MPAS
Model for Prediction Across Scales

MPAS V7.0 release

MPAS-Atmosphere Version 5.0: 7 January 2017
Version 5.1: 12 May 2017; Version 5.2: 1 August 2017;
Version 5.3: 22 March 2018

MPAS-Atmosphere Version 6.0: 17 April 2018
Version 6.1: 11 May 2018; Version 6.2: 14 March 2019
Version 6.3: 11 May 2019

MPAS-Atmosphere Version 7.0: 8 June 2019

In contrast to WRF, MPAS does not follow a yearly release schedule.
Releases in new functionality increments the integer version number.
Bugfixes increments the integer to the right of the decimal point.

MPAS Version 7.0: Limited-area capabilities for the atmosphere.
Physics updates and some "usability" enhancements.

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MPAS – Ongoing Development

- MPAS and WRF physics unification.
- MPAS-Atmosphere in CESM/CAM.
- Any GPU/accelerator capabilities in MPAS-Atmosphere.
- Mesh generation.
- Deep atmosphere capability

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MPAS – Ongoing Development

MPAS and WRF physics unification

- There are distinct versions of the “same” WRF physics in the WRF and MPAS repositories (i.e. not a single source).
- We are going to have a single repository from which we will pull this shared physics for both WRF and MPAS builds.
- We may evolve to sharing a single NCAR repository for WRF/MPAS/CAM physics.
- We are developing a Common Physics Framework (CPF) that will replace the physics drivers in NCAR atmospheric models. We expect it will be compatible with NOAA’s CCPP (and likely share code).

MPAS – Ongoing Development

MPAS-Atmosphere in CESM/CAM

Community Earth System Model (CESM)

- MPAS-A Version 4 is an atmospheric dynamical core in CAM
- NWP and climate testing is ongoing
- Coupled model simulations are being performed (w/ocean, ice)
- Physics evaluation for NWP is major focus of early testing

A clean, supportable implementation of MPAS-A into CESM is being engineered. MPAS-A will be a CESM external (like the new CESM ocean core MOM). Builds of MPAS-A in CESM/CAM will pull MPAS-A directly from the MPAS development/release github repository.

The new MPAS-Atmosphere port to CESM is part of the *SIMA (System for Integrated Modeling of the Atmosphere)* development project to unify atmospheric modeling at NCAR (weather, climate, chemistry and geospace).

MPAS-Atmosphere will adopt and use the Community Physics Framework (CPF) being developed to access both WRF and CESM/CAM physics.

Regional MPAS-A capabilities should be available in CESM/CAM.

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MPAS – Ongoing Development

GPU/accelerator capabilities in MPAS-Atmosphere

A version of MPAS-A using GPUs through OpenACC directives is being developed.

Participating organizations: The Weather Company, IBM, NCAR, Univ. Wyoming, KISTI, NVIDIA

Questions being addressed in this development:

- Can we achieve significant performance enhancement on GPUs using OpenACC?
- Can we maintain and evolve a single-source code (CPU/GPU) in our development and for release and support to the community?

We are expecting to have an initial implementation of this capability soon.

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MPAS – Ongoing Development

MPAS mesh generation

Mesh generation utilities are not in the MPAS V7 release.

Mesh generation is expensive (expensive algorithms, parallelization issues, etc). Variable high-resolution meshes can take months to generate with existing utilities.

Recent development efforts suggest we may be able to speed-up our existing algorithms by an order of magnitude or more.

Mesh generation tools will appear in the public MPAS-Tools repository:
https://github.com/MPAS-Dev/MPAS-Tools

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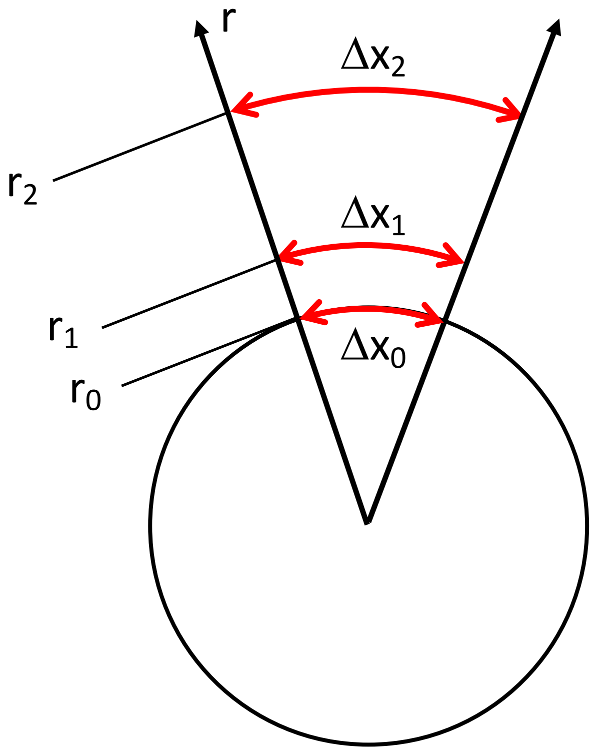
MPAS: Deep-Atmosphere



Deep atmosphere capability in MPAS will likely appear in the next release.

Shallow atmosphere (WRF, MPAS, most models)

$\Delta x_0 = \Delta x_1 = \Delta x_2$

Deep atmosphere

$\Delta x_1 = (r_1/r_0)\,\Delta x_0$; $\Delta x_2 = (r_2/r_0)\,\Delta x_0$; $\Delta x_k = (r_k/r_0)\,\Delta x_0$

$$\frac{\partial \mathbf{V}_H}{\partial t} = -\frac{\rho_d}{\rho_m}\left[\nabla_\zeta\left(\frac{p}{\zeta_z}\right) - \frac{\partial \mathbf{z}_H p}{\partial \zeta}\right] - \eta\,\mathbf{k}\times\mathbf{V}_H$$
$$- \mathbf{v}_H \nabla_\zeta \cdot \mathbf{V} - \frac{\partial \Omega \mathbf{v}_H}{\partial \zeta} - \rho_d \nabla_\zeta K - \beta_d\left(eW\cos\alpha_r + \frac{uW}{r}\right) + \mathbf{F}_{V_H}$$

$$\frac{\partial W}{\partial t} = -\frac{\rho_d}{\rho_m}\left[\frac{\partial p}{\partial \zeta} + g\tilde{\rho}_m\right] - \left(\nabla\cdot\mathbf{v}\,W\right)_\zeta$$
$$+ \beta_d\left[\frac{uU + vV}{r} + e\left(U\cos\alpha_r - V\sin\alpha_r\right)\right] + F_W$$

$\beta_d = 0$, $r = r_{earth}$ for shallow atmosphere
$\beta_d = 1$, r = radius for deep atmosphere
$g = g_0\,(r^2/r_0^2)$