MPAS
Model for Prediction Across Scales

Obtaining and Compiling MPAS-A

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How do I get the code?

Before we begin discussing how to run MPAS-Atmosphere in upcoming talks, a reasonable first question is:

> How do I get a copy of the source code?

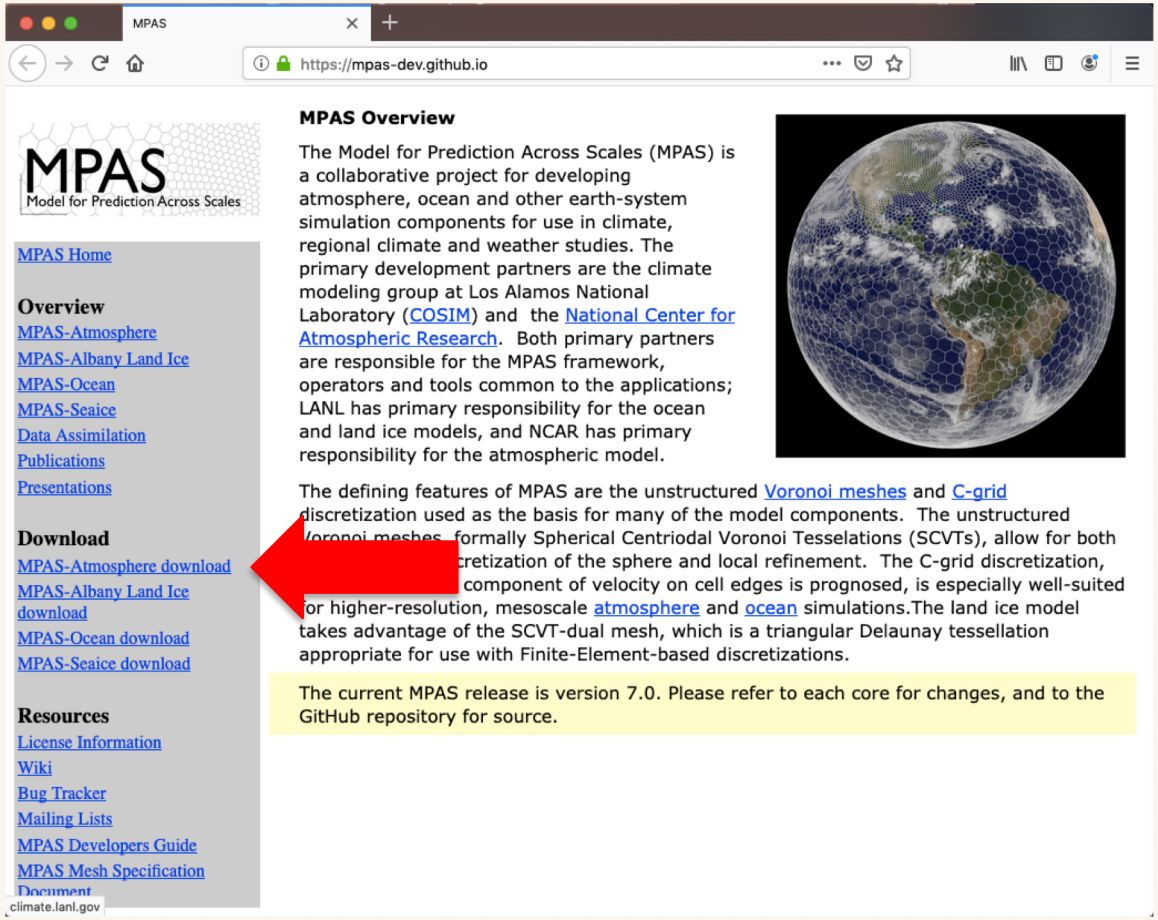
There are essentially two options:

1) The “traditional”, but not necessarily encouraged, method
   - Download a .tar.gz or .zip file

2) The preferred method
   - Make a *clone* of the MPAS-Model repository

The ”less preferred” method of obtaining code

One can navigate to a download link from the MPAS homepage at https://mpas-dev.github.io/



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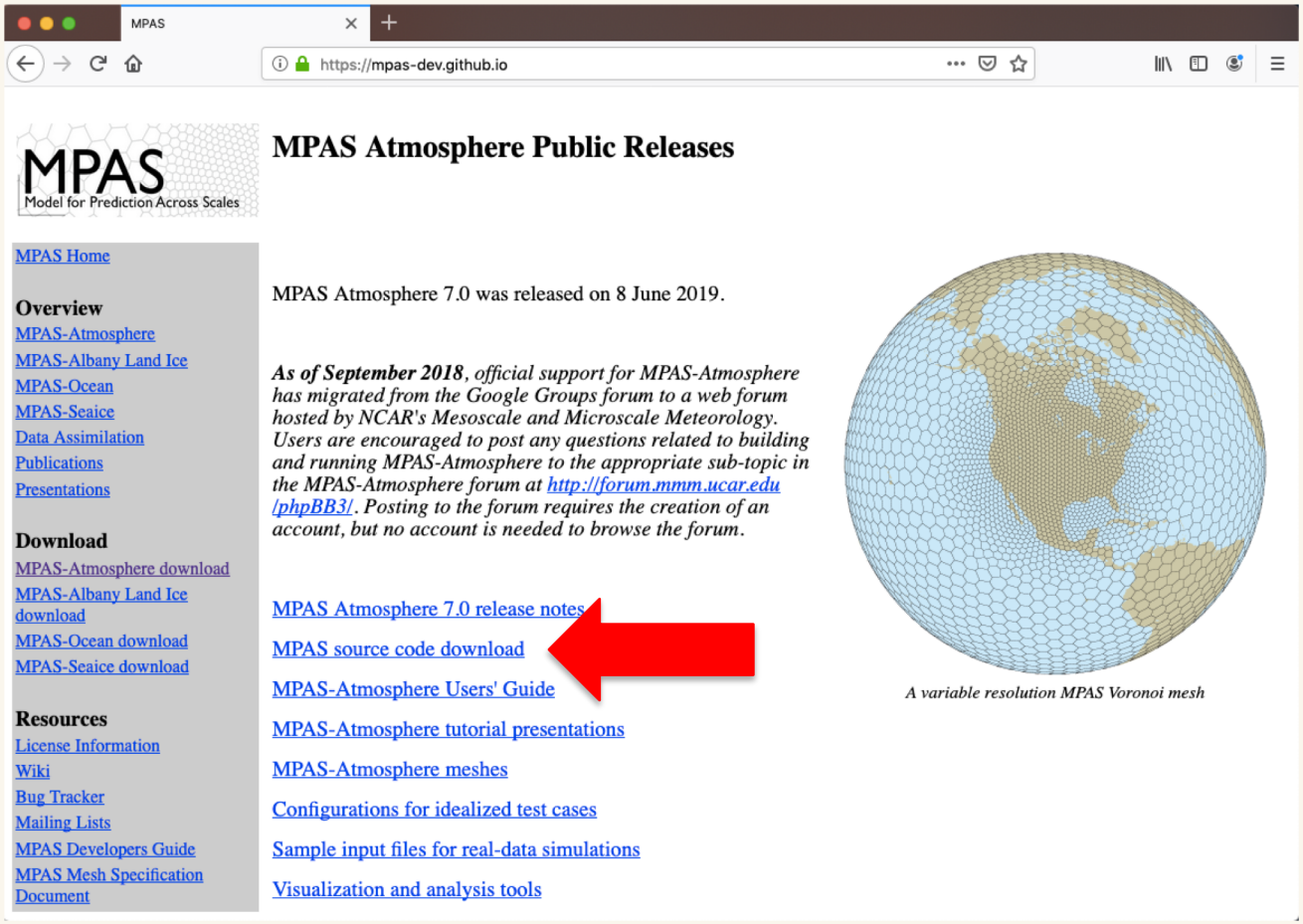

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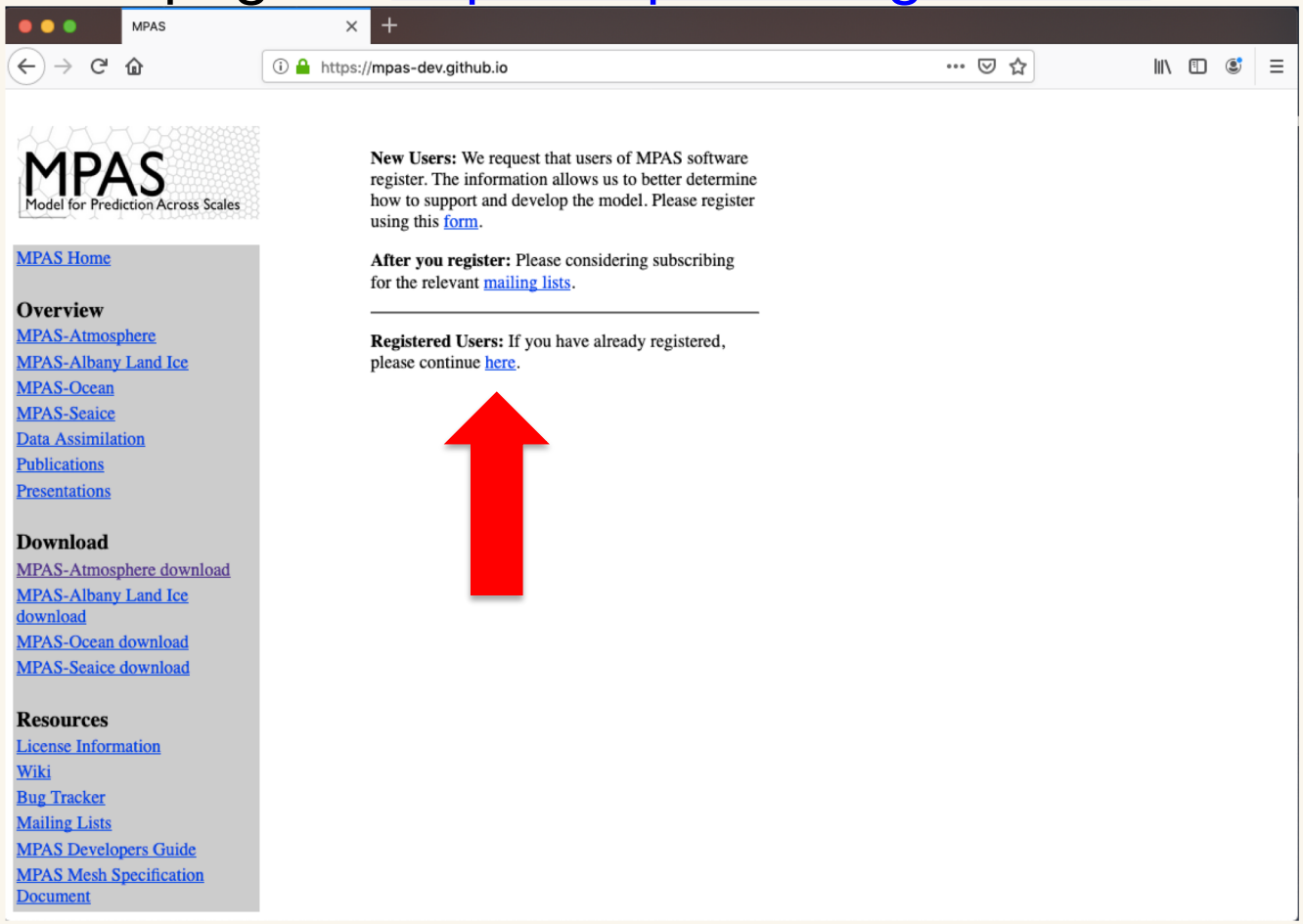

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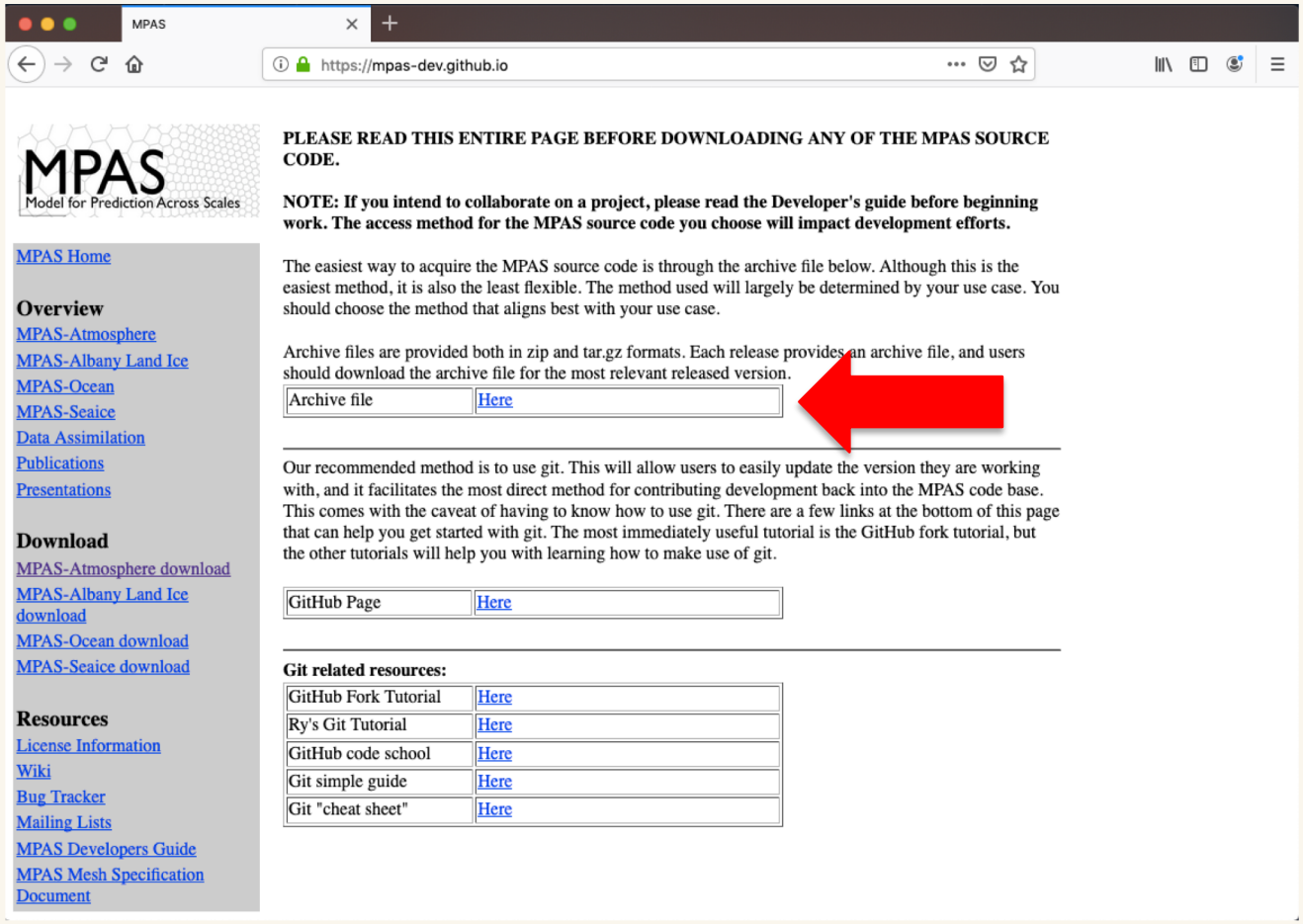

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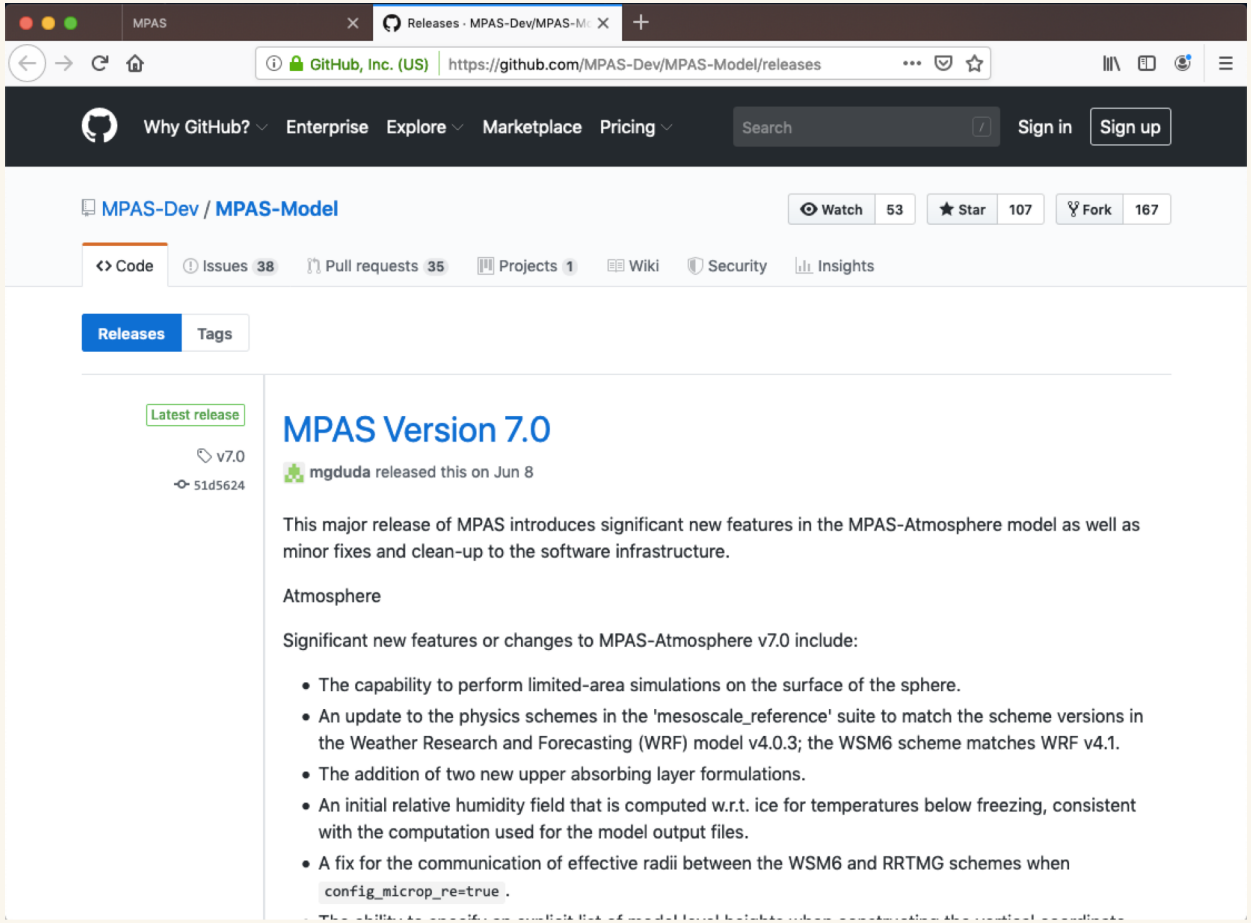

The ”less preferred” method of obtaining code

Downloading a `.tar.gz` file of a particular release of the MPAS code certainly works, but it has several disadvantages:

1. You’ll only obtain a specific release of the code
2. It’s more difficult to see what local modifications have been made to the code
3. There’s no easy route to updating to a newer release while preserving your local code modifications
4. There’s no direct way to see the history of changes to parts of the code

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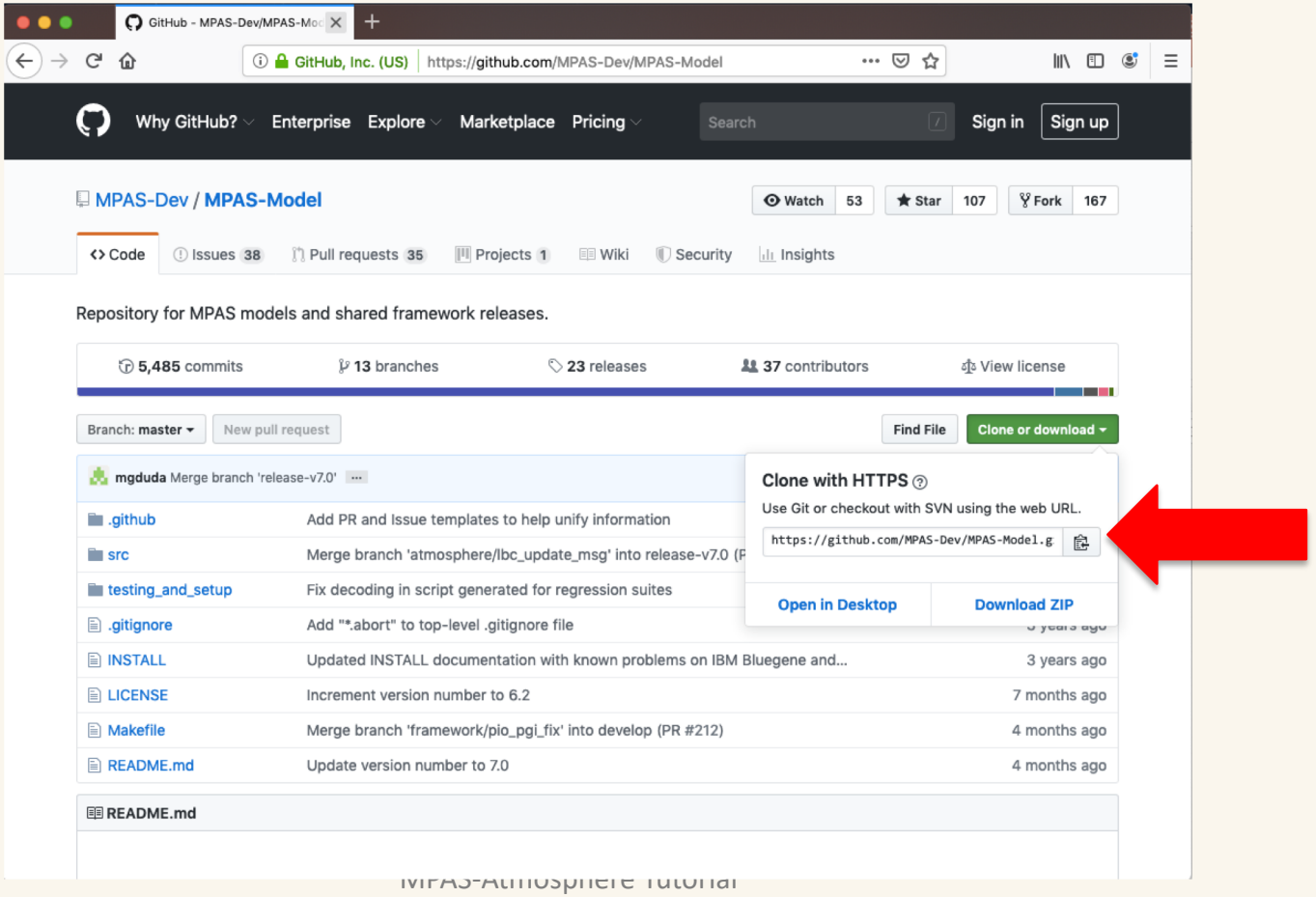
The preferred method of obtaining code

A much better option is to *clone* the MPAS-Model repository

- The repository URL can be found from the MPAS GitHub page at https://github.com/MPAS-Dev/MPAS-Model



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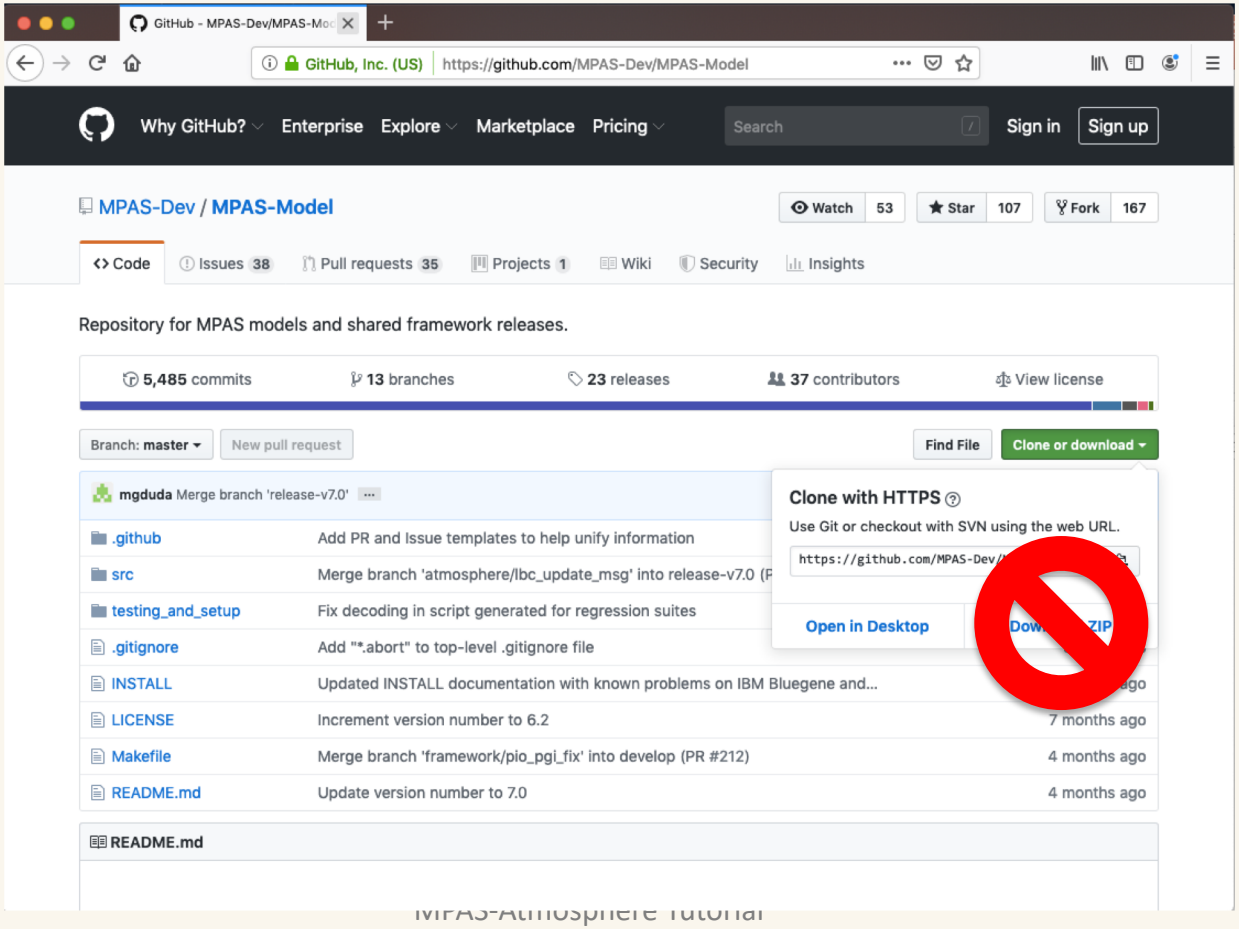

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The preferred method of obtaining code

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

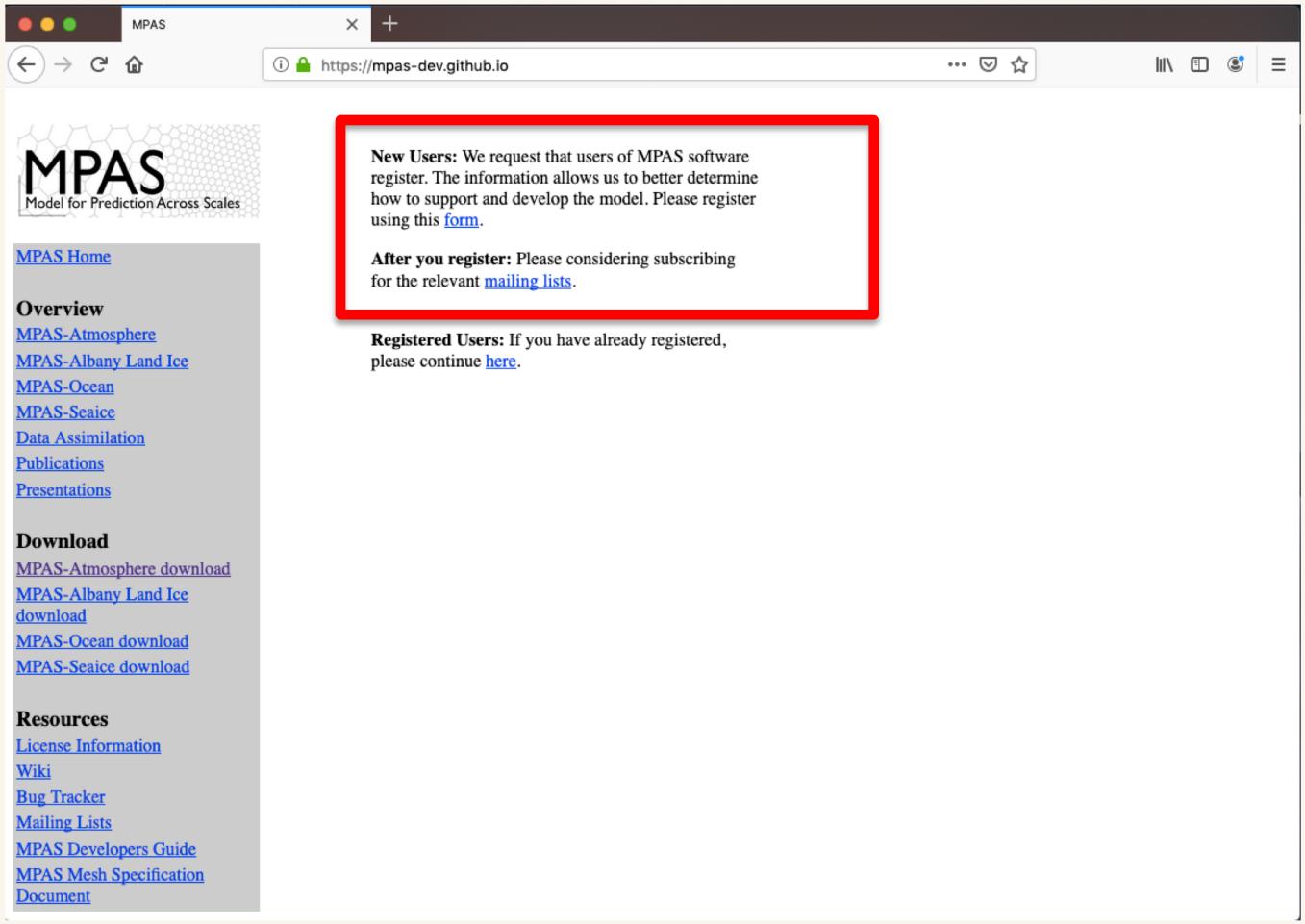
```
git clone https://github.com/MPAS-Dev/MPAS-Model.git
```

Cloning the repository should take about 10 seconds or less…

```
$ 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.
```

After obtaining the code for the first time

You may also like to register as an MPAS user and join the MPAS-Atmosphere Users mailing list



Preliminary requirements

In order to compile MPAS and its required libraries, working C and Fortran compilers are necessary

- The Fortran compiler should be recent enough to support the ISO_C_BINDING module from the Fortran 2003 standard and procedure pointer components of derived types
- Most versions of common compilers from the last couple of years should be fine

Building MPAS requires *at least* the following libraries:

- Any implementation of MPI-2, e.g., MPICH, MVAPICH, OpenMPI
  - Ensure that `mpif90` and `mpicc` commands are in your path
- Parallel-netCDF (http://trac.mcs.anl.gov/projects/parallel-netcdf/)
  - Set `PNETCDF` environment variable to base installation directory
- PIO (https://github.com/NCAR/ParallelIO/)
  - Set `PIO` environment variable to base installation directory

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Preliminary requirements: the easiest route

Assuming Fortran and C compilers are available, and a working MPI installation is also available, installing Parallel-netCDF and PIO should take less than 10 minutes:

Parallel-netCDF 1.8.1

```
$ setenv CC gcc
$ setenv FC gfortran
$ setenv F77 gfortran
$ setenv MPICC mpicc
$ setenv MPIF90 mpif90
$ setenv MPIF77 mpif90
$ setenv PNETCDF /home/duda/pnetcdf
$ cd parallel-netcdf-1.8.1
$ ./configure \
  --prefix=$PNETCDF \
  --disable-cxx
$ make
$ make install
```

PIO 1.7.1

```
(Assuming environment variables
from Parallel-NetCDF installation)
$ setenv MPIFC mpif90
$ setenv PNETCDF_PATH $PNETCDF
$ setenv PIO /home/duda/pio
$ cd pio1_7_1/pio
$ ./configure \
  --prefix=$PIO \
  --disable-netcdf \
  --disable-mpiio
$ make
$ make install
```

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Which versions of PIO should I try?

The PIO library is undergoing rapid development, and many different versions of the library are available; *which versions are supported and recommended?*

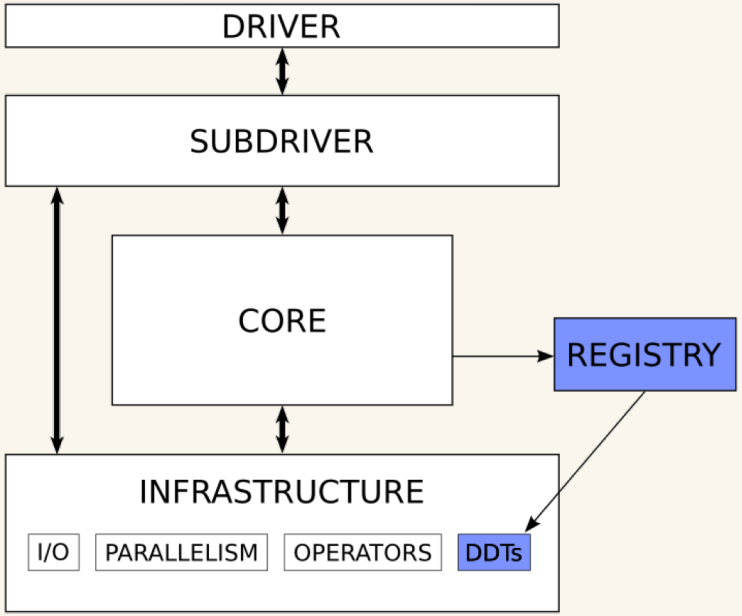
1) For ease of installation, try PIO 1.7.1

- Can be installed using only standard 'configure' and 'make' tools
- Supports NetCDF-3 and Parallel-netCDF I/O
- Download: https://github.com/NCAR/ParallelIO/releases/tag/pio1_7_1

2) If netCDF-4 I/O is needed or desirable, try the latest PIO release

- Requires recent versions of *'cmake'*, plus standard 'make'
- Supports netCDF-3, netCDF-4 (in parallel via PHDF5), and Parallel-netCDF I/O
- Download: https://github.com/NCAR/ParallelIO/
- See iolib_installation.sh at http://www2.mmm.ucar.edu/people/duda/files/mpas/sources/

Model Organization

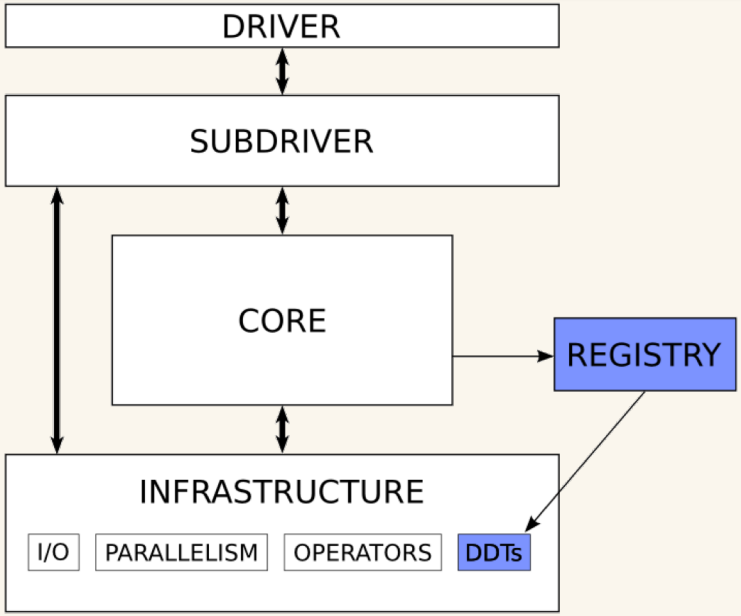


Checking out the MPAS code provides all MPAS models, not just MPAS-Atmosphere

- All models share a common set of infrastructure modules
- Each MPAS model is implemented as a "core" that lives in its own directory
- User must select which "core" to compile
- Each "core" is associated with a source code subdirectory under src/ and has a Registry file (similar to WRF)

```
MPAS-Model/
    └──> src/
            ├──> core_atmosphere/
            ├──> core_init_atmosphere/
            ├──> core_landice/
            ├──> core_ocean/
            ├──> driver/
            ├──> external/
            ├──> framework/
            └──> operators/
```

Model Organization



Running MPAS-Atmosphere involves two “cores”:

- The **init_atmosphere** core is responsible for
  - Interpolating static fields to the mesh (similar to geogrid.exe)
  - Generating a vertical grid (similar to real.exe)
  - Horizontally and vertically interpolating meteorological data to the 3-d grid (similar to metgrid.exe and real.exe)
  - *Where to we get meteorological data? From ungrib.exe!*
- The **atmosphere** core is the model itself, the equivalent of wrf.exe

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Compiling MPAS

There is no "configuration" step for MPAS, unlike, e.g., for the WRF model

- 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

```
xlf
gfortran
ifort
pgi
llvm
... plus a few others...
```

For MPAS-Atmosphere, core may be

```
atmosphere
init_atmosphere
```

<options> can be zero or more of

```
DEBUG=true
AUTOCLEAN=true
PRECISION=single
OPENMP=true
USE_PIO2=true
```

Compiling MPAS

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For MPAS-Atmosphere, core may be

```
atmosphere
init_atmosphere
```

<options> (

```
DEBUG=
AUTOCL
PRECISIO
OPENMP=true
USE_PIO2=true
```

If using the latest PIO2 library, be sure to set this option!

Compiling MPAS

Typical build of both the init_atmosphere and atmosphere cores involves:

$ make gfortran CORE=init_atmosphere *(build init_atmosphere_model)*

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

$ make gfortran CORE=atmosphere *(build atmosphere_model)*

By default, MPAS cores are built with double-precision reals

MPAS-Atmosphere can be built in single precision

- Add `PRECISION=single` to build commands for single-precision executables
- execution time ~35% less compared with double-precision
- output files approximately half as large
- Beginning with MPAS v3.0, it is possible to run the model in double precision while writing history files in single precision!

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Cheyenne users: you're in luck!

If you're working on Cheyenne, there are just seven commands to obtain and build everything you need (assuming the default module setup):

```
module unload netcdf
module load pio
git clone https://github.com/MPAS-Dev/MPAS-Model.git
cd MPAS-Model
make ifort CORE=init_atmosphere PRECISION=single USE_PIO2=true
make clean CORE=atmosphere
make ifort CORE=atmosphere PRECISION=single USE_PIO2=true
```