High Resolution Coupled Ocean-Atmosphere Modeling over the Intra-American Seas

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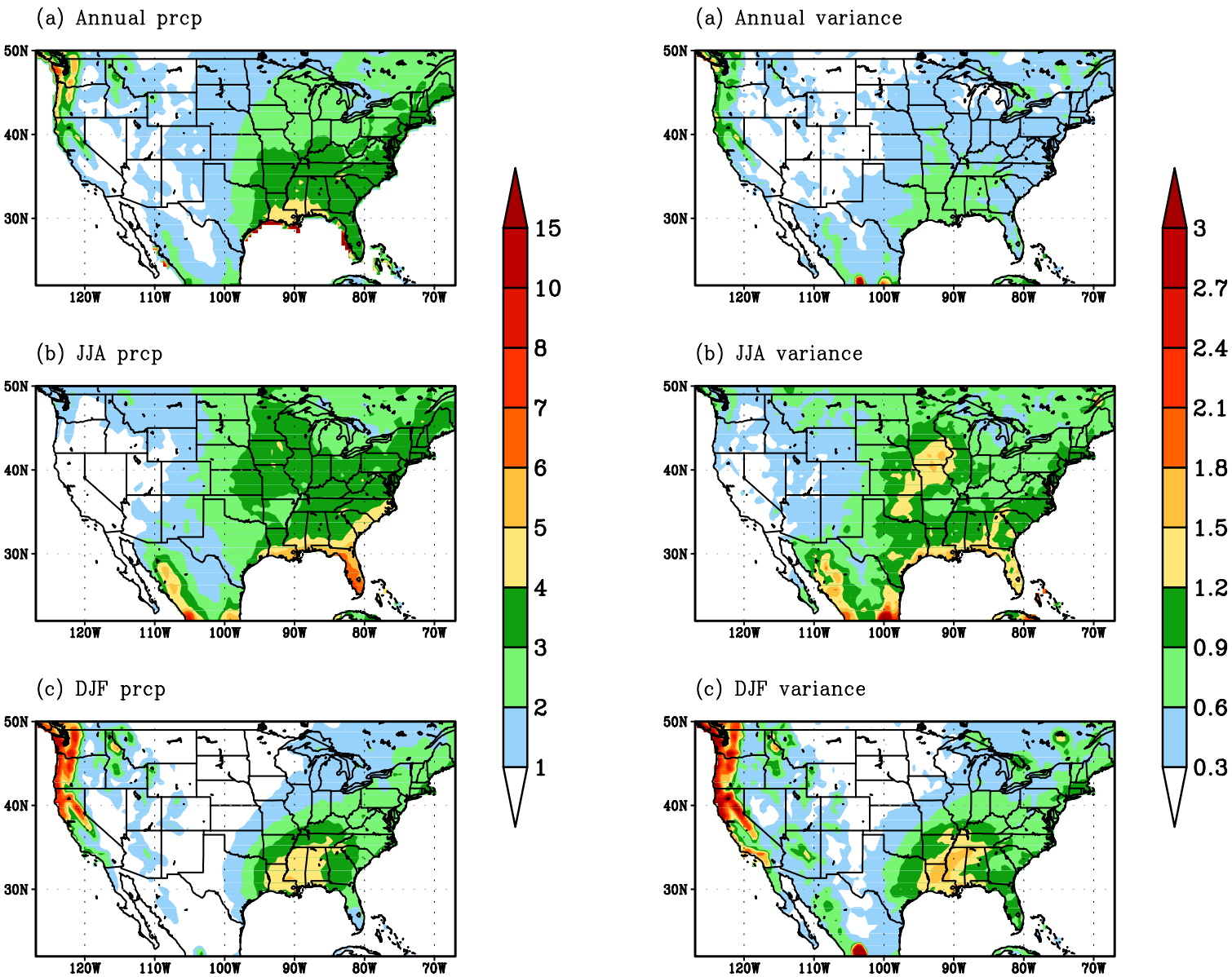
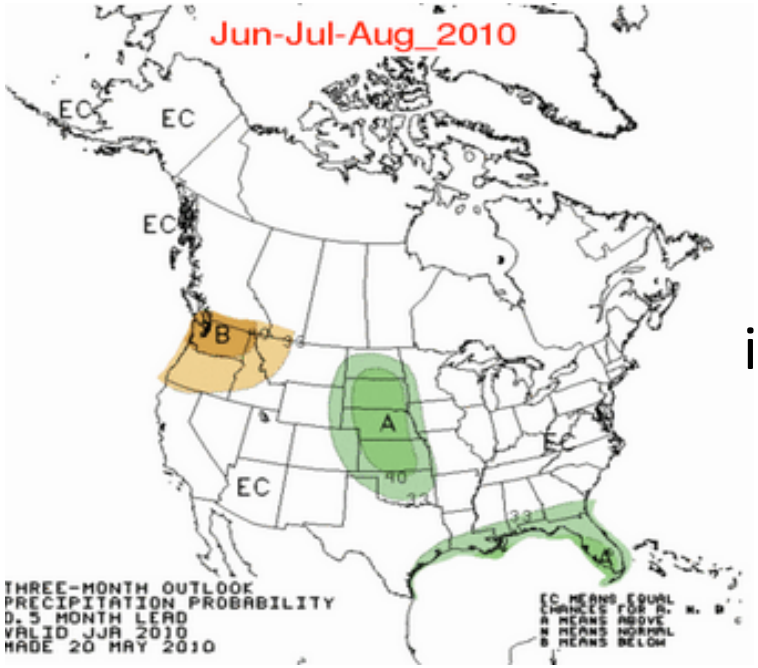
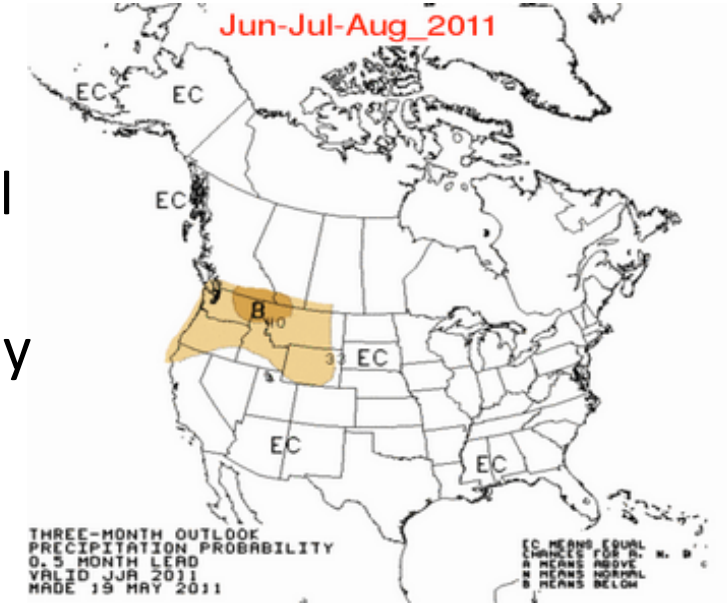
Observed Seasonal Cycle of Precipitation over Continental US

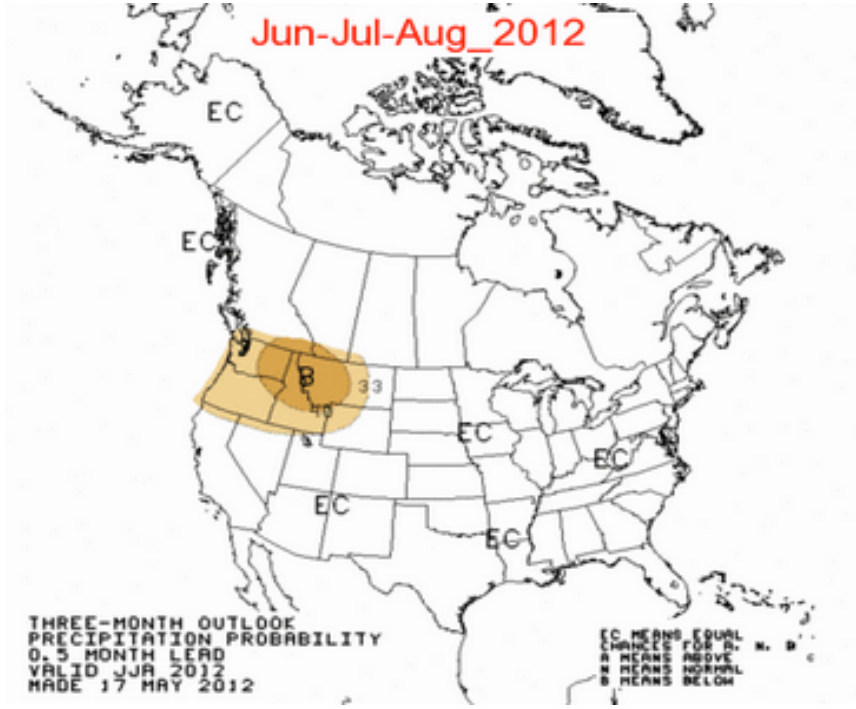


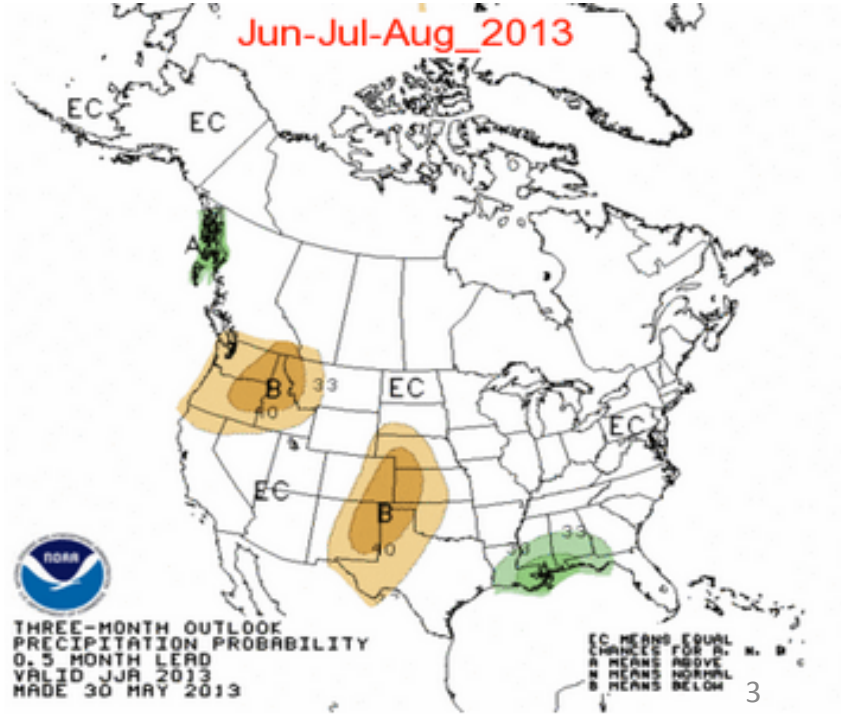
Summer and winter precipitation largely dominated over US Gulf coast

Typical seasonal outlook for JJA issued on 15 May

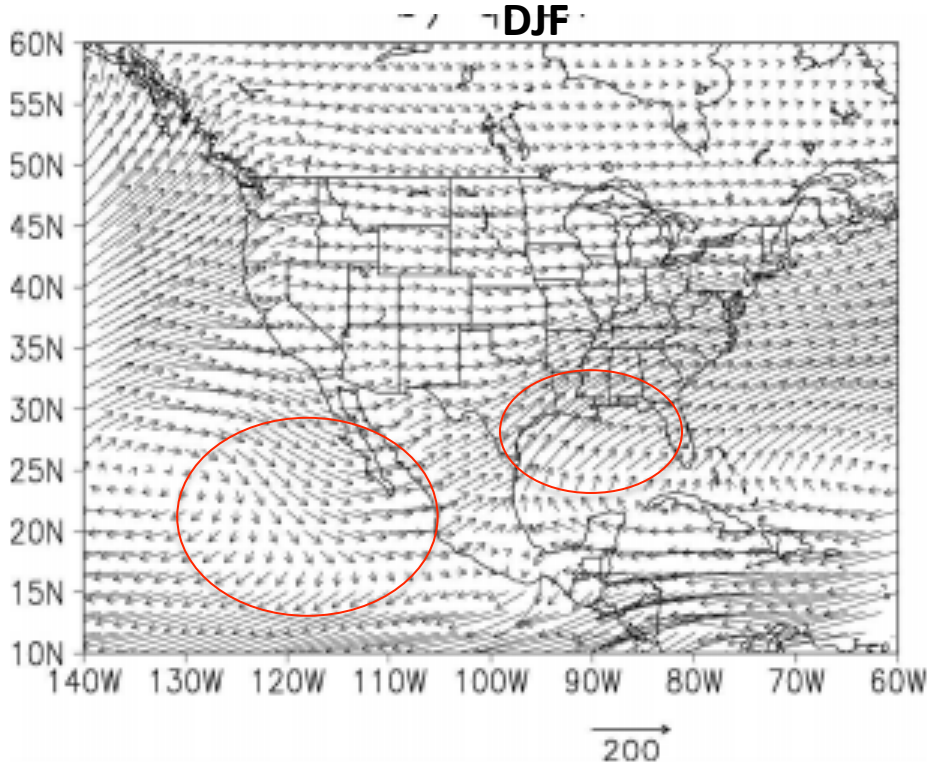






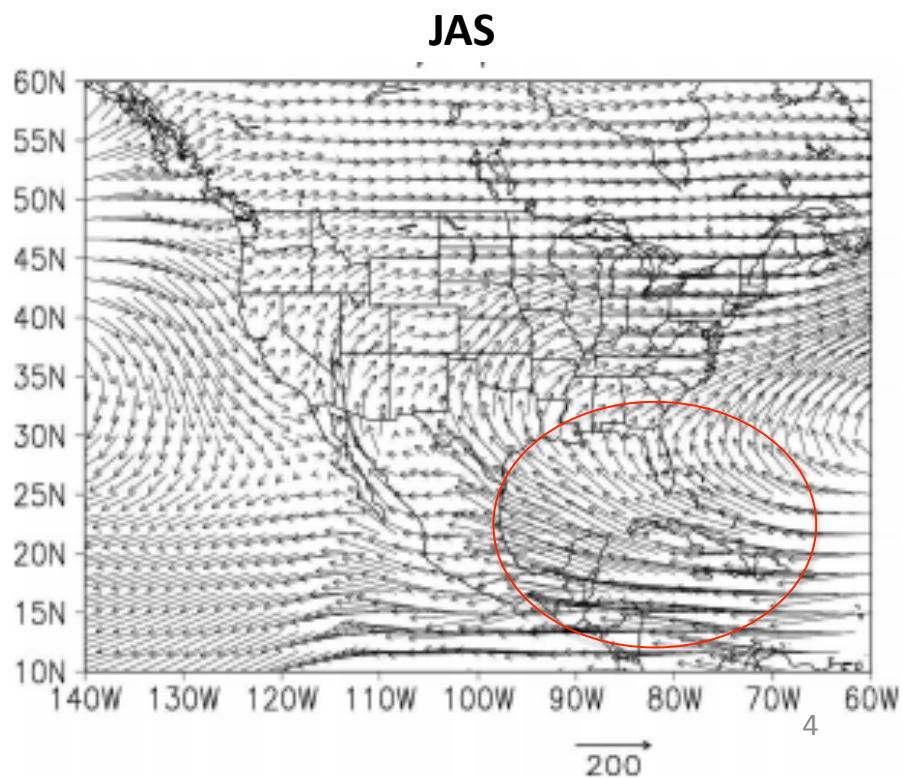


Vertically Integrated Moisture Flux from NCEP RR



Moisture flux in summer over eastern US is almost exclusively from the Atlantic Oceans

Moisture flux in the winter over eastern US is combination from the Pacific and the Atlantic Oceans



Courtesy: Mo et al. (2005)

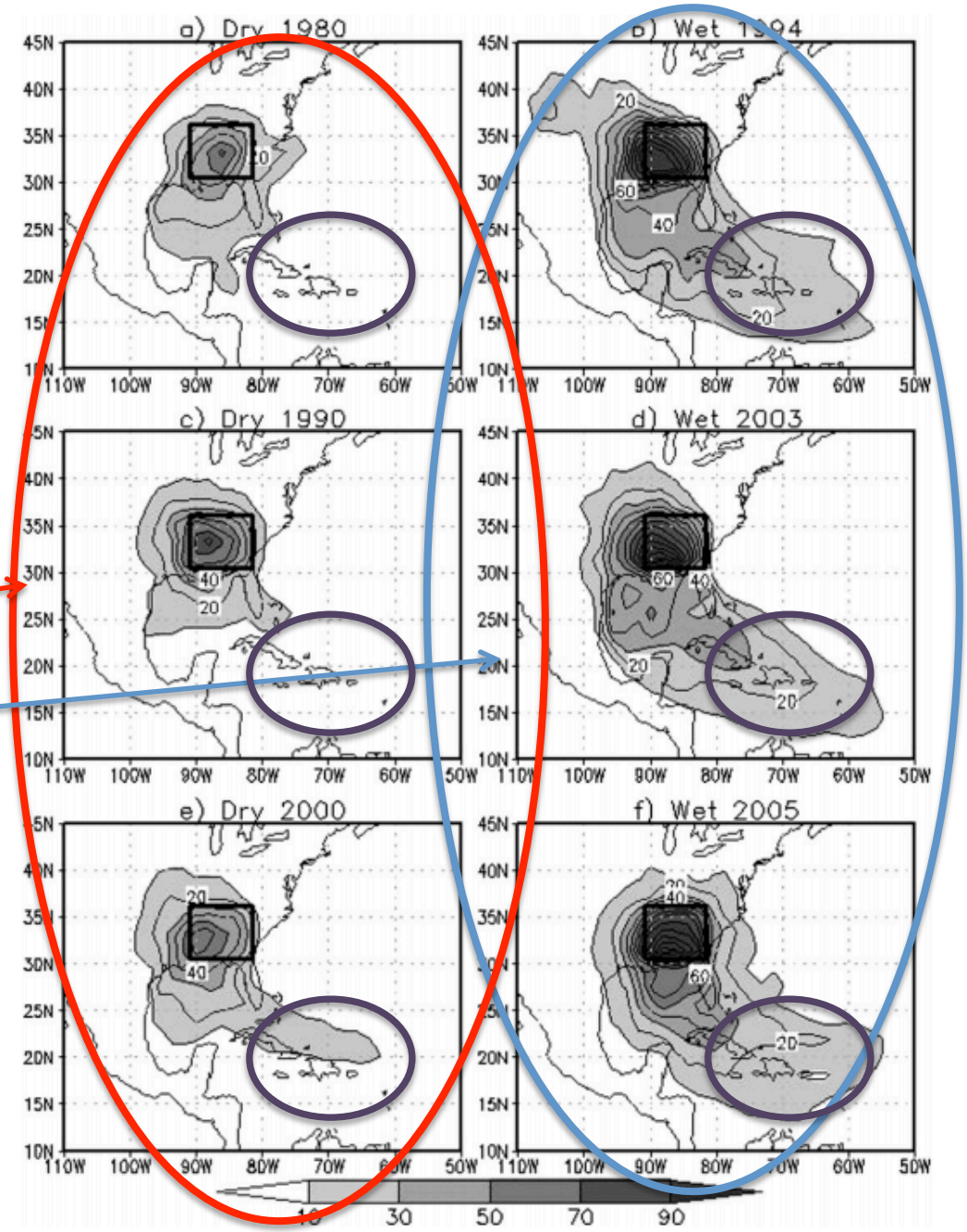
The Caribbean as the "extra" moisture source

In wet years, it's a combination of tropical systems and moisture recycling.

In dry years, it's mostly moisture recycling.

Dry years

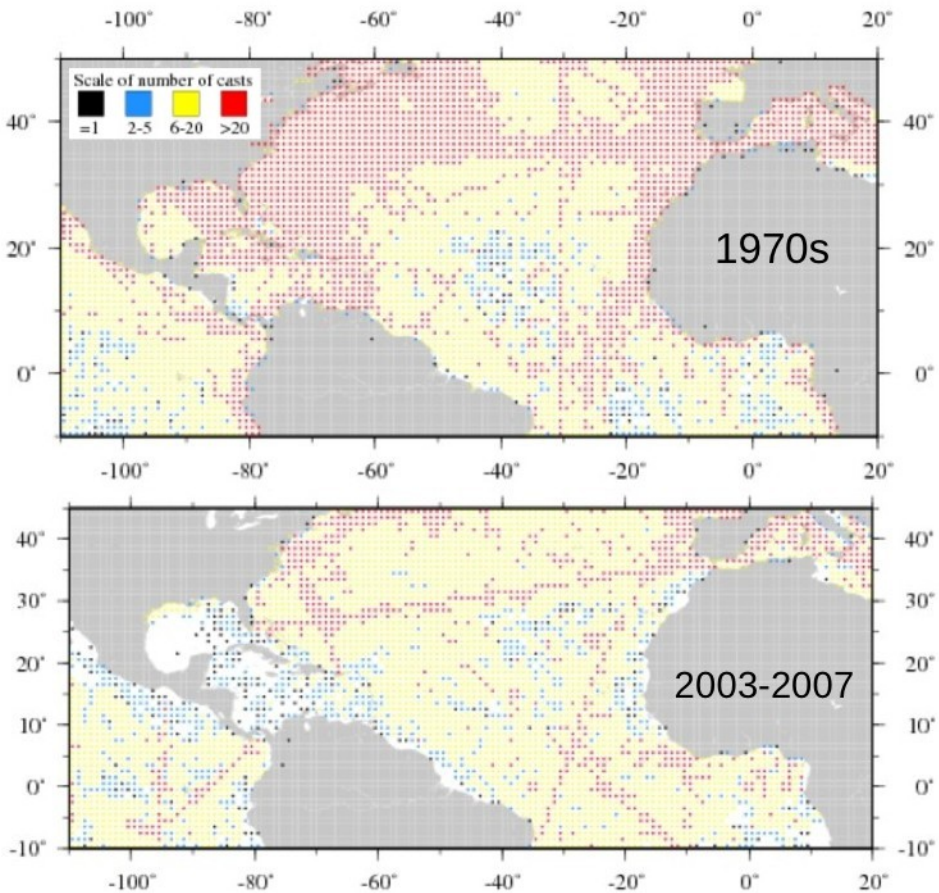
Wet years

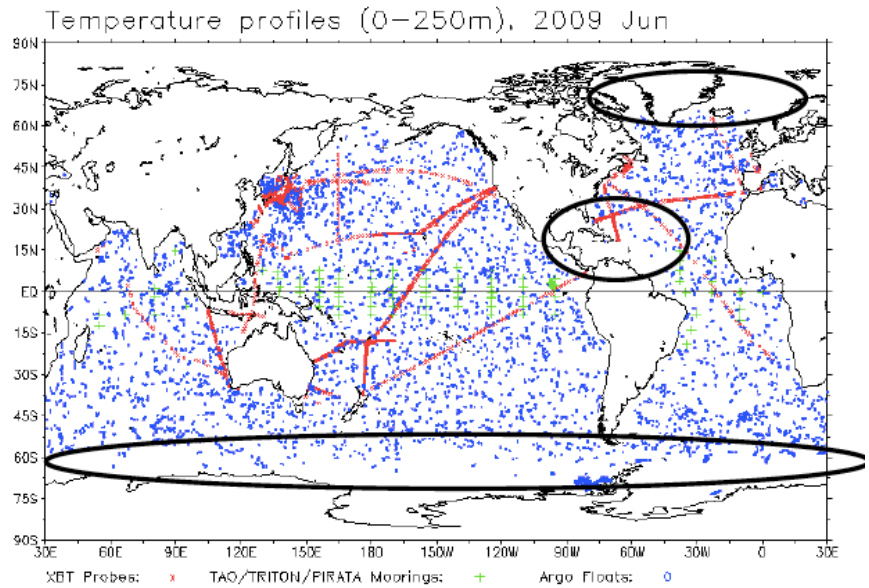


From NCEP R2 for winds and humidity and CMAP precipitation

Chan and Misra (2010)

And yet…..





IAS region is as poorly observed as the Polar Oceans

Courtesy: David Enfield, AOML NOAA

IPCC-AR4: The JAS climatological mean SST

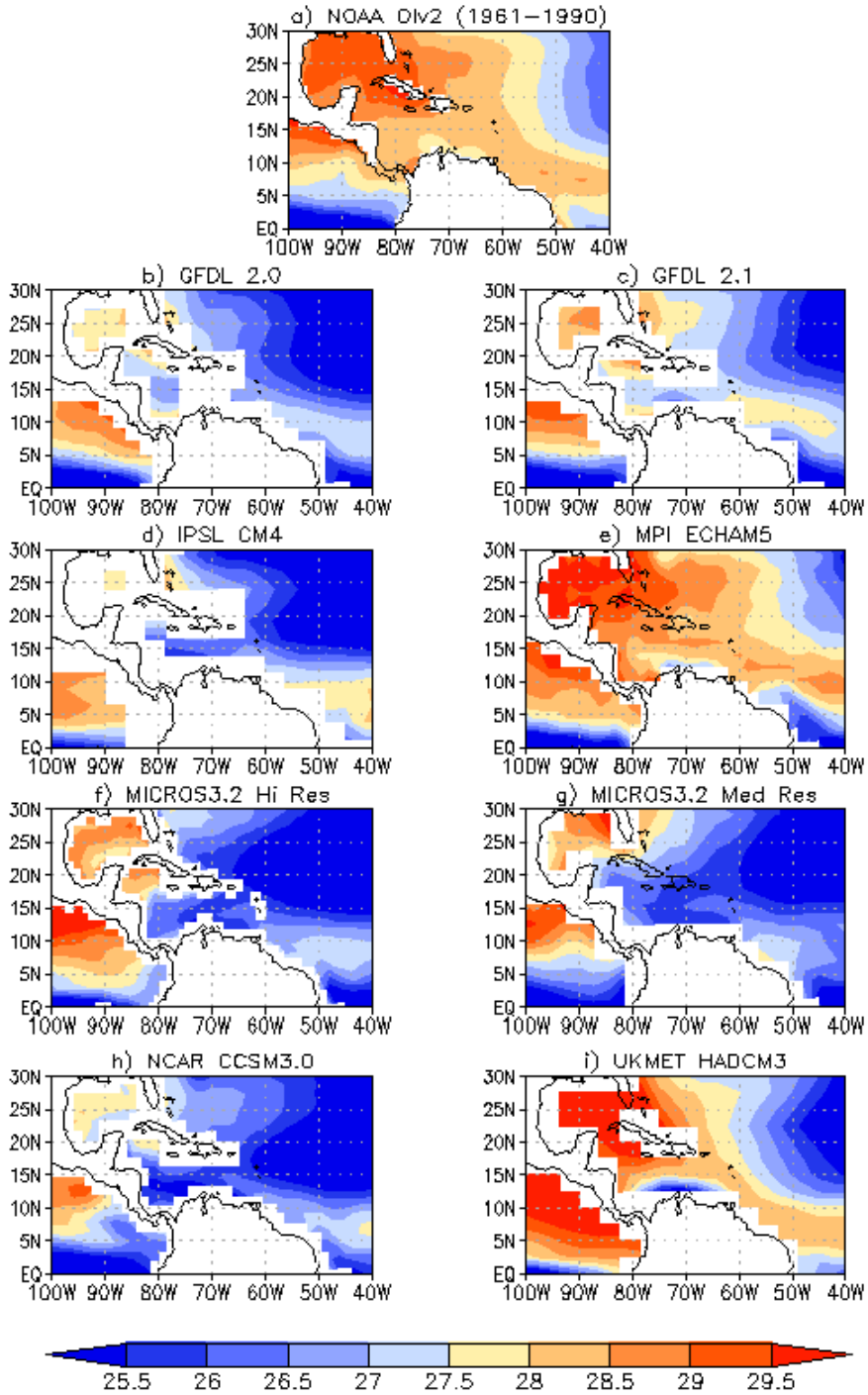


Table 4 Average monthly AWP areas (in 10^6 km^2) from 1909 to 2005 based on various CMIP5 models and ERSSTv3 observations

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 ($10^6 km^2$)

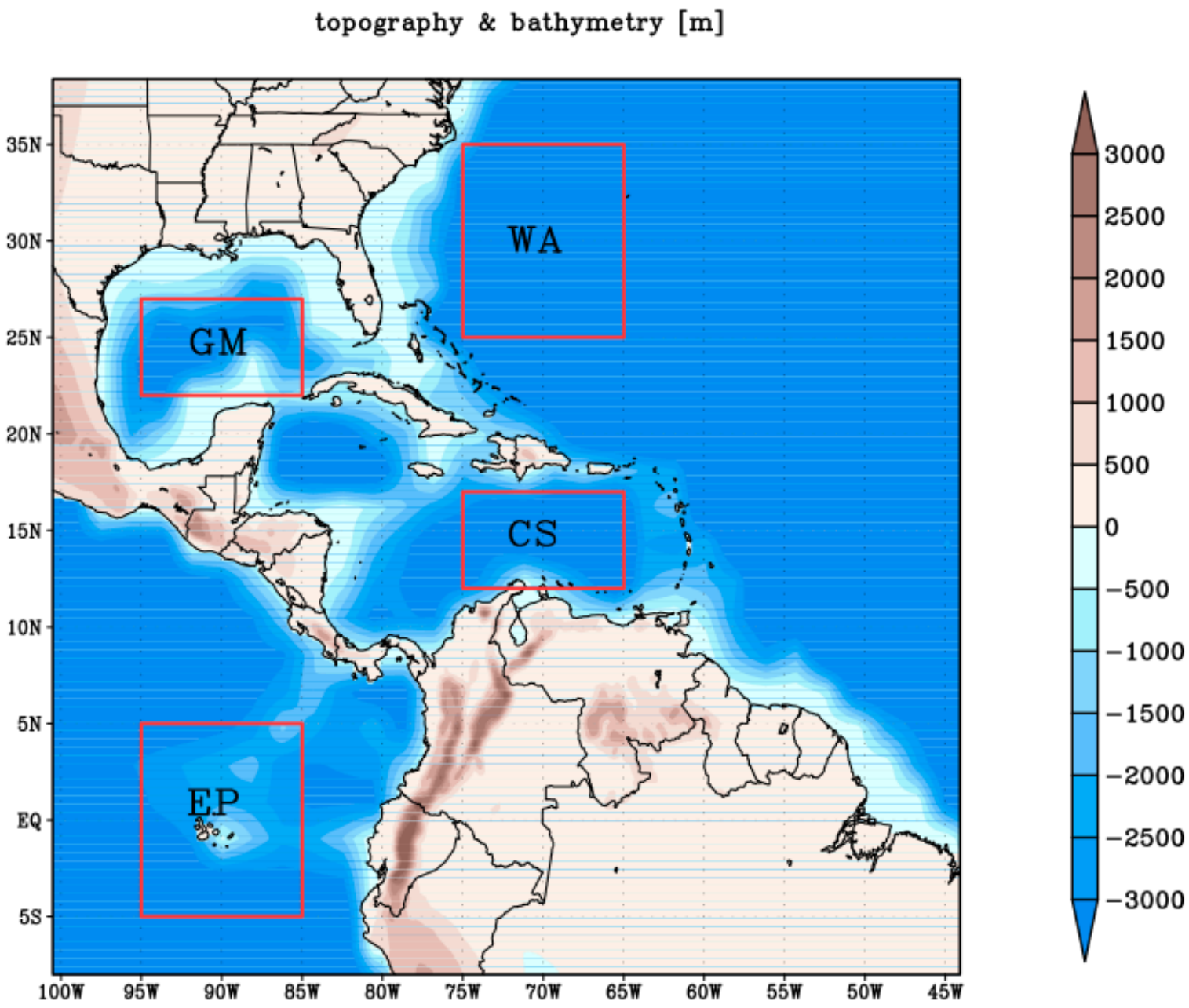
Each cell in the table is color coded (cool colors indicate a small AWP; warm colors indicate a large AWP) in order to show the average seasonal evolution of the AWP's areal extent

Regional **O**cean-**A**tmosphere coupled downscaling of global **R**eanalysis over the Intra-American **S**eas (ROARS)

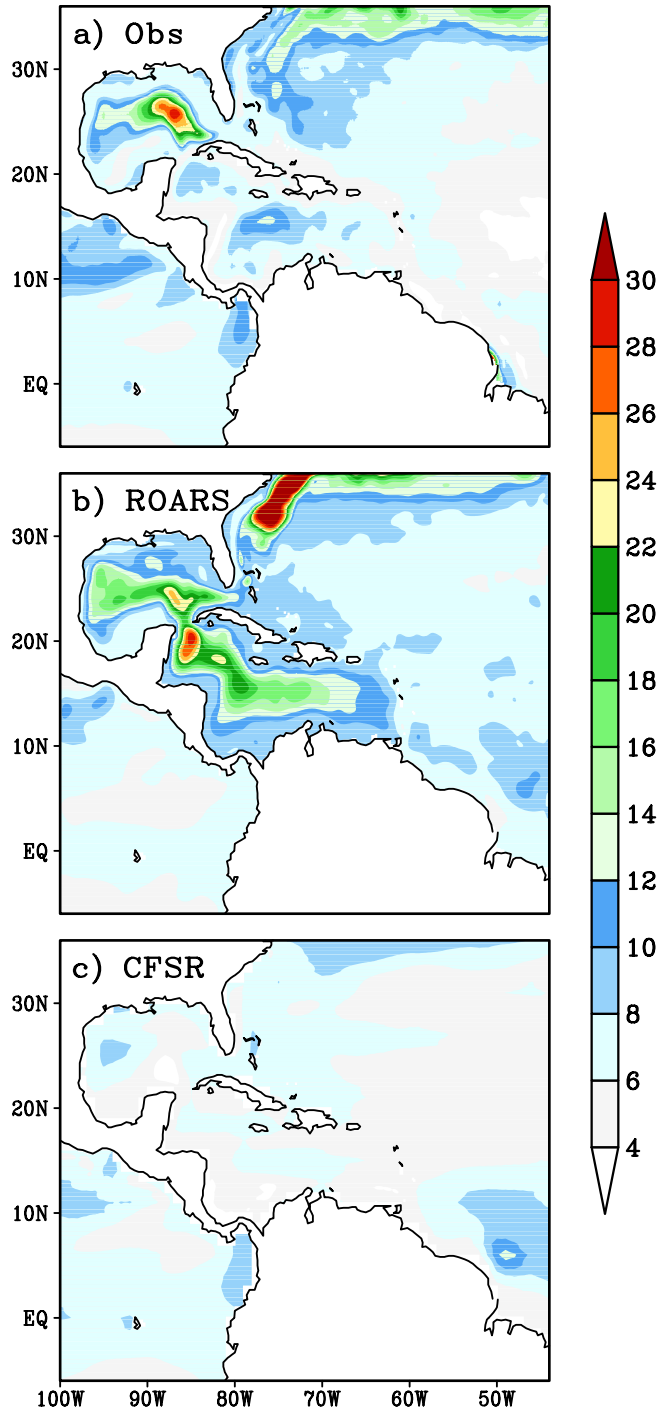
- Model: RSM-ROMS
- 15km grid resolution
- Coupling interval: 1 day
- No flux correction
- Forced by R2 and SODA

	References
Convection	Moorthi and Suarez (1992)
Shallow convection	Tiedtke (1983)
Boundary layer	Hong and Pan (1996)
Longwave radiation	Chou and Suarez (1994)
Shortwave radiation	Chou and Lee (1996)
Cloud	Slingo (1987)
Gravity wave drag	Alpert et al. (1988)
Land model	Ek et al. (2003)

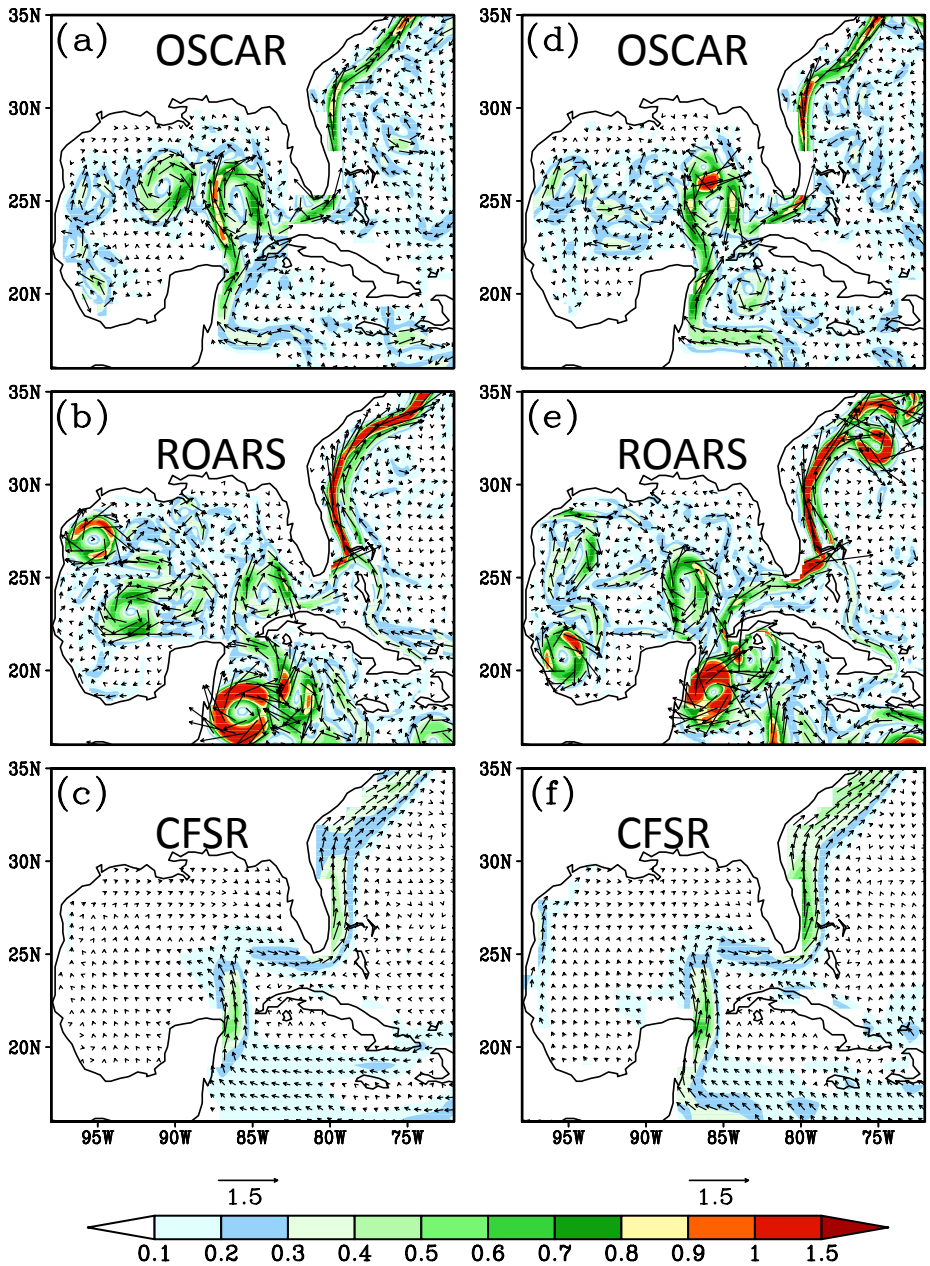
Model domain of RSM-ROMS

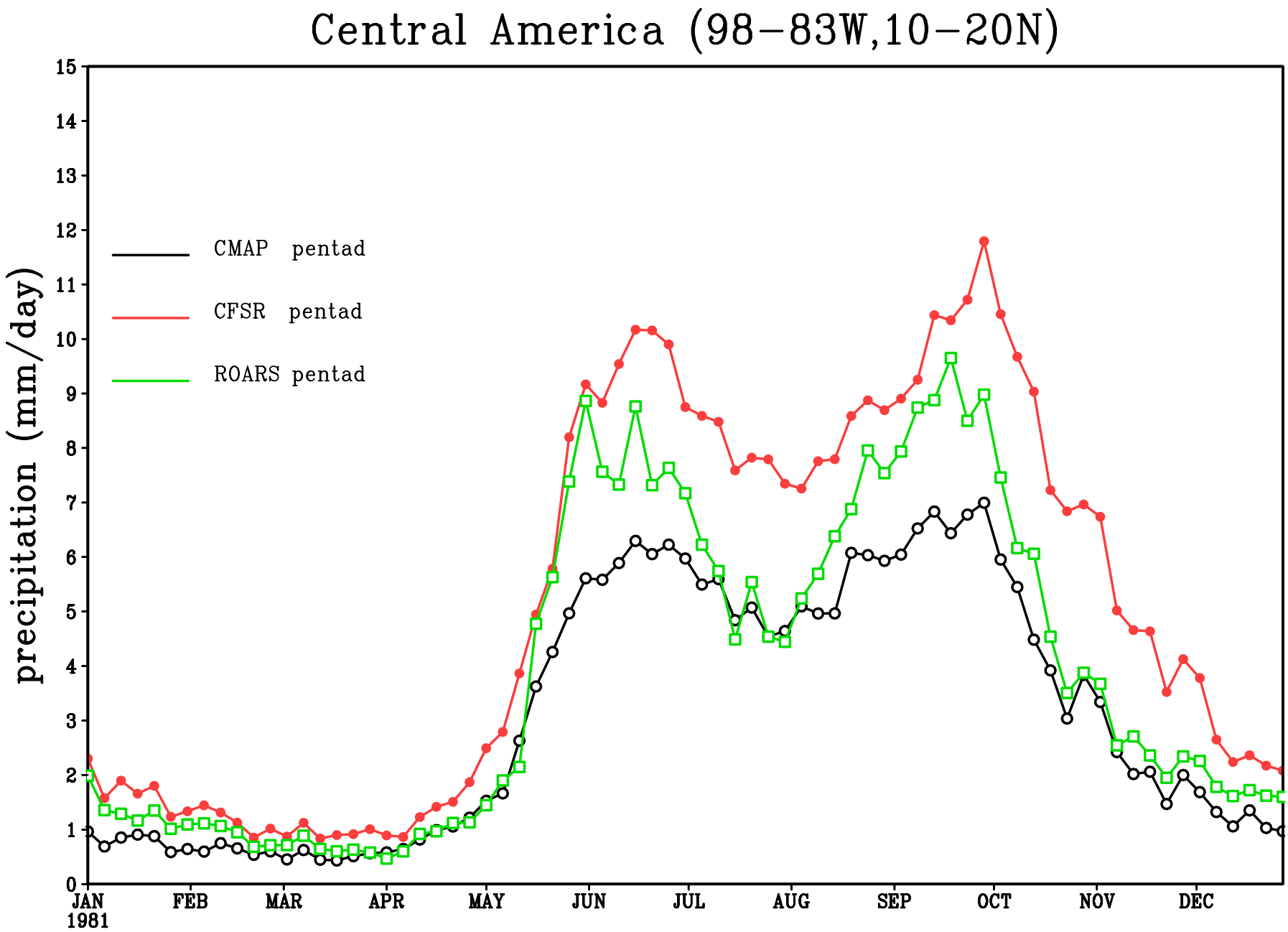


Standard deviation of annual mean Sea Surface Height



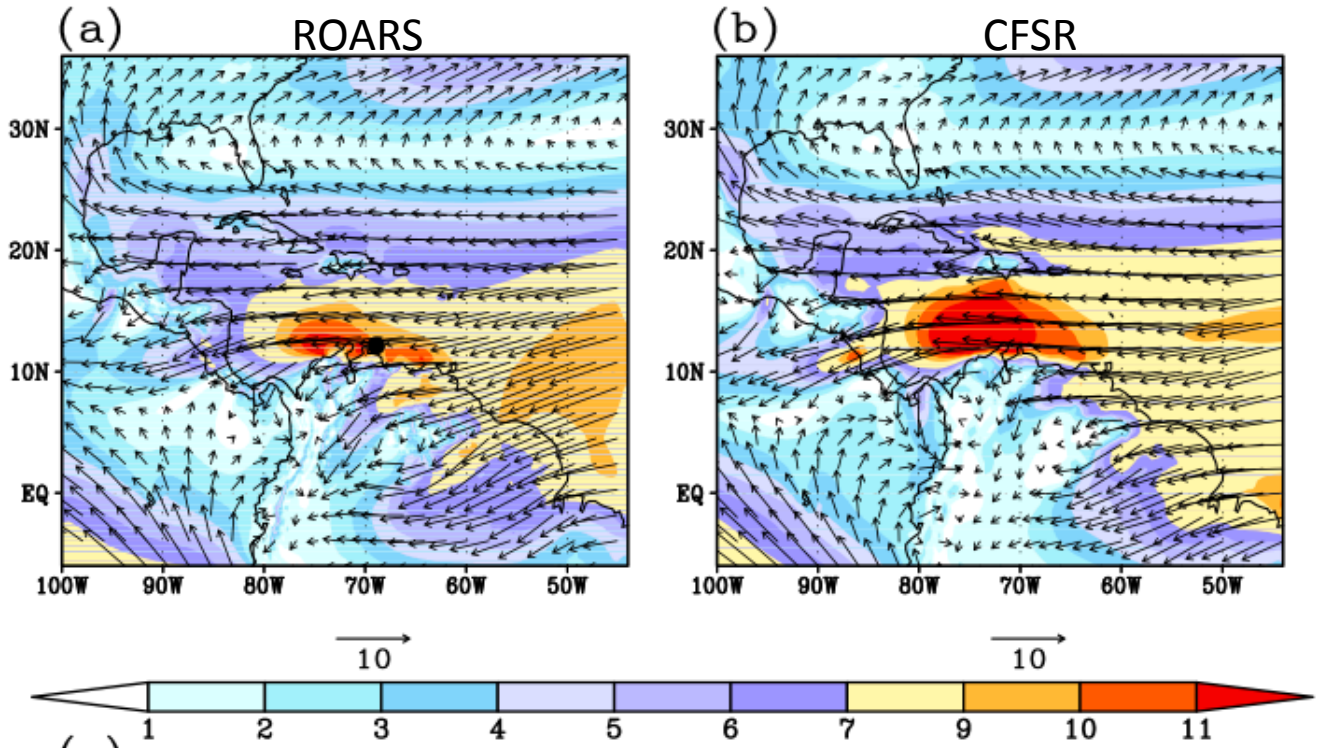
January 2000 July 2000

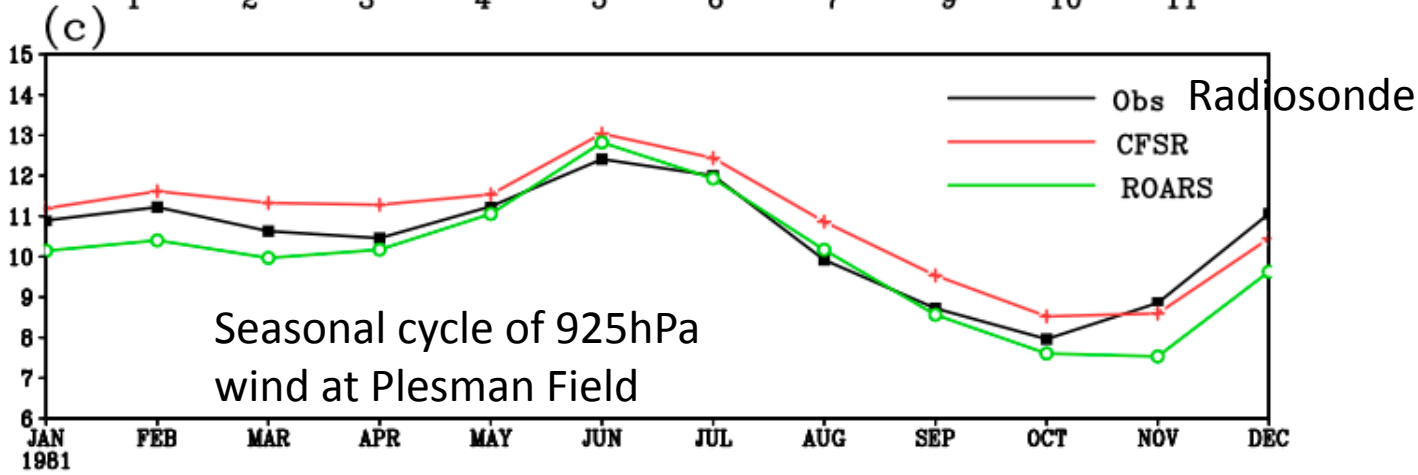



Central America (98-83W,10-20N)
precipitation (mm/day)
CMAP pentad
CFSR pentad
ROARS pentad
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
JAN
1981
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

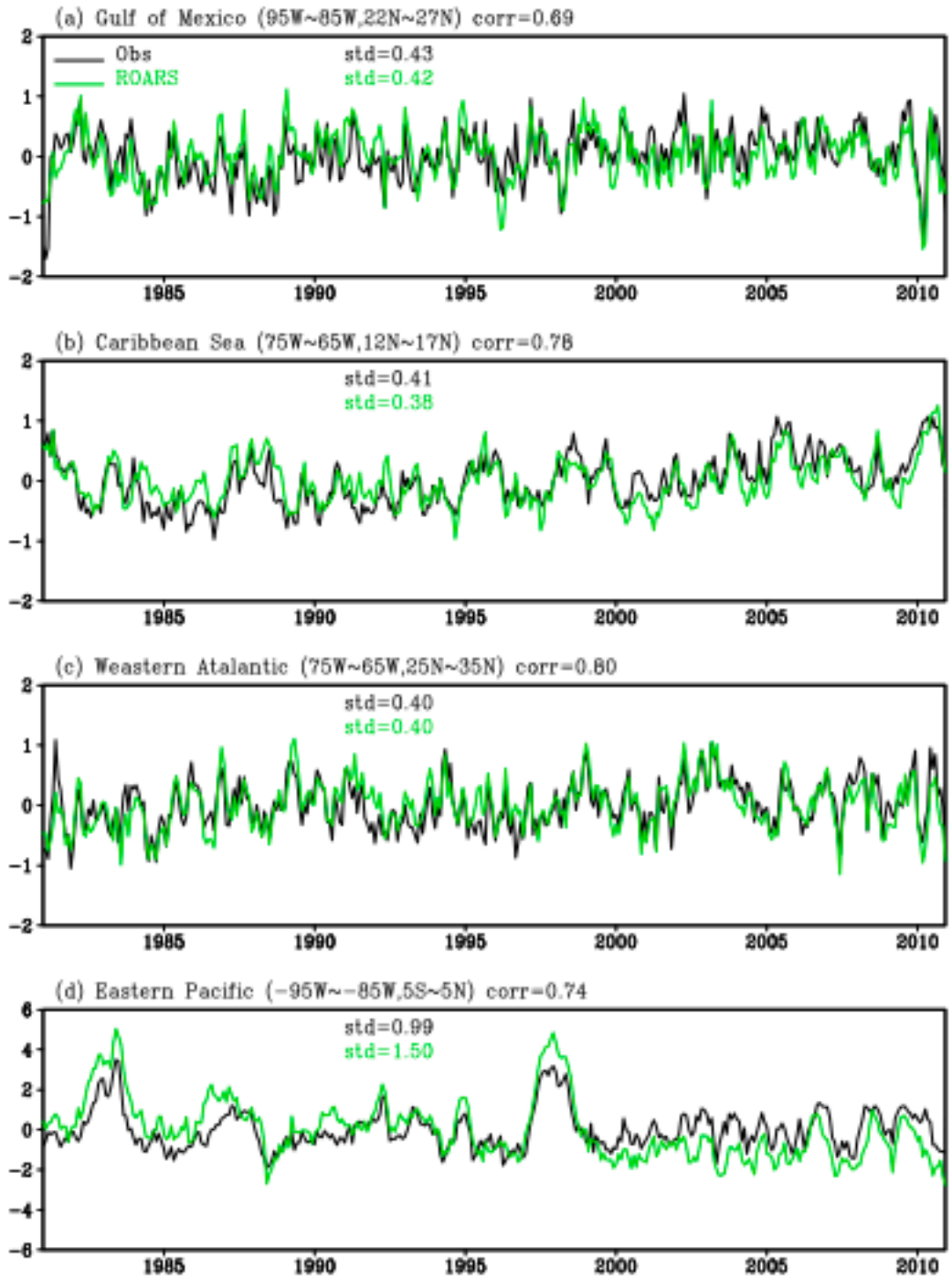
Caribbean Low Level Jet

Annual mean 925hPa wind climatology





Monthly mean SST (C)



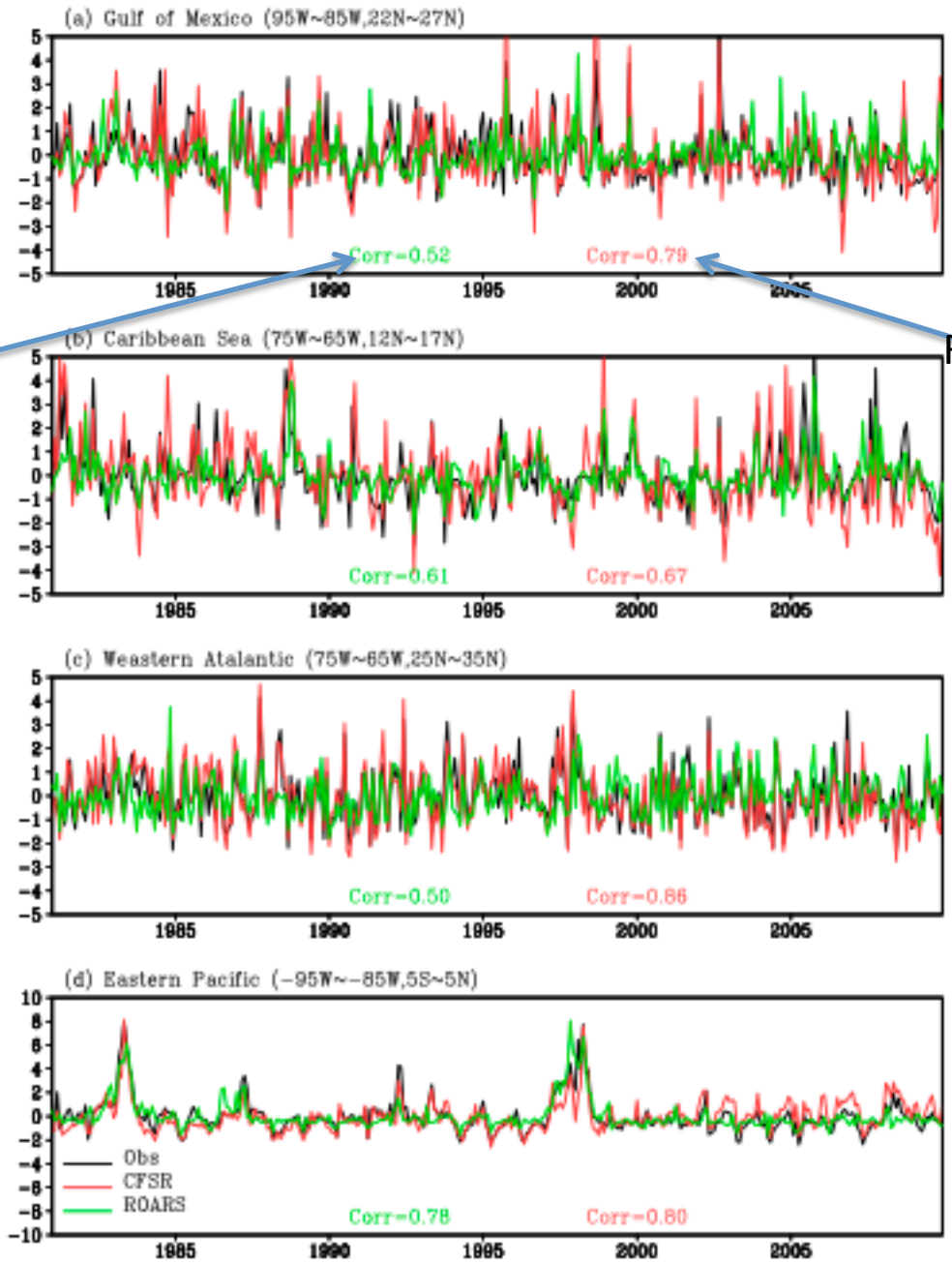
Observations: Reynolds SST at 0.25x0.25

Monthly mean precipitation (mm/day)

Observations: CMAP (2.5x2.5)

CFSR (green)

ROARS (red)



CONCLUSIONS

- Role of IAS on US hydroclimate is quite important and yet ignored!
- **CFSR is resolving loop current barely and not resolving eddies**
- ROARS datasets demonstrates the importance of resolution on simulating loop current and eddies off of it
- ROARS demonstrates that you can downscale from very coarse global reanalysis (R2 and SODA) to resolve the IAS features---**shifting paradigm for regional modeling**