A comparison of observed and model-generated tropical cyclone climatologies using a spatial lattice

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5 June 2013

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Objectives

- Quantitatively compare the spatial distributions of observed and GCM-generated track data
- Examine statistical relationships between the track data and various environmental and climate variables (here we focus on SST)

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Data: observations

Global TC Track Data:

- International Best Track Archive for Climate Stewardship (IBTrACS)
- Data from 1981-2008 are used
- Interpolated from 6-hourly to hourly intervals following the method described in Elsner et al. (2013)

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Data: the models

Model 1: GFDL-HiRAM (Zhao et al. 2009)

- 50 km horizontal grid spacing
- 32 vertical levels
- Forced with HadISST from 1981-2008
- Global

Model 2: FSU-COAPS (LaRow et al. 2008)

- Spectral model with T126 horizontal resolution
- 27 vertical levels
- Forced with HadISST from 1981-2008
- Use data from North Atlantic basin

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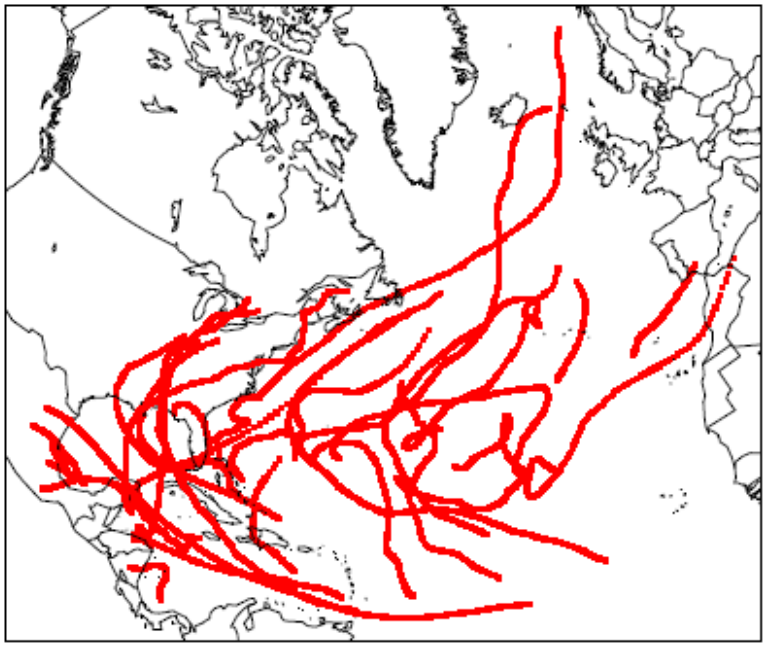
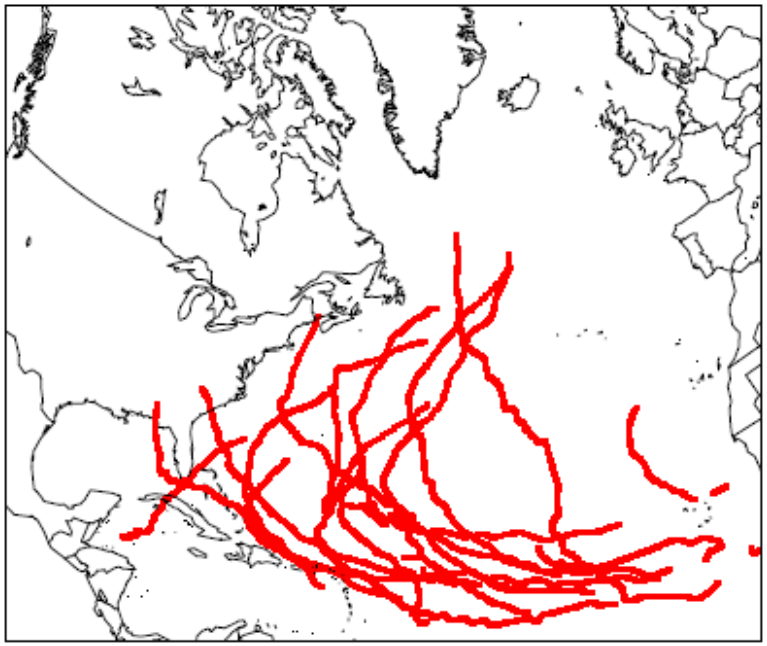
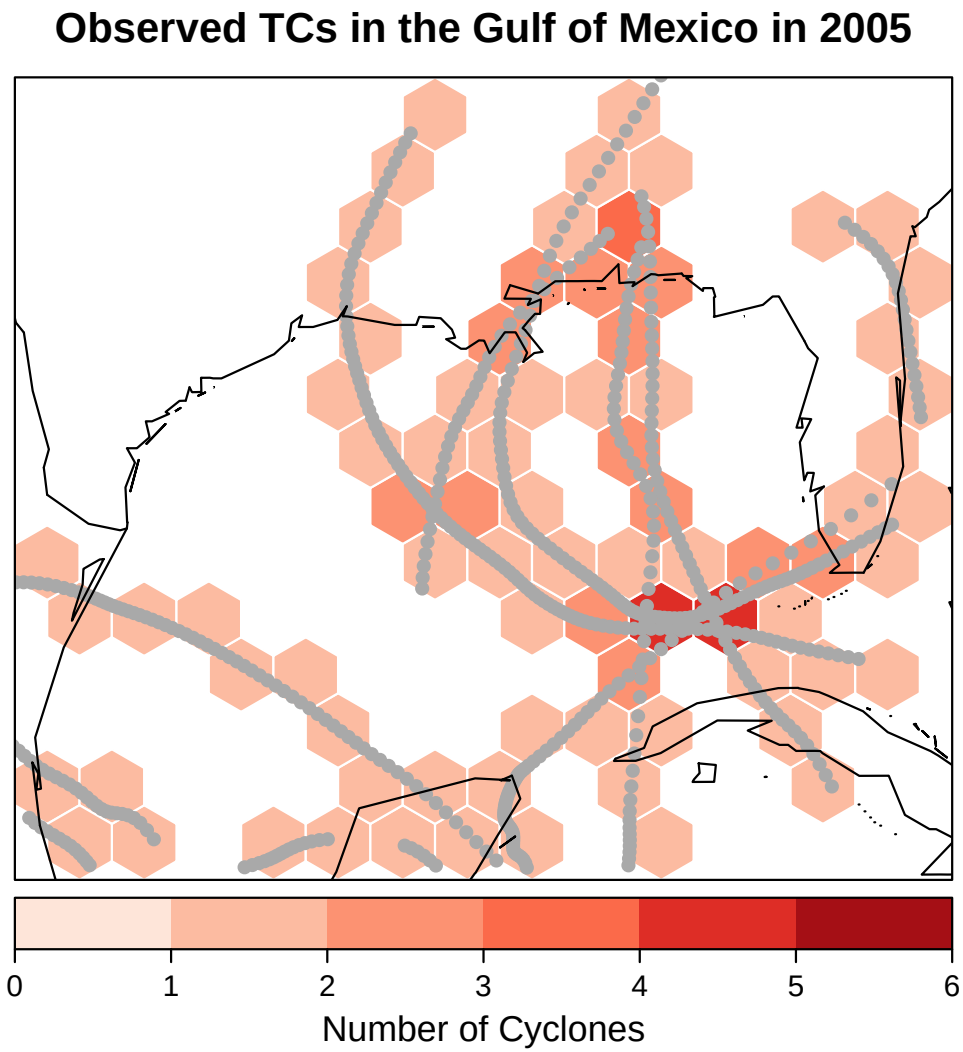
Observations: 2005



Model: 2005



The spatial framework



(see Elsner et al. (2012) for more details)

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Part I: Spatial Distributions

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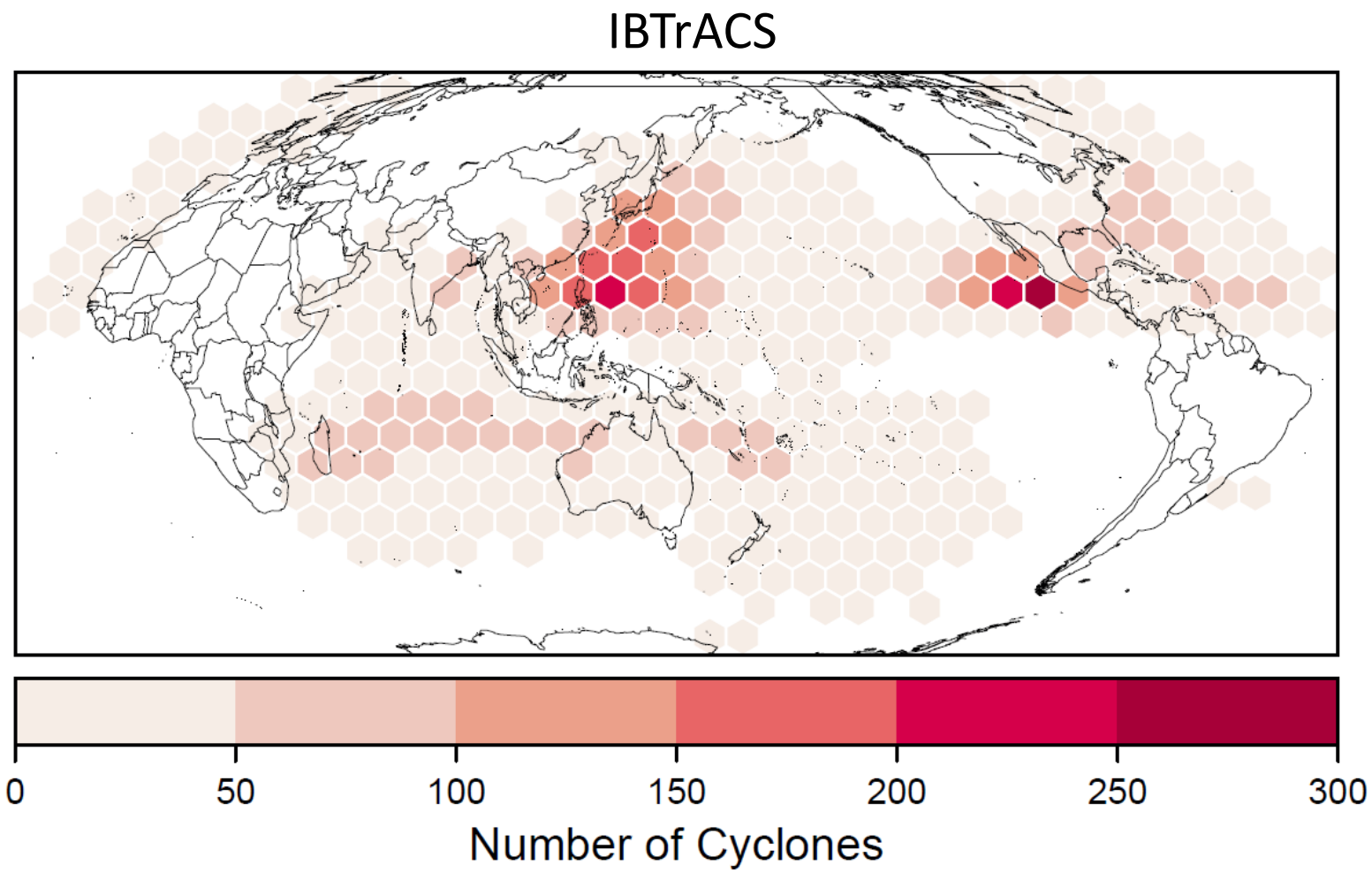
Comparing spatial distributions (Global)



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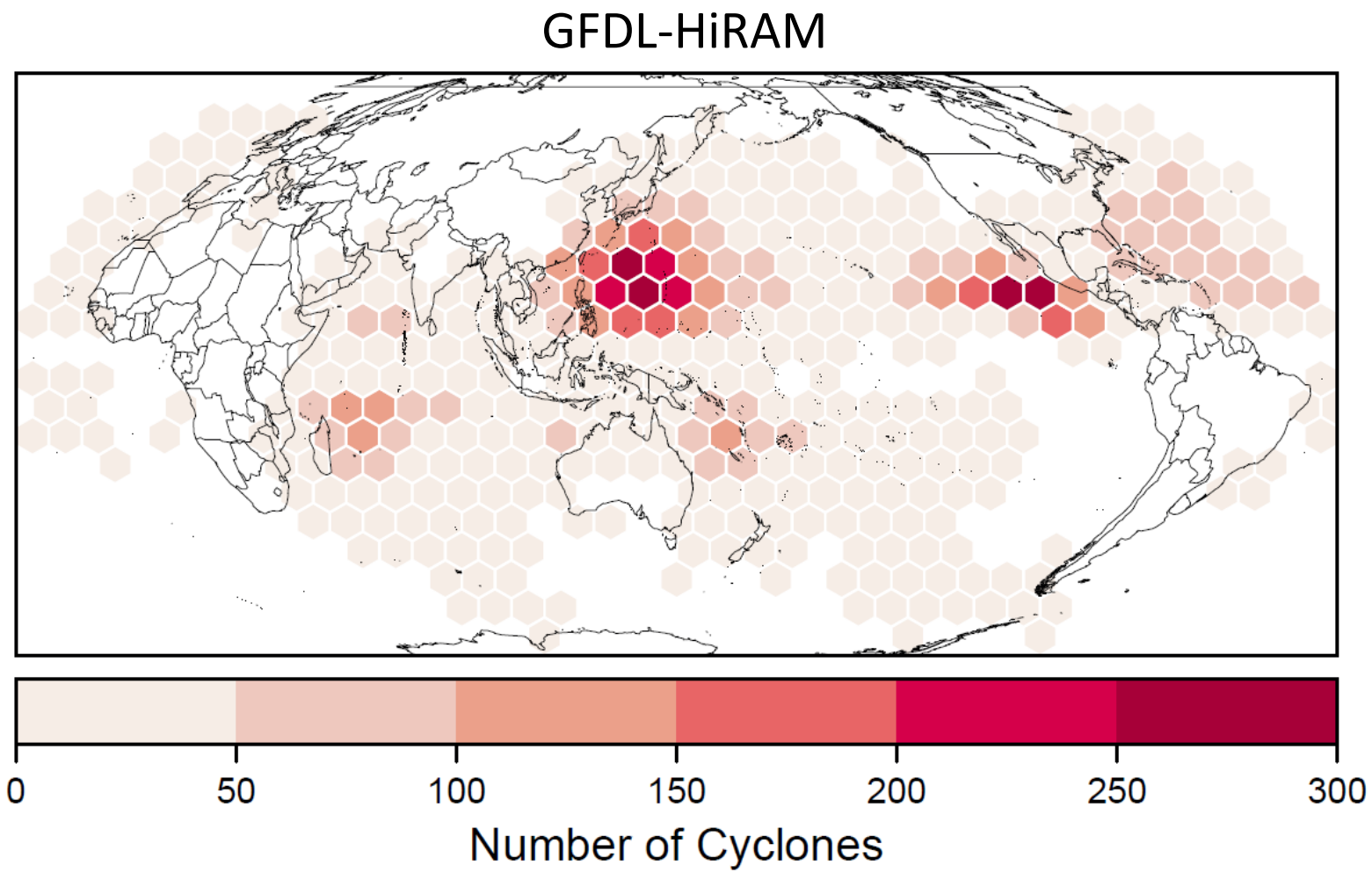

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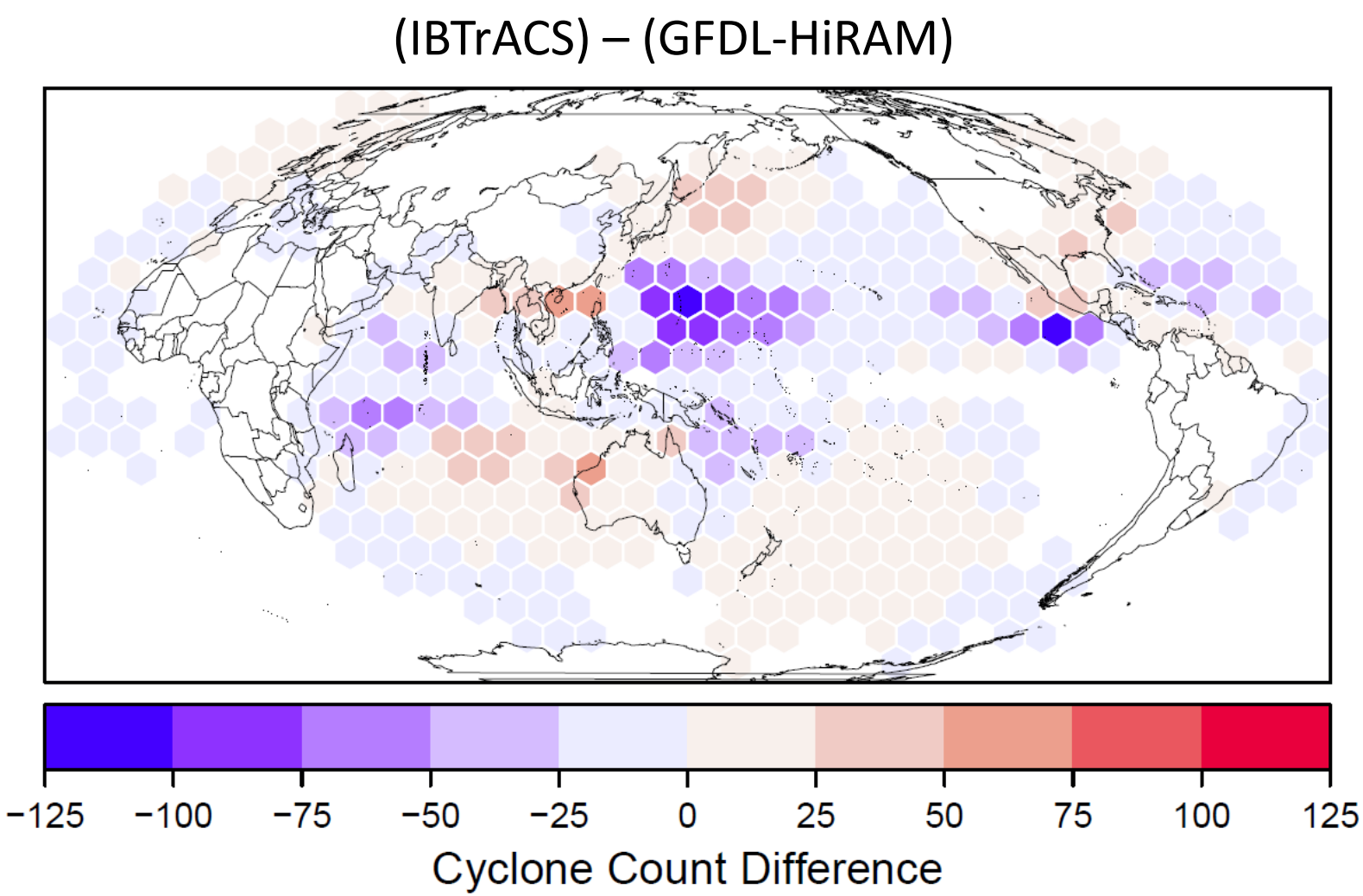

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Model Performance Metrics

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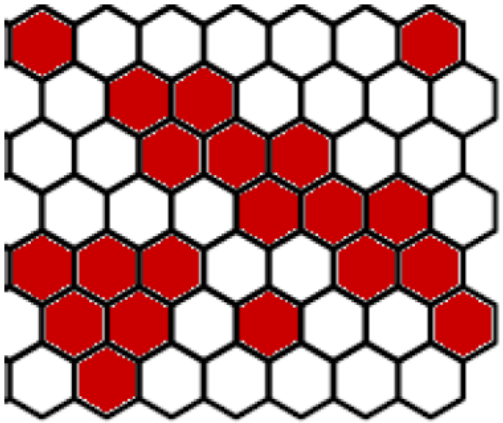
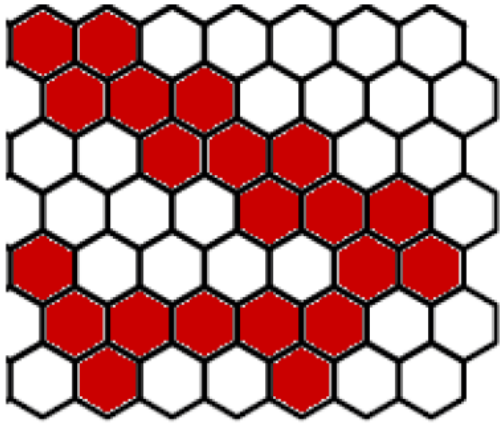
Observations



Model



		Obs	
Model		True Pos.	False Pos.
		False Neg.	True Neg.

		Obs	
Model		16	5
		4	24

Model Performance Metrics

Bias:

$$\text{Bias} = \frac{\text{TP} + \text{FP}}{\text{TP} + \text{FN}} \tag{1}$$

Critical Success Index:

$$\text{CSI} = \frac{\text{TP}}{\text{TP} + \text{FP} + \text{FN}}. \tag{2}$$

Probability of Detection:

$$\text{POD} = \frac{\text{TP}}{\text{TP} + \text{FN}}. \tag{3}$$

Success Ratio:

$$\text{SR} = 1 - \frac{\text{FP}}{\text{TP} + \text{FP}}. \tag{4}$$

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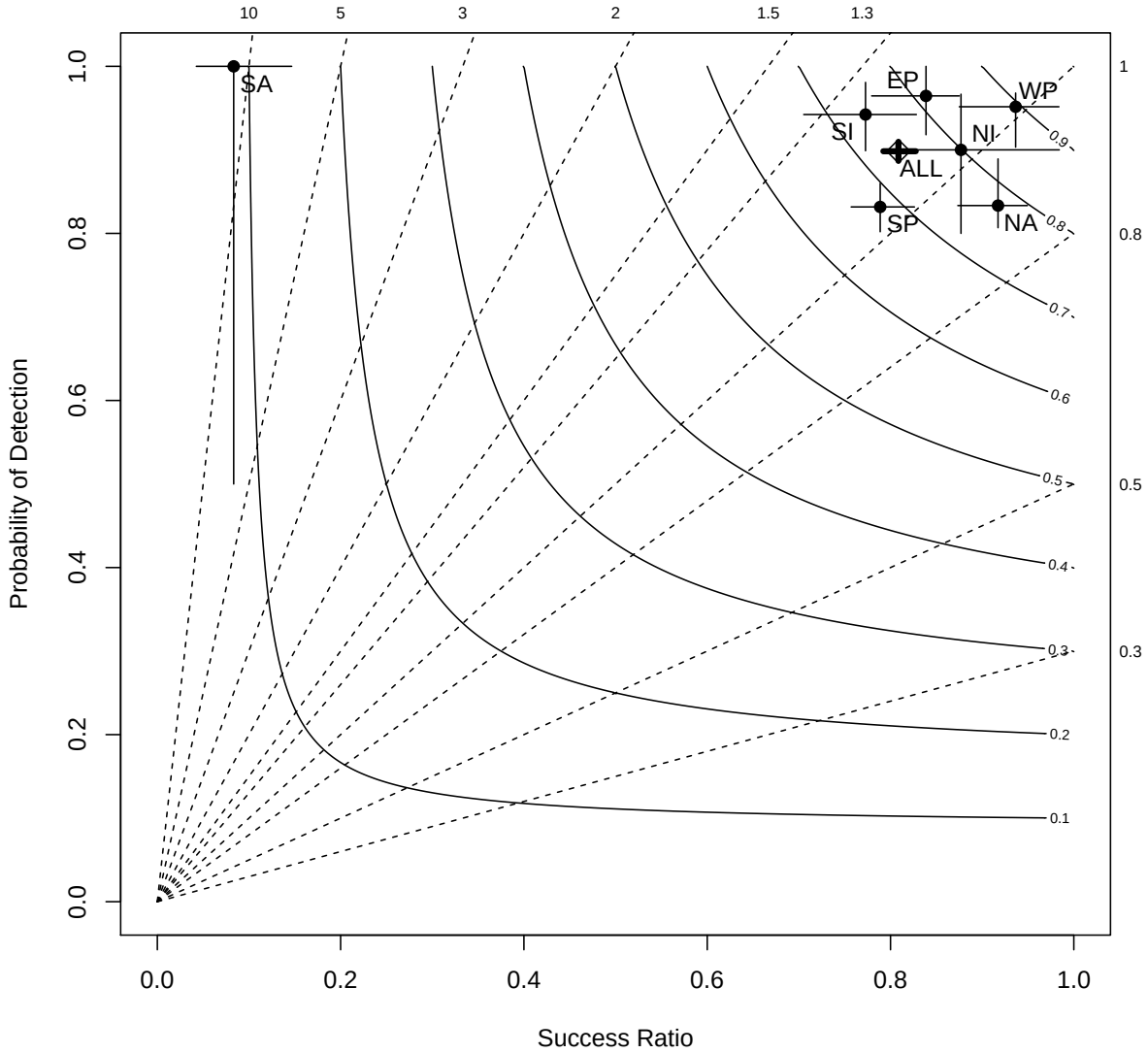
Model Performance Metrics



US CLIVAR Hurricane Workshop, 5 June 2013

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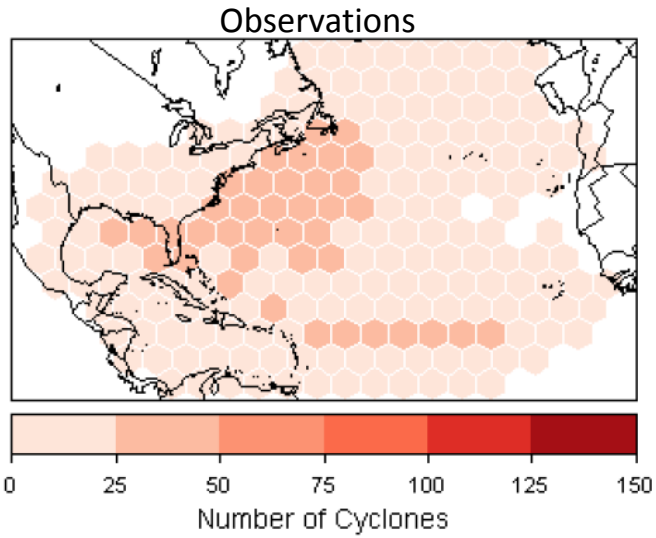
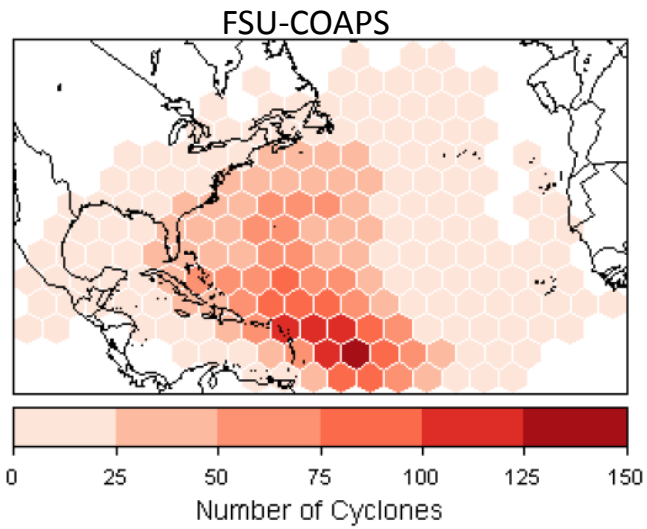
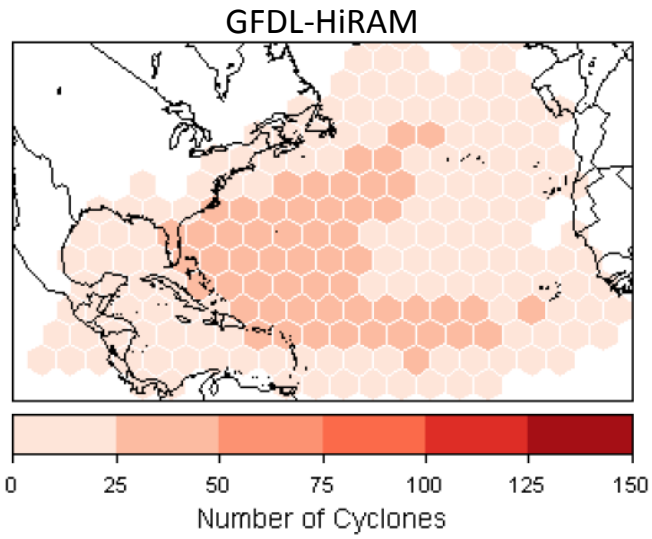
Comparing Spatial Distributions: North Atlantic







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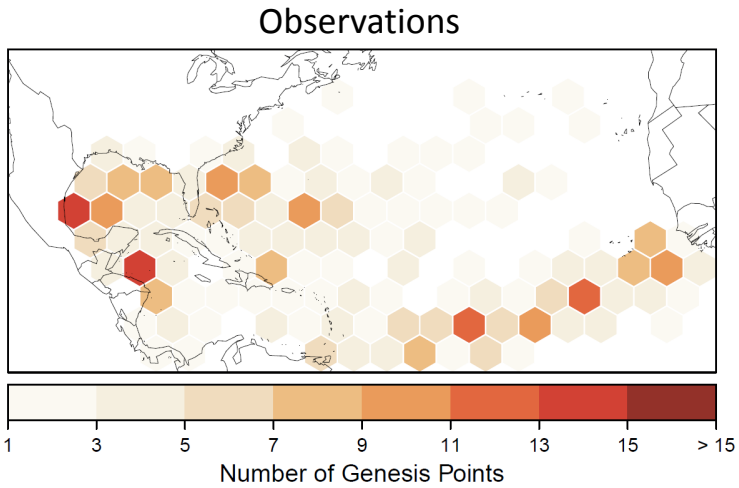

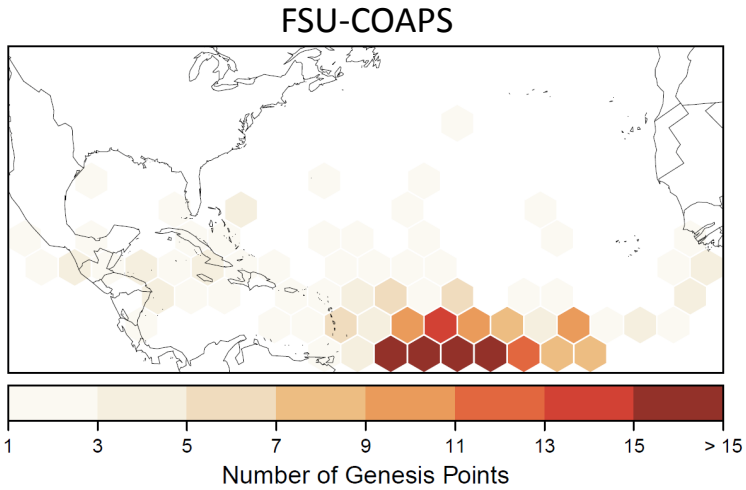

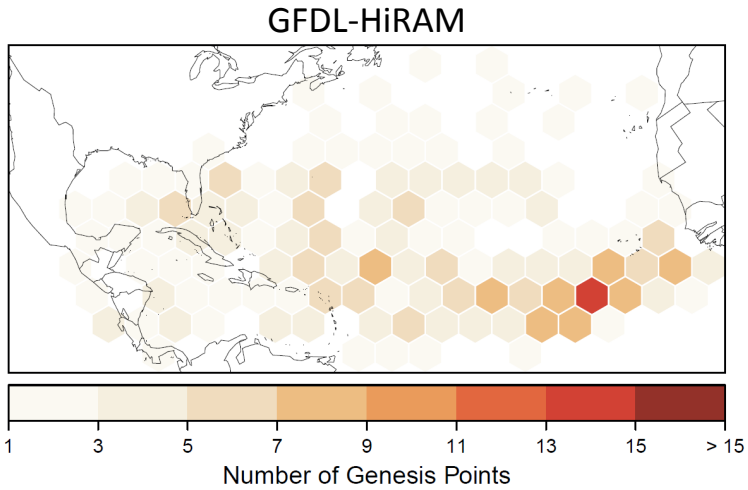

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Spatial Distribution Summary:

Globally

- The overall spatial distribution of TCs generated by the GFDL-HiRAM matches reasonalby well with observations, although there are clear areas of over/under prediction by the model.
- Quantitative performance metrics verify that the GFDL-HiRAM is generally generating TCs in the correct areas.

North Atlantic

- There are significant areas of overprediction by the FSU-COAPS model in the central portion of the basin.
- Interestingly, neither model correctly reproduces the spatial distribution of storms in the Caribbean and Gulf of Mexico.

Part II: Sensitivity of Limiting Intensity to SST

Sarah E. Strazzo, James B. Elsner, Timothy E. LaRow, Ming Zhao, and Daniel J. Halperin

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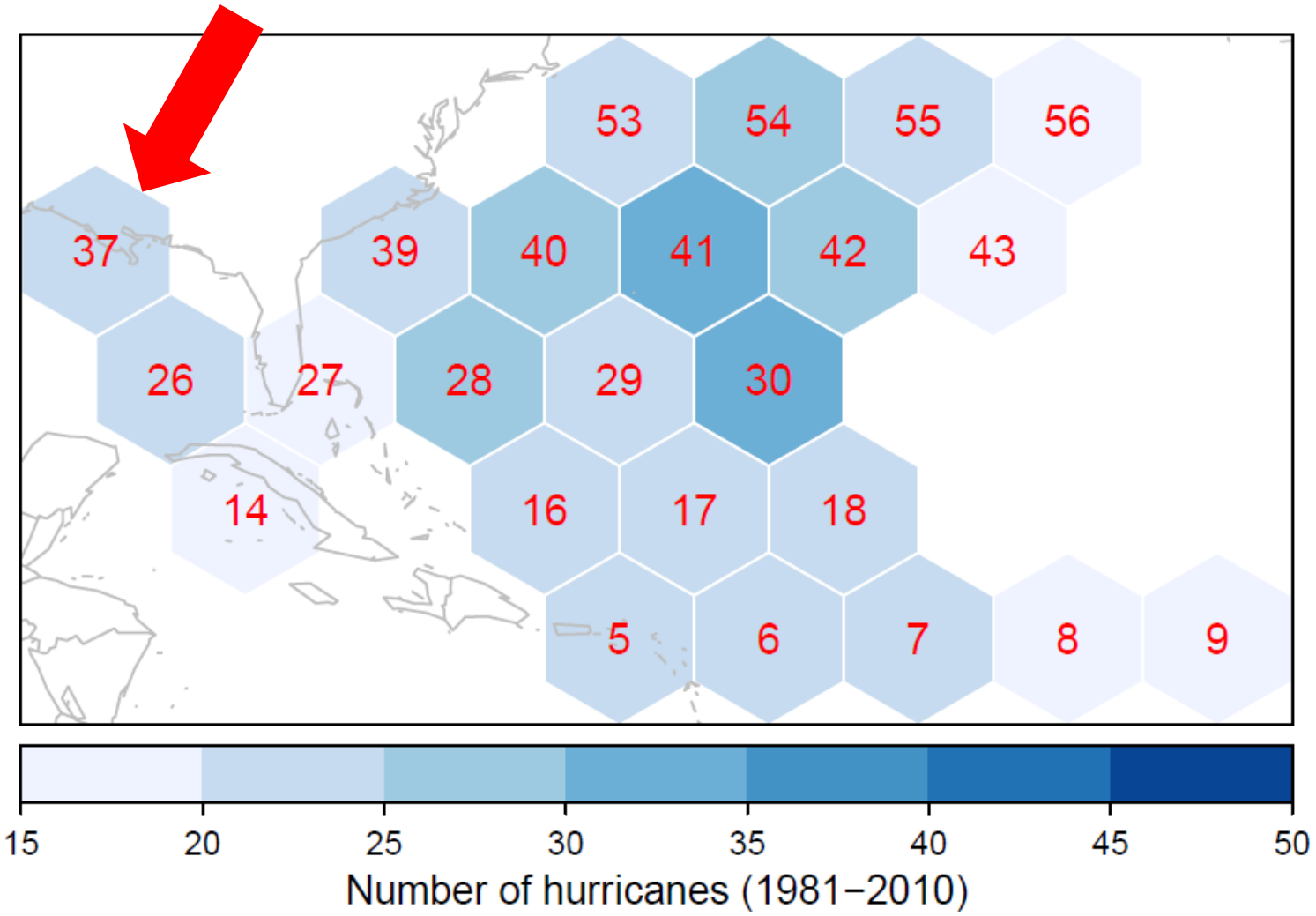
Per Hexagon TC Counts



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Per Hexagon Wind Speed Distributions

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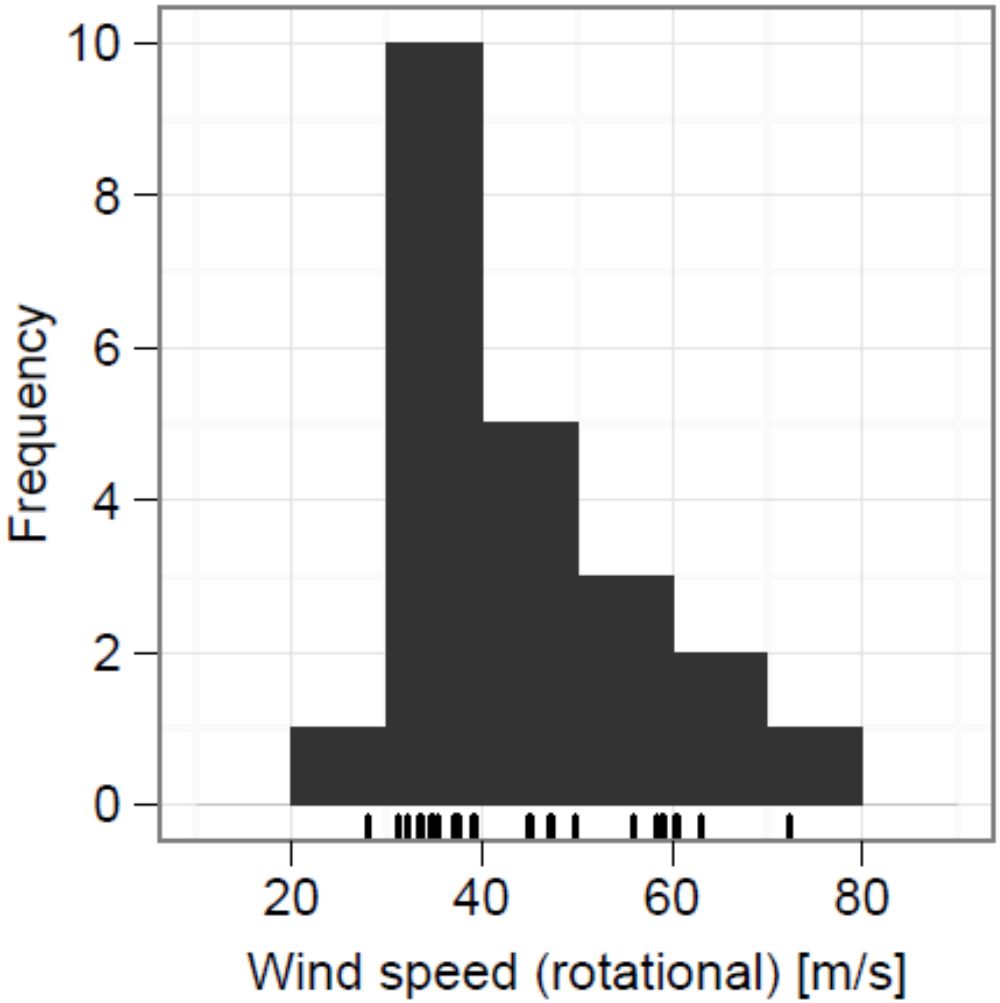
Wind speed distribution for hexagon #37



Limiting Intensity

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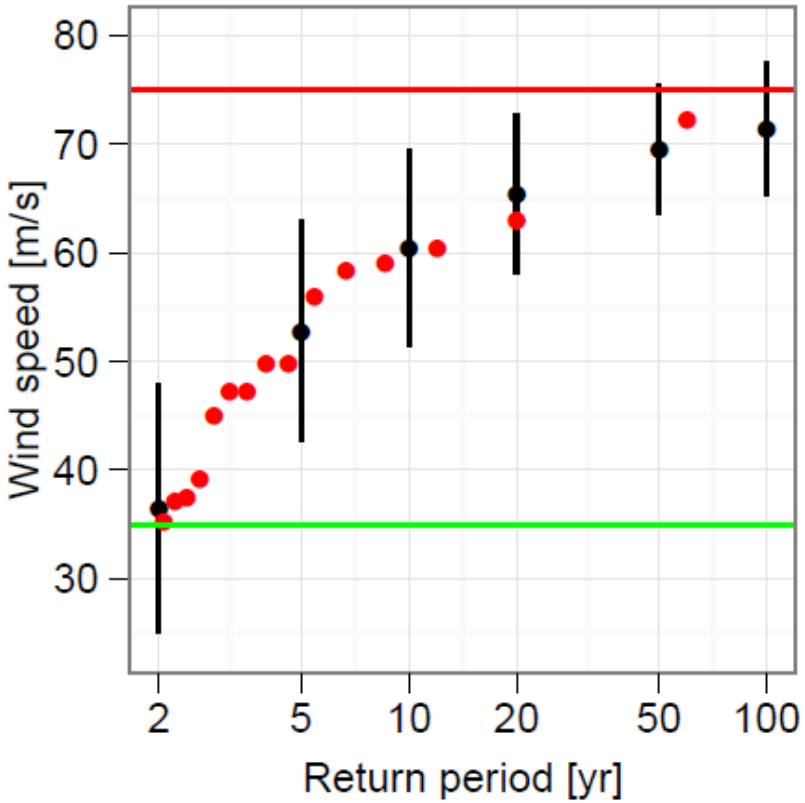
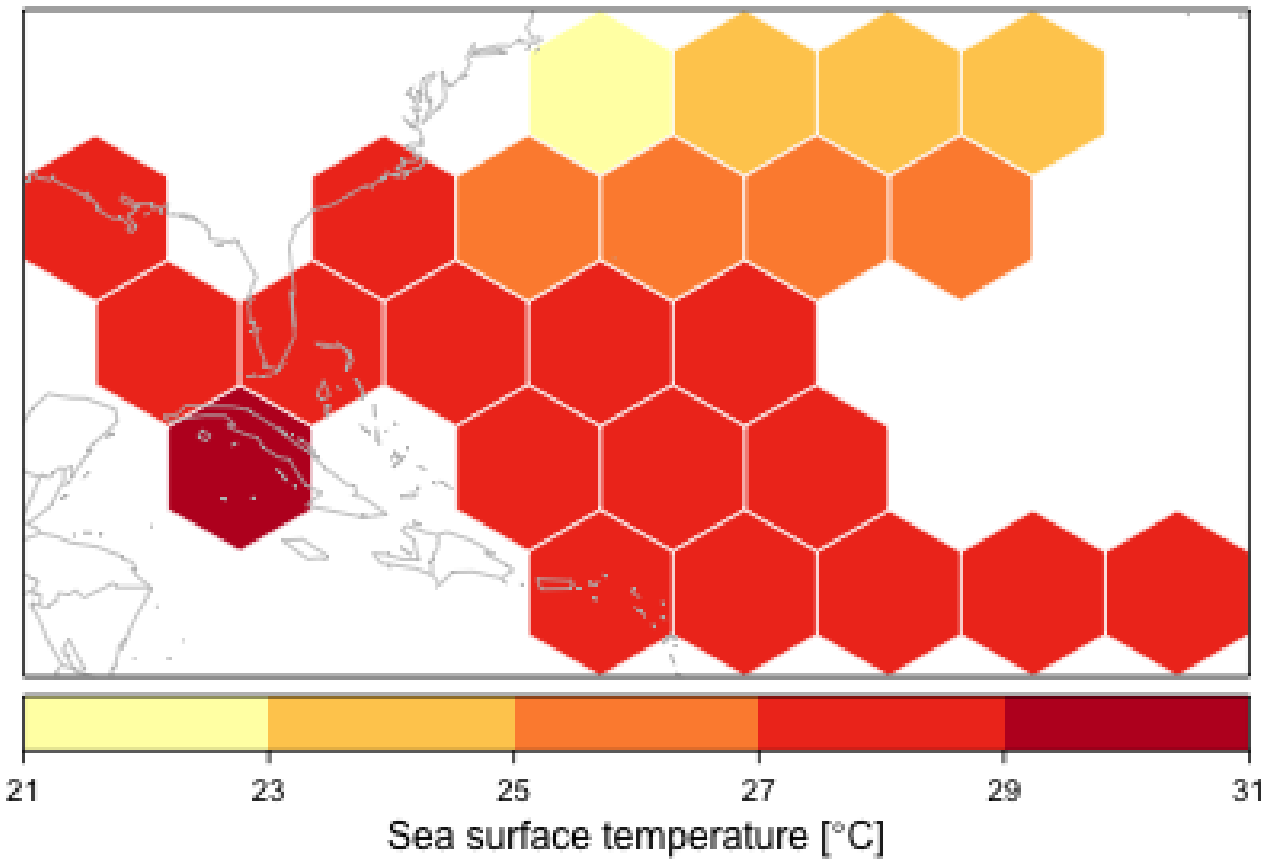
Statistical model for hexagon #37



$$\mathrm{LI} = u - \sigma/\xi \tag{5}$$

Per Hexagon Average SST



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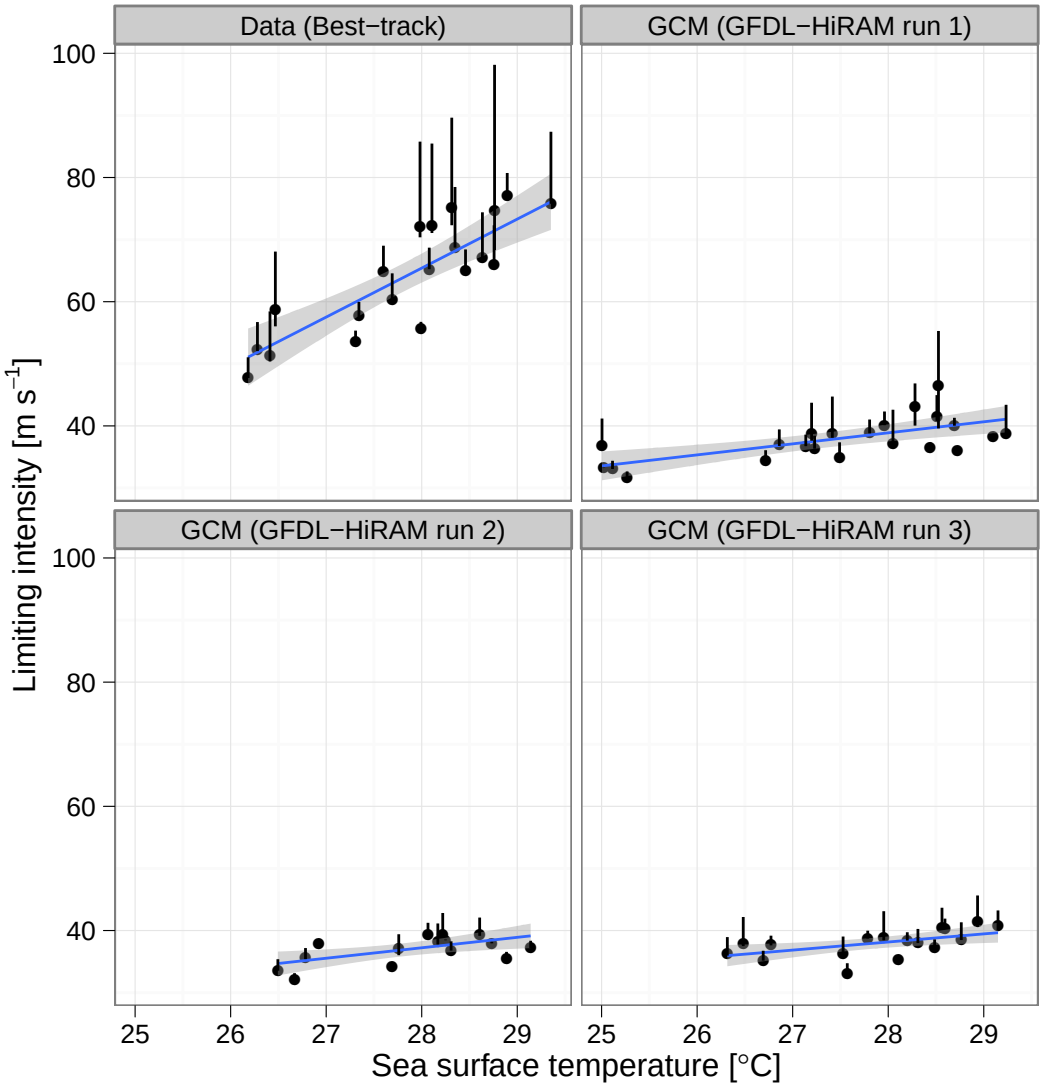

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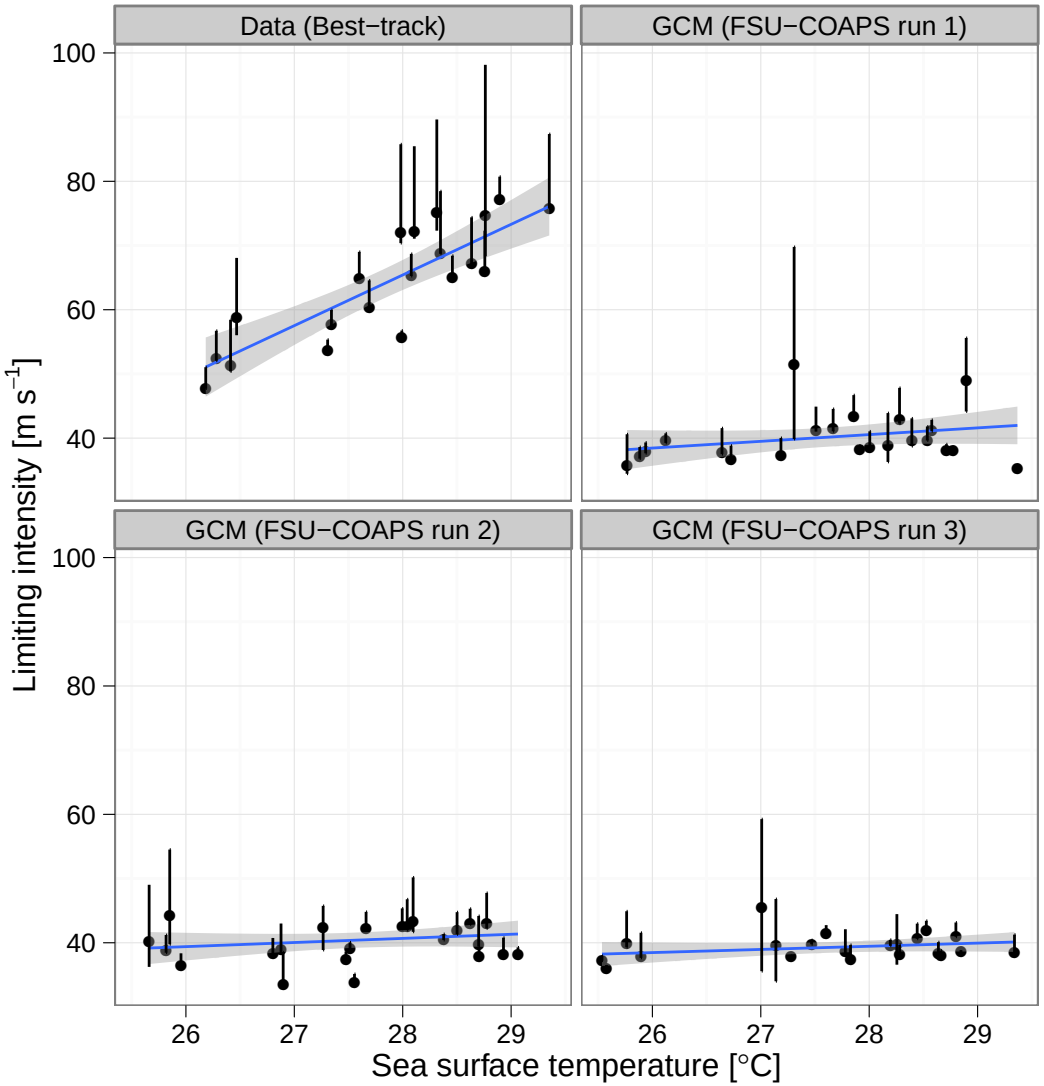

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Sensitivity Summary:

- Sensitivity of limiting intensity to SST
  - Observations: 7.9 ± 1.19 m s^{-1} K^{-1}
  - GFDL-HiRAM (unadjusted): 1.8 ± 0.42 m s^{-1} K^{-1}
  - GFDL-HiRAM (adjusted): 6.9 ± 3.33 m s^{-1} K^{-1}
  - FSU-COAPS: 2.9 ± 2.64 m s^{-1} K^{-1}
- Sensitivities from model-generated data are significantly lower than those from observations

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Future Work

- Add more models for a comprehensive intercomparison
- Examine relationships between sensitivity and climate (e.g., ENSO, relative SST)
- Explore the use of Bayesian models to examine regional and temporal relationships between LI and SST

Thank you

Questions