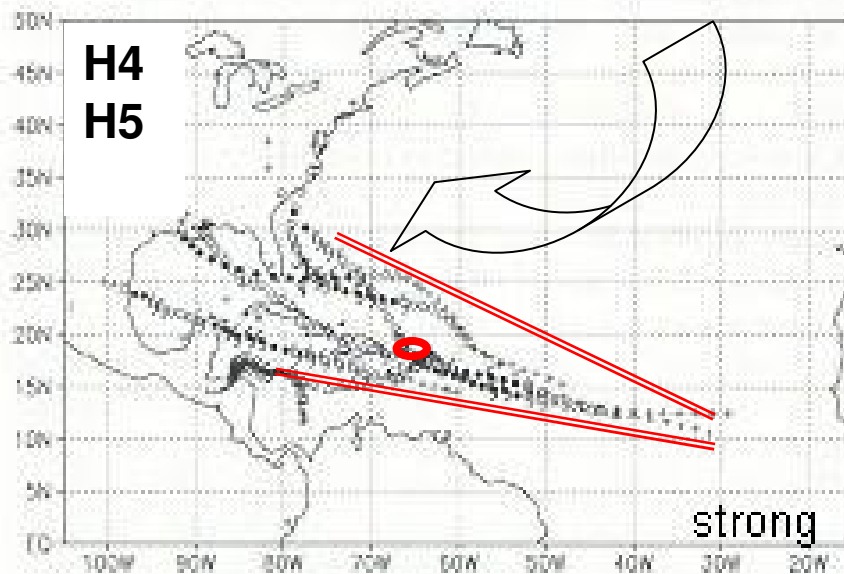
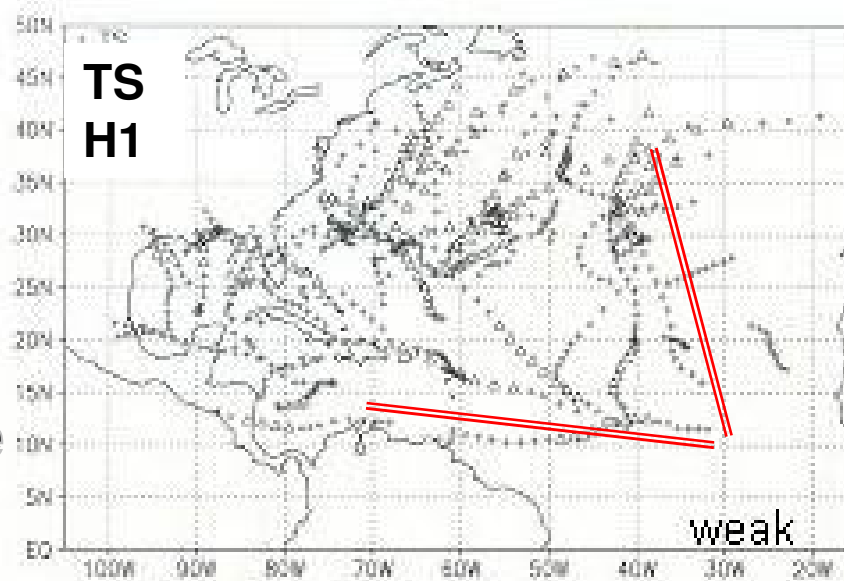


Atlantic hurricane climatology



Timing and spatial distribution of hurricanes. A minimum occurs west of Hispaniola. Season peak - September 10th.

Hurricane tracks become more focused and westward as intensity increases



Here - cases are chosen when intense hurricanes affect Puerto Rico, Hispaniola and Cuba - on a **westward track**

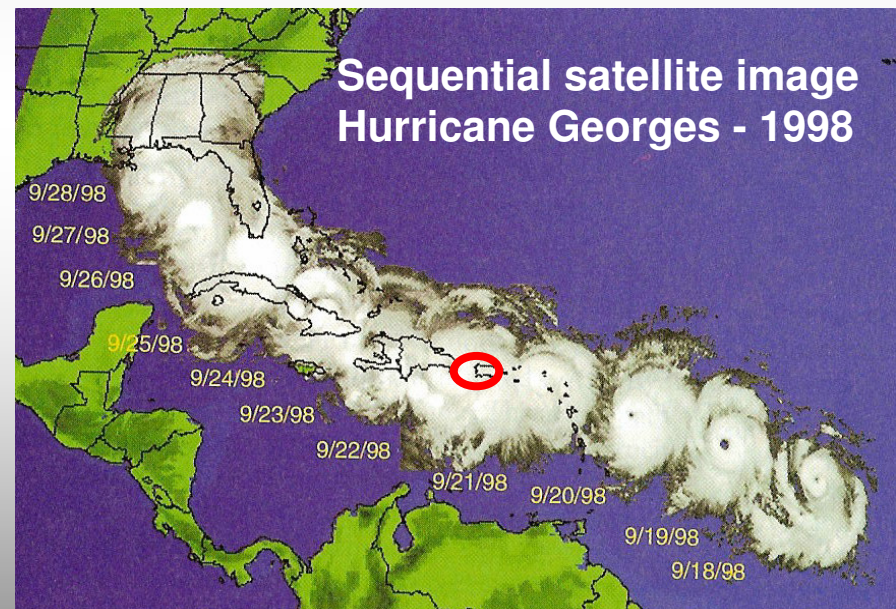
The composite features of hurricanes causing widespread impacts on Puerto Rico, Hispaniola and Cuba in the past 40 years are studied.

Individual cases have peculiar symptoms, averaging these together, common features are revealed.

Aims:

to analyze large-scale weather patterns and interaction between the hurricane and its surrounding circulation

to determine which factors relate to intensity and track, comparing local and remote (tropical and mid-latitude) signals.



Data and Methods:

**obtain hurricane impact lists from the NWS of
Puerto Rico and Dominican Rep. - 1950s+**

**obtain daily NCEP atmospheric variables and
SST at low 2.5° resolution**

find 8 overlapping cases

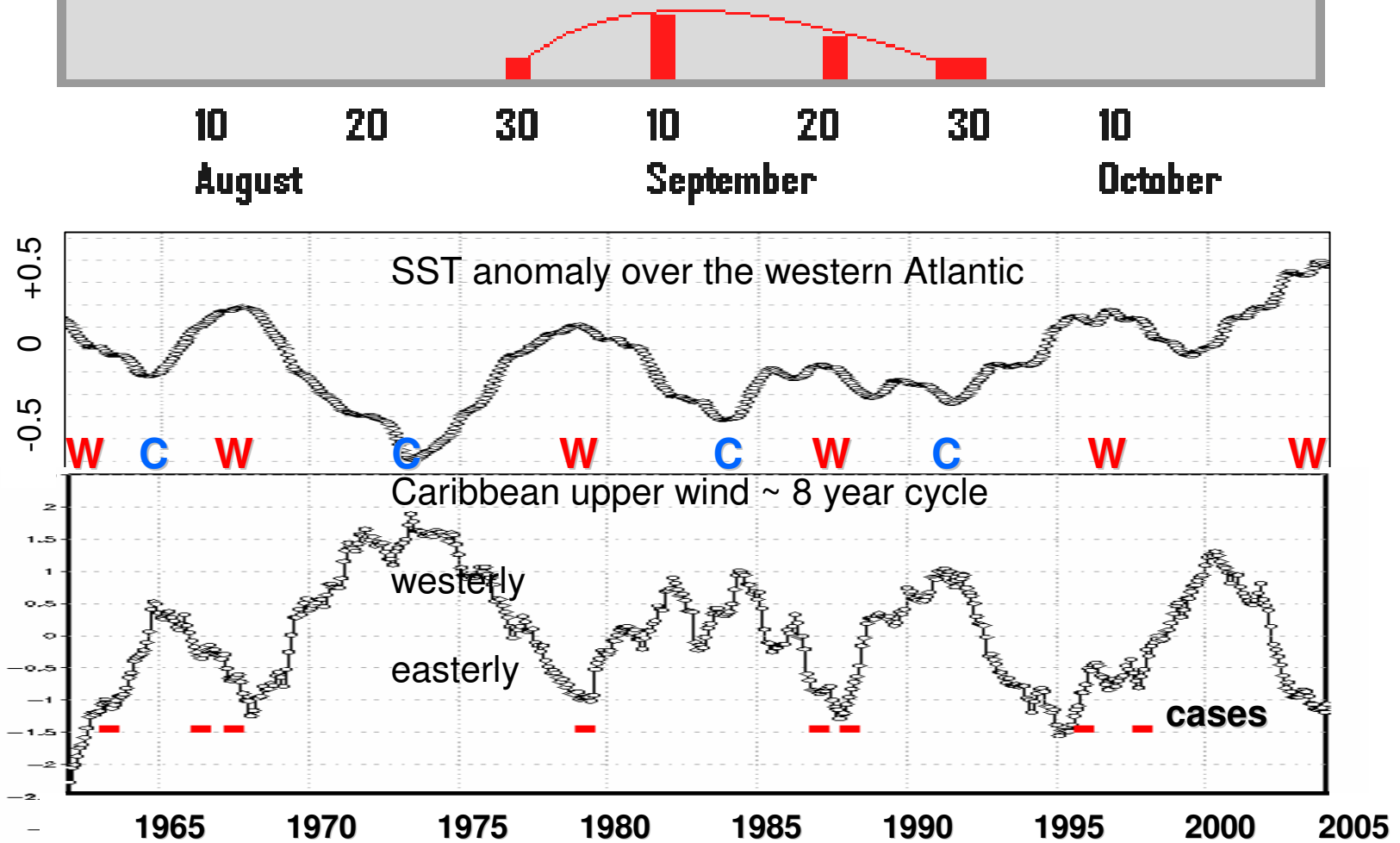
> H 3 intensity, winds > 50 m s⁻¹ :

27 Sept 1963	Edith
29 Sept 1966	Inez
10 Sept 1967	Beulah
30 Aug 1979	David
22 Sept 1987	Emily
10 Sept 1988	Gilbert
10 Sept 1996	Hortense
22 Sept 1998	Georges

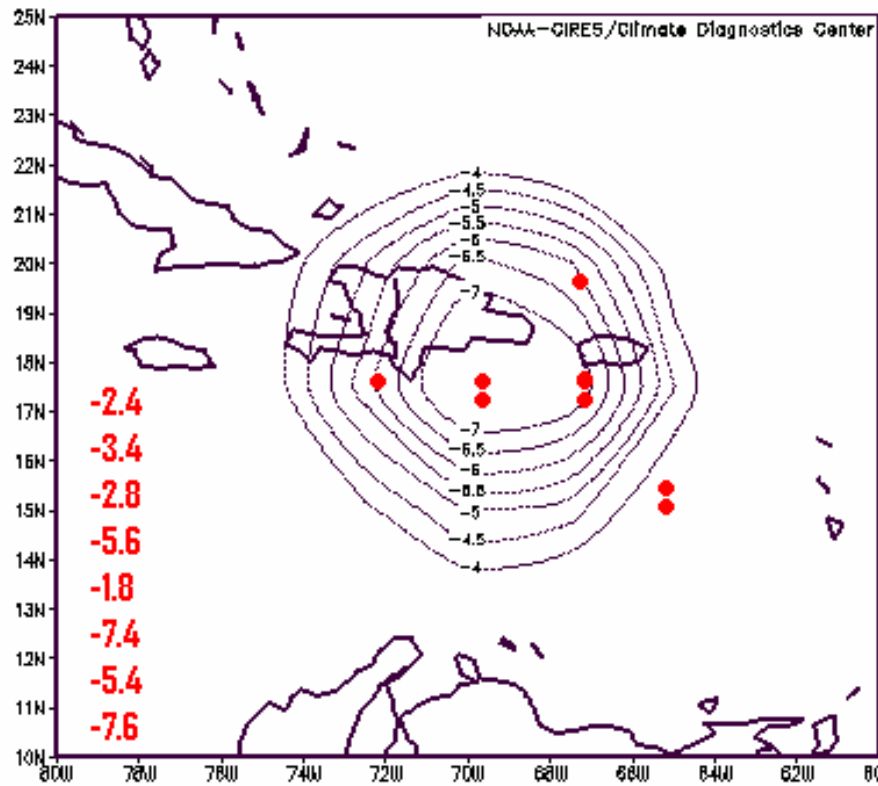
**Check for coherence; then calculate composite maps for
days closest to PR / DR; analyze evolution and forcing**

The timing of hurricanes

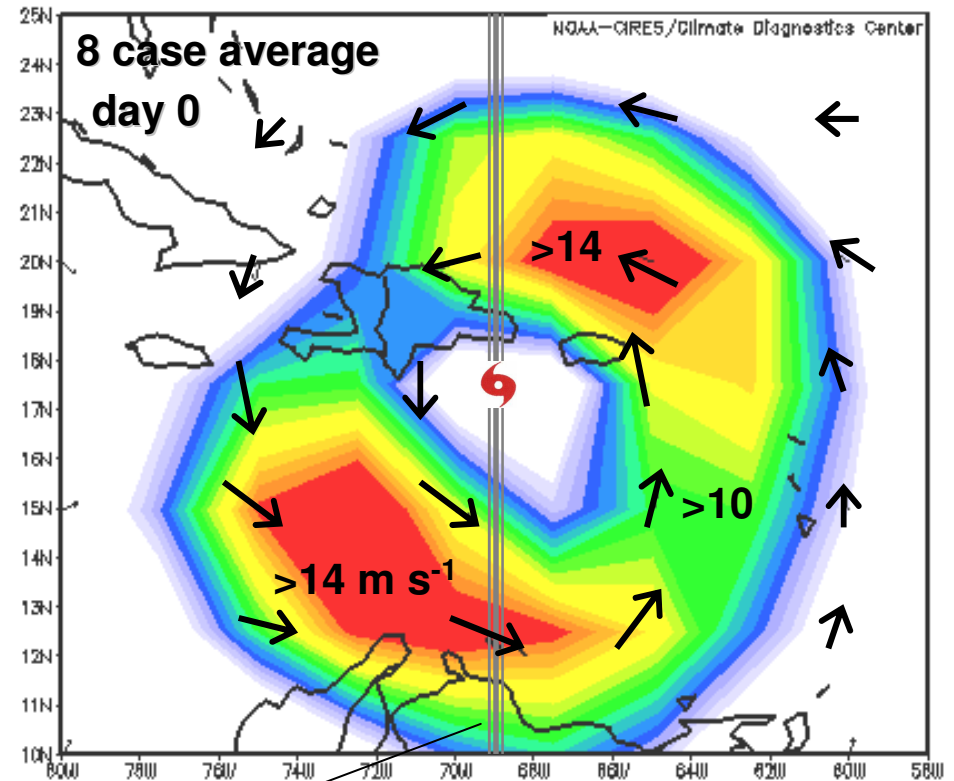
Probability max : 10 & 22 Sept, ~ 10 day intervals, phase-locked?



Variations in P_{\min} intensity and position

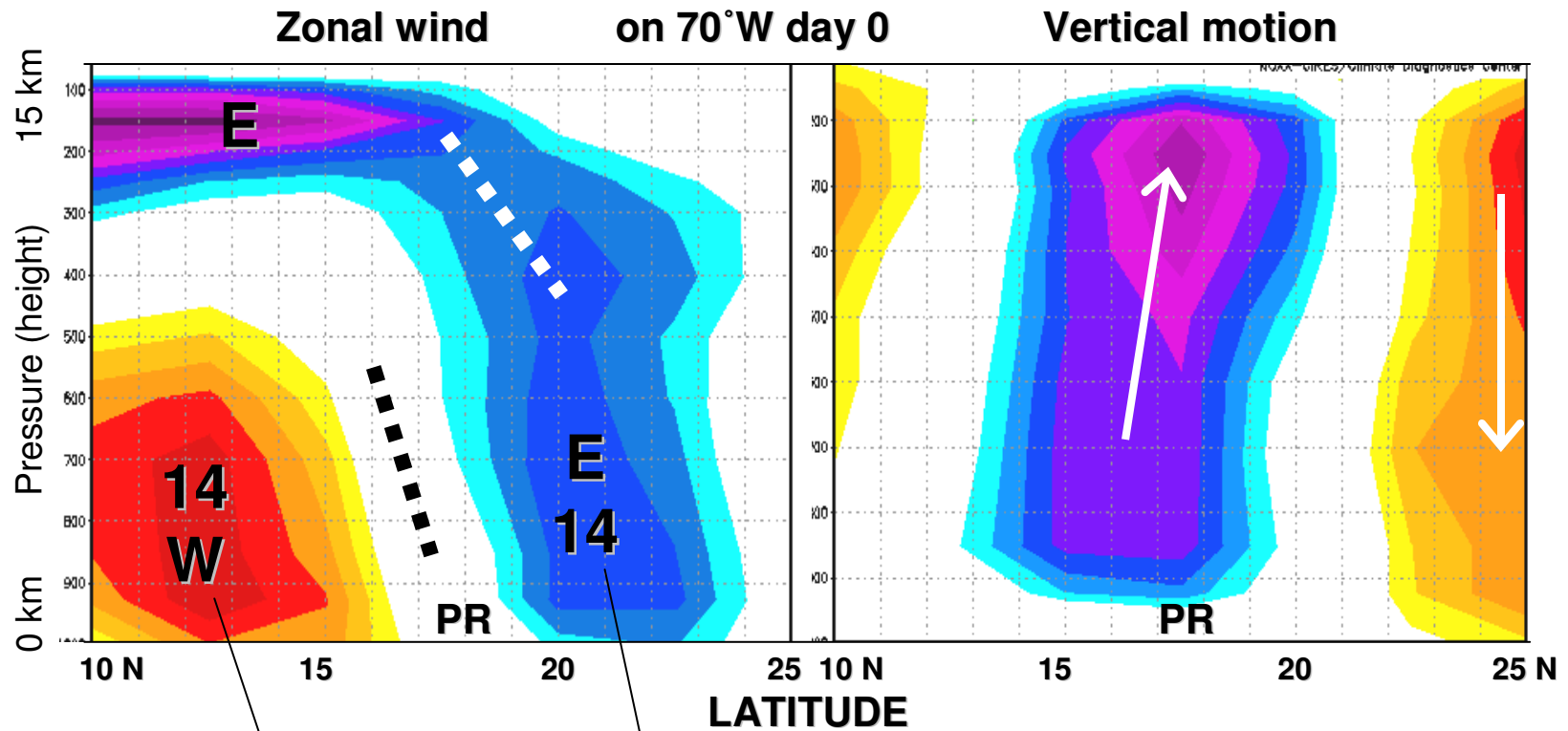


Composite surface wind anomaly



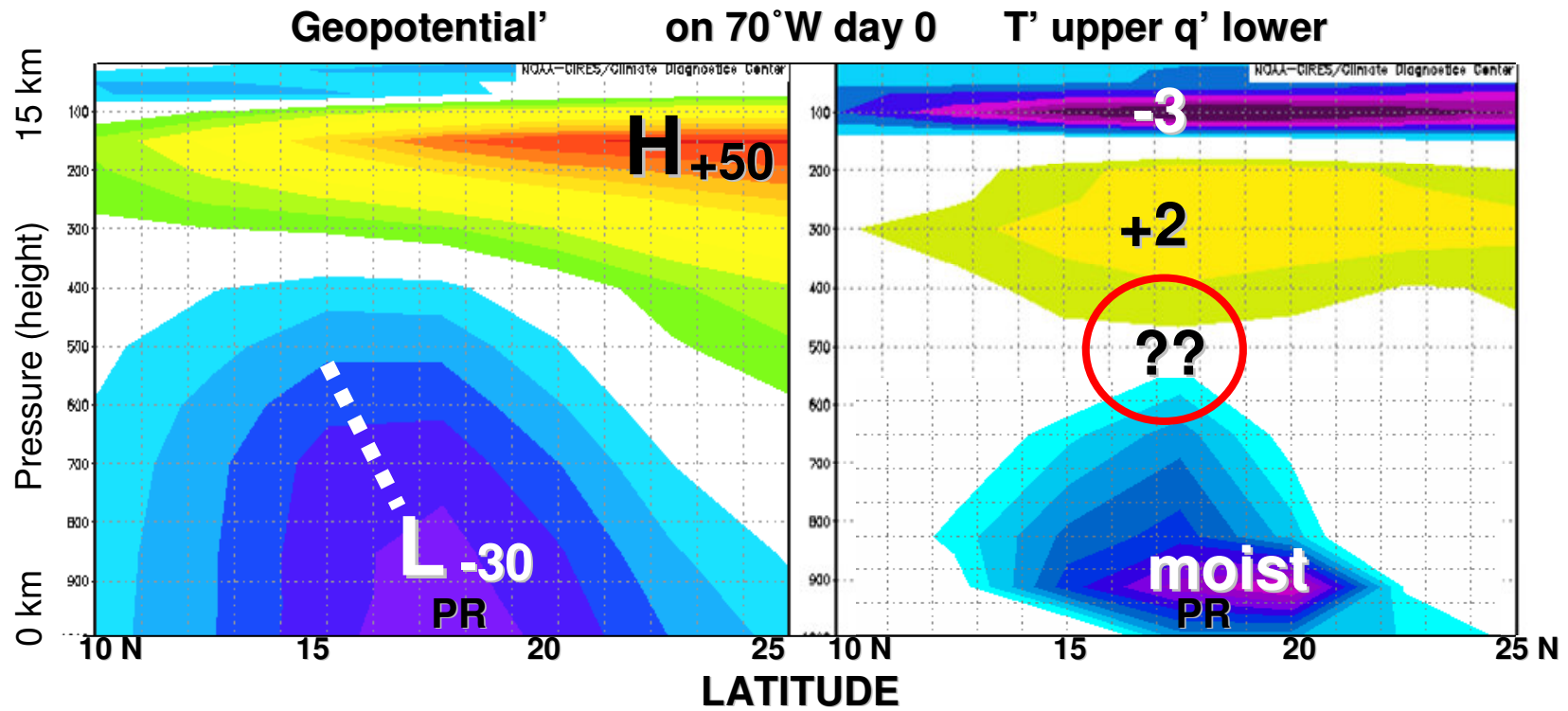
Subsequent N-S vertical section analysis

Vertical N-S section wind structure: link to upper easterlies



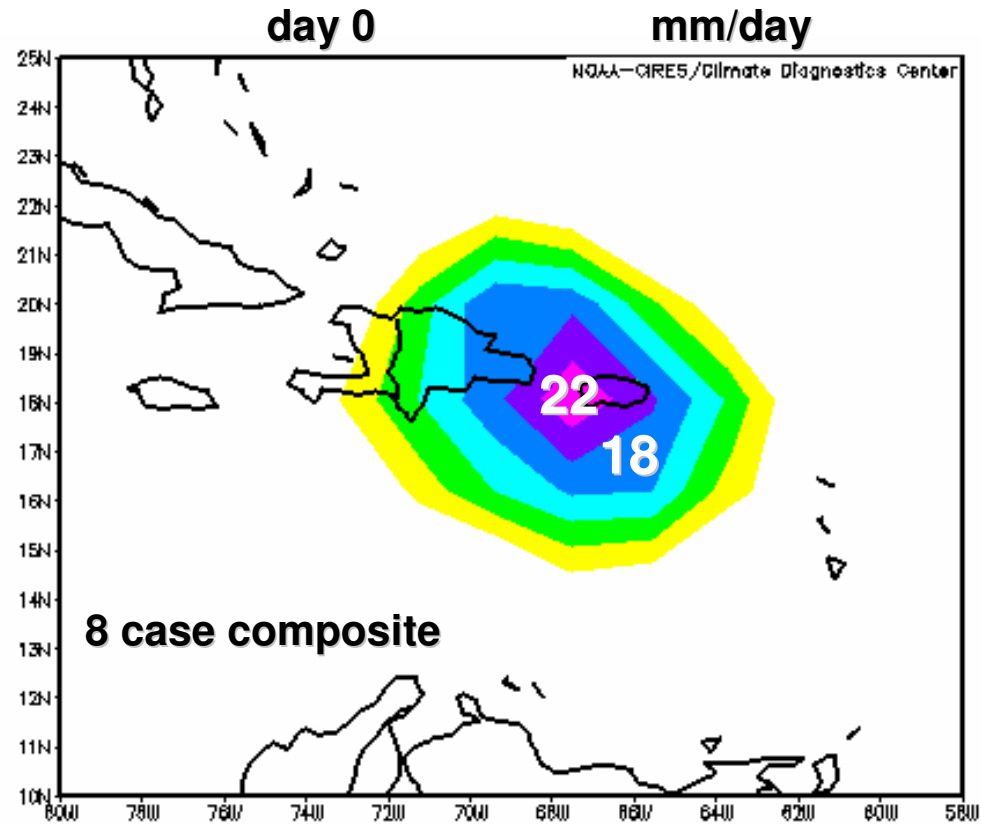
Observed average $V_T = 55 \text{ m s}^{-1}$!
Model interpolated winds are 25% of actual.

Vertical N-S section thermodynamic structure:



8 case composite

Rain rate structure:

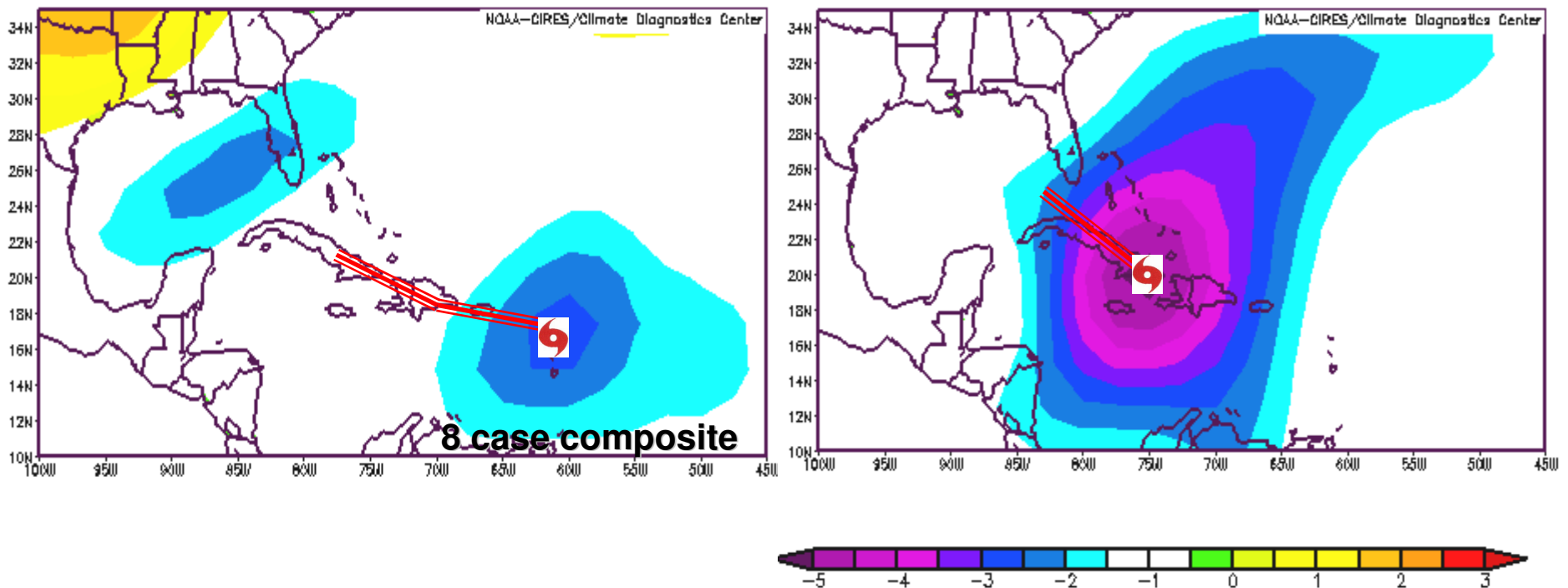


Observed average $R_R \sim 100$ mm/day !
Model interpolated rainfall is $\sim 20\%$ of actual.

Tropopause temperature anomaly

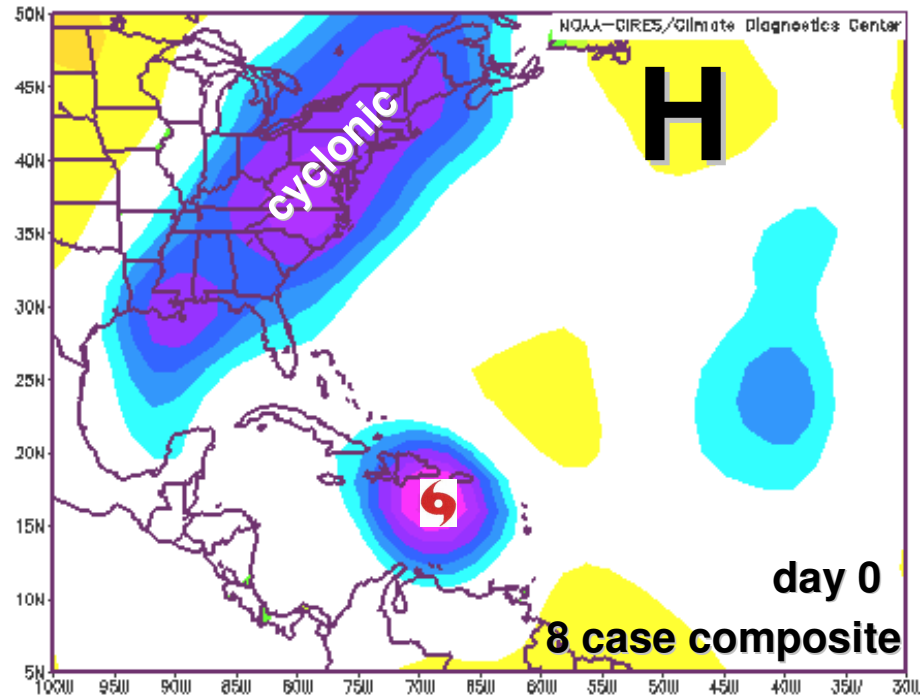
day - 2

day + 2



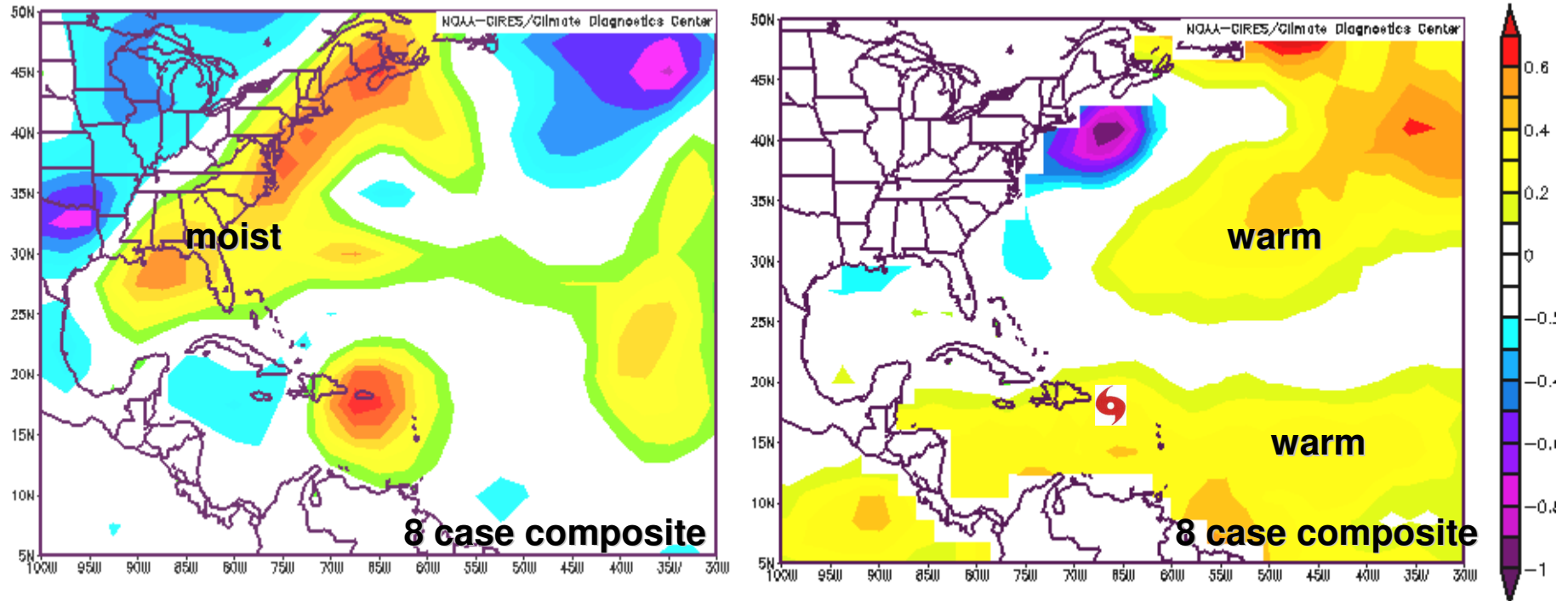
The composite hurricane intensifies to day +2; track re-curves slowly: San Juan, Santo Domingo, Havana, and Key West are directly in the path !

Composite streamfunction anomaly



The cyclonic low circulation over the eastern mainland is of similar intensity to the hurricane near PR !

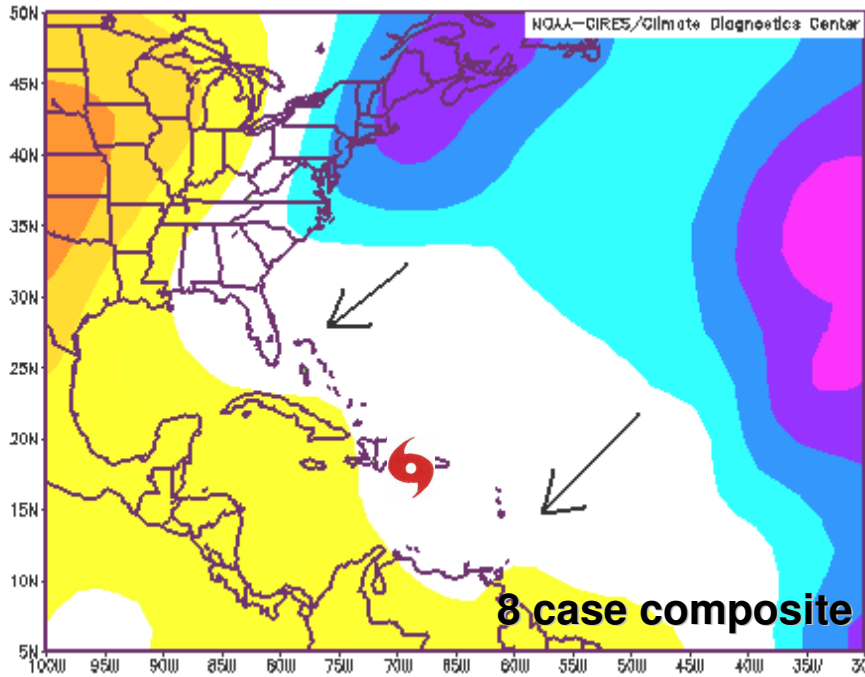
Composite humidity and SST anomaly



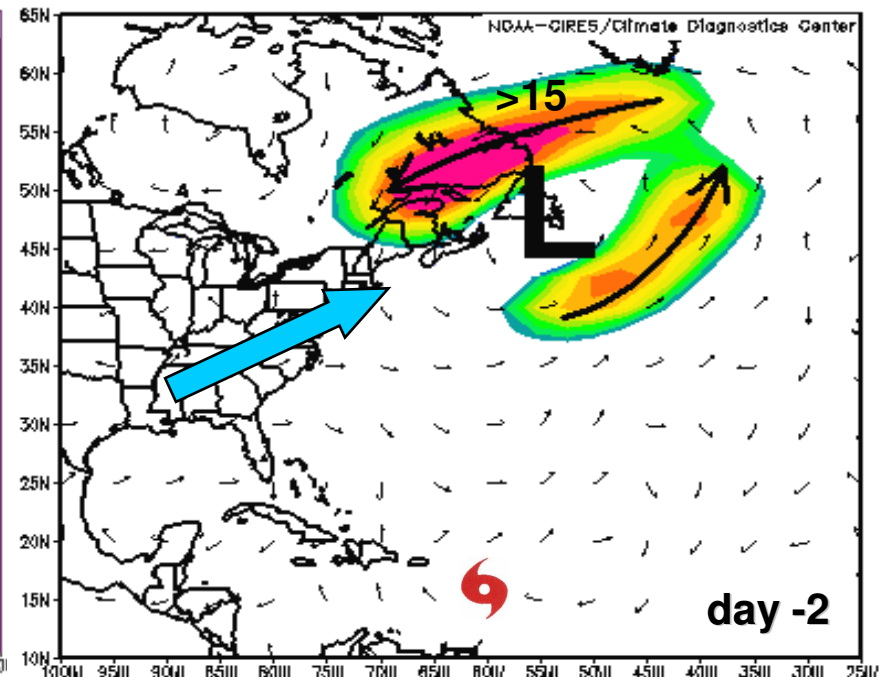
The hurricane is 'attracted' toward a moist region over the SE mainland, and comes from a region of higher SST as expected.

Remote mid-latitude effects:

Composite upper velocity potential and upper wind anomaly

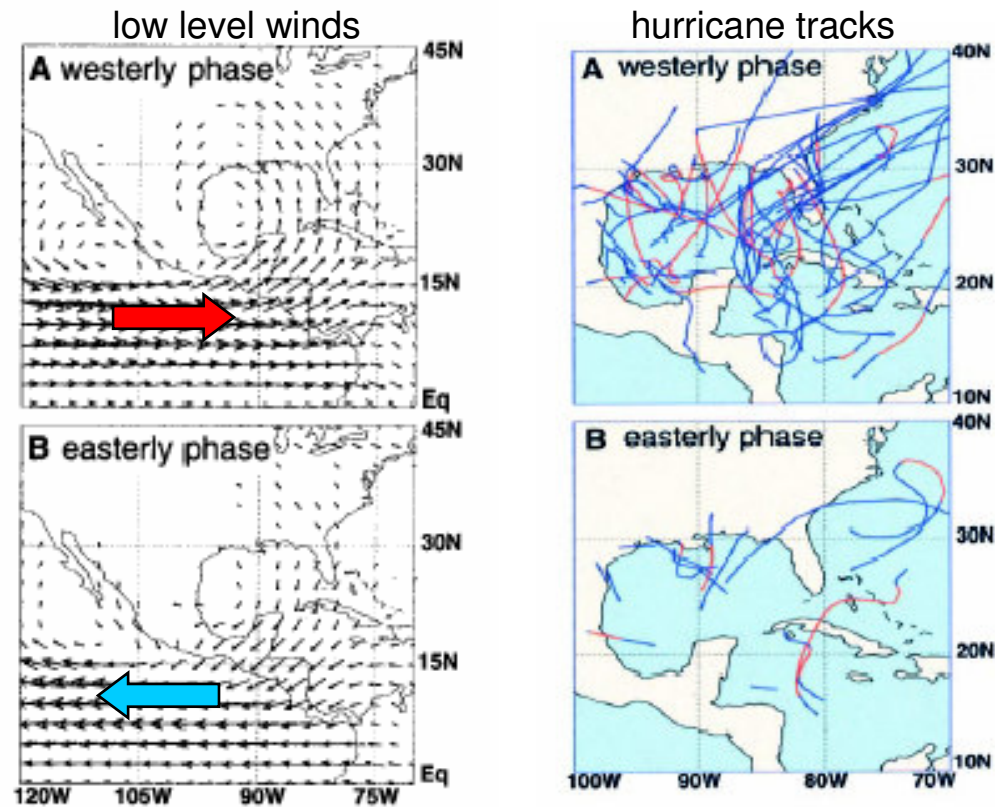


The hurricane is pushed westward by the divergent circulation across the Atlantic



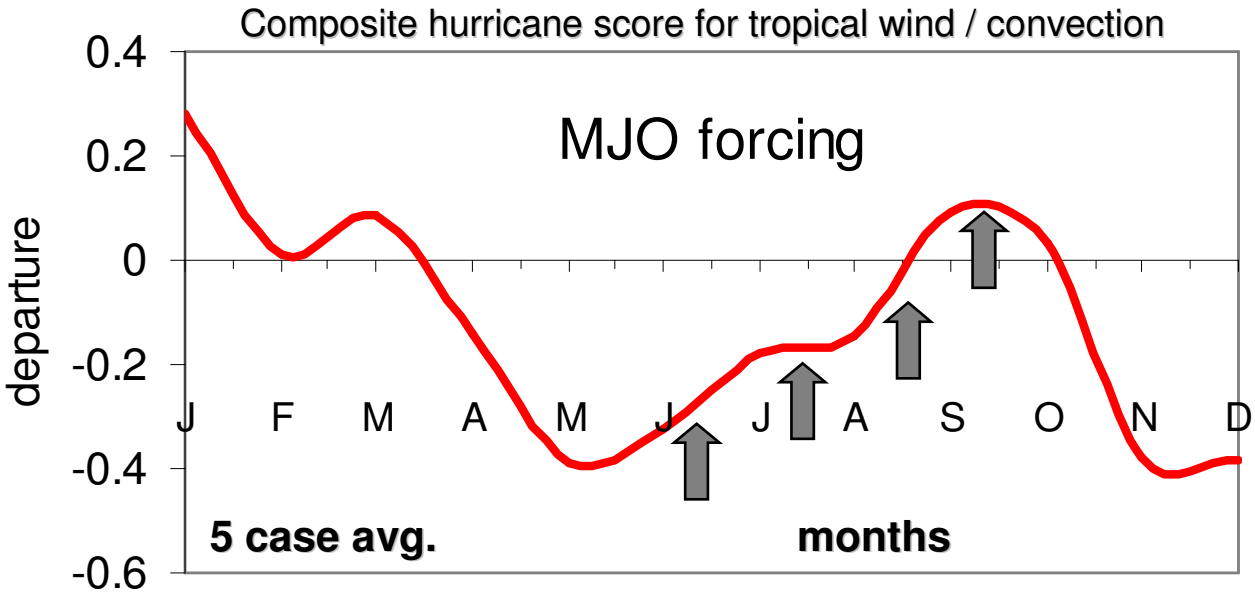
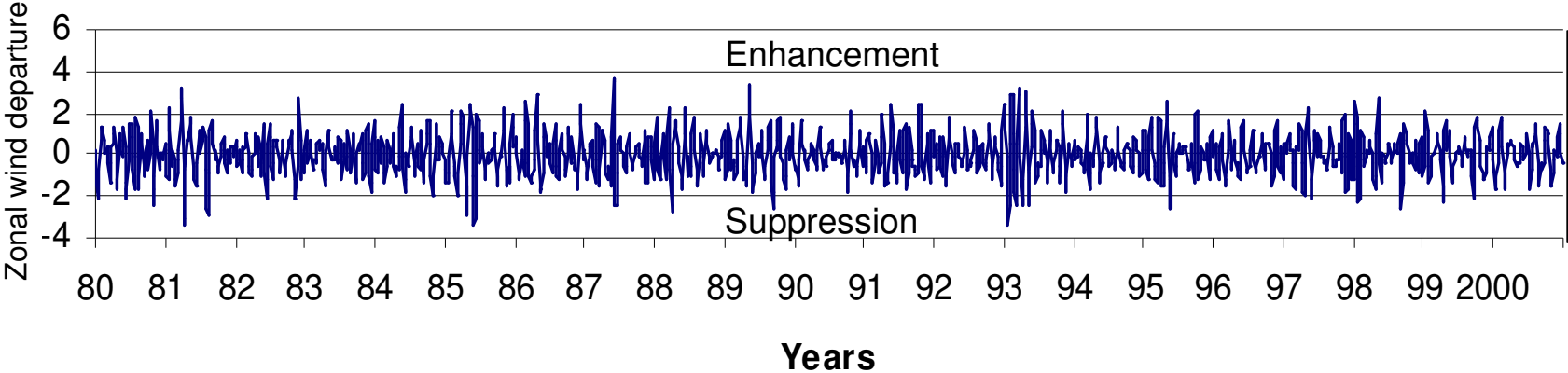
An intense polar low and sub-tropical jet streak acts as an 'attractor'

Pulses of tropical wind are known to affect hurricanes in the western Atlantic



**Madden-Julian Oscillation
a 40- 50 day alternation**

Remote tropical effects



Summary:

A large-scale pattern for the composite hurricanes is evident.

Signal intensity is weakened by model averaging of low resolution data based on sparse observations. NCEP reanalysis hurricane P_{\min} , wind and rain anomalies are $\sim 1/3$ of observed mean values. The lack of diabatic heating in the 500-400 hPa layer is the problem.

Major cities are impacted throughout the Caribbean:

$\sim \$ 10^9$ damage and $\sim 10^3$ lives per hurricane !



Composite hurricane patterns indicate:

- **Enhancement by warmer SSTs and favorable MJO, enabling development 7° further south than usual.**
- **Attraction by moist conditions and a jet streak over the eastern mainland induced by polar low.**
- **Tracks guided westward by upper divergent circulation, and link with upper tropical easterlies.**

These preliminary findings deserve further attention by researchers at UPRM

