Facilitating Development of Physical Parameterizations for NOAA's Unified Forecast System

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About the Global Model Test Bed

GMTB is a project within the Developmental Testbed Center (DTC) that fosters and facilitates community engagement in atmospheric physics by:

- Providing a physics library and driver that allow distributed development in a model-agnostic setting
- Supporting a single-column model for experimentation in physics
- Conducting testing and evaluation of innovations
- Bringing the research and operational groups together in tutorials and workshops

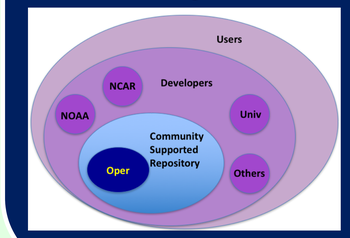
CCPP v3 Public Release (June 2019)

Schemes/Suites	GFS_v15	GFS_v15+	csawmg	GSD_v0
Microphysics	GFDL	GFDL	M-G3	Thompson
Boundary Layer	K-EDMF	TKE EDMF	K-EDMF	saMYNN
Surface Layer	GFS	GFS	GFS	GFS
Deep cu	saSAS	saSAS	Chikira-Sugiyama	Grell-Freitas
Shallow cu	saSAS	saSAS	saSAS	saMYNN and saSAS
Radiation	RRTMG	RRTMG	RRTMG	RRTMG
GWD	GFS	GFS	GFS	GFS
Land Surface	Noah	Noah	Noah	RUC
Ozone	NRL 2015	NRL 2015	NRL 2015	NRL 2015
H_2O	NRL	NRL	NRL	NRL

Public support includes

- GMTB single-column model
- Scientific documentation for parameterizations
- User and technical guide
- Website for user support
  - Email helpdesk
  - FAQ
  - Known issues
- Short course at AMS 2020 Boston
- Tutorial

R2O path

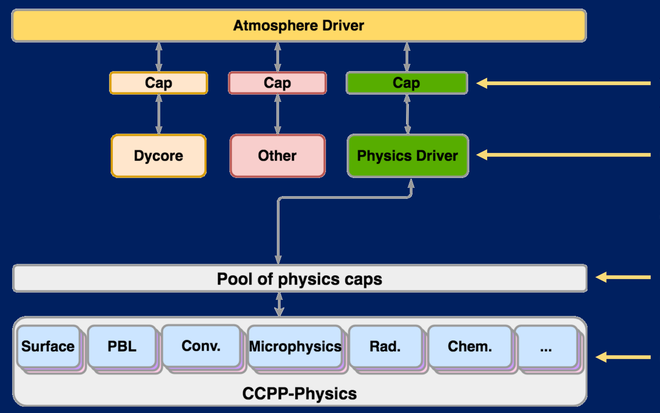


CCPP will contain operational physics plus candidates for next ~3y operational implementations. GMTB will facilitate ongoing development and testing

For more information

ligia.bernardet@noaa.gov
gmtb-help@ucar.edu
https://dtcenter.org/gmtb/users/ccpp/

Common Community Physics Package Architecture



Host application cap with autogenerated code from host metadata

CCPP-Framework Used before/at compile time and during model run

Physics caps (autogenerated)

CCPP-Physics (parameterizations)

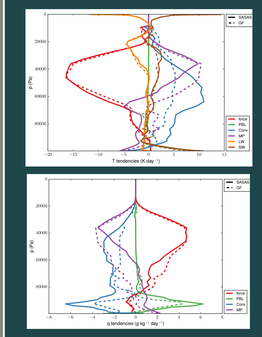
CCPP-Physics is a collection of dycore-agnostic physical parameterizations.
There are multiple schemes of each type (PBL, convection, etc.) to support various applications (high-res., seasonal, etc.) and maturity levels (operational, developmental)

- **Dycore-agnostic:** parameterizations can be used with any dycore through the CCPP-Famework
  - Active use with the GMTB single-column model and the FV3-based NOAA Unified Forecast System
  - Under development for WRF, MPAS, and CESM
- **Selected capabilities**
  - Configurable order/frequency of physics calls
  - User-specified grouping of schemes

Multiple Ways to Use the CCPP for Physics Experiments

Single-Column Model

CCPP + SCM can be used for simplified experiments

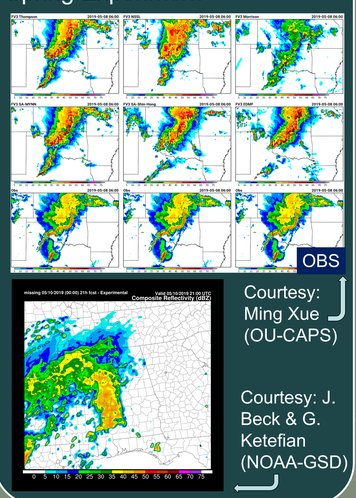


GFS v14 (saSAS) versus alternate with GF convection

Temperature and moisture tendencies compared for two suites used to simulate a Tropical Warm Pool-International Cloud Experiment (TWP-ICE) case

Regional Model

CCPP + FV3 high-resolution running in realtime at the HWT Spring Experiment



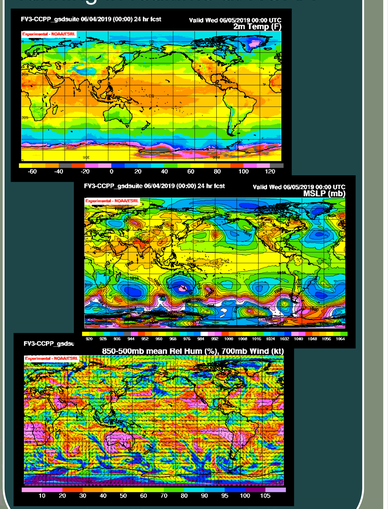
OBS

Courtesy: Ming Xue (OU-CAPS)

Courtesy: J. Beck & G. Ketefian (NOAA-GSD)

Global Model

CCPP + FV3 + GSD suite running in realtime at NOAA

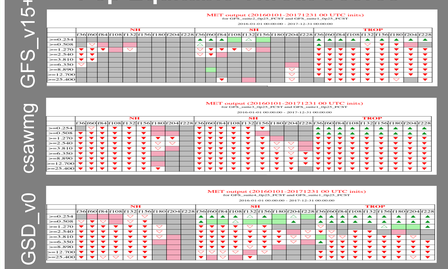


https://fim.noaa.gov/FV3

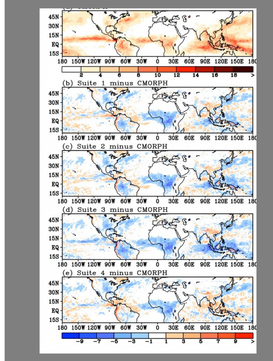
Test to Inform Operational GFS v16

Four CCPP v3 suites were tested with sampling from 2-year period. Atmos init from ECMWF analyses

Pcp Equitable Threat Scores



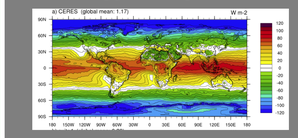
GFS_v15+ results similar to GFS v15. csawmg and GSD_v0 suites have mixed results with some improvements in the tropics



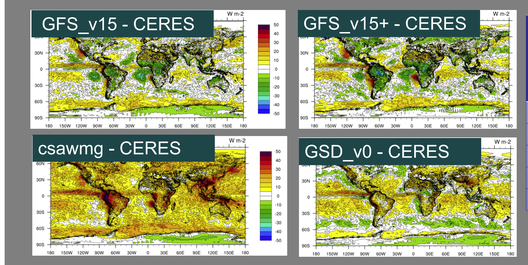
CMORPH analysis and model biases

All suites have dry biases over African monsoon regions and central US. The GFS_v15, GFS_v15+, and csawmg suites also underpredict precipitation over the Indo-Pacific warm pool and the Amazon tropical rainforest

Energy Budget at the Top of the Atmosphere



By day 10, all suites gain excessive energy, with implications for their use in seasonal forecasts



Annual Net (W m^{-2}; positive means downward)	
Obs	1.2
S1	2.9
S2	1.9
S3	15.2
S4	6.26

Outcomes

- Verification and diagnostics were used to decide way forward
- Further development for GFS v16 will use GFS_v15+. Although it did not perform as well as GFS_v15, it has enough positives to move forward to additional testing
- Further improvements in physics will be sought incrementally, possibly by introducing parameterizations or processes from other suites