Next-Gen Coupler with MOAB

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Goals for Next-Gen Coupler in CMDV

- Rewrite and rethink many parts of the ACME coupler to better meet ACME's near-term science and technical goals.

- Simplify coupling workflow through unified infrastructure for mesh and data handling provided by MOAB

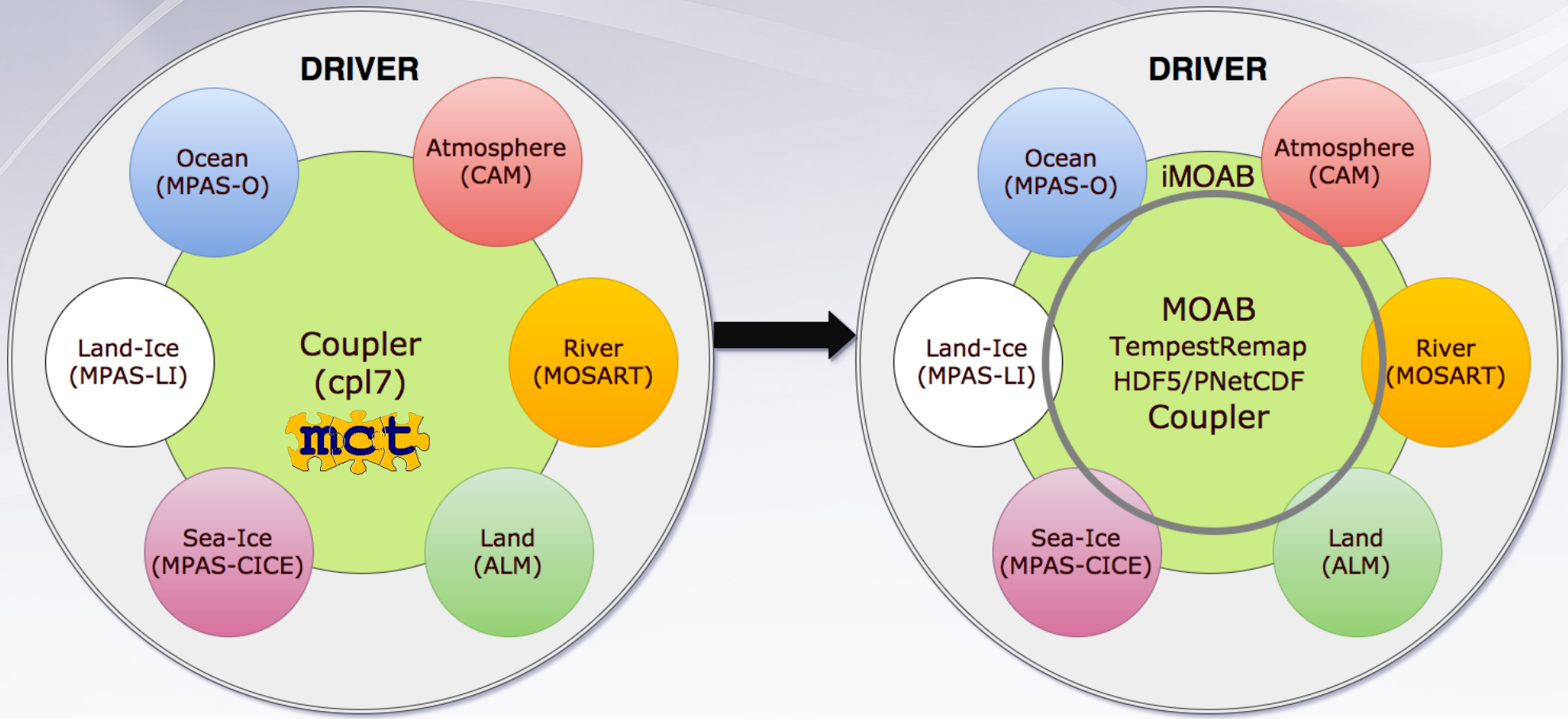
  - Uniform methodology to prescribe mesh decomposition to minimize *time to solution*
  - Move away from the current offline-online weight generation model and support *fully online* capability with high-order conservative remapping schemes

- Build expertise in the coupler software.

- Think beyond the current split-coupling methods and reduce spatiotemporal inaccuracies

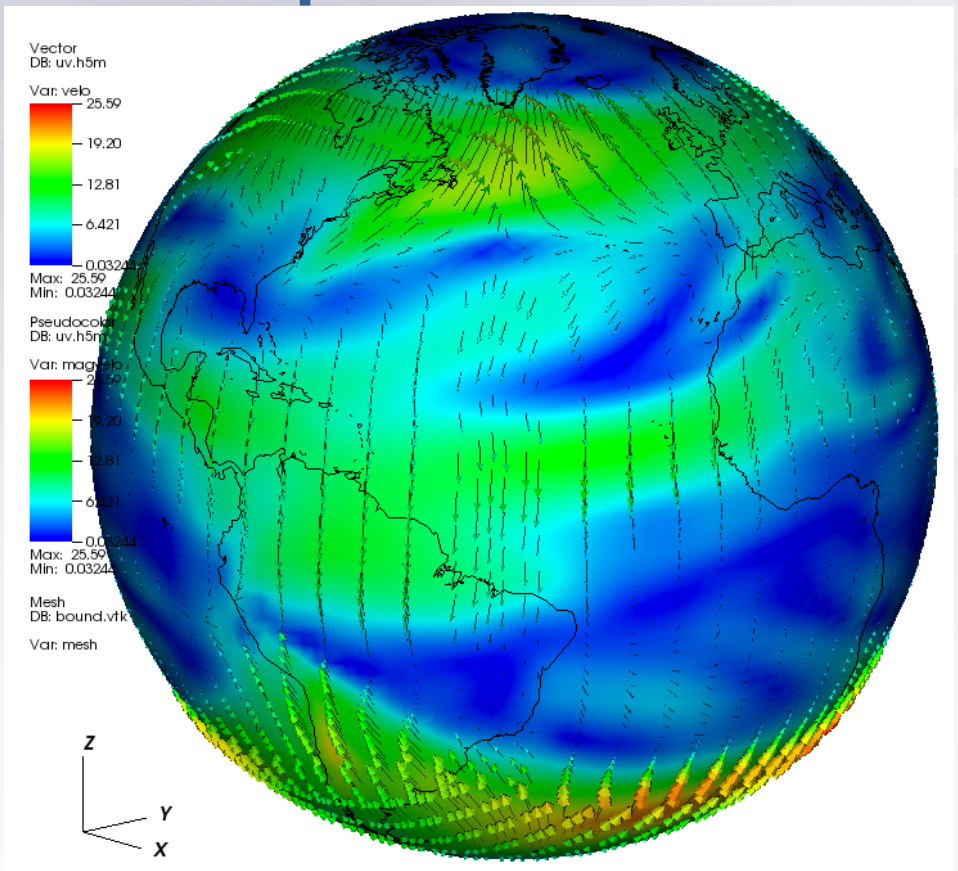
MOAB (v5.0) serves as a mesh and coupler infrastructure to unify model interfaces

- MOAB: C++, open-source, LGPLv3 and part of the SIGMA toolkit
  - MOAB: http://bitbucket.org/fathomteam/moab
  - SIGMA: http://sigma.mcs.anl.gov
- Uses efficient array-based data structures to represent both structured and unstructured grid representations
- Allow field data serialization natively on mesh entities (vertices, elements, edges and faces)
- Parallel algorithms to compute nearest neighbors, grid intersections and field interpolations
- Language agnostic interfaces (Fortran/C/C++) through iMOAB implementation. (MOAB is C/C++)
- Fully parallel visualization of meshes and fields with VisIt-MOAB plugin
  - Avoid interpolating data for visualization
  - Perform analysis with a rich in-memory data-model
  - For data placed in MOAB data types (coupler fields only)


DRIVER
Ocean
(MPAS-O)
Atmosphere
(CAM)
Land-Ice
(MPAS-LI)
Coupler
(cpl7)
mct
River
(MOSART)
Sea-Ice
(MPAS-CICE)
Land
(ALM)
DRIVER
Ocean
(MPAS-O)
iMOAB
Atmosphere
(CAM)
Land-Ice
(MPAS-LI)
MOAB
TempestRemap
HDF5/PNetCDF
Coupler
River
(MOSART)
Sea-Ice
(MPAS-CICE)
Land
(ALM)

Step 0: Install MOAB on ACME platforms

- Verified configuration/installation on various platforms
  - ANL: Blues, Mira, Theta,
  - NERSC: Edison, Cori,
  - ORNL: Titan



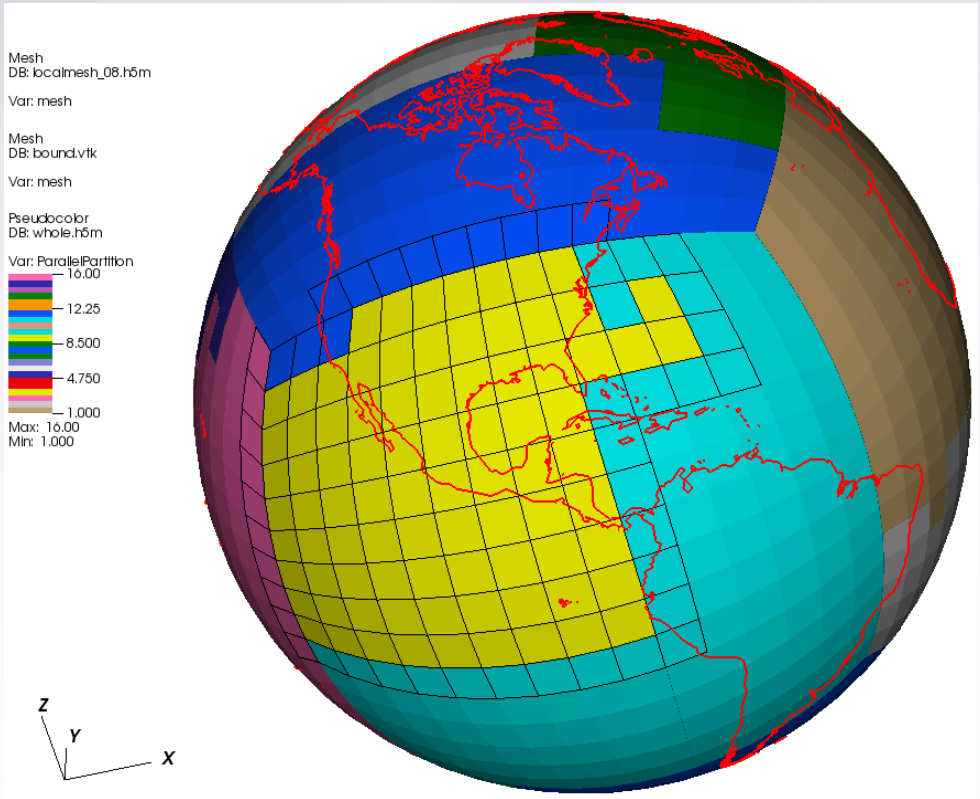
First Steps

- Interface MOAB with HOMME and MPAS-O, standalone.
- Find interpolation weights offline (to compare with Tempest, ESMF_Regrid)
- Improve mesh partitioning schemes for coupler performance and to minimize data-transfer

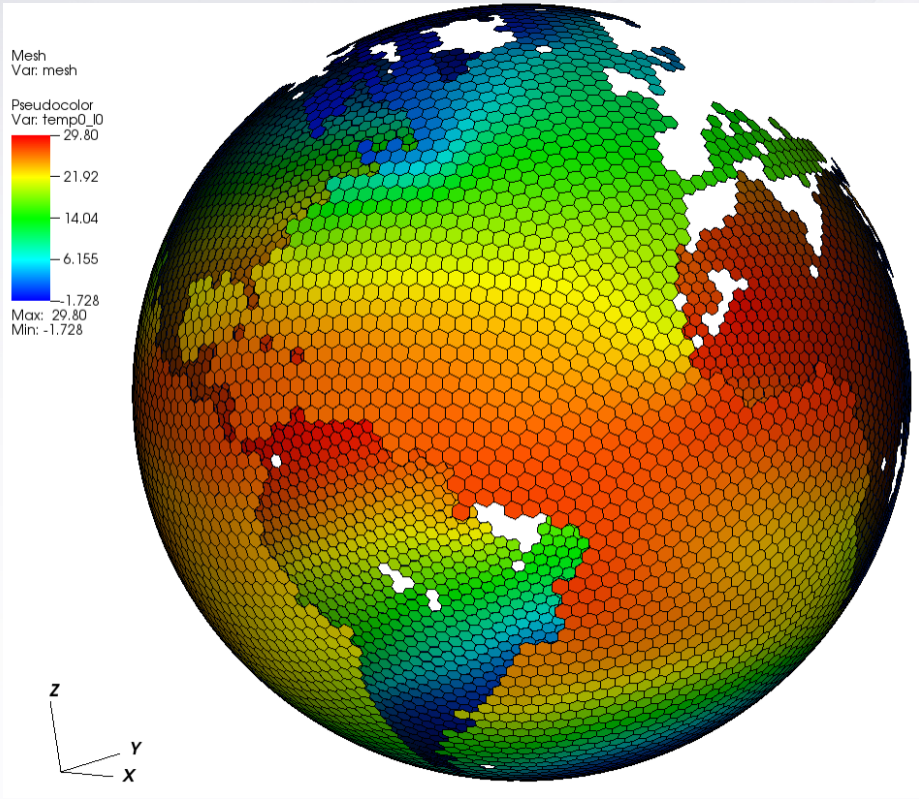
Interface to standalone HOMME and MPAS-O

- Made branches in ACME (HOMME) and MPAS-Dev (MPAS-O).
- Added calls to MOAB_init
- Add calls to define mesh in MOAB
- Write out mesh to visualize.

HOMME Atmosphere Model

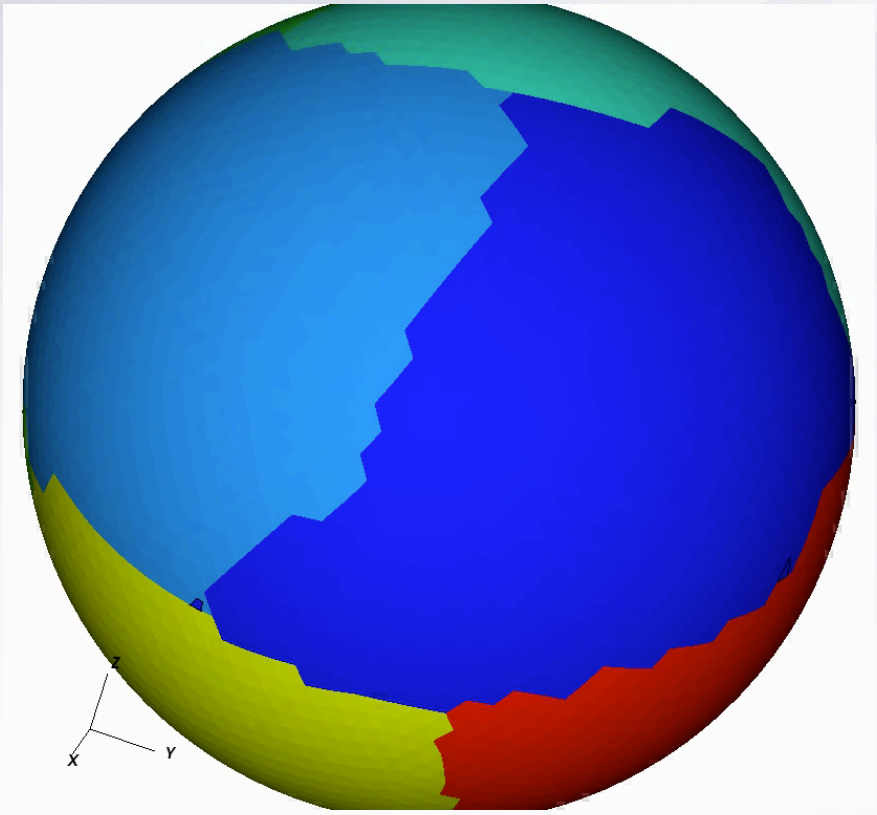


MPAS Ocean Model

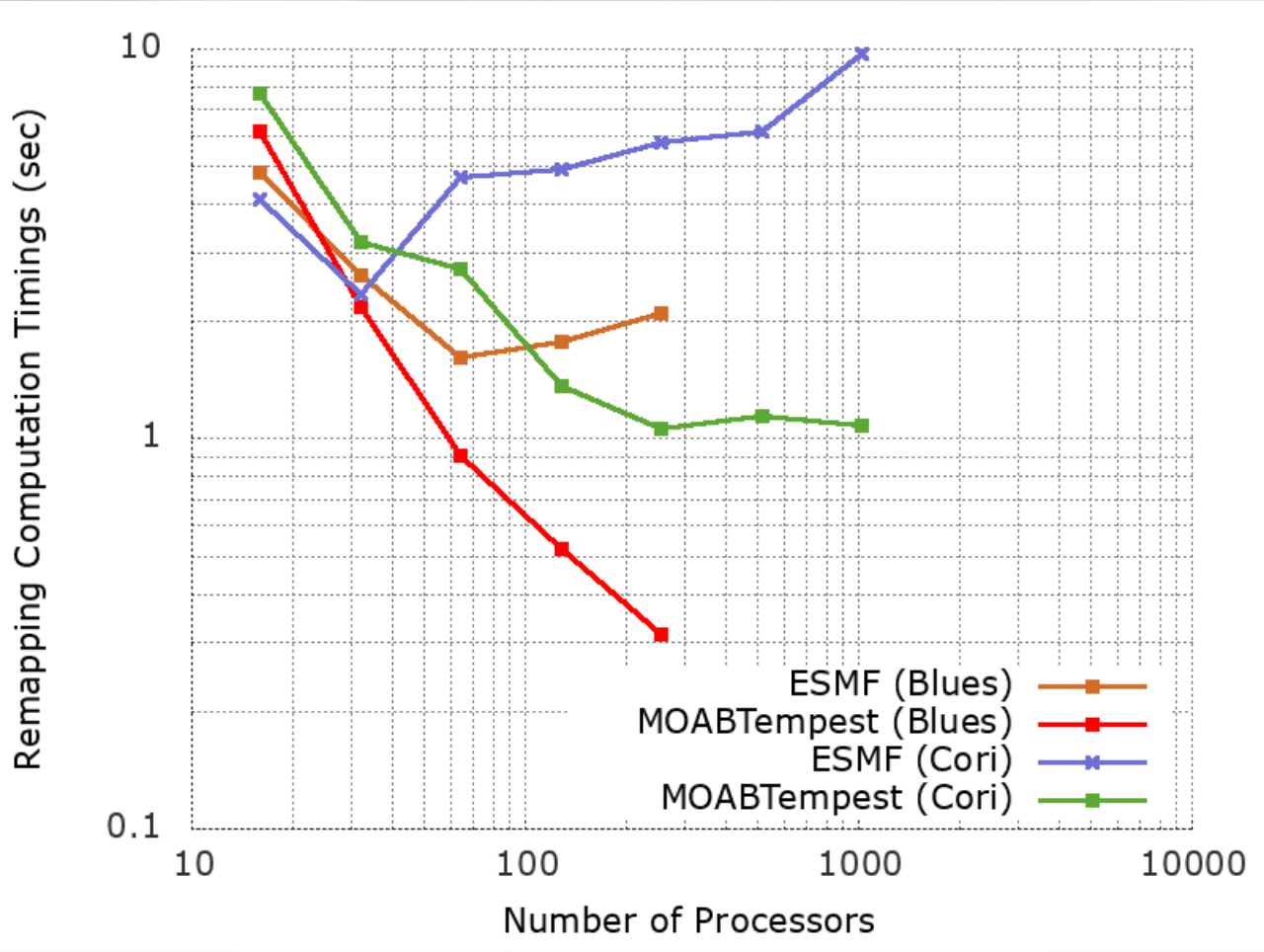


Offline weight generation

- Combine
  - MOAB's parallel "advancing front" intersection algorithm (to find where two grid intersect)
  - TempestRemap (to find area of elements within intersection)
- "Library-ify" TempestRemap within MOAB.
  - Replaces the (serial) intersection algorithm in Tempest.
- "mbtempest": new command line tool to generate mapping weights.



Compare mbTempest with ESMF_Regridder



CS (E=614400 quads) -> CS (E=153600 quads) remapping (-m conserve)

New multi-model mesh partitioning schemes for coupler performance to minimize data-transfer

- Bad parallel decompositions of a source and target mesh increase communication time to compute (source) coverage mesh
- Use the target mesh (master) and generate partitions that have **maximal overlap** with the source (slave)
- New MOAB function *mbslave*

Processors	Metis Partition	Enslaved
2	0.500	0.255
4	0.725	0.358
8	0.850	0.422
16	0.923	0.543
32	0.972	0.63

Table: Area Imbalance between a coarse CS and ICO grid with 128 partitions

Next Steps

- Introduce our standalone examples in to ACME's driver, CAM and MPAS-O.
- Build new coupler "plumbing and wiring" first. Stay in sync with master.
  - Code will be isolated with "HAVE_MOAB" ifdefs.
  - Create MOAB data pathways coincident with MCT.
- Compare fully online MOAB interpolation with MCT offline-> read weights -> apply online at scale for atm-> ocn interpolation.
- Extend to other model coupling pairs.