



# MPAS-Atmosphere Resources

MPAS-Atmosphere Users' Guide: On the MPAS-Atmosphere download page



MPAS Atmosphere Public Releases

MPAS Atmosphere 8.2.1 was released on 7 August 2024.

For information on the GPU-enabled MPAS-Atmosphere model, please refer to [this documentation](#)

[MPAS Atmosphere 8.2.1 release notes](#)

Source code downloads:

- [MPAS v8.2.1](#)
- [GPU-enabled MPAS-Atmosphere v6.x](#)

[MPAS-Atmosphere Users' Guide](#)

[MPAS-Atmosphere tutorial](#)

[MPAS-Atmosphere meshes](#)

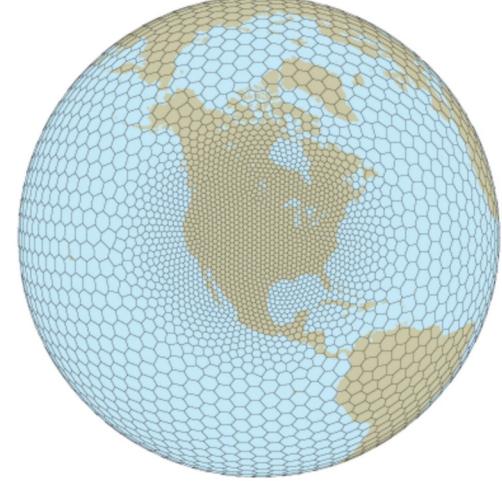
[Static geographical datasets](#)

[Monthly climatological aerosol dataset \(QNWFA\\_QNIFA\\_SIGMA\\_MONTHLY.dat\)](#)

[Configurations for idealized test cases](#)

[Sample input files for real-data simulations](#)

[Visualization and analysis tools](#)



A variable resolution MPAS Voronoi mesh





# MPAS-Atmosphere Resources

MPAS-Atmosphere tutorial: On the MPAS-Atmosphere download page

The screenshot shows the MPAS Atmosphere Public Releases page. At the top right, there is a large globe with a hexagonal grid pattern labeled "A variable resolution MPAS Voronoi mesh". The main content area has a heading "MPAS Atmosphere Public Releases". Below it, a message states "MPAS Atmosphere 8.2.1 was released on 7 August 2024. For information on the GPU-enabled MPAS-Atmosphere model, please refer to [this documentation](#)". To the left, a sidebar contains links for "MPAS Home", "Overview" (with sub-links for MPAS-Atmosphere, MPAS-Albany Land Ice, MPAS-Ocean, MPAS-Seaiice, Data Assimilation, Publications, and Presentations), "Download" (with sub-links for MPAS-Atmosphere download, MPAS-Albany Land Ice download, MPAS-Ocean download, and MPAS-Seaiice download), "Resources" (with sub-links for License Information, Wiki, Bug Tracker, Mailing Lists, MPAS Developers Guide, MPAS Mesh Specification Document), and "MPAS Atmosphere 8.2.1 release notes". A red arrow points from the text "MPAS-Atmosphere tutorial" in the first paragraph to the "MPAS-Atmosphere tutorial" link in the sidebar. Another red arrow points from the "MPAS-Atmosphere tutorial" link in the sidebar back to the text "MPAS-Atmosphere tutorial" in the first paragraph.





# MPAS-Atmosphere Resources

## WRF&MPAS-A Support Forum

You need to create an account to post to it.

Searchable

The screenshot shows a web browser window with the following details:

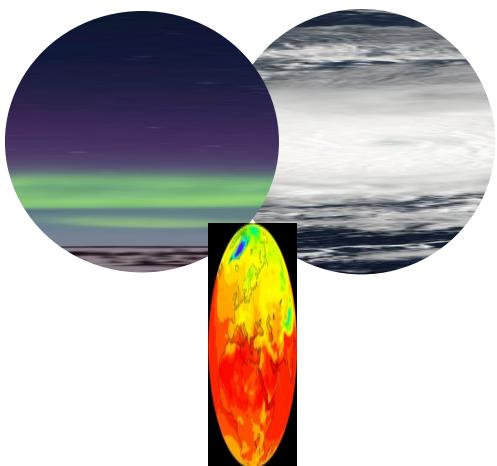
- Title Bar:** MPAS, WRF & MPAS-A Support Forum
- Address Bar:** forum.mmm.ucar.edu (highlighted with a red circle)
- Toolbar:** NCAR Library Proxy, Skamarock Home..., Imported From Sa..., RAP Real-Time W..., MPAS, NCAR Library
- Header:** NCAR MMM WRF&MPAS-Aforum, Forums, What's new, Tags, Members, Log in, Register, Search
- Content Area:**
  - Section:** WRF & MPAS-A Support Forum
  - Image:** A map of the United States showing atmospheric conditions with various color-coded regions and labels like "552".
  - Welcome Message:** Welcome to the WRF/WRFDA/WRF-Chem/MPAS Users' Support Forum, please read the guidelines & suggestions below.  
**\*WRFDA NOTICE\***
  - Registration:** You must create an account to post, first-time posts need manager approval and it may take 2-3 business days.
  - Posting Threads:** Before posting, use the search utility to verify whether a solution to your inquiry already exists.
    - Post inquiries to the relevant forum and open a new thread for each new question. Do not post inquiries more than once.
    - State the problem or error in the subject line and attach relative files - e.g., namelists, error logs
    - Under "Options" check the boxes for "Watch this thread..." and "receive email notifications" to stay up to date on replies. Alternatively, click your name at the top of the forum site, and then "preferences" to choose notification options for the entire forum site.
    - If the problem is related to compiling, please first see the [WRF/WPS Compiling web page](#).
    - Add relevant tags to your thread (see [list of all tags](#)). Contact us if you need additional tags.
    - There is no need to quote the previous post unless you are quoting a specific section. It is assumed your response is to the most recent submission.
- Right Sidebar:** Latest posts (listing topics like "WRF Default Landcover and Soil Texture dataset sources and citations", "UCM model Issue", etc.)



# The Model for Prediction Across Scales Atmosphere

## MPAS-Atmosphere and the future

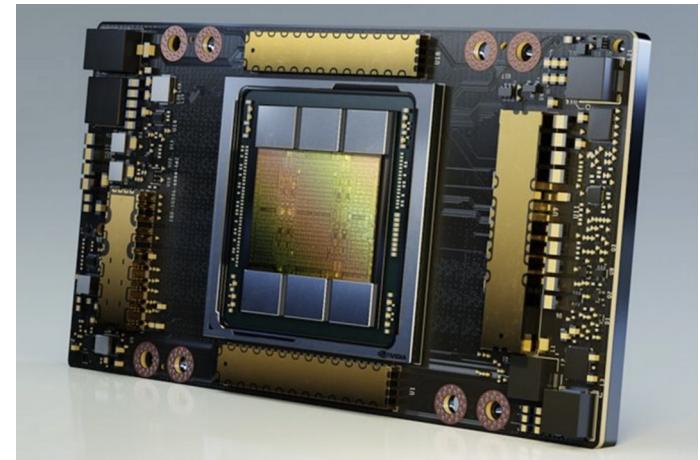
MPAS-A in an Earth System Model



SIMA

EarthWorks

MPAS-A and GPUs



NVIDIA Ampere A100 GPU



# System for Integrated Modeling of the Atmosphere (SIMA)

## (1) MPAS-Atmosphere in an Earth System

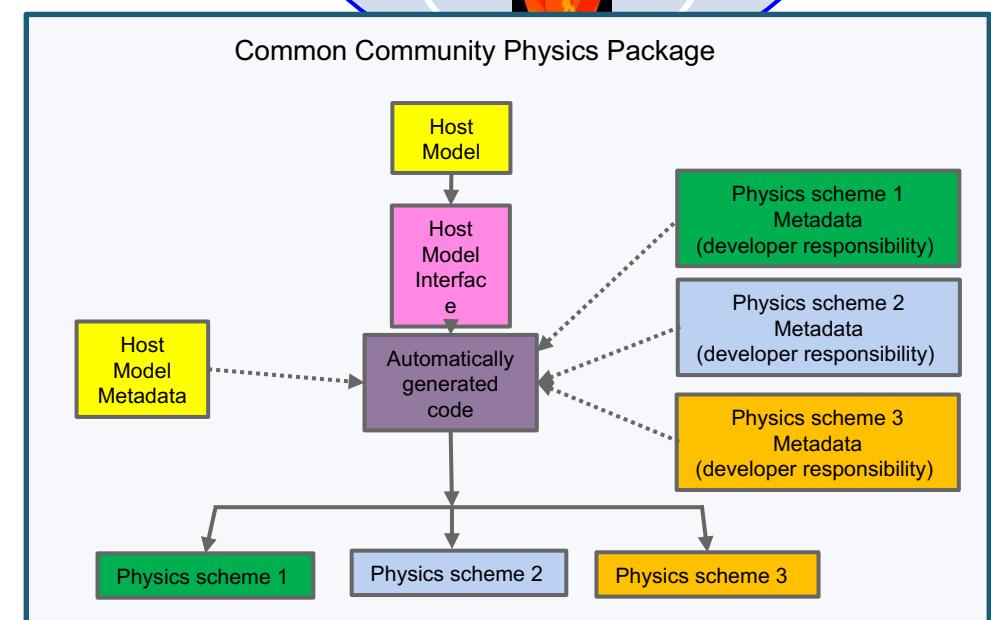
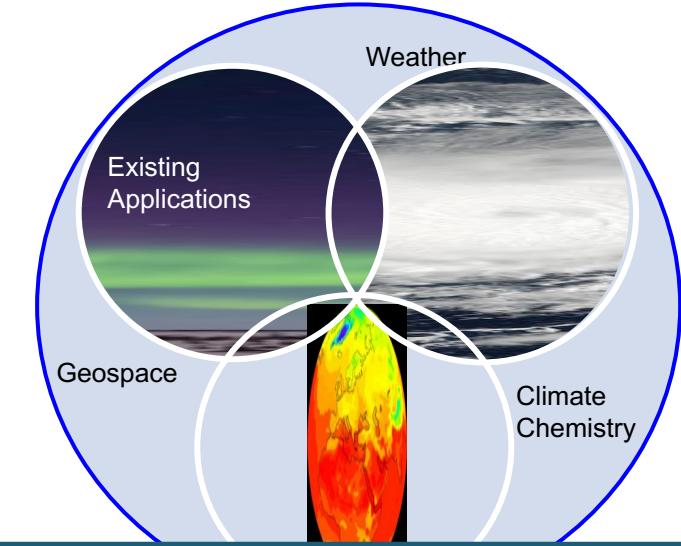
Model (ESM), using CESM components.

Other ESM components: ocean, land,  
land and sea ice, chemistry

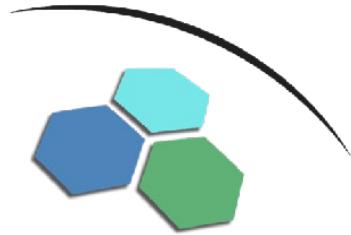
## (2) WRF/MPAS physics in an ESM using the Common Community Physics Package (CCPP) interface.

### Status:

- MPAS-A in CESM is being tested.
- Only CESM/CAM physics will be available in a first release.
- CCPP implementation in MPAS and CESM is not yet complete.
- Initial release (experimental) TBD.



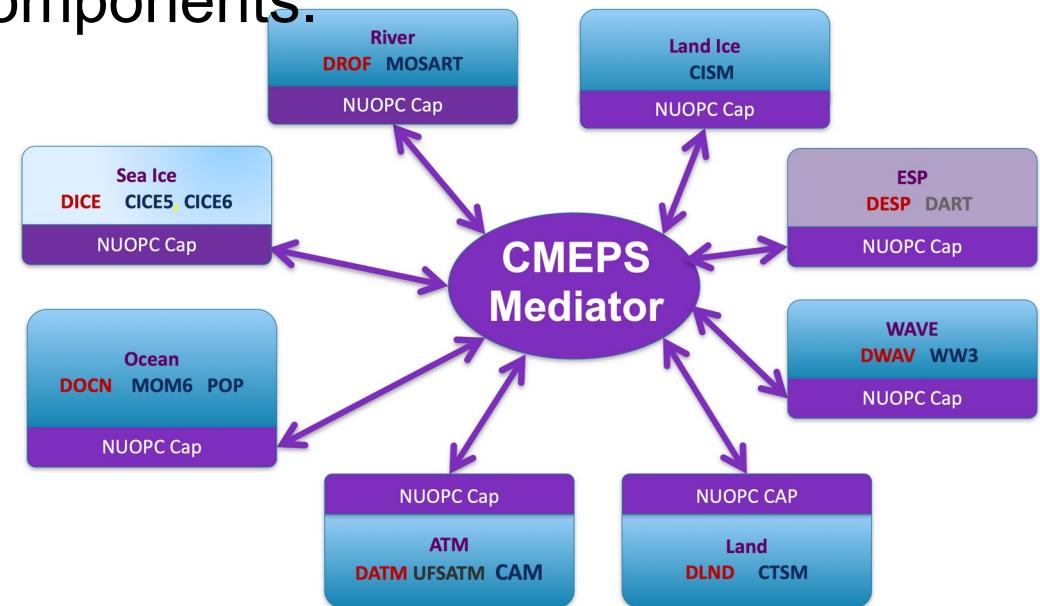
# EarthWorks



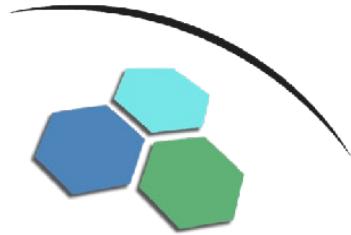
EarthWorks is a five-year university-based project (CSU), supported by NSF/CISE, to develop a *global convection-permitting coupled model* based on the CESM with GPU capability for all components.

Earthworks consists of:

- The MPAS non-hydrostatic dynamical core, with a resolved stratosphere and CAM-ish physics
- The MPAS ocean model, developed at Los Alamos
- The MPAS sea ice model, based on CICE
- The Community Land Model (CLM)
- The Community Mediator for Earth Prediction Systems (CMEPS)



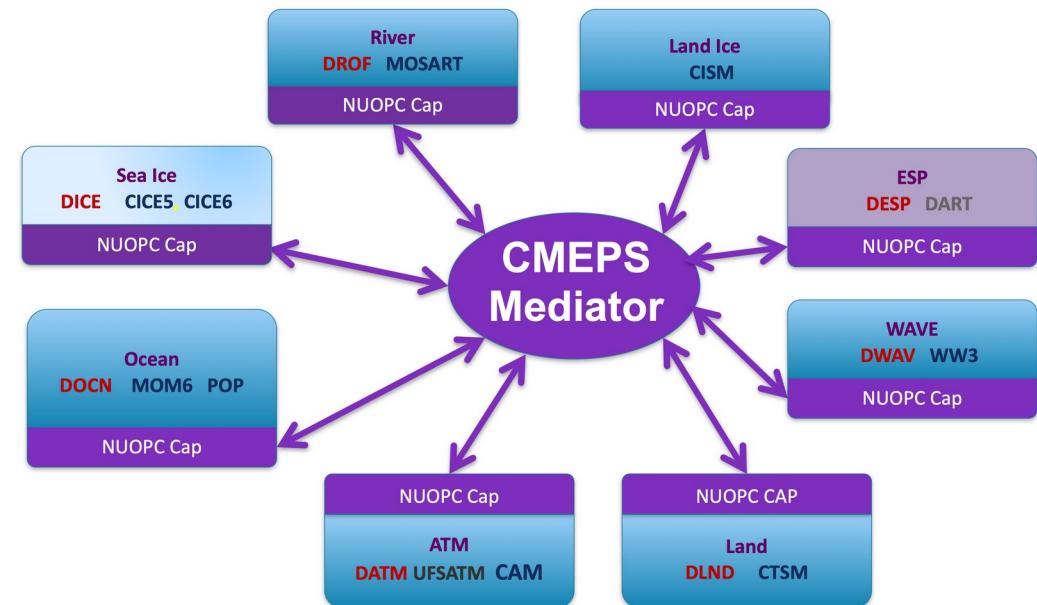
# EarthWorks



EarthWorks is available now in a first “functional” release:  
`git clone https://github.com/EarthWorksOrg/EarthWorks.git`

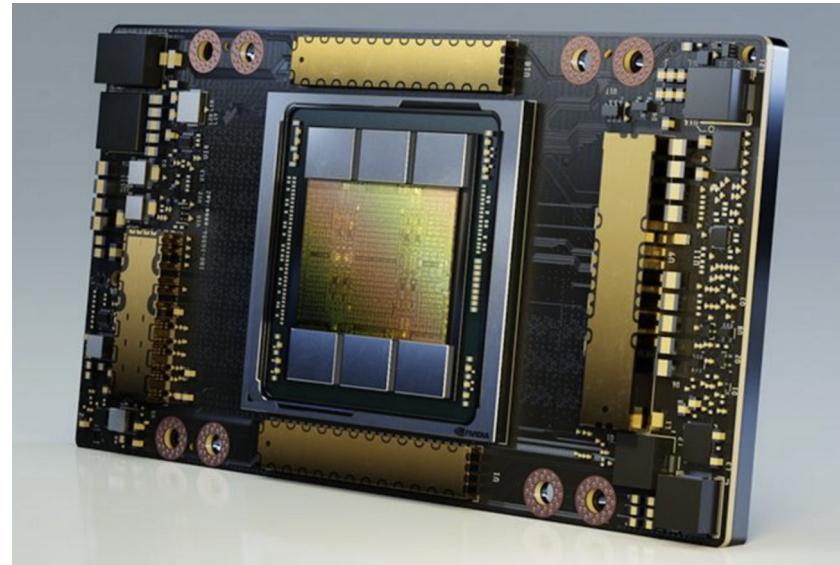
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## MPAS and GPUs

We released the GPU-enabled MPAS-Atmosphere in October 2020 as a branch from MPAS Version 6.1. We have a Version 7 update but it has not been released.



NVIDIA Ampere A100 GPU

What is in current (2020) release:

- GPU-enabled MPAS dynamical core using OpenACC directives.
- Some GPU-enabled physics (e.g. YSU, WSM6, M-O, scale-aware nTiedtke)
- Asynchronous execution capability on heterogeneous architectures - currently radiation (lagged) and NOAH land model on CPUs, all else on GPUs
- Configurations tested and validated on IBM POWER9 architectures and on AMD architectures employing NVIDIA V100 and A100 GPUs.

# MPAS-Atmosphere Upcoming Releases

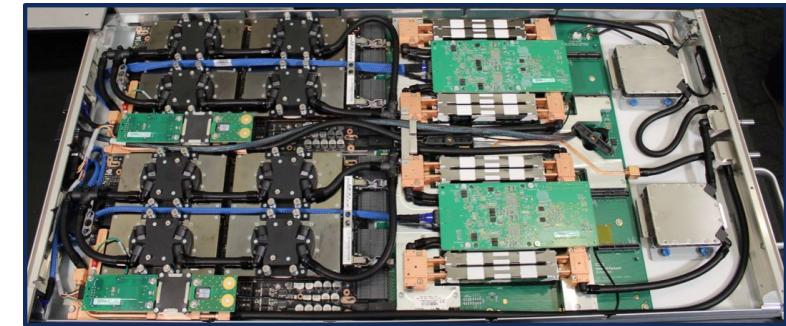
## MPAS-Atmosphere GPU Implementation

GPU implementation for MPAS-Atmosphere

<https://mpas-dev.github.io/atmosphere/OpenACC/index.html>

Based on our experience with this release, we are re-implementing this capability

- Initial (partial) GPU capability has been released and in MPAS v8.2.0
- Subsequent MPAS-A releases will incrementally extend GPU capabilities in the dynamical core and physics.
- Demonstrates commitment to MPAS-A as a community model designed for next-generation computing systems
- Builds on lessons learned from past partnerships with IBM, The Weather Company, the University of Wyoming, and NVIDIA.



Above: A Derecho GPU blade with two GPU nodes, each with 1 AMD EPYC Zen3 "Milan" 64-core processor and 4 NVIDIA A100 Ampere GPUs.

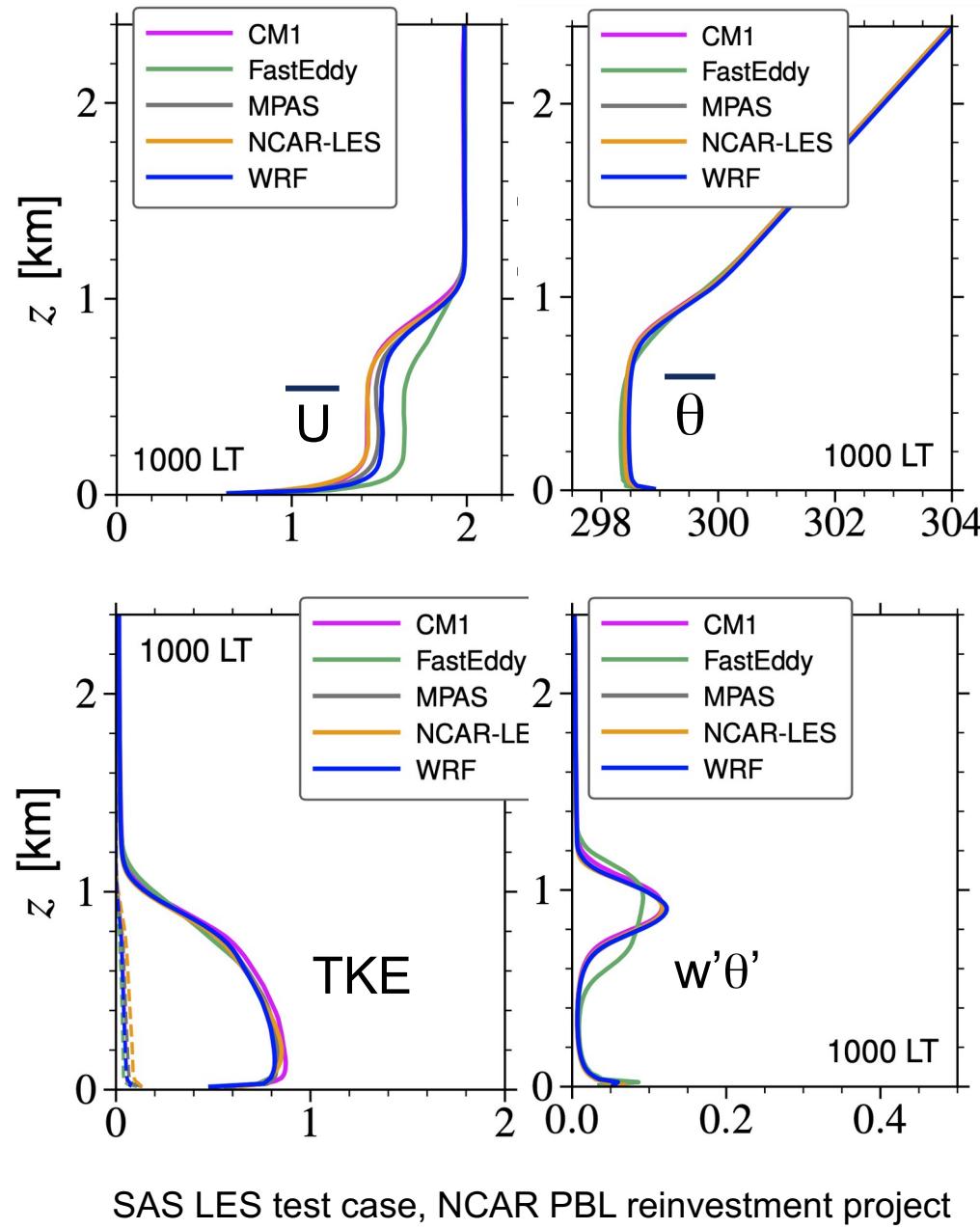
## LES capabilities in MPAS

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.

Release timetable TBD.



SAS LES test case, NCAR PBL reinvestment project



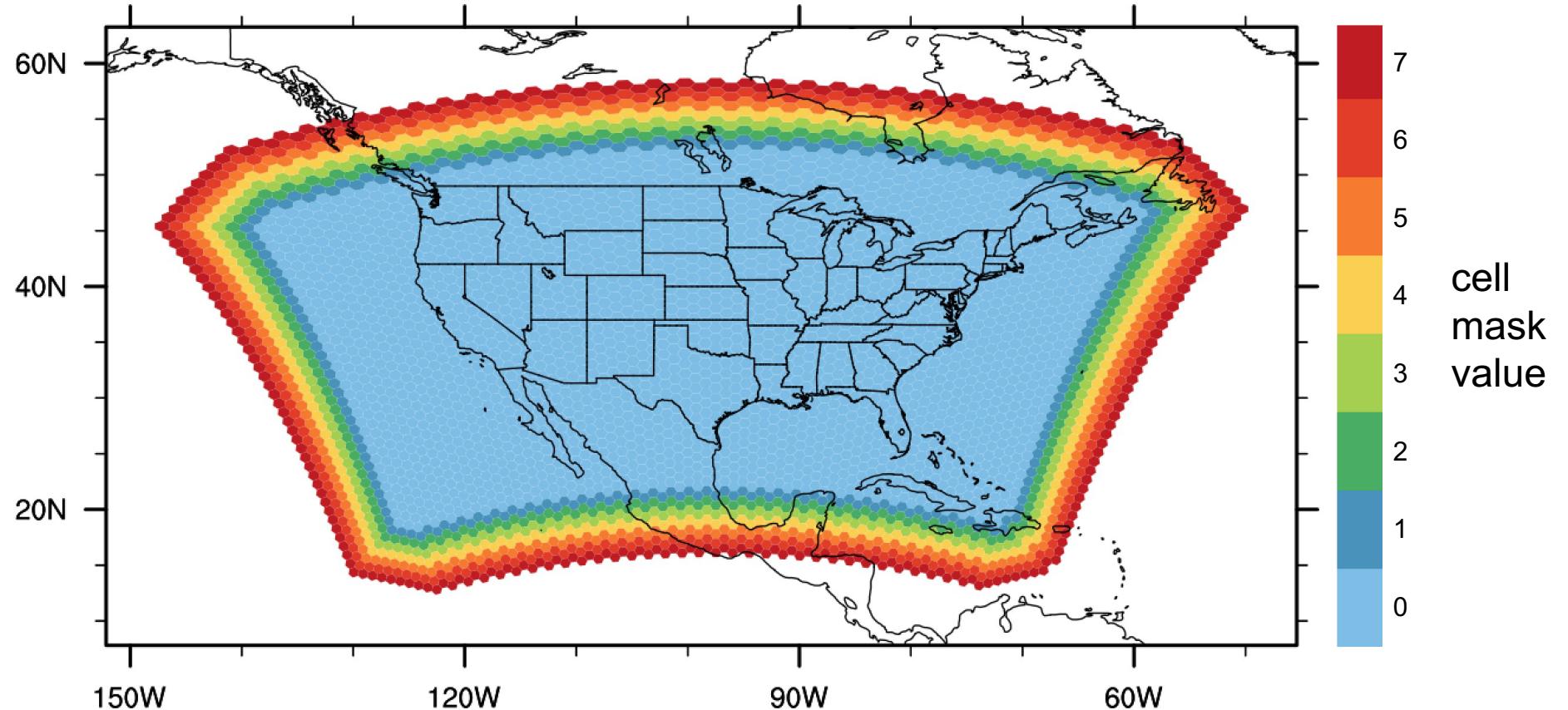
## Also under development...

- Scalar transport in physics parameterizations (convection, boundary layer) in preparation for chemistry.
- Prognostic ozone
- GOCART implementation
- Unified (MPAS, WRF, CM1) physics
- Mesh generation, global and regional
- MPAS-Atmosphere Technical Note

There are ongoing discussions about a full chemistry implementation

## Also under development...

Mesh of perfect hexagons projected to the sphere. Lambert conformal projection



# An example from the draft technical note

## Vertical Vorticity

The discrete vertical vorticity is evaluated at the vertices of the MPAS CVT mesh. Referring to figure 2.1, the vertical vorticity at vertex  $a$  is computed using the circulation theorem applied to the MPAS dual triangular mesh. The relative vertical vorticity at vertex  $a$  is computed as

$$\zeta_a = \frac{u_{13} |\overrightarrow{CA}| t_{13,a} + u_{14} |\overrightarrow{AB}| t_{14,a} + u_{15} |\overrightarrow{BC}| t_{15,a}}{A_a}, \quad (4.27)$$

where  $A_a$  is the area of the triangle centered at vertex  $a$ . The indicator function  $t_{e,v}$  corrects for the direction of a positive velocity from the first cell center to the second in the circulation calculation. In the example (4.27), the indicator functions are all equal to 1. In contrast, the indicator functions would be equal to -1 for these same velocities contributing to the circulation about vertices  $b$ ,  $f$  and  $j$ . Also note that these computations are performed on MPAS horizontal surfaces. Finally, the absolute vorticity at the vertices  $\eta_a = \zeta_a + 2\Omega \sin(\phi)$ , where  $\Omega$  is the angular velocity of the earth's rotation and  $\phi$  is the latitude.

**MPAS code:** *The vertical vorticity is computed in subroutine atm\_compute\_solve\_diagnostics found in [MPAS-Model/src/core\\_atmosphere/dynamics/mpas\\_atm\\_time\\_integration.F](#). The relative vertical vorticity at a vertex  $\zeta_v$  is stored in the array vorticity(level,vertex). The indicator function  $t_{e,v}$  is stored in the array edgesOnVertex\_sign(edge,vertex). The absolute vorticity at the vertices  $\eta_v$  is stored in the array pv\_vertex(level,vertex). The name goes back to MPAS-A's initial implementation of a shallow water model.*



# Coming Events

WRF-MPAS workshop

June 2025 (in person), specific week TBD (likely 2-6 June 2025).

We've begun work on an MPAS NCAR Technical Note. Draft – early 2025?

We have two tutorials each year, NH spring (virtual) and NH fall (in person):

- September 30 – October 4, Howard University Washington DC.
- April or May 2025.

Feature and bug releases occur whenever components are ready.