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Plans for infrastructure development in CESM-CAM

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CESM (including CAM) is moving to git

- CESM2 will be released from a GitHub repository
  - git is a distributed version control system, GitHub is a cloud-based git workflow service
  - CIME has been in git (at GitHub) for over two years
  - CLM5 (part of CESM2) was recently released on GitHub
- CAM will move to GitHub after the CESM2 release

Why git? Why GitHub?

- git is becoming the standard for open source collaborative development.
- Distributed version control makes it easier for anyone in the community to keep their developments in version control.
- GitHub provides great collaborative tools for code development and review.
- Integration of code, issues and project management creates greater transparency.
- We will develop new, transparent development procedures for future community CAM development.
- Questions? Want to help? Please contact me.

Requirements for CAM Physics -- after CAM6

- Support for new physics suites (packages) while maintaining ability to run older suites
  - Interoperable development of new unified physics suite
  - Ability to continue to run mainline CAM and WRF physics suites
- Interoperability between NCAR atmosphere models (WRF, MPAS, CAM)
  - For example, run WRF physics inside CAM without any changes to parameterizations or suite definition
- Ability to run chemistry and/or physics on different grid from dynamics

What is wrong with what we have?

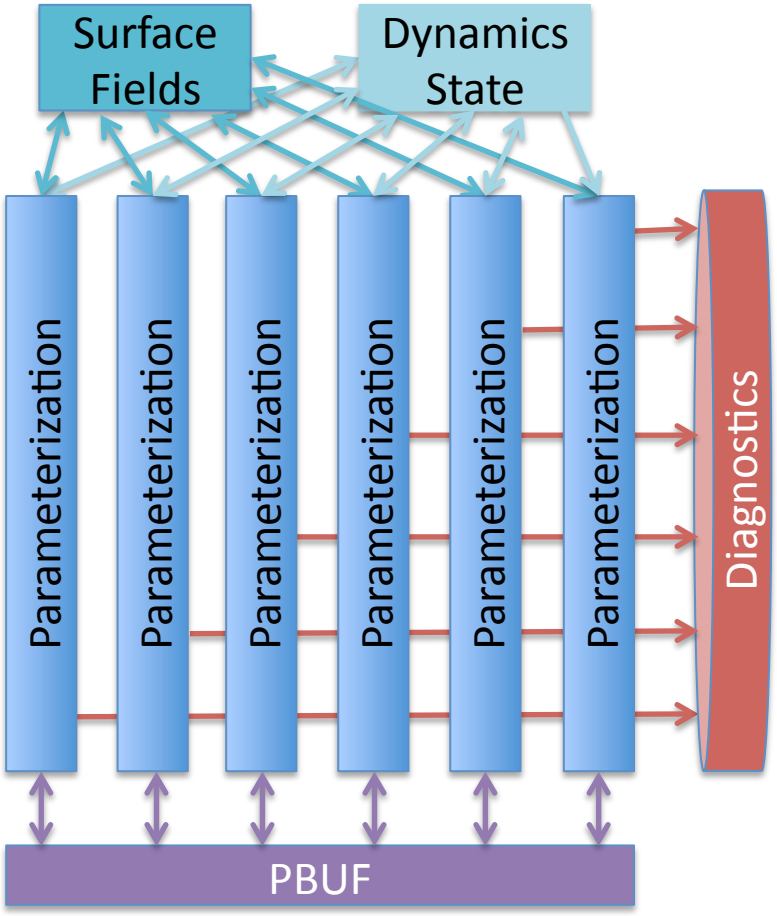
- CAM physics parameterizations depend on several CAM-specific data structures (physics_state, physics_tend, surface fields in, surface fields out, PBUF). Other models have very different state data structures.
  - This inhibits portability between models.
- physpkg (tphysbc, tphysac) logic has combined implementation of CAM3, CAM4, CAM5 & CAM6 including several options for CAM5 and CAM6.1
  - Increases difficulty in experimenting with new physics parameterizations and suites.

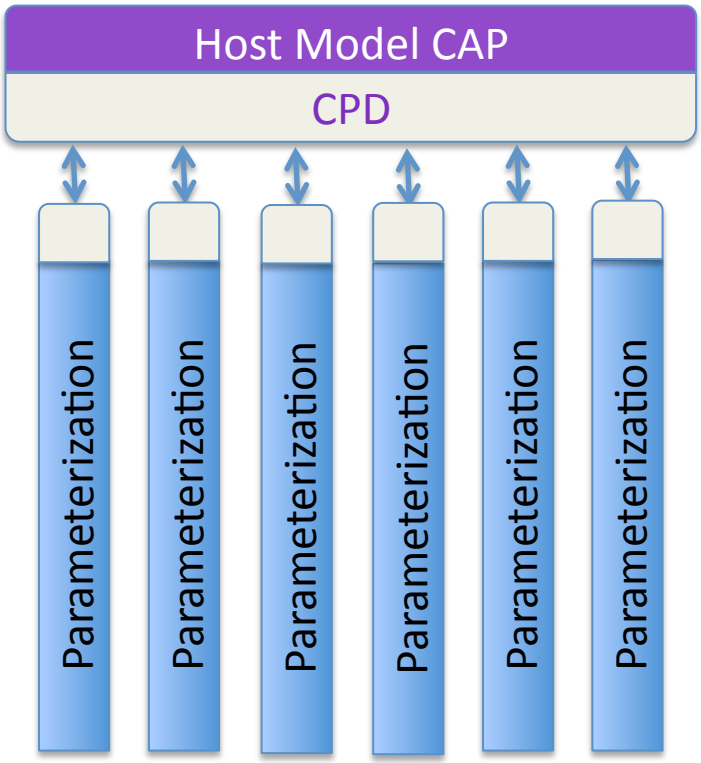
What is the Community Physics Driver Framework?

- Multi-model effort to build flexible physics-package driver with a common, model-independent interface
- Replaces hardcoded, complex logic with a data-driven schedule of parameterization calls
- Handles data flow to and from host model as well as between parameterization calls
- Recently funded for implementation by CGD (CAM), MMM (WRF & MPAS), ACOM (Chemistry package)
- Goal is to also be compatible with NOAA (NGGPS, CCPP)

CAM6 ⟹ CPD

CAM6 Physics vs. CPD





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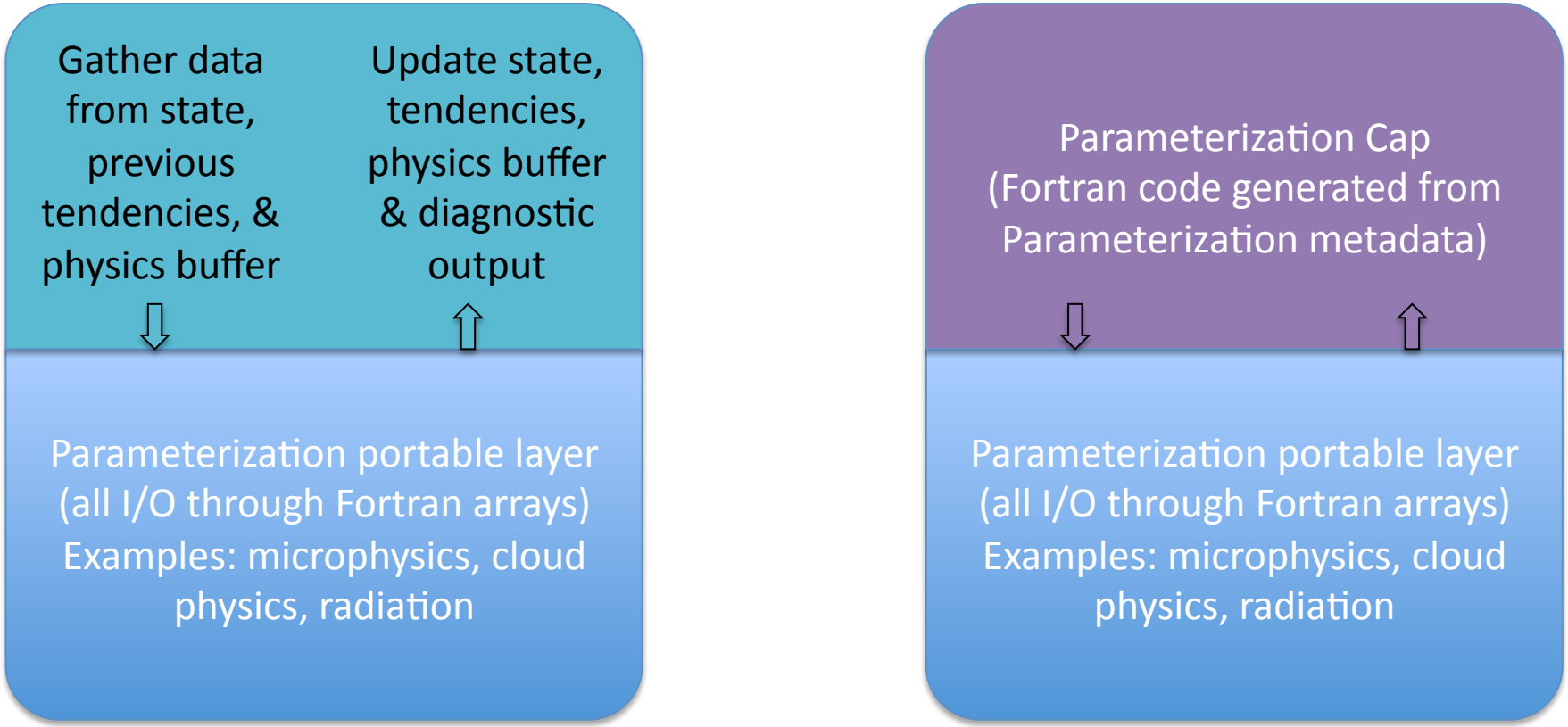
Parameterization

CAM6 Physics Parameterization

vs.

CPD



Summary

- Physics parameterizations and suites can be shared among models without modification.
- The CPD creates a uniform data interface for parameterization inputs and outputs.
- Shared infrastructure lowers coding, testing, and maintenance costs.
- Well-documented interfaces makes it easier for the community to contribute usable parameterizations.

Parameterization CAP

```
! \section arg_table_held_suarez_1994
!| var   | standard name                | description              | units   | rank | type    |
!|-------|------------------------------|--------------------------|---------|------|---------|
!| ncol  | horizontal_loop_extent       | horizontal loop extent   | index   | 0    | integer |
!| pcols | horizontal_dimension         | horizontal dimension     | index   | 0    | integer |
!| pver  | vertical_dimension           | vertical layer dim       | index   | 0    | integer |
!| delt  | time                         | physics time step        | s       | 0    | real    |
!| pmid  | air_pressure                 | midpoint pressure        | Pa      | 2    | real    |
!| u     | eastward_wind                | zonal wind speed         | m s-1   | 2    | real    |
!| v     | northward_wind               | meridional wind speed    | m s-1   | 2    | real    |
!| t     | air_temperature              | temperature              | K       | 2    | real    |
!| du    | tendency_of_eastward_wind    | zonal wind tendency      | m s-2   | 2    | real    |
!| dv    | tendency_of_northward_wind   | meridional wind tend.    | m s-2   | 2    | real    |
!| ds    | tendency_of_air_temperature_due_to_radiative_heating
!                                      | heating tendency         | K s-1   | 2    | real    |
```

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Parameterization CAP

```
! \section arg_table_held_suarez_1994
!| var   | standard name                | description              |   kind    | intent | opt.|
!|-------|------------------------------|--------------------------|-----------|--------|-----|
!| ncol  | horizontal_loop_extent       | horizontal loop extent   |           | in     | F   |
!| pcols | horizontal_dimension         | horizontal dimension     |           | in     | F   |
!| pver  | vertical_dimension           | vertical layer dim       |           | in     | F   |
!| delt  | time                         | physics time step        |           | in     | F   |
!| pmid  | air_pressure                 | midpoint pressure        | kind_phys | in     | F   |
!| u     | eastward_wind                | zonal wind speed         | kind_phys | in     | F   |
!| v     | northward_wind               | meridional wind speed    | kind_phys | in     | F   |
!| t     | air_temperature              | temperature              | kind_phys | in     | F   |
!| du    | tendency_of_eastward_wind    | zonal wind tendency      | kind_phys | out    | F   |
!| dv    | tendency_of_northward_wind   | meridional wind tend.    | kind_phys | out    | F   |
!| ds    | tendency_of_air_temperature_due_to_radiative_heating
!                                      | heating tendency         | kind_phys | out    | F   |
```

Physics Suite

```
<suite name=”Held_Suarez">
 <init>held_suarez_init</init>
 <ipd part=“tphysbc">
  <subcycle loop="1">
   <scheme>check_energy_fix</scheme>
   <scheme>physics_update</scheme>
   <scheme>held_suarez_tend</scheme>
     …
   <scheme>physics_update</scheme>
  </subcycle>
 </ipd>
</suite>
```

Summary

The Pitch

- Both the move to GitHub and conversion to a common physics framework will enhance community engagement with CAM.
- There are decisions to be made along the way and we hope the community will be involved!
- Questions? Want to help? Please contact me.