Evaluation of Physical Parameterizations for NGGPS - a Community Testbed

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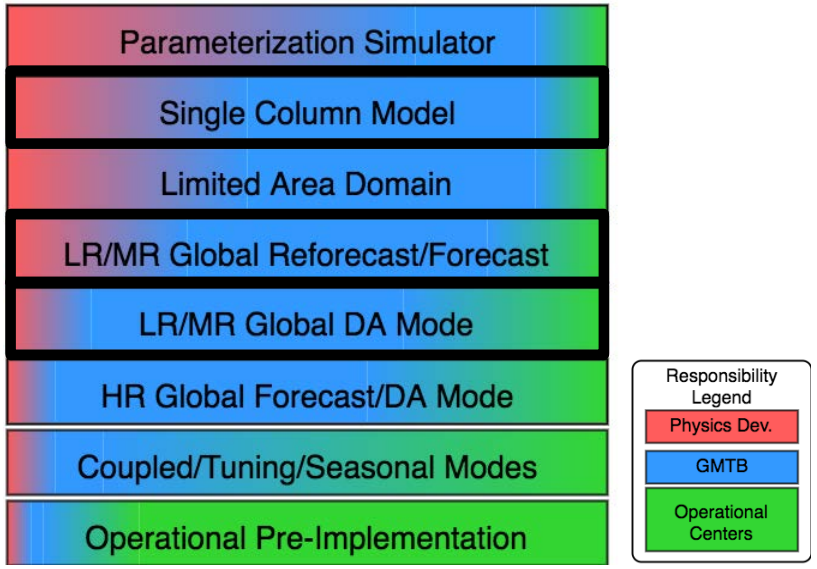
Developmental Testbed Center

What is the GMTB?

- GMTB is an NGGPS-funded effort aimed at accelerating the transition of community developments into NOAA's global prediction system – ***current focus on atmospheric physics***
  - Common Community Physics Package (CCPP)
  - Development of hierarchical physics testbed
  - Assessment of physics innovations
- Overarching goal to create information that can be used for an evidence-based decision making process

Physics Testbed: Hierarchal Framework

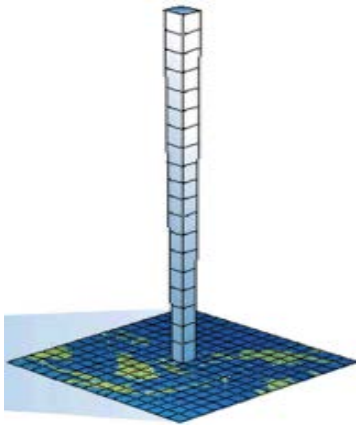
- The GMTB is developing a hierarchical testing framework to enable in-depth investigation of various physical parameterizations and advanced physics suites
  - Simple-to-complex testing
  - Common infrastructure for testing across all temporal and spatial scales
  - Facilitates an efficient R2O pipeline
  - Framework for evidenced-based decision making



LR/MR/HR=low/medium/high-resolution

GMTB Single Column Model

- Available at http://www.dtcenter.org/GMTB/gmtb_scm_doc/
  - Contains current operational GFS physics suite
  - Documented with instructions on how to acquire, compile, and run
  - Three cases available from observational campaigns:
    - GCSS/TWP-ICE (convection; near Australia, Jan-Feb 2006)
    - ARM Great Plains (convective, Jun-Jul 1997)
    - EUCLIPSE/ASTEX field campaign (stratocumulus, June 1992)
- Under development
  - Connection with CCPP for Spring 2018 release
  - More cases (additional weather regimes)
    - RICO, DYCOMS, BOMEX, LASSO
    - Community collaborators can also add cases



Global Workflow

NOAA EMC-based Workflow

Cold or cycled initialization → Forecast → Post-Processing

Complementary workflows

EMC workflow

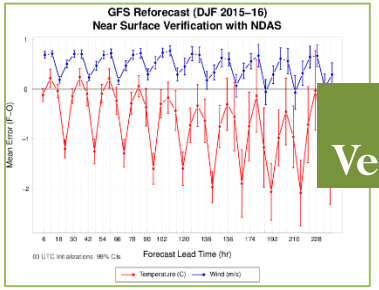
- GMTB keeping pace with EMC
- GMTB/EMC collabor[illegible] issues on both sides

Available to community w/ NOAA access

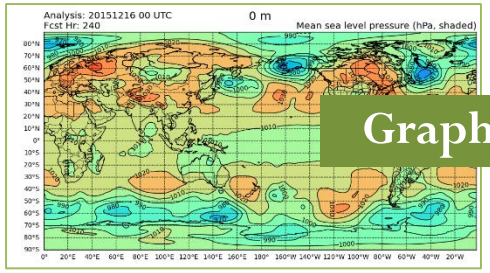
[illegible]rkflow

- Highly flexible and configurable
- DTC's Model Evaluation Tools
- Diagnostics

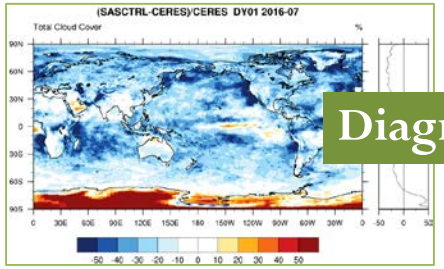
GMTB Workflow



MET Verification



Graphics



Diagnostics

Illustrating the Hierarchical Framework

Grell-Freitas vs. Simplified Arakawa Schubert convection within GFS physics suite

SCM

Phase I (GFS FY16)

Cu	Initial Conditions
GF	1 case: maritime convection
SAS	

Phase II (GFS FY17)

Cu	Initial Conditions
GF	2 cases: maritime and continental convection
SASAS	

Global

Phase I (GFS FY16)

Cu	Initial Conditions	Period
GF	GFS analyses (cold start)	JJA 2016
SAS		

Phase II (GFS FY17)

Cu	Initial Conditions	Period
GF	GFS analyses (cold start)	June 1-15, 2016
GF	Cycled DA	
SASAS	Cycled DA	

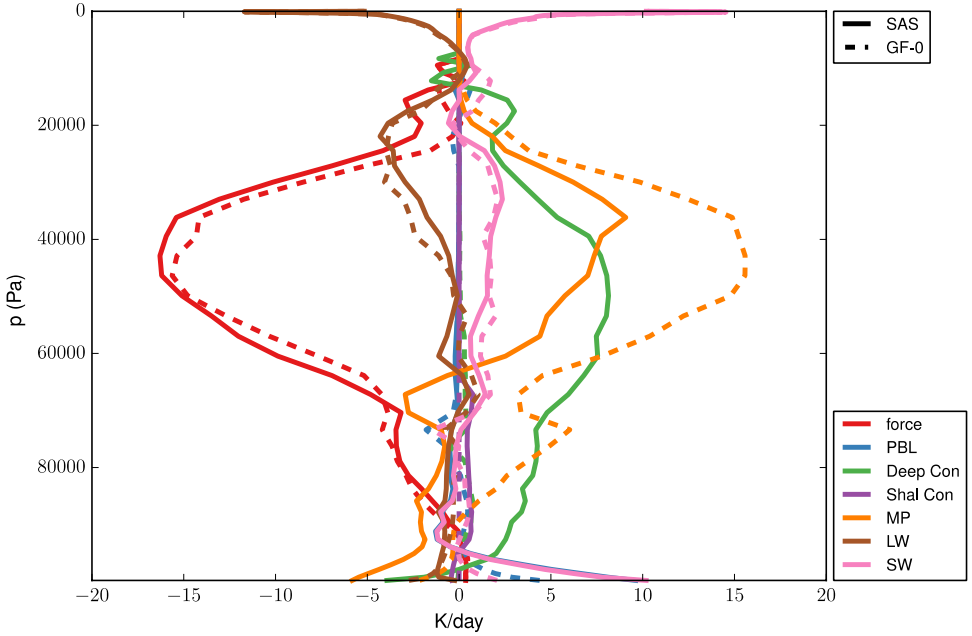
Test planned and conducted in close collaboration with physics developer, EMC, and NGGPS Program Office

Illustrating the Hierarchical Framework

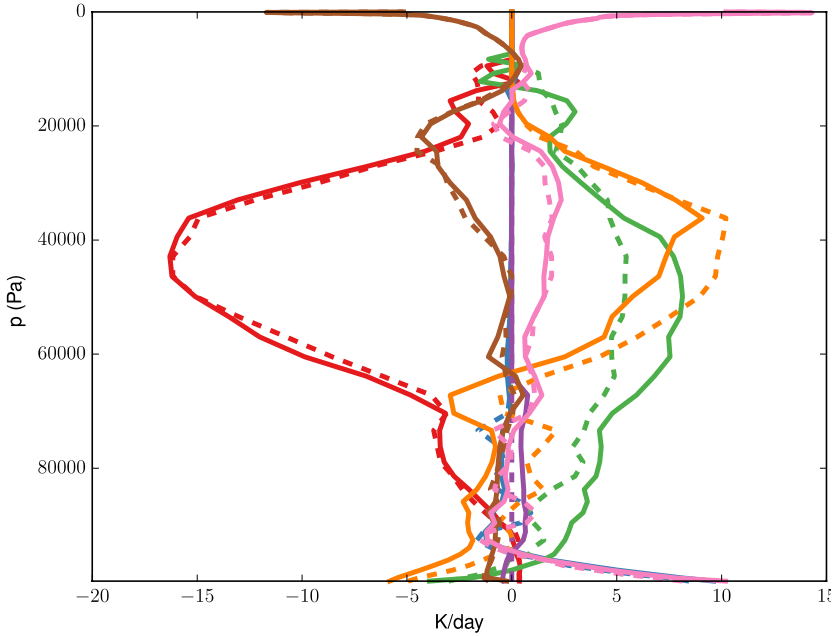
Phase I: SCM Highlights

Temperature Tendencies

Grell-Freitas r84921 (older version)



Grell-Freitas r85909 (Phase 1 version)



Problem in GF code identified using SCM, led to fix by developer:
Erroneous near zero deep convection (dashed green line) in implemented GF code

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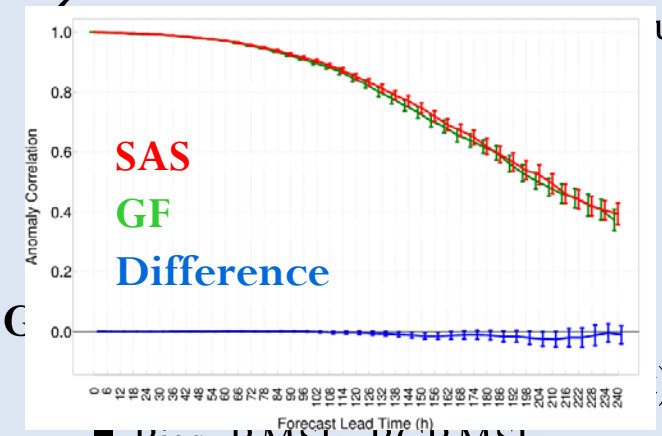
Phase I: Global Experiment Verification Highlights

500-hPa geopotential height AC (NH)

- Grid-to-grid



um.)

- G

)

- Bias, RMSE, BCRMSE

SL)

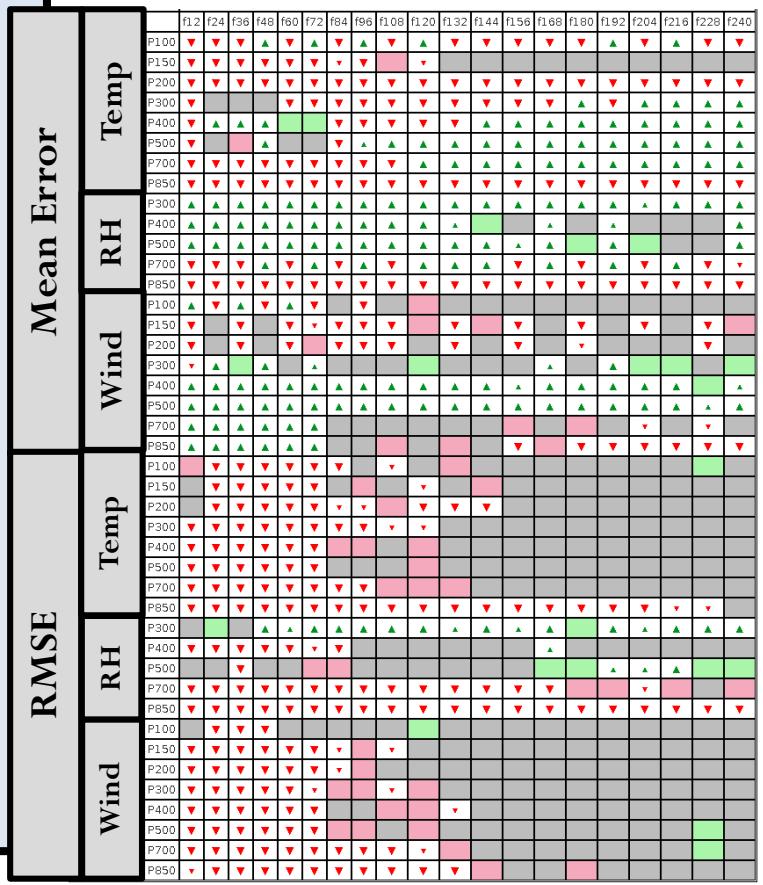
- Similar AC for two configurations
- Scorecard differences favor SAS
- Advantage of SAS diminishes w/ lead time → Points to limitation of test (no cycled DA)

°)

12km)

Scorecard (NH)

SAS better
GF better



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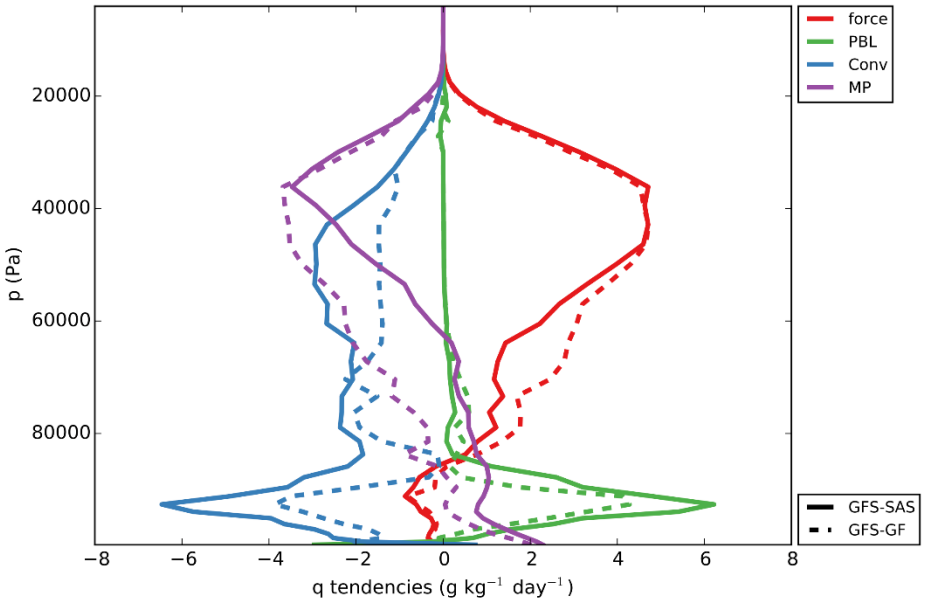
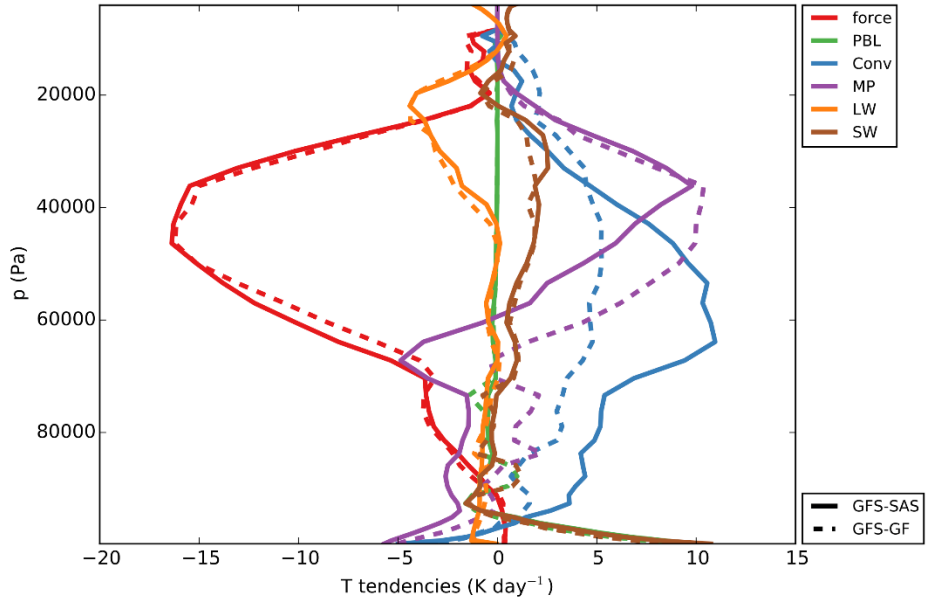
Phase II: SCM Highlights

q tendencies during active phase



T tendencies during active phase



GF produces weaker tendencies, leaving the microphysics to do more "work" to balance the forcing

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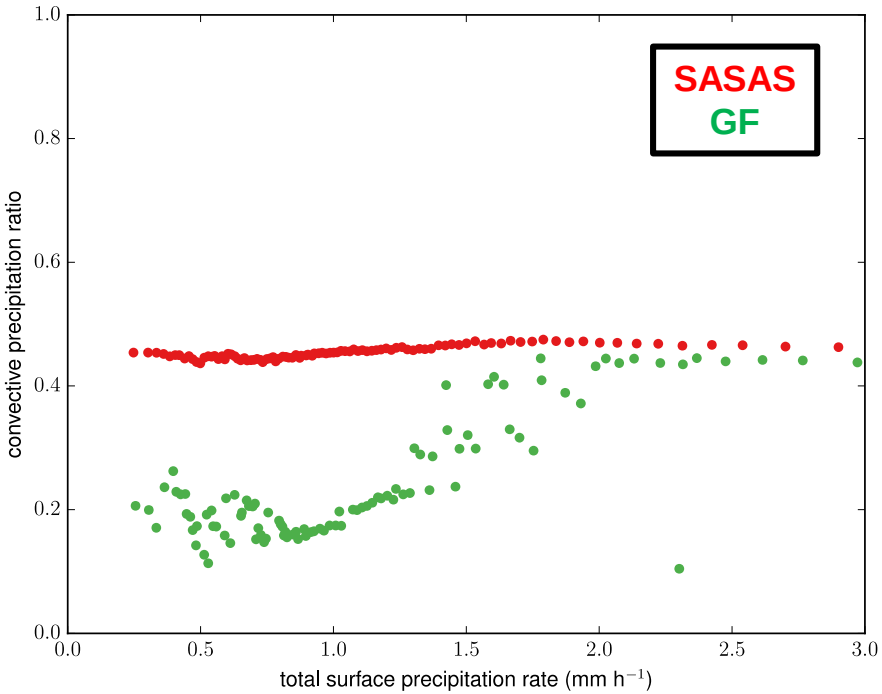
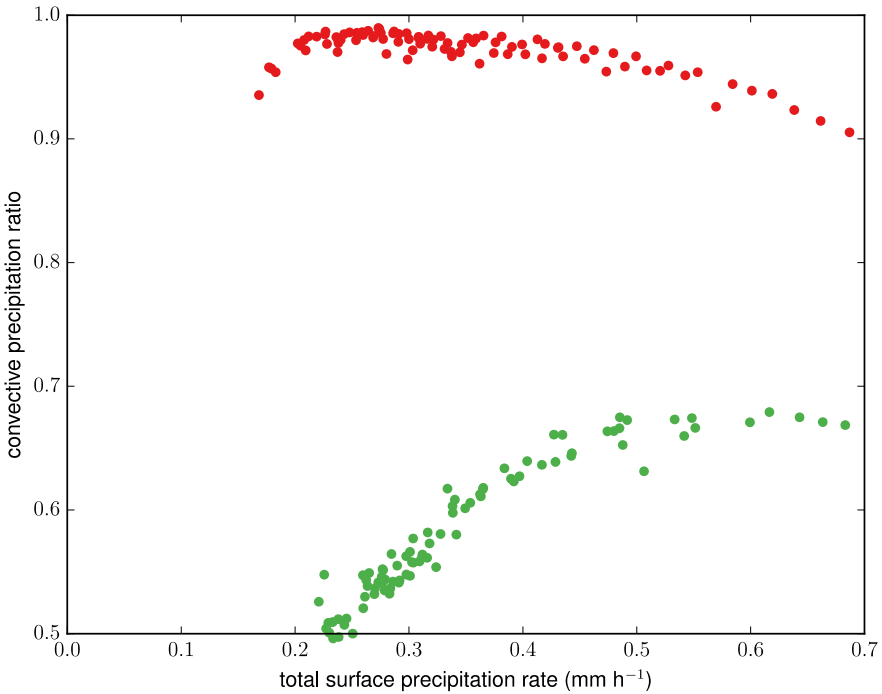
Phase II: SCM Highlights

Precipitation Partition

Deep Convective Period



Shallow Convective Period



The GF suite, for both the deep and shallow period, produced much lower convective precipitation ratio

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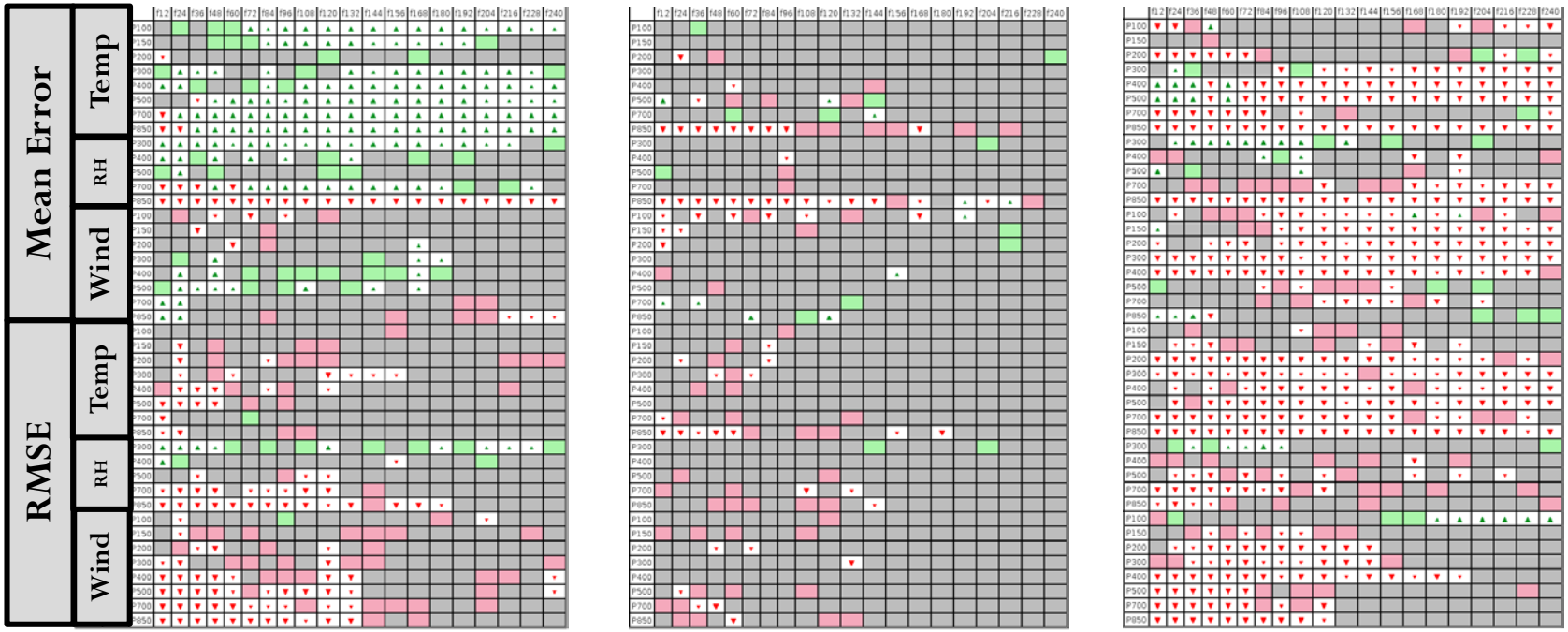
Phase II: Global Experiment Verification Highlights

NH **SH** **Tropics**

Forecast Lead Hour →



▲	gftest_0p25_G3 is better than sasctrl_0p25_G3 at the 99.9% significance level
▲	gftest_0p25_G3 is better than sasctrl_0p25_G3 at the 99% significance level
	gftest_0p25_G3 is better than sasctrl_0p25_G3 at the 95% significance level
	No statistically significant difference between gftest_0p25_G3 and sasctrl_0p25_G3
	gftest_0p25_G3 is worse than sasctrl_0p25_G3 at the 95% significance level
▼	gftest_0p25_G3 is worse than sasctrl_0p25_G3 at the 99% significance level
▼	gftest_0p25_G3 is worse than sasctrl_0p25_G3 at the 99.9% significance level
	Not statistically relevant

Cycled SAS better

Cycled GF better

Mixed results, with smallest number of differences in the SH and the most in the Tropics

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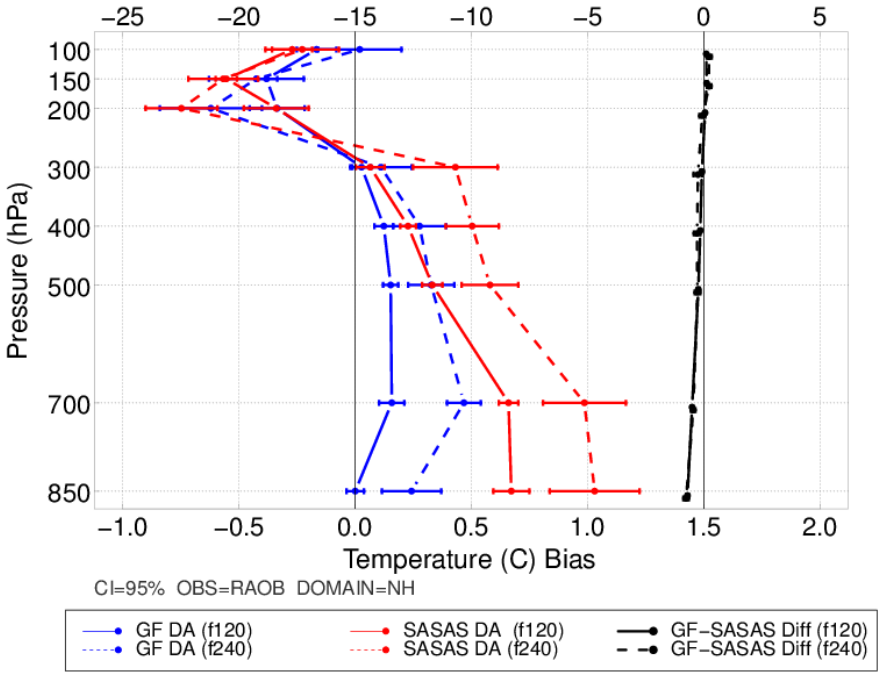
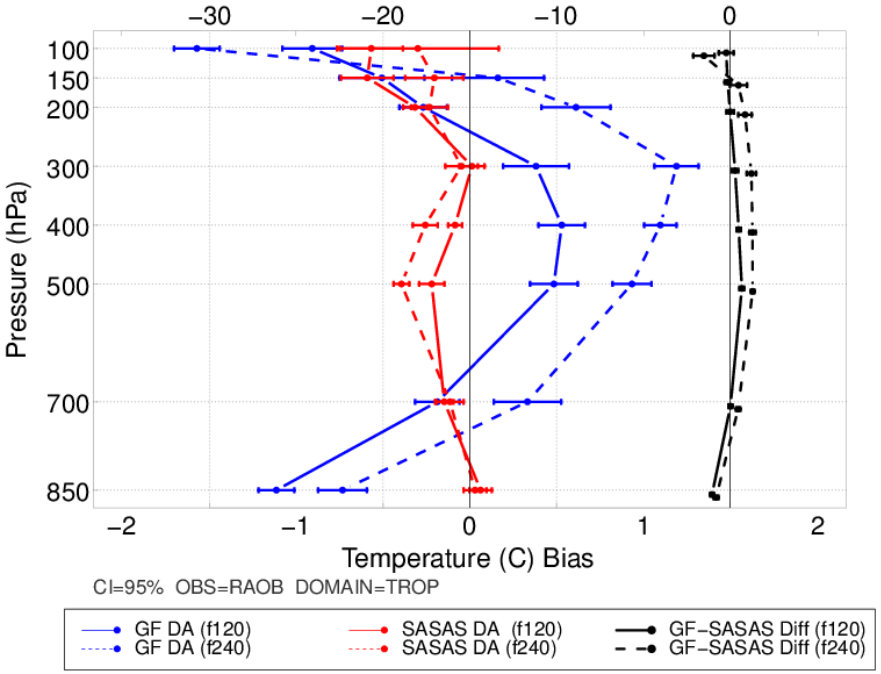
Phase II: Global Experiment Verification Highlights

Temperature Bias (°C)

NH



Tropics



- In the NH, error grows with lead time; GF generally has less bias than SASAS
- In the Tropics, large differences between GF and SASAS at 850 hPa and mid-levels; SASAS generally less biased

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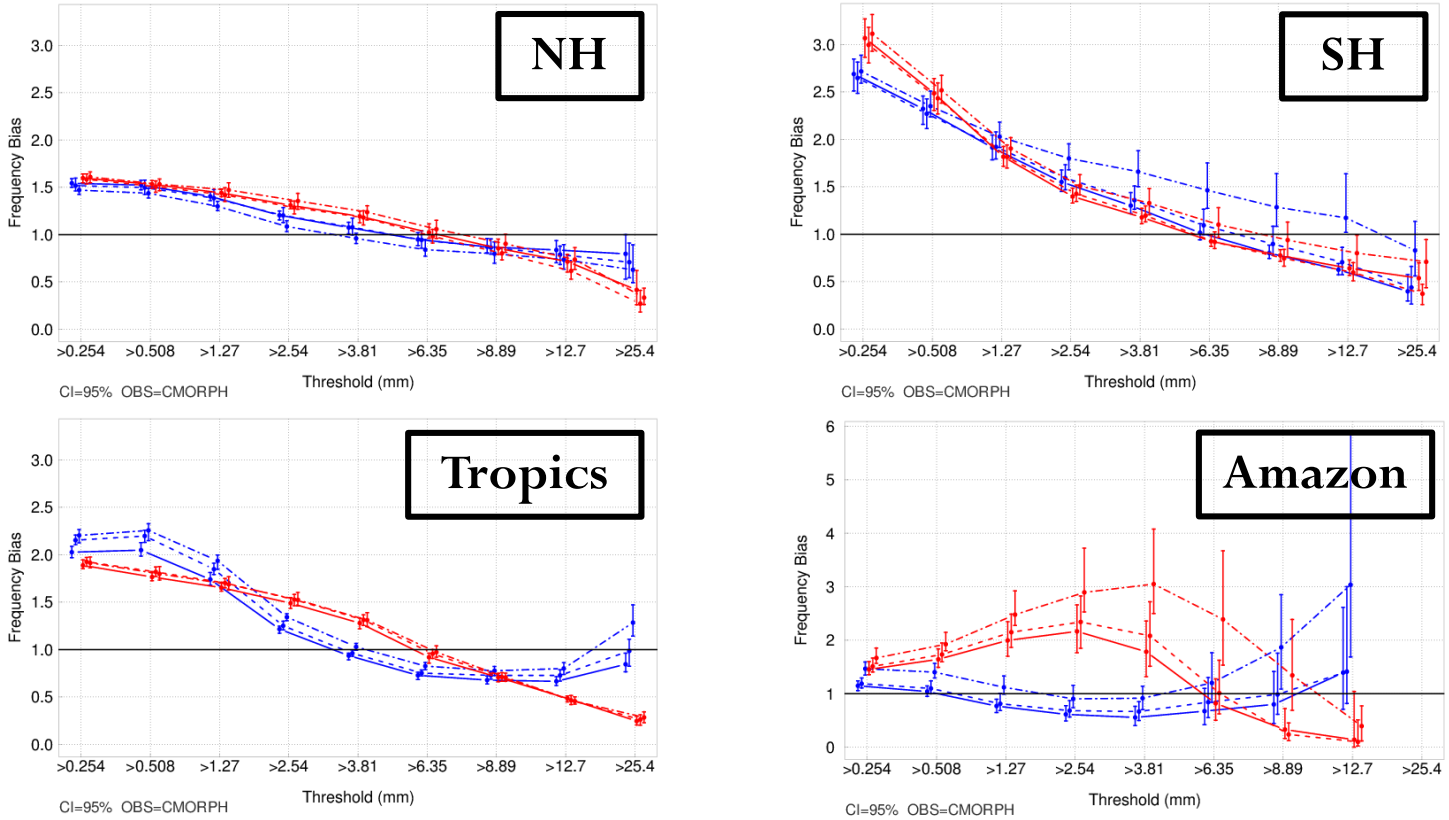
Phase II: Global Experiment Verification Highlights

6-h Accumulated Precipitation Frequency Bias



Both see an increase in precipitation coverage with forecast lead time

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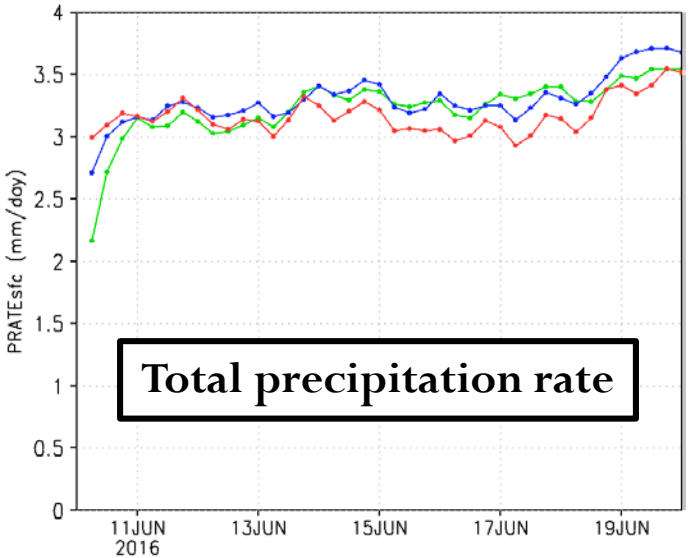
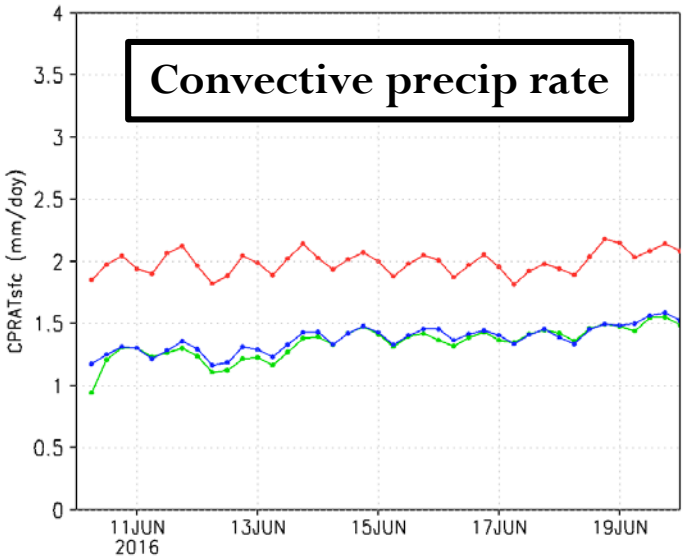
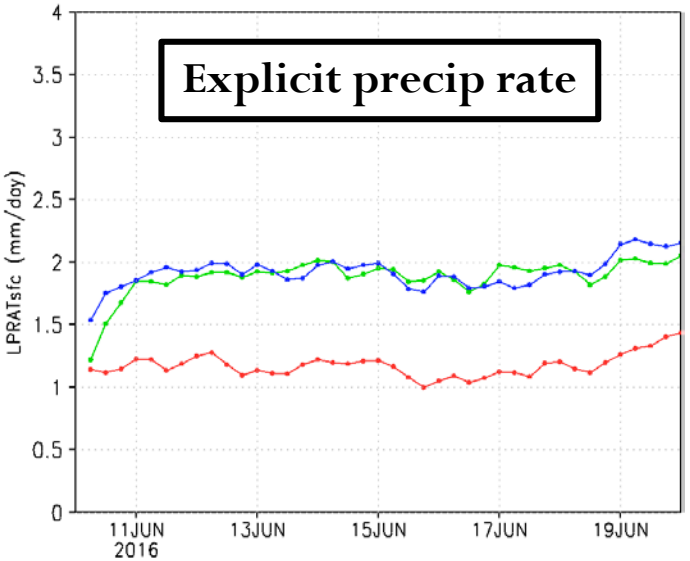
Phase II: Global Experiment Diagnostic Highlights

SASAS
GF
GFFF







GF has less convective and more explicit precipitation than SASAS

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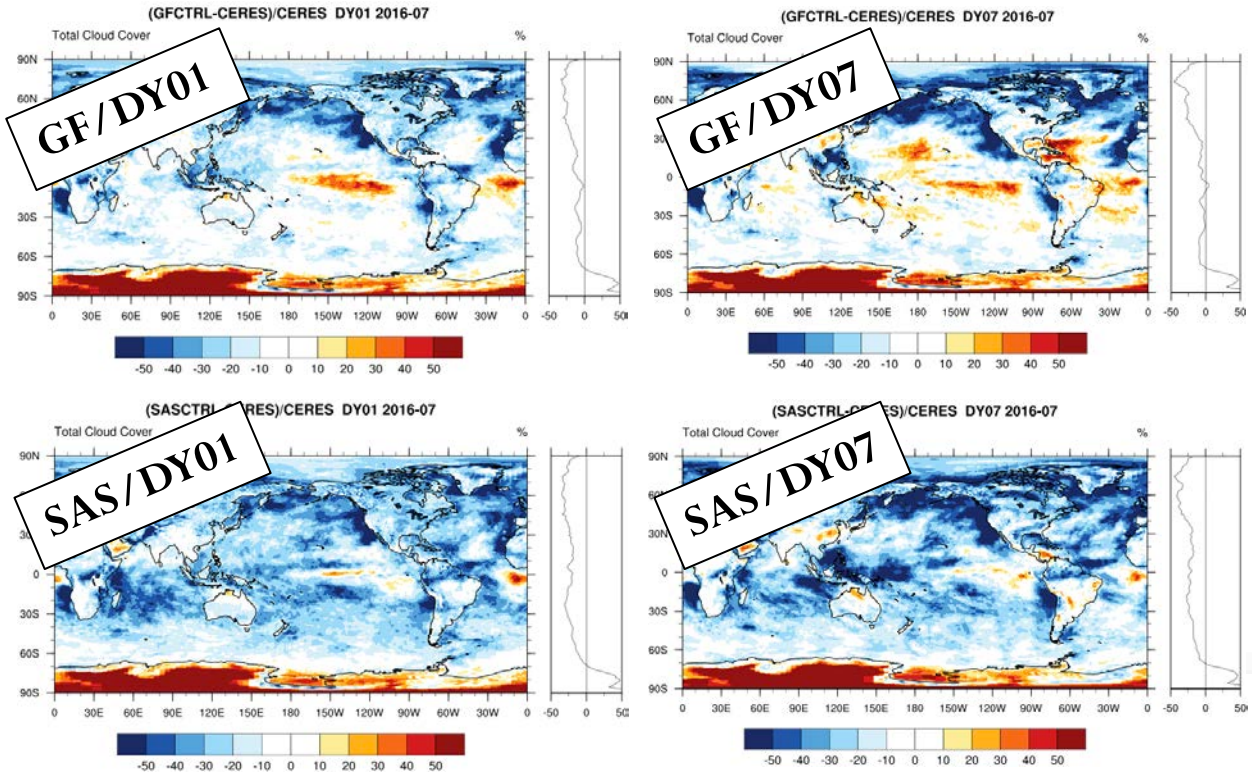
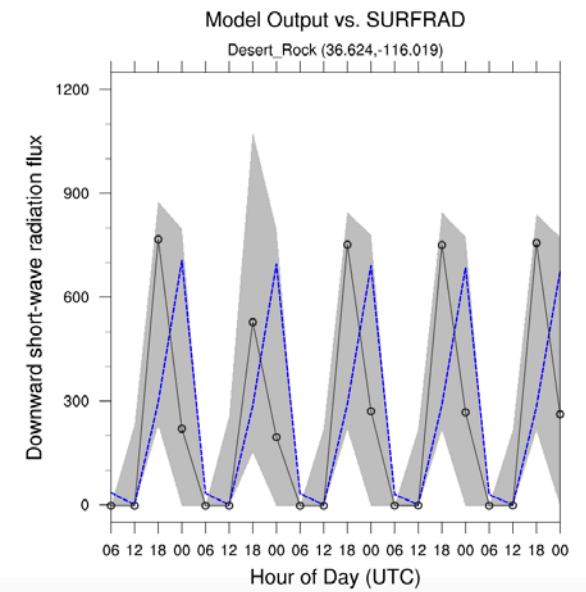
Diagnostics in GMTB Utilities Repository

GFS 07/16 total cloud fraction (CLDFRA) difference (%) with CERES-EBAF-4.0



SURFRAD observations vs. FV3GFS



https://github.com/NCAR/gmtb-utilities

GMTB's Path Forward…

- **Main focus of GMTB is assessment of community contributions in atmospheric physics for NGGPS**
  - Design and implement tools to facilitate community experimentation
    - GMTB has made the GFS FY17 operational physics CCPP compliant
    - CCPP v1 release: GFS FY17 physics for Single Column Model (Spring 2018)
    - CCPP v2 release: Extended to FV3 (Summer 2018)
  - Implement and maintain physics testbed ***(also for collaborators!)***
  - Conduct physics test and evaluation

DTC visitor program currently accepting proposals!

✓ Adding cases to SCM

✓ Contributing process-based diagnostics to testbed

https://dtcenter.org/visitors