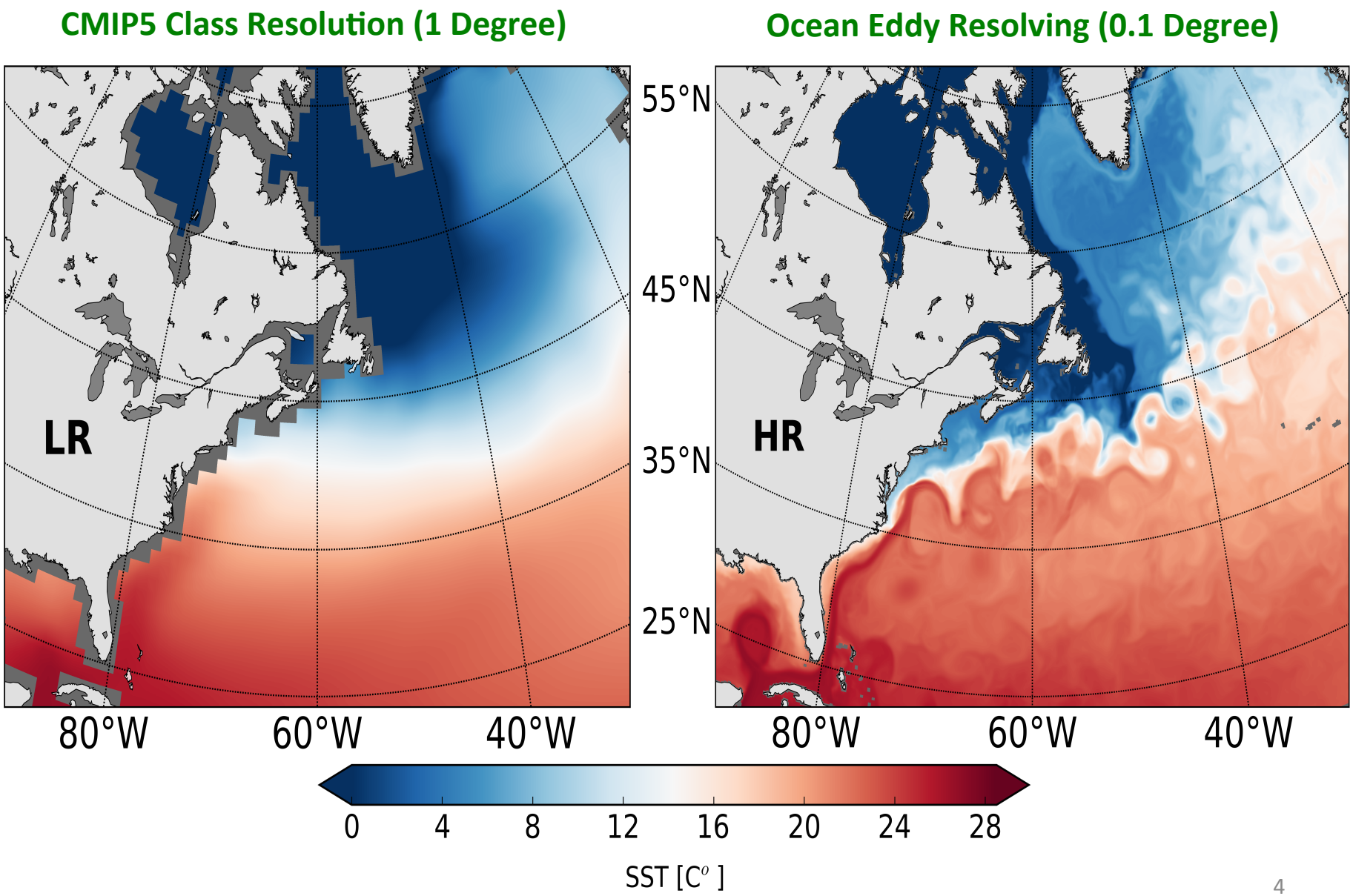
# The Role of Ocean Eddies Resolving Models in Seasonal to Decadal Prediction

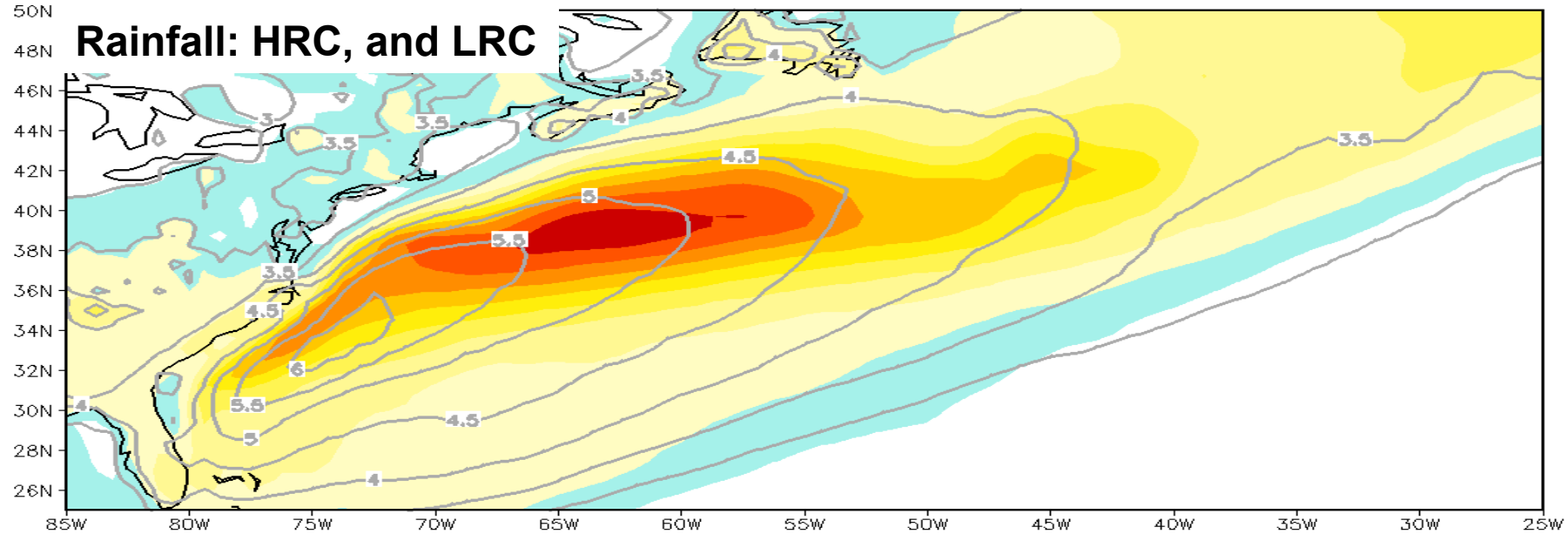
# Ocean Eddy Resolving Coupled Predictability

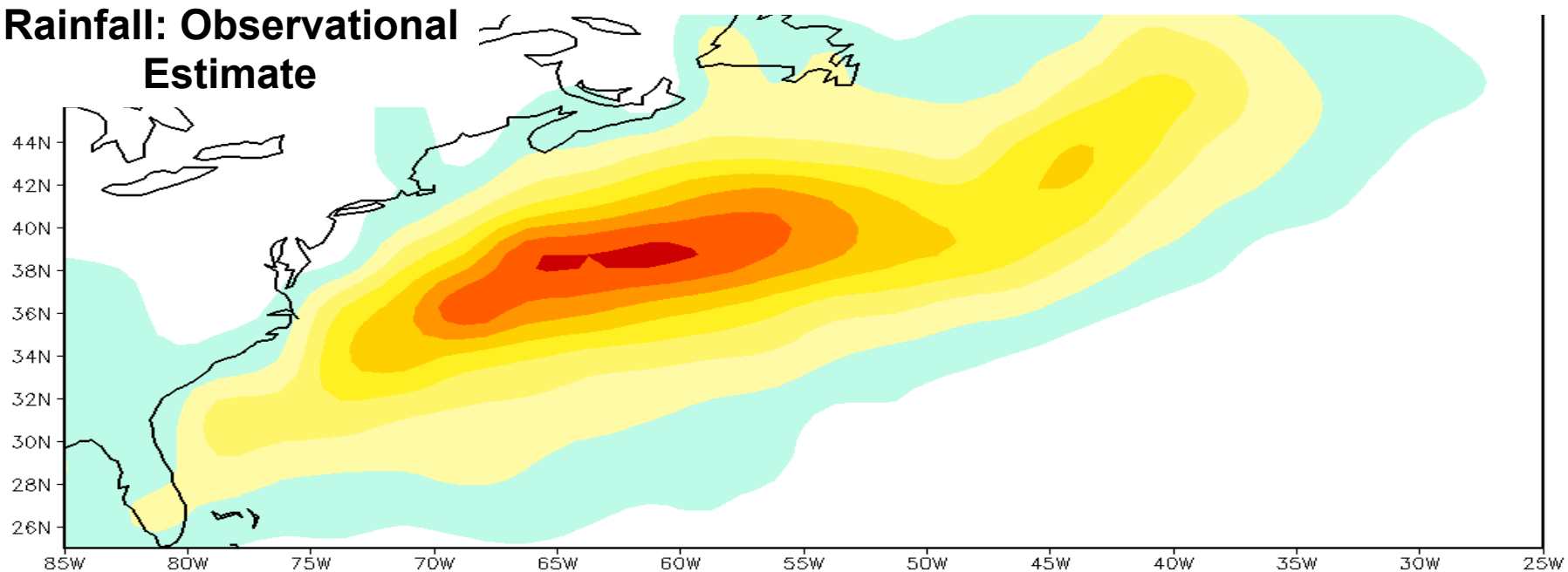
- **CESM**
  - **Atmosphere: 0.5x0.5**
  - **Ocean: 0.1x0.1 [HRC] vs. 1x1 [LRC]**
- **"New" Seasonal-to-Decadal Variability**
  - **Means, Fronts vs. Eddies (or Both)?**
- **Does the Atmosphere Interact with the Individual Ocean Eddies?**
- **Forecast Errors and DA Errors with LRC**
  - **Local Air-Sea Feedbacks**

# The Role of Ocean Eddies in Decadal Prediction (UMiami-NCAR EaSM-3 Collaboration)

- Comprehensive Assessment of How Ocean Eddies Affect Decadal Predictability
- Strategies for Initializing Ocean Eddy Resolving Prediction Systems
  - Does the DA need to use the same resolution?
- Test these Strategies in Experimental Decadal Prediction

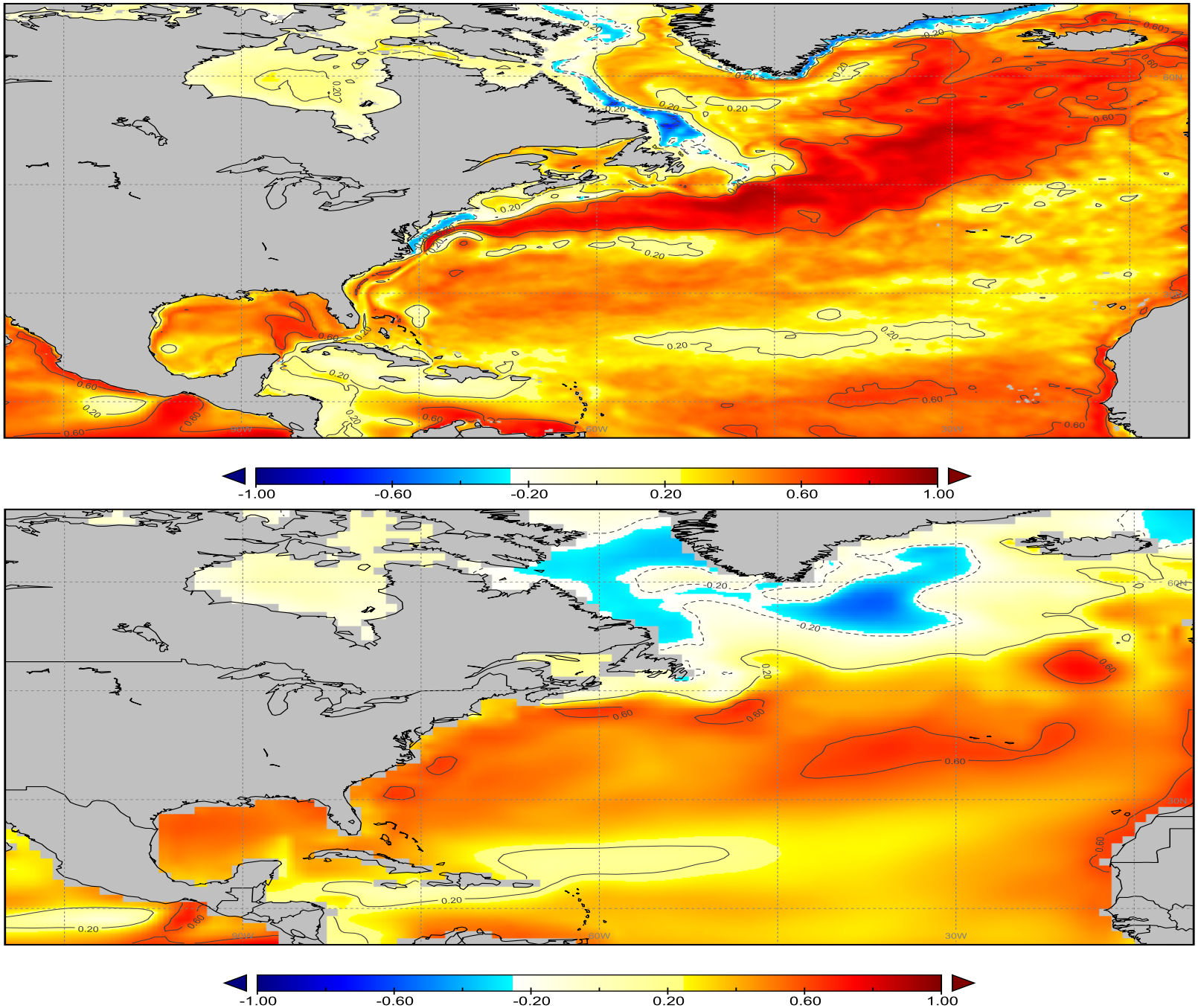

CMIP5 Class Resolution (1 Degree)
Ocean Eddy Resolving (0.1 Degree)
LR
HR
55°N
45°N
35°N
25°N
80°W
60°W
40°W
80°W
60°W
40°W
0
4
8
12
16
20
24
28
SST [C° ]

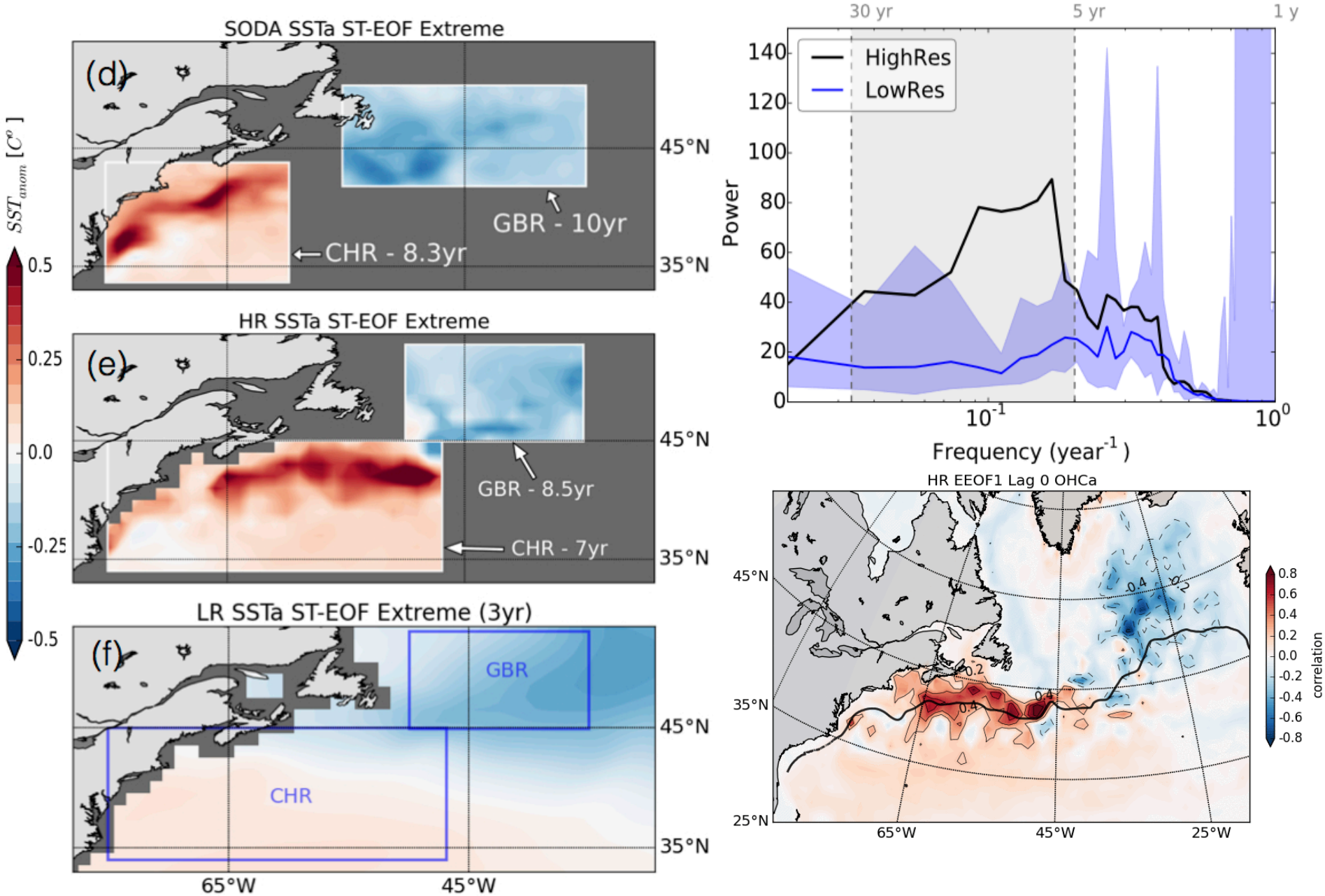

Rainfall: HRC, and LRC
50N
48N
46N
44N
42N
40N
38N
36N
34N
32N
30N
28N
26N
85W
80W
75W
70W
65W
60W
55W
50W
45W
40W
35W
30W
25W
3
3.5
4
4.5
5
5.5
6

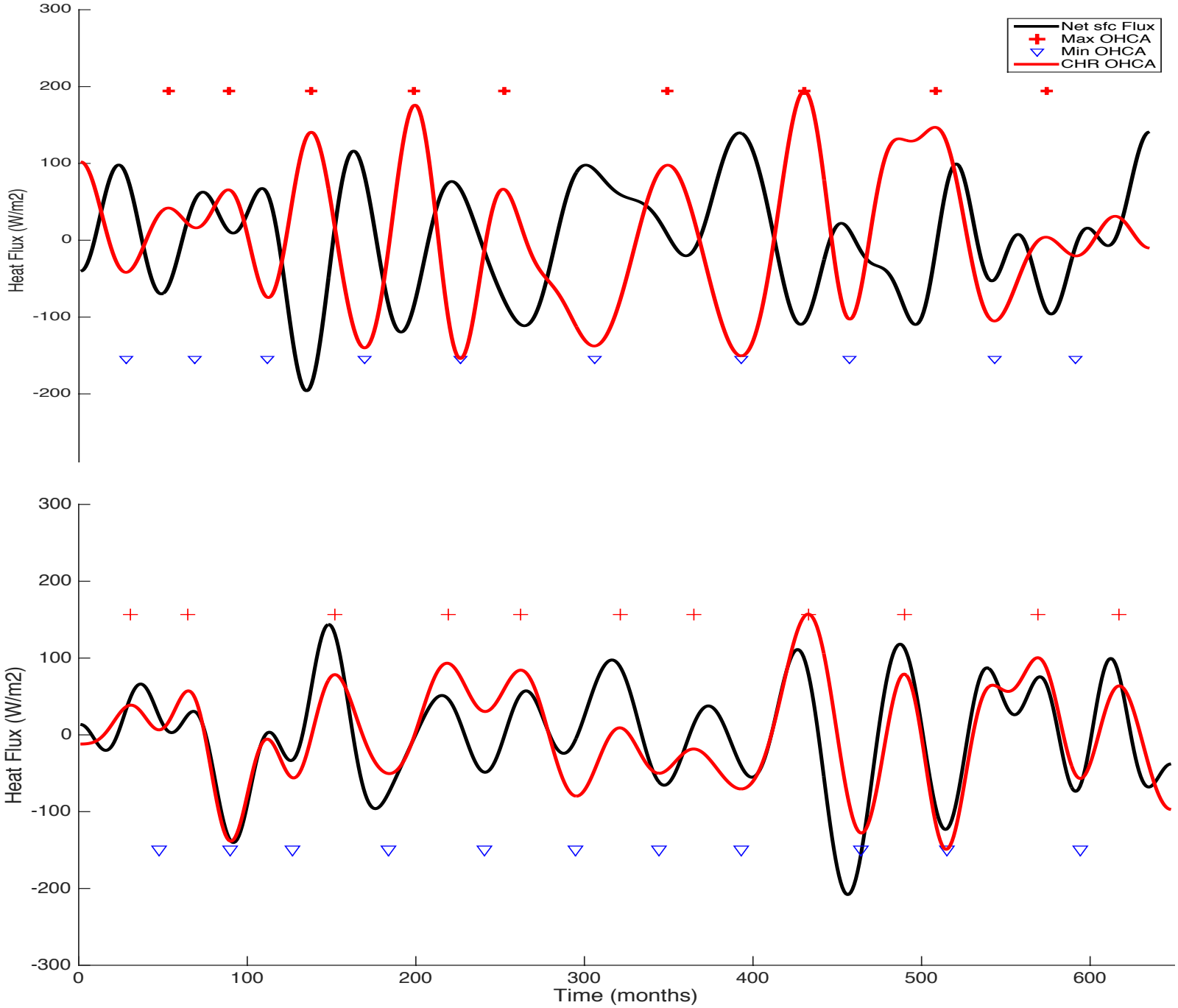

Rainfall: Observational Estimate
44N
42N
40N
38N
36N
34N
32N
30N
28N
26N
85W
80W
75W
70W
65W
60W
55W
50W
45W
40W
35W
30W
25W

3
3.5
4
4.5
5
5.5
6
6.5

# SST-SSH Local Correlation: HRC

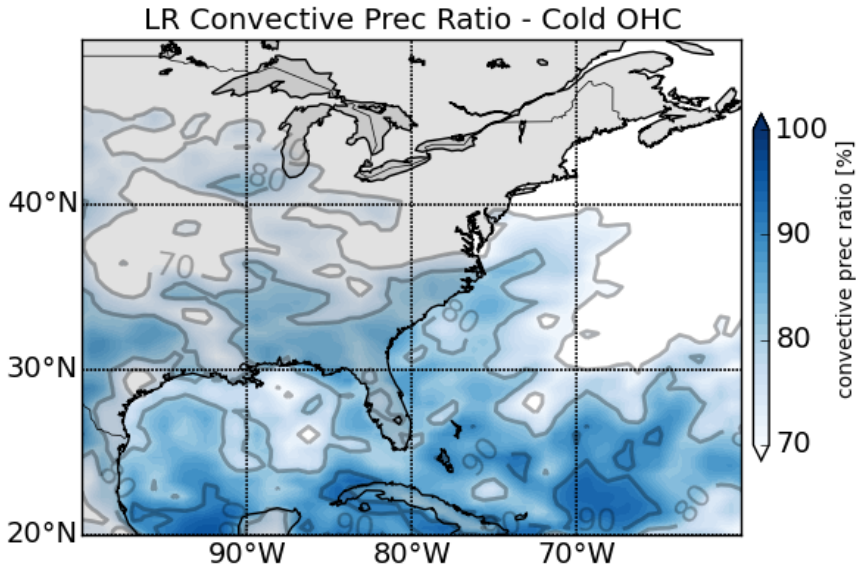


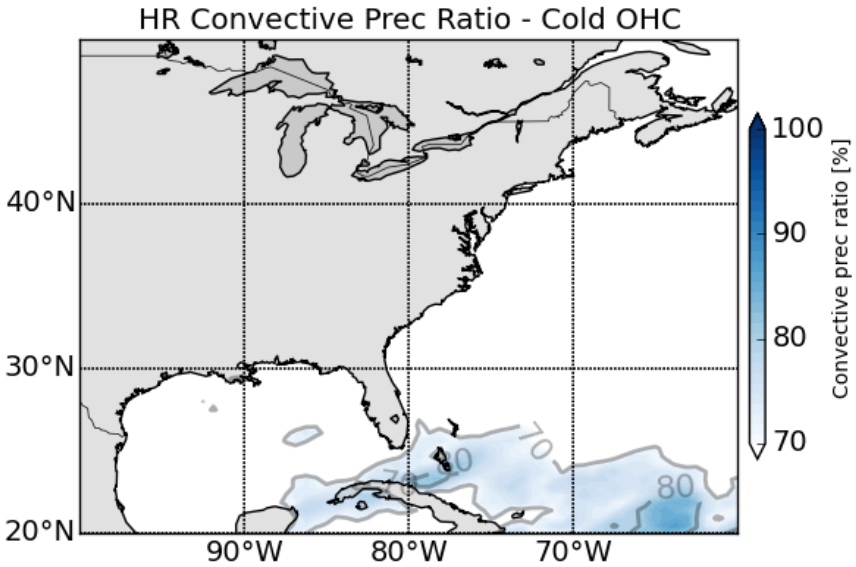

SODA SSTa ST-EOF Extreme
(d)
GBR - 10yr
CHR - 8.3yr
HR SSTa ST-EOF Extreme
(e)
GBR - 8.5yr
CHR - 7yr
LR SSTa ST-EOF Extreme (3yr)
(f)
GBR
CHR
45°N
35°N
65°W
45°W
$SST_{anom}$ [$C^o$]
0.5
0.25
0.0
-0.25
-0.5
30 yr
5 yr
1 y
HighRes
LowRes
Power
Frequency (year$^{-1}$)
HR EEOF1 Lag 0 OHCa
25°N
correlation

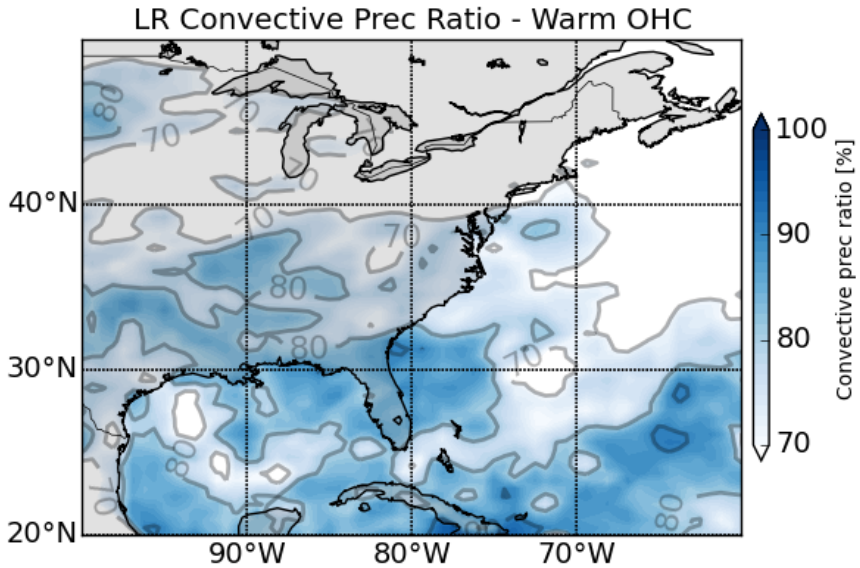

Net sfc Flux
Max OHCA
Min OHCA
CHR OHCA
Heat Flux (W/m2)
300
200
100
0
-100
-200
Heat Flux (W/m2)
300
200
100
0
-100
-200
-300
0
100
200
300
400
500
600
Time (months)

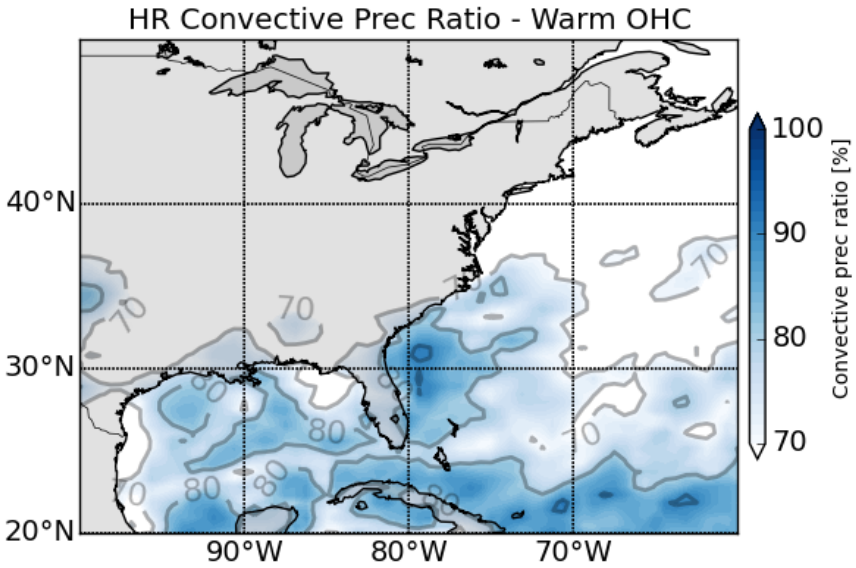
LR

HR

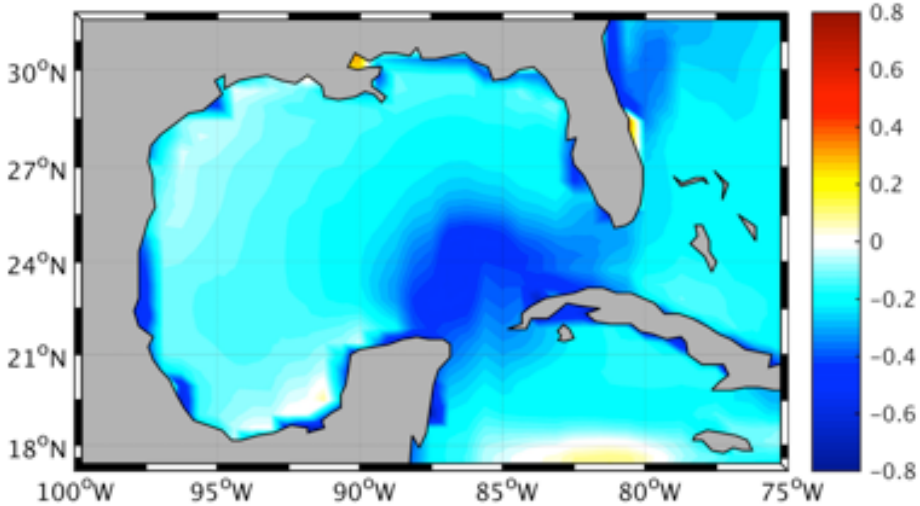

LR Convective Prec Ratio - Cold OHC
40°N
30°N
20°N
90°W
80°W
70°W
100
90
80
70
convective prec ratio [%]


HR Convective Prec Ratio - Cold OHC
40°N
30°N
20°N
90°W
80°W
70°W
100
90
80
70
Convective prec ratio [%]

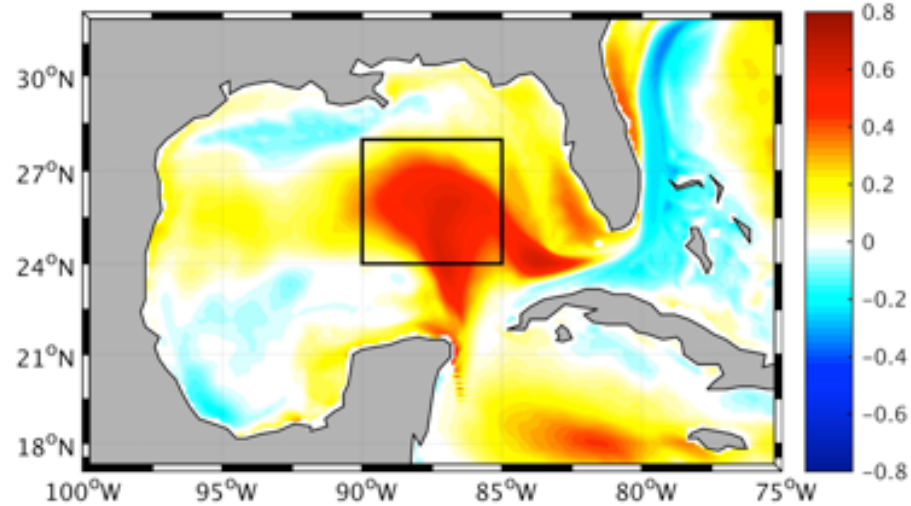

LR Convective Prec Ratio - Warm OHC
40°N
30°N
20°N
90°W
80°W
70°W
100
90
80
70
Convective prec ratio [%]


HR Convective Prec Ratio - Warm OHC
40°N
30°N
20°N
90°W
80°W
70°W
100
90
80
70
Convective prec ratio [%]

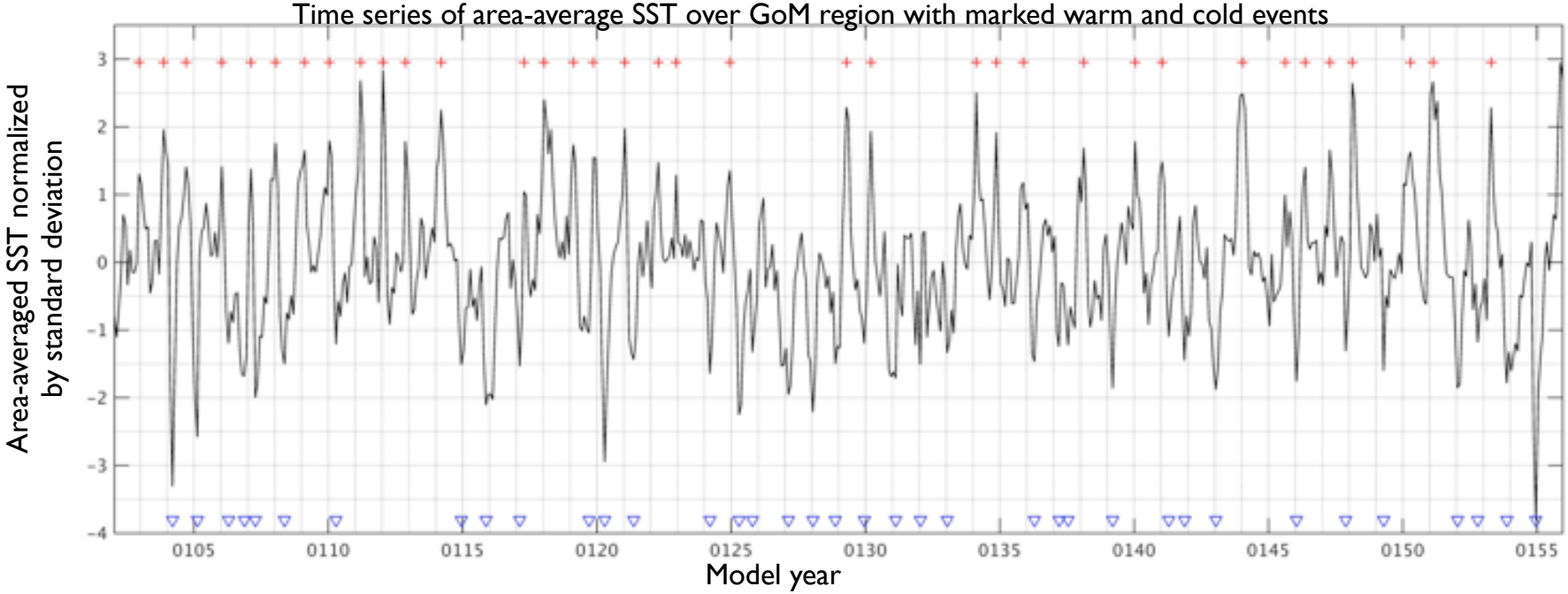
Correlation of LHF and SST for LRC

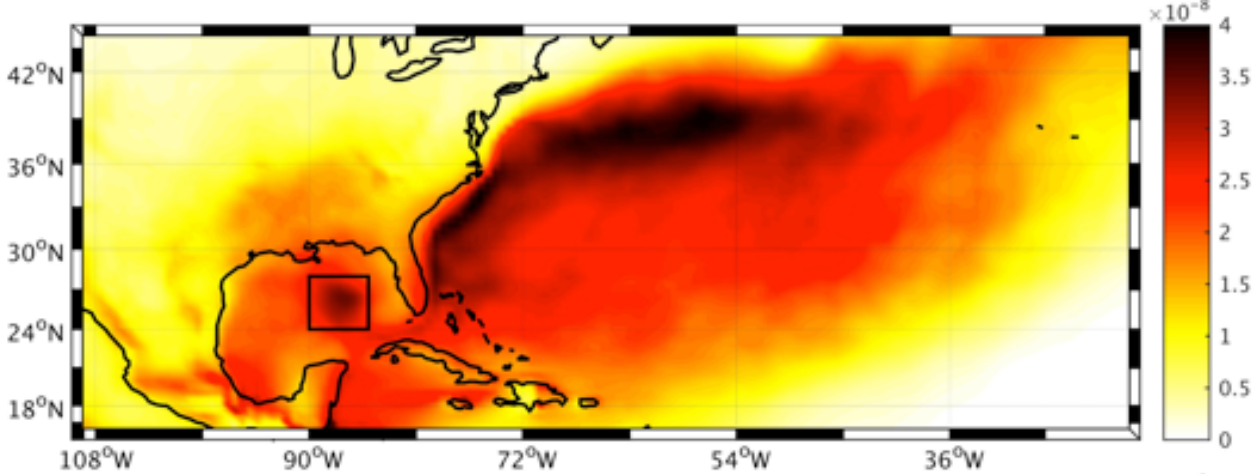



Correlation of LHF and SST for HRC

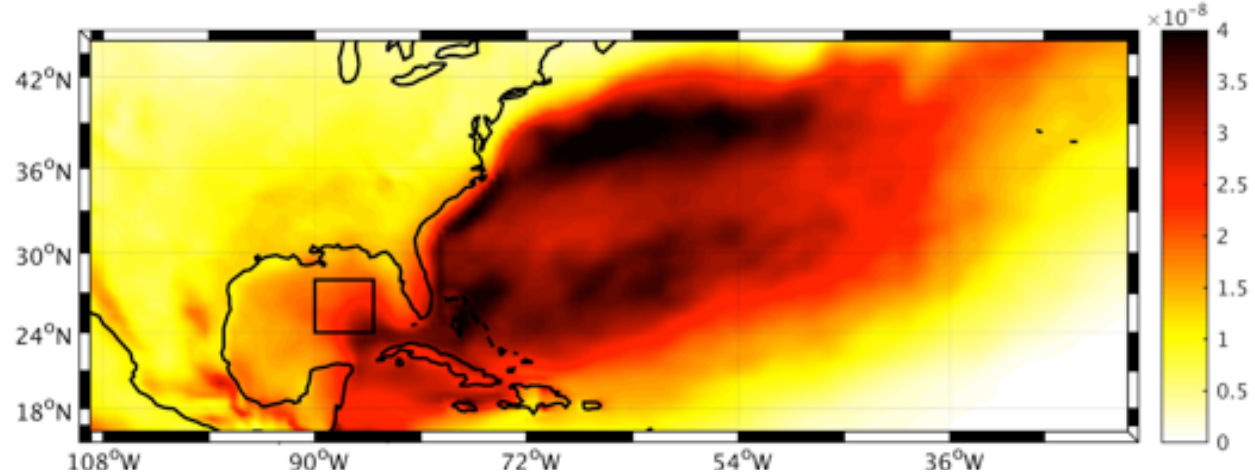



Time series of area-average SST over GoM region with marked warm and cold events

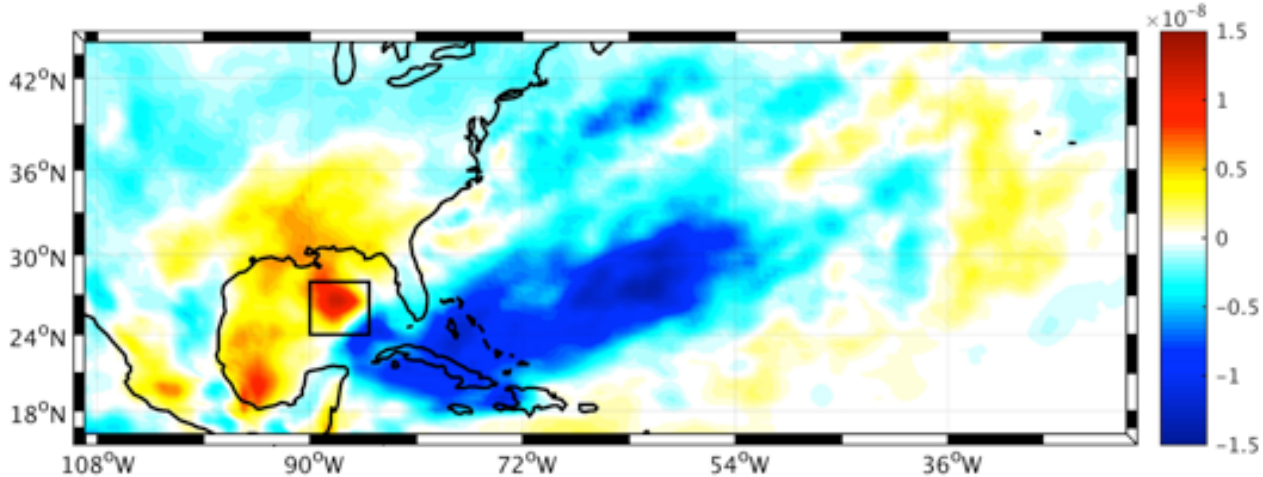





Full precipitation composite based on warm SST events over GoM (m/s)

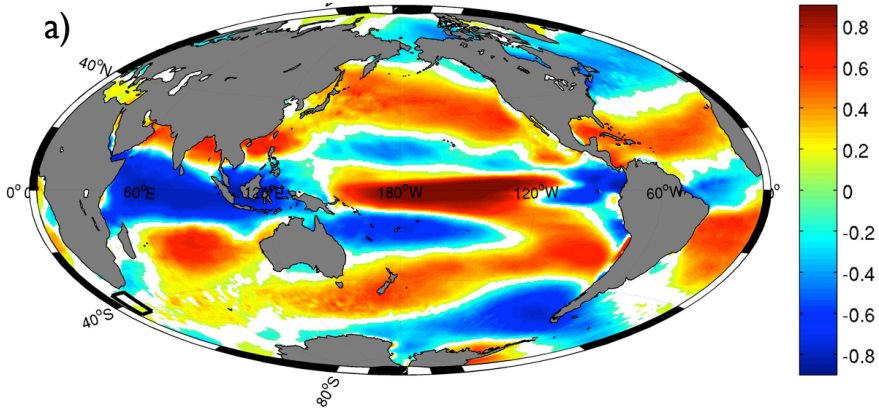



Full precipitation composite based on cold SST events over GoM (m/s)

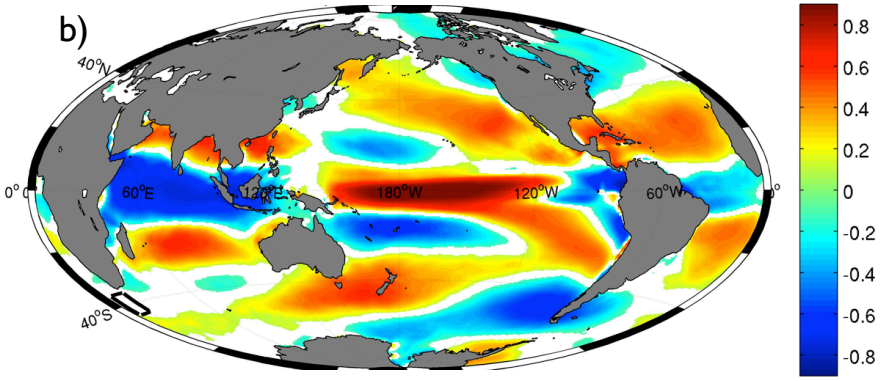



Full precipitation composite based on warm-cold SST events over GoM (m/s)

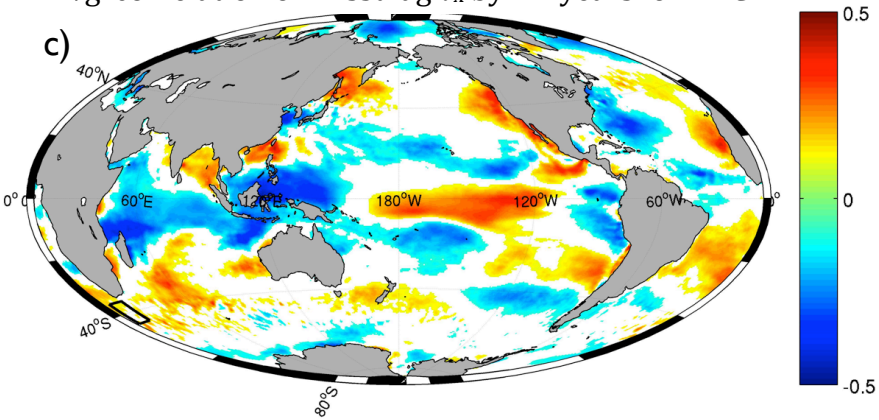
Contemporaneous correlation of Nino3.4 with $\tau_x$ for HRC



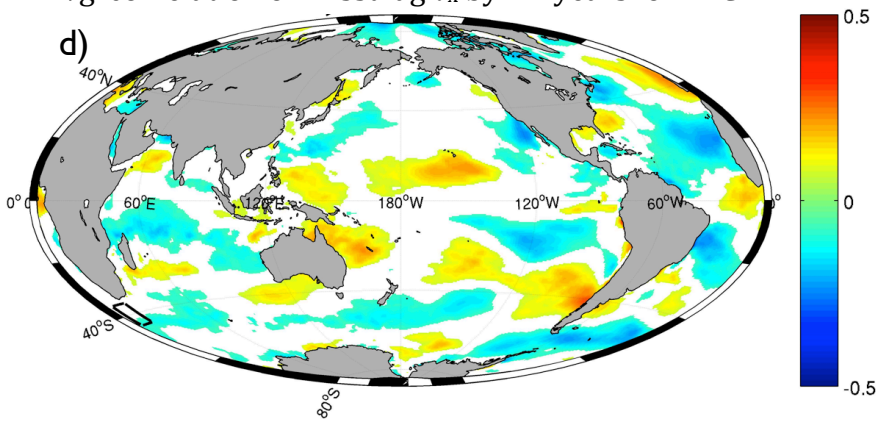

Contemporaneous correlation of Nino3.4 with $\tau_x$ for LRC



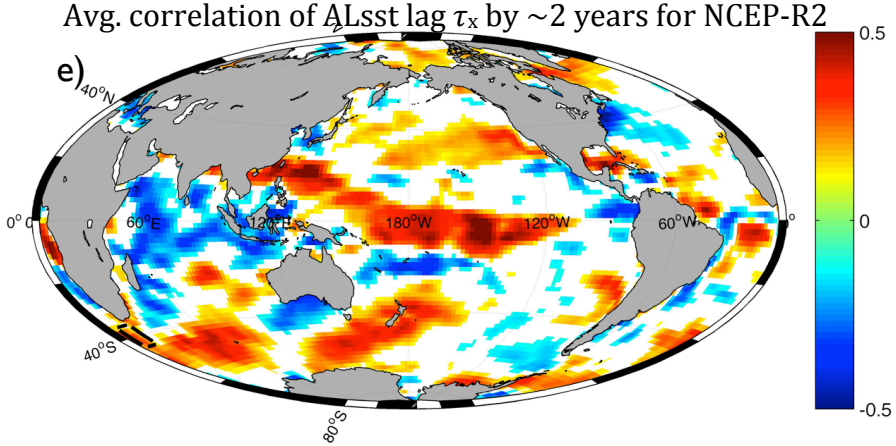

Avg. correlation of ALsst lag $\tau_x$ by ~2 years for HRC




Avg. correlation of ALsst lag $\tau_x$ by ~2 years for LRC




Avg. correlation of ALsst lag $\tau_x$ by ~2 years for NCEP-R2



# Ocean Eddy Resolving Coupled Predictability

- CESM
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  - Ocean: 0.1x0.1 [HRC] vs. 1x1 [LRC]
- "New" Seasonal-to-Decadal Variability
  - Means, Fronts vs. Eddies (or Both)?
- Does the Atmosphere Interact with the Individual Ocean Eddies?
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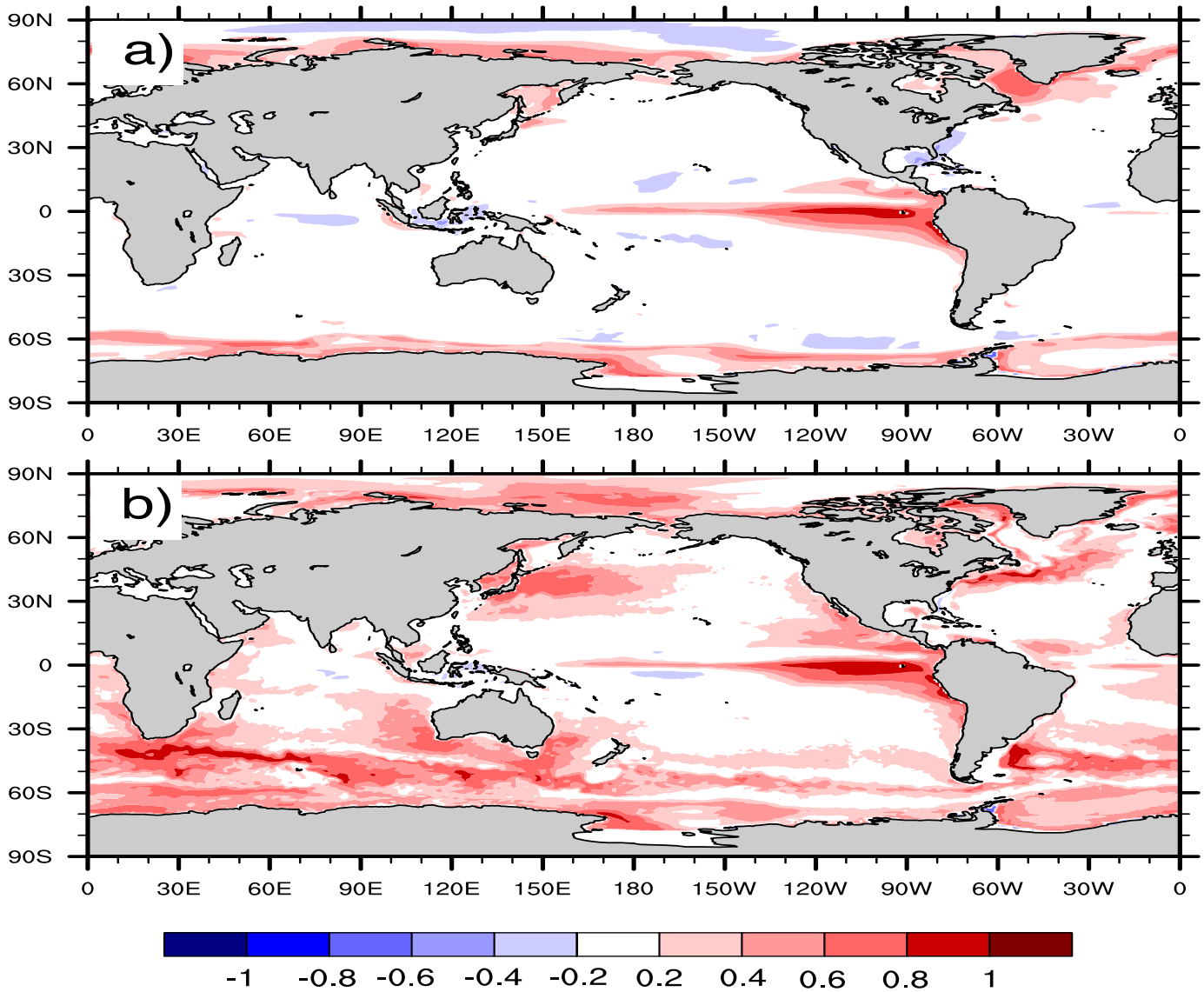
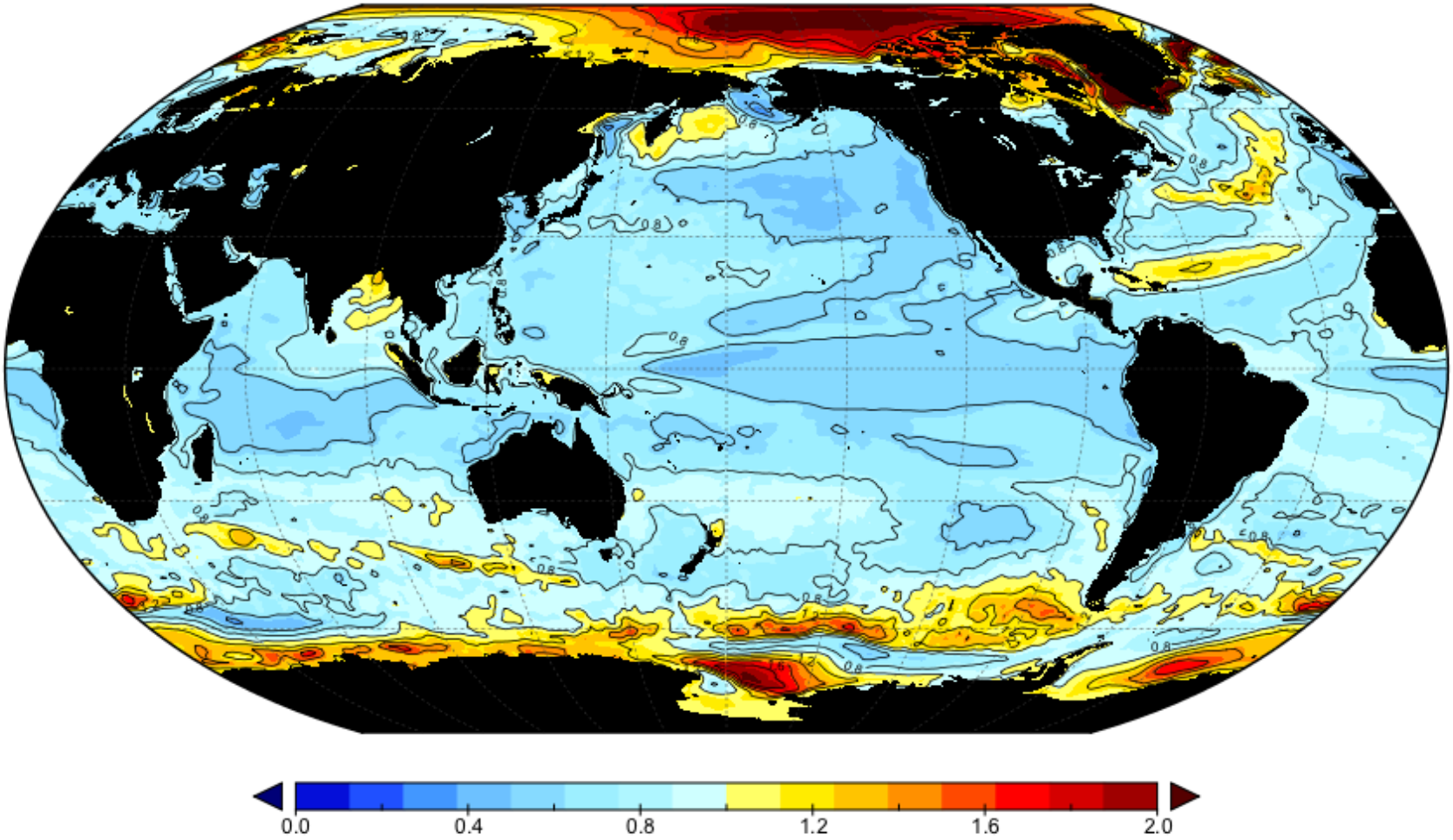
# Local SSTA- Turbulent Heat Flux Correlation



# SST Standard Deviation Ratios



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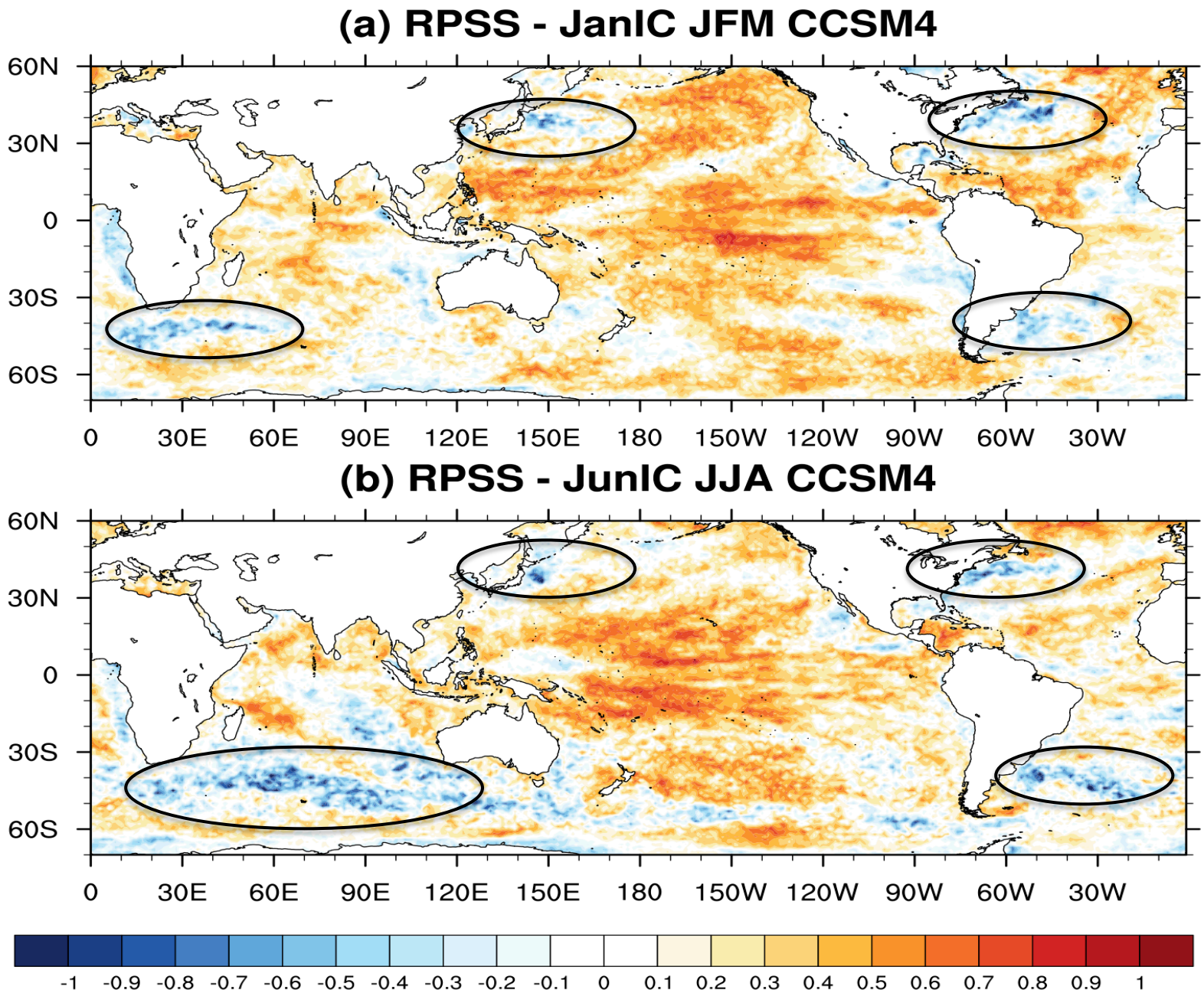
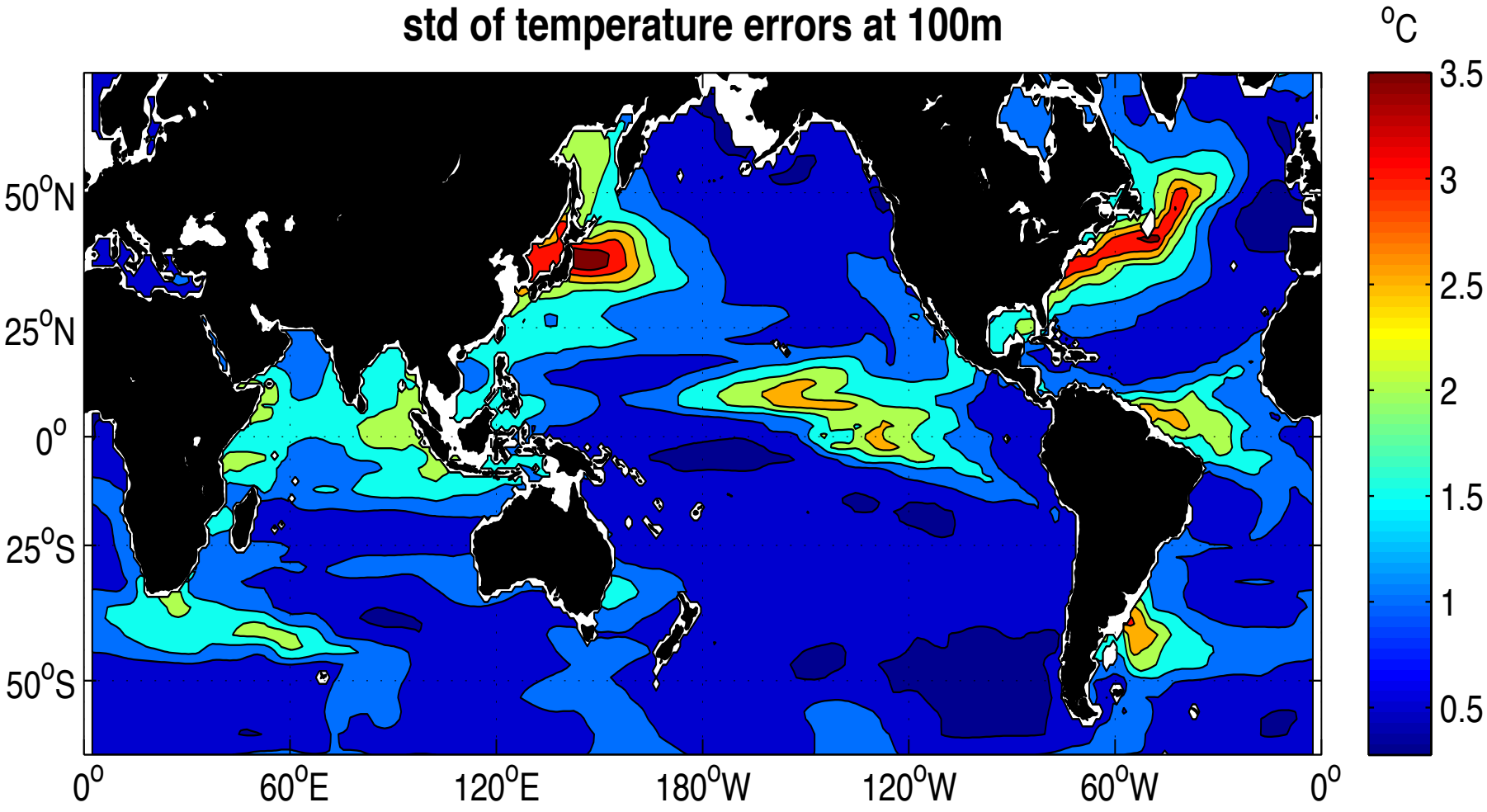
# Seasonal Forecast Errors



# DART LRC Representativeness Errors



# Discussion

- Evidence for the Need for Eddy Resolving Resolutions
  - Means, Fronts vs. Eddies?
- Develop Strategies for Initializing Ocean Eddy Resolving Prediction Systems
  - Technology/Software Infrastructure Development
  - Do we need to assimilate the eddy field?
  - Does the DA need to use the same resolution?
- Test these Strategies in Experimental Decadal Prediction