On Ameliorating the bias over the Intra-Americas Seas

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Dr. Haiqin Li, ESRL/NOAA

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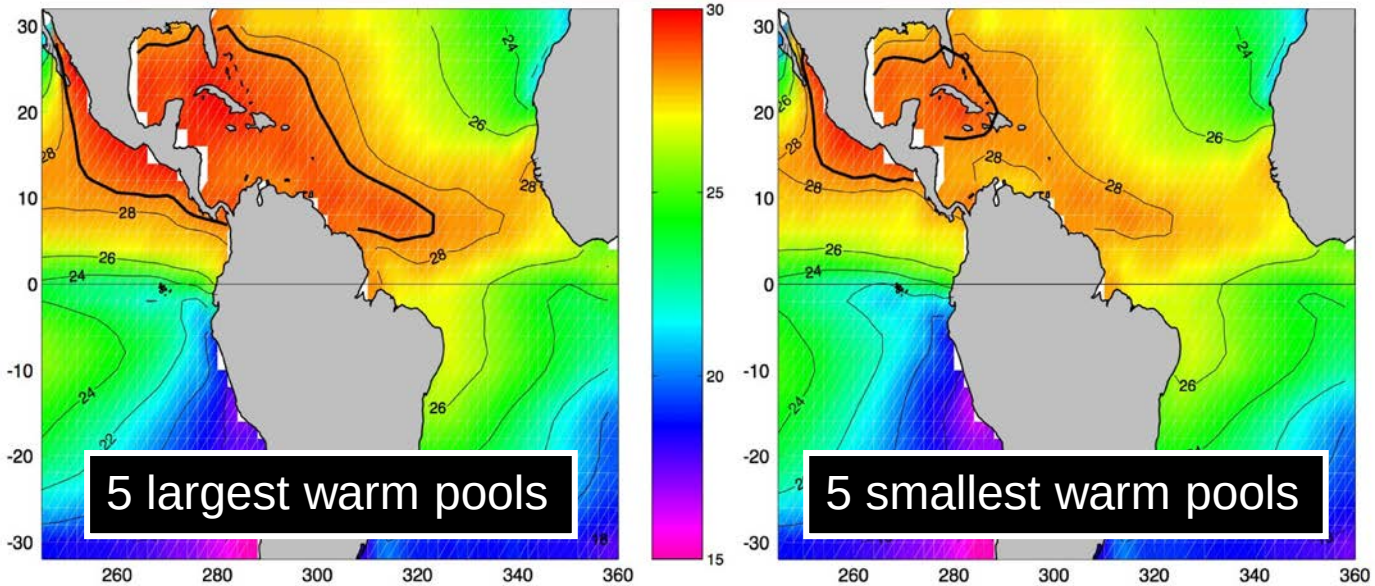
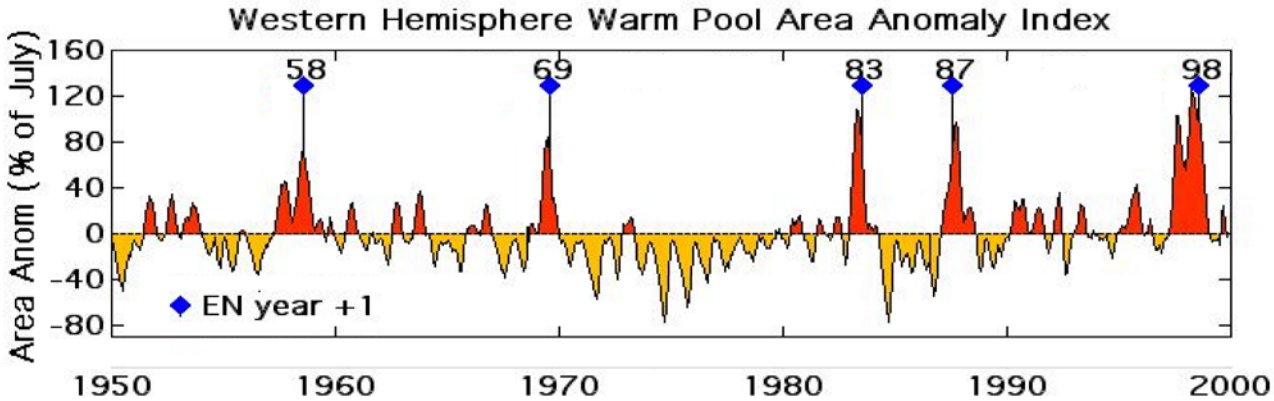
Florida Climate Institute AT FLORIDA STATE UNIVERSITY

Southeast Climate Consortium

IAS centerpiece: Atlantic Warm Pool (AWP)



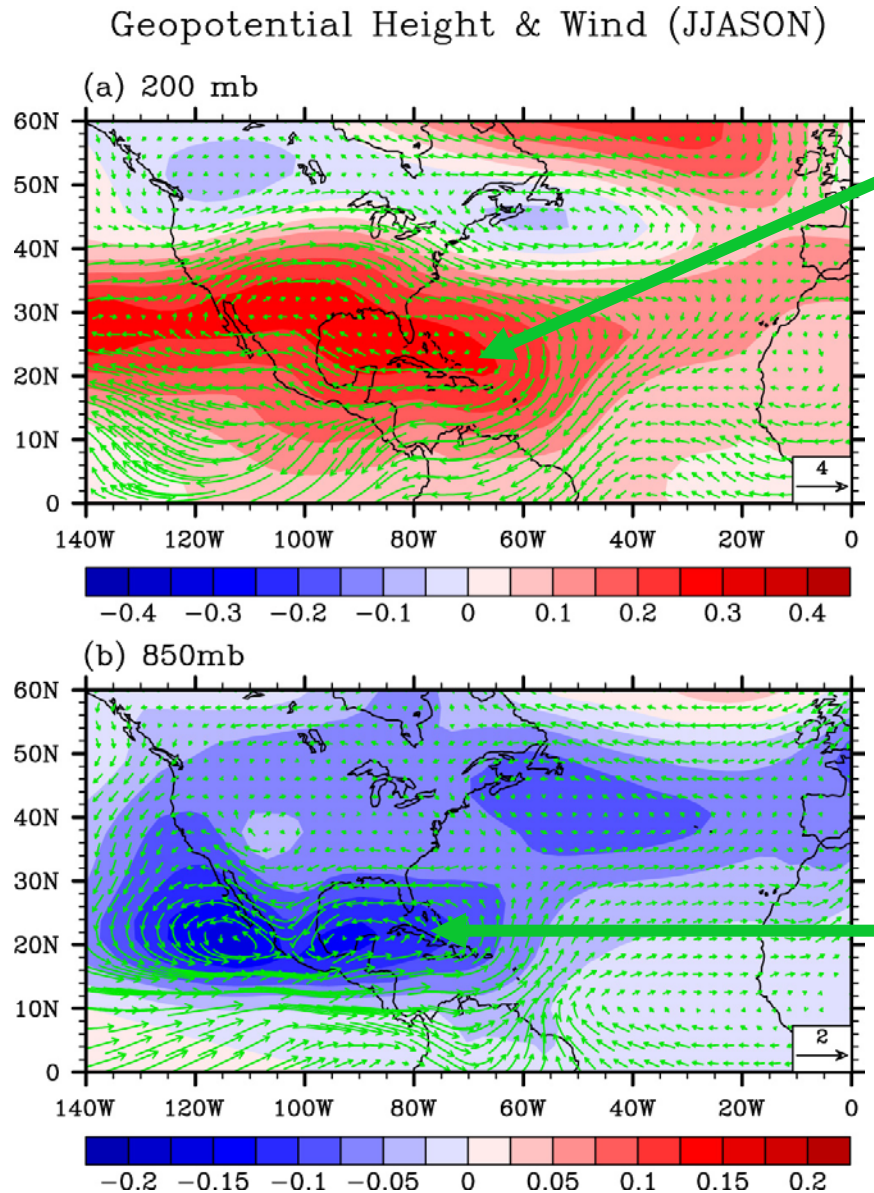


Courtesy D. Enfield, RSMAS/NOAA

Gill atmosphere response to Warm Pool anomalies

Forced AGCM

Large minus Small AWP

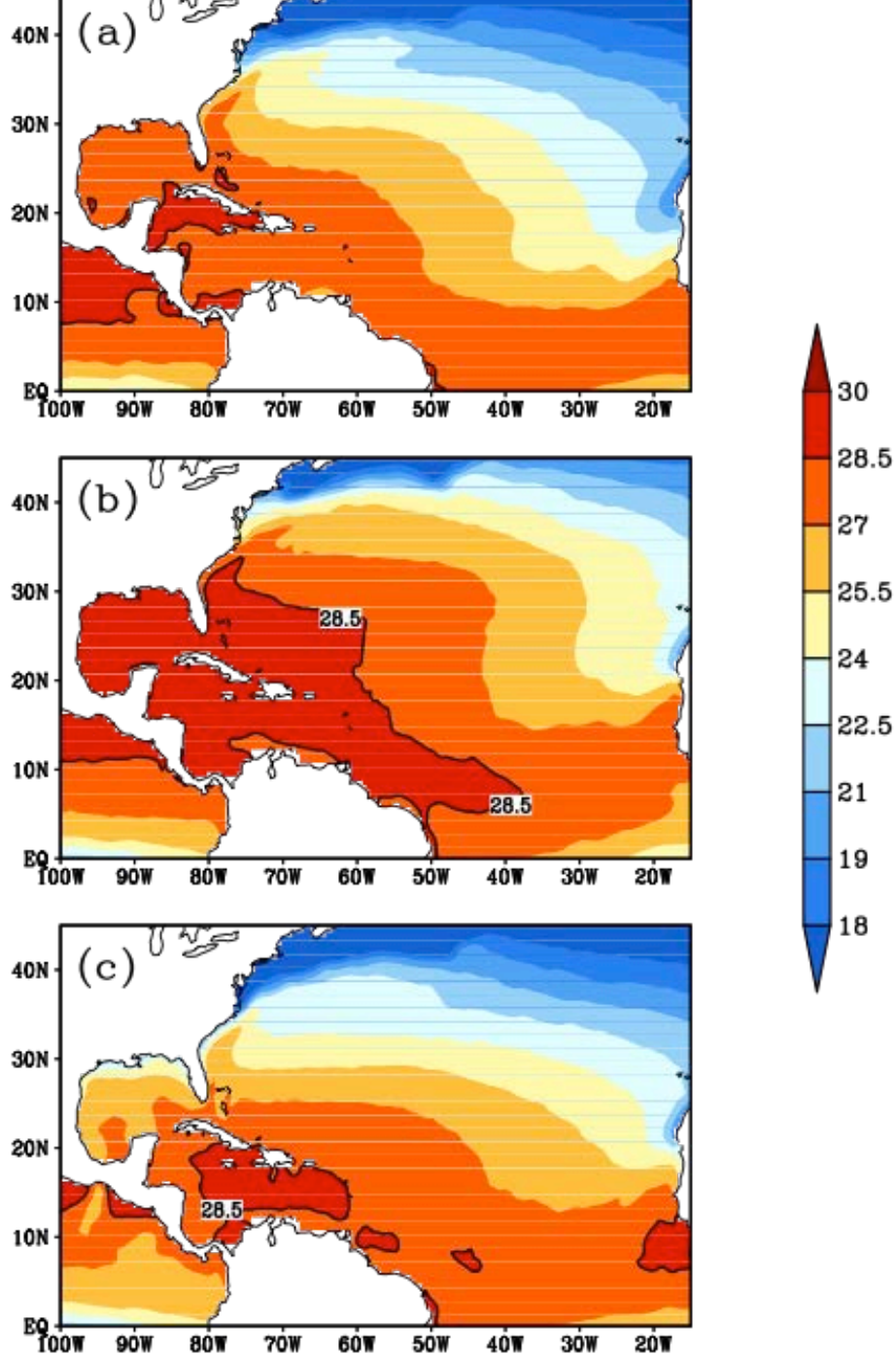


200 mb anticyclone

This is the textbook baroclinic response of a "Gill atmosphere" to an off-equatorial heating anomaly

850 mb cyclone

Courtesy: Sang-Ki Lee-RSMAS/NOAA-AOML

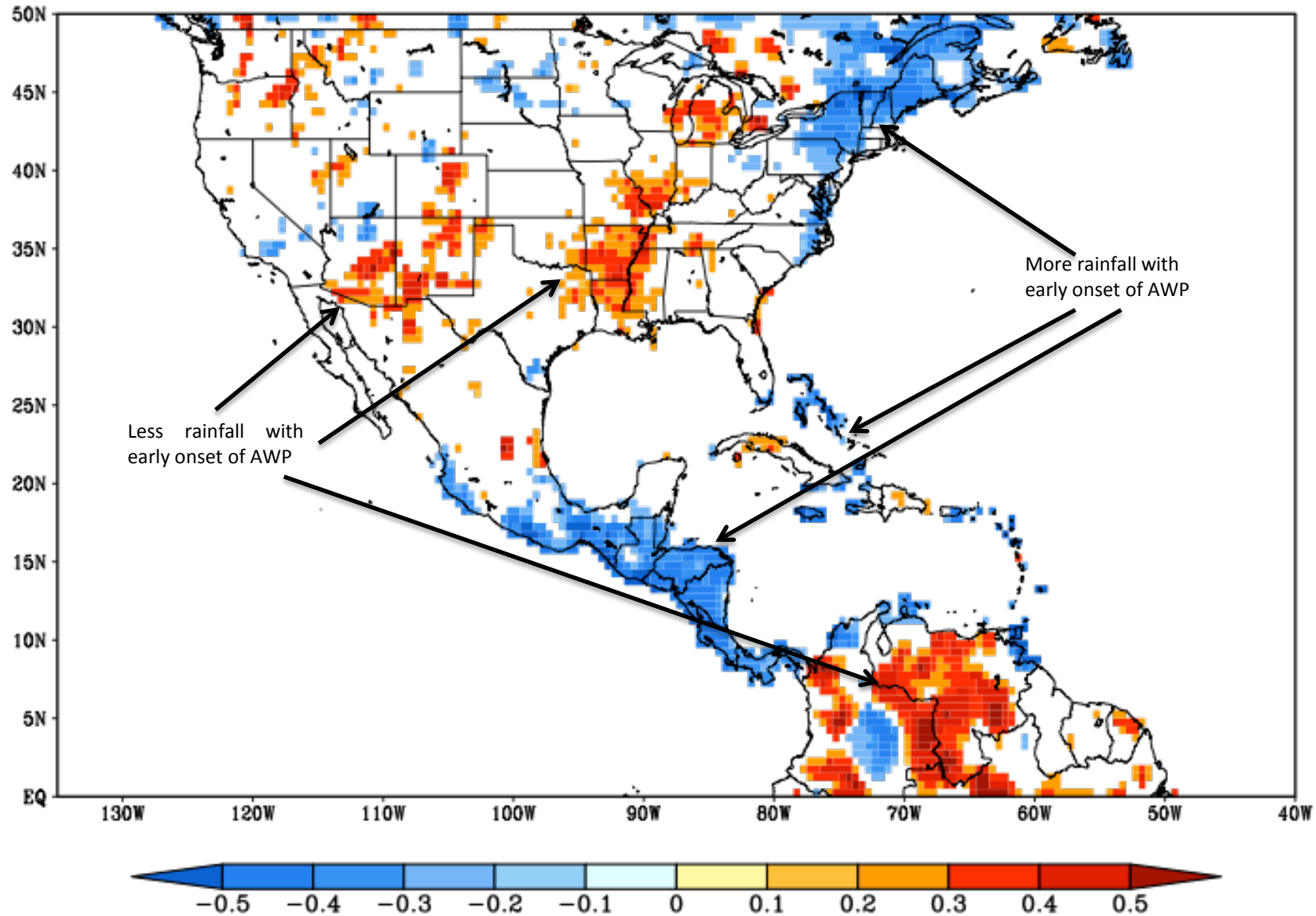


The climatological mean SST ( ) at a) time of onset, b) peak, and c) time of demise of AWP season. The corresponding 28.5 isotherm is contoured in each of the panels.

Climatological onset date	June 21
Climatological peak date	September 3
Climatological demise date	November 5

Table 1: Correlations of the AWP onset date with other AWP variants. Those that pass the significance test at 10% significance level are in bold.

	Onset date (y_1)	Demise date (y_3)	Length of AWP season (L)	Seasonal areal average of AWP
Onset	**1**	**-0.58**	**-0.89**	**-0.71**
Demise	**-0.58**	**1**	**0.88**	**0.82**
Length	**-0.89**	**0.88**	**1**	**0.86**



The correlation of variability of onset date of AWP with the **August-September-October** seasonal mean rainfall anomaly over North America over land. Only significant values at 90% confidence interval are shaded.

CMIP3:
The Jul-Aug-Sep climatological mean SST

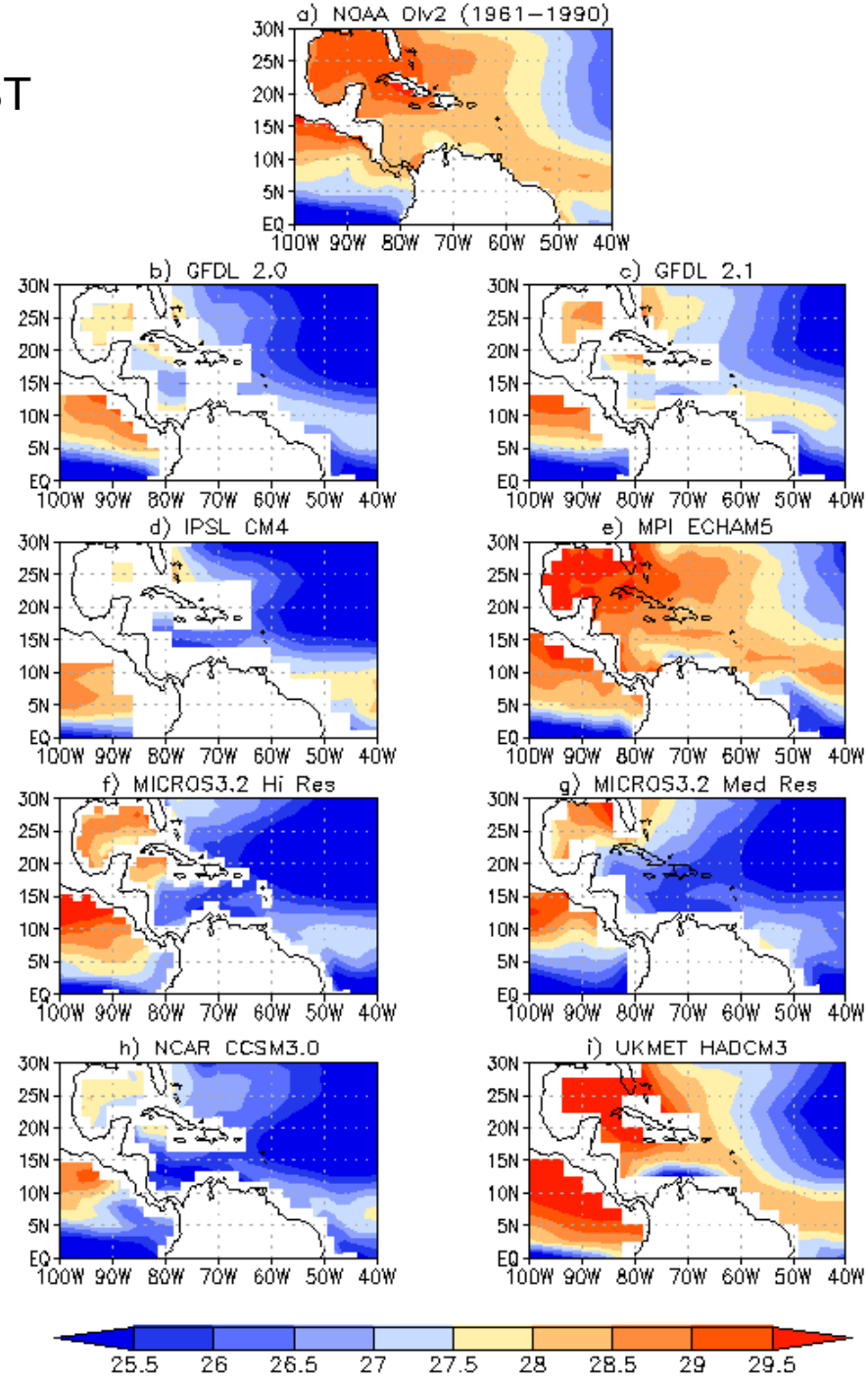


Table 4 Average monthly AWP areas (in 10^6 km^2) from 1909 to 2005 based on various CMIP5 models and ERSSTv3 observations

Seasonal Cycle of AWP Area

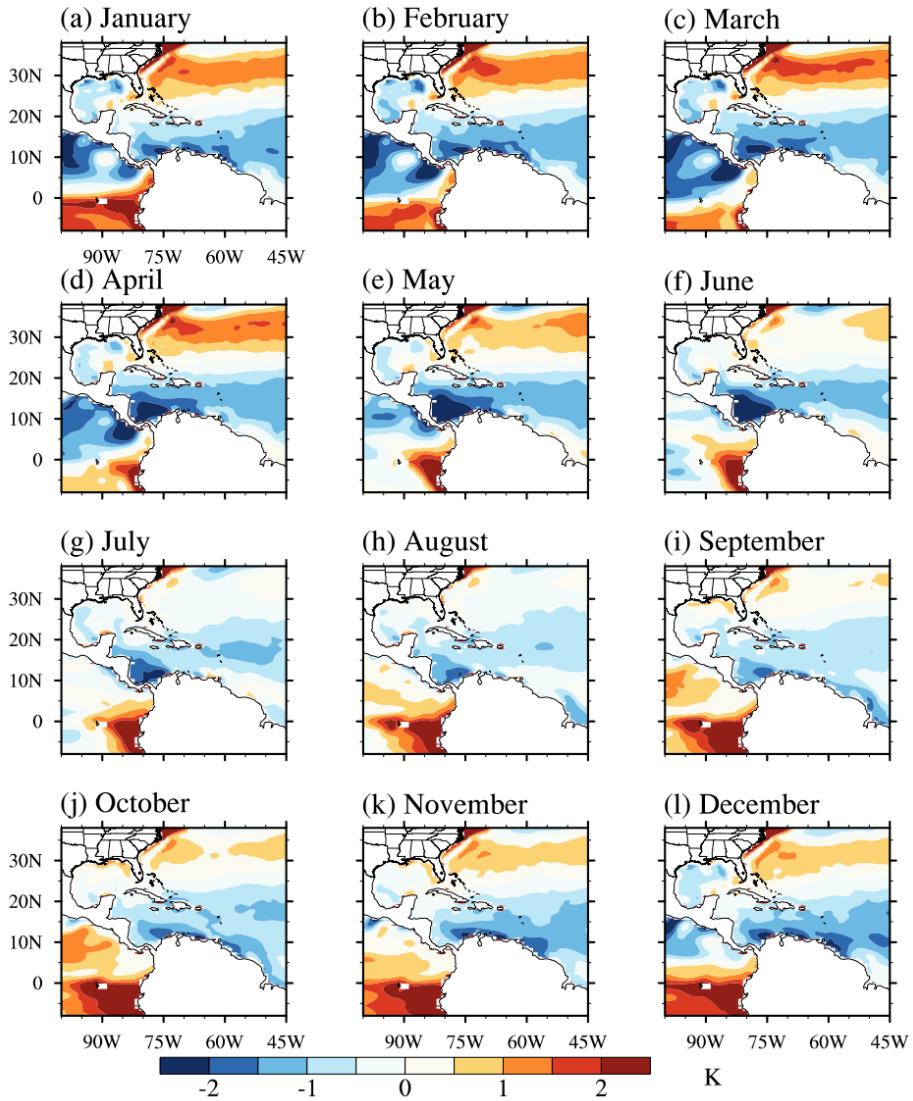
Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ERSST v3	0.0010	0.0015	0.0020	0.0091	0.0486	0.3983	2.4866	3.7066	3.9859	1.6280	0.0706	0.0010
BCC-CSM1-1	0.0000	0.0000	0.0000	0.0003	0.0006	0.0141	0.2934	0.6754	0.3805	0.0181	0.0000	0.0000
CanESM2	0.0000	0.0000	0.0028	0.0085	0.0025	0.0265	0.2942	0.8290	0.7793	0.1535	0.0128	0.0000
CCSM4	0.0000	0.0002	0.0024	0.0167	0.0204	0.0402	0.5120	1.3070	1.1203	0.1214	0.0019	0.0000
CNRM-CM5	0.0004	0.0010	0.0031	0.0082	0.0227	0.0724	0.2707	0.7918	0.8510	0.2817	0.0250	0.0056
CSIRO-Mk3.6	0.0000	0.0000	0.0000	0.0000	0.0437	0.4341	2.0641	2.9905	3.0941	1.4189	0.2617	0.0000
GFDL-CM3	0.0001	0.0000	0.0004	0.0020	0.0025	0.0559	0.5422	1.1756	0.7579	0.1113	0.0033	0.0002
GFDL-ESM2G	0.0000	0.0000	0.0001	0.0009	0.0002	0.0084	0.1824	0.8142	0.8066	0.2210	0.0110	0.0001
GFDL-ESM2M	0.0000	0.0001	0.0003	0.0017	0.0049	0.0135	0.1406	0.6971	0.6439	0.2587	0.0203	0.0003
GISS-E2-H	0.0013	0.0038	0.0172	0.0917	0.1877	0.2572	0.3098	0.7030	1.0184	0.9023	0.2383	0.0089
GISS-E2-R	0.0031	0.0031	0.0176	0.1640	0.4012	0.6770	1.7286	3.5522	3.8256	2.8540	1.0380	0.0894
HadGEM2-ES	0.0516	0.0439	0.0586	0.1021	0.2070	0.3251	0.5714	1.3660	1.4805	0.5714	0.2056	0.0954
INM-CM4	0.0061	0.0008	0.0001	0.0053	0.0192	0.0030	0.0059	0.0581	0.0212	0.0001	0.0025	0.0098
IPSL-CM5A-LR	0.0000	0.0000	0.0000	0.0001	0.0029	0.0250	0.0715	0.2065	0.0725	0.0063	0.0000	0.0000
MIROC5	0.0000	0.0000	0.0004	0.0229	0.0435	0.0929	0.1080	0.2307	0.2562	0.1224	0.0200	0.0012
MPI-ESM-LR	0.0000	0.0000	0.0000	0.0009	0.0020	0.0752	0.7075	2.0492	2.4500	1.0084	0.1371	0.0107
MRI-CGCM3	0.0000	0.0000	0.0000	0.0000	0.0024	0.0230	0.1204	0.3863	0.3844	0.1760	0.0050	0.0000
NorESM1-M	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0032	0.0261	0.0209	0.0000	0.0000	0.0000

0.00	0.05	0.10	0.15	0.20	0.30	0.40	0.60	0.80	1.00	1.25	1.50	1.75	2.00	2.50	3.00	3.50	4.00

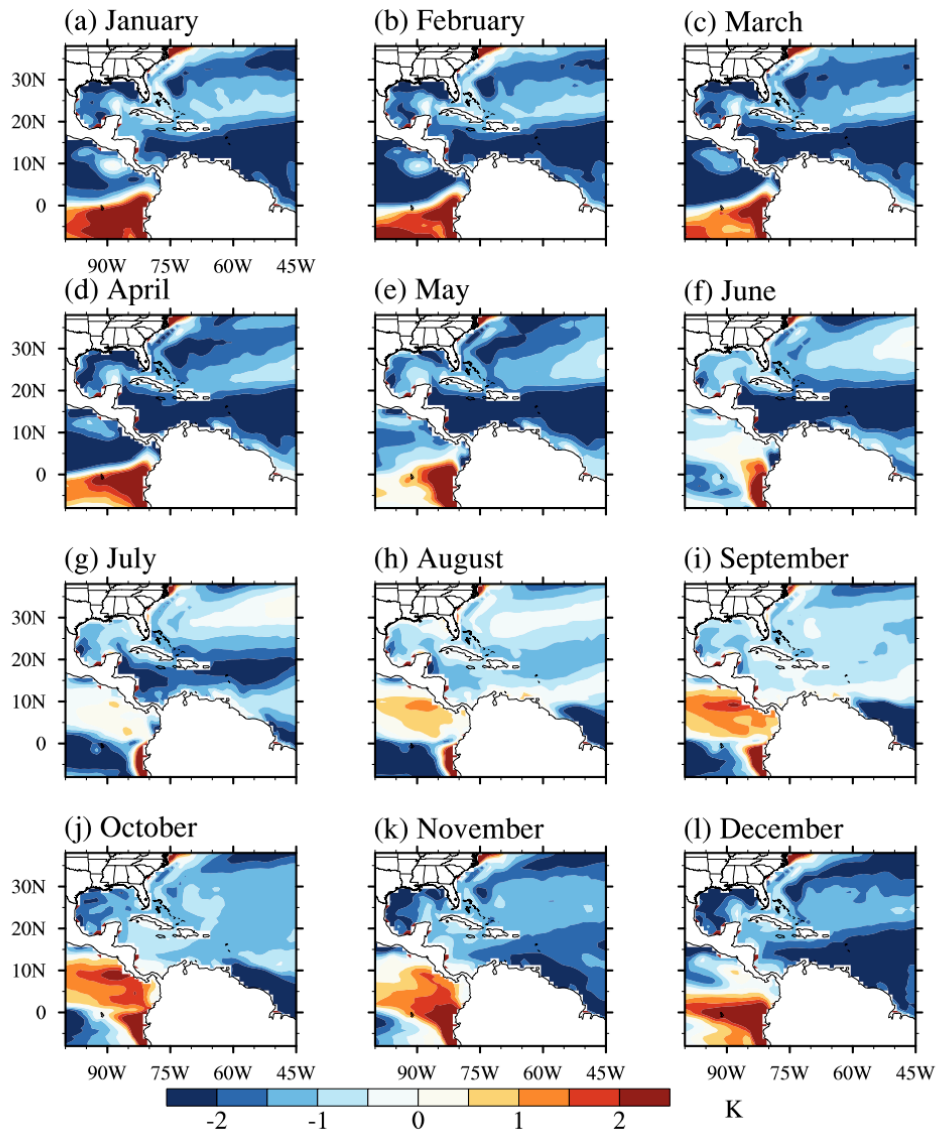
AREA OF 28.5°C MONTHLY AVERAGED ISOTHERM (10^6km^2)

Each cell in the table is color coded (cool colors indicate a small AWP; warm colors indicate a large AWP) in order to show the average seasonal evolution of the AWP's areal extent

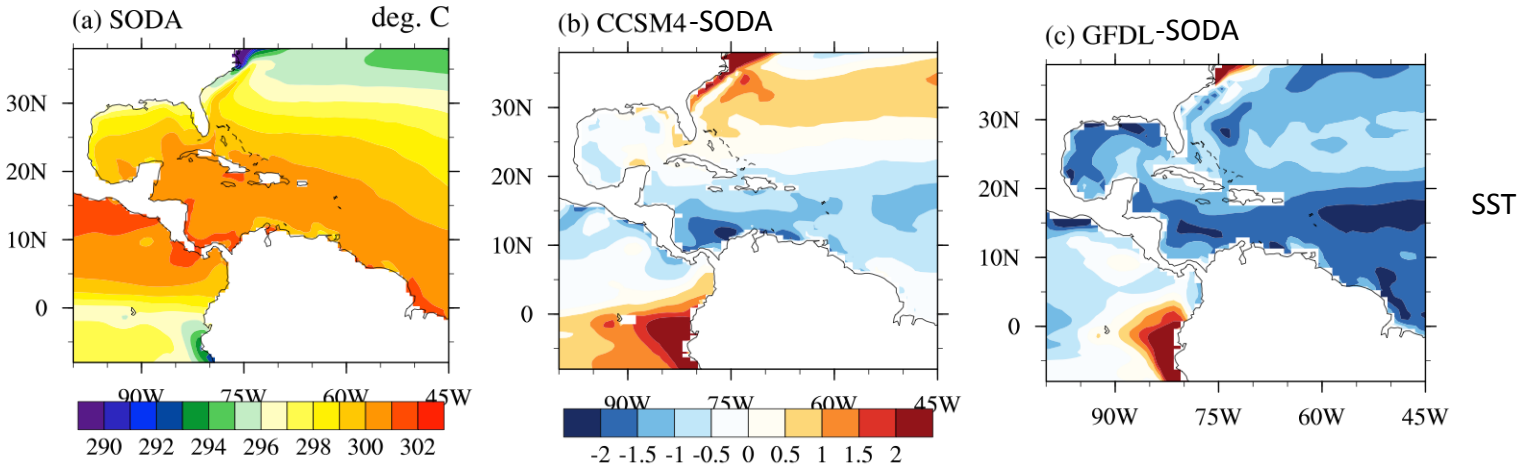
Mean SST bias from CCSM4 20th century simulation



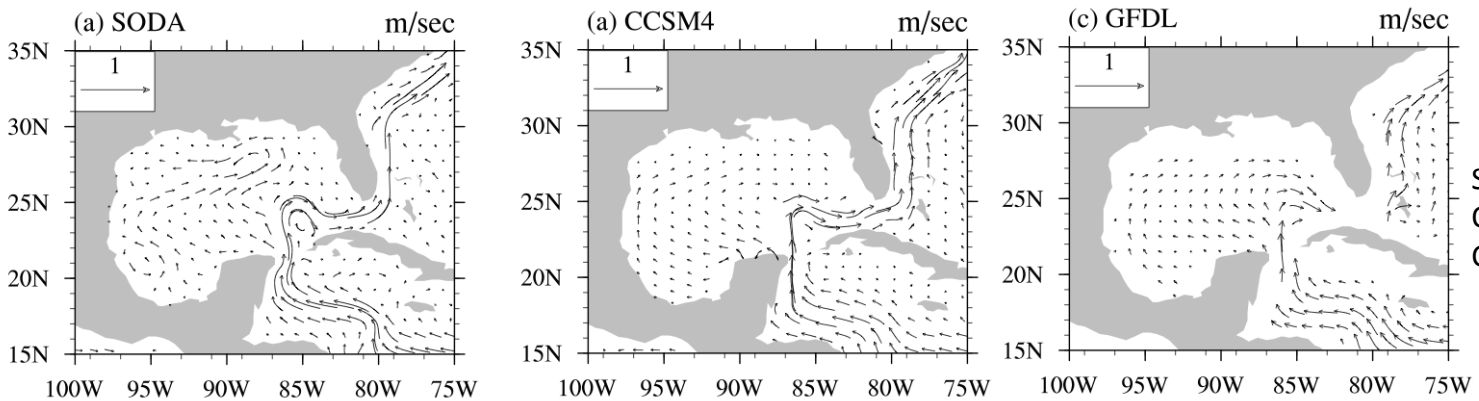
Mean SST bias of GFDL-ESM2G from the 20th century simulation



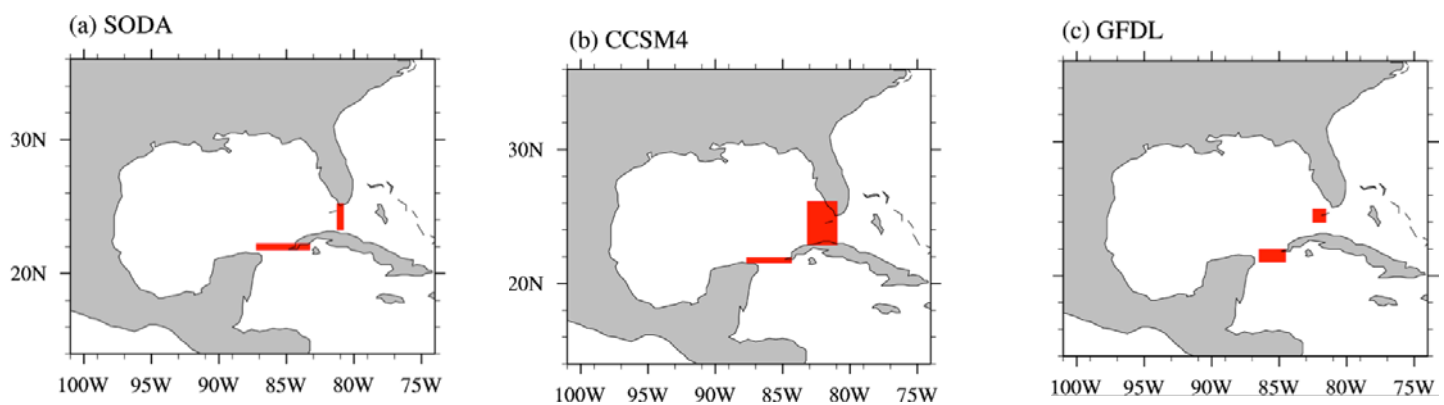
20th Century Simulation from CMIP5 repository



SST

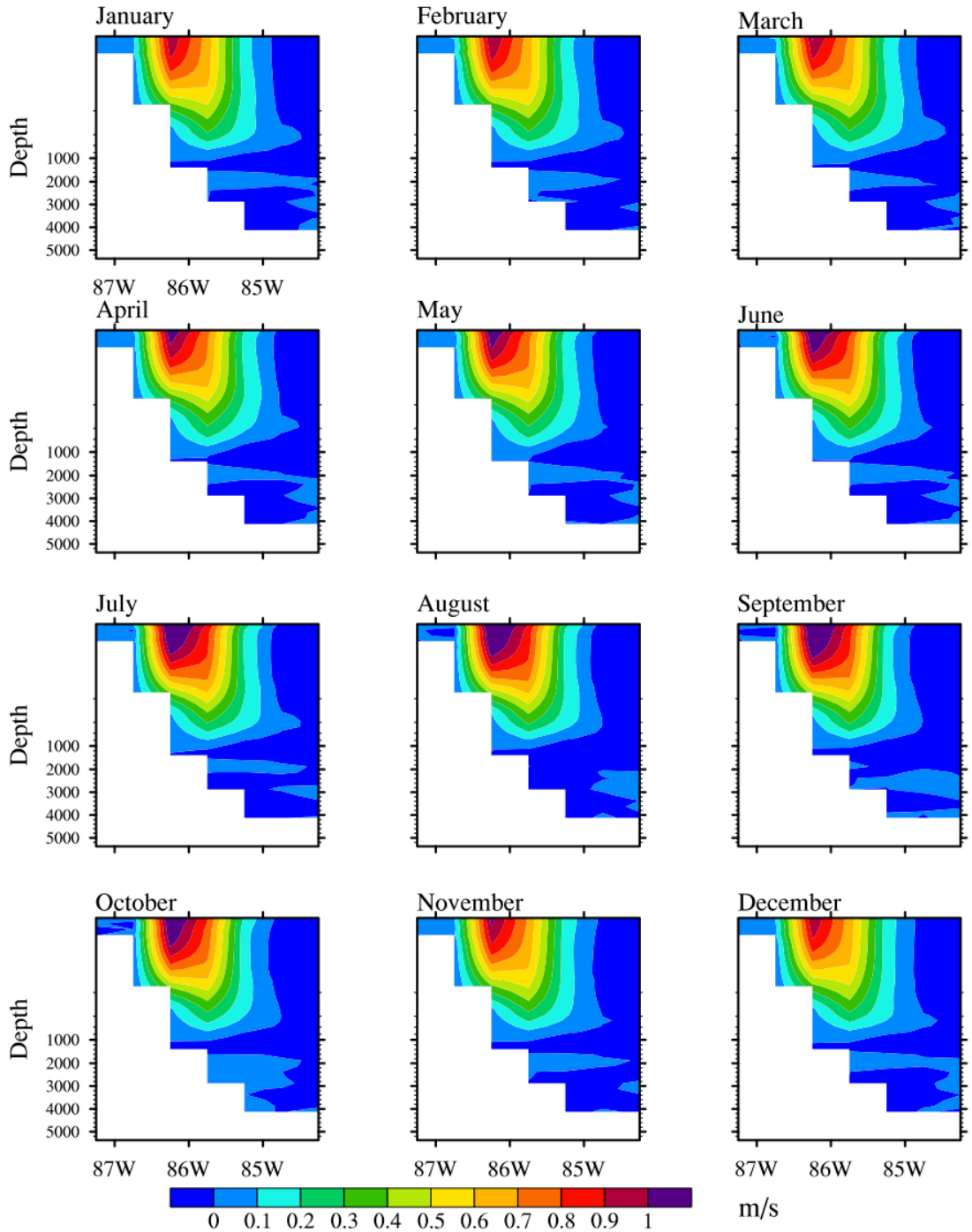


Surface Ocean Currents



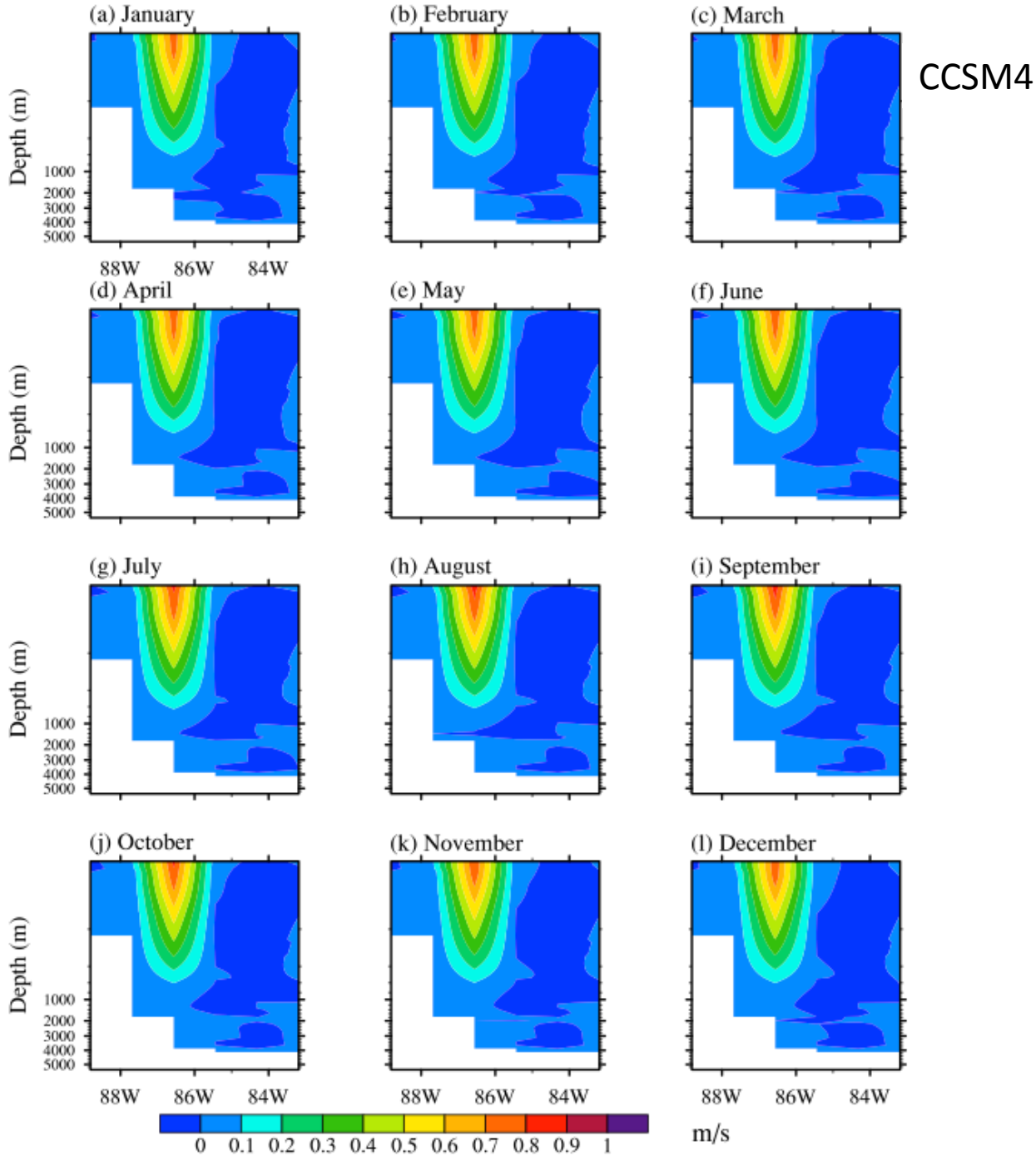
Granularity of channels

Monthly Climatology of vertical cross-section of Ocean Current across Yucatan Channel



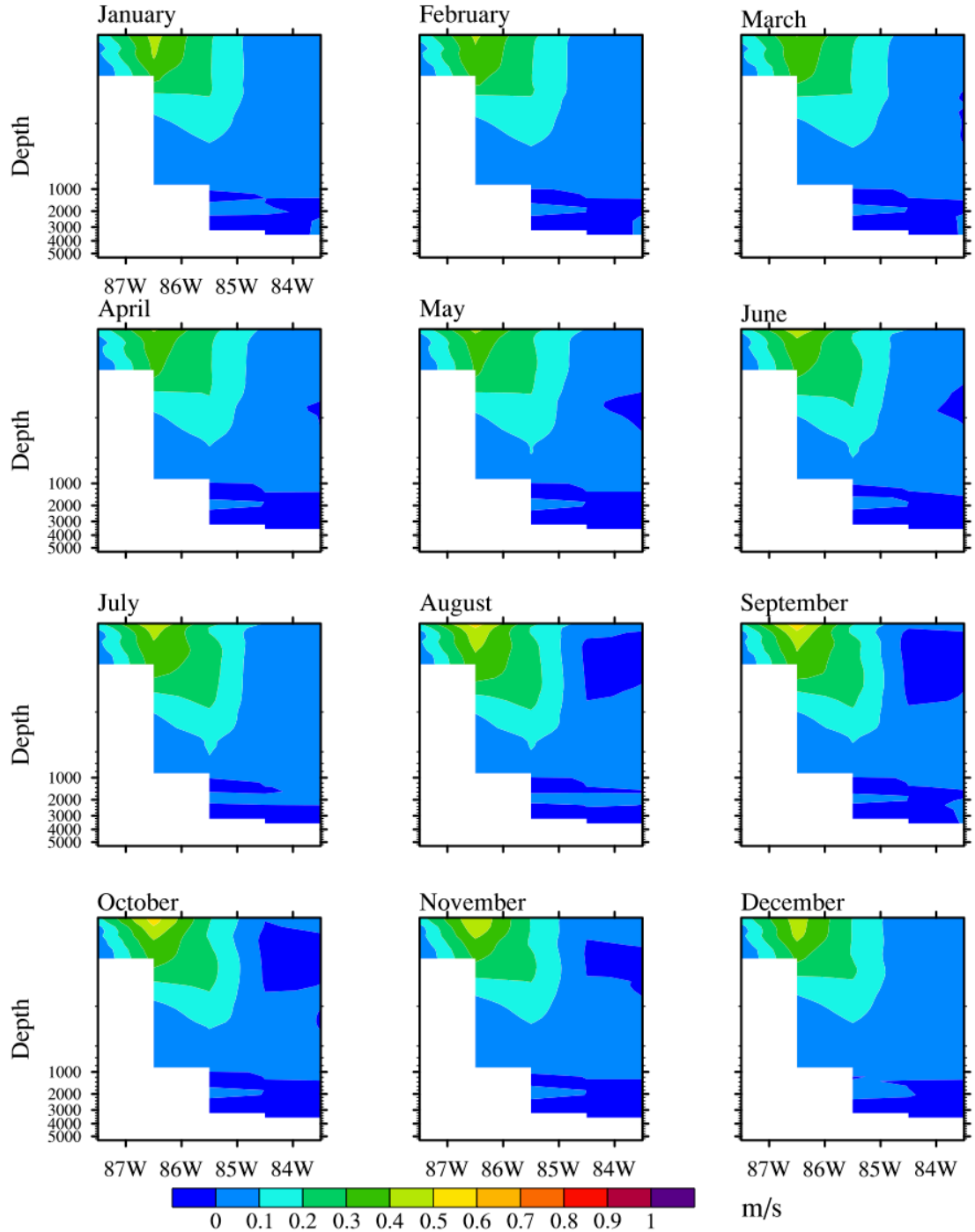
SODA

Monthly Climatology of vertical cross-section of Ocean Current across Yucatan Channel



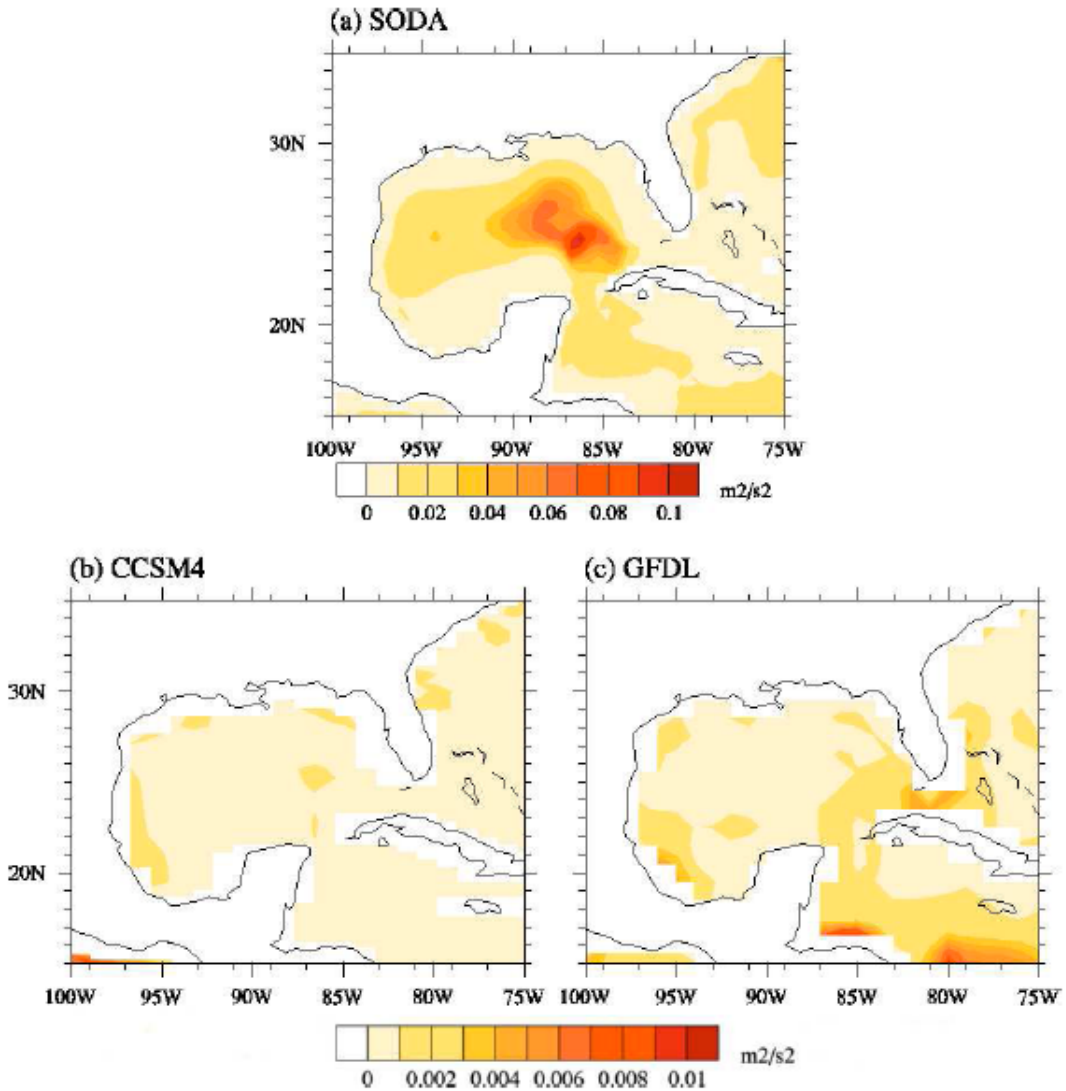
Monthly Climatology of vertical cross-section of Ocean Current across Yucatan Channel

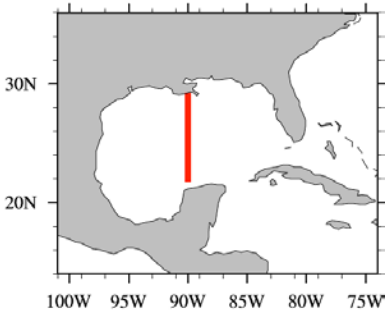
GFDL-ESM2G



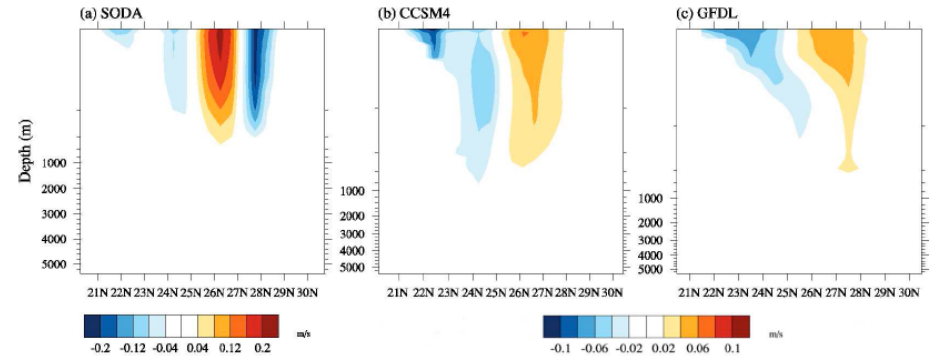
The surface eddy kinetic energy

$$K.E._{eddy} = \frac{1}{2}(u'^2 + v'^2)$$

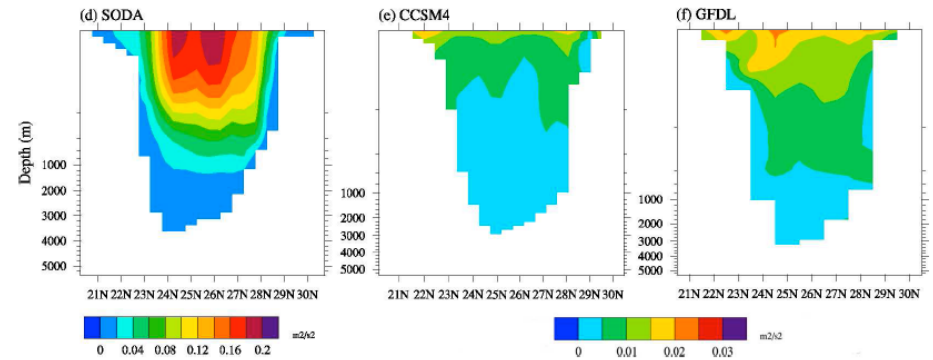




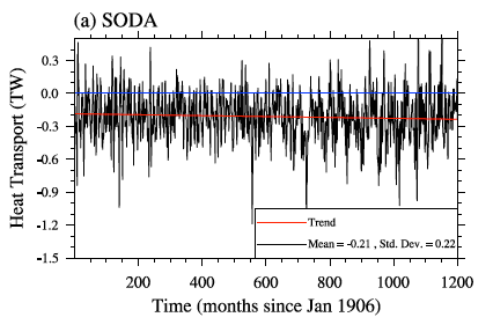
Mean zonal flow across 90W



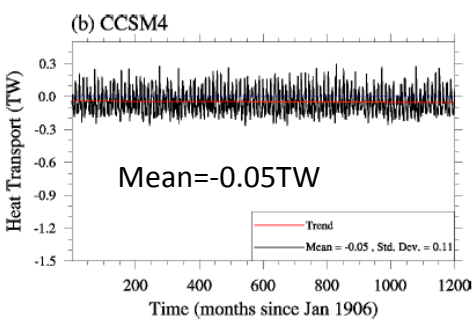
$$\text{Heat Transport} = \rho C_p \int u\ T\ dy\ dz \Big|_{90W}$$



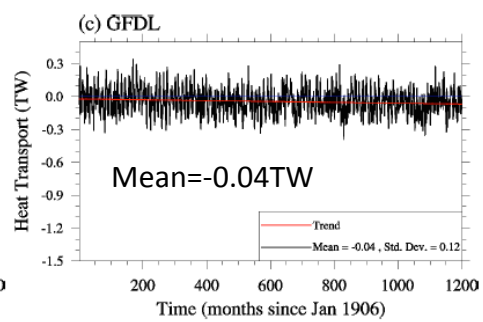
Standard deviation of zonal flow across 90W



Mean=-0.21TW

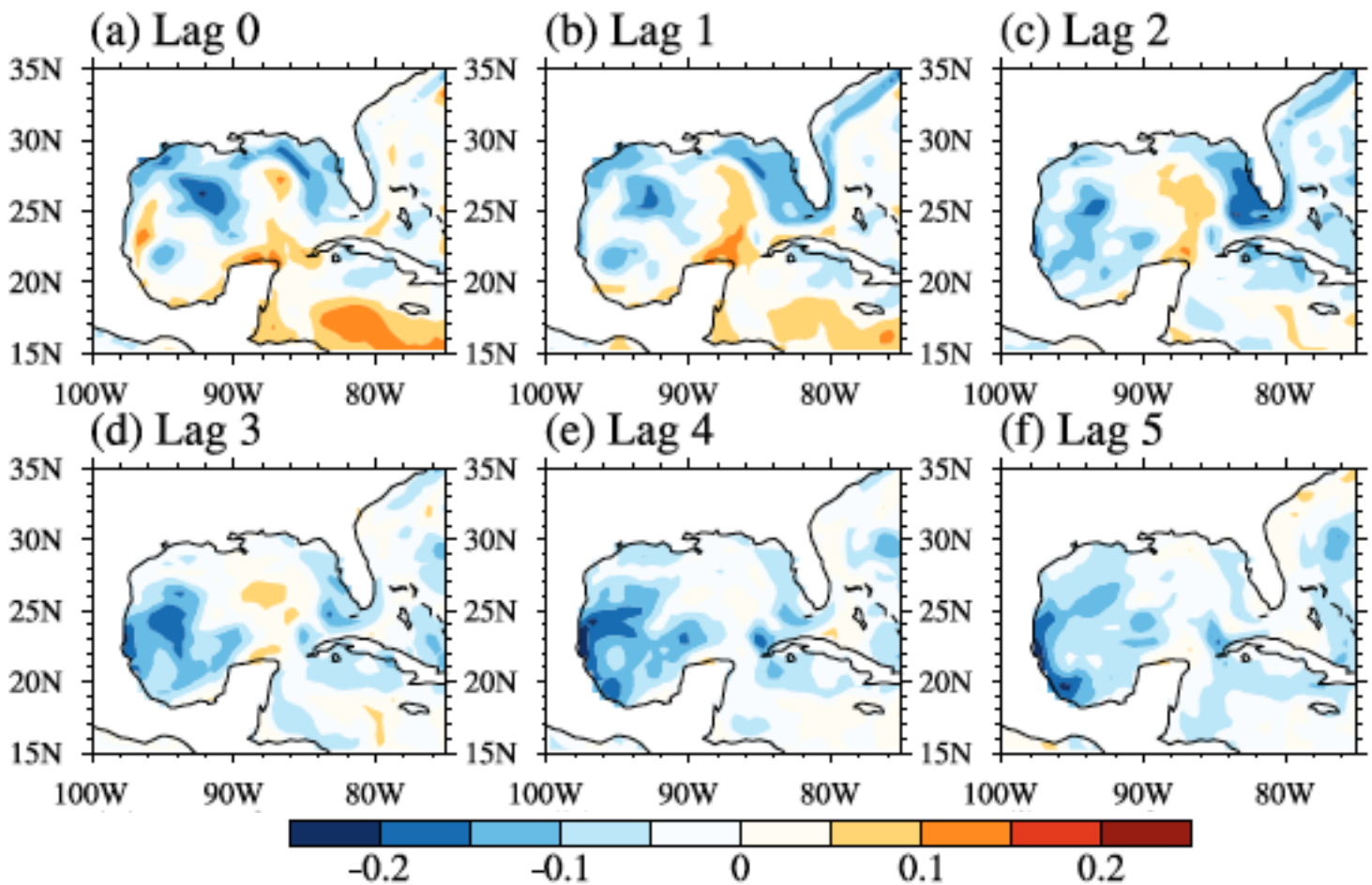


Mean=-0.05TW



Mean=-0.04TW

Correlation of heat transport across 90W with SST



Positive lag in months suggests heat transport is leading SST

North Atlantic tropical storm and hurricane tracks, genesis and landfall clusters

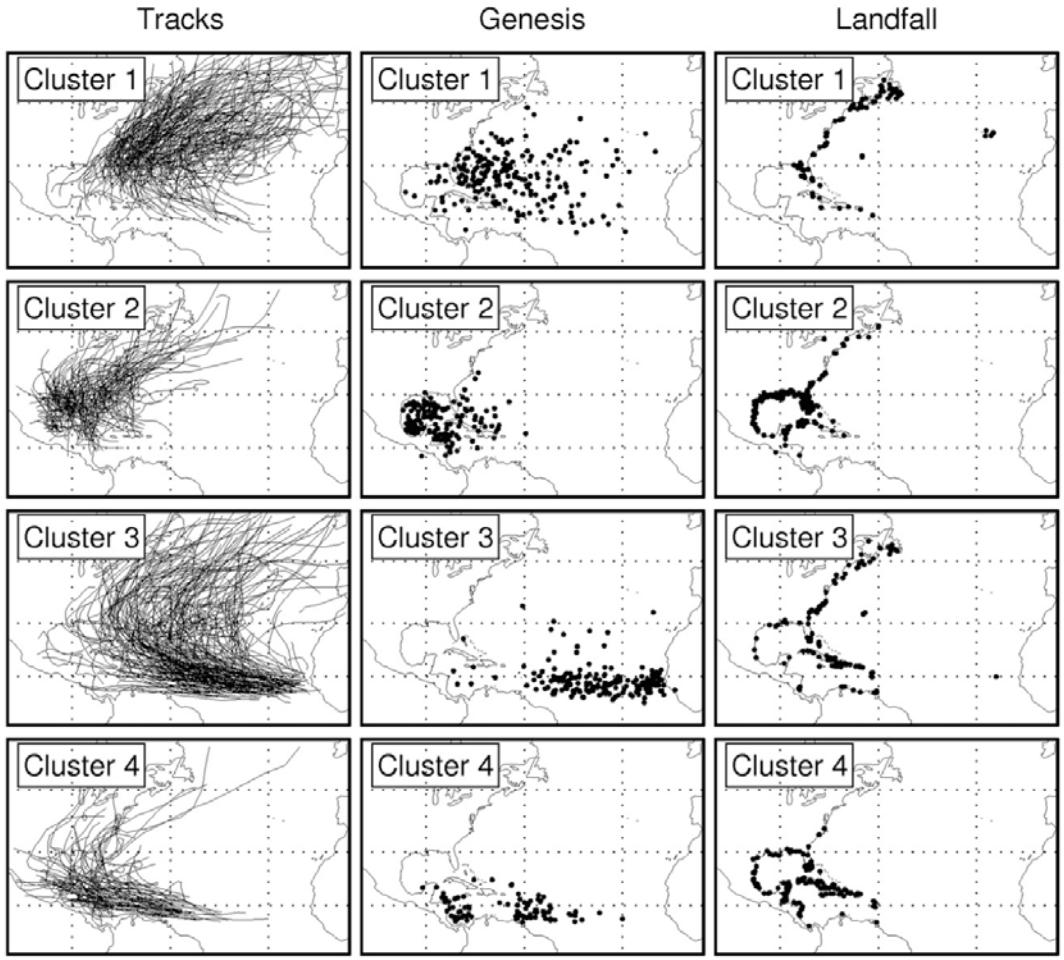
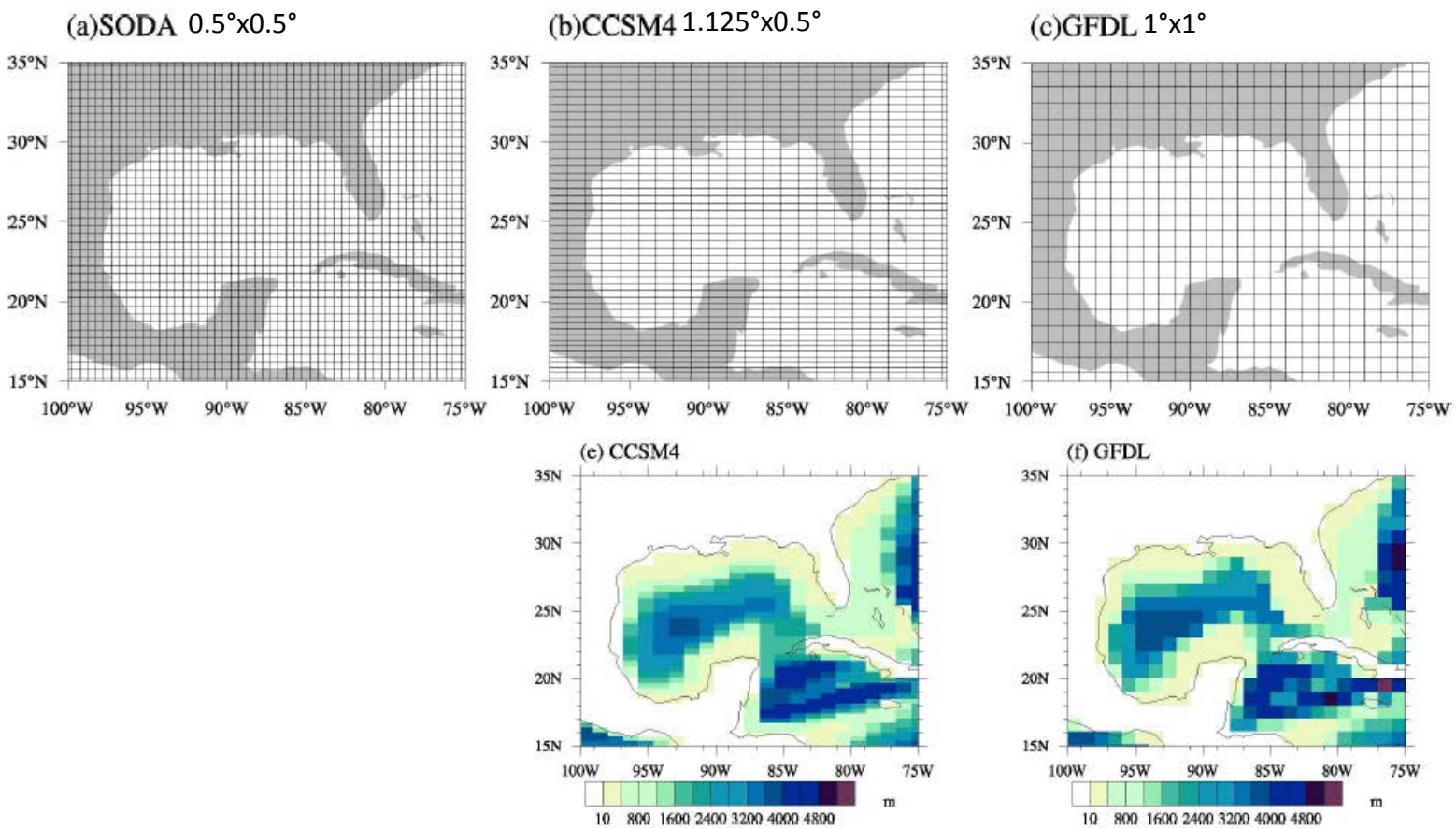


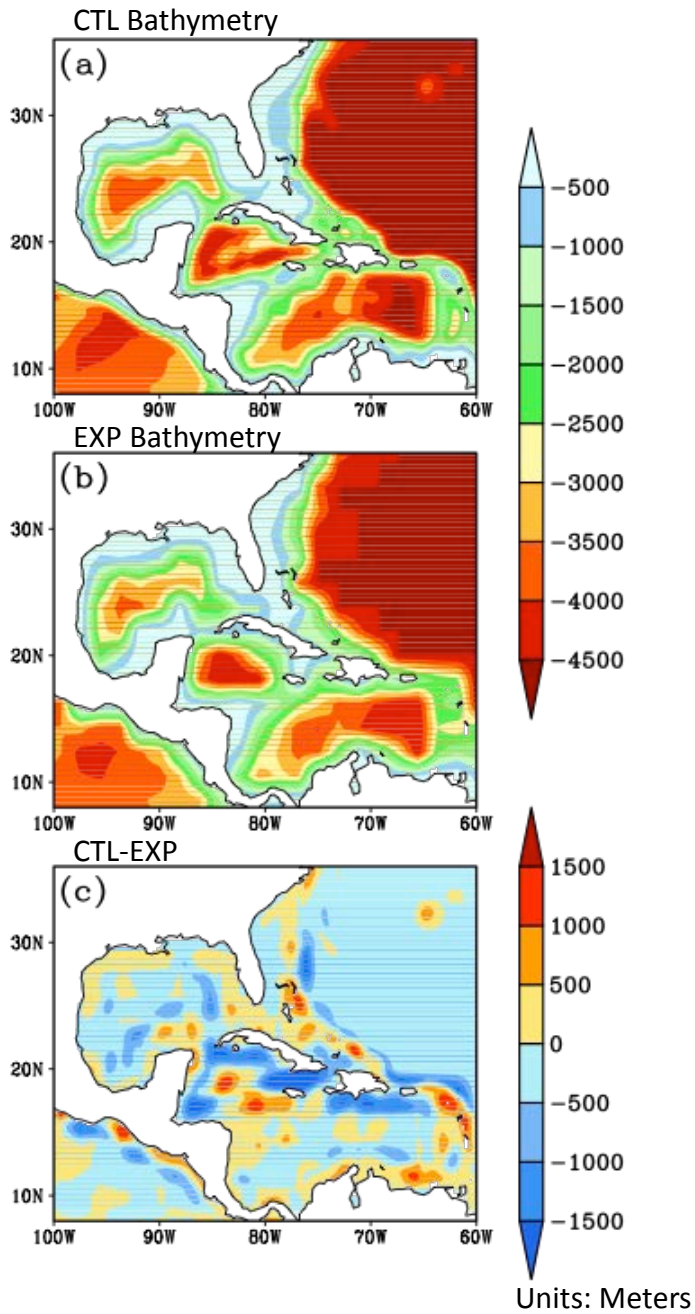
FIG. 1. North Atlantic tropical storm and hurricane tracks, genesis locations, and landfall locations during the period 1950–2007, as separated by the cluster analysis.

1. Most Cat 3-5 hurricanes originate from cluster 4.
2. TC's in cluster 4 contribute significantly to landfalls (87%).
3. TC's in cluster 4 contribute significantly to the PDI.
4. A large proportion of TC's in cluster 4 reach hurricane strength (65%).

From Kossin et al. (2010)

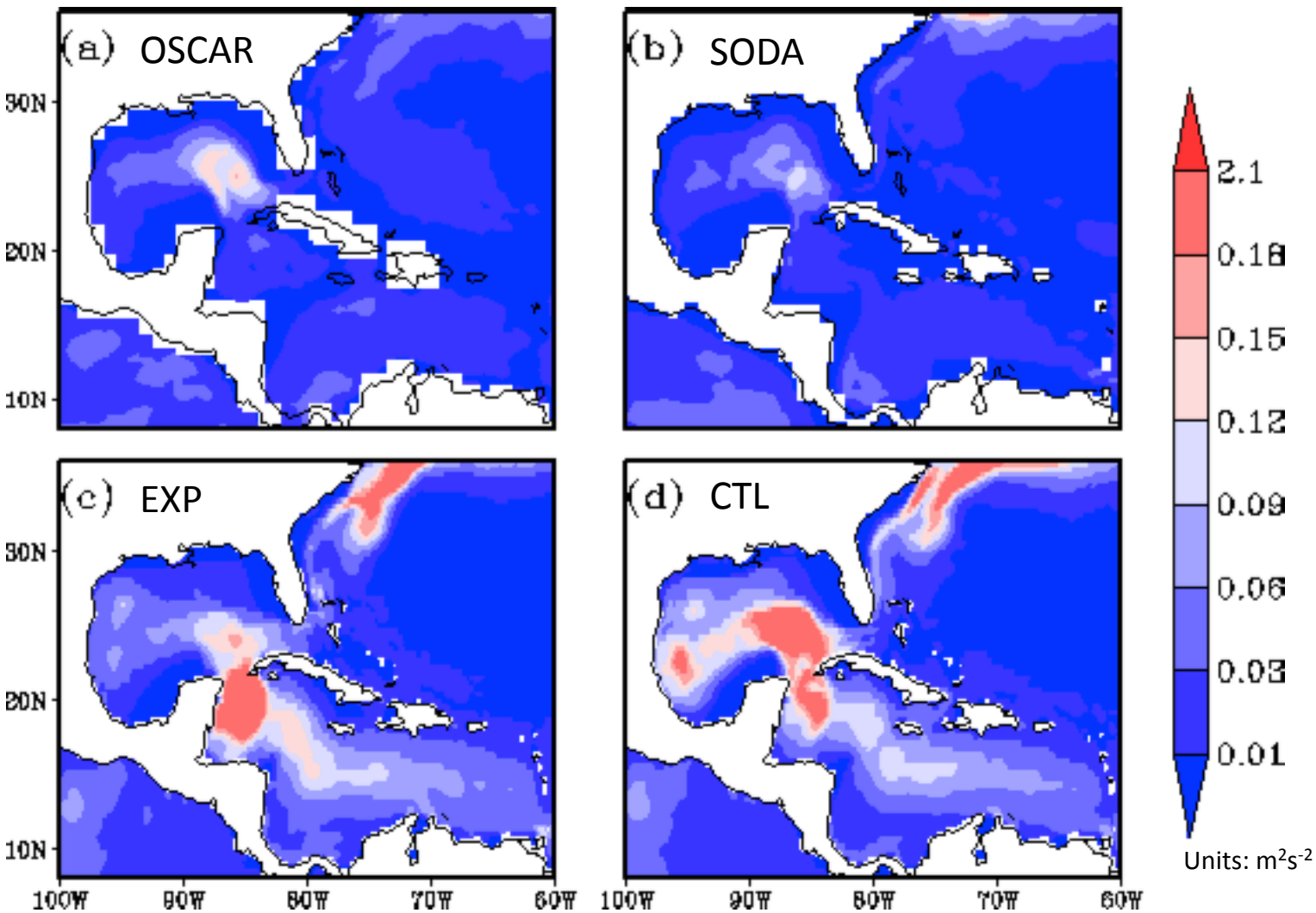

(a)SODA 0.5°x0.5°
(b)CCSM4 1.125°x0.5°
(c)GFDL 1°x1°
35°N
30°N
25°N
20°N
15°N
100°W
95°W
90°W
85°W
80°W
75°W
(e) CCSM4
(f) GFDL
35N
30N
25N
20N
15N
100W
95W
90W
85W
80W
75W
10 800 1600 2400 3200 4000 4800
m

Sensitivity of the simulation to bathymetry

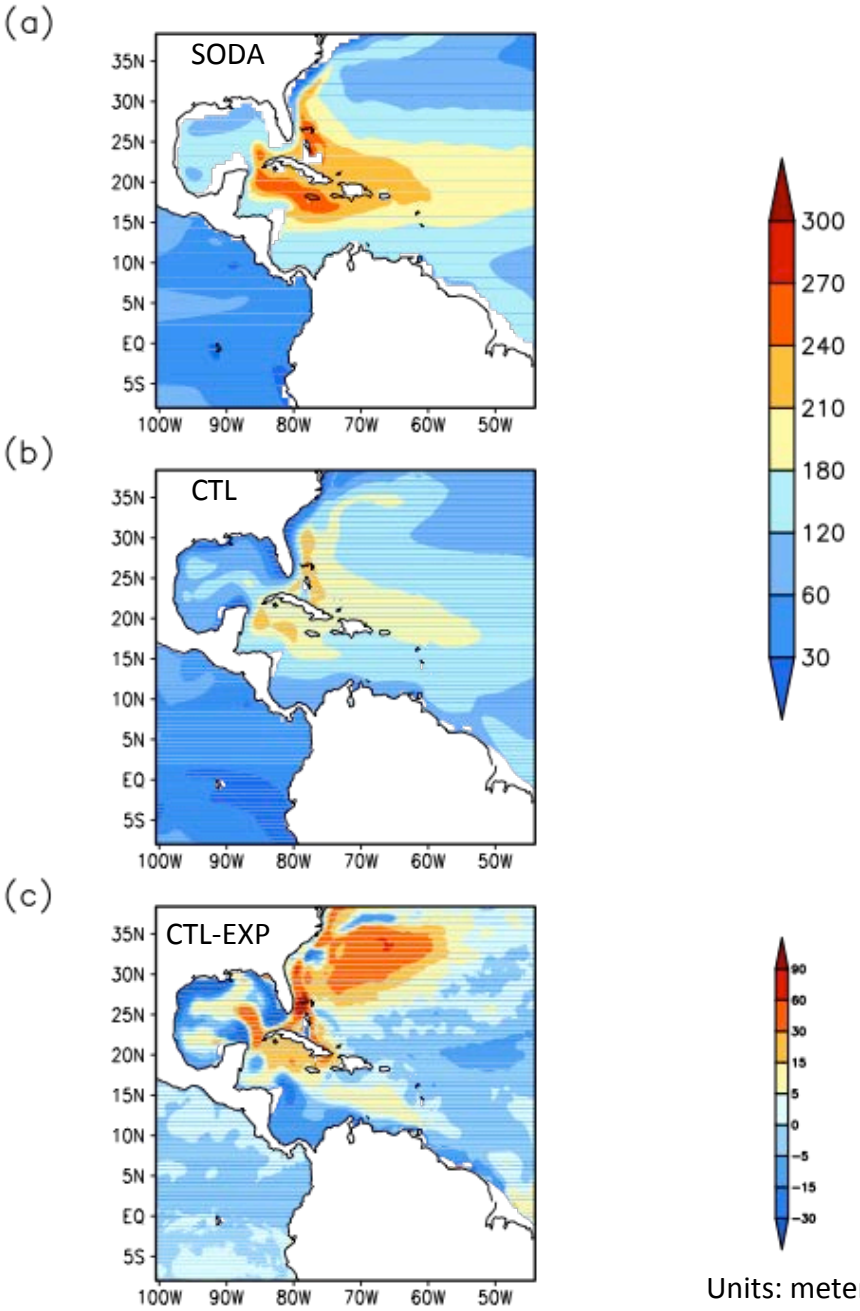


Model: RSM-ROMS
Grid Interval: 15km
Period of integration: January 1979-Dec2010
Lateral boundary forcing: NCEP-R2 and SODAv2.2.4

The surface eddy kinetic energy

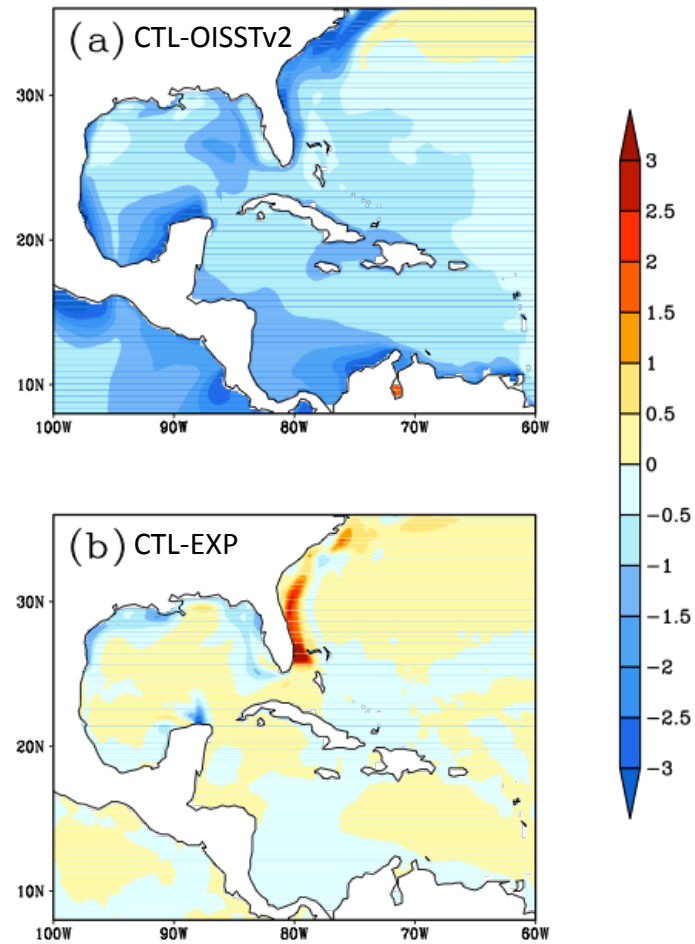


Depth of 20°C isotherm



Units: meters

SST bias



Conclusions

- Cold bias in the IAS is a pervasive phenomenon in the CMIP5 suite of models
- Bias in surface ocean currents is one of the major contributors to this bias
- Lack of resolution to resolve eddies off of loop current in CMIP5 is a shortcoming
- Sensitivity experiments reveal that these issues can be modulated by the resolution of the bathymetry used