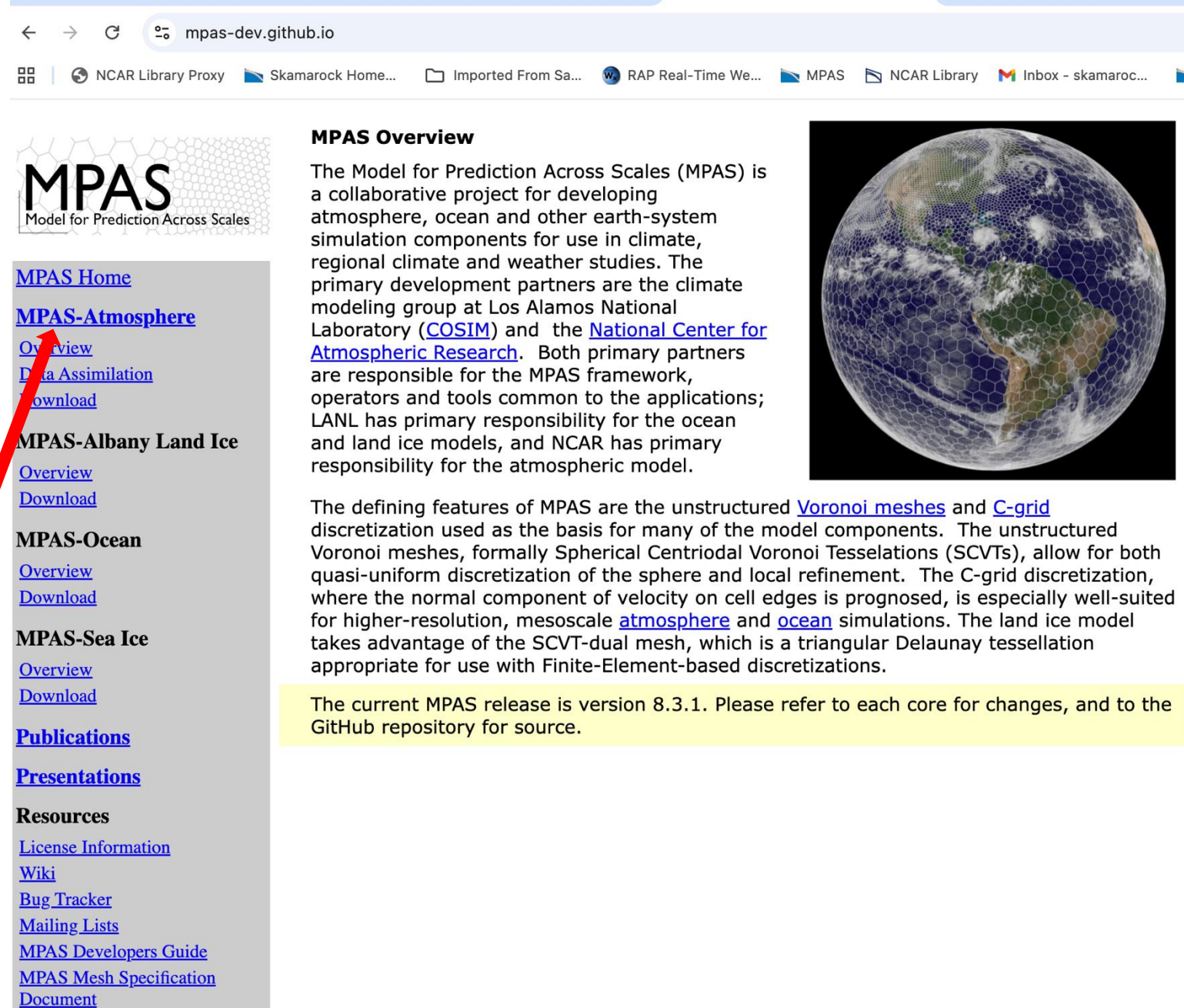


## The Github MPAS web page

## MPAS-Atmosphere

*All MPAS-A links will take  
you to the new web pages*



The screenshot shows the MPAS-Atmosphere GitHub page. The browser address bar displays 'mpas-dev.github.io'. The page features a sidebar with navigation links: 'MPAS Home', 'MPAS-Atmosphere' (highlighted with a red arrow), 'Overview', 'Data Assimilation', 'Download', 'MPAS-Albany Land Ice', 'MPAS-Ocean', 'MPAS-Sea Ice', 'Publications', 'Presentations', and 'Resources'. The main content area includes an 'MPAS Overview' section with a paragraph describing the project and its partners, followed by a paragraph detailing the model's discretization features. A yellow box at the bottom of the main content area contains a note about the current release version (8.3.1) and where to find updates. On the right side of the page, there is a large image of the Earth showing a global mesh overlay.

MPAS Overview

The Model for Prediction Across Scales (MPAS) is a collaborative project for developing atmosphere, ocean and other earth-system simulation components for use in climate, regional climate and weather studies. The primary development partners are the climate modeling group at Los Alamos National Laboratory ([COSIM](#)) and the [National Center for Atmospheric Research](#). Both primary partners are responsible for the MPAS framework, operators and tools common to the applications; LANL has primary responsibility for the ocean and land ice models, and NCAR has primary responsibility for the atmospheric model.

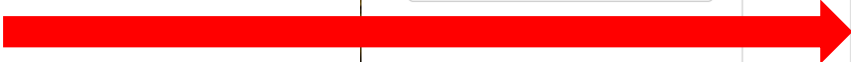
The defining features of MPAS are the unstructured [Voronoi meshes](#) and [C-grid](#) discretization used as the basis for many of the model components. The unstructured Voronoi meshes, formally Spherical Centriodal Voronoi Tessellations (SCVTs), allow for both quasi-uniform discretization of the sphere and local refinement. The C-grid discretization, where the normal component of velocity on cell edges is prognosed, is especially well-suited for higher-resolution, mesoscale [atmosphere](#) and [ocean](#) simulations. The land ice model takes advantage of the SCVT-dual mesh, which is a triangular Delaunay tessellation appropriate for use with Finite-Element-based discretizations.

The current MPAS release is version 8.3.1. Please refer to each core for changes, and to the GitHub repository for source.



The official  
MPAS-Atmosphere  
web page

MPAS-Atmosphere  
Users Guide



MPAS

Model for Prediction Across Scales

NSF

NCAR

MPAS Atmosphere

Model for Prediction Across Scales - Atmosphere

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GitHub

Model for Prediction Across Scales - Atmosphere

The atmospheric component of MPAS uses an unstructured centroidal Voronoi mesh (grid, or tessellation) and C-grid staggering of the state variables as the basis for the horizontal discretization in the fluid-flow solver. The unstructured variable resolution meshes can be generated having smoothly-varying mesh transitions (see figure (a) below), which ameliorates many issues associated with the traditional mesh refinement strategy of one-way and two-way grid nesting where the transitions are abrupt. The flexibility of the MPAS meshes allows for applications in high-resolution numerical weather prediction (NWP) and regional climate, in addition to global uniform-resolution NWP and climate applications.

Documentation & Resources

Overview of MPAS-A

MPAS-A User Guide

MPAS-A Technical Description

MPAS Mesh Specification

MPAS-A Tutorial Practice Guide

MPAS Data Assimilation

MPAS-JEDI Tutorial Practice Guide

Access Code, Data, & Meshes

Information and links to MPAS-A source code, static geographical datasets, meshes, and input files for real-data and idealized test cases

NSF

NCAR

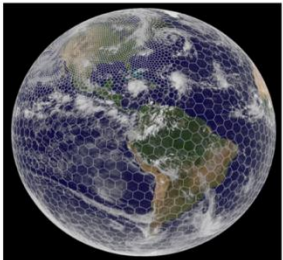
OPERATED BY UCAR

— MPAS Tutorial, 10-12 August 2026

[←](#) [→](#) [↺](#) [www2.mmm.ucar.edu/projects/mpas/site/index.html](#)

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## MPAS Atmosphere

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# Model for Prediction Across Scales - Atmosphere

The atmospheric component of MPAS uses an unstructured Voronoi mesh (grid, or tessellation) and C-grid variables as the basis for the horizontal discretization. The unstructured variable resolution mesh allows for having smoothly-varying mesh transitions (see Figure 1) which ameliorates many issues associated with the traditional strategy of one-way and two-way grid nesting which is abrupt. The flexibility of the MPAS meshes allows for high resolution numerical weather prediction (NWP) in addition to global uniform-resolution NWP and

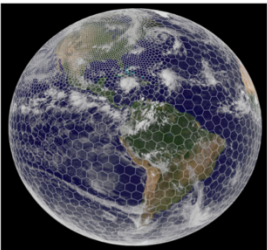
Documentation & Resources

[Overview of MPAS-A](#)  
[MPAS-A User Guide](#)  
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[←](#) [→](#) [↺](#) [www2.mmm.ucar.edu/projects/mpas/site/documentation.html](#)

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## MPAS Atmosphere

MPAS Documentation and Resources

Documentation -  
Overview of MPAS-A  
Users' Guide +  
MPAS-A Technical Description  
MPAS Tutorial Practice Guide  
Mesh Specification  
MPAS Data Assimilation  
MPAS-JEDI Tutorial Practice Guide

Downloads +  
GPU-enabled MPAS-A +  
Visualization  
News & Events  
Publications

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[Home](#) / [MPAS Documentation and Resources](#)

# MPAS Documentation and Resources

Click the links below to access documentation resources for MPAS-A.

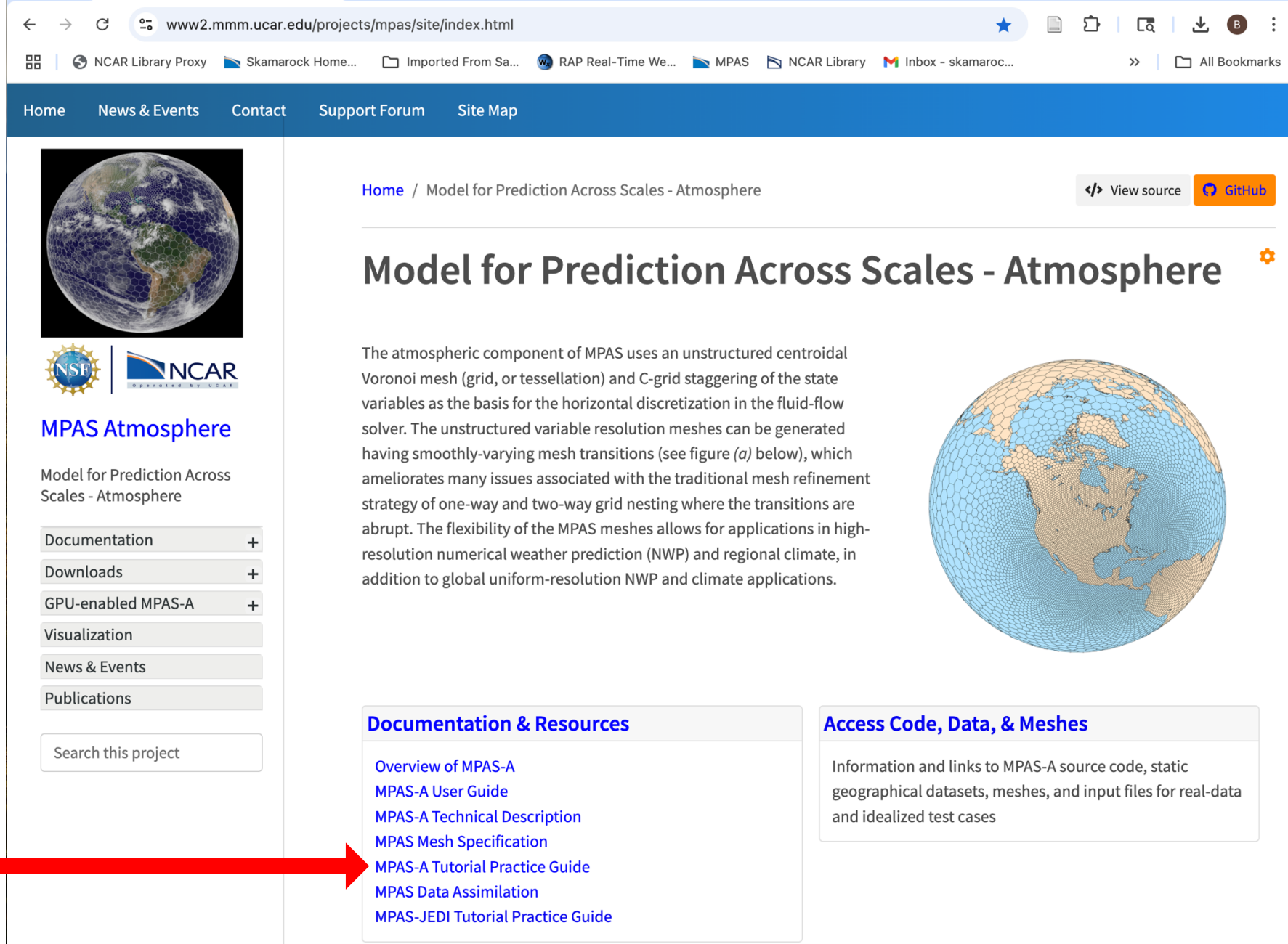
[Overview of MPAS-A](#)  
[MPAS-A Users' Guide \(pdf\)](#)  
[MPAS-A Technical Description](#)  
[MPAS Mesh Specification](#)  
[MPAS-A Tutorial Practice Guide](#)  
[MPAS Data Assimilation](#)  
[MPAS-JEDI Tutorial Practice Guide](#)

pdf version of the User's guide  
(updated with each new feature release)

# MPAS

Model for Prediction Across Scales

## MPAS-Atmosphere Tutorial (currently the winter 2026 virtual tutorial)

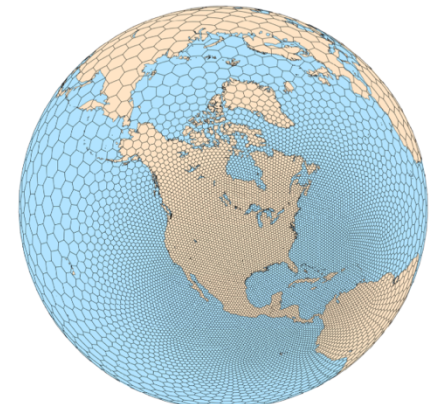


The screenshot shows the MPAS website interface. The top navigation bar includes links for Home, News & Events, Contact, Support Forum, and Site Map. The main content area is titled "Model for Prediction Across Scales - Atmosphere". It features a globe with a mesh overlay and a sidebar with links to Documentation, Downloads, GPU-enabled MPAS-A, Visualization, News & Events, and Publications. A red arrow points from the text "MPAS-Atmosphere Tutorial (currently the winter 2026 virtual tutorial)" to the "MPAS-A Tutorial Practice Guide" link in the "Documentation & Resources" section.

Home / Model for Prediction Across Scales - Atmosphere

## Model for Prediction Across Scales - Atmosphere

The atmospheric component of MPAS uses an unstructured centroidal Voronoi mesh (grid, or tessellation) and C-grid staggering of the state variables as the basis for the horizontal discretization in the fluid-flow solver. The unstructured variable resolution meshes can be generated having smoothly-varying mesh transitions (see figure (a) below), which ameliorates many issues associated with the traditional mesh refinement strategy of one-way and two-way grid nesting where the transitions are abrupt. The flexibility of the MPAS meshes allows for applications in high-resolution numerical weather prediction (NWP) and regional climate, in addition to global uniform-resolution NWP and climate applications.



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### Access Code, Data, & Meshes

Information and links to MPAS-A source code, static geographical datasets, meshes, and input files for real-data and idealized test cases



# MPAS-Atmosphere Technical Note

*2025 draft*

www2.mmm.ucar.edu/projects/mpas/site/index.html

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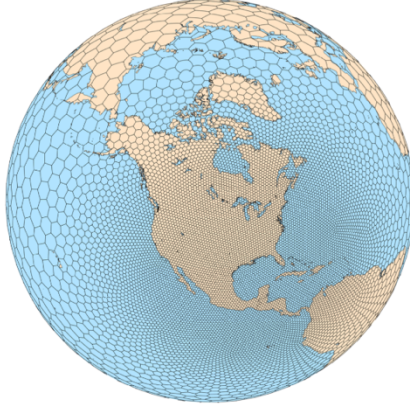
Home News & Events Contact Support Forum Site Map

Home / Model for Prediction Across Scales - Atmosphere

[View source](#) [GitHub](#)

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Publications

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## Technical Note Example

### 5.1.2 4th-Order Horizontal Filter

The continuous form for the fourth-order horizontal filter is given by the RHS term for the update equation for a scalar  $\phi$ :

$$\frac{\partial(\tilde{\rho}_d\phi)}{\partial t} = \dots - \nabla \cdot (\tilde{\rho}_d\nu_4\nabla(\nabla_\zeta \cdot \nabla_\zeta\phi)), \quad (5.4)$$

where the hyperviscosity  $\nu_4$  has units  $m^4s^{-1}$ . Defining a discrete turbulent flux divergence operator  $T_2(\phi)$  as

$$\nabla_\zeta \cdot \nabla_\zeta\phi \rightarrow \frac{1}{A_i} \sum_{e_i} L_{e_i} (\mathbf{n}_{e_i} \cdot \nabla\phi) = T_2(\phi), \quad (5.5)$$

Continuous and discrete operators

we can write the discrete 4th-order filter term as

$$\nabla \cdot (\tilde{\rho}_d\nu_4\nabla(\nabla_\zeta \cdot \nabla_\zeta\phi)) \rightarrow \frac{1}{A_i} \sum_{e_i} L_{e_i} \tilde{\rho}_d \nu_4 (\mathbf{n}_{e_i} \cdot \nabla T_2(\phi)). \quad (5.6)$$

The hyperviscosity  $\nu_4$  is constant in the current MPAS implementation, thus there is no averaging operator applied to it. As in the second-order filter, the density at the cell edges is an average of the densities from the cell centers of the two cells sharing the edge for vertically unstaggered variables ( $\theta$ ). The density will also be averaged in  $z$  when the filter is applied to  $w$ .

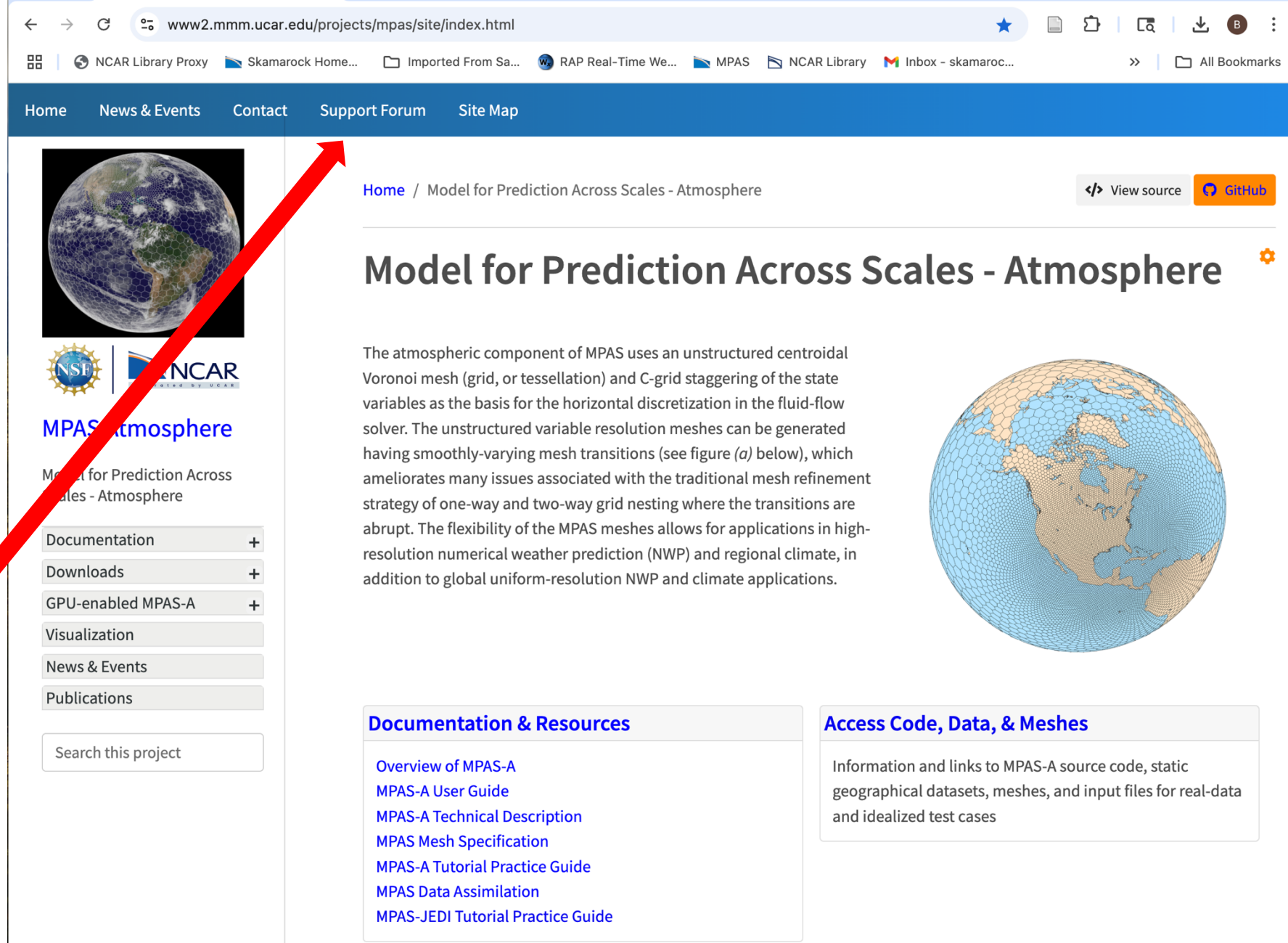
Locations in the code where specific computations take place, along with implementation notes

**MPAS code:** The second-order and fourth-order horizontal filtering for  $\theta$  and  $w$  are computed in *subroutine atm\_compute\_dyn\_tend* in *MPAS-Model/src/core\_atmosphere/dynamics/mpas\_atm\_time\_integration.F*. The computations occur only once in each dynamics timestep, during the first RK3 substep. When the 4th-order filter is applied, the turbulent flux divergences from the 2nd-order filter application (5.5) are saved and used in the second application of the turbulent flux divergence operator (5.6) needed to complete the 4th-order operator.

# MPAS

Model for Prediction Across Scales

MPAS-Atmosphere  
support forum



The screenshot shows the MPAS-Atmosphere website. A red arrow points from the text 'MPAS-Atmosphere support forum' to the 'Support Forum' link in the top navigation bar. The website header includes links for Home, News & Events, Contact, Support Forum, and Site Map. The main content area features a globe with a mesh overlay, the MPAS-Atmosphere logo, and a list of links: Documentation, Downloads, GPU-enabled MPAS-A, Visualization, News & Events, and Publications. A search bar is also present. The right sidebar contains a 'Documentation & Resources' section with links to Overview of MPAS-A, MPAS-A User Guide, MPAS-A Technical Description, MPAS Mesh Specification, MPAS-A Tutorial Practice Guide, MPAS Data Assimilation, and MPAS-JEDI Tutorial Practice Guide. Another section, 'Access Code, Data, & Meshes', provides information and links to MPAS-A source code, static geographical datasets, meshes, and input files for real-data and idealized test cases.

Home / Model for Prediction Across Scales - Atmosphere

## Model for Prediction Across Scales - Atmosphere

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# MPAS-Atmosphere Resources

## WRF & MPAS-A Support Forum

You need to create an account to post to it.

Searchable

## Under Development

- NOAA physics used in the UFS and the WoFS.
- Physics from the community.
- Chemistry: CheMPAS
- Scalar transport in physics parameterizations (convection, boundary layer) for GOCART and chemistry.
- Urban modeling capability.
- Earth System Model capabilities.
- GPU capability.

# NOAA Physics in MPAS

- (1) The MPAS dynamical core will be used in the Rapid Refresh Forecast System (RRFS) Version 2
- (2) The MPAS-Atmosphere model will be used in the next version of the Warn-on Forecast System (WoFS)
- (3) NOAA is planning to use the MPAS dynamical core in their global forecast system.

NOAA is contributing their physics to the community release of MPAS that are used in their MPAS-based pre-operational prototypes.

RRFS: MYNN PBL, TEMPO microphysics, IGW gravity-wave drag (in MPAS V8.3.1), Noah-MP land model

WoFS: multiple PBL schemes, NSSL-2M microphysics.

Global Forecast System (GFS, part of the UFS) physics (ozone, etc)

*These physics will be pulled from the authoritative NOAA repositories in the MPAS build.  
NOAA physics developers are now also MPAS developers.*

*MYNN PBL, TEMPO microphysics, NSSL-2M microphysics will be available in the next release – Fall 2026*

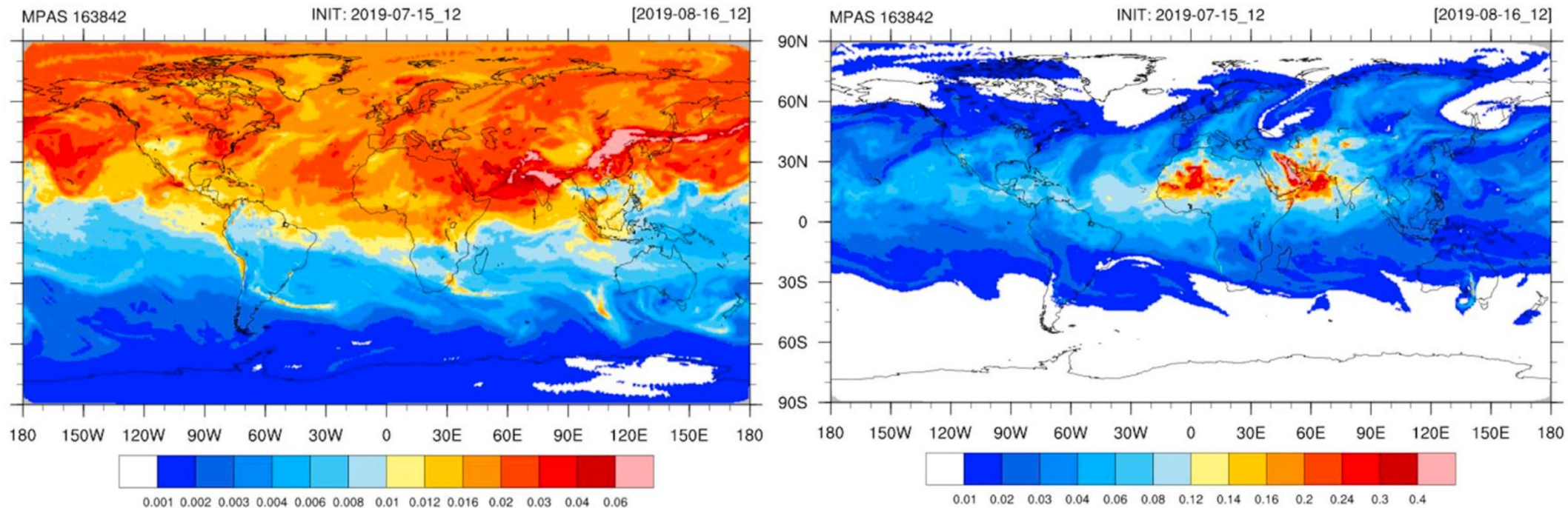


## GOCART-2G in MPAS

Goddard Chemistry Aerosol Radiation and Transport –  
Second Generation (GOCART-2G) model.

A simplified chemistry and aerosol component that predicts the major aerosol species including dust, organic and black carbon, sea salt, and sulfate aerosols.

1 month MPAS-A 60 km global forecast, column mass ( $\text{gm}^{-2}$ )



*We are targeting a release before the end of this calendar year (ACOM, MMM, RAL)*

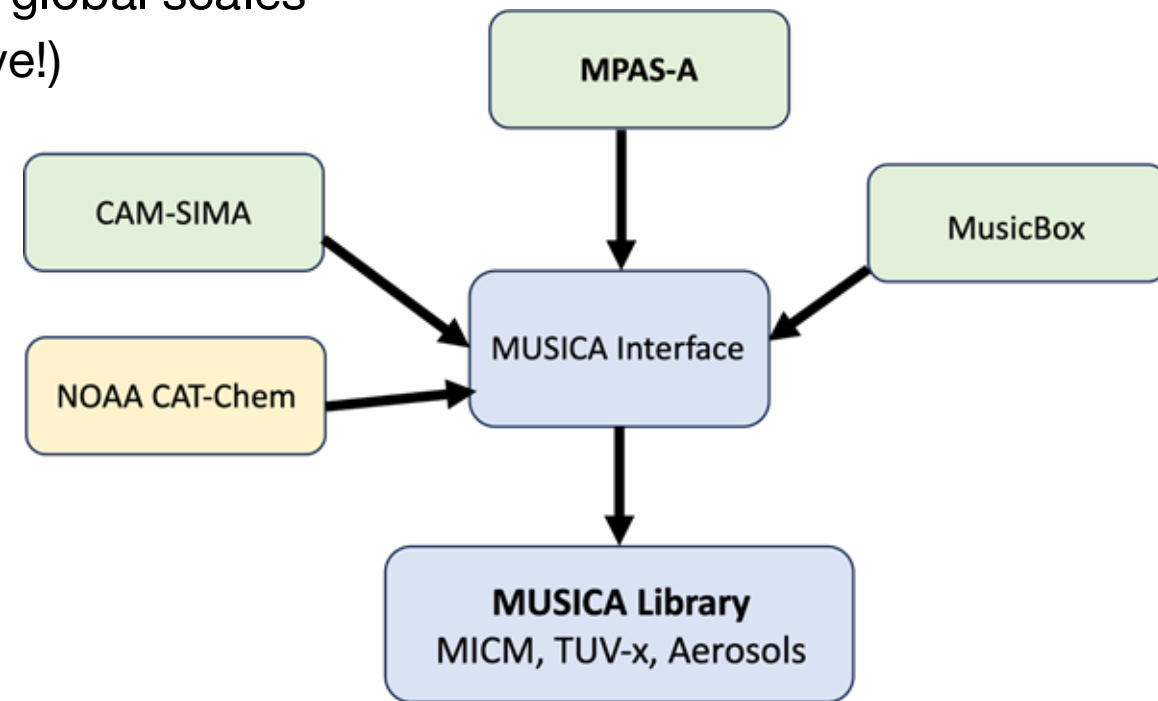
# Ongoing Developments: CheMPAS

- Integrating Chemistry into MPAS-A
  - A successor to WRF-Chem
  - Flexible and state-of-the-art modeling
  - Community co-development
  - New frontier science covering micro, meso and global scales
  - Provide a GPU capability (chemistry is expensive!)
  - Compatible with JEDI data assimilation

Integrate the **MUSICA** library in MPAS-A

**MUSICA**

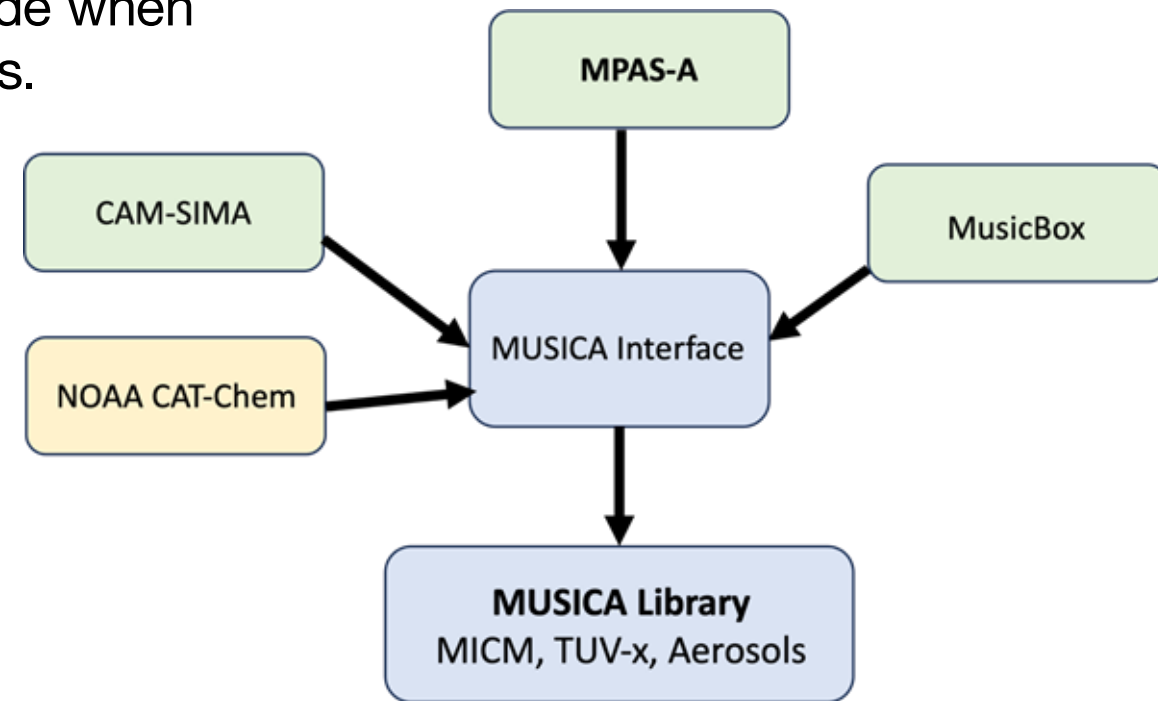
Multiscale Infrastructure for  
Chemistry and Aerosols



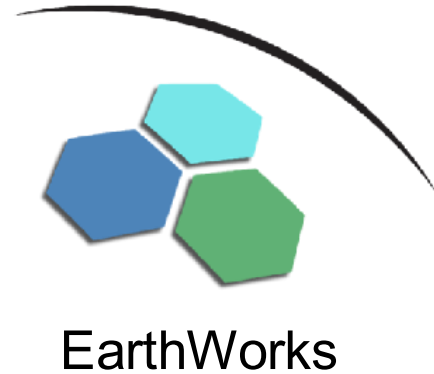
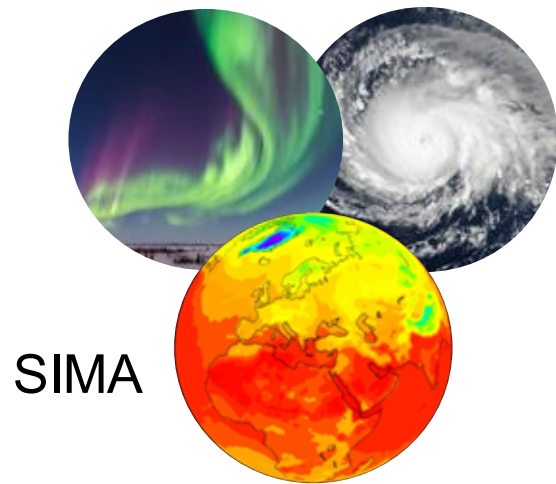
# Ongoing Developments: CheMPAS

- MUSICA is a model-independent infrastructure for chemistry in atmospheric models
- Facilitates use of a variety of chemistry schemes
- MUSICA allow users to build chemical mechanisms at run-time, eliminating the need to work with source code when adding or modifying chemical species or reactions.
- Currently being developed for CESM
- Initial stage for UFS and MPAS-A

*There is no timeline for a first version release.*



## MPAS-A Earth Systems Modeling



**NOAA**  
**Unified Forecast System**

Based on NCAR's Community Earth System Model  
SIMA (CESM using MOM6 and MPAS-A)  
EarthWorks (CESM, using MPAS-A and MPAS-O)

*Scaling problems limit applications.*  
*Uncertain support.*

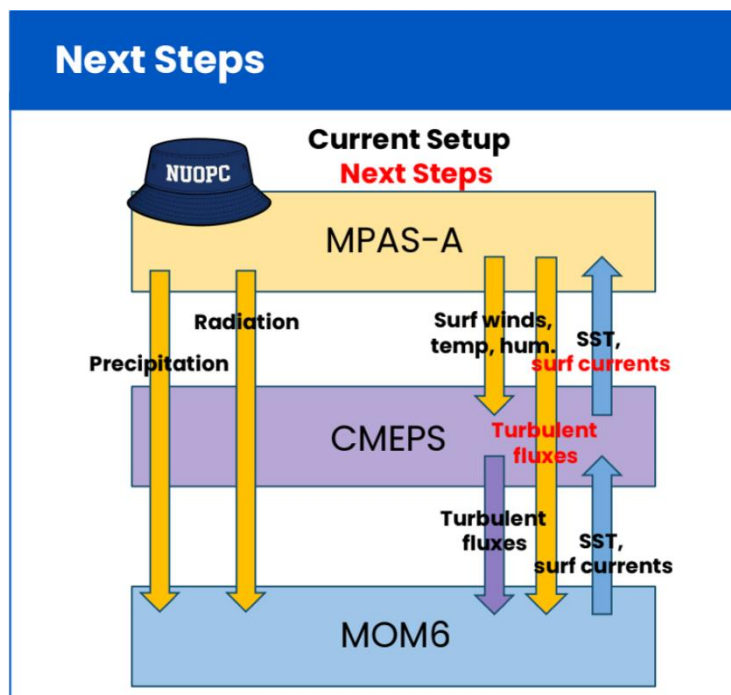
Based on CESM infrastructure  
UFS using MOM6 and MPAS-A

*Awaiting port of MPAS-A into the UFS.*  
*Scaling issues? Support?*

## MPAS-A Earth Systems Modeling

<https://www.mmm.ucar.edu/events/133496/agenda>

*A High-Resolution Regional Coupled MPAS-A–MOM6 Prototype for Air-Sea Interaction Research and Prediction*  
Amrhein et al, 2026, MPAS-WRF Workshop



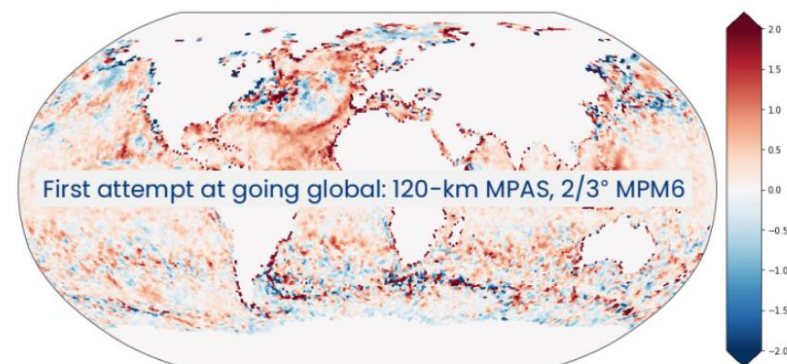
### Coupling

- Communicating turbulent fluxes from MPAS-A to MOM6 and surface currents to MPAS-A
- Coupling to WaveWatch 3 and CICE (CROCODILE)

### Profiling

- Quantify effects of mixed resolution; different load balancing; I/O choices; memory footprints
- How does this coupling scale to global km-scale?

**Global km-scale** (3.75-km MPAS, 1/36° MOM6)



*Further testing and development is underway*

# MPAS-Atmosphere Upcoming Releases

## MPAS-Atmosphere GPU Implementation

Based on our experience with the existing separate release, we are re-implementing this capability in the main MPAS release.

- Initial (partial) GPU capability has been released - MPAS v8.4.0 (the dynamics and LES).
- Subsequent MPAS-A releases will incrementally extend GPU capabilities in the physics and optimizations to the dynamics.



*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.*

# Upcoming Events

MPAS-WRF workshop: June 2027 (in person (Boulder CO, USA), plus virtual option)  
<https://www.mmm.ucar.edu/events/workshops/>. Dates TBD.

We have two NSF NCAR-based tutorials each year, winter (virtual) and summer (in person):

- Winter 2027 (virtual, dates TBD, January or early February)
- Feature and bug releases occur whenever components are ready.