

Experience with CAM/HOMME: CAM aqua planet simulations using a cubed-sphere grid.

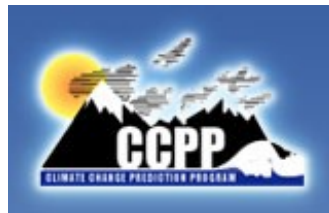
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Atmospheric Model Working Group Meeting, Boulder, February, 2008

U.S. Department of Energy



Office of Science



Motivation

- **Test CAM software infrastructure to allow for non latitude-longitude grids**
- **Scalability**
 - Cubed-sphere (and other grids, like icosahedral) allow for full 2D domain decomposition in the dycore
 - Example: 0.5 degree scales to 21K processors, each with a 3x3 array of vertical columns
- **Proof-of-concept work:**
 - H. Wang et al. MWR 2007: CAM2 and SEAM.
- **CAM/HOMME**
 - Integrated with CAM development trunk
 - Latest branch: `homme_cam_3_5_29`
 - APE simulations: `homme_cam_3_4_10` (CAM 3.1 physics)
 - Parallel I/O for history and some restart files



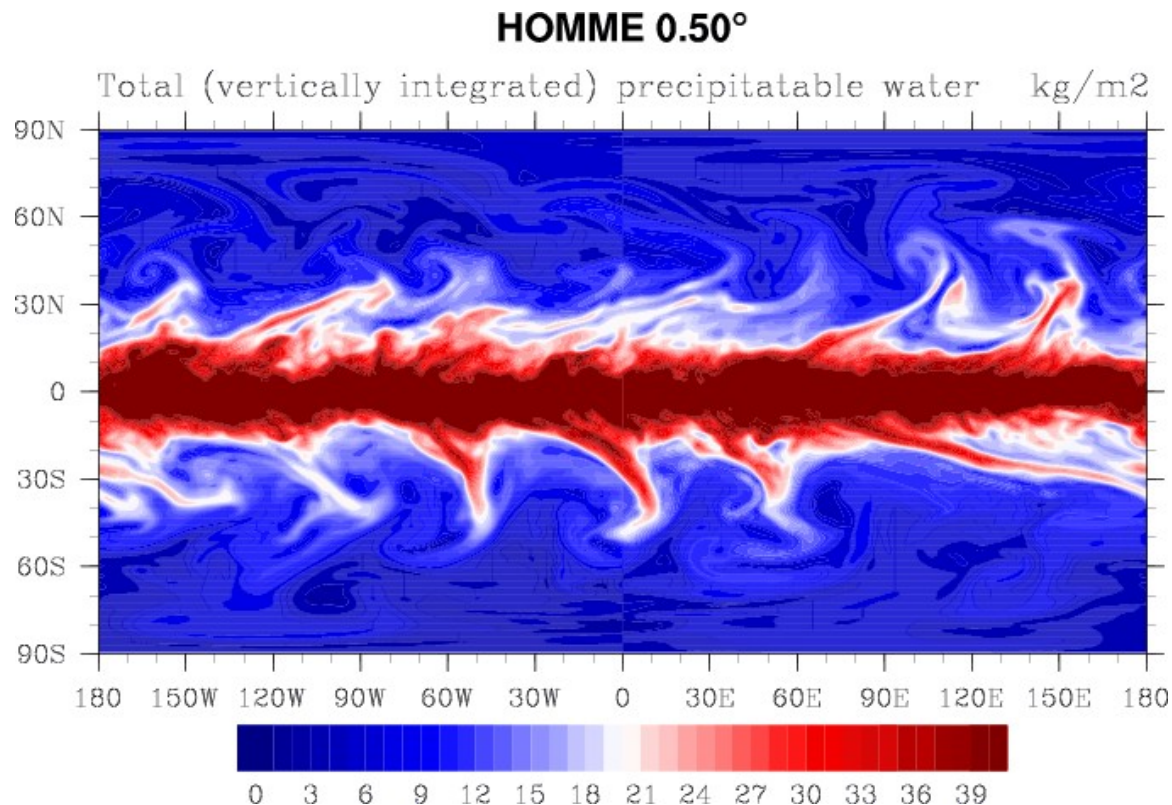
HOMME Spectral Element Dycore

- Finite element method:
 - Naturally handles unstructured grids
 - solves integral formulation of the equations
- Local Conservation of both mass and energy
- Advection does not dissipate KE. All KE dissipation comes from hyperviscosity term
- 4th order accurate
- Tracer advection is oscillatory



Aqua Planet Experiment

- Neale & Hoskins, 2000a: A standard test for AGCMs including their physical parameterizations, *Atmos. Sci. Lett.*
- Williamson, *Convergence of aqua planet simulations with increasing resolution in the Community Atmospheric Model, Version 3*", *Tellus*, under review.



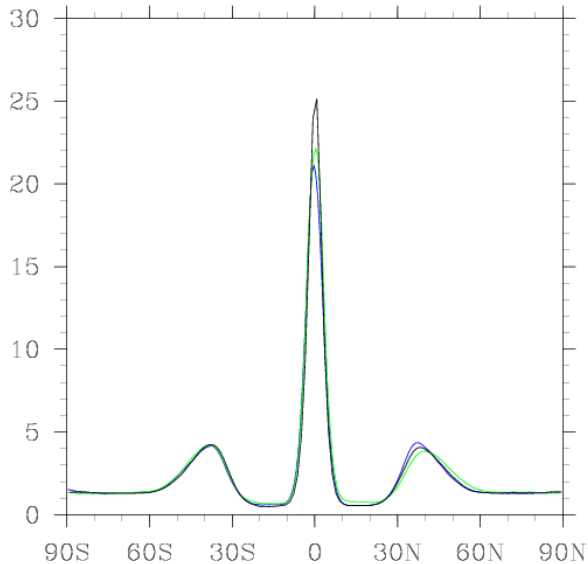
Aqua Planet Experiment: Comparison with Eulerian Dycore

EUL T85 (black)

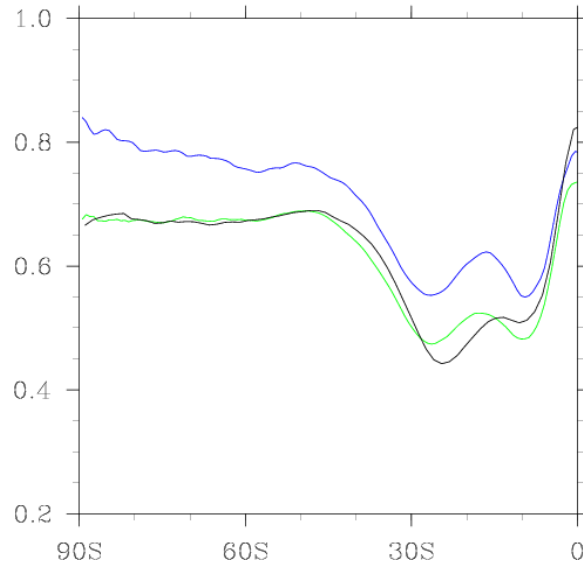
HOMME 1.4 (blue)

HOMME 0.5 (green)

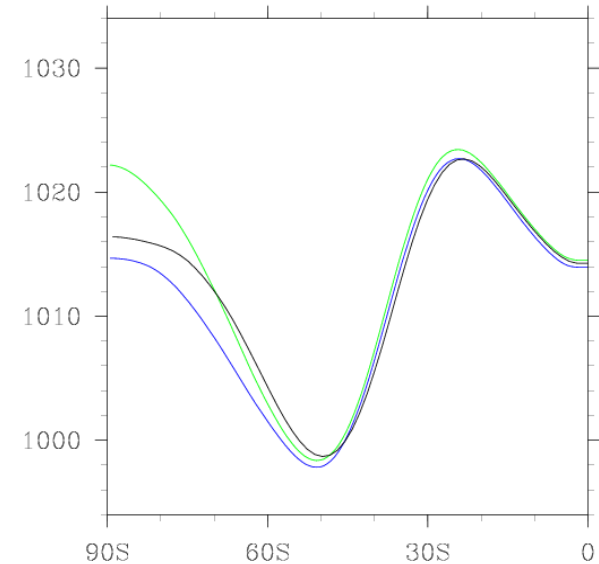
zonal ave PRECT



zonal ave CLDTOT



zonal ave PS



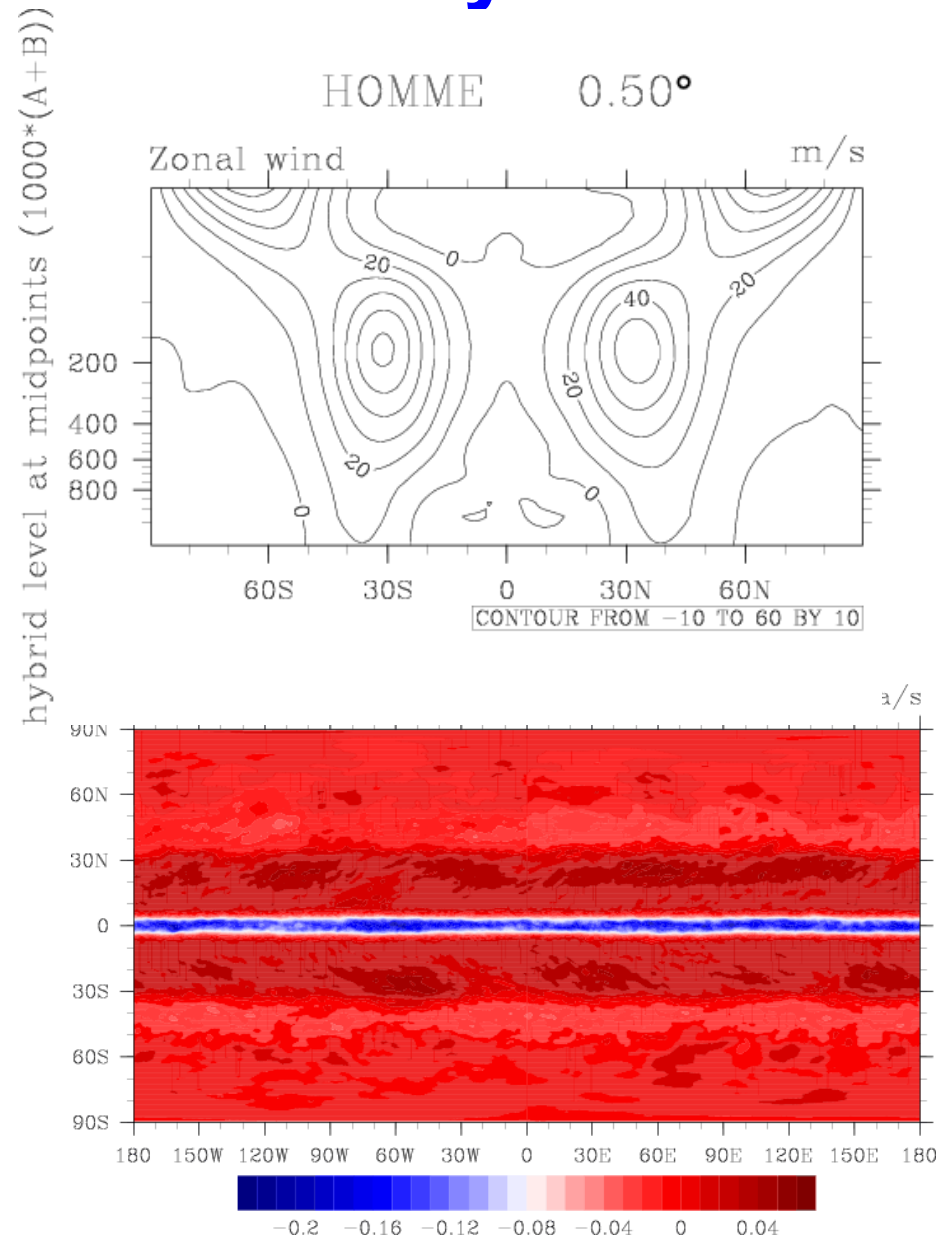
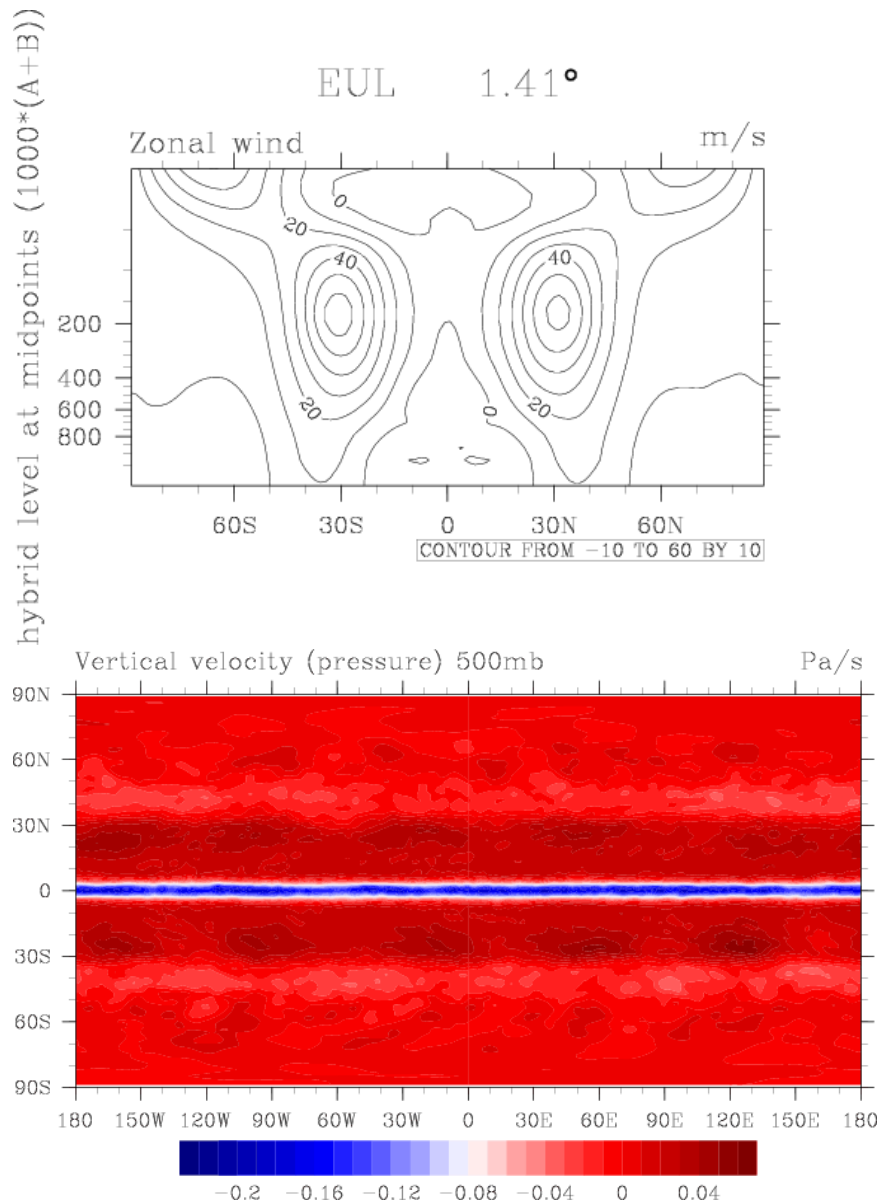
Eulerian

| Resolution | Physics dt | PRECC | PRECL | CLDTOT | TMQ |
|------------|------------|-------|-------|--------|-------|
| T85 | 5m | 1.59 | 1.38 | 0.60 | 19.63 |
| T170 | 5m | 1.44 | 1.62 | 0.55 | 19.13 |
| T340 | 5m | 1.36 | 1.75 | 0.50 | 18.75 |

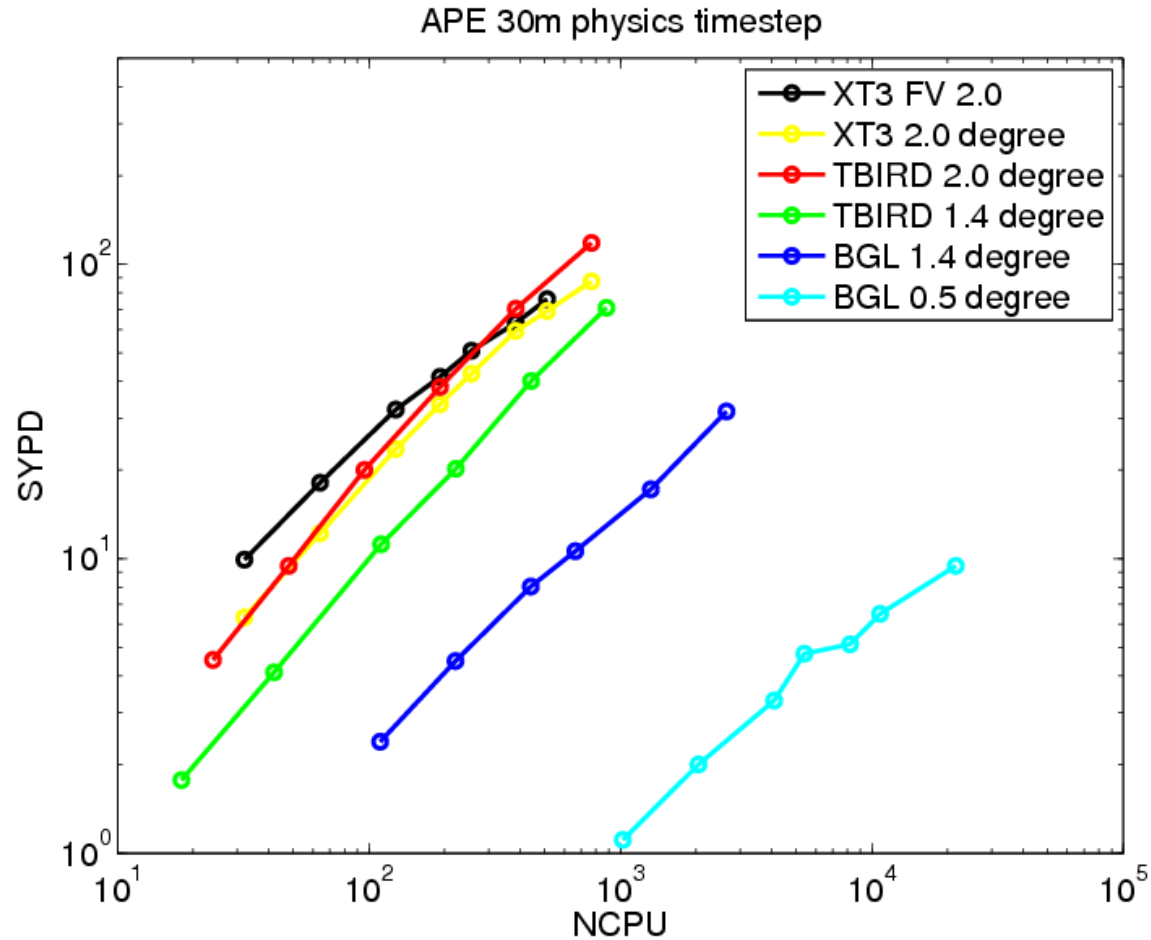
HOMME

| Resolution | Physics dt | PRECC | PRECL | CLDTOT | TMQ |
|------------|------------|-------|-------|--------|-------|
| 1.4 | 4m | 1.62 | 1.35 | 0.66 | 20.00 |
| 0.5 | 5.5m | 1.51 | 1.61 | 0.59 | 19.70 |

Aqua Planet Experiment: Comparison with Eulerian Dycore



Aqua Planet Experiment: Performance Benchmarks



Summary and Future Plans

- CAM/HOMME gives a very reasonable aqua planet simulation
- Excellent scalability, using a single decomposition, down to 9 columns per process
- Next week: 64K processors on LLNL BG/L for 5 days:
 - 0.25 and 0.125 degree APE?
- Cubed-sphere/lat-lon interpolation so we can couple to the land model and data ocean model (to run AMIP simulations)
- Run tracer advection at advective CFL limit (instead of the gravity wave CFL)
- Non-oscillatory advection schemes in HOMME (NCAR: Amik St.Cyr, Ram Nair)