

The Common Community Physics Package: Recent Updates and New Frontiers

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Common Community Physics Package

CCPP Physics

- A library of physical parameterizations
- <u>https://github.com/NCAR/ccpp-physics</u>

CCPP Framework

- Software infrastructure that allows using the CCPP-Physics in a host model
- https://github.com/NCAR/ccpp-framework

CCPP Single Column Model

- A simple host model that employs the CCPP Physics and CCPP Framework
- https://github.com/NCAR/ccpp-scm



Motivations for the CCPP

COMMON COMMUNITY PHYSICS PACKAGE

Interoperability at the code level to foster collaborations

• A synergistic resource for research, development, transitions, and operations

Code Management

- Efficiency in physics development via centralization
- Process that facilitates research and transitions to operations

Hierarchical structure

- Flexible for development
- Promotes process understanding and physics interactions
- Efficient for operations



Host Models Using CCPP

CCPP Single Column Model

For hierarchical testing with CCPP

Unified Forecast System (UFS)

• For research and NOAA operations (in operational HAFS as of June 2023)

US Navy Research Laboratory NEPTUNE model

Using CCPP for pre-operational implementation tests

NSF NCAR WRF, MPAS, CM1, CESM CAM-SIMA

• Experimental: Converting physics to CCPP-compliant



CCPP Single Column Model (SCM) Overview

- All CCPP schemes/suites are available to use with the SCM
- Decouples physics from dynamics for hierarchical studies
- Initialization from field program data
 - GASS/TWP-ICE (maritime convection; near Australia)
 - ARM Great Plains (continental convection)
 - EUCLIPSE/ASTEX (stratocumulus)
 - LASSO (shallow cumulus)
 - GABLS3 (mid-latitude continental)
 - Other cases offered through the <u>DEPHY case repository</u>

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CCPP v6.0 Public Release – June 2022

- Central hub: <u>https://dtcenter.org/ccpp</u>
- Released with SCM
- 23 supported schemes and 6 suites
- Online tutorial and documentation
- SciDoc, TechDoc, and User's Guide
- Support provided via GitHub discussions
- See Heinzeller et al., 2023, <u>GMD</u>

New release planned for mid-2024



Visioning Workshop 2023 - Major Recommendation 1

Delineate a multi-institutional high-level vision

for how the <u>CCPP Physics repos</u> will work together

to better serve the community

Host	CCPP Physics repo		
SCM, UFS, NEPTUNE	Root (DTC)		
MPAS, WRF, CM1	NSF NCAR MMM		
CESM CAM-SIMA	NSF NCAR CGD		

Code management group actively working on this. Increasing interoperability is key!



Visioning Workshop 2023 - Major Recommendation 2

Adoption of <u>next-gen CCPP Framework</u> by all hosts (CESM CAM-SIMA, UFS, SCM, NEPTUNE etc.)

- Long term development led by NCAR CGD with DTC collaboration
- Advantages
 - Ability to query physics and inform dycore of tracers
 - More robust enforcement of metadata attributes

For other recommendations, see Firl et al. 2024 (submitted to BAMS)



New and Updated Physics (thank you to developers)

- New: Community Convective Cloud (C3; GSL, PSL, CIRES, ...)
 - A forward looking new scheme, including aspects of GF and SAS
 - A collaborative work-in-progress effort
- New: Community Land Model (CLM) Lake Model (NCAR, CIRES)
 - 1-D lake model intended for small lakes
- Updated: Many!
 - Initial single-precision capability (on target for RRFS v1 operations)
 - Schemes for now-operational HAFS v1
 - Ongoing development for RRFS v1, GFS v17, GEFS v13, SFS v1
 - Readiness for experiments (HFIP, HWT, HMT, etc.)
 - <u>GPU-compliancy</u>: GF convection

Single Column Model: New Initialization and Capability

- Parameterization simulator for SCM
 - Data models replace parameterization(s)
- Initialization from UFS history files (replay)
 - Enables more closely exploring the sources of UFS biases



Other Ongoing Work

- Repository reorganization (DTC)
 - More modularity and ease of use
- GPU compliancy Lead: CIRA, CIRES, NOAA GSL (non-DTC)
 - Several schemes GPU compliant
 - Schemes tested with standalone drivers substantial speedup
 - Currently integrating with Framework and host models
- ML radiation Lead: CIRA, NOAA GSL (non-DTC)
 - First developed as a standalone scheme
 - Currently integrating in CCPP SCM



Opportunities for Engagement

- CCPP hub at dtcenter.org/ccpp
 - Code, documentation, tutorial, support
- DTC Visitor Program (<u>dtcenter.org/visitors</u>)
 - Propose a project to work with us!
 - PI Up to 2 months salary, travel and per diem can be multiple visits
 - Grad Student Up to 1 year of temporary living per diem and travel expenses for graduate student, plus support for advisor visits







An empowered research and development community

- Hierarchical System Development
- Releases with documentation, tutorials (CCPP v7 expected mid-2024)
- Support
- A vibrant software environment to foster R2O
- A robust CCPP infrastructure for use in **operations**
- Strong NOAA-NCAR-Navy collaboration

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CCPP Architecture with Framework



Capabilities enabled by CCPP Framework include

- Altering order of schemes in suite
- Subcycling
- Unit conversions
- Fast and slow physics

Parameterizations in Authoritative CCPP Repository

Microphysics	Zhao-Carr, GFDL, MG2-3, Thompson, F-A, NSSL					
PBL	K-EDMF, old TKE-EDMF, TKE-EDMF, YSU, saYSU, MYJ					
Surface Layer	GFS, MYNN, MYJ					
Deep Convection	oldSAS, saSAS, RAS, Chikira-Sugiyama, GF, Tiedtke, C3					
Shallow Convection	oldSAS, saSAS, RAS, GF, Tiedtke					
Gravity Wave Drag	GFS orographic, GFS convective, GFS UGWP, uGWP v0, drag suite					
PBL and Shal Convection	SHOC, MYNN	Contributions				
Radiation	RRTMG, RRTMGP	DTC EMC NSSL PSL GSL				
Surface (Land and Lake)	Noah, Noah-MP, RUC, CLM Lake, FLake					
Ocean, Sea Ice	Near SST and Simple GFS ocean, Simple GFS sea ice					
Ozone	2006 NRL, 2015 NRL					



CCPP v6.0 Supported Parameterizations & Suites

Туре	Operational	Developmental				
Suites	GFS_v16	GFSv17_p8	RAP	RRFS_v1beta	WoFS	HRRR
UFS regional						
SCM						
Microp	GFDL	Thomp	Thomp	Thomp	NSSL	Thomp
PBL	TKE EDMF	TKE EDMF	MYNN	MYNN	MYNN	MYNN
Sfc lay	GFS	GFS	MYNN	MYNN	MYNN	MYNN
Deep cu	saSAS	saSAS + CA	Grell-Freitas	N/A	N/A	N/A
Shal cu	saMF	saMF	Grell-Freitas	N/A	N/A	N/A
Radiation	RRTMG	RRTMG	RRTMG	RRTMG	RRTMG	RRTMG
GWP	cires_ugwp	unified_ugwp	drag_suite	cires_ugwp	cires_ugwp	drag_suite
LSM	Noah	NoahMP	RUC	NoahMP	Noah	RUC

DTC