Community Mediator for Earth Predictive Systems (CMEPS)
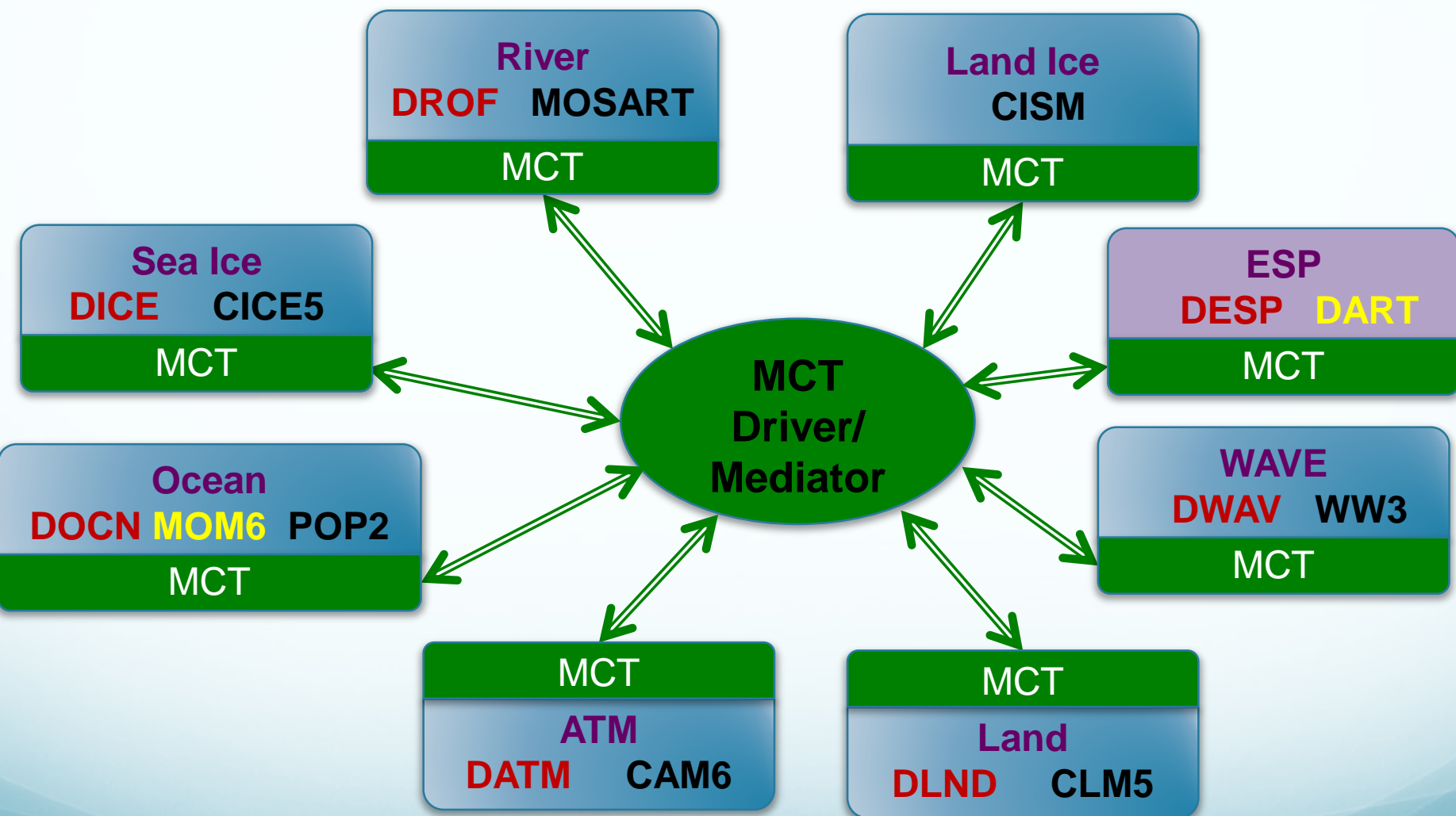
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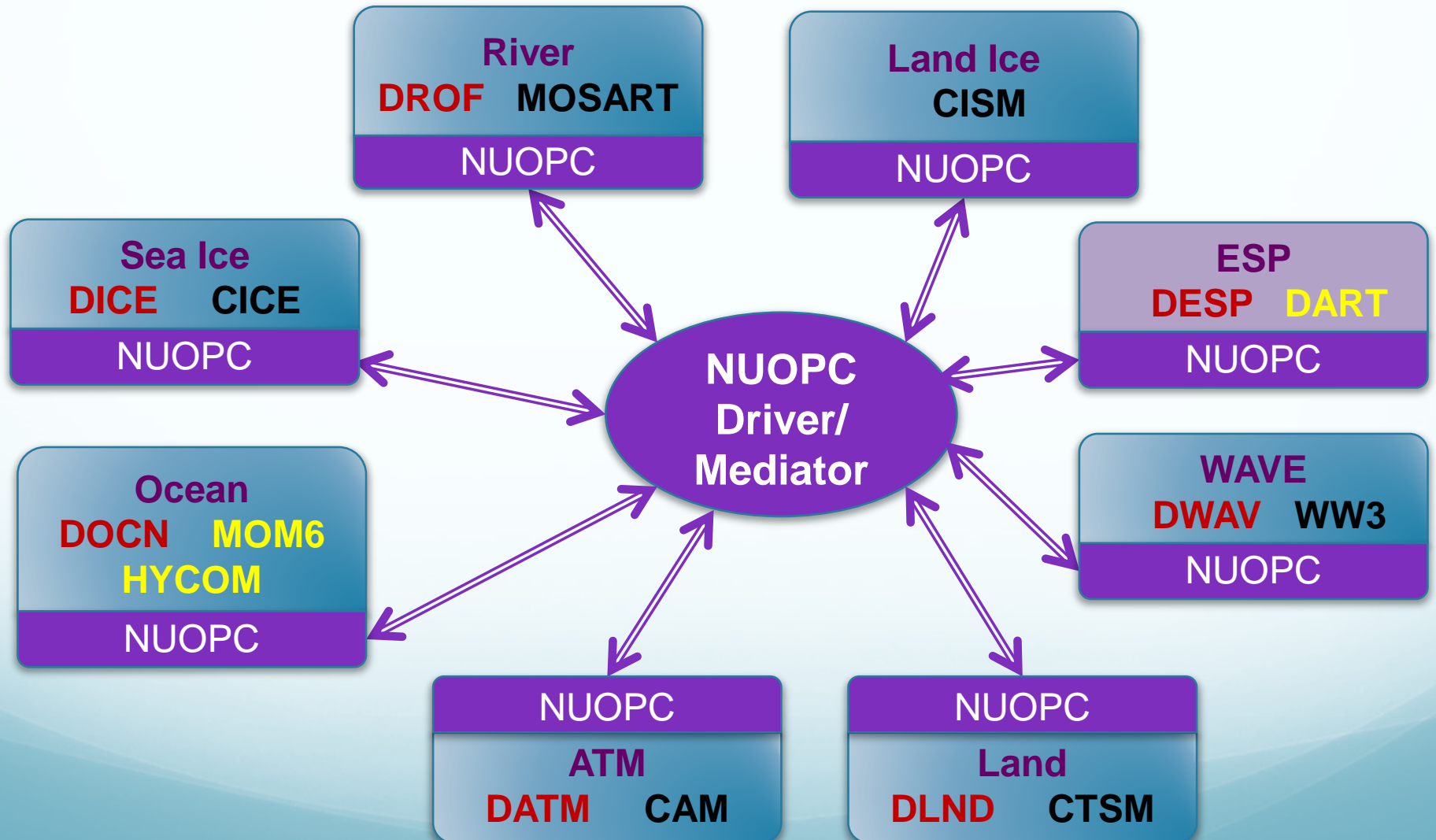
Outline

- Quick review of NUOPC/ESMF in CESM

- What is CMEPS?

- CMEPS status and roadmap

Current CESM Coupling (cpl7) – data components permit flexible activation/deactivation of feedbacks

# New ESMF/NUOPC Driver/Mediator will enable community new collaborations

What is NUOPC?

NUOPC is effectively a layer on top of ESMF and bundled with the ESMF distribution

ESMF NUOPC Layer defines conventions and templates in order to make it easier to collaboratively build coupled modeling systems using ESMF.

Contains 4 generic components

- **Driver** – coordinates initialization and run sequence of mediator, models and connectors
- **Mediator** – in CESM does the regridding, atm/ocn flux calc, diagnostics, merging
- **Model** – in CESM one of the components
- **Connector** - connects *pairs* of component, in CESM does the redistribution
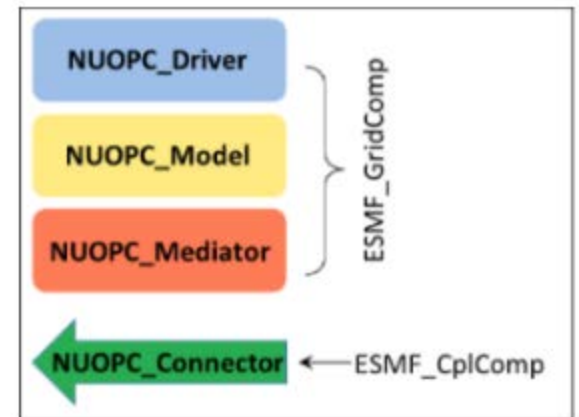
Example of NUOPC configuration file

```
runSeq::
      @1800    #ocean coupling step
        MED med_phases_prep_ocn
        MED med_connectors_prep_med2ocn
        MED -> OCN :remapMethod=redist
        OCN
      @1800    # atmosphere coupling step
         MED med_phases_prep_ice_foo
         MED med_connectors_prep_med2ice
         MED -> ICE :remapMethod=redist
         MED med_phases_prep_rof
         MED med_connectors_prep_med2rof
         MED -> ROF :remapMethod=redist
         ICE
         ROF
         ROF -> MED :remapMethod=redist
         MED med_connectors_post_rof2med
         ICE -> MED :remapMethod=redist
         MED med_connectors_post_ice2med
         MED med_fraction_set
         MED med_phases_atmocn_flux
         MED med_phases_atmocn_ocnalb
         MED med_phases_prep_atm
         MED med_connectors_prep_med2atm
         MED -> ATM :remapMethod=redist
         ATM
         ATM -> MED :remapMethod=redist
         MED med_connectors_post_atm2med
         MED med_phases_accum_fast
      @
      OCN -> MED :remapMethod=redist
      MED med_connectors_post_ocn2med
    @
::
```

```
DRIVER_info_attributes::
      aoflux_grid = ocn
      aqua_planet = .false.
      aqua_planet_sst = 1
      atm_gnam = 1.9x2.5
      bfbflag = .false.
      brnch_retain_casename = .false.
      budget_ann = 1
      budget_daily = 0
      budget_inst = 0
      budget_ltann = 1
      budget_ltend = 0
      budget_month = 1
      case_desc = UNSET
      case_name = atest_nuopc
      cime_model = cesm
      cpl_decomp = 0
      cpl_seq_option = CESM1_MOD
      do_budgets = .false.
      do_histinit = .false.
      drv_threading = .false.
      eps_aarea = 9e-07
      eps_agrid = 1e-12
      eps_amask = 1e-13
      eps_frac = 1.0e-02
      eps_oarea = 0.1
      eps_ogrid = 0.01
      eps_omask = 1e-06
      flux_albav = .false.
```

Runtime sequence

Config file removes need of namelist input

Advantages of NUOPC Infrastructure

- ESMF:
    - Run-time generation of mapping weights - eliminates need to compute AND maintain growing number of mapping files generated offline

- NUOPC:
    - Initialization sequence – carries out field brokering (compliance checking between components) and resolves data dependencies between components during initialization
    - Data-driven run-time configurable sequencing of driver phases (currently this is all hard-coded and fragile)
    - Compatibility testing - ensures a certain level of inter-component compatibility via field and component metadata that is automatically checked in the NUOPC Layer.

- Support of ESMF/NUOPC
    - The ESMF group is committed to supporting the needs of CESM as this infrastructure is implemented and deployed

More Advantages

- No need for stub components
  - are no longer insisting that an atmosphere component MUST exist at the driver level with an atm_comp_mct interface
  - Can greatly simplify compset definitions

- No need for namelists in driver mediator

What is CMEPS?

Community Mediator for Earth Prediction Systems - CMEPS

- CMEPS is a community mediator
  - based on ESMF and the NUOPC Layer
  - being developed and evaluated for use by CESM, NOAA/NCEP, and GFDL

- CMEPS goals
  - Advance model coupling across scales by *enabling the exploration of coupling science* options now implemented at different sites
  - Bring decades of *coupling expertise in the research community* to the implementation of the new unified forecast system at the National Weather Service
  - ***Provide operational centers and community modeling efforts with a feature-rich, flexible, documented and supported mediator with standard NUOPC interfaces, distributed through CIME***

CMEPS (cont)

- *Technically,* CMEPS will leverage ESMF and NUOPC-Layer features, including:

  - Runtime grid remapping

  - Runtime and easily reconfigurable run sequence

  - Support for coupling hierarchies

  - Compliance checking and development tool

- *Scientifically,* goal is to support science options implemented at multiple coupled modeling centers in a single mediator code, including CESM and GFDL:

  - Implicit coupling (GFDL) or explicit coupling (CESM)

  - Exchange grid (GFDL, NASA, Navy) remapping

  - Standard grid remapping (CESM)

CMEPS Approach

- NUOPC-based mediators - like CMEPS - divide coupling science operations into mediator phases, which can be sequenced at run-time

- Sharing some mediator phases and customizing others enables multiple centers to understand and use the same coupling system
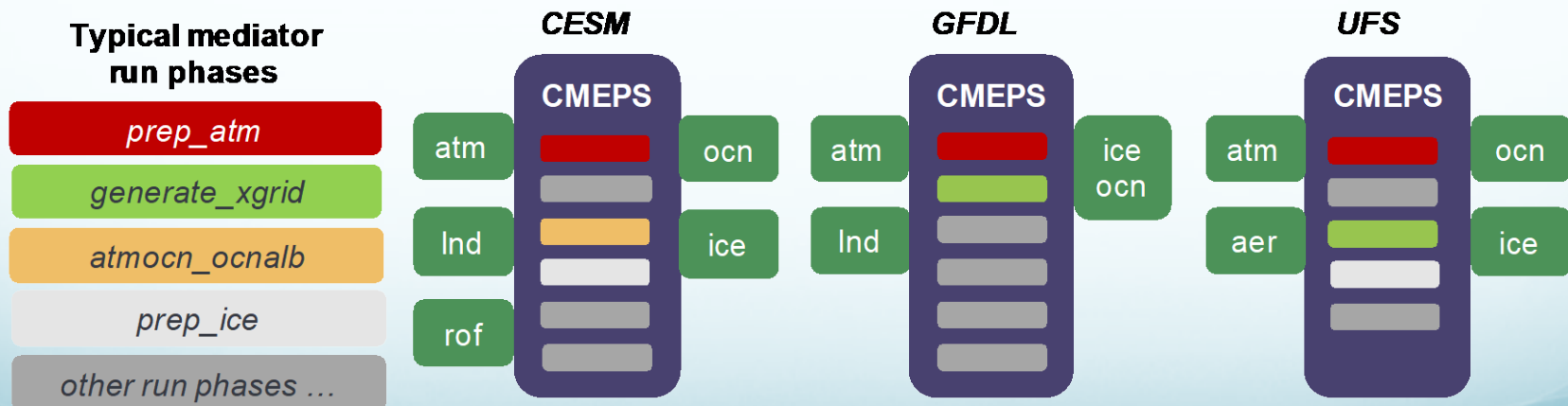
Typical mediator run phases

- prep_atm
- generate_xgrid
- atmocn_ocnalb
- prep_ice
- other run phases ...

CESM

CMEPS

atm — ocn
lnd — ice
rof

GFDL

CMEPS

atm — ice ocn
lnd

UFS

CMEPS

atm — ocn
aer — ice

Diagram is illustrative only — components are not complete/correct.

CMEPS - CESM Status

- CIME modified to accept new argument to create_newcase to use the ESMF/NOUPC mediator

    - ./create_newcase --driver nuopc

- All **CIME data and xcpl** components now have both MCT and NUOPC caps and have successfully carried out smoke tests with the CMEPS mediator/driver

- **CAM, CLM, CICE** now have both MCT and NUOPC caps (on component branches)

    - F, I and D compsets are either bit-for-bit OR roundoff relative to the MCT driver case baseline

- Plan - have MOSART, RTM, CISM, WW3 have NUOPC caps by early spring (i.e. be CMEPS v0 compliant)

CMEPS – GFDL and EMC Status

- GFDL:
  - Validated simple coupled configurations of GFDL models – MOM6 standalone; active atmosphere and land with data ice on the same grid
  - Work in progress to replicate GFDL exchange grid approach with ESMF exchange grid, including dynamic masking

- EMC
  - Running dead (i.e. xcpl) compset in CIME workflow on theia computer at NOAA.

- Upcoming CMEPS milestones (Q2FY18):
  - At least one active component running on the theia computer at NOAA (plan is for MOM6 in a C compset configuration)
  - All active CESM components

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Thank you!

Questions?