CAM dynamical cores

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Historically CAM has accommodated several dynamical cores (dycores)

👍 Provides a unique modeling environment where the same physics can easily be run with different dycores:
- evaluate physics sensitivity to dycore
- easily compare dycores in idealized settings

👍 CAM can accommodate throughput requirements on small compute platforms to massive parallel supercomputers by having dycores suitable for the respective platforms.
Historically CAM has accommodated several dynamical cores (dycores)

 vå Our dycores capability requirements have evolved and some of the dycores do not meet our needs anymore (e.g., mesh-refinement capability)

 vå We do not have the resources to support an increasing number of dycores (scientific support and software engineering support)
CAM dynamical core inventory

Current dycores:

EUL (Eulerian spectral-transform)
SLD (semi-Lagrangian spectral-transform)
FV (finite-volume)
SE (spectral-elements)

Dycores being integrated into CAM:

MPAS (Model for Prediction Across Scales)
FV3 (“cubed-sphere version” of FV from NOAA)
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• Not used anymore for climate (used to be a “workhorse” dynamical core)
• Used by the university community for paleo climate applications and simpler models configurations
• Documented and with some functional support (fully supported for simpler model applications)
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- “workhorse” dynamical core in CESM for 1 degree (horizontal resolution) applications
- Used in CAM, WACCM, WACCM-X
- Documented and supported
- Very well tested and widely used (very mature dycore)
- Plans: No further development
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- NOAA funded effort to implement FV3 (“cubed-sphere non-hydrostatic version” of FV) in CESM
  -> implementation starting soon
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• CISL’s HOMME (High-Order Methods Modeling Environment); Now SE is managed by CGD i.e. a standalone version of HOMME will not be used in CESM2!

• Actively being developed by CGD and CISL: Numerical methods: separate physics grids, CSLAM transport, … (See Lauritzen talk “CESM2 release of CAM-SE” and “Variable-resolution updates: CAM-SE” talk by Zarzycki)

Performance and new architectures: Used widely by CISL for computer science applications and performance research

• Current “workhorse” for ¼ degree applications
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MPAS
(Model for Prediction Across Scales)

• Developed by MMM with WRF physics for high resolution global weather forecasting
• Being implemented and tested in CAM
• Plans:
  - Given adequate resources the integration into CAM should be completed soon
  - Evaluation as a dynamical core for climate with CAM6 physics
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### Summary of “capabilities”
(Does not reflect accuracy, throughput, etc.)

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CESM plans

Please note: CESM will be in a unique position having three state-of-the-art dynamical cores (in the same infrastructure) spanning diverse spherical grids and numerical methods.

The CESM group is planning to perform a comparison of the different dycores for “workhorse” CESM applications.

The dynamical core requirements list includes (not an exhaustive list):

- Sufficient throughput (cost not just scalability is important!) on current and future architectures
- Conservation (mass, a closed energy budget in the system as a whole, axial angular momentum, …)
- Dynamical core developer support
- Support for simplified setups (see Lauritzen’s talk “An Overview of the Simplified CESM2 Model Configurations”)
- Climate needs to be competitive with CESM2 release simulations
- Mesh-refinement capability for regional climate applications