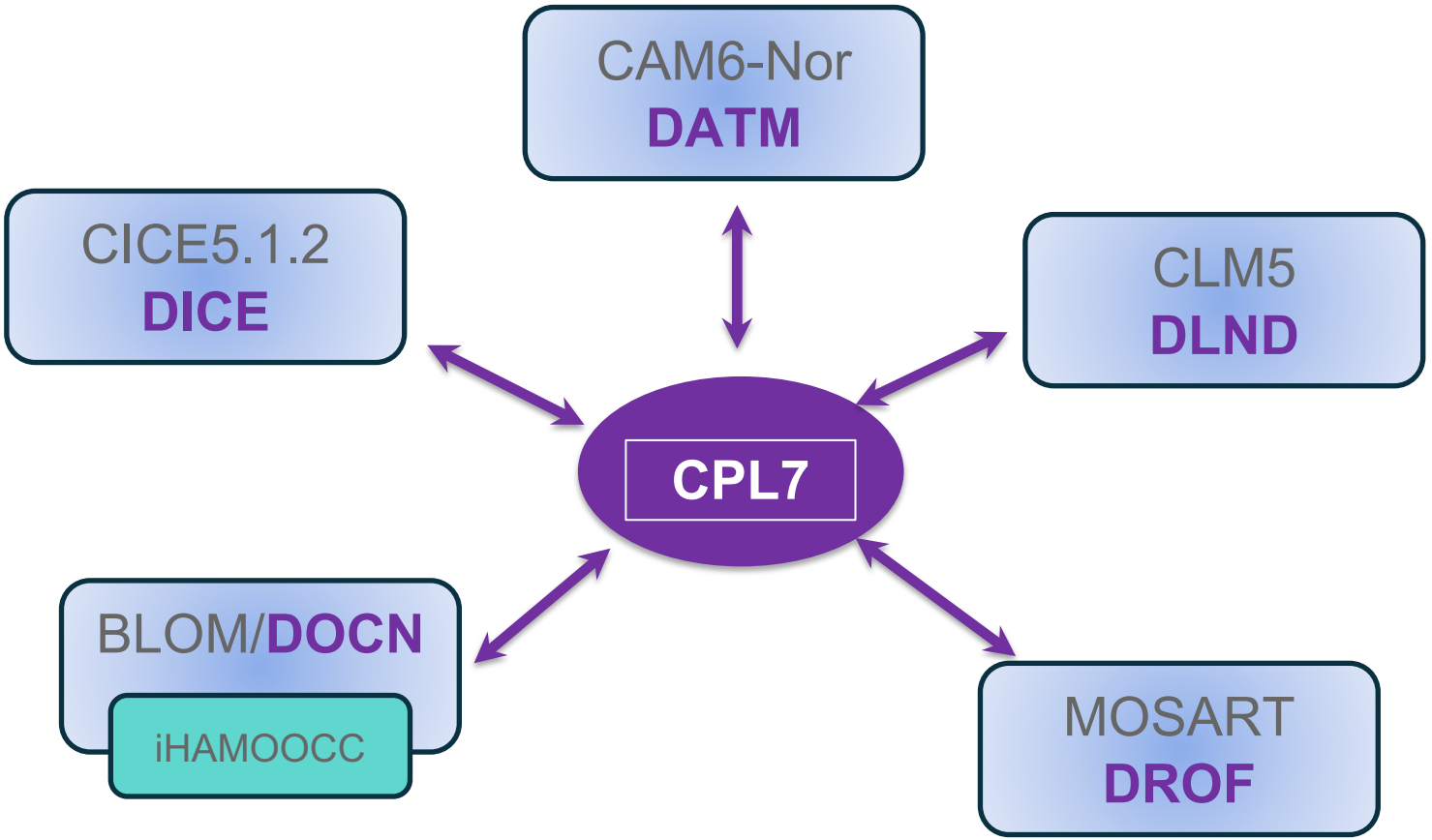
What is the NorESM2.1 architecture

NorESM2.1 Coupling Architecture



What are the parts of specifying an experiment

Two independent parts of specifying an experiment

(1) Choosing the model Compset:

- which components will be used along with possible component physics options and associated forcing files (time period)
- Fully coupled: (compset aliases beginning with N or B)
  - **1850_CAM60%NORESM_CLM50%BGC_CICE_BLOM%ECO_MOSART**_SGLC_SWAV
  - Run ./query_config --compsets allactive
- CAM (atm) with prescribed docn/cice forcing (alias NF, F or Q)
  - **1850_CAM60%NORESM_CLM50%BGC_CICE%PRES_DOCN%DOM_MOSART**_SGLC_SWAV
  - Run ./query_config --compsets cam
- CLM (lnd) with prescribed datm forcing (alias I)
  - **1850_DATM%GSWP3v1_CLM40%BGC**_SICE_SOCN_**MOSART**_SGLC_SWAV
  - Run ./query_config --compsets clm
- BLOM with prescribed datm and rof forcing (alias G and C)
  - **1850_DATM%NYF**_SLND_**CICE_BLOM%ECO_DROF%NYF**_SGLC_SWAV
  - Run ./query_config --compsets blom

Two independent parts of an experiment (cont)

(2) Choosing the model grid:

- Grid specification for each component
  - **a%name_l%name_oi%name_r%name_m%mask_g%name_w%name**
- Fully coupled:
  - a%1.9x2.5_l%1.9x2.5_oi%tnx1v4_r%r05_g%null_w%null_m%tnx1v4
  - alias is f19_tn14
- CAM with prescribed docn/cice forcing
  - a%1.9x2.5_l%1.9x2.5_oi%1.9x2.5_r%r05_g%null_w%null_m%tnx1v4
  - alias is f19_f19_mtn14
- CLM with prescribed datm forcing
  - a%1.9x2.5_l%1.9x2.5_oi%null_r%r05_g%null_w%null_m%tnx1v4
  - alias is f19_f19_mtn14
- BLOM with prescribed datm and rof forcing
  - a%1.9x2.5_l%null_oi%tnx1v4_r%rx1_g%null_w%null_m%tnx1v4
  - alias is f19_tn14

Understanding your case

- xmlquery
- pelayout
- preview_namelist
- preview_run

Understanding your case –
README.case and xmlquery

> ./create_newcase –case foo –compset N1850 –res f19_tn14

Compset is:

1850_CAM60%NORESM_CLM50%BGC-CROP_CICE%NORESMCMIP6_BLOM%ECO_MOSART_SGLC_SWAV_BGC%BDRDDMS

Model grid is:

a%1.9x2.5_l%1.9x2.5_oi%tnx1v4_r%r05_g%null_w%null_m%tnx1v4

- **What to do first – look README.case**
- **What are are the available xml variables, their definition and their values?**

  Most information you need to know about the case is in **xmlquery!!!**

  How does xmlquery work?

  > ./xmlquery –help

  What are all the variables in the xml files (don't need to look inside)

  > ./xmlquery –- listall

  What if I want to look at particular xml variables but don't know the full name

  > ./xmlquery –-partial (or –p)

  > ./xmlquery –-partial –-full (or –p –-full)

Example: query the BLOM configuration

> ./xmlquery –p BLOM

Results in group build_component_blom

BLOM_TRACER_MODULES: iage ecosys

BLOM_TURBULENT_CLOSURE: oneeq advection

BLOM_UNIT: cgs

Results in group run_component_blom

BLOM_COUPLING: full

BLOM_NDEP_SCENARIO: 1850

BLOM_N_DEPOSITION: TRUE

BLOM_RIVER_NUTRIENTS: TRUE

BLOM_VCOORD: isopyc_bulkml

> ./xmlquery --full BLOM_TRACER_MODULES

Results in group build_component_blom

BLOM_TRACER_MODULES: value=iage ecosys

type: c

valid_values: ['iage', 'iage ecosys']

description: Optional ocean tracers.

Valid values are acombination of: iage ecosys

file: $CASEROOT/foo/env_build.xml

Understanding your case –
preview_namelists

What are my resolved namelists?

The namelists that actually get read by the components.

> cd $CASEROOT

> **./preview_namelists**

- This must be run after ./case.setup
- Output namelists are in $CASEROOT/CaseDocs as well as in $RUNDIR/run
- CaseDocs/ is where you can quickly see namelists – this is used ONLY for documentation
- Customize: You can customize namelists by editing the appropriate user_nl_XXX file and then run ./preview_namelists again (DO NOT edit files in either CaseDocs or run – they will be overwritten)

Understanding your case –
pelayout

What is my processor layout?

NOTE: this might not be optimal for your experiment out of the box!

>./pelayout

```
Comp   NTASKS   NTHRDS   ROOTPE
CPL  :    768/      1;        0
ATM  :    768/      1;        0
LND  :    192/      1;        0
ICE  :    544/      1;      224
OCN  :    256/      1;      768
ROF  :    128/      1;        0
GLC  :    768/      1;        0
WAV  :     32/      1;      192
ESP  :      1/      1;        0
```

NTASKS: number of MPI tasks for each component
NTHRDS: number of OpenMP threads for each component
ROOTPE: first MPI task for each component

Understanding your case
preview_run

- What batch information is being submitted?
- How is the short-term archiving used?
- What are the environment variables that are set?
- What are the batch queue settings?

➢ **./preview_run**

```
CASE INFO:
  nodes: 8
  total tasks: 1024
  tasks per node: 128
  thread count: 1

BATCH INFO:
  FOR JOB: case.run
    ENV:
      module command is /cluster/installations/lmod/lmod/libexec/lmod python --quiet restore system
      module command is /cluster/installations/lmod/lmod/libexec/lmod python load StdEnv intel/2020a
      Setting Environment KMP_STACKSIZE=64M
      Setting Environment MKL_DEBUG_CPU_TYPE=5
      Setting Environment OMPI_MCA_mpi_leave_pinned=1
      Setting Environment OMPI_MCA_btl=self,vader
      Setting Environment OMPI_MCA_rmaps_rank_file_physical=1
      Setting Environment OMPI_MCA_coll_hcoll_enable=1
      Setting Environment OMPI_MCA_coll=^fca
      Setting Environment OMPI_MCA_coll_hcoll_priority=95
      Setting Environment OMPI_MCA_coll_hcoll_np=8
      Setting Environment HCOLL_MAIN_IB=mlx5_0:1
      Setting Environment HCOLL_ENABLE_MCAST_ALL=1
      Setting Environment OMP_NUM_THREADS=1
    SUBMIT CMD:
      sbatch --time 00:59:00 --account nn2345k .case.run --resubmit

  FOR JOB: case.st_archive
    ENV:
      module command is /cluster/installations/lmod/lmod/libexec/lmod python --quiet restore system
      module command is /cluster/installations/lmod/lmod/libexec/lmod python load StdEnv intel/2020a
      Setting Environment KMP_STACKSIZE=64M
      Setting Environment MKL_DEBUG_CPU_TYPE=5
      Setting Environment OMPI_MCA_mpi_leave_pinned=1
      Setting Environment OMPI_MCA_btl=self,vader
      Setting Environment OMPI_MCA_rmaps_rank_file_physical=1
      Setting Environment OMPI_MCA_coll_hcoll_enable=1
      Setting Environment OMPI_MCA_coll=^fca
      Setting Environment OMPI_MCA_coll_hcoll_priority=95
      Setting Environment OMPI_MCA_coll_hcoll_np=8
      Setting Environment HCOLL_MAIN_IB=mlx5_0:1
      Setting Environment HCOLL_ENABLE_MCAST_ALL=1
      Setting Environment OMP_NUM_THREADS=1
    SUBMIT CMD:
      sbatch --time 0:59:00 --account nn2345k  --dependency=afterok:0 case.st_archive --resubmit

MPIRUN:
  srun  /cluster/work/users/mvertens/noresm/test_tutorial/bld/cesm.exe  >> cesm.log.$LID 2>&1
```

Before you run – checking your case

Some steps to perform before starting a longer run

1. first build the case (case.build)
2. verify that input data is present – and download if not (check_inputdata)
3. perform a debug test (xmlchange DEBUG=TRUE)
4. run a performance test and check timing file
   - Determining best processor layout can be a huge benefit for performance!

Why a debug test?

- Normally if the xml variable DEBUG is not enabled the compiler flags to check for floating point exceptions or array bound problems are not turned on. Its important to do this before you run a long run. You can do a 1 day test with debug on out of your $CASEROOT.

- Simply do the following:
  - ./case.build – clean-all
  - ./xmlchange DEBUG=TRUE
  - ./xmlchange STOP_OPTION=ndays
  - ./xmlchange STOP_N=1
  - ./case.build
  - ./case.submit
- If this works – the simply reset the default values and build again
  - ./case.build –clean-all
  - ./xmlchange DEBUG=FALSE
  - ./case.build
- If it crashes – need to resolve the problem!

How to validate performance

- Start with a simple case - clm, datm, rof, cpl

- ./create_newcase \
  --case test_perf \
  --compset 2000_**DATM%GSWP3v1_CLM50%BGC-CROP**_SICE_SOCN_**MOSART**_SGLC_SWAV \
  --res f19_f19_mtn14
- cd test_perf
- ./xmlchange NTASKS=512
- ./xmlchange DIN_LOC_ROOT_CLMFORC=/cluster/shared/noresm/inputdata/atm/datm7
- ./pelayout
- ./case.setup
- ./case.build
- ./case.submit

```
Comp   NTASKS  NTHRDS  ROOTPE
CPL :    512/      1;       0
ATM :    512/      1;       0
LND :    512/      1;       0
ICE :    512/      1;       0
OCN :    512/      1;       0
ROF :    512/      1;       0
GLC :    512/      1;       0
WAV :    512/      1;       0
ESP :    512/      1;       0
```

However, we know that DATM and CLM run concurrently in time – so can place DATM on a separate processor set
Let's start with a 5 day test and see the timing file

How can we get better performance?

> cd timing/test_perf/

> look at cesm_timing.test_perf.$id

```
Overall Metrics:
  Model Cost:             112.34   pe-hrs/simulated_year
  Model Throughput:       109.39   simulated_years/day

   Init Time   :      27.490 seconds
   Run Time    :      10.820 seconds        2.164 seconds/day
   Final Time  :       0.002 seconds

   Actual Ocn Init Wait Time     :       0.000 seconds
   Estimated Ocn Init Run Time   :       0.000 seconds
   Estimated Run Time Correction :       0.000 seconds
     (This correction has been applied to the ocean and total run times)

Runs Time in total seconds, seconds/model-day, and model-years/wall-day
CPL Run Time represents time in CPL pes alone, not including time associated with data exchange

   TOT Run Time:      10.820 seconds        2.164 seconds/mday       109.39 myears/wday
   CPL Run Time:       0.486 seconds        0.097 seconds/mday      2435.31 myears/wday
   ATM Run Time:       1.644 seconds        0.329 seconds/mday       719.93 myears/wday
   LND Run Time:       8.402 seconds        1.680 seconds/mday       140.87 myears/wday
   ICE Run Time:       0.000 seconds        0.000 seconds/mday         0.00 myears/wday
   OCN Run Time:       0.000 seconds        0.000 seconds/mday         0.00 myears/wday
   ROF Run Time:       0.815 seconds        0.163 seconds/mday      1452.22 myears/wday
   GLC Run Time:       0.000 seconds        0.000 seconds/mday         0.00 myears/wday
   WAV Run Time:       0.000 seconds        0.000 seconds/mday         0.00 myears/wday
   ESP Run Time:       0.000 seconds        0.000 seconds/mday         0.00 myears/wday
   CPL COMM Time:      2.595 seconds        0.519 seconds/mday       456.09 myears/wday
```

Let's reset the PE-layout and Put the atm on its own pes – but with much fewer tasks

./xmlchange NTASKS=496
./xmlchange NTASKS_ATM=16
./xmlchange ROOTPE_ATM=496

./pelayout now gives

```
Comp  NTASKS  NTHRDS  ROOTPE
CPL :    496/      1;       0
ATM :     16/      1;     496
LND :    496/      1;       0
ICE :    496/      1;       0
OCN :    496/      1;       0
ROF :    496/      1;       0
GLC :    496/      1;       0
WAV :    496/      1;       0
ESP :    496/      1;       0
```

How can we get better performance? (cont)

Now let's look at the new timing file

```
 Overall Metrics:
    Model Cost:              93.37   pe-hrs/simulated_year
    Model Throughput:       131.61   simulated_years/day

    Init Time   :     136.563 seconds
    Run Time    :       8.993 seconds        1.799 seconds/day
    Final Time  :       0.002 seconds

    Actual Ocn Init Wait Time     :       0.000 seconds
    Estimated Ocn Init Run Time   :       0.000 seconds
    Estimated Run Time Correction :       0.000 seconds
      (This correction has been applied to the ocean and total run times)

Runs Time in total seconds, seconds/model-day, and model-years/wall-day
CPL Run Time represents time in CPL pes alone, not including time associated with data exchange

    TOT Run Time:       8.993 seconds        1.799 seconds/mday       131.61 myears/wday
    CPL Run Time:       5.070 seconds        1.014 seconds/mday       233.44 myears/wday
    ATM Run Time:       2.137 seconds        0.427 seconds/mday       553.84 myears/wday
    LND Run Time:       8.158 seconds        1.632 seconds/mday       145.08 myears/wday
    ICE Run Time:       0.000 seconds        0.000 seconds/mday         0.00 myears/wday
    OCN Run Time:       0.000 seconds        0.000 seconds/mday         0.00 myears/wday
    ROF Run Time:       0.845 seconds        0.169 seconds/mday      1400.66 myears/wday
    GLC Run Time:       0.000 seconds        0.000 seconds/mday         0.00 myears/wday
    WAV Run Time:       0.000 seconds        0.000 seconds/mday         0.00 myears/wday
    ESP Run Time:       0.000 seconds        0.000 seconds/mday         0.00 myears/wday
    CPL COMM Time:      2.476 seconds        0.495 seconds/mday       478.01 myears/wday
```

Throughput is increased by ~30% with the same number of total PES

Model cost is less

HUGE performance saving If you will run a long time!