The Impact of the MJO on Atlantic Tropical Cyclone Activity in NOAA's CFS Model

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Two versions of NOAA/NCEP CFS Model:

1) CFS T382 (38 km): GFS, MOM3
   5 members initialized in April each year
   1981-2008 (28 yrs)
   Experimental version of CFSv2

2) CFSv2 (T126) (94 km): GFS, MOM4
   Noah land surface model
   4 times daily, 1999-2010 (12 yrs)
   (Saha et al. 2014)

For predictability of MJO and TCs, CFSv2 model version used.

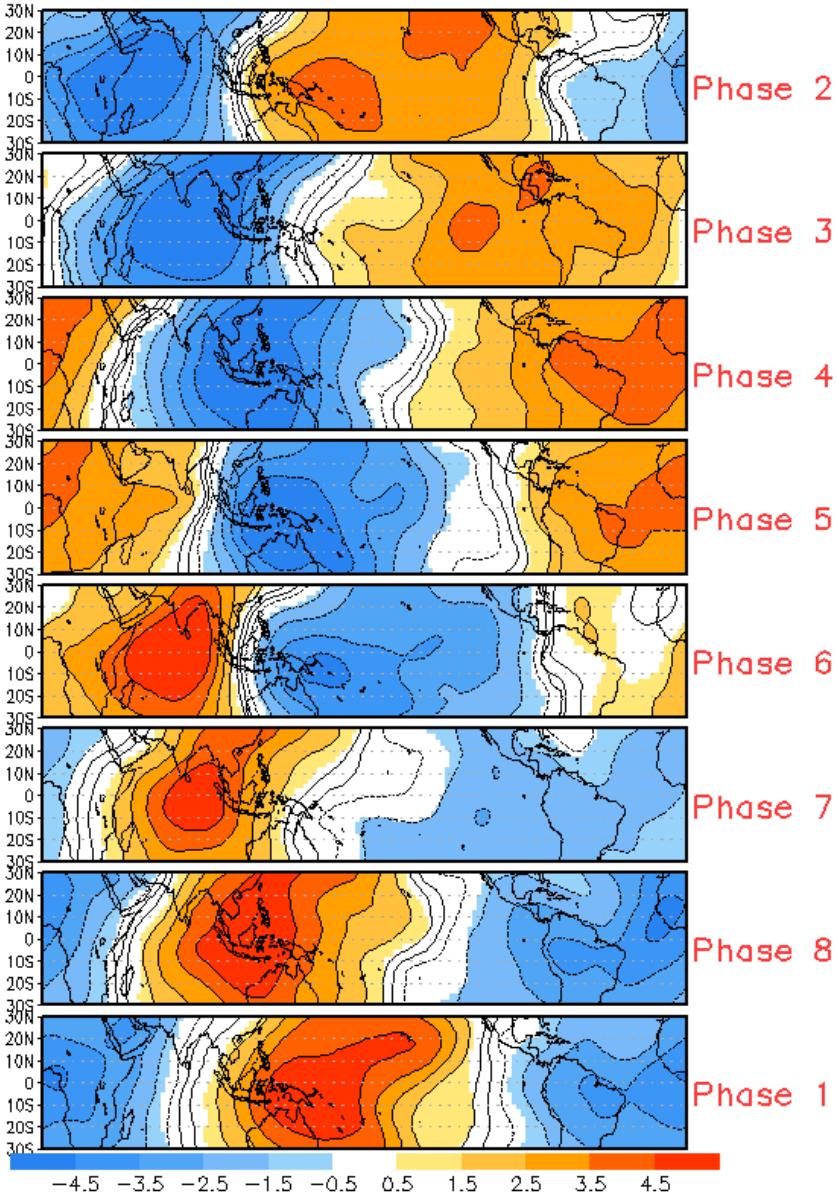
For more detailed MJO vs. TC relationships, CFS T382 used.

Model Atlantic tropical cyclone activity described using tracking methods of Camargo and Zebiak (2002).

Model MJO defined using method of Wheeler and Hendon (2004), using EOF1 and EOF2, using 200hPa and 850hPa wind and OLR.

MJO Phases
(OLR anomaly)

from
Wheeler &
Hendon (2004)



Hurricane-enhancing

{ *Hurricane inhibiting* }

Hurricane-enhancing

Obs

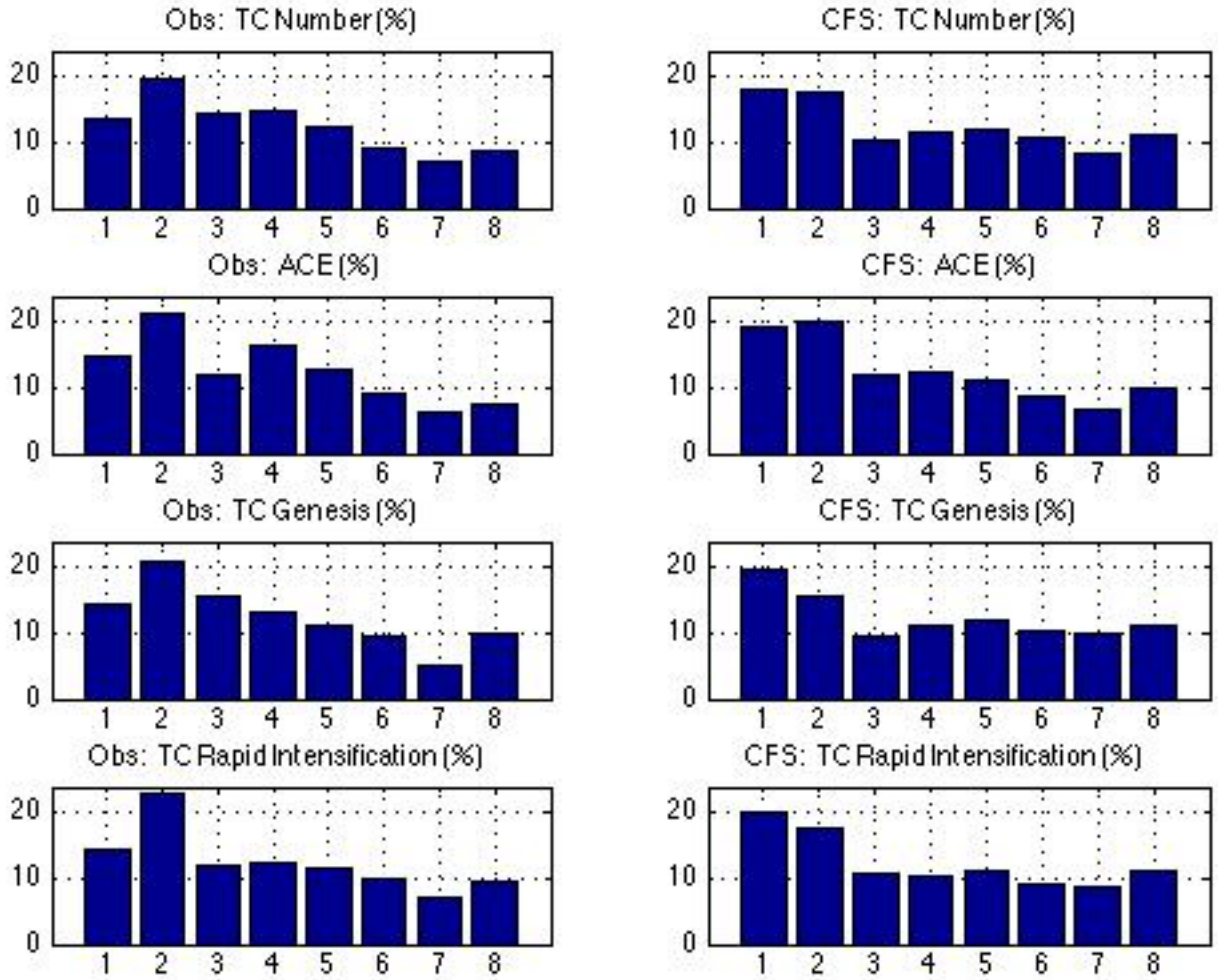
CFS T382

TC Number

ACE

Genesis

Rap Intensif



MJO Phase

MJO Phase

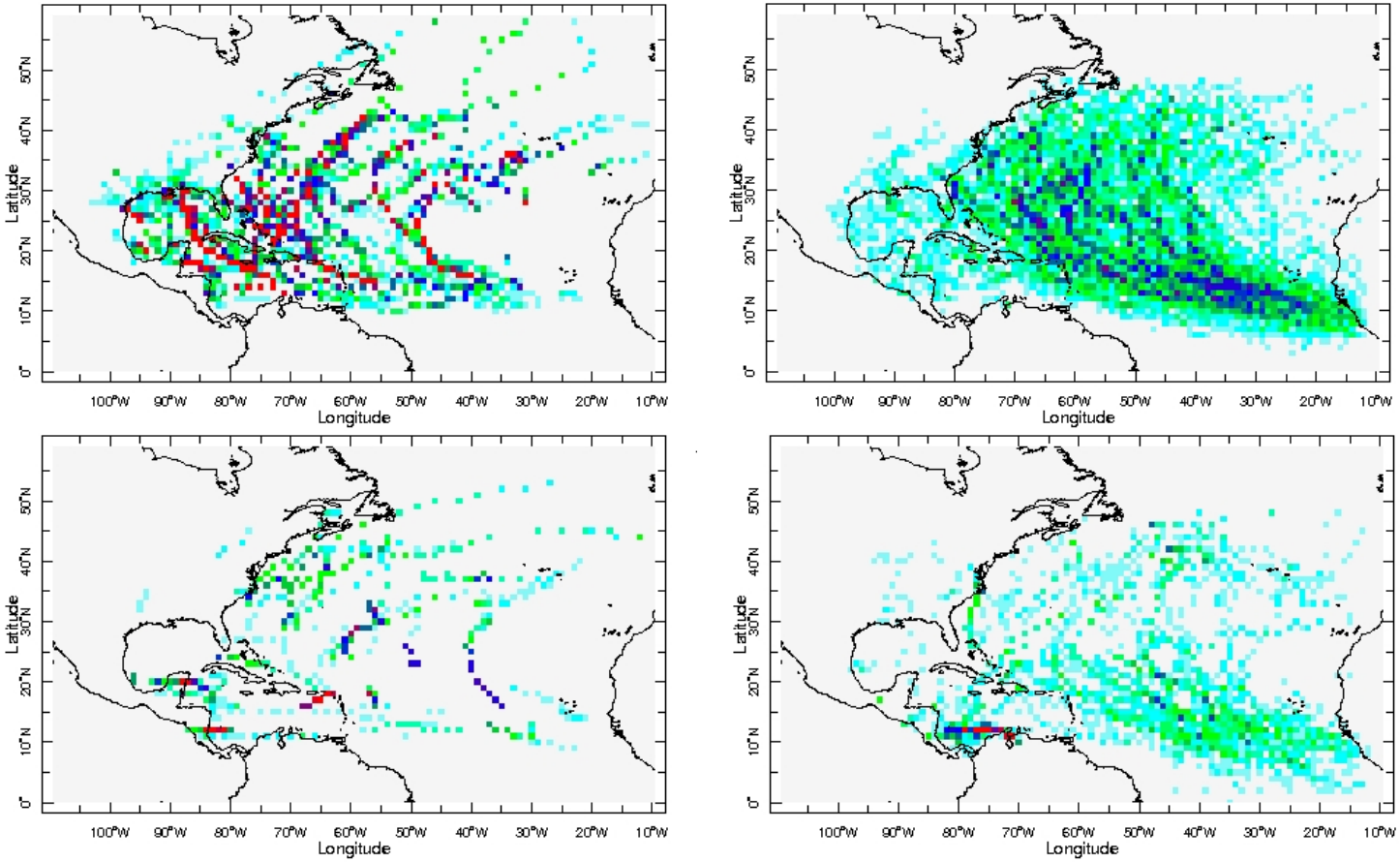
ACE

Obs

CFS T382

MJO Phase 2

MJO Phase 7

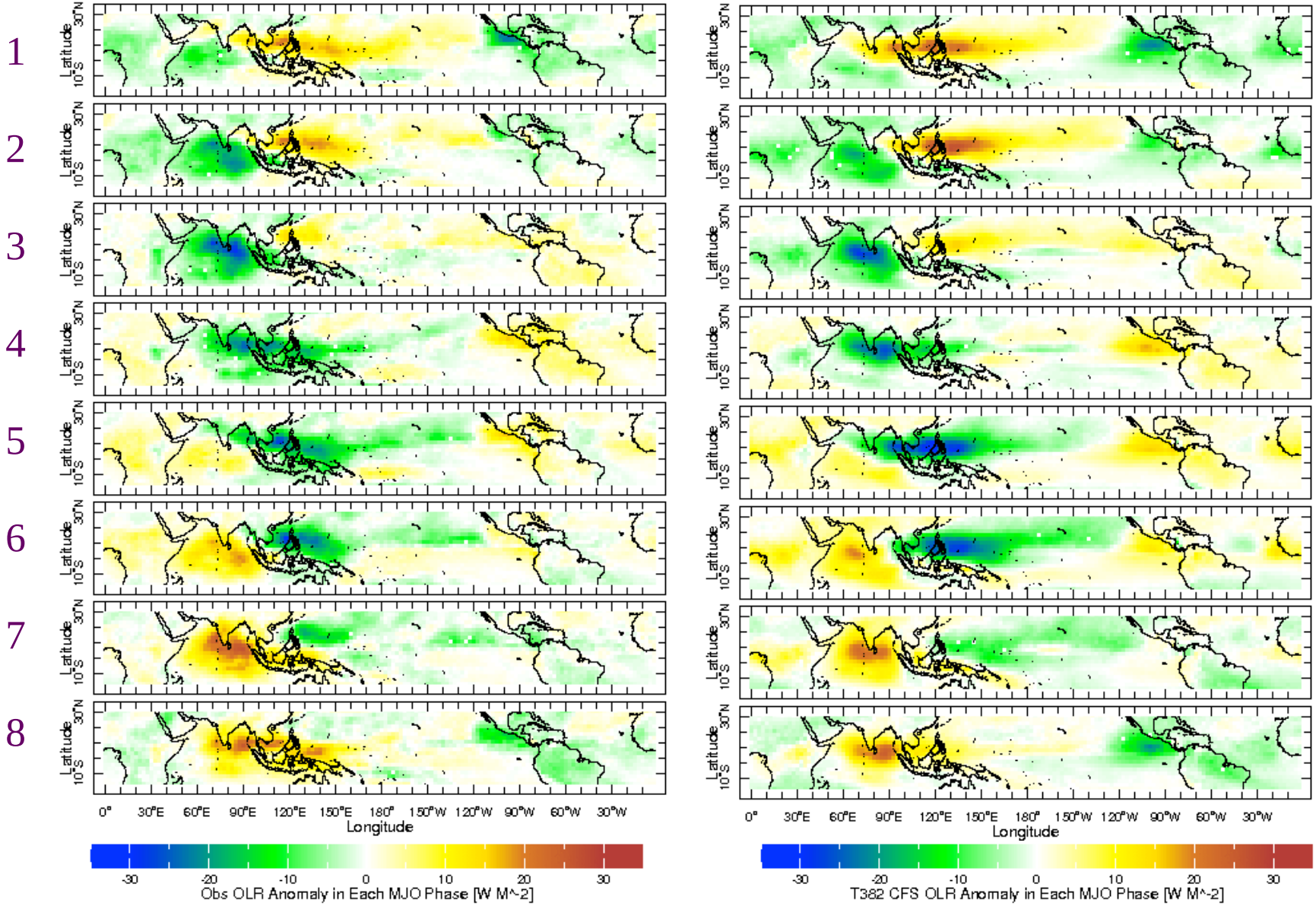


7.0 ACE

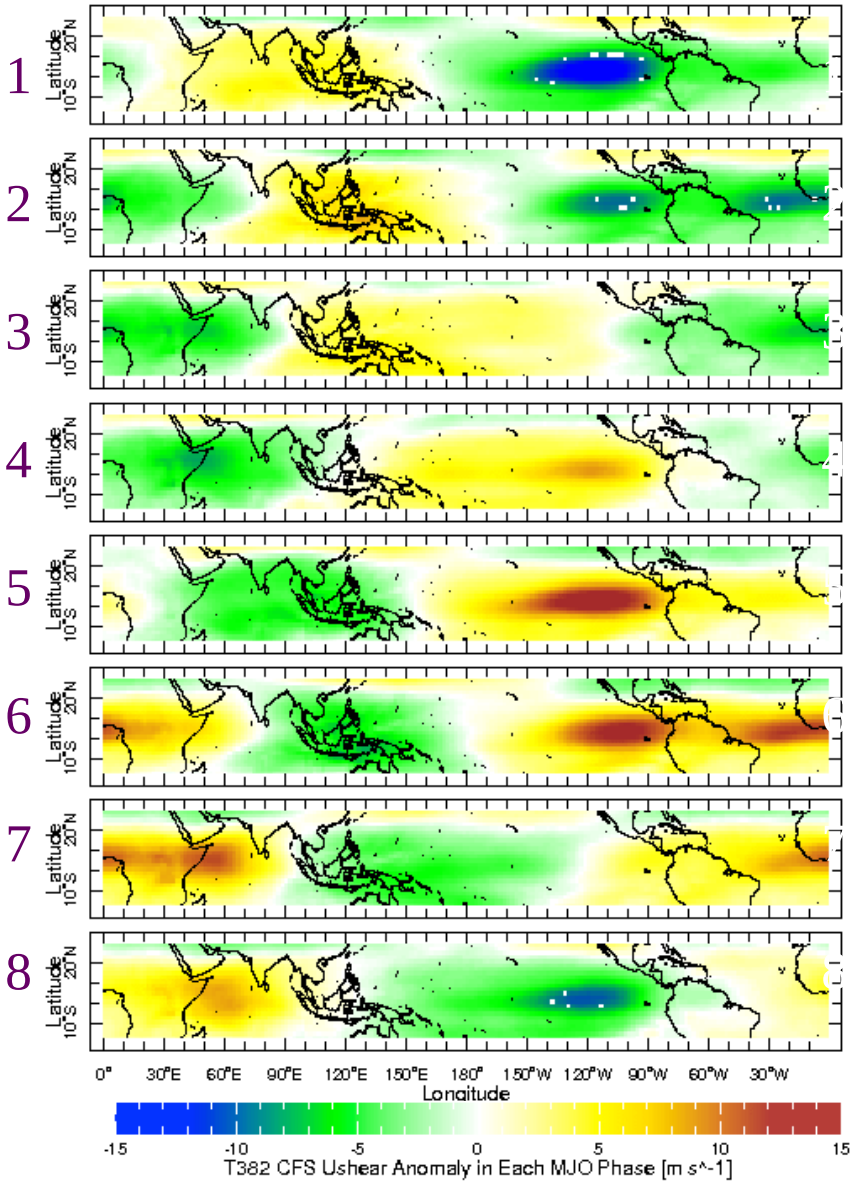
7.0 ACE

OLR Anom – Observations

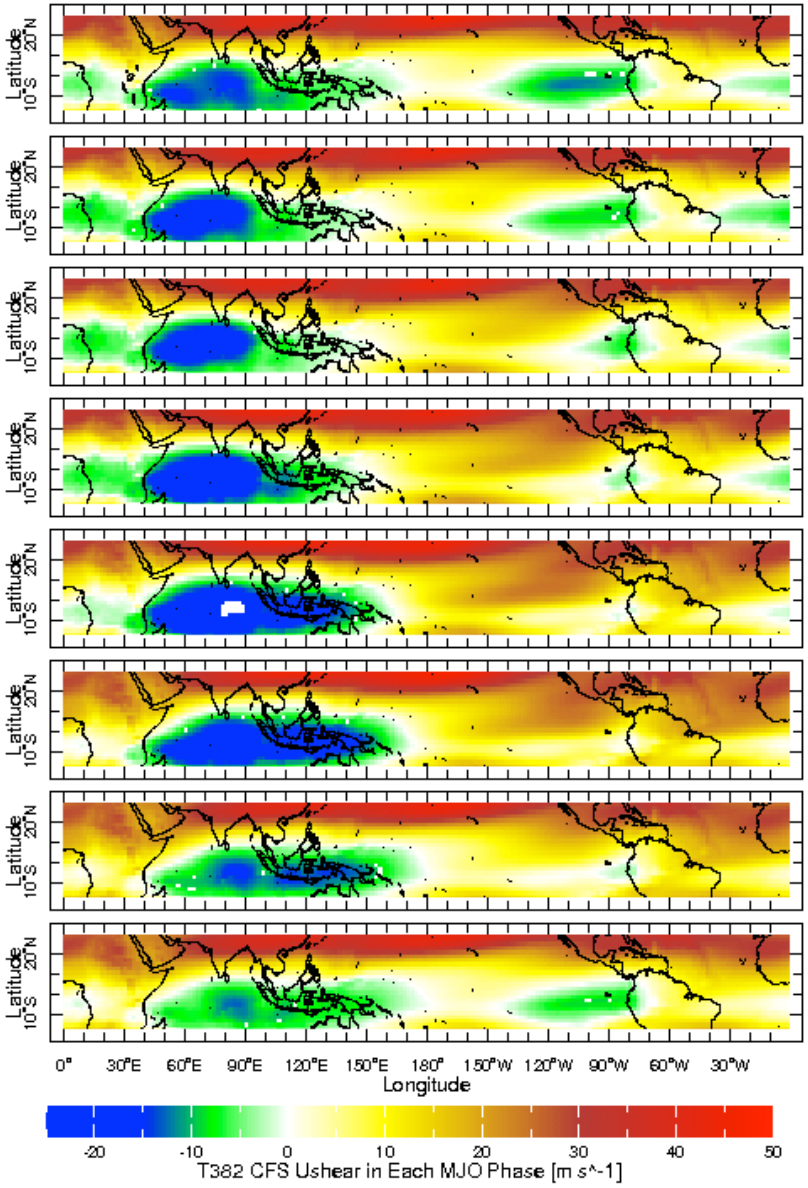
OLR Anom – CFS T382



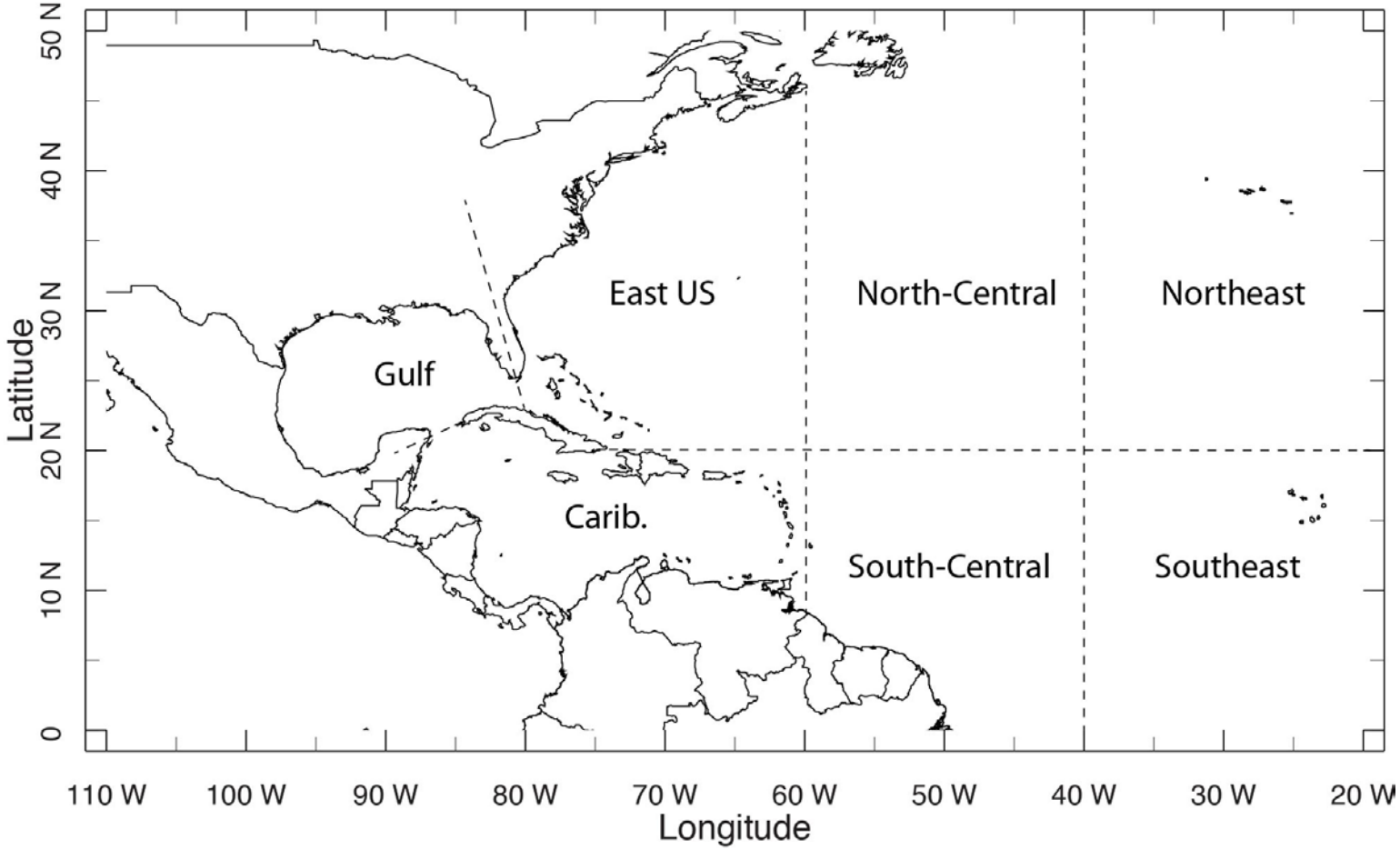
Ushear Anom – CFS T382



Ushear – CFS T382

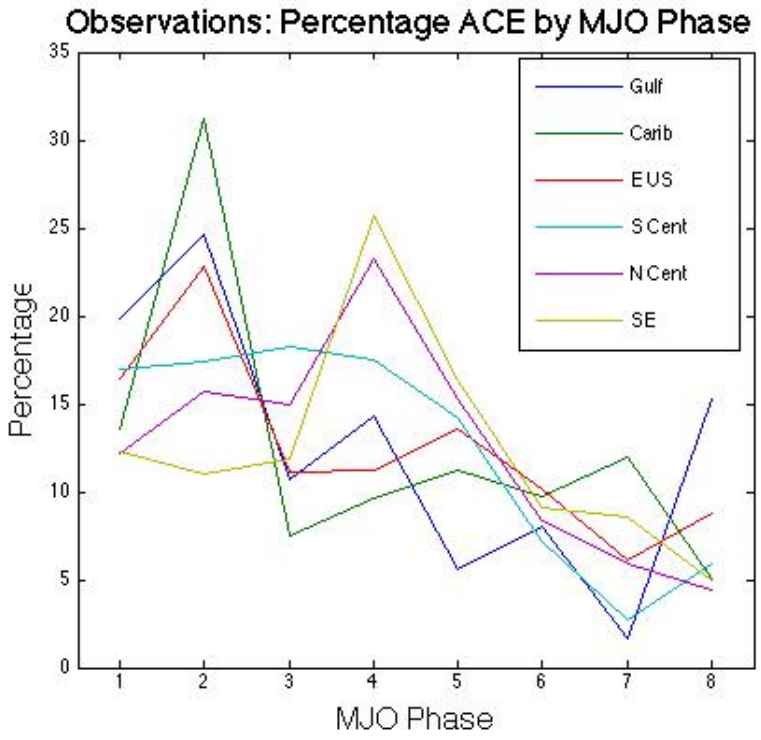


North Atlantic Sectors

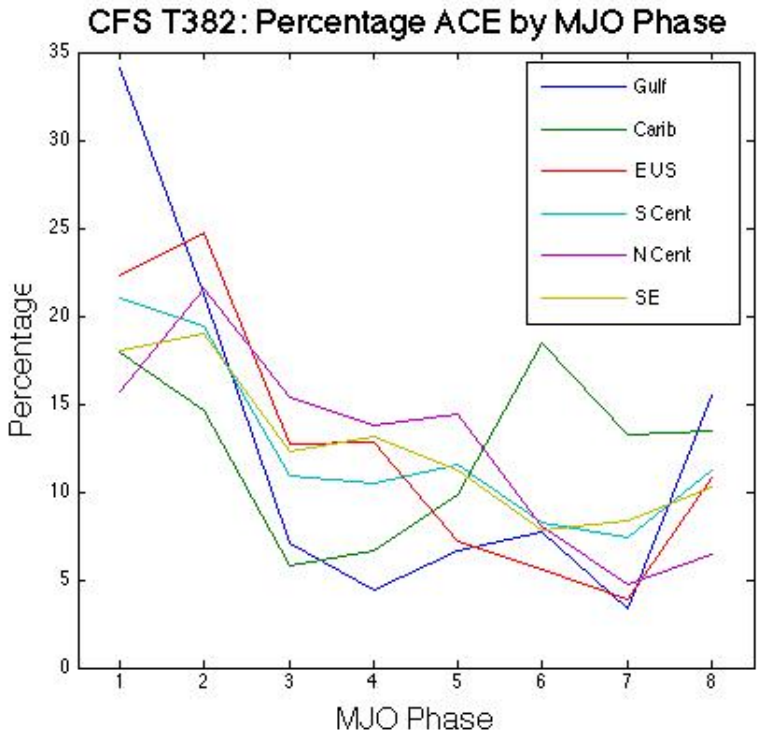


Percentage ACE by MJO Phase for Each of 6 Sectors

Obs



CFS T382



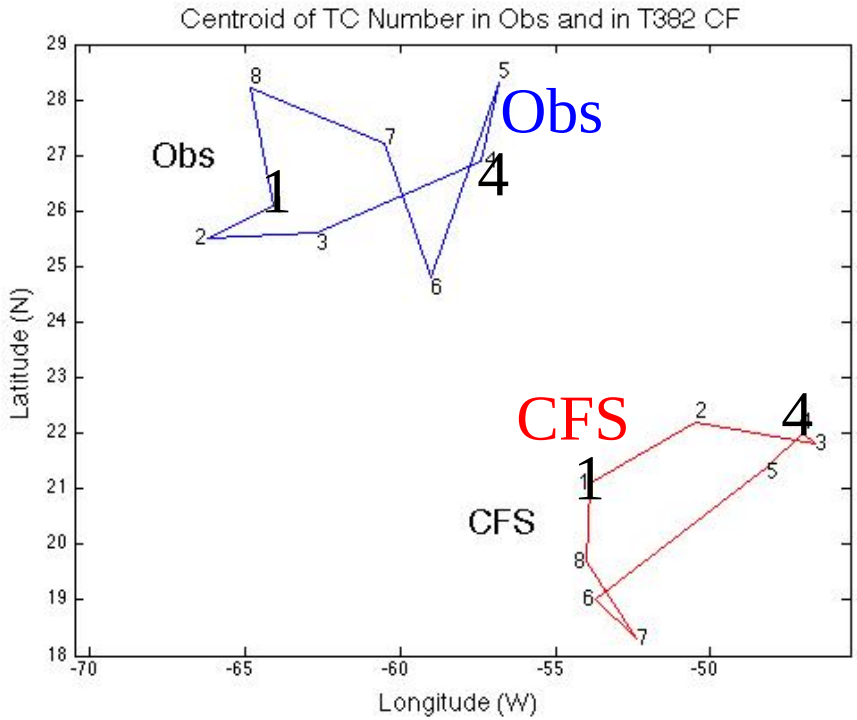
Correlation between ACE in each subsector and ACE in Atlantic basin as a whole, over 8 MJO phases, for obs and CFS T382 model.

	Observations	CFS T382 Model
Gulf of Mexico	0.74	0.80
Caribbean	0.75	0.19
East US	0.90	0.98
South-Central	0.84	0.97
North-Central	0.77	0.87
Southeast	0.52	0.99

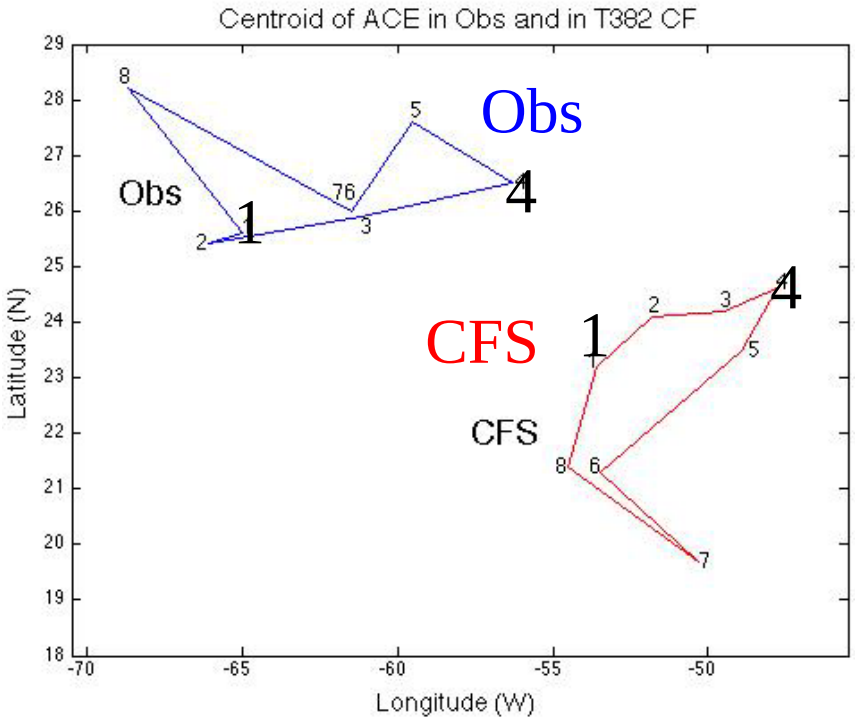
ACE in subsectors tends to parallel that in basin as whole

Centroid of TC Activity by MJO Phase for Obs and CFS T382

TC Number



ACE



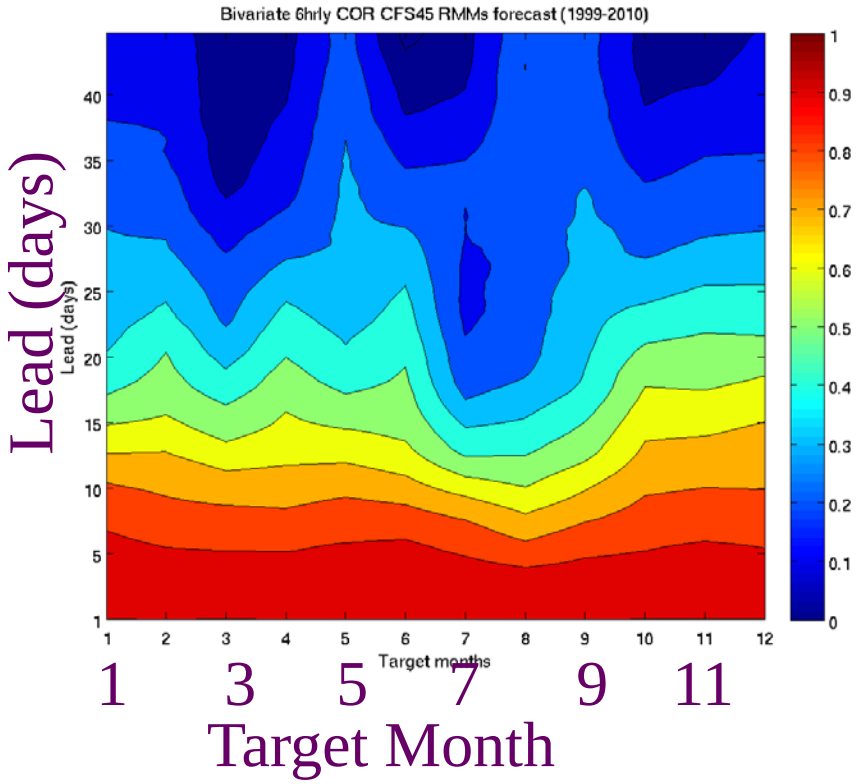
CFS T382 has activity farther to southeast than observations.

If we average the centroids of 2 running phases (e.g. phases 1 and 2, 2 and 3, etc.), the zonal direction of the centroid changes only twice per cycle, for TC number and ACE, for both observations and T382 model.

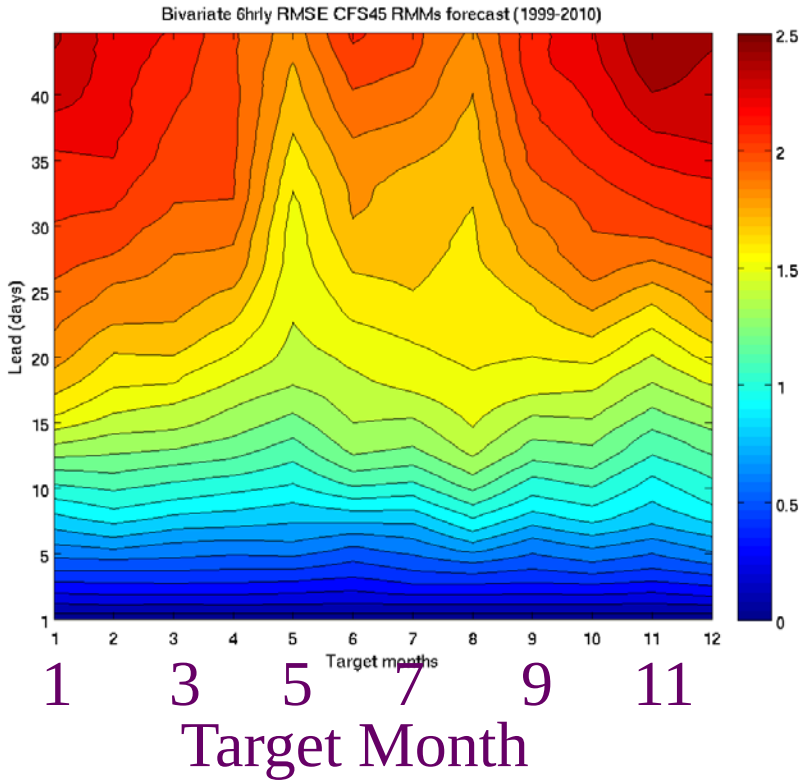
Probability of just two changes per cycle by chance is 0.22. So evidence of systematic propagation behavior is statistically weak.

Skill in CFSv2 predictions of MJO behavior (RMM1 And RMM2)

Correlation



RMSE



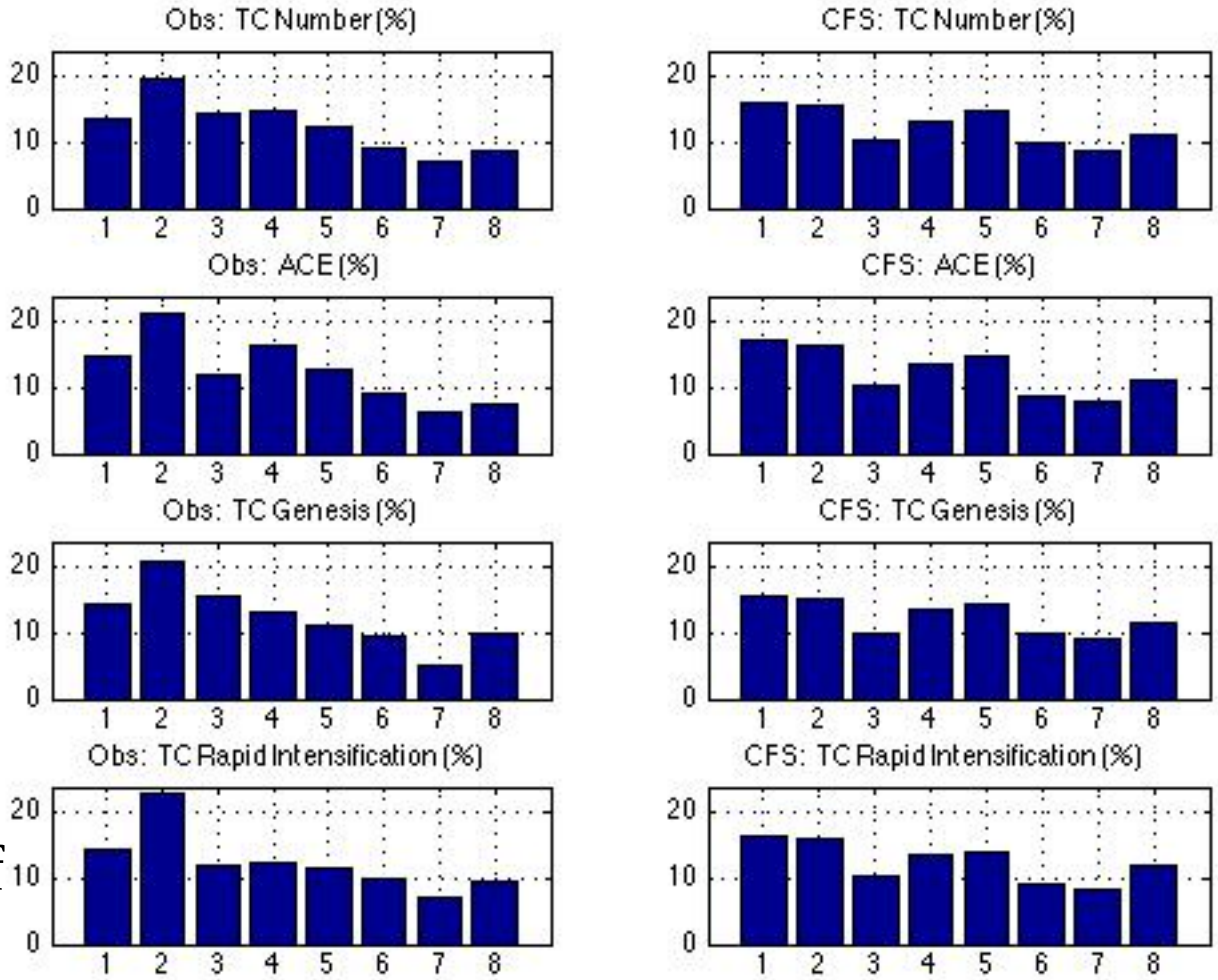
1999-2010 Obs CFSv2

TC Number

ACE

Genesis

Rap Intensif



MJO Phase MJO Phase

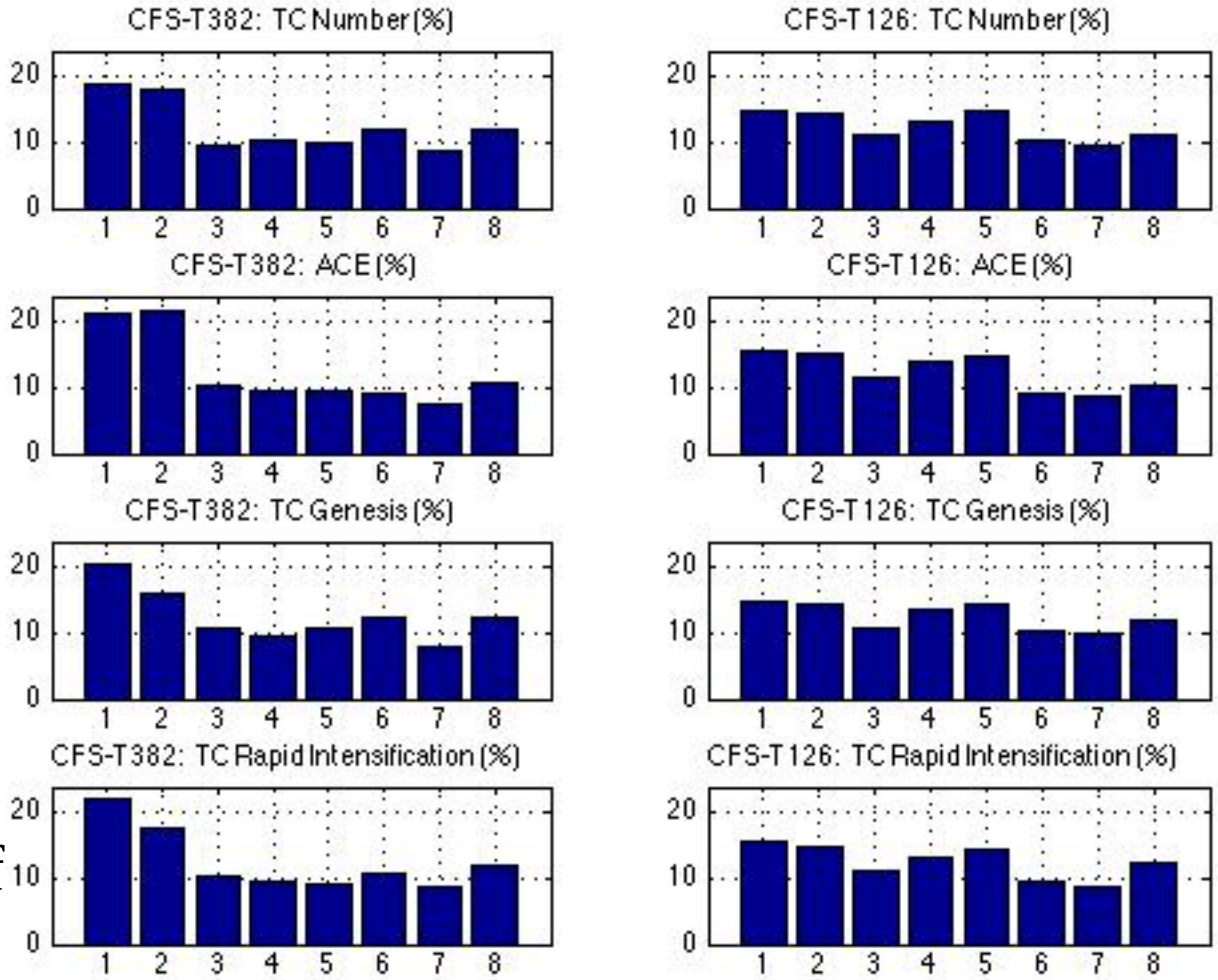
1999-2008 CFS T382 CFSv2

TC Number

ACE

Genesis

Rap Intensif

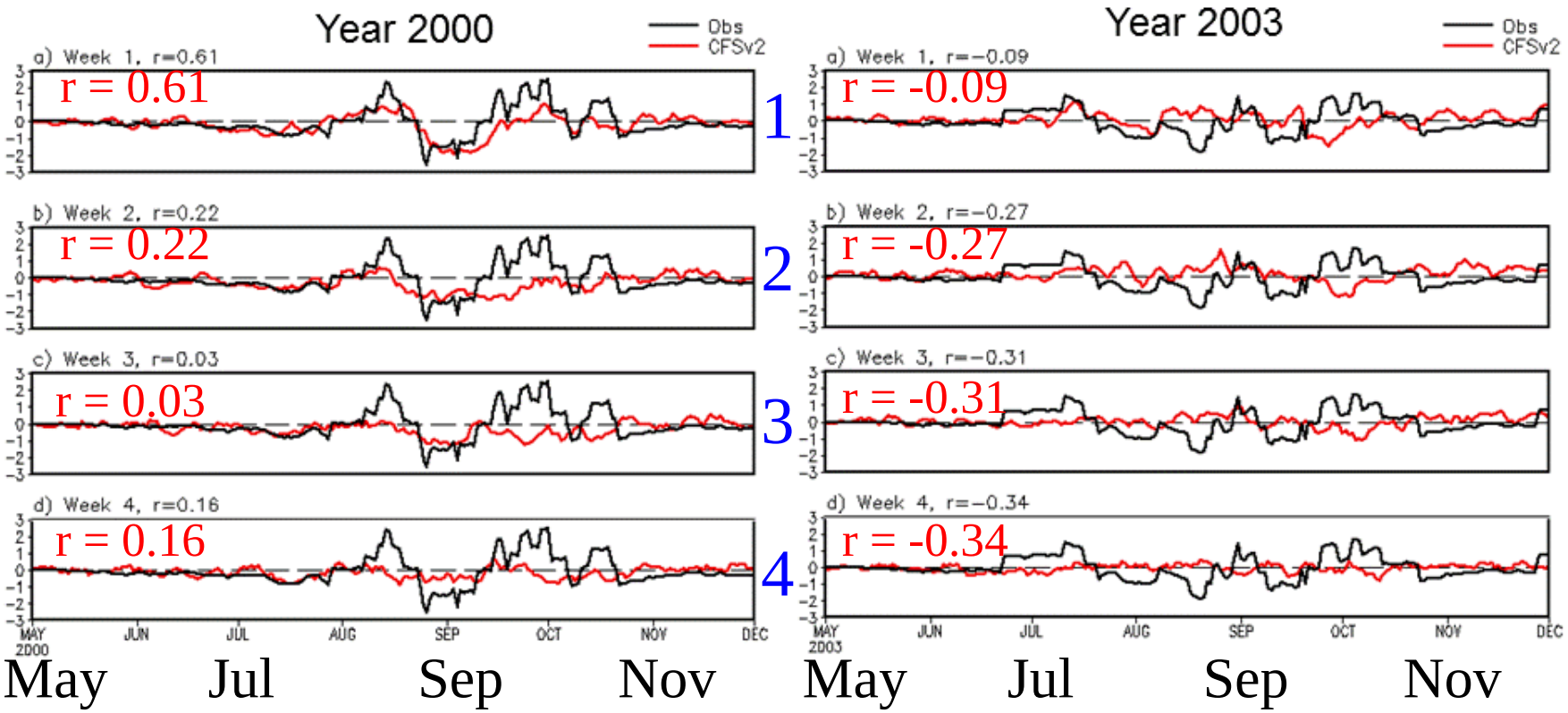


MJO Phase MJO Phase

Comparison of Model vs. Observed Atlantic TC Activity: Variation as a Function of MJO Phase

Model Version	Analysis Period	Integrated TC Activity	
		Cor	RMSE
T382 CFS	1981-2008 (own)	0.73	3.1
T382 CFS	1999-2008 (common)	0.62	3.8
CFSv2 (T126)	1999-2010 (own)	0.75	2.9
CFSv2 (T126)	1999-2008 (common)	0.71	3.1

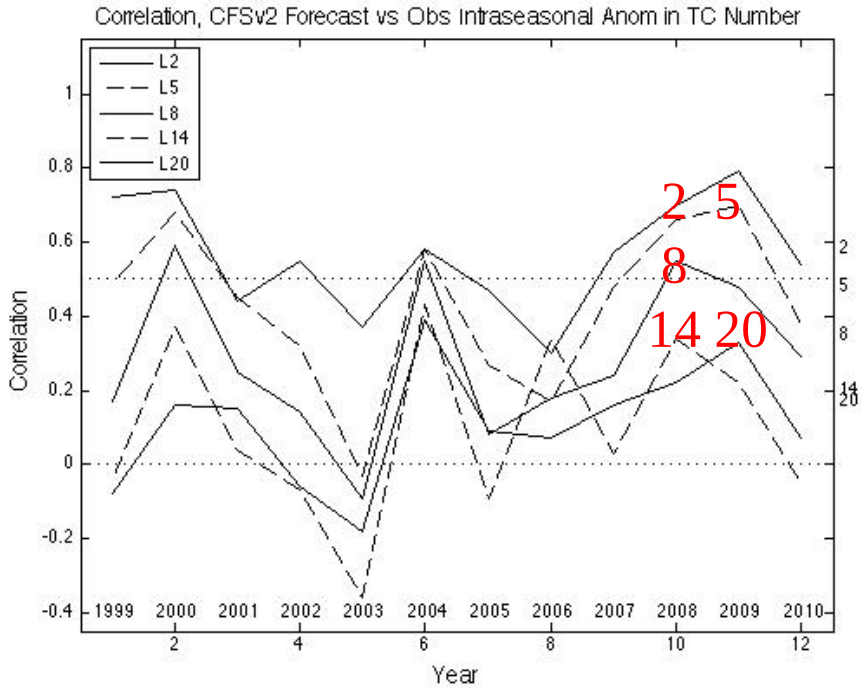
CFSv2: Verification of TC Number in North Atlantic: 2000, 2003



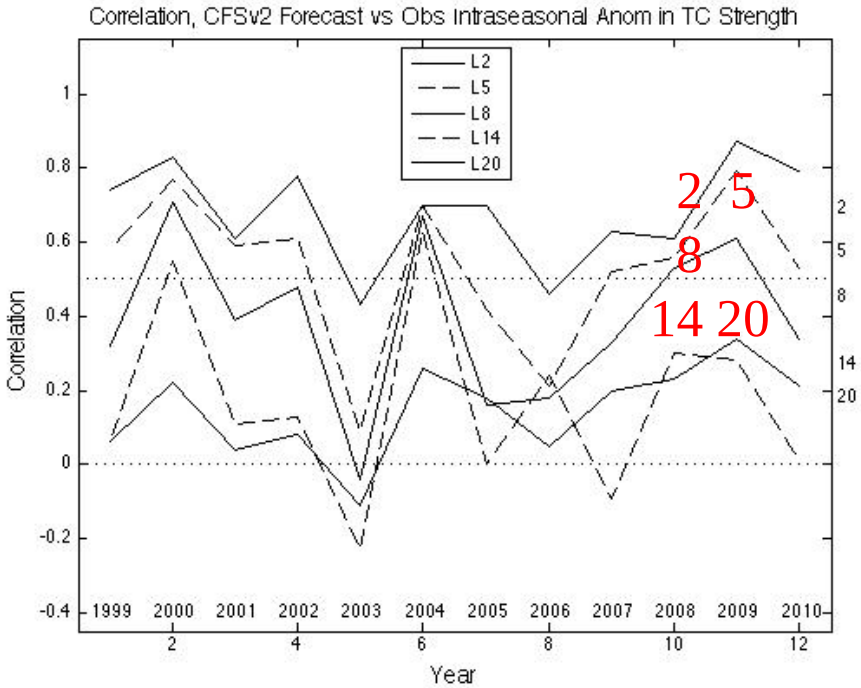
CFSv2: Correlation Skill by Year, 1999-2010

5 lead times: 2, 5, 8, 14, 20 days

TC Number



ACE



Conclusions

1. Both the T382 CFS and CFSv2 (T126) reproduce MJO behavior fairly realistically, as well as the observed relationships between MJO phase and TC activity.

2. Minor biases are noted in the T382 CFS environmental fields.

3. Weak tendency for eastward propagation of TC activity with MJO phase noted in T382 CFS (probably not useful for forecasts).

4. CFSv2 shows useful skill ($r>0.5$) in predicting MJO to ~3 weeks, and in predicting TC activity anomalies out to 1-2 weeks.

5. An advantage of higher resolution is unable to be confirmed (differing historical period, different ocean model components).