Computing New Diagnostic Fields in MPAS-Atmosphere Simulations

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Motivation

As the number of people using MPAS-Atmosphere increased to even a very modest number, it was recognized that we needed some structured way of introducing the computation of new diagnostics

We wanted a framework that could handle:

- Instantaneous diagnostics
- Cumulative diagnostics
- Extreme value diagnostics
- Or anything that looked like the above from a computational standpoint!

Diagnostics should be able to change in response to modifications of the streams that write them, too.



Introduction

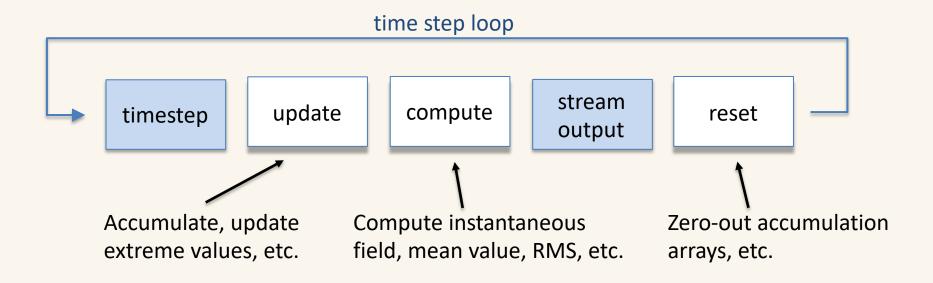
Broadly, there are five stages in the computation of diagnostics like those types listed on the previous slide:

- 1. Setup Pre-allocate arrays that will be needed by the diagnostic during the simulation, initialize values, etc.
- 2. Update Accumulate values, update extrema, etc.
- 3. Compute Divide by the accumulation period to get mean values, compute instantaneous fields, etc.
- 4. Reset After writing the diagnostic, zero-out accumulation arrays, etc.
- 5. Cleanup Deallocate any memory that was allocated by the diagnostic



Diagnostics framework

Other than Setup and Cleanup, how do these phases fit into the sequence of a model timestep?



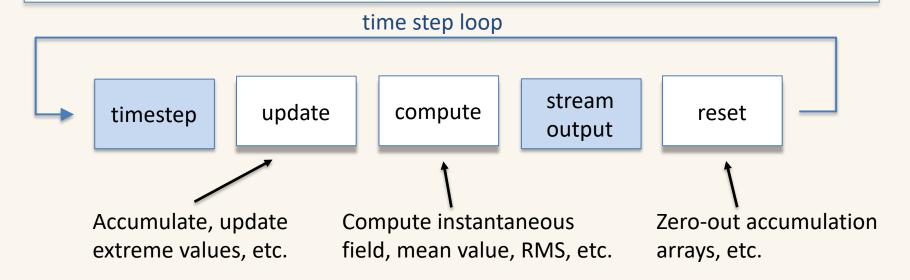
Critically, we need some way for a diagnostic to determine whether it will be written out in a given timestep!



Diagnostics utilities

Along with the diagnostics framework, a utility module has been written that will tell a diagnostic:

- Whether its field will be written in a given timestep
 - Generally called from the Compute phase
- How many output streams include its field





Code organization

In terms of code structure, where do we add diagnostics?

- The idea is that all diagnostics should be implemented as self-contained modules
- All diagnostics modules should reside in the same place

```
MPAS-Model/
src/
core_atmosphere/
diagnostics/
dynamics/
inc/
physics/
Registry.xml
utils/
Add new diagnostics in this directory

The main Registry.xml file will include "sub-Registry" sections from the diagnostics directory
```



Code organization

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```
MPAS-Model/
    src/
        core atmosphere/
            diagnostics/
                                                            These files serve
               Makefile
                                                            as the interface
               Registry diagnostics.xml
                                                           between your new
                                                           diagnostic and the
               mpas atm diagnostics manager. F
                                                             rest of MPAS
            dynamics/
            inc/
            physics/
            Registry.xml
            utils/
```



How to add a new diagnostics?

- 1. Define new namelist options and fields in a new Registry_<your_diagnostic>.xml file. Add a #include statement for this new Registry section in the Registry diagnostics.xml file.
- 2. Create a new module for the diagnostic.
- 3. Add calls to your diagnostic's *setup*, *update*, *compute*, *reset*, and *cleanup* routines in the diagnostic manager.
- 4. Update the Makefile to compile your new diagnostic module.

The README file in the diagnostics/ subdirectory describes the step-by-step process to adding a new diagnostic



Working in the src/core_atmosphere/diagnostics/ directory:

1. Define the maximum SWDOWN field in a new

Registry swdown.xml file

2. Include Registry_swdown.xml in Registry_diagnostics.xml

```
<!-- SW radiation diagnostics --> #include "Registry_swdown.xml"
```



Working in the src/core atmosphere/diagnostics/ directory:

3. Write the setup, update, and reset routines for the diagnostic:

```
subroutine swdown_setup(all_pools)

type (MPAS_pool_type), pointer :: all_pools

type (MPAS_pool_type), pointer :: diag_physics

call mpas_pool_get_subpool(all_pools, 'diag_physics', diag_physics)

call mpas_pool_get_array(diag_physics, 'gsw', gsw)

call mpas_pool_get_array(diag_physics, 'gsw_max', gsw_max)

gsw_max(:) = 0.0

end subroutine swdown_setup
```

Not shown in the code above is the declaration of gsw and gsw_max pointers as module variables...



Working in the src/core atmosphere/diagnostics/ directory:

3. Write the setup, update, and reset routines for the diagnostic:

```
subroutine swdown_update()

gsw_max(:) = max(gsw_max(:), gsw(:))

end subroutine swdown_update
```



Working in the src/core_atmosphere/diagnostics/ directory:

3. Write the setup, update, and reset routines for the diagnostic:



After adding a couple of lines to the Makefile, we're ready to compile MPAS-Atmosphere and try out our new diagnostic

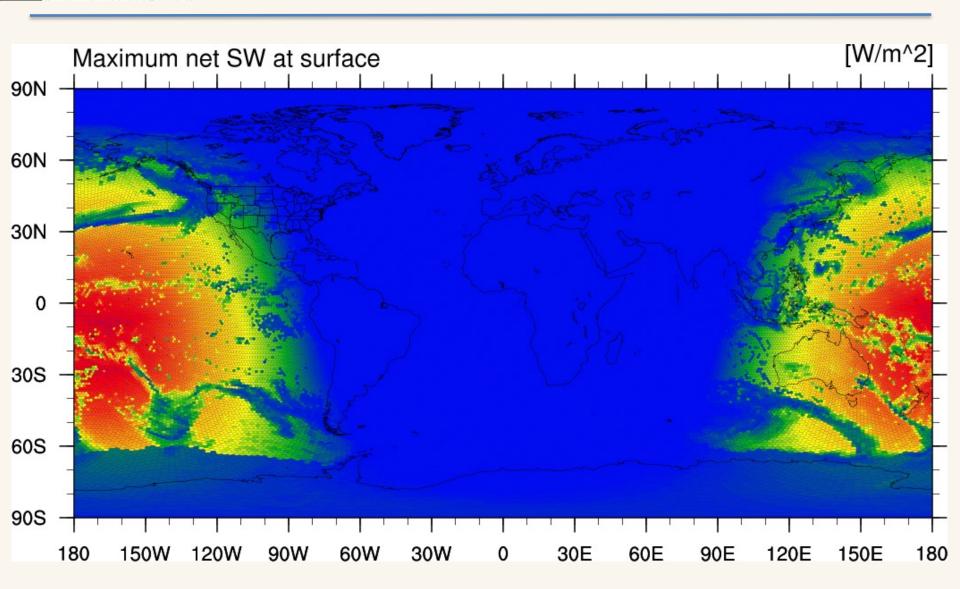
We'll test it by:

- Outputting the gsw_max field every 60 minutes
- Outputting the gsw max field every 1440 minutes

Our test simulation will start at 2010-10-23 at 00 UTC, and we'll look at the output that we get at 2010-10-24 at 00 UTC...

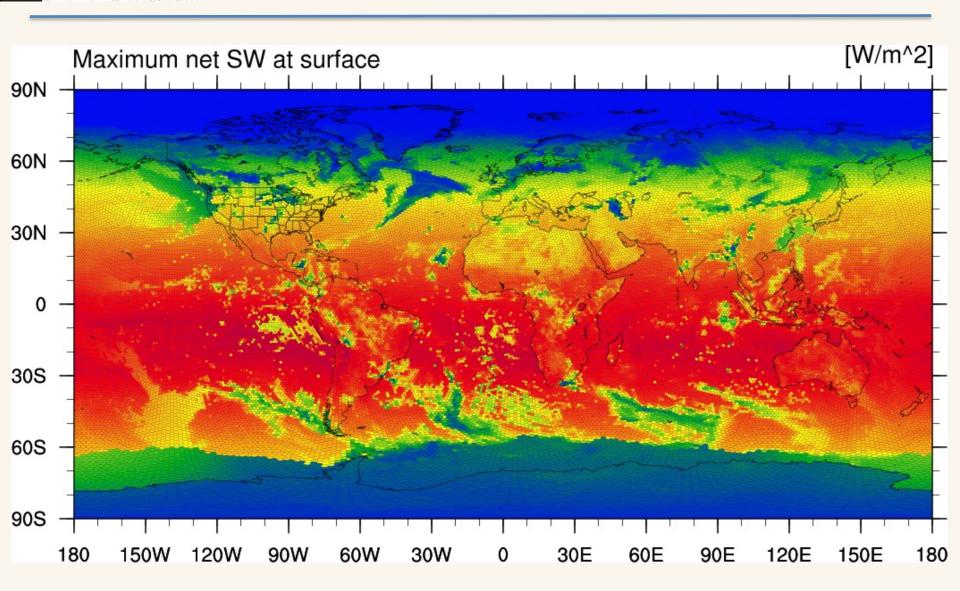


Example: 60-minute output interval





Example: 1440-minute output interval





Summary

MPAS-Atmosphere provides a framework that enables many types of diagnostic fields to be implemented in a modular way

The file

MPAS-Model/src/core_atmosphere/diagnostics/README summarizes the steps to implementing a new diagnostic.