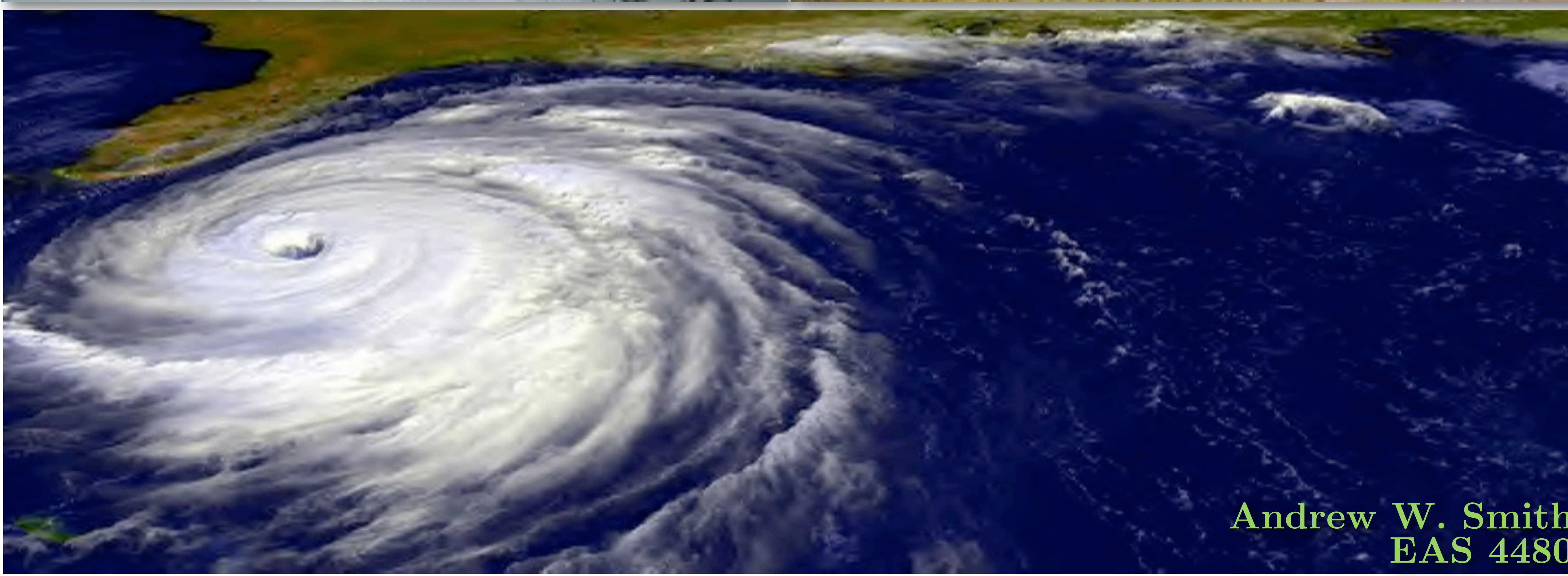
Precipitation accumulations and distribution in Florida in non-hurricane years

1990-2011



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Overview

Florida's climate, specifically rainfall influenced by

1. **Subtropical geography**
2. **Large annual solar flux**
3. **Tropical cyclones**
4. **Winds**

Goal: **Since tropical cyclones bring heavy rainfall, what are primary influences on rainfall in years without tropical cyclones?**

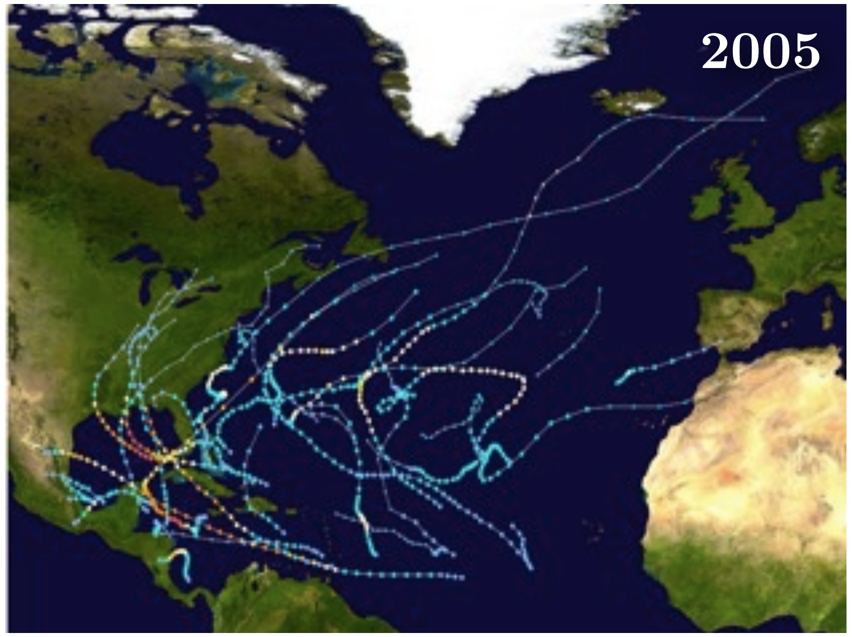
Data

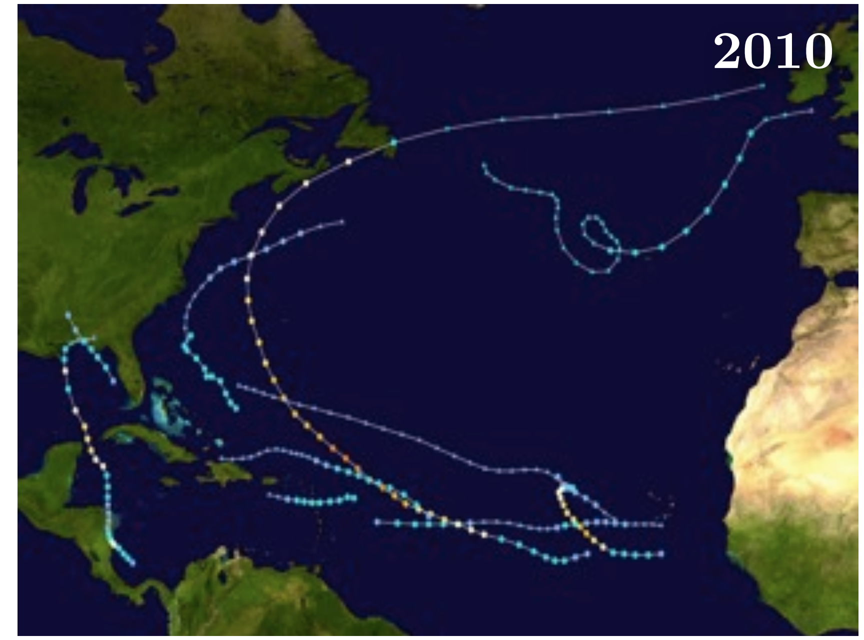
Methods: **Univariate statistics, bivariate statistics, timeseries analysis**

Conclusions

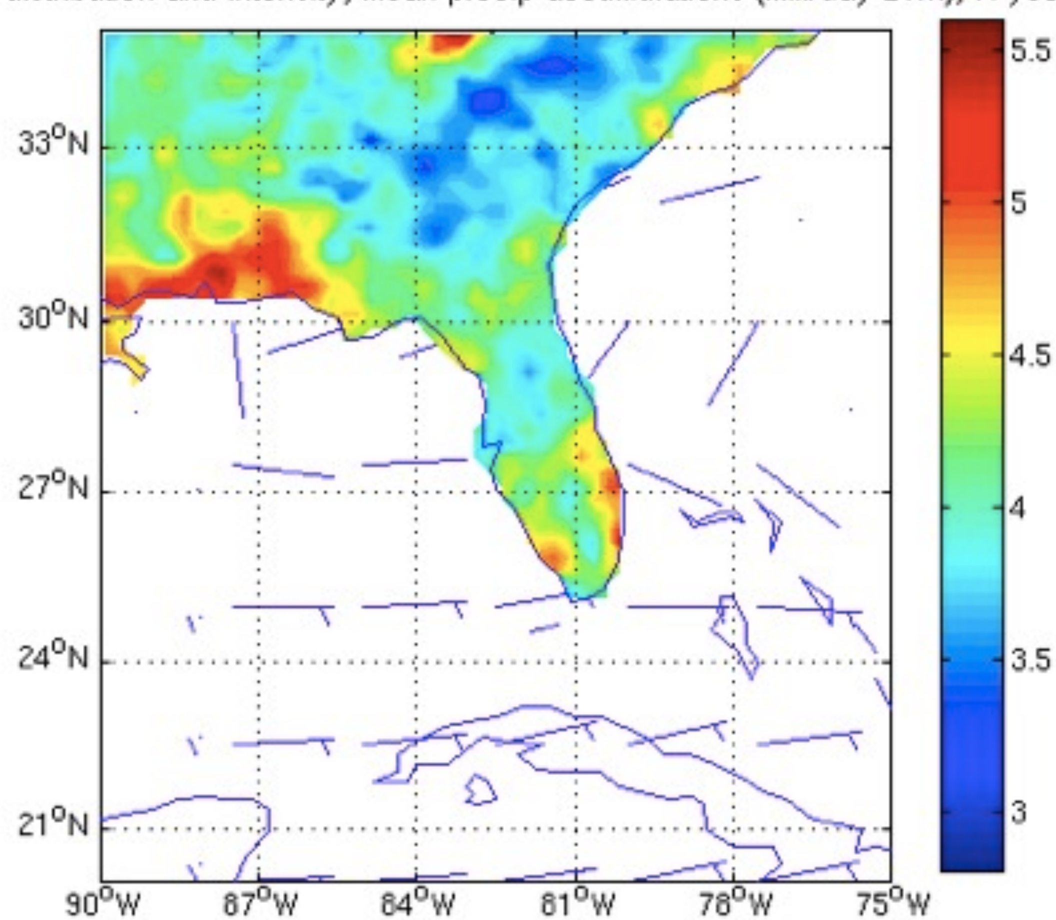
Influence of hurricanes

***Years with a landfalling hurricane in FL*:** **1992,1996,1998,1999,2004,2005**

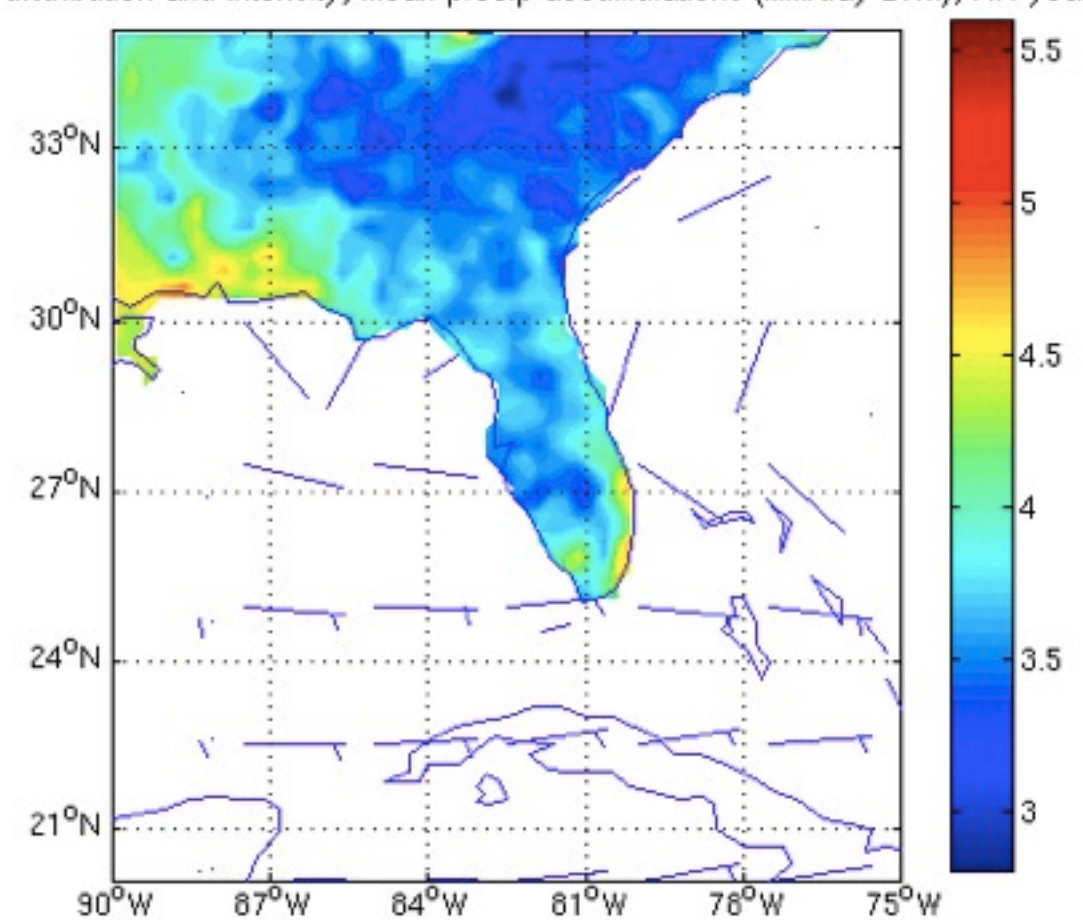




Spatial distribution and intensity, mean precip accumulations (mm/day LTM), H years



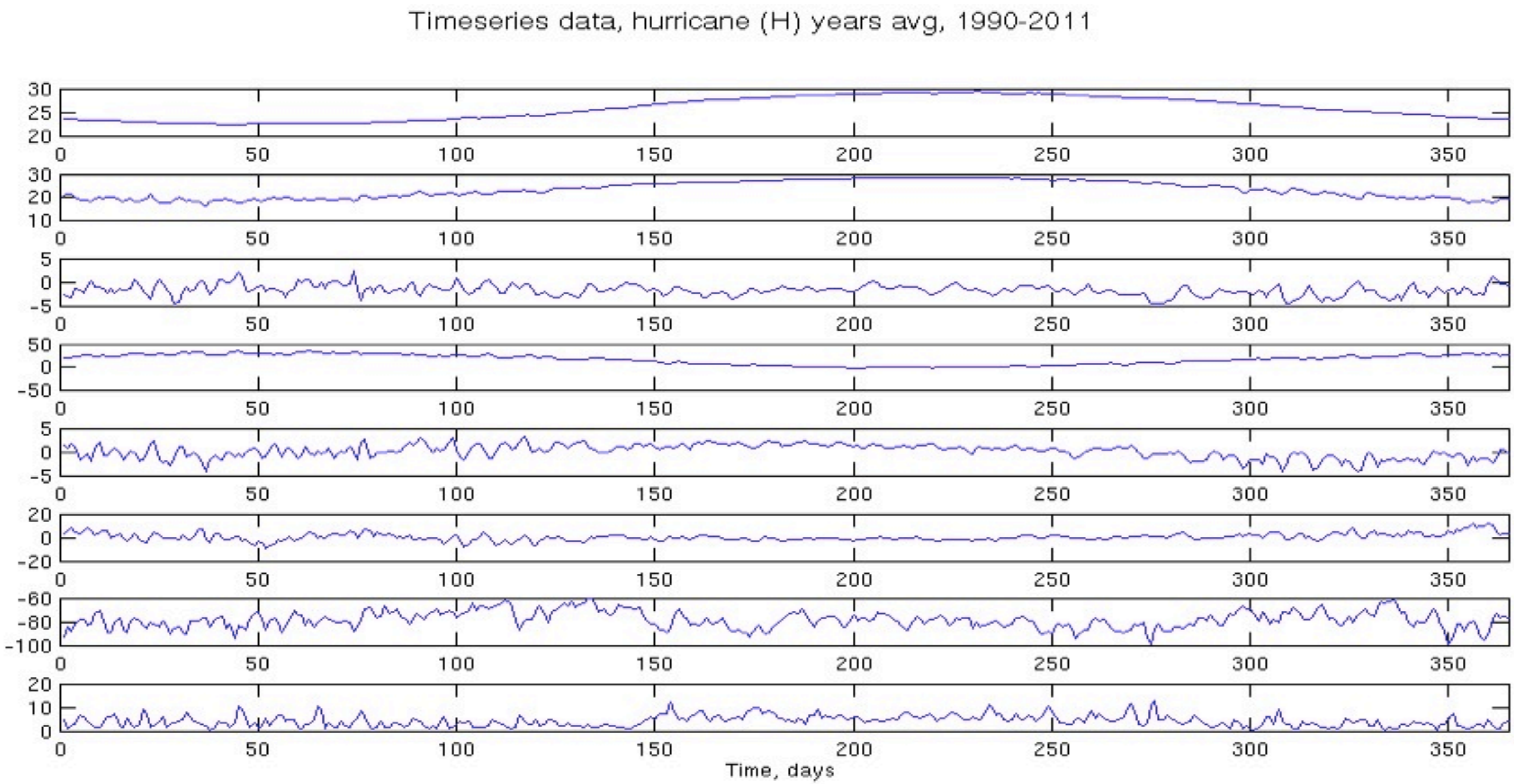
Spatial distribution and intensity, mean precip accumulations (mm/day LTM), NH years



Data

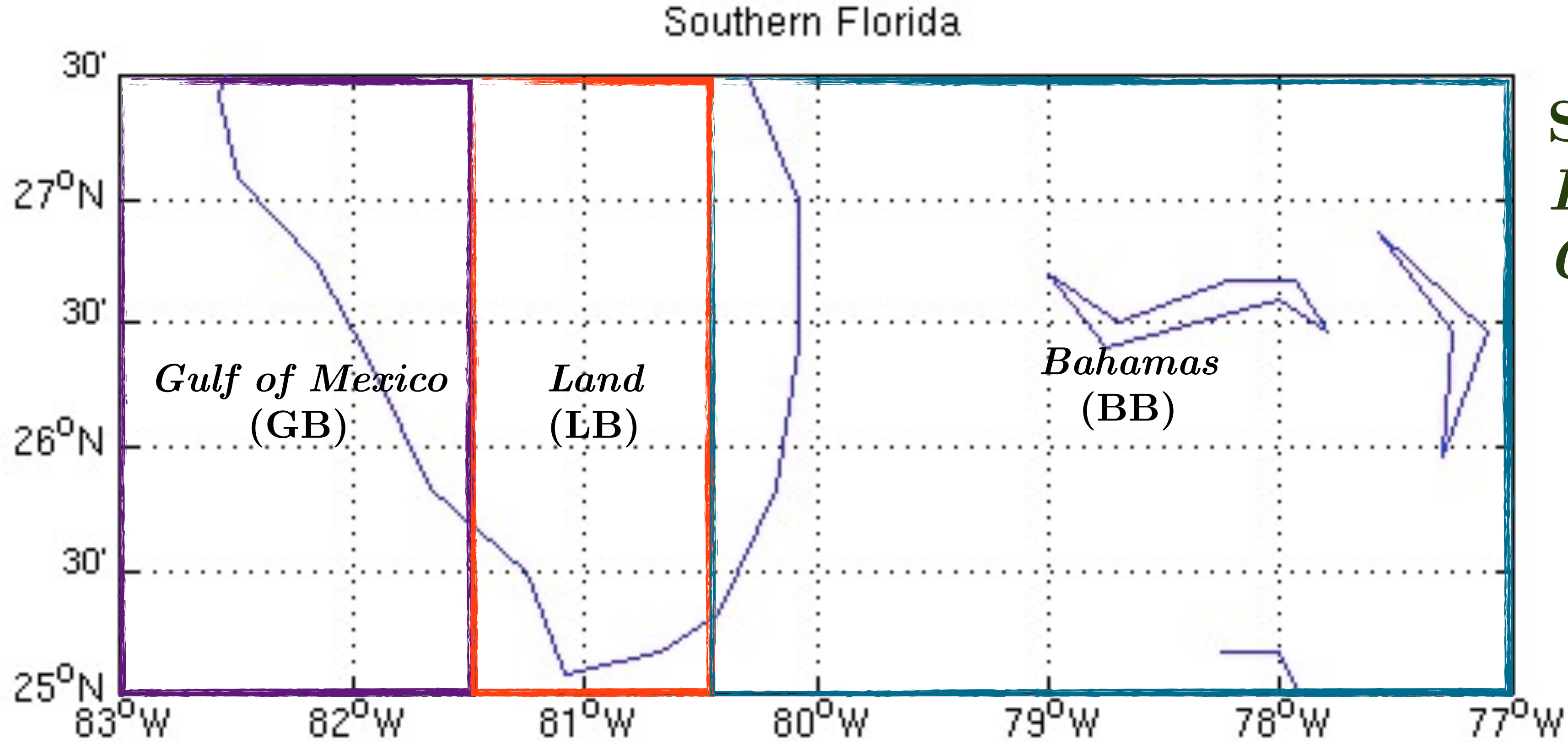
From NOAA's Earth Systems Research Laboratory gridded datasets

- **Sea surface temperature**
- **2m AG air temperature**
- **Zonal (u) wind at 1000 hPa and 300 hPa distinctively**
- **Meridional (v) wind at 1000 hPa and 300 hPa distinctively**
- **Precipitation accumulations (land only)**
- **Outgoing long-wave radiation (OLR, land only)**



Land-sea contrast

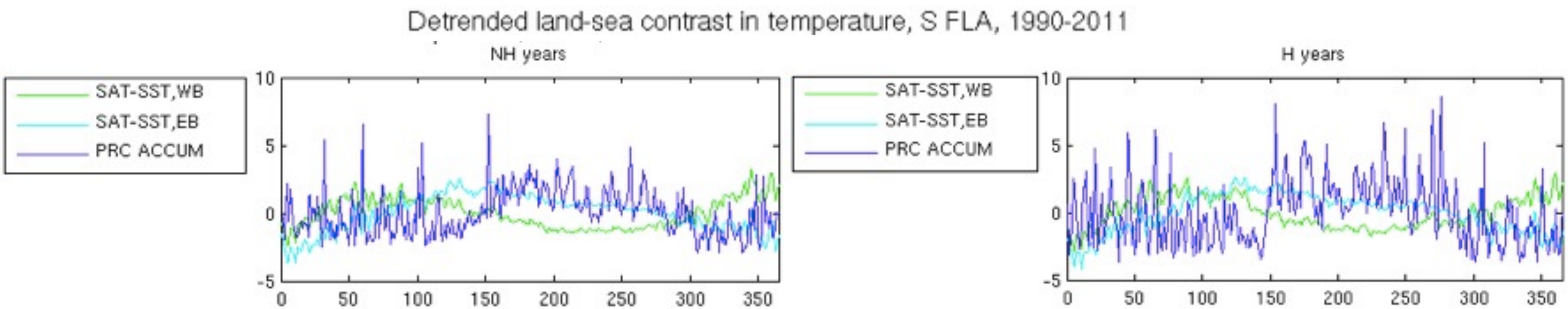
Comparing heating over land, ocean helpful for convection likelihood, intensity



Spatial averaging

Land masked in ocean boxes,

Ocean masked in land boxes



Land-sea contrast

Correlation coefficients and significance determined for both NH, H years

NH years: 1990, 1991, 1993, 1994, 1996, 1997, 2000, 2001, 2002, 2003, 2006,2007,2008,2009,2010 and 2011

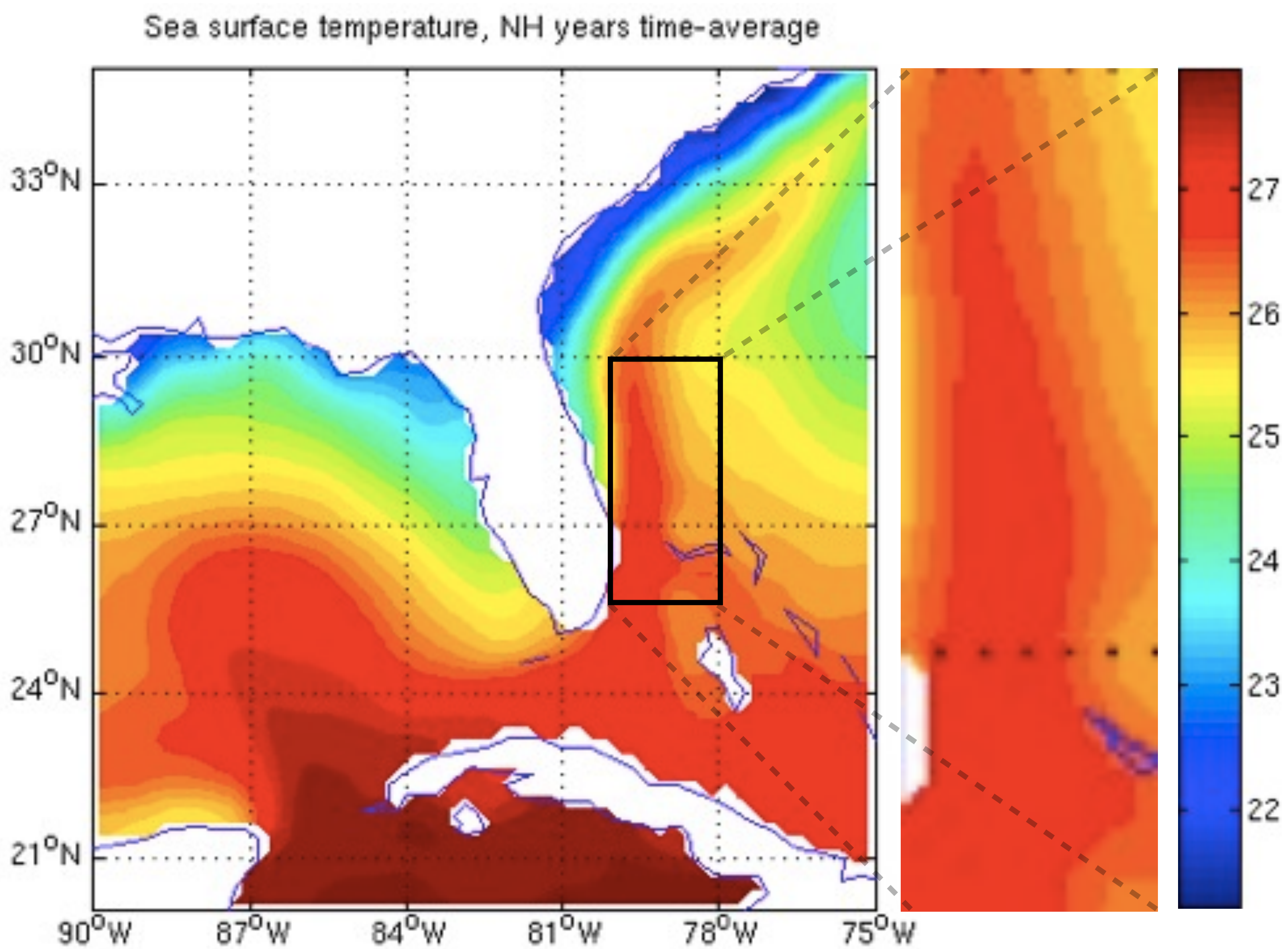
	r	*p*	*rlow*	*rhigh*	*correlation and significance*
GB	-0.417	0.000	-0.498	-0.328	Moderate negative correlation; sig.
BB	0.296	0.000	0.199	0.387	Low-moderate positive correlation; sig.

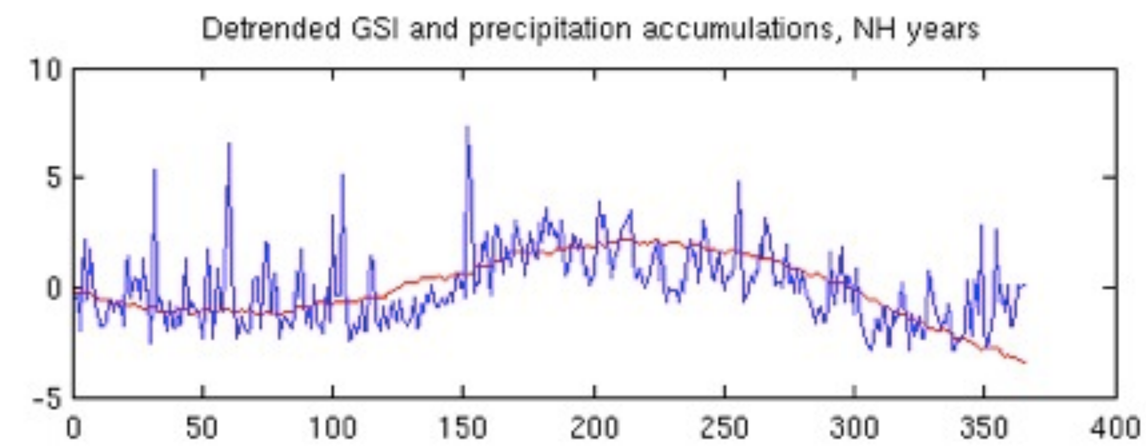
H years: 1992, 1995, 1998, 1999, 2004, and 2005

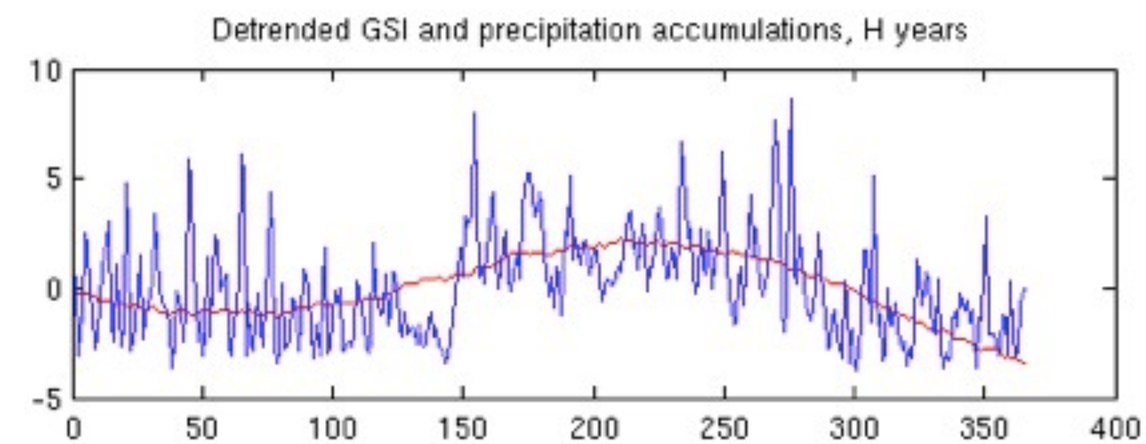
	r	*p*	*rlow*	*rhigh*	*correlation and significance*
GB	-0.386	0.000	-0.470	-0.295	Moderate negative correlation; sig.
BB	0.199	0.001	0.098	0.296	Low positive correlation; sig.

Positive correlations in Bahamas region box, consistent with avg. SFC easterlies

Consider Gulf Stream warm anomalies, impact

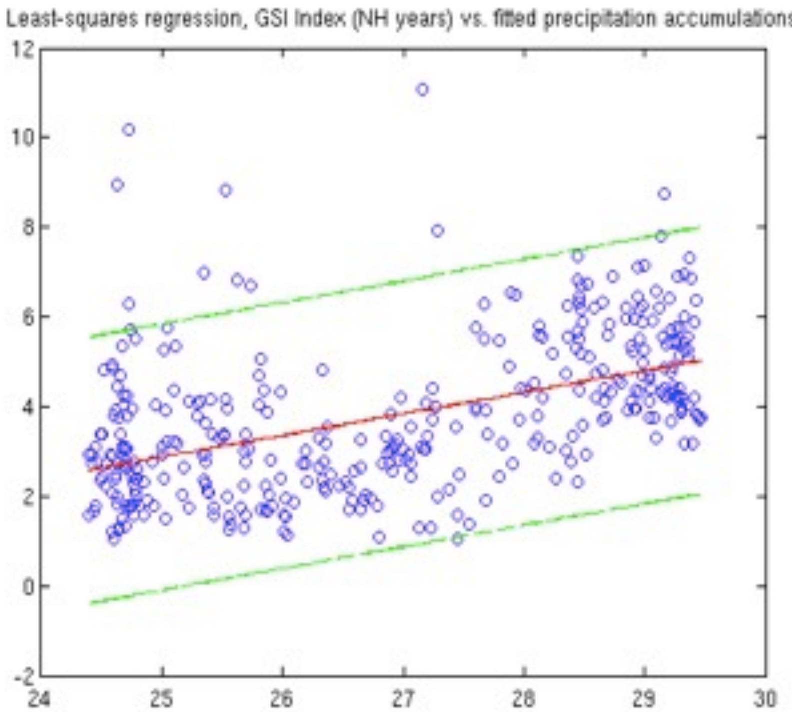


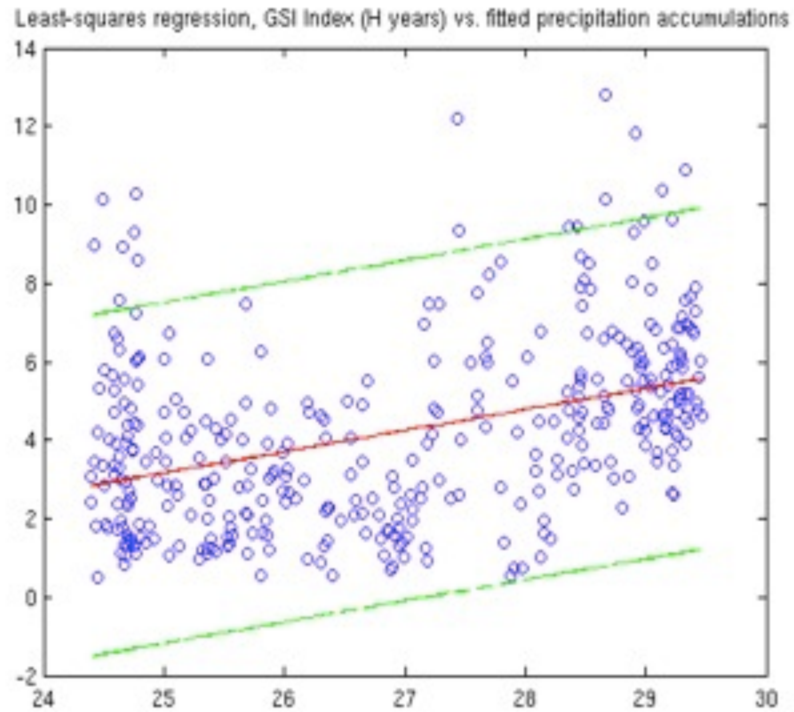




Land-sea contrast

Gulf Stream Index (spatial average timeseries of SST within box) **used to regress fit precipitation**





LSR results

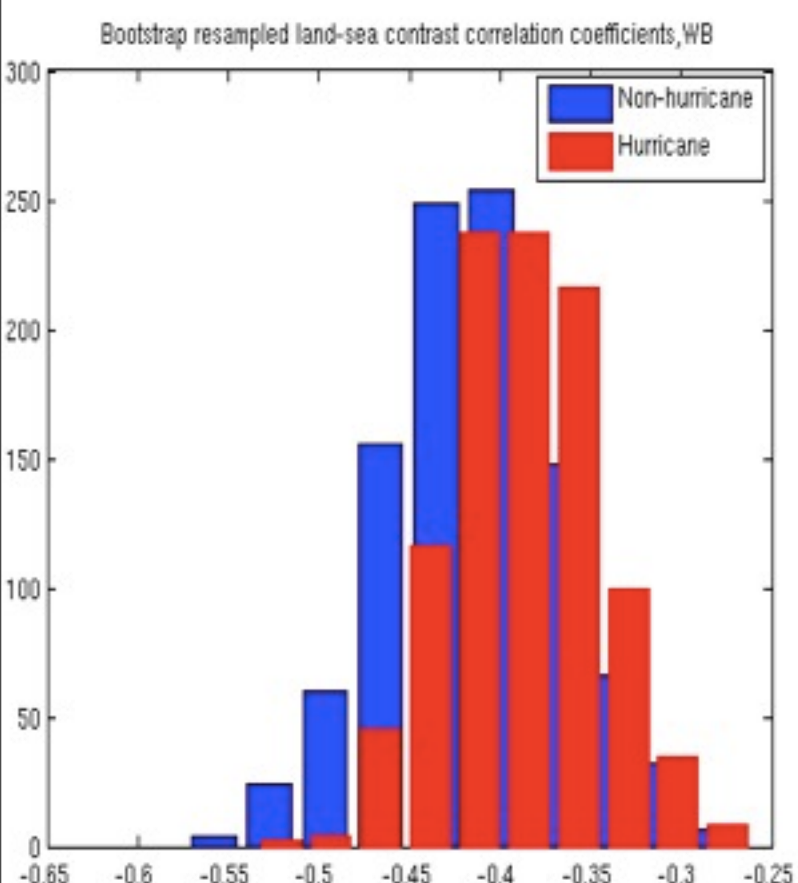
pNH:

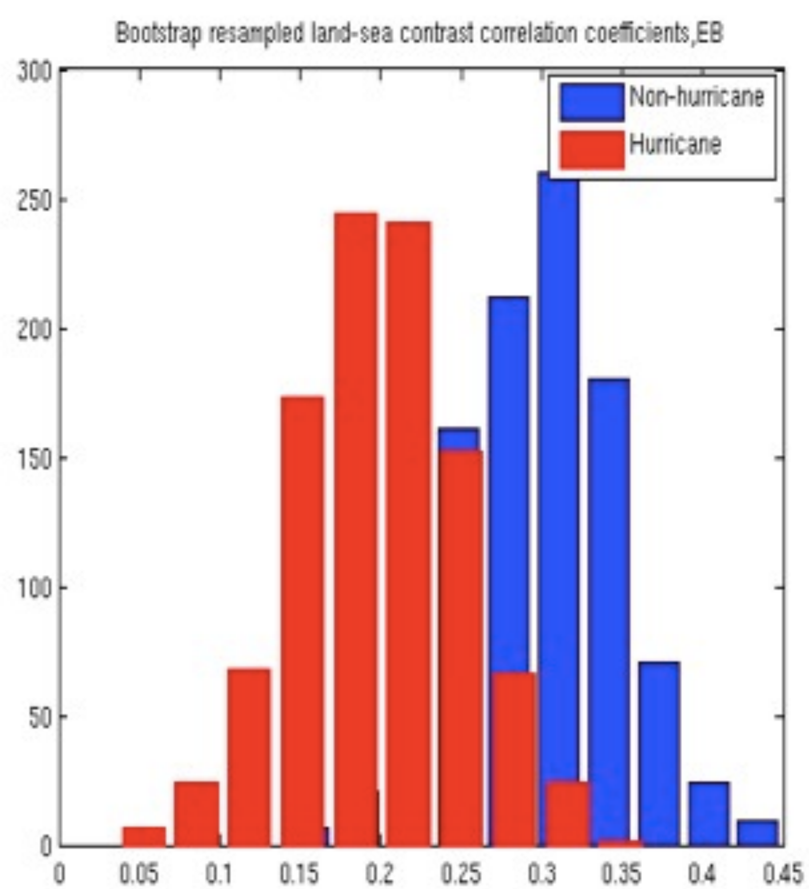
SLOPE: *0.482* INT: *-9.167*

pH:

SLOPE: *0.538* INT: *-10.27*

Resampled correlation coefficients via bootstrap approach



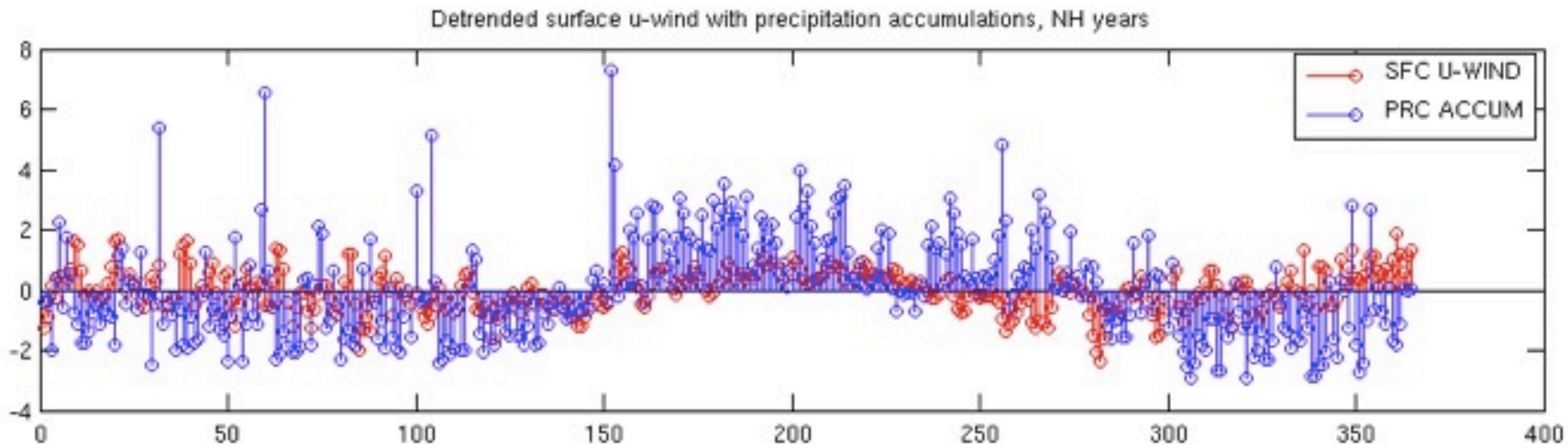


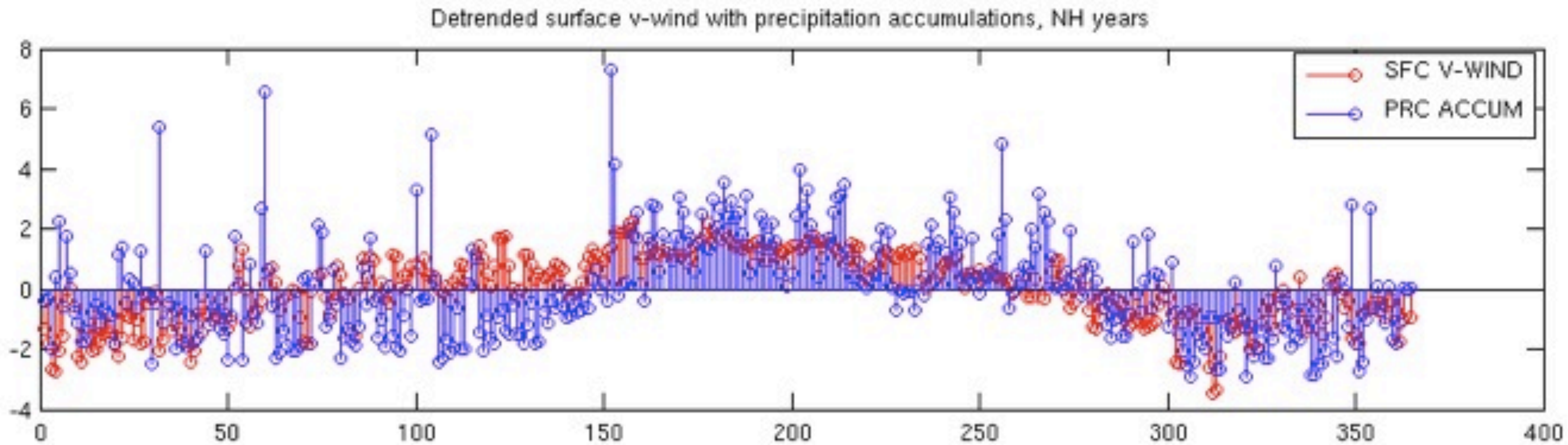
Bootstrap results

	BEFORE	AFTER
NH		
*r*LSW	*-0.416*	*-0.418*
*r*LSE	*0.296*	*0.295*
H		
*r*LSW	*-0.386*	*-0.388*
*r*LSE	*0.199*	*0.201*

Surface wind and precipitation

Question: Does either component of surface wind have statistically similar spread to precipitation? **F-test performed to provide the answer for NH years**

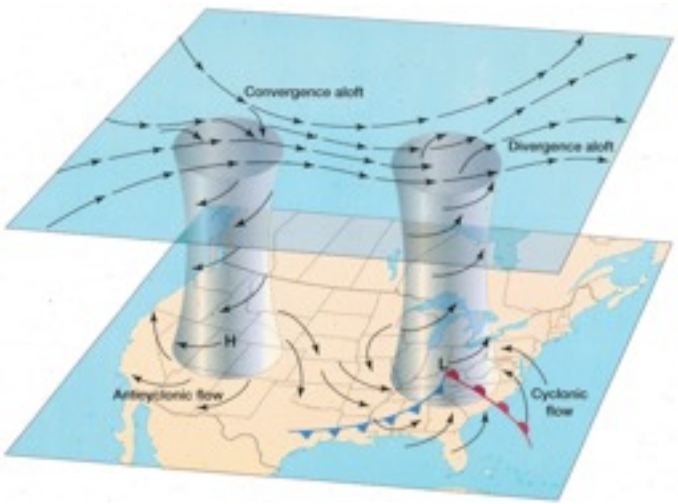




Samples	F_{real}	F_{theor}	*Meaning*
uSFC, prc	*5.876*	*1.189*	Var equal reject
vSFC, prc	*0.469*	*1.189*	Var equal accept

Divergence and precipitation

Question: Does upper tropospheric divergence have statistically similar variance to precipitation?

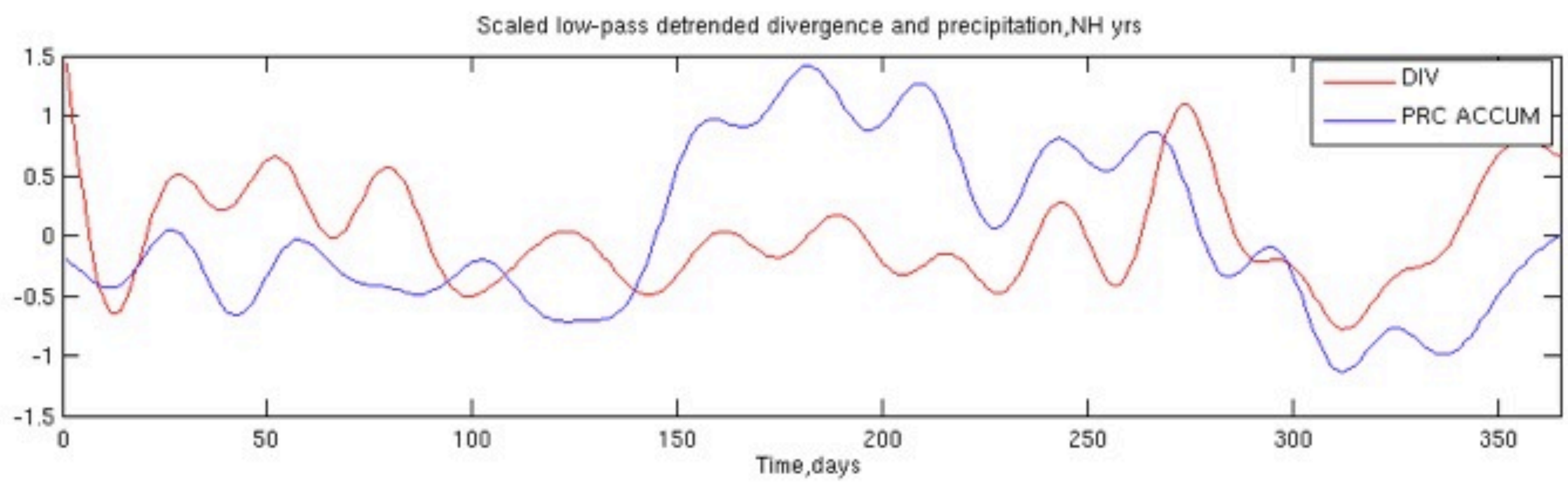


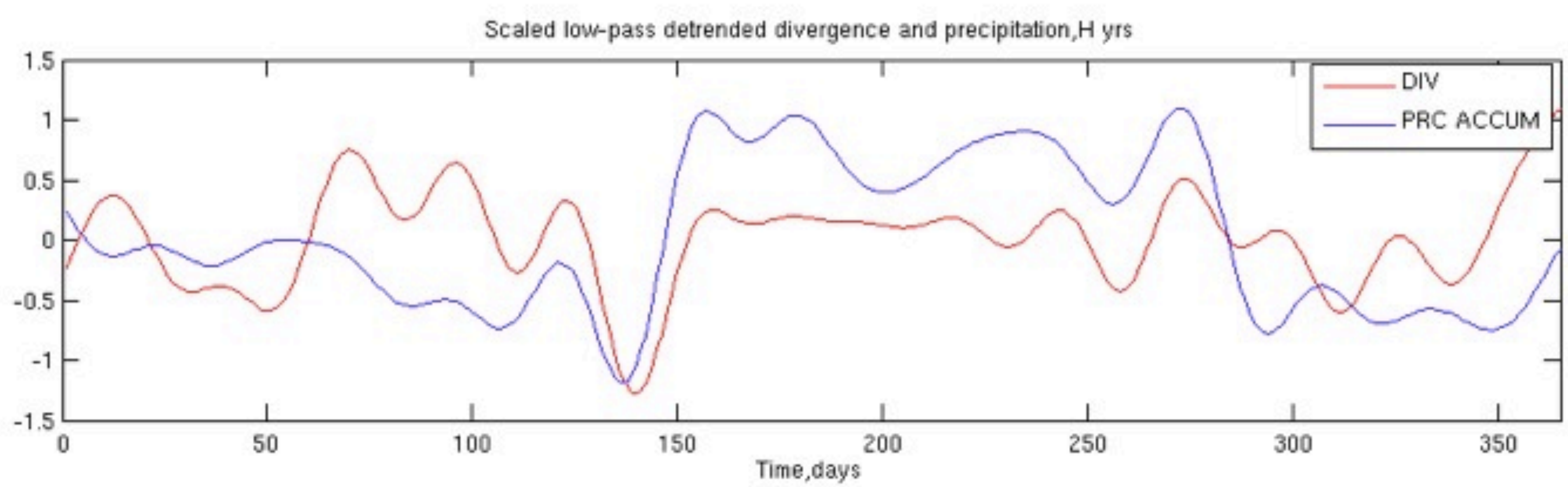
Samples	F_{real}	F_{theor}	*Meaning*
div (NH), *prc*	*8.7e11*	*1.189*	**Var equal reject**
div (H), *prc*	*6.8e11*	*1.189*	**Var equal reject**

Timeseries filter results

Low pass filter shows general direct relationship between forced upward motion through the troposphere and precipitation accumulations

Data scaled by standard deviation; divergence has units of order 10^{-5}

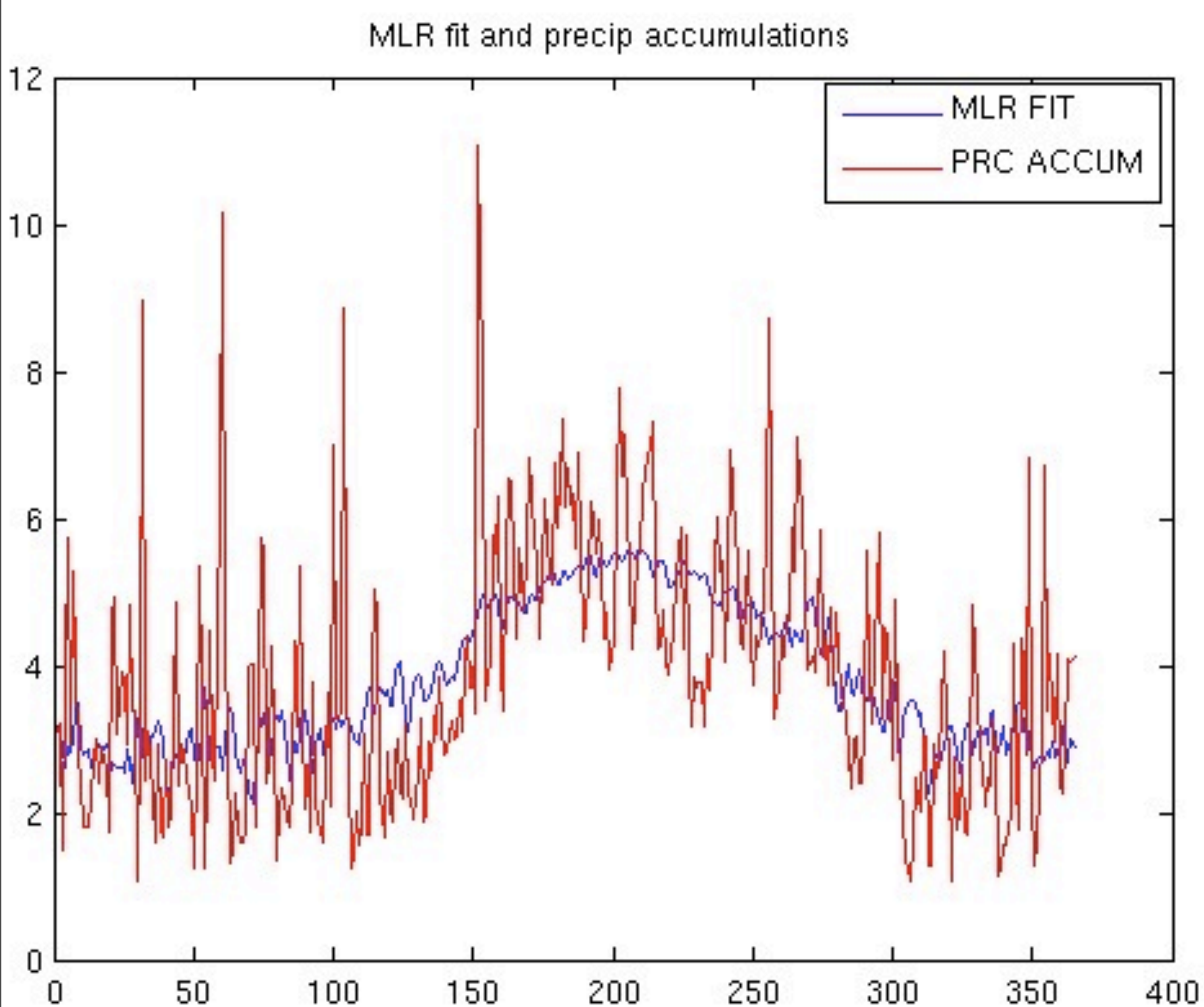


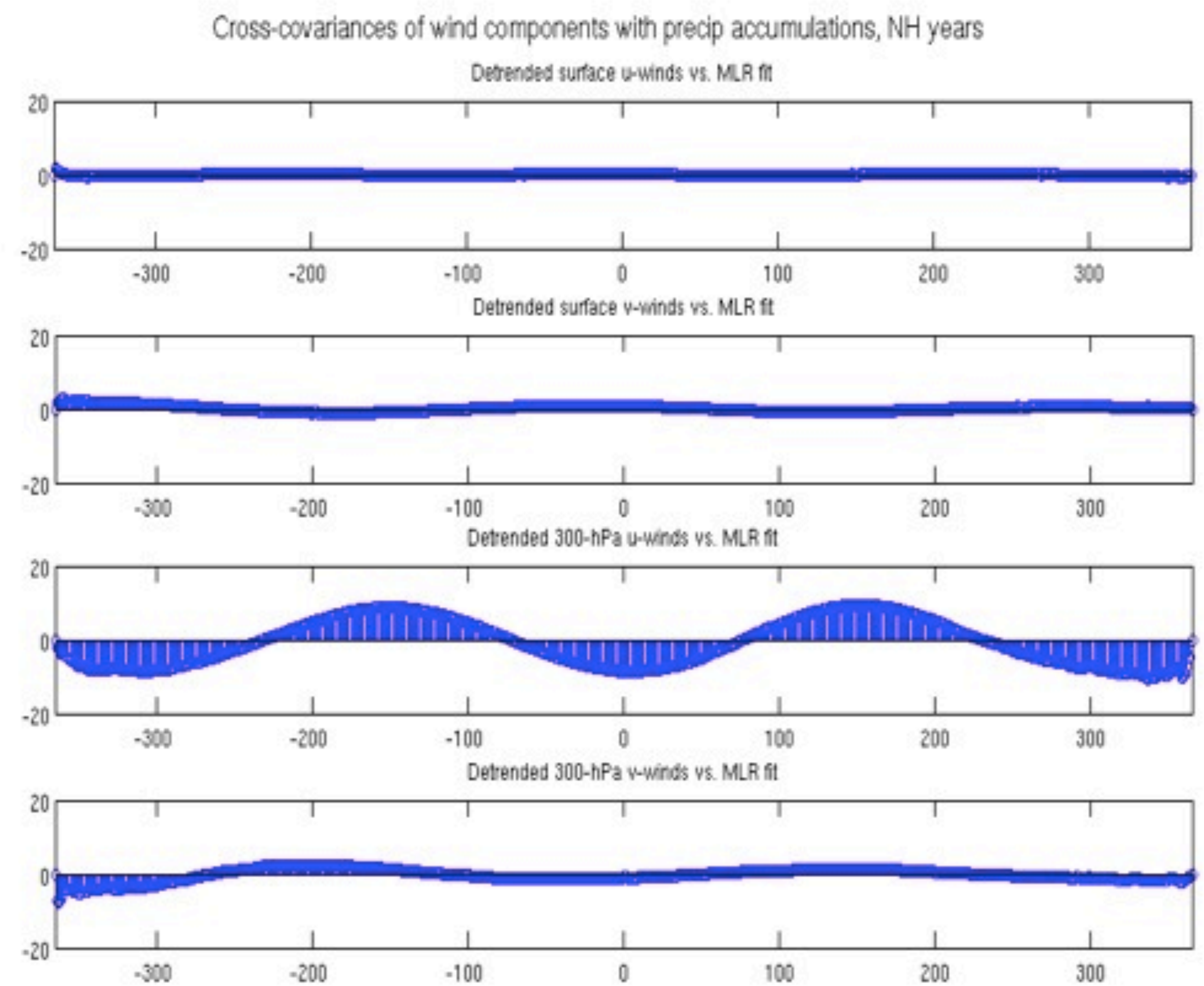


Wind variance and precipitation

$$Y_{fit} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \longrightarrow \begin{matrix} X_1 = u_{SFC} & X_2 = v_{SFC} \\ X_3 = u_{300hPa} & X_4 = v_{300hPa} \end{matrix}$$

MLR fit follows precipitation well **(NH years)**

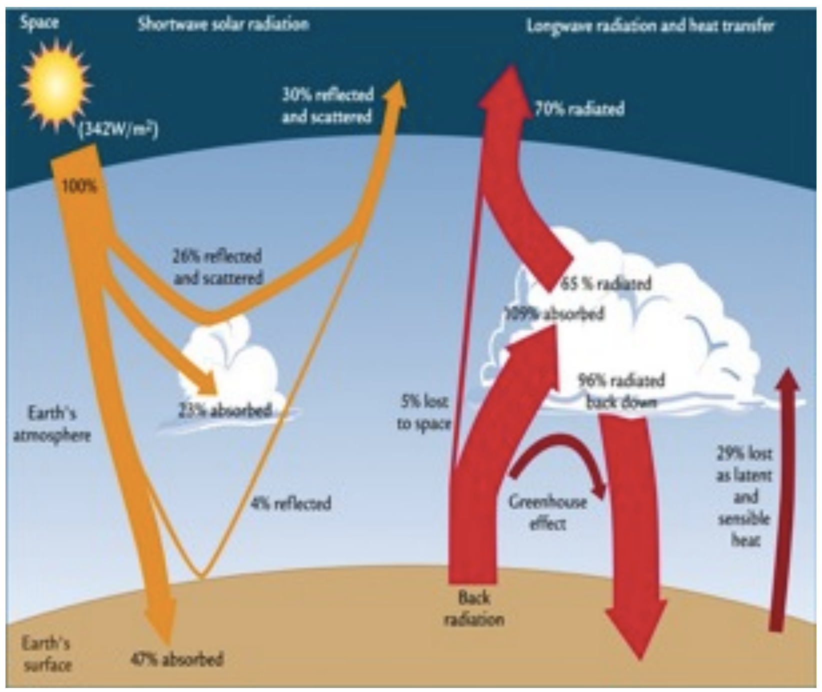


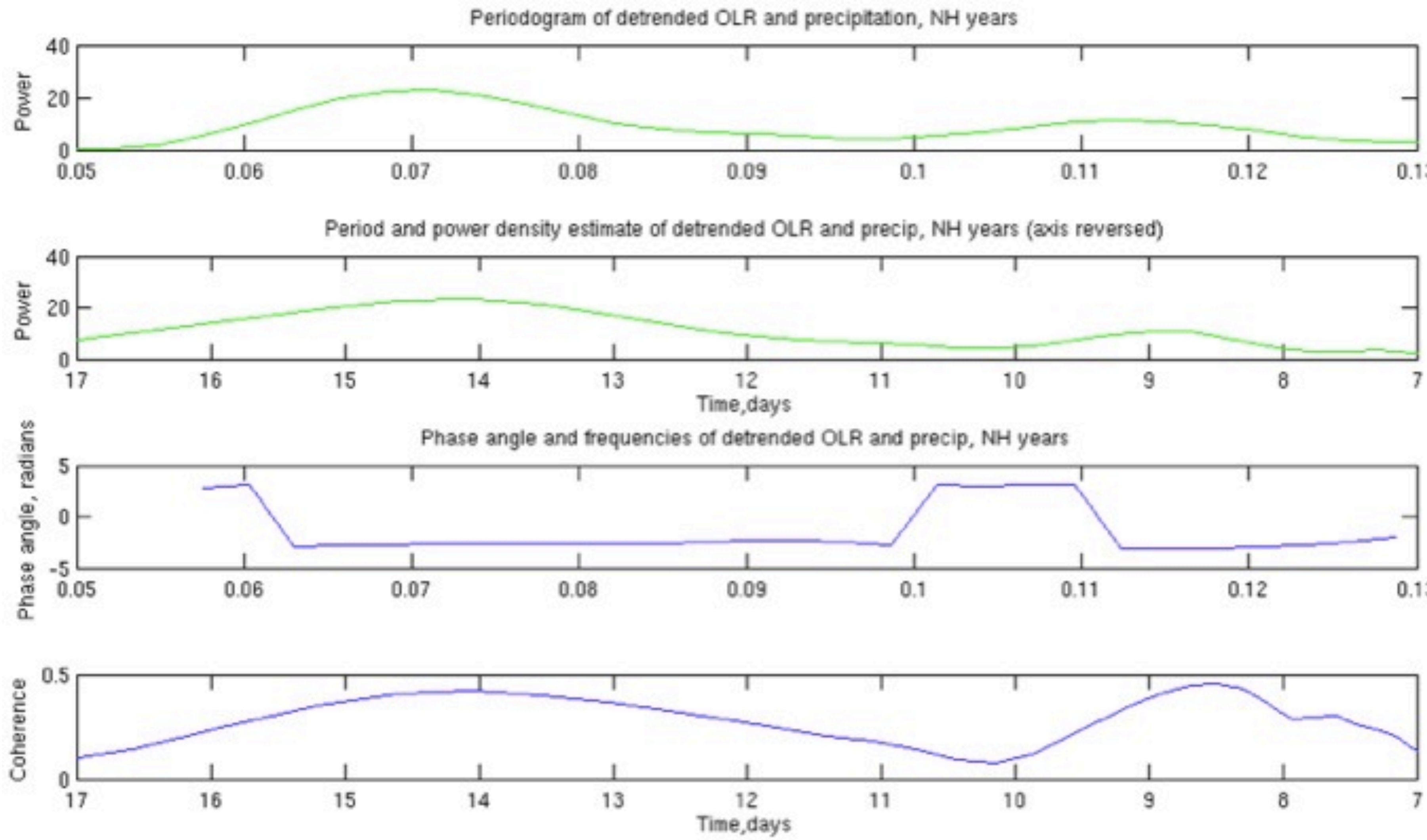


Zonal wind at 300 hPa has strongest cross-covariance signal with MLR fit

Outgoing long-wave radiation and precipitation

OLR refers to IR being reradiated to space, which radiates at $T_{layer,cloud\ top}$





Negative maxima in OLR imply strong vertical development of convective clouds (and therefore, precipitation)
Periodicity is on synoptic timescales, about 8-14 days

Conclusions

- *More accumulated precipitation seen in H years than NH years*

- *Surface winds on average suggest onshore flow on E FL coast important*

- *Positive correlation coefficients reaffirm E FL (Bahamas box) impact*

- *Gulf Stream temperature anomalies show positive slope, regression to precipitation*

- *Resampled coefficients affirm accuracy of correlations*

- *Surface v-wind variance statistically similar to precipitation in NH years* (consistent with N/S temperature gradient importance for i.e., frontal systems)

- *Timeseries filtering shows divergence affects a greater response from precipitation during NH years* (cross-correlation not shown)

- *300 hPa westerlies over N. America consistent with strongest cross covariance to precipitation* (upper level divergence)

- *Synoptic weather systems develop on time scales 5-13 days, OLR changes consistent with formation/decay of convection and its vertical development*