

MPAS Development Update.

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Integration of WUDAPT with Modeling Systems Meeting, 13 Jan 2023



Model for Prediction Across Scales (MPAS)

Current release – Version 7.3

- Atmosphere and land only
- Open Source: <https://mpas-dev.github.io/>
- Global and regional, variable-resolution capabilities
- Annual tutorials; new releases as needed
- GPU-enabled for some configurations (V6.1, October 2020)
- DA – both DART and JEDI

Last major release June 2019 (V7) - What have we been doing?

MPAS in CESM (SIMA, EarthWorks)

GPU development

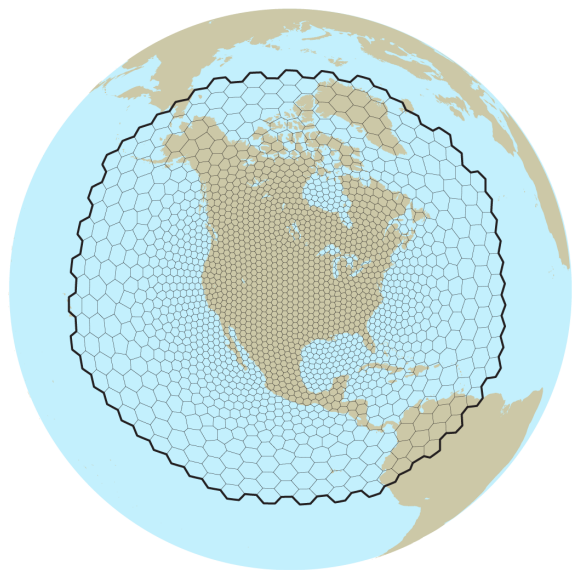
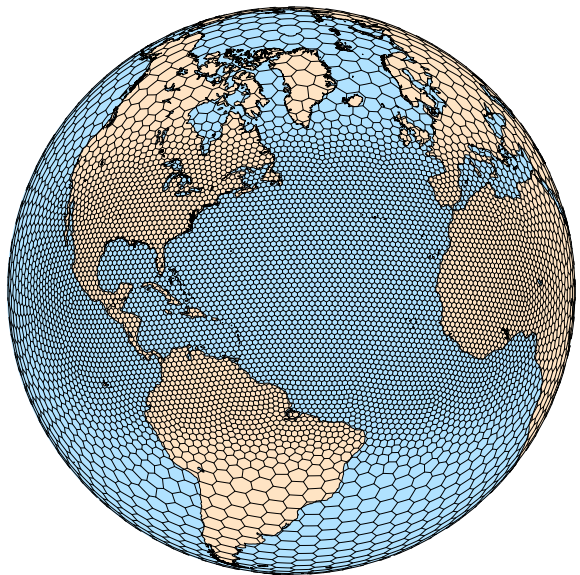
Regional MPAS testing and updates

LES capabilities

Physics

Infrastructure

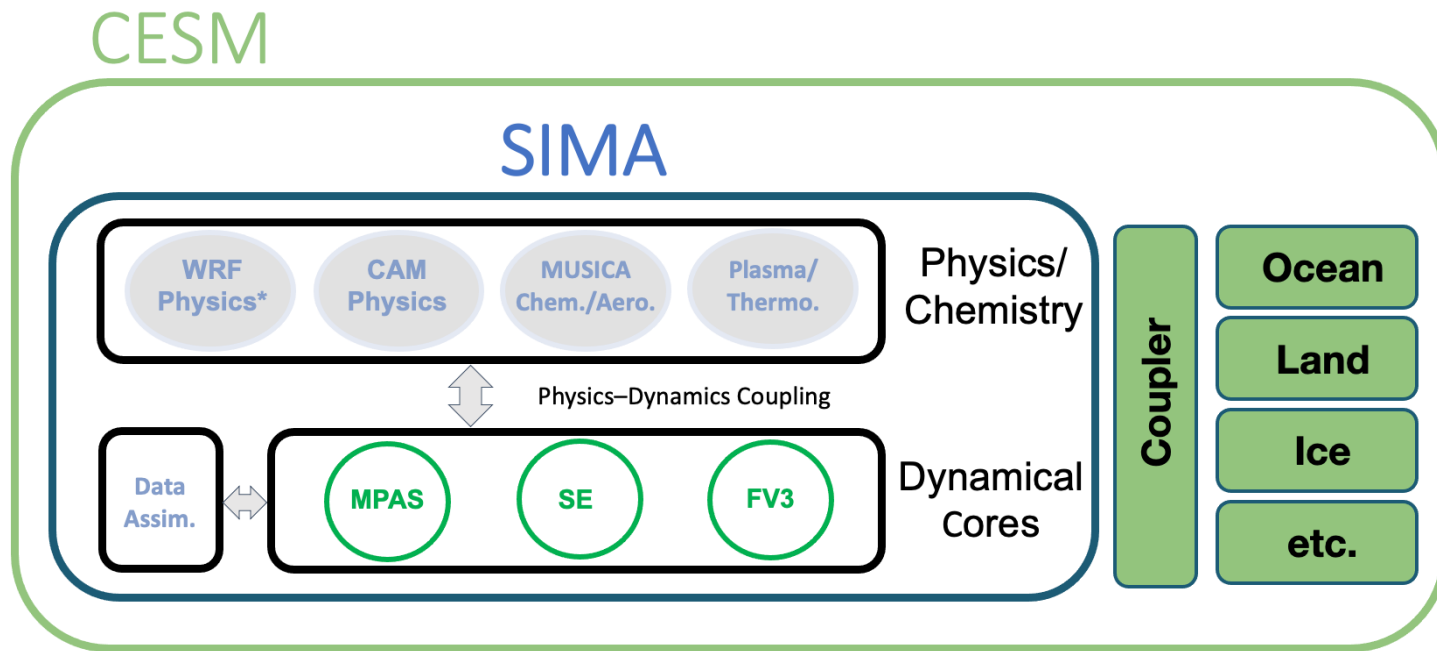
Deep-atmosphere extensions



MPAS Earth System Model Capabilities

System For Integrated Modeling of the Atmosphere (SIMA)

SIMA is the effort to unify NCAR-based community atmospheric modeling across Weather, Climate, Chemistry, and Geospace applications



* where needed to augment CAM physics

<https://sima.ucar.edu>

MPAS – Atmosphere brings nonhydrostatic modelling capabilities to CESM.

- We have a clean port of MPAS that is pulled from the MPAS github development repository at build time.
- We have test results that show MPAS-CAM6 produces credible climate results at O(1 degree) resolution.
- We are currently testing MPAS and CAM6 physics at convection-permitting resolution.
- We are working on resolving issues associated with CESM and CAM infrastructure within high-resolution configurations (i.e. memory and cost).

We hope to release these capabilities this year (2023). It will be an experimental release.

Accelerators (GPUs) and MPAS-Atmosphere

We will be releasing configurations of GPU-enabled MPAS-Atmosphere for NCAR's new supercomputer *Derecho*



- We anticipate releasing significant updates to GPU-enabled MPAS-A
- We are working on merging the GPU release with our main release
- Regional capability will be ported to the GPU enabled MPAS.
- GPU physics are the main impediment for some applications.

EarthWorks

Five-year project led by
CSU: Randall PI, Hurrell
NCAR: Gettelman, Hauser,
Skamarock
Funded by NSF CSSI.



Enabling new science in an earth-system-model for both weather and climate, in a unified framework

- A global coupled configuration of CESM
 - A single ~ 4 km global mesh for all components
- GPU-enabled MPAS Atmosphere & MPAS-Ocean
- GPU physics (augmented CAM6)
- Goal: ~0.5 SYPD for the coupled system in 2025

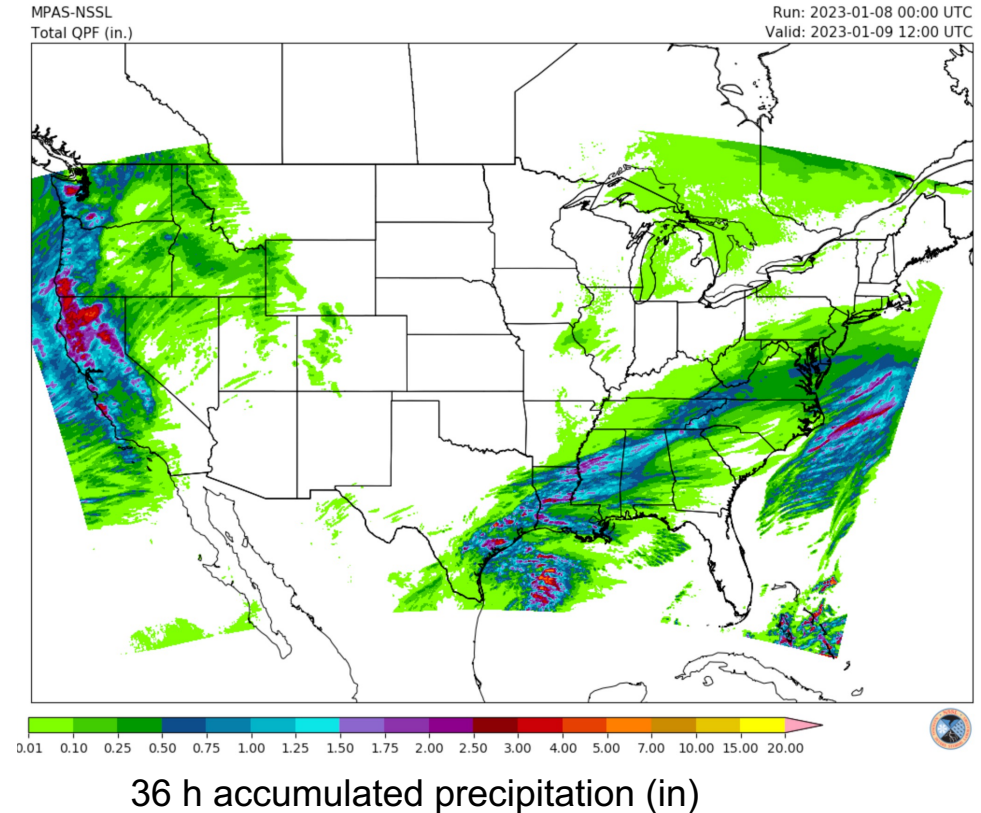
Goal is to release EarthWorks configurations in 2025

<http://hogback.atmos.colostate.edu/earthworks>

MPAS-Atmosphere

MPAS Regional Capability

- Working with NOAA-WOF group to stand-up a regional MPAS-based HRRR configuration.
- We have introduced lateral BC updates to improve regional-MPAS reliability. Available in the upcoming V8 release.
- Developing a utility to create regional meshes on standard projections.
- Streamlining the regional MPAS workflow.



MPAS NSSL HRRR-like configuration

- 3 km mesh
- 24 second timestep
- 59 levels, 25 km model top
- daily 36 h cold-start forecasts, 00 UTC init

MPAS-Atmosphere

LES capabilities in MPAS

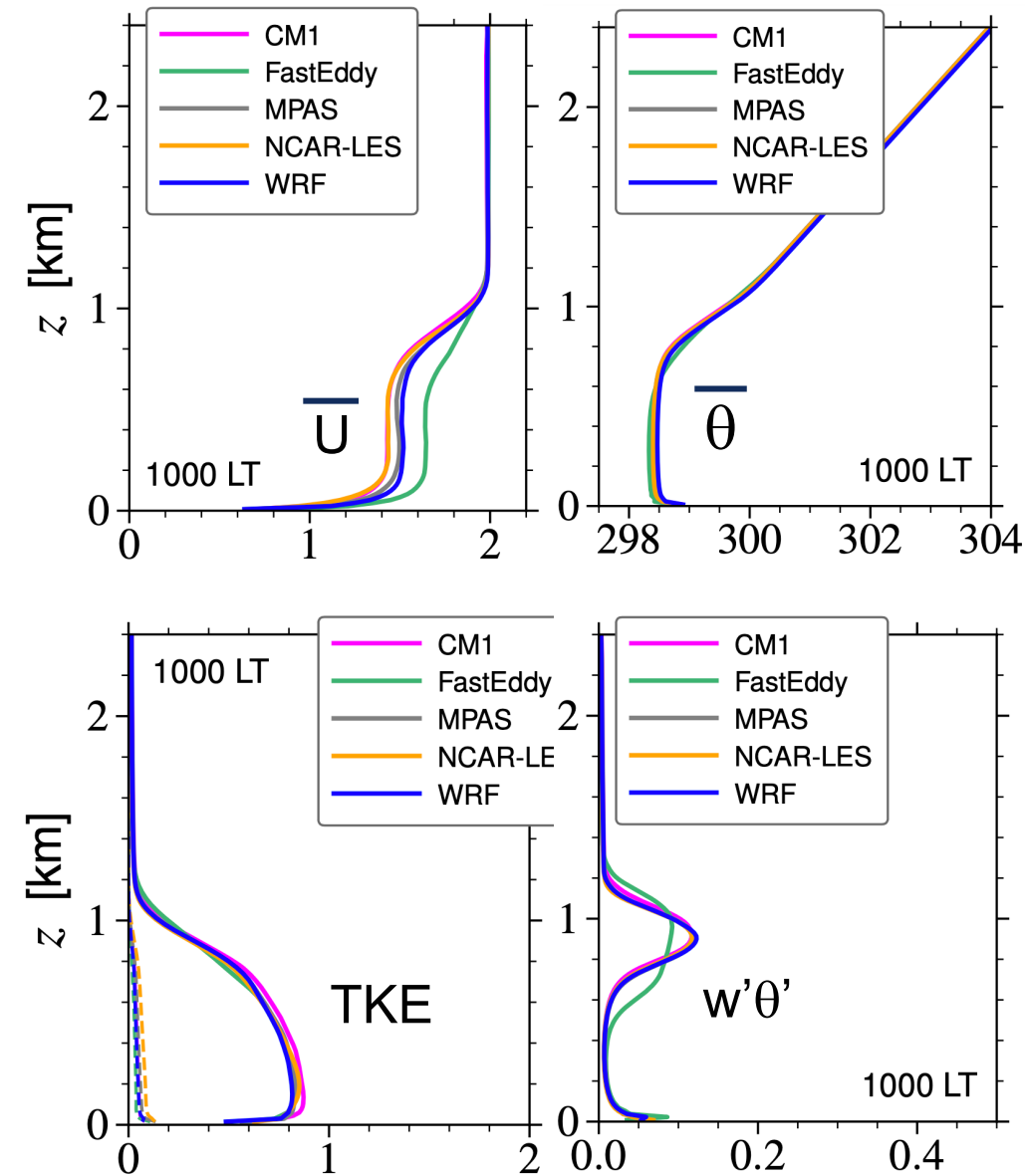
As part of the an NCAR reinvestment project, we implemented 2 LES SGS turbulence models in MPAS: 3D Smagorinsky scheme (diagnostic) and a 1.5 order TKE scheme (prognostic).

MPAS LES results look at lot like WRF and CM1 results.

Extensions for terrain need implementing.

Needs to be GPU enabled.

We may be porting this to CAM/CESM.



SAS LES test case, NCAR PBL reinvestment project

MPAS-Atmosphere

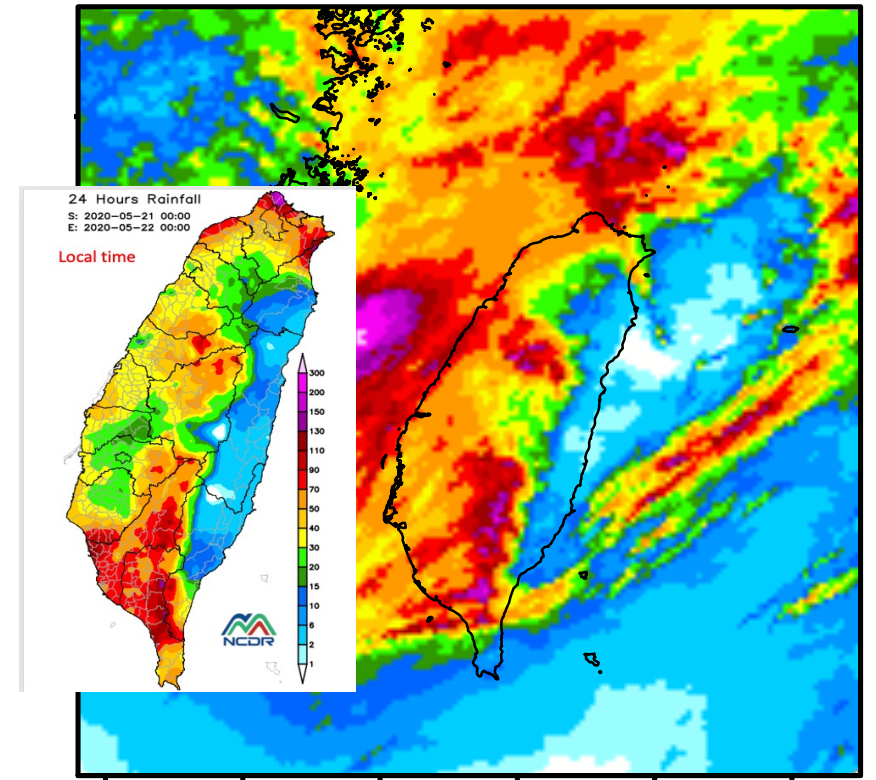
MPAS Physics

Version 8 release:

- Updates to the existing physics
- Noah-MP land model
- Prognostic ozone option

Other development efforts:

- Shared repository for WRF, MPAS, and CM1 shared physics – this calendar year
- CCPP-compatible physics in the shared repository
- We may implement to full CCPP in MPAS, but it is currently low priority.
- RUC LSM (?)
- GPU-enabled physics
 - RRTMG-P (radiation, from EarthWorks)
 - PUMAS (microphysics (MG), from EarthWorks)



Regional MPAS simulation for Taiwan, 3 km, valid 22 May 2020, 24h accumulated precipitation (mm)

MPAS-Atmosphere

MPAS Infrastructure updates for Version 8

Simple MPAS I/O Library (SMIOL) – an alternative
to PIO

Parallelization clean up (removal of block loops)

Dual-stream I/O (static data in separate file from
model state and diagnostics). Greatly reduced
restart file size.

New (aggregated) halo exchanges.

