Evaluation of an advanced convective scheme using the Global Model Test Bed's physics test harness

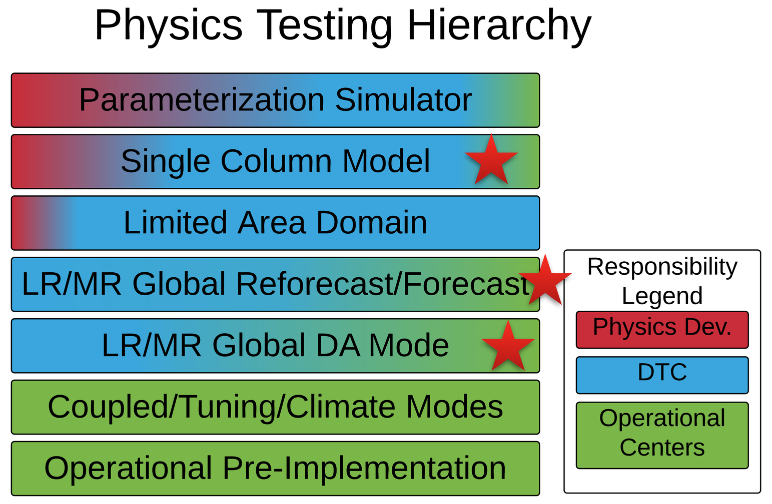
G. Firl*[1], M. Harrold[1], M. Zhang[2], J. Wolff[1], J. Henderson[2], L. Bernardet[2], J. Hacker[1]
*grantf@ucar.edu
NCAR — National Center for Atmospheric Research; Earth System Research Laboratory, Global Systems Division; DTC Developmental Testbed Center

Motivation

Working through the Developmental Testbed Center, the initial focus of the Global Model Test Bed (GMTB) is to develop a framework to evaluate advancements in physics parameterizations for future use in operational NWP. Such a framework consists of an Interoperable Physics Driver (IPD), a Common Community Physics Package (CCPP), and a physics test harness. All three components are under active development. This poster provides a look at the initial use of the physics test harness to evaluate the *untuned* Grell-Freitas convective parameterization (Grell and Freitas, 2014).

Physics Test Harness

Physics Testing Hierarchy



- Common infrastructure for testing physics development
- Simple-to-complex progression, conceptually and computationally
- Researchers can "enter" test harness at whichever level is appropriate

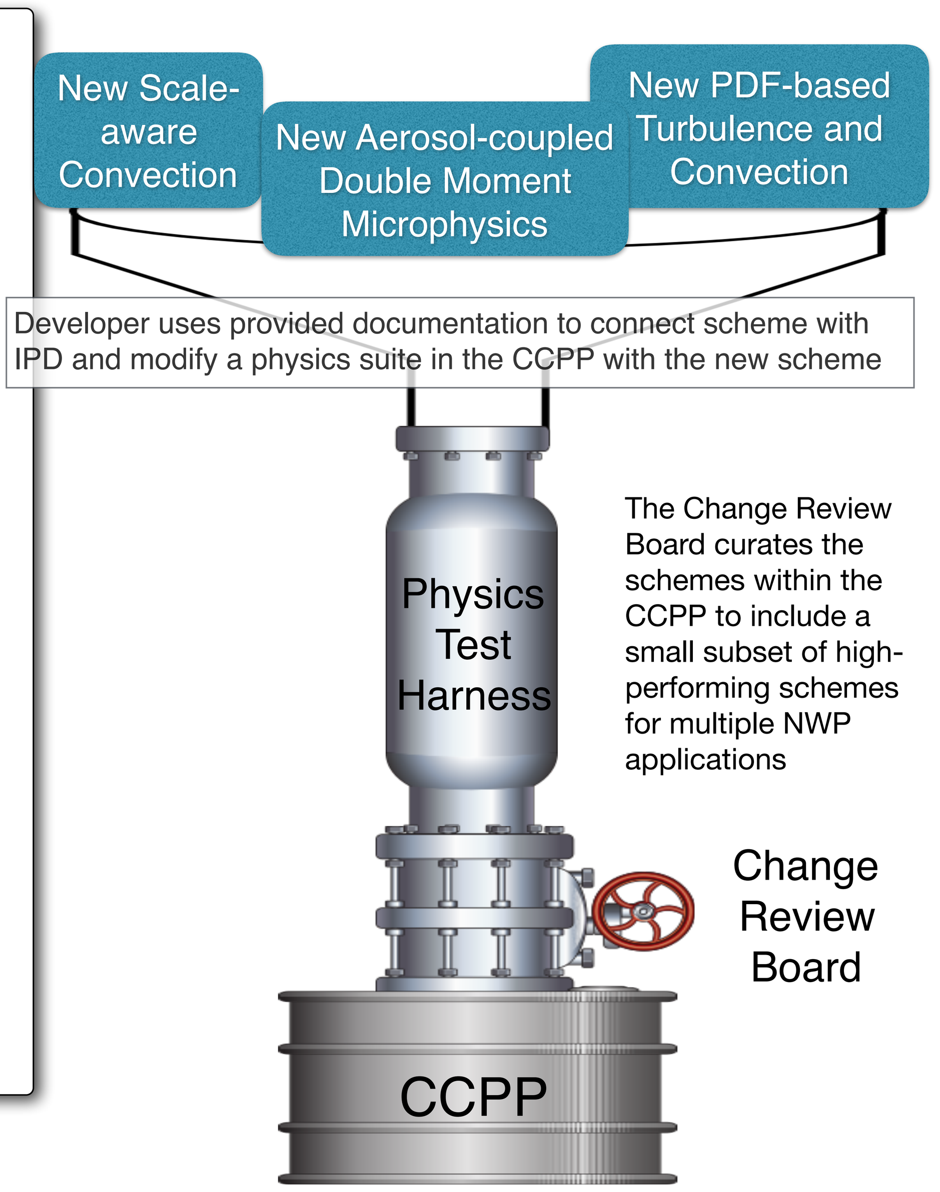
Provided by the DTC...

- documentation and access to IPD and CCPP code
- support for developers to connect schemes
- SCM code, supported case catalog, ability to compare with observations and operational GFS physics suite
- Support for running operational global model (GFS now, FV3-GFS soon) in cold start and cycled DA mode on Theia

Research-to-Operations Pipeline

Steps

1. Developer connects scheme to IPD with tech. support from DTC
2. Developer uses test harness tools to provide evidence of improvement
3. Developer/DTC/ NOAA EMC collaborate on formal test plan
4. Developer/DTC/ NOAA EMC carry out test plan
5. Results of test plan are provided to governing body for CCPP inclusion decision



Methods and Tools

The goal of this study is to preliminarily evaluate an untuned version of the Grell-Freitas convection scheme as a potential replacement of the convection scheme (scale-aware simplified Arakawa-Schubert or SASAS) in the 2017 operational GFS physics suite.

SCM

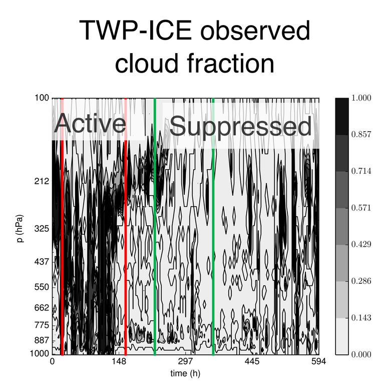
Two deep convective cases:

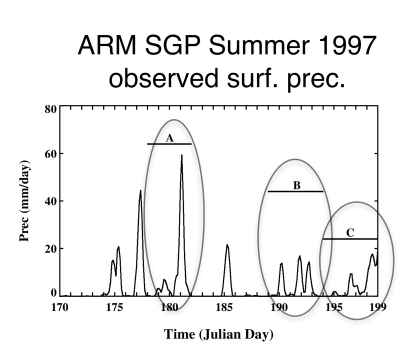
Maritime (TWP-ICE) | **Continental (ARM SGP Summer 1997)**

Forcing Method

Maritime (TWP-ICE)	Continental (ARM SGP Summer 1997)
fixed SST (interactive surf. flux)	prescribed surf. flux
prescribed hor. advective tendencies	prescribed hor. advective tendencies
prescribed vertical velocity	prescribed vertical advective tendencies
nudged u, v	nudged u, v
100-member forcing ensemble	

Analysis Periods

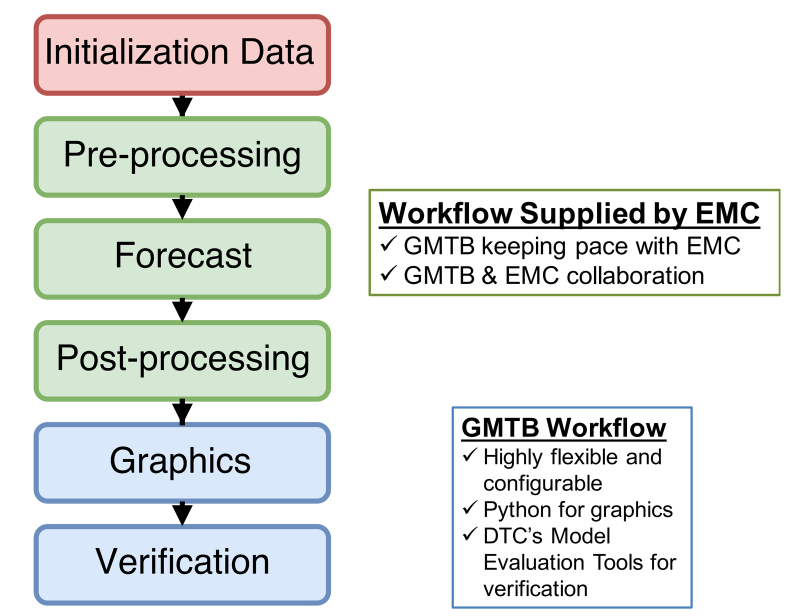




Global (Cold-start and Cycled)

- Three configurations
  1. cycled operational GFS suite with SASAS
  2. cycled modified GFS suite with G-F
  3. cold-start modified GFS suite with G-F
- All use T574 grid
- 15 runs initialized at 00Z from June 1, 2016 to June 15, 2016

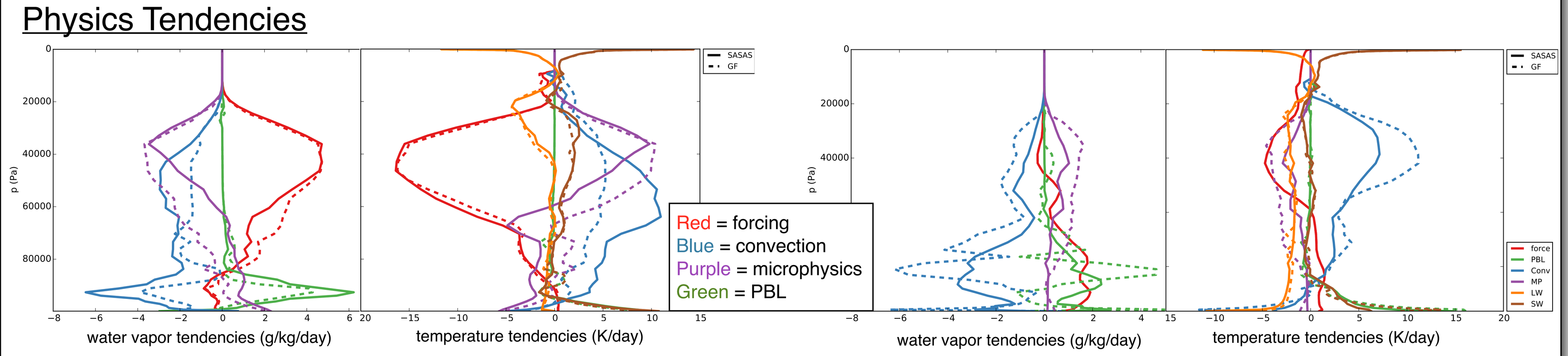
Global Workflow



SCM Results

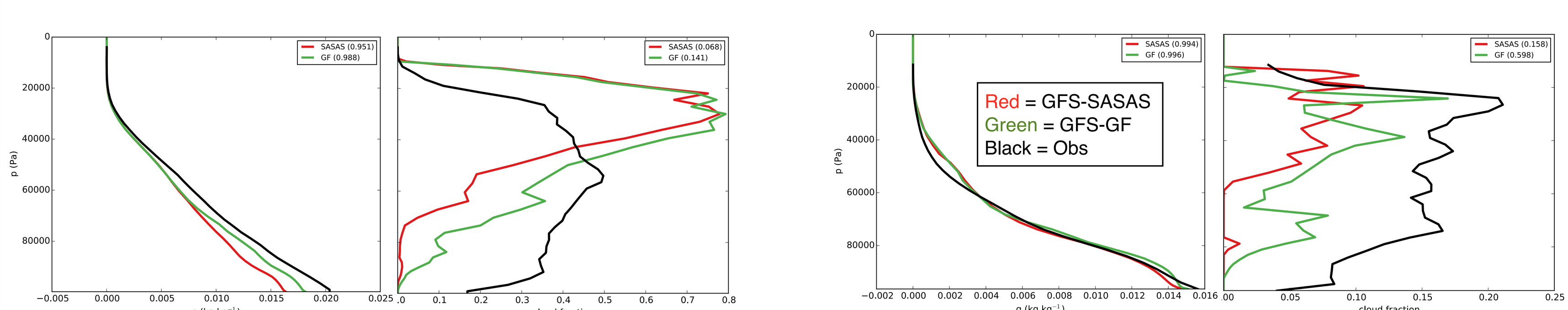
Maritime Deep Convection (strong forcing) | **Continental Deep Convection (weak forcing)**

Physics Tendencies



For the maritime case, G-F produces weaker convective tendencies, leaving the grid-scale microphysics scheme to do more "work" to balance the forcing. Interestingly, for the continental case, convective tendencies and microphysics tendencies are both stronger. It appears the SASAS scheme had less PBL moisture to work with, resulting in less-active convection.

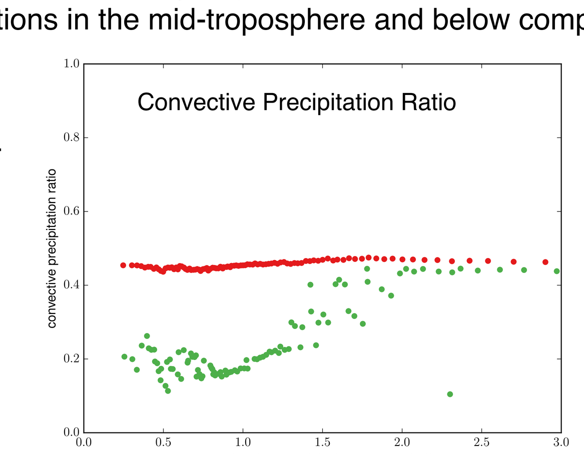
Water Vapor and Clouds



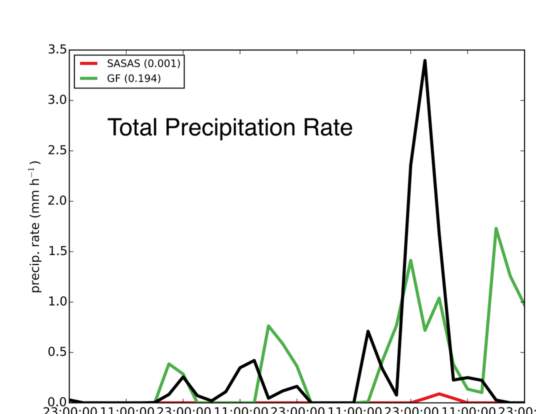
For both cases and for all analysis periods, the GFS suite with G-F produced profiles with a higher moisture content and higher cloud fractions in the mid-troposphere and below compared to the GFS suite with SASAS.

Precipitation

The suite with G-F produced a much lower convective precipitation ratio than the suite with SASAS.



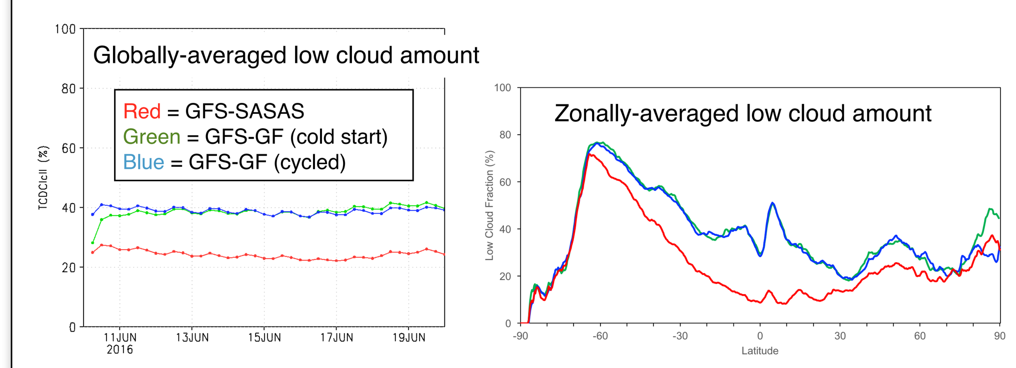
For the continental convection case, the SASAS suite produced convective cloud water but very little precipitation, while G-F produced reasonable amounts.



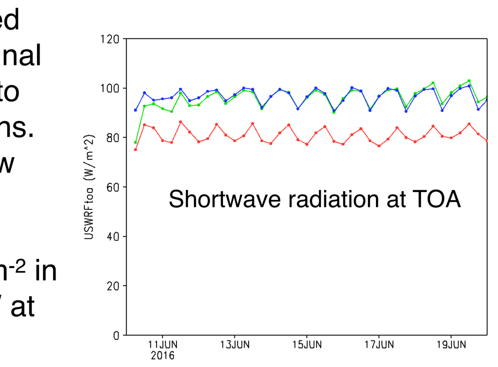
Global Results

Diagnostics

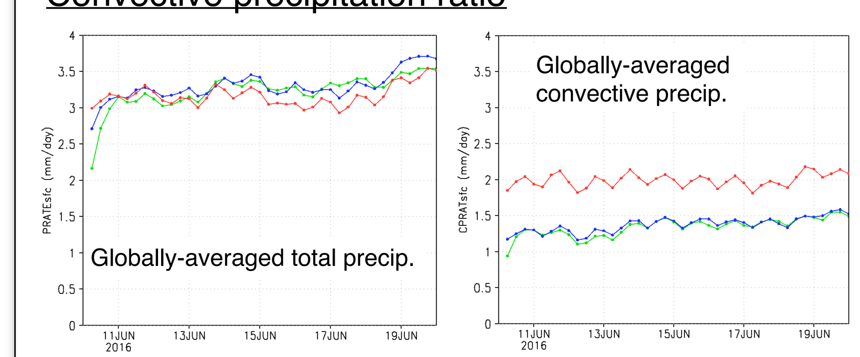
G-F low cloud cover increase



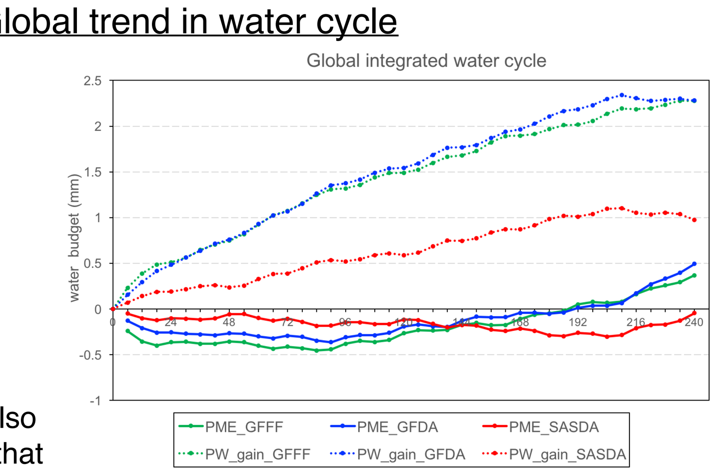
The increased low cloud signal carries over to the global runs. Increased low cloudiness accounts for about 15 Wm-2 in reflected SW at TOA.



Convective precipitation ratio

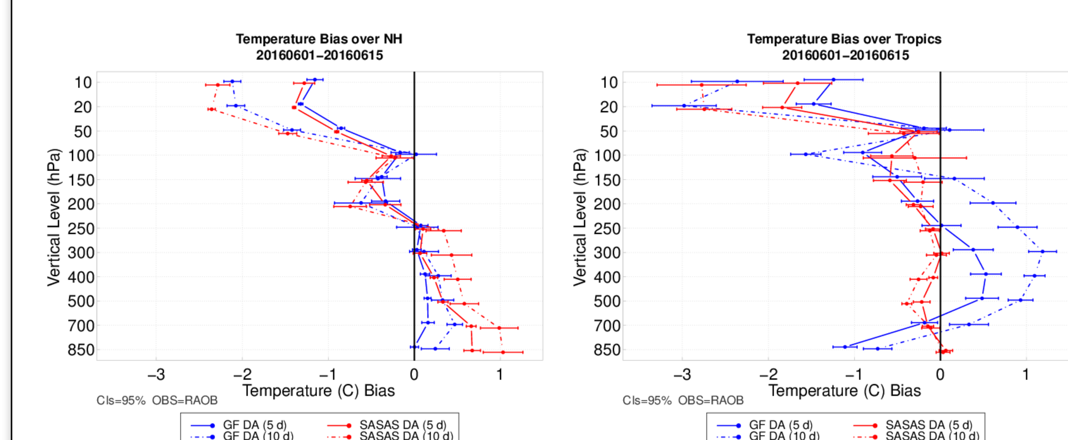


Global trend in water cycle

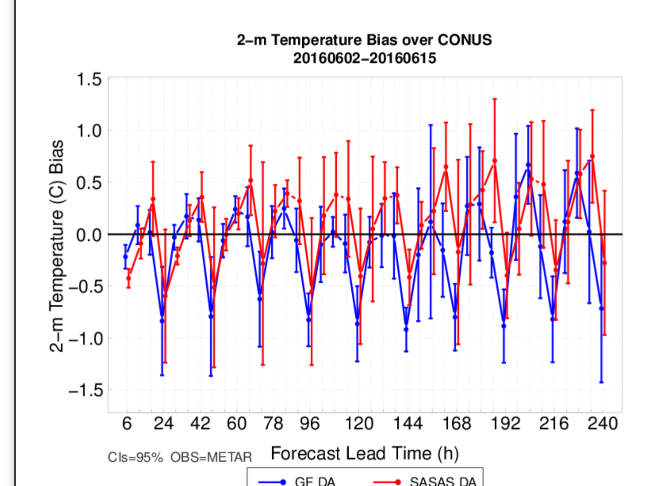


The reduced convective precipitation ratio with the GFS-GF suite also carries over to global runs. In addition, global precipitable water in that suite increases at about twice the rate of the GFS-SASAS suite.

Verification

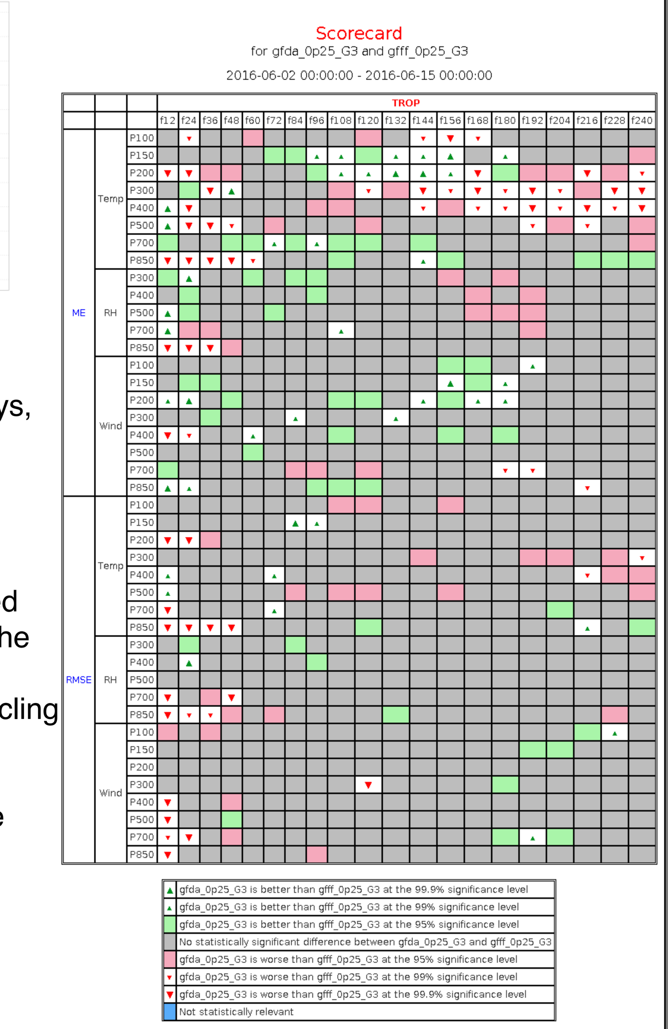


The G-F modified suite reduces temperature biases over NH at 5 and 10 days, but increases temperature bias in the tropics at both lead times. Two-meter temperature shows a somewhat reduced range and tends to warm up more slowly during the day than the operational suite.



Cycled vs Cold Start

A previous test using cold starts with the G-F modified suite was compared with the cycled runs from this test. Somewhat surprisingly, cycling seemed to produce little difference. The greatest differences are seen in the tropics (right), but little statistical significance is reported.



Summary

- Point 1
- Point 2
- Point 3

Acknowledgements

This work is a collaboration of the Developmental Testbed Center; the GMTB project is funded by NOAA's Next-Generation Global Prediction System (NGGPS).

References

Grell, G.A, and S. R. Freitas: A scale and aerosol aware stochastic convective parameterization for weather and air quality modeling. Atmos. Chem. Phys., 14, (2014), 5233- 5250.