US National Oceanic and Atmospheric Administration
Climate Test Bed Joint Seminar Series
IGES/COLA, Calverton, Maryland, 21 January 2009

Dynamic Hurricane Season Prediction Experiment with the NCEP CFS CGCM

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A series of experimental forecast runs with the NCEP Climate Forecast System (CFS) coupled GCM was made to examine the feasibility of dynamical hurricane season prediction as one of the Climate Test Bed internal projects in 2007/2008. A series of 7-month forecast experiments with the initial conditions in mid-April during 1981-2008 were made in T382 spectral resolution to evaluate tropical storm statistics in the CFS at the highest possible spatial resolution. This is a preliminary report based on the experimental runs and a set of CFS runs in the T62, T126 and T382 resolutions initialized at 0Z, May 15 for 1981-2008.

Tropical storms in the CFS runs were identified using the tropical storm detection method devised by Carmago and Zebiak (2002). Storms depicted in the CFS have very realistic tracks in all four basins in the Northern Hemisphere (Fig. 1) and a robust seasonal cycle (Fig. 2a). Comparisons of interannual variability in storm activities (Fig. 2b) indicate that the CFS has a reasonable skill and captures the shift to more active storm era in the Atlantic basin during the post-1995 period. Two environmental variables that control interannual variability in storm activity over the Atlantic basin are sea surface temperature (SST) and vertical wind shear over the main development region. The T382

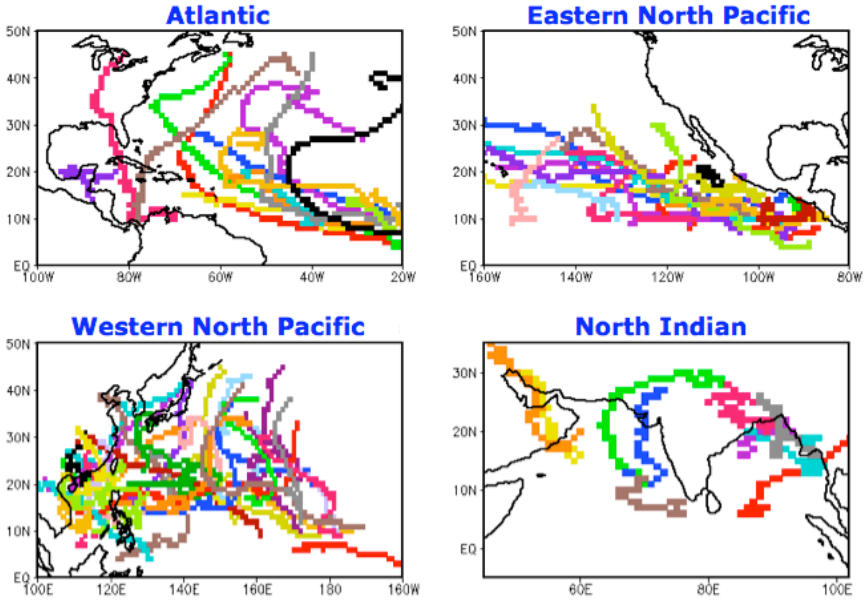

Fig. 1 Examples of tropical storm tracks over the four basins in the Northern Hemisphere depicted in one of CFS hindcast runs. Each color represents an individual storm.

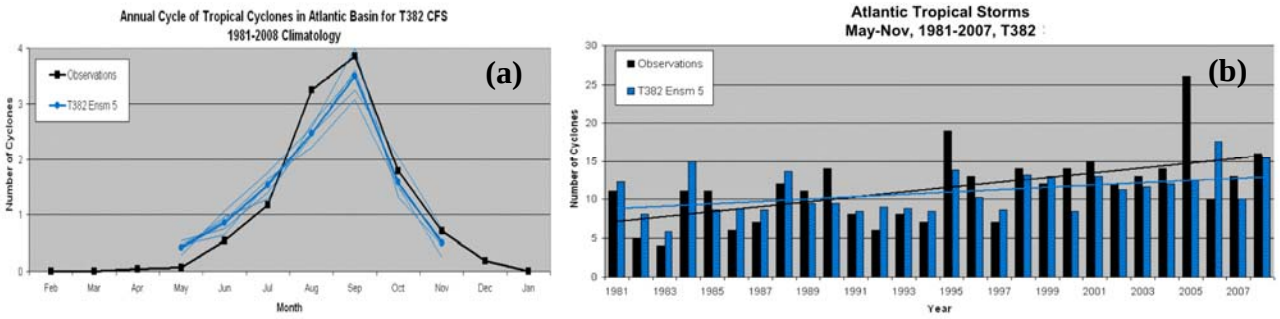

Fig. 2 Climatological seasonal cycle (left panel, a) and interannual variability of tropical storms (right panel, b) for the Atlantic basin. Black lines and black bars correspond to seasonal cycle and number of storms based on observations over the 1981-2008 period, and blue lines and blue bars are for those from CFS hindcast ensemble runs. Straight lines in the right panel represent linear trends over the period.

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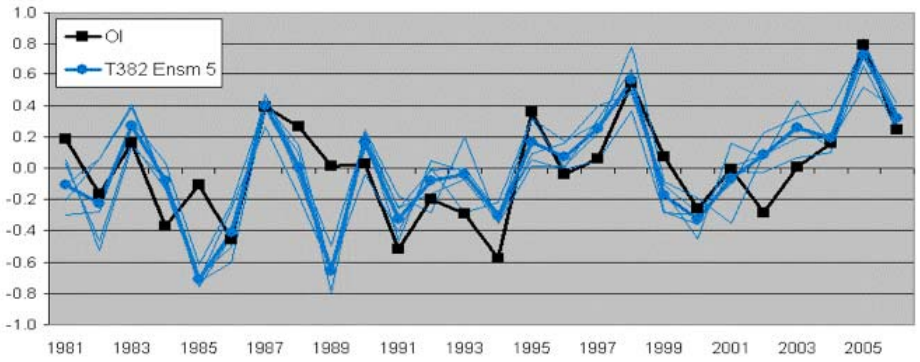
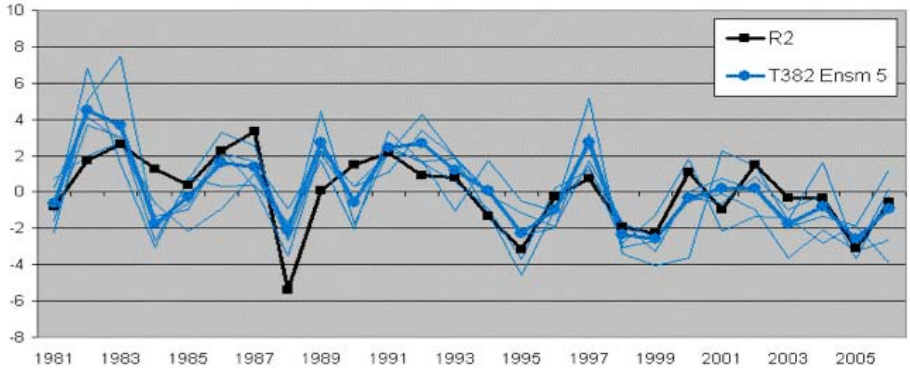


T382	Correlations
IC=0419	0.63
IC=0420	0.64
IC=0421	0.73
IC=0422	0.67
IC=0423	0.67
April Ensm 5	0.71

Red = Statistically Significant at 0.95

Fig. 3 Interannual variability of JJA SST index over the Atlantic Main Development Region (20ºW-80ºW, 10ºN-20ºN) and anomaly correlation scores of each ensemble member and the ensemble mean. Black line corresponds to the SST index based on the NCEP OI SST analysis and blue lines to the index from CFS hindcast runs.



T382	Correlations
IC=0419	0.43
IC=0420	0.54
IC=0421	0.66
IC=0422	0.68
IC=0423	0.69
April Ensm 5	0.70

Red = Statistically Significant at 0.95

Fig. 4 Interannual variability of JJA wind shear index over the Atlantic main development Region (20ºW-80ºW, 10ºN-20ºN) and anomaly correlation scores of each ensemble member and the ensemble mean. Black line corresponds to the shear index based on the NCEP/DOE Reanalyis-2 and blue lines to the index from CFS hindcast runs.

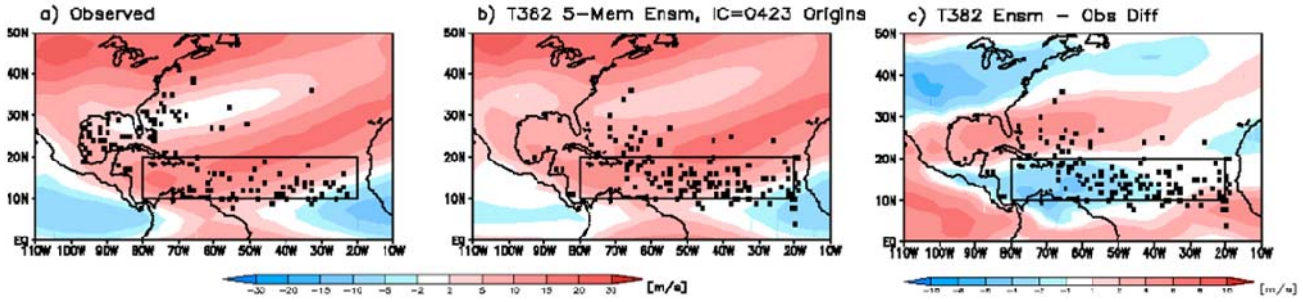


Fig. 5 JJA tropical storm origins (black square) and climatological vertical wind shear (shaded) from observations (a) and CFS hindcast runs (b). Right panel shows wind shear bias and the storm origins in the CFS (c).

CFS has shown a fair level of skill in predicting these environmental conditions over the region (Figs. 3 and 4). A preliminary analysis of bias of storm origins in the CFS hindcasts indicates that over the Atlantic basin, more storms tend to form over the Main Development Region (MDR, 20W-80W, 10N-20N) and that fewer storms form over the Gulf of Mexico and along the east coast of US (Fig. 5). The primary factor controlling storm formation is found to be the vertical wind shear over the basin. Compared to observations, the CFS hindcasts have weaker shear bias over the MDR and stronger bias over the Gulf of Mexico and the Atlantic north of 20N (Fig. 5c).

Companion experiments with the CFS in T62 and T126 resolutions were also conducted to investigate the impact of spatial resolution on storm statistics. The structure and intensity of storms in the lower resolution runs did not compare so well to the observed as in the T382 cases. However, the computing resources needed for routine operation of the T382 CFS are very large in the current computing environment. The T126 resolution might be a good compromise in view of the relatively comparable number of storms generated and the advantage of adopting a multi-member ensemble approach.

Reference

Carmago, S. J. and S. E. Zebiak, 2002: Improving the detection and tracking of tropical cyclones in atmospheric general circulation models. *Weather and Forecasting*, **17**, 1152-1162.