Analyzing the Diurnal Cycle of Precipitation in the NCEP Global Forecast System

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Introduction

Over the continental United States (CONUS), the diurnal cycle of precipitation plays a large role in surface hydrology and surface temperature, especially in the summer. The ability of numerical weather prediction models to correctly forecast the diurnal cycle of precipitation is a crucial test of their physics parameterizations, especially moist convection.

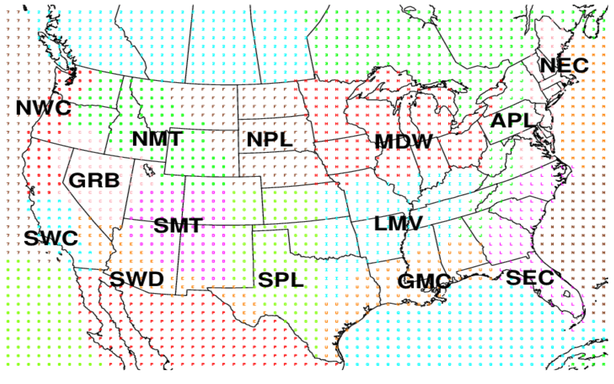
What is the objective of this research?

To use different verification processes to examine how the diurnal cycle of precipitation in the GFS departs from relevant observations and to assess whether GFS17 land-surface and convective parameterization changes, designed to make convective triggering more difficult, affect the GFS's diurnal cycle.

Methodology

-Compare 3 hourly totals from Climatology-Calibrated Precipitation Analysis (CCPA) dataset to the GFS16 (operational until July 2017) and GFS17 (GFSX) (Implemented July 2017).
-Use METviewer to generate 3-hourly averaged accumulated precipitation vs. forecast hour plots, for the different models.
-Plot seasonal mean diurnal cycle of precipitation from CCPA and operational GFS for 14 sub-regions of CONUS.
-Plot regional seasonal mean precipitation every 3 forecast hours from 24 to 48 hours for GFS16, GFS17 and CCPA.

Region of Study



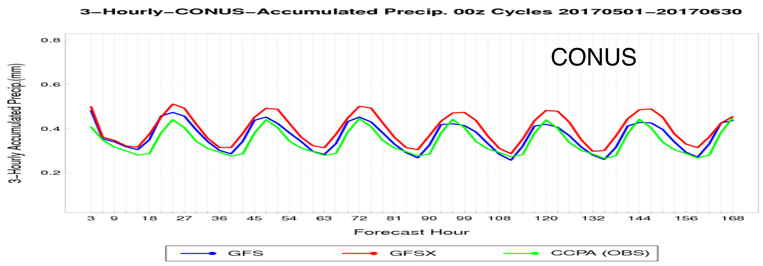
http://www.emc.ncep.noaa.gov/mmb/ylin/pcpverif/scores/
verification scores for 24 h and 3 h accumulations and the CONUS-scale diurnal cycle on a monthly basis

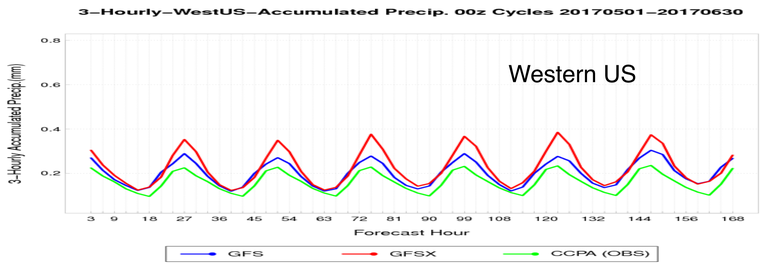
http://www.emc.ncep.noaa.gov/mmb/ylin/pcpverif/gfs.diurnal/
Seasonal diurnal cycle for 14 sub-regions

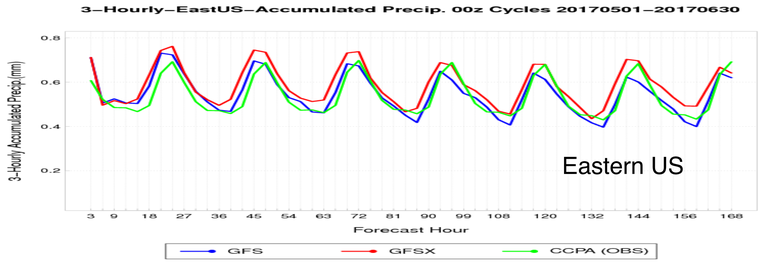
West Region: NWC, SWC, GRB, NMT, SMT, SMD, NPL, SPL

East Region: MDW, APL, LMV, GMC, SEC, NEC

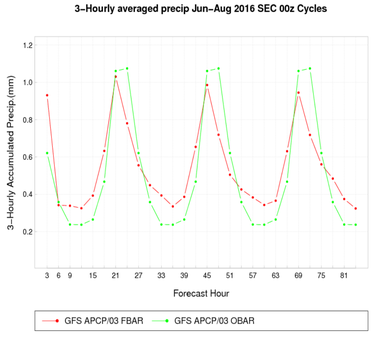
Models Vs. Observations



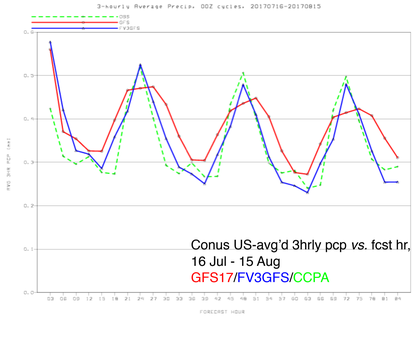




The figures above show 3-hourly accumulated precipitation vs. forecast hour for the CONUS, West and East regions for the 05/01/2017 – 06/30/17 time period comparing the GFS, GFSX and CCPA datasets.

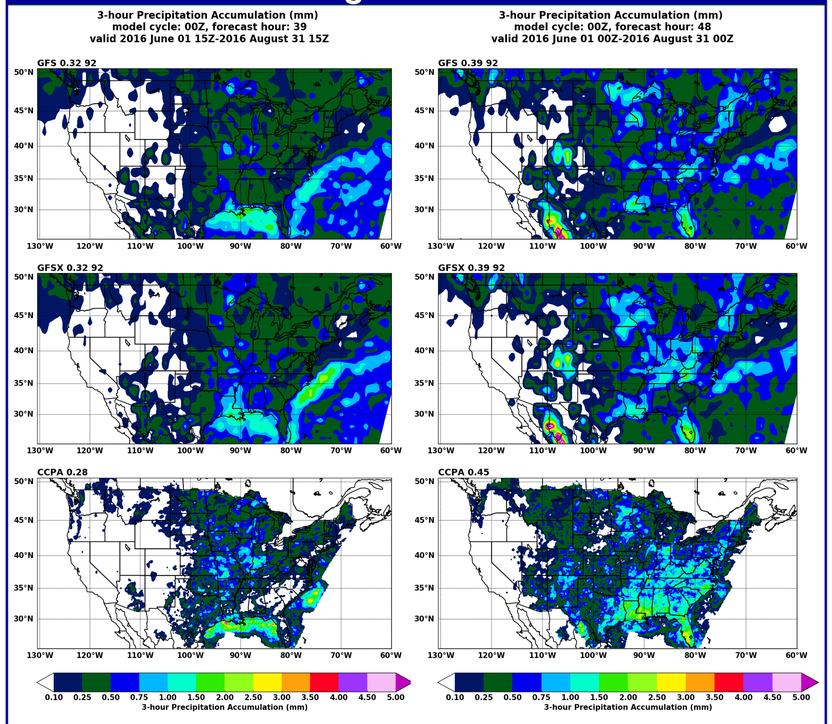


Diurnal cycle over SEC US JJA16
GFS16/CCPA



FV3 (experimental replacement for GFS) much better agreement than GFS17 (GFSX) with CCPA on diurnal cycle
http://www.emc.ncep.noaa.gov/mmb/ylin/pcpverif/scores.fv3/

Regional Plots



Minimum of diurnal cycle 36-39 h forecasts (12-15Z) JJA16

Maximum of diurnal cycle 45-48 h forecasts(21-00Z) JJA16

-Over SE US, diurnal cycles over land, adjoining oceans out of phase
-After 00Z precip dies out over SE US, develops over ocean off east coast
-Models develop more rain over ocean than CCPA (CCPA not so reliable over ocean)
-Models too dry over SE US at 0Z, too wet at 15Z
-Models weaker diurnal cycle over Florida than CCPA
-Models have stronger maxima over Colorado (right plots) than CCPA
-GFS dry bias over SE US appears mostly at 00Z

Conclusions

-Examining diurnal cycle of precipitation gives insight into model physics and usefulness of hourly GFS output.
-GFS diurnal cycle in precipitation seems reasonable in many regions
-GFS17 (GFSX) tends to have more precipitation, later diurnal maximum than GFS16, reflecting upgrades in convective parameterization making it harder to trigger convection
-In some regions GFS fails to have as sharp a maximum in diurnal cycle as CCPA

Acknowledgements

Special thanks to Howard NCAS, NCEP, EMC, and the entire model evaluation group for making this research possible and to Tara Jensen and DTC for help with METviewer