Simulating diurnal variations over the southeastern United States

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INTRODUCTION

The southeastern United States is, climatologically speaking, the wettest region of the United States (Chan and Misra 2010), and a major contributor to this are convectively driven diurnal rainfalls (Bastola and Misra 2013). Numerous models have been employed to study this phenomenon, but little attention has been given to how well the model configurations used are able to model diurnal rainfall.

In this study, we analyze the ability of the Regional Spectral Model (Kanamaru and Kanamitsu 2007) to recreate observed NCEP Stage IV (Lin and Mitchell 2005) rainfall data. We test multiple boundary conditions using the Relaxed Arakawa-Schubert (RAS) and Kain-Fritsch 2 (KF) convection schemes. Boundary conditions used are the NCEPR2, ECMWF 40-year Reanalysis (ERA40) and 20th Century Reanalysis (20CR). (Kanamitsu et al. 2002, Uppala et. al 2005, Compo et al. 2011)

METHODOLOGY

Model integrations are carried out over the period of January 1st, 1989 to December 31st, 1999 using the configurations mentioned in the introduction. Simulated temperatures and precipitation are validated against the NLDAS-1 forcing package for the period 1997-2007 and STAGEIV rainfall observation data for the period 2003-2010 respectively. A vegetation map of the region can be seen below, in addition to the sub-regions used for Figures 6 and 7. In order to extract diurnal signals, Ensemble Empirical Mode Decomposition is used, a technique that isolates time series into component signals.

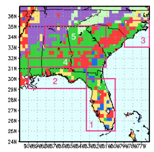


Fig. 1

RESULTS

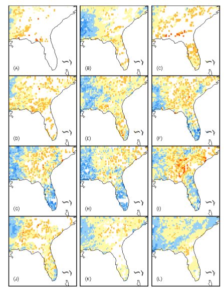
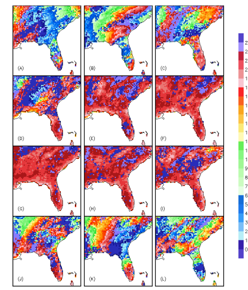


Fig. 2 **Fig. 3**

Filtered amplitude of diurnal precipitation for NCEPR2-KF (left) and time of maximum rainfall rate (right). Note the increase in points throughout the year, matching the strengthening of the diurnal signal, and the homogeneity in time of max during that period



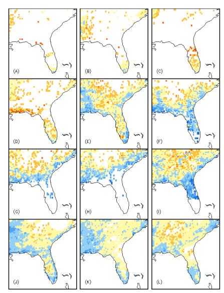
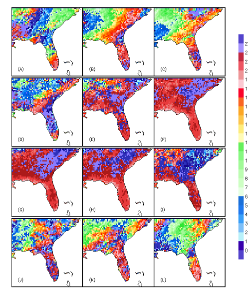


Fig. 4 **Fig. 5**

Filtered amplitude of diurnal precipitation for 20CR-KF (left) and STAGEIV observed time of max (right). In all cases, more points are masked, suggesting that this configuration is not optimal for amplitude modeling.



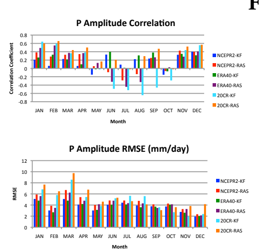
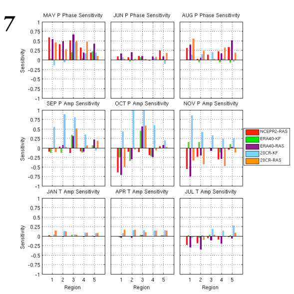


Fig. 6 **Fig. 7**

Histogram of region-wide correlation and RMSE of precipitation amplitude (left) and sensitivity of selected sub-regions, variables and months to lateral boundary conditions and convection scheme choice (right). Sensitivity is defined as $(V_{CONTROL}-V_{EXP})/V_{OBS}$ where V is defined as {P', T', or ϕ_P}



CONCLUSIONS

1. The optimum configuration for the RSM uses NCEP-R2 lateral boundary forcing, and the Kain-Fritsch cumulus parameterization scheme
2. Kain-Fritsch cumulus parameterizations outperform Relaxed Arakawa-Schubert parameterizations in nearly all months in simulating the both the amplitude and phase of diurnal variations in T and P.
3. Both cumulus parameterization schemes produce exceptionally high RMSE when using 20th Century Reanalysis as lateral boundary conditions for most months
4. The phase of precipitation is found to be sensitive to convection schemes choice in all sub-regions in months with strong diurnal signals. An exception is June, as all models model the phase well.
5. Diurnal temperatures are insensitive to both cumulus parameterization and lateral boundary forcing for all sub-regions, for all months.

ACKNOWLEDGEMENTS

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