

# Using MOM6 in CESM

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**National Center for Atmospheric Research**

**NCAR  
UCAR**

**MOM6 Webinar Series**

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## Updates

- ▶ MOM6 is fully incorporated in CESM testing and tagging workflow.
- ▶ MOM6 is to be an *optional* component in CESM 2.2.
  - ▶ First CESM 2.2 release tag this summer.
  - ▶ CESM 2.2 alpha tags already available.

- ▶ What's currently available:

**Compsets:** C, G, B

**Forcings:** CORE2 (*default*), JRA-55

**Drivers:** MCT (*default*), NUOPC

**Grids:** tx0.66v1 (*workhorse*)

gx1v6 (*testing only*)

tx0.25v1 (*testing only*)

# CESM Component Sets

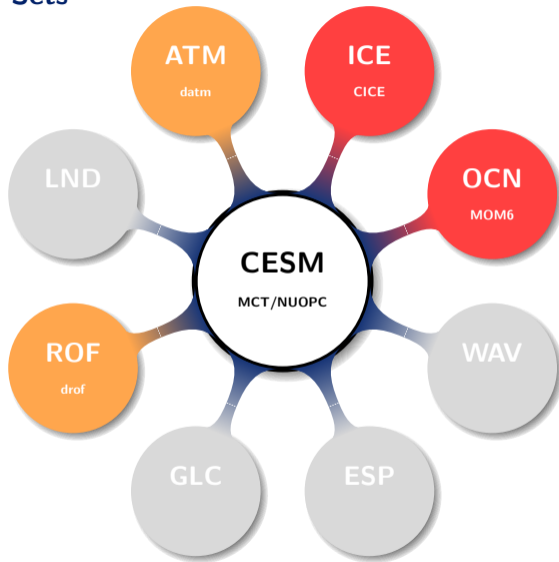
**CMOM  
COMPSET**



- Active component
- Data component
- Stub component

# CESM Component Sets

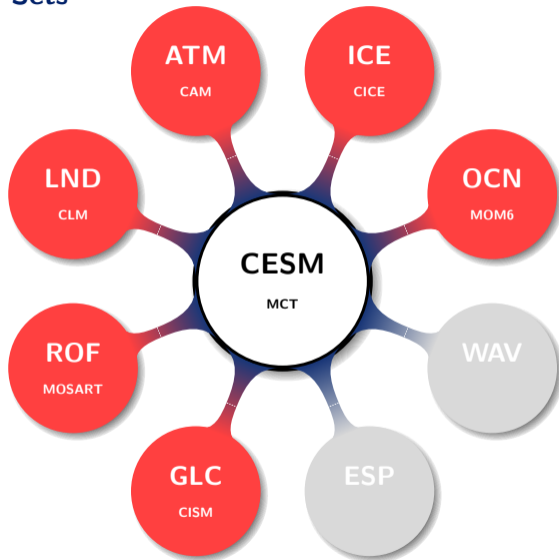
**GMOM  
COMPSET**



- Active component
- Data component
- Stub component

## CESM Component Sets

**BMOM  
COMPSET**



- Active component
- Data component
- Stub component

## CESM Repository Structure

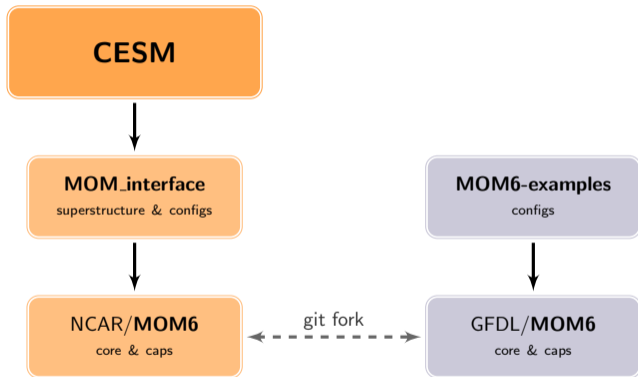
- ▶ All components and libraries on GitHub and public.
- ▶ A custom-made package manager: `manage_externals`
  - ▶ `external`  $\approx$  git submodule

```
CESM/  
├── Externals.cfg  
├── manage_externals  
│   └── checkout_externals  
└── ...
```

*checkout\_externals*  
→

```
CESM/  
├── Externals.cfg  
├── manage_externals  
│   └── checkout_externals  
├── components  
│   ├── cam  
│   ├── mom  
│   └── ...  
├── libraries  
│   └── fms  
└── ...
```

# CESM & MOM6 Repository Structure



## Tutorial: Using MOM6 in CESM



## Downloading CESM+MOM6

- ▶ Clone CESM Github repository: (~5 sec.)

```
$ git clone https://github.com/ESCOMP/CESM.git
```

```
CESM/  
├── Externals.cfg  
├── manage_externals  
└── ...
```

## Downloading CESM+MOM6

- ▶ Clone CESM Github repository: (*~5 sec.*)

```
$ git clone https://github.com/ESCOMP/CESM.git
```

- ▶ Check out the CESM 2.2 alpha tag including MOM6: (*~1 sec.*)

```
$ cd CESM/  
$ git checkout cesm2_2_alpha04d_mom6
```

```
CESM/  
├── Externals.cfg  
├── manageexternals  
└── ...
```

## Downloading CESM+MOM6

- ▶ Clone CESM GitHub repository: (*~5 sec.*)

```
$ git clone https://github.com/ESCOMP/CESM.git
```

- ▶ Check out the CESM 2.2 alpha tag including MOM6: (*~1 sec.*)

```
$ cd CESM/  
$ git checkout cesm2_2_alpha04d_mom6
```

- ▶ Check out externals: (*~2 min.*)

```
$ ./manage_externals/checkout_externals -o
```

```
CESM/  
├── Externals.cfg  
├── manage_externals  
├── cime  
├── components  
│   ├── mom  
│   ├── cice  
│   ├── cam  
│   └── ...  
├── libraries  
│   ├── fms  
│   └── ...  
└── ...
```

## Prerequisite

- ▶ Port CESM 2.2+
  - ▶ Can be ported to laptops, small clusters, supercomputers.
  - ▶ Already ported to some major ESM community machines:  
NCAR machines, lonestar5, stampede2, theia, gaea, aleph, cori, etc.
  
- ▶ *Porting documentation:*  
[https://esmci.github.io/cime/versions/maint-5.6/html/users\\_guide/porting-cime.html](https://esmci.github.io/cime/versions/maint-5.6/html/users_guide/porting-cime.html)

## Running a MOM6 case – Available Configurations

COMPSET	Compatible Resolutions	Description
CMOM	T62_t061, T62_g16, T62_t025	<i>MOM6 only, CORE2 NYF</i>
CMOM_IAF	T62_t061, T62_g16, T62_t025	<i>MOM6 only, CORE2 IAF</i>
CMOM_JRA	TL319_t061, TL319_g16	<i>MOM6 only, JRA55</i>
GMOM	T62_t061, T62_g16, T62_t025	<i>MOM6 and CICE only, CORE2 NYF</i>
GMOM_IAF	T62_t061, T62_g16, T62_t025	<i>MOM6 and CICE only, CORE2 IAF</i>
GMOM_JRA	TL319_t061, TL319_g16	<i>MOM6 and CICE only, JRA55</i>
BMOM	f09_t061	<i>Fully Coupled</i>

▶ t061: tx0.66v1    ▶ t025: tx0.25v1    ▶ g16: gx1v6

## Running a MOM6 case

- ▶ Create a new case: (~5 sec.)

```
$ CESM/cime/scripts/create_newcase \  
  --run-unsupported                \  
  --res T62_t061                   \  
  --compset CMOM                   \  
  --case c.T62_t061.001
```

```
c.T62_t061.001/  
├── *.xml  
├── case.setup  
├── case.build  
├── case.submit  
├── xmlchange  
├── SourceMods/  
│   └── ...  
└── ...
```

## Running a MOM6 case

- ▶ Create a new case: (*~5 sec.*)

```
$ CESM/cime/scripts/create_newcase \  
  --run-unsupported                \  
  --res T62_t061                   \  
  --compset CMOM                   \  
  --case c.T62_t061.001
```

- ▶ Setup and build the case: (*~5-10 mins.*)

```
$ cd c.T62_t061.001  
$ ./case.setup  
$ ./case.build
```

```
c.T62_t061.001/  
├── *.xml  
├── case.setup  
├── case.build  
├── case.submit  
├── xmlchange  
├── SourceMods/  
│   └── ...  
├── user_nl_???  
└── ...
```

## Running a MOM6 case

- ▶ Create a new case: (*~5 sec.*)

```
$ CESM/cime/scripts/create_newcase \  
  --run-unsupported                \  
  --res T62_t061                  \  
  --compset CMOM                  \  
  --case c.T62_t061.001
```

- ▶ Setup and build the case: (*~5-10 mins.*)

```
$ cd c.T62_t061.001  
$ ./case.setup  
$ ./case.build
```

- ▶ Submit the run: (*~2 sec.*)

```
$ ./case.submit
```

```
c.T62_t061.001/  
├── *.xml  
├── case.setup  
├── case.build  
├── case.submit  
├── xmlchange  
├── SourceMods/  
│   └── ...  
├── user_nl_???  
└── ...
```



## Customizing a MOM6 case

- ▶ Mechanisms:

1. **xml changes:**

- ▶ General, model-agnostic settings, e.g., NTASKS, NCPL
- ▶ High-level MOM6 diagnostics control.

2. **user\_nl\_mom**

- ▶ Runtime Parameters
- ▶ Automatically transformed to MOM\_override.

3. SourceMods

- ▶ For development only.
- ▶ Overrides auto-generated input files:  
MOM\_input, MOM\_override, diag\_table, input.nml

## Example xml changes

### ► Before building the case:

```
$ ./xmlchange NTASKS_OCN=360 # change no. of MOM6 MPI tasks
$ ./xmlchange DEBUG=TRUE # turn on compiler debug mode
$ ./xmlchange NCPL_OCN=48 # change the coupling frequency
```

### ► Before submitting the run:

```
$ ./xmlchange CONTINUE_RUN=TRUE # make it a restart run
$ ./xmlchange STOP_N=3 # set the run duration
$ ./xmlchange STOP_OPTION=nmonths # set the run duration
$ ./xmlchange JOB_WALLCLOCK_TIME=01:00:00 # set the job duration
```

### ► High-level MOM6 diagnostics control:

```
$ ./xmlchange OCN_DIAG_MODE=spinup # spinup, production, development
$ ./xmlchange OCN_DIAG_SECTIONS=FALSE # turn off section diags
```

## Example xmlquery use cases

```
$ ./xmlquery RUNDIR
    RUNDIR: /glade/scratch/altuntas/c.T62_t061.001/run
```

```
$ ./xmlquery -p DOUT
    DOUT_S: TRUE
    DOUT_S_SAVE_INTERIM_RESTART_FILES: FALSE
    DOUT_S_ROOT: /glade/scratch/altuntas/archive/c.T62_t061.001
```

```
$ ./xmlquery --description DOUT_S
    DOUT_S: Logical to turn on short term archiving. If TRUE,
           short term archiving will be turned on.
```

```
$ ./xmlquery --valid-values OCN_DIAG_MODE
    OCN_DIAG_MODE: ['development', 'spinup', 'production']
```

## Example `user_nl_mom` changes

- ▶ All MOM6 runtime parameters to be changed via `user_nl_mom`.
- ▶ Same syntax as `MOM_override`.
- ▶ Example entries:

```
DT = 900           ! change baroclinic timestep
KHTH = 800.0       ! bckg horizontal thickness diffusivity
KPP%INTERP_TYPE = 'linear' ! interpolation to determine OBL depth
```

**Note:** Unlike `MOM_override`, the `#override` keyword is not needed.

## MOM6 Runtime Parameters in CESM

## Conventional MOM6 Runtime Parameter System (sans CESM)

- ▶ **MOM6 code** - *A typical input parameter initialization:*

```
call get_param(param_file, "MOM", "HFREEZE", CS%HFrz, &  
    "The depth over which melt potential is computed." &  
    units="m", default=-1.0)
```

- ▶ **MOM\_input file:** *all non-default params defining a “baseline” experiment.*

```
HFREEZE = 10.0 ! [default=-1.0m] The depth over which  
            ! melt potential is computed.
```

- ▶ **MOM\_override file:** *a few parameters that define a “derived” experiment.*

```
#override HFREEZE = 2.5
```

## MOM6 Runtime Parameter System in CESM

Conventional MOM6 parameter files adopted/repurposed within the CESM framework:

- ▶ MOM\_input:
  - ▶ Out-of-the-box MOM6 configuration in CESM.
  - ▶ Auto-generated.
  - ▶ Cannot be changed by the user. (*except, via SourceMods*)
- ▶ MOM\_override:
  - ▶ Auto-generated from user\_nl\_mom.
  - ▶ Cannot be changed directly by the user. (*except, via SourceMods*)
- ▶ diag\_table:
  - ▶ Auto-generated.
  - ▶ Can be altered via xml changes (*or, via SourceMods*)
- ▶ input.nml:
  - ▶ Auto-generated, cannot (and should never) be changed.

# MOM6 Runtime Parameters in CESM

- DIN\_LOC\_ROOT: Directory of all component input data, e.g., grids, forcings, ... } *common*
- CASEROOT: Control desk, where the user can apply changes. } *case-specific*
- RUNDIR: temporary directory for run. files staged automatically. }
- DOUT\_S\_ROOT: short-term archive directory. }

## CASEROOT

```
c.T62_t061.001/  
├── *.xml  
├── case.setup  
├── case.build  
├── case.submit  
├── xmlchange  
├── SourceMods/  
│   └── ...  
├── user_nl_mom  
└── ...
```

## RUNDIR

```
[SCRATCH]/c.T62_t061.001/run/  
├── .
```



# MOM6 Runtime Parameters in CESM

- DIN\_LOC\_ROOT: Directory of all component input data, e.g., grids, forcings, ... } *common*
- CASEROOT: Control desk, where the user can apply changes. }
- RUNDIR: temporary directory for run. files staged automatically. } *case-specific*
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## CASEROOT

```
c.T62_t061.001/  
├── *.xml  
├── case.setup  
├── case.build  
├── case.submit  
├── xmlchange  
├── SourceMods/  
│   └── ...  
├── user_nl_mom  
└── ...
```

```
./preview_namelists,  
./case.build,  
./case.submit
```



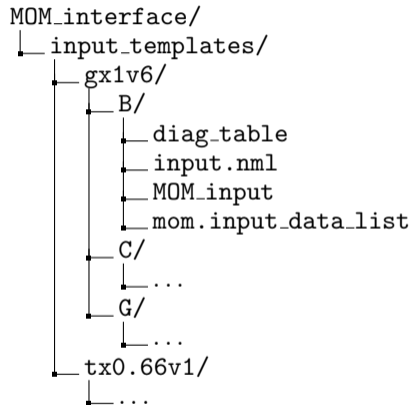
## RUNDIR

```
[SCRATCH]/c.T62_t061.001/run/  
├── MOM_input  
├── MOM_override  
├── diag_table  
├── input.nml  
├── ???_in  
└── ...
```

## Staging input files – Initially, in CESM...

*Maintain copies for each grid × compset:*

- ▶ Static files: parameter values hard-coded.
- ▶ Not extensible/tractable.
- ▶ Restrictive: out-of-the-box configurations depend only on OCN\_GRID and COMPSET.



## Staging input files – Currently, in CESM:

*Single yaml file for each file category:*

- ▶ All possible CESM configurations.
- ▶ Dynamic: param values can be tied to any CESM variable, e.g., OCN\_GRID, DATM\_MODE, COMP\_WAV, etc.

```
MOM_interface/  
├─ param_templates/  
│   ├── diag_table.yaml  
│   ├── input_nml.yaml  
│   ├── MOM_input.yaml  
│   └─ input_data_list.yaml
```

## Example MOM\_input.yaml entries

```
INPUTDIR:  
  value: ${DIN_LOC_ROOT}/ocn/mom/${OCN_GRID}
```

```
TRIPOLAR_N:  
  value:  
    $OCN_GRID in ["tx0.66v1", "tx0.25v1"]: True  
    else: False
```

```
DT_THERM:  
  value: |  
    = ( ( $NCPL_BASE_PERIOD == "decade" ) * 86400.0 * 3650.0 +  
        ( $NCPL_BASE_PERIOD == "year" ) * 86400.0 * 365.0 +  
        ( $NCPL_BASE_PERIOD == "day" ) * 86400.0 +  
        ( $NCPL_BASE_PERIOD == "hour" ) * 3600.0 ) / $OCN_NCPL
```

**Reminder:** MOM\_input.yaml is to reflect our out-of-the-box MOM6 configurations, and, thus, should not be modified for the purpose of customizing a particular case.

## Testing MOM6 in CESM

## Testing MOM6 in CESM

- ▶ **Continuous Integration – Travis:**

- ▶ MOM6 repository: same as GFDL fork.
- ▶ MOM\_interface: unit tests for MOM\_RPS module, consistency checks, linter.

- ▶ **CESM testing infrastructure**

- ▶ Test suites run before every MOM6 PR and tag creation.
  - ▶ aux\_mom: comprehensive
  - ▶ pr\_mom: lightweight
- ▶ Test suite run by CSEG before every CESM alpha tag.
  - ▶ prealpha: comprehensive, inter-component.

## Testing MOM6 in CESM

- ▶ Run an exact restart test:

```
$ CESM/cime/scripts/create_test ERS.T62_t061.cheyenne_intel
```

- ▶ Create a baseline:

```
$ CESM/cime/scripts/create_test ERS.T62_t061.cheyenne_intel \  
  -g [YOUR-BASELINE-DIR]
```

- ▶ Compare against a baseline:

```
$ CESM/cime/scripts/create_test ERS.T62_t061.cheyenne_intel \  
  -c [YOUR-BASELINE-DIR]
```

- ▶ Run a full test suite:

```
$ CESM/cime/scripts/create_test \  
  --xml-category aux_mom --xml-machine cheyenne
```

## Remarks



## Remarks

- ▶ A *functional* MOM6 release in upcoming CESM 2.2.
  - ▶ Not fully scientifically vetted.
  - ▶ Current focus on GMOM\_JRA. Next, BMOM.
- ▶ Early versions available for download and experimentation.
  - ▶ “Out-of-the-box” configurations change rapidly.
- ▶ Mechanisms for customizing a MOM6 case:
  - ▶ `xmlchange`
  - ▶ `user_nl_mom`
- ▶ Check out online user manual: “MOM6 in CESM”
  - ▶ [https://github.com/ESCOMP/MOM\\_interface/wiki](https://github.com/ESCOMP/MOM_interface/wiki)
- ▶ Post your questions to CESM/MOM6 forum.
  - ▶ <https://bb.cgd.ucar.edu/cesm/forums/mom.148/>

Thanks!  
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