

MPAS-A System Requirements and Installation

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NCAR
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Can I run MPAS-A on my computer?



Left: A Cray-1 supercomputer.

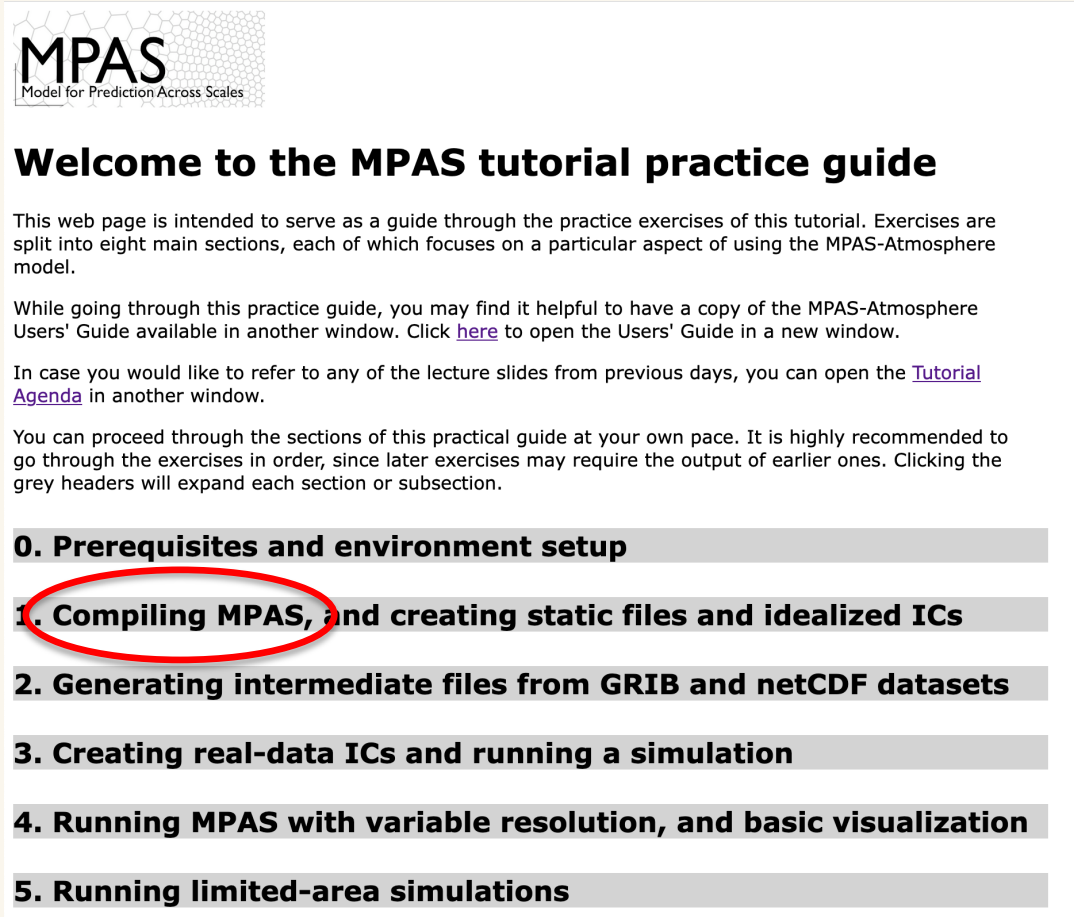
(Trivia: In 1977, the National Center for Atmospheric Research acquired a Cray-1, serial number 3.)

Image credit: Irid Escent, [CC BY-SA 2.0](https://creativecommons.org/licenses/by-sa/2.0/),
via Wikimedia Commons

If so, how do I install MPAS-A on it?

MPAS-Atmosphere is distributed as *source code*

- No pre-compiled model or binary distribution!



The screenshot shows the 'Welcome to the MPAS tutorial practice guide' page. It includes a header with the MPAS logo, a welcome message, and a list of five sections. The first section, '1. Compiling MPAS, and creating static files and idealized ICs', is circled in red.

Welcome to the MPAS tutorial practice guide

This web page is intended to serve as a guide through the practice exercises of this tutorial. Exercises are split into eight main sections, each of which focuses on a particular aspect of using the MPAS-Atmosphere model.

While going through this practice guide, you may find it helpful to have a copy of the MPAS-Atmosphere Users' Guide available in another window. Click [here](#) to open the Users' Guide in a new window.

In case you would like to refer to any of the lecture slides from previous days, you can open the [Tutorial Agenda](#) in another window.

You can proceed through the sections of this practical guide at your own pace. It is highly recommended to go through the exercises in order, since later exercises may require the output of earlier ones. Clicking the grey headers will expand each section or subsection.

- 0. Prerequisites and environment setup**
- 1. Compiling MPAS, and creating static files and idealized ICs**
- 2. Generating intermediate files from GRIB and netCDF datasets**
- 3. Creating real-data ICs and running a simulation**
- 4. Running MPAS with variable resolution, and basic visualization**
- 5. Running limited-area simulations**

The first practical exercise will involve compiling your own copy of MPAS-A on Derecho.

Compiling MPAS-A is probably also the first step on your own machine!

System Requirements

What system attributes need to be considered?

Hardware

Processor(s)

Memory (RAM)

Software

Operating system

Compilers

Libraries



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Hardware Requirements: Processors

MPAS-A itself does not require any particular kind of processor

Consider this (not actual MPAS-A) Fortran code:

```
! Compute temperature in K from temperature in deg. C
do i = 1, nCells
    tk(i) = tc(i) + 273.15
end do
```

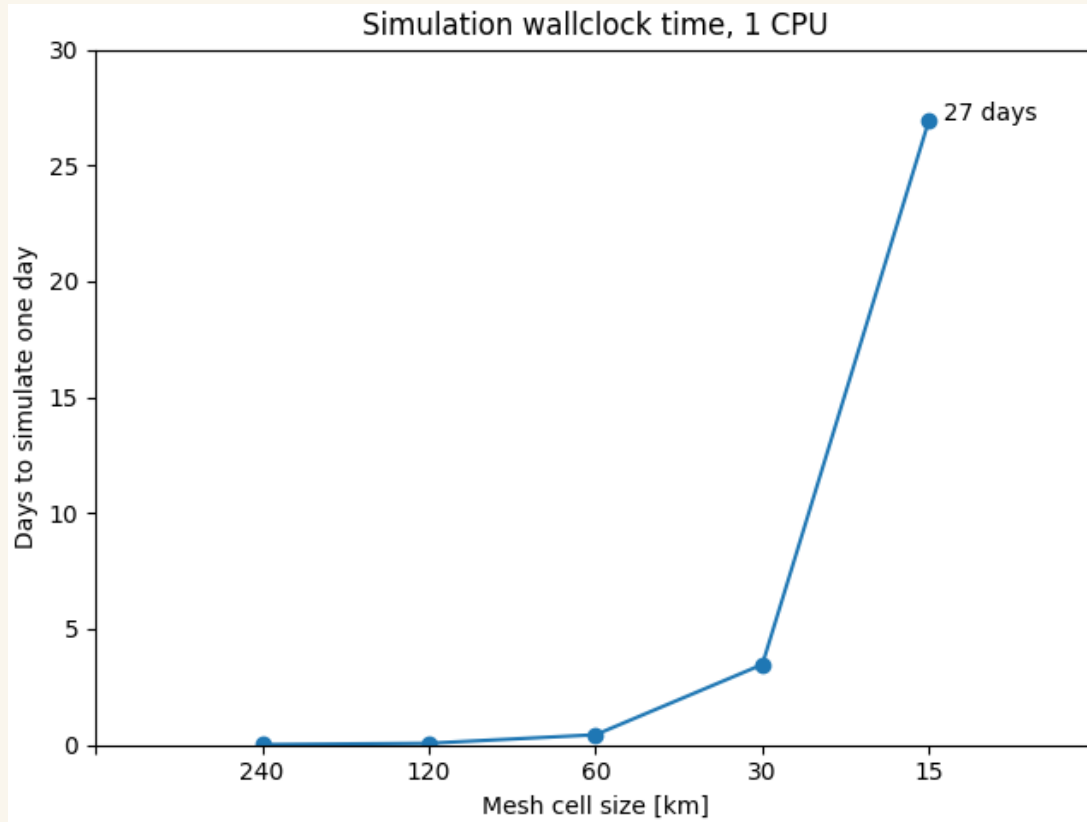
Nothing here is processor-specific!

Any of the following processor architectures should be fine:

- ARM
- POWER
- Various GPU architectures!
- x86_64
- RISC-V

Hardware Requirements: Processors

If you are patient enough, *a single processor is all that you need.*



Left: Time to simulate one day on a global mesh for different mesh sizes using a single processor

In practice, using multiple processors is critical for achieving useful simulation rates

Hardware Requirements: Memory

The memory requirement is a function of:

1. The number of grid columns in the mesh (simulation domain)
2. Choice of physics schemes / suite
3. The number of MPI tasks
4. The number of I/O tasks

A reasonable starting point:

0.4 MB / grid column

(for the default MPAS-A configuration with 55 layers, 'mesoscale_reference' physics suite, single precision).

Software requirements

Generally, a UNIX-like OS is needed

- *E.g.*, Linux, *BSD, macOS, AIX
- Also need `make`, `grep`, `awk`, `sed`, `cat`, **`git`**, etc.

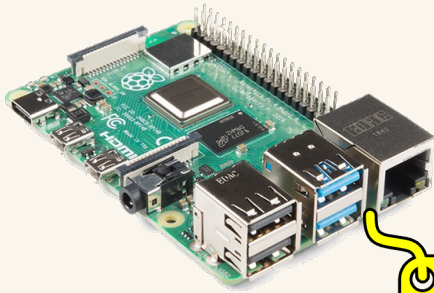
Fortran 2008, C, and C++ compilers

- *E.g.*, GCC, Intel oneAPI, NVIDIA NVHPC, Cray, NAG

Libraries

- MPI (OpenMPI, MPICH, etc.)
- Parallel-NetCDF

Example systems that run MPAS-A



\$35



\$35M



\$5000



\$200M
(?)

Obtaining MPAS-Atmosphere source code

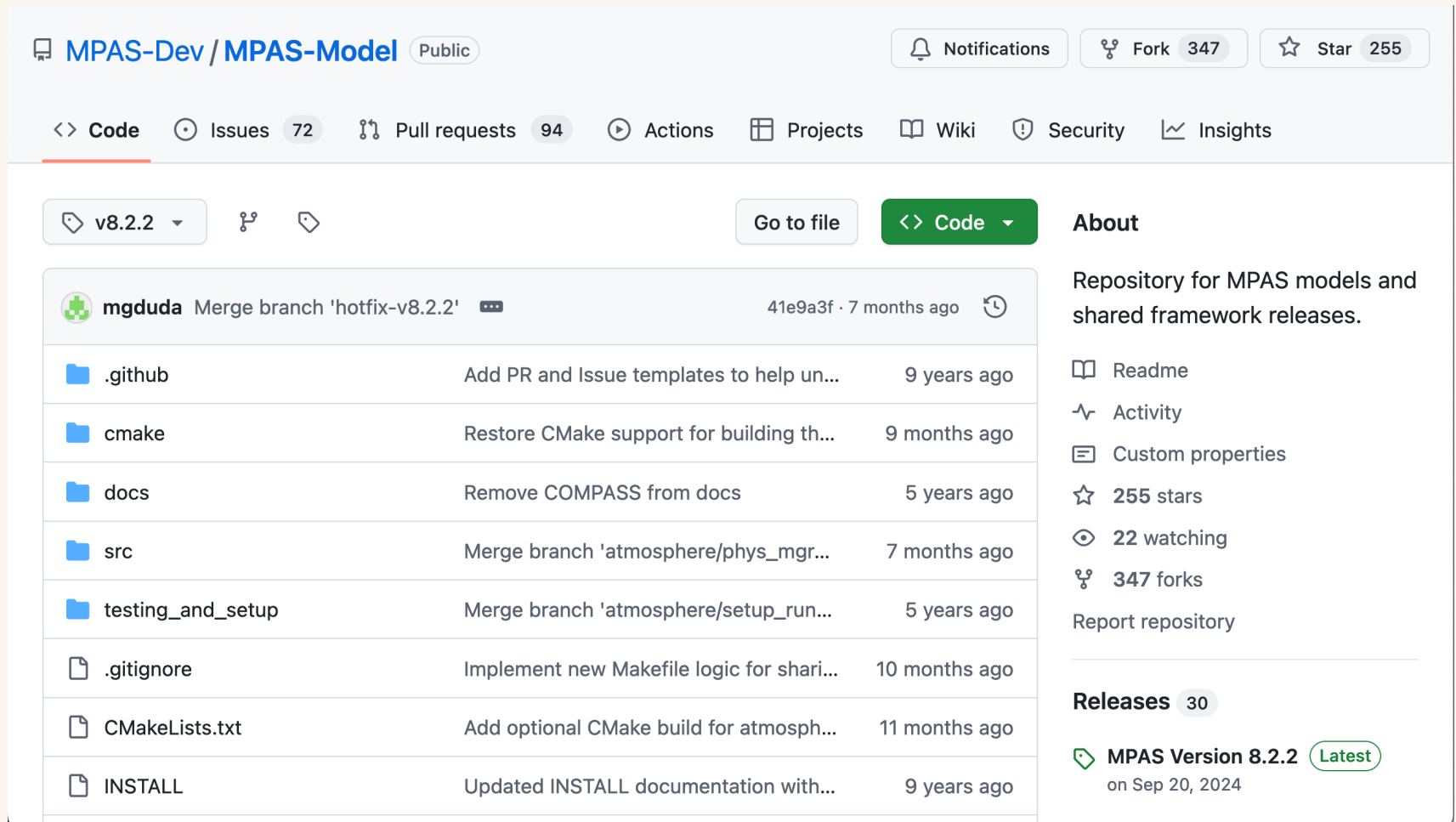
Working under the assumption that we have a system that meets the basic requirements, we can then ask:

How do I get a copy of the source code?

If you are working on a machine with the git command-line tools and internet access, this can be done in under 10 seconds!

Obtaining MPAS-Atmosphere source code

The MPAS-Atmosphere code is developed on and distributed through a GitHub repository: <https://github.com/MPAS-Dev/MPAS-Model>



The screenshot shows the GitHub repository page for **MPAS-Dev / MPAS-Model**. The repository is public and has 347 forks and 255 stars. The main navigation bar includes links for Code, Issues (72), Pull requests (94), Actions, Projects, Wiki, Security, and Insights. The repository is currently on the **v8.2.2** branch. The file list shows the following files and their commit history:

File/Folder	Description	Commit Date
.github	Add PR and Issue templates to help un...	9 years ago
cmake	Restore CMake support for building th...	9 months ago
docs	Remove COMPASS from docs	5 years ago
src	Merge branch 'atmosphere/phys_mgr...	7 months ago
testing_and_setup	Merge branch 'atmosphere/setup_run...	5 years ago
.gitignore	Implement new Makefile logic for shari...	10 months ago
CMakeLists.txt	Add optional CMake build for atmosph...	11 months ago
INSTALL	Updated INSTALL documentation with...	9 years ago

The right sidebar contains the **About** section, which describes the repository as a place for MPAS models and shared framework releases. It also includes links to the Readme, Activity, and Custom properties, as well as statistics: 255 stars, 22 watching, and 347 forks. The **Releases** section shows the latest release, **MPAS Version 8.2.2**, dated on Sep 20, 2024.

Obtaining MPAS-Atmosphere source code

The MPAS-Atmosphere code is developed on and distributed through a GitHub repository: <https://github.com/MPAS-Dev/MPAS-Model>

The screenshot shows the GitHub repository page for **MPAS-Dev / MPAS-Model**. The repository is public and has 347 forks and 255 stars. The **Code** dropdown menu is open, showing options to clone the repository using HTTPS, GitHub CLI, or the web URL. The HTTPS URL, `https://github.com/MPAS-Dev/MPAS-Model.git`, is circled in red. Other options include 'Open with GitHub Desktop' and 'Download ZIP'. The repository description states it is for MPAS models and shared framework releases. The latest release is **MPAS Version 8.2.2**, marked as 'Latest' and dated Sep 20, 2024. The file list on the left includes folders like `.github`, `cmake`, `docs`, `src`, and `testing_and_setup`, and files like `.gitignore`, `CMakeLists.txt`, and `INSTALL`.

Obtaining MPAS-Atmosphere source code

From the command-line, the following should be sufficient:

```
git clone https://github.com/MPAS-Dev/MPAS-Model.git
```

Cloning the repository should take about 10 seconds or less...

- *(I timed this at home, and it took 5.65 s)*

```
$ git clone https://github.com/MPAS-Dev/MPAS-Model.git
Cloning into 'MPAS-Model'...
remote: Enumerating objects: 71, done.
remote: Counting objects: 100% (71/71), done.
remote: Compressing objects: 100% (47/47), done.
remote: Total 46608 (delta 38), reused 42 (delta 23), pack-reused
46537
Receiving objects: 100% (46608/46608), 19.65 MiB | 2.57 MiB/s,
done.
Resolving deltas: 100% (35848/35848), done.
```

Optional: Registration and Mailing Lists

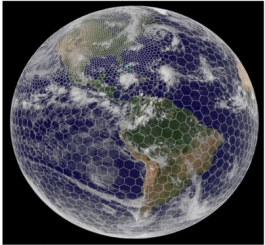
As a new user, you may like to:

- **Register** – *this is completely optional*, but helpful for us to gauge how widely used MPAS-A is, justify development and support resources, etc.
- Join the **mpas-atmosphere-users mailing list** – Very low traffic, mostly announcements of tutorials, workshops, and code releases

Links for the above are available from the MPAS-A website:

<https://www2.mmm.ucar.edu/projects/mpas/site/>

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[Contact](#)
[Support Forum](#)
[Site Map](#)




MPAS Atmosphere

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MPAS-Atmosphere Source Code Download

New Users

We request that users of MPAS software register. The information allows us to better determine how to support and develop the model. Please register using [this form](#).

After You Register

Please consider subscribing to the relevant [mailing lists](#).

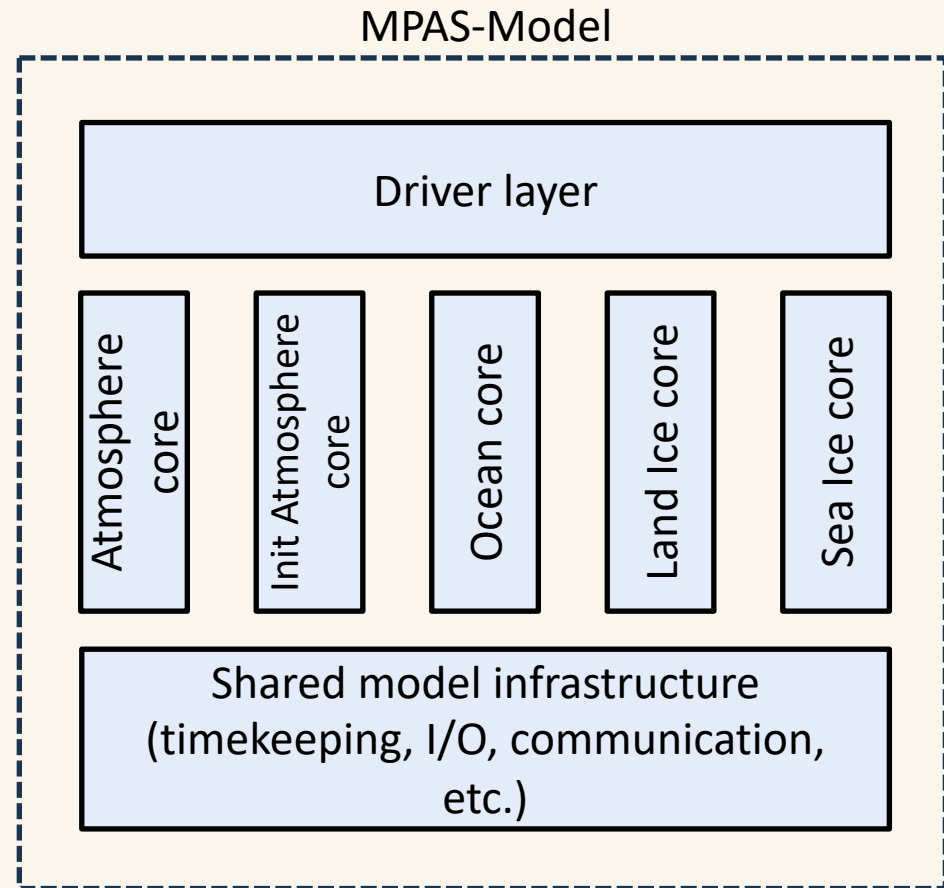
Registered Users

If you have already registered, please continue to the [source code](#).

Model Organization

Cloning the MPAS-Model repository provides all MPAS models, not just MPAS-Atmosphere

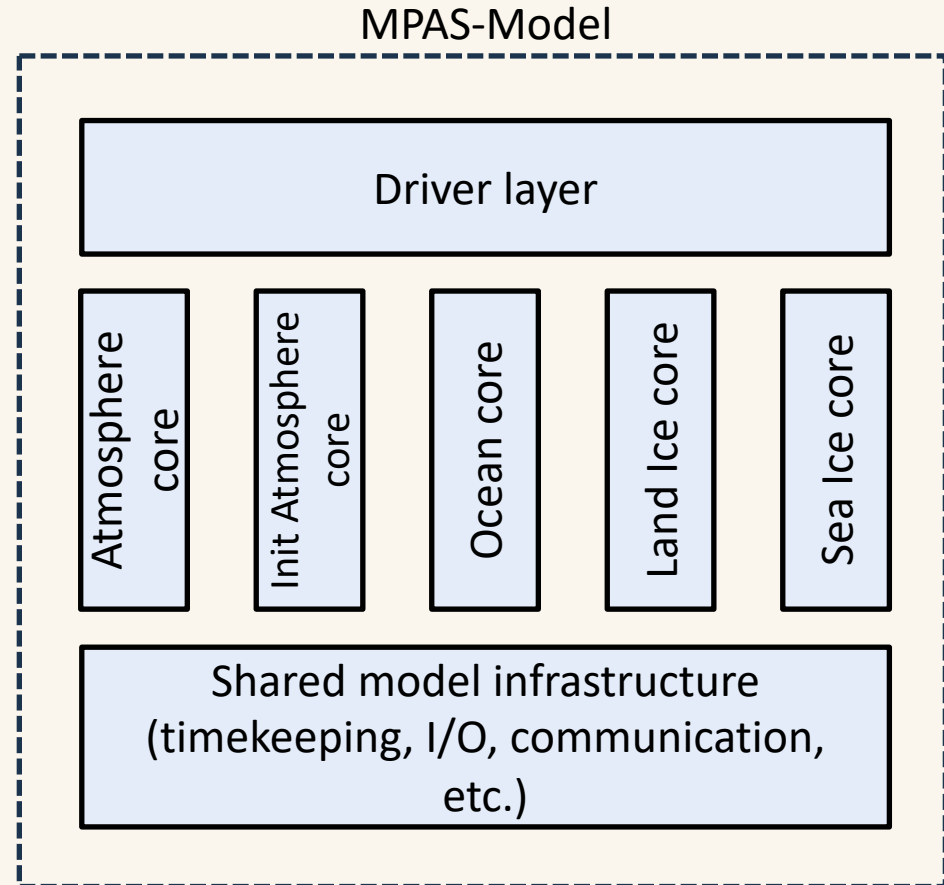
- All models share a common set of infrastructure modules
- Each MPAS model is implemented as a “core” that lives in its own sub-directory
- The MPAS models *are not coupled in this repository!*
- You must select which “core” to compile



Model Organization

Running MPAS-Atmosphere involves two “cores”:

- The **init_atmosphere** core is responsible for
 - Interpolating static fields to the mesh
 - Generating a vertical grid
 - Horizontally and vertically interpolating meteorological data to the 3-d grid
- The **atmosphere** core is the model itself; integrates forward in time from initial state



Compiling MPAS

There is no “configuration” step for MPAS

- All build flags are either set in the top-level `Makefile` or on the command-line

General MPAS build command:

```
$ make target CORE=core <options>
```

target can be either

clean

or

gnu

intel

nvhpc

llvm

... plus a few others...

For MPAS-Atmosphere, **core** may be

atmosphere

init_atmosphere

<options> can be any of

DEBUG=true

AUTOCLEAN=true

PRECISION=double

OPENMP=true

OPENACC=true

Compiling MPAS

Historically, building both the **init_atmosphere** and **atmosphere** cores involved:

```
make gnu CORE=init_atmosphere (build init_atmosphere_model)
```

```
make clean CORE=atmosphere (clean any infrastructure files used by both  
init_atmosphere and atmosphere)
```

```
make gnu CORE=atmosphere (build atmosphere_model)
```

Beginning with MPAS v8.2.0,
an intermediate “clean” step is
no longer needed!

By default, MPAS cores are built with single-precision

MPAS-Atmosphere can be built in double precision

- Add `PRECISION=double` to build commands for double-precision executables
- Execution time is slower compared with single-precision
- Output files approximately twice as large

Compiling MPAS v8.2.0+

Typical build of both the `init_atmosphere` and `atmosphere` cores involves:

```
make -j8 gnu CORE=init_atmosphere (build init_atmosphere_model)
```

```
make -j8 gnu CORE=atmosphere (build atmosphere_model)
```

The `-j8` option causes `make` to use up to 8 jobs (simultaneous commands) to compile the code and can reduce build times; values other than 8 can be used.

By default, MPAS cores are built with single-precision floating-point variables

MPAS-Atmosphere can be built in double precision

- Add `PRECISION=double` to build commands for double-precision executables
- Execution time is slower compared with single-precision
- Output files approximately twice as large

Summary

- Ensure that you have a system running a UNIX-like operating system with the usual commands: `make`, `awk`, `sed`, `grep`, **`git`**, etc.
 - Available memory dictates maximum number of grid cells
- Ensure that you have modern Fortran, C, and C++ compilers
- Install supporting libraries (MPI, Parallel-NetCDF)
- Obtain the MPAS-Model source code with *git clone*
- Compile the *init_atmosphere* and *atmosphere* cores