E3SM Chemistry Solver Project Plan at UTK

Joshua Fu

Current Status: ROS2

- ROS2 solver implemented in CESM can save almost half of computation time of the default first-order implicit solver
- The improved computational efficiency of the ROS-2 solver is due to the reuse of the Jacobian matrix and lower upper (LU) factorization during its multistage calculation

$$\frac{\text{Chemistry}}{\text{CAM4\_Chem}} \approx 24\%$$

Saved time: **47%**

Speedup: **1.9×**

$$\frac{\text{Chemical solver}}{\text{Chemistry}} \approx 52\%$$

Solver	Total CPU time for chemistry alone
1 month simulation	
ORI solver	59 hours
ROS-2 solver	**31** hours
1 year simulation	
ORI solver	686 hours
ROS-2 solver	**360** hours

Next Step: MAGMA

- Progress:
  - Chemistry **box model** ported to GPU
  - GPU is 2.33x to 11.7x as fast as CPU for computation alone
  - GPU is 1.29x to 3.82x as fast as CPU for total wall-clock time
  - Potential benefit: Summit architecture provides fast CPU-GPU transfer which can lead to further speedup
- On-going: MAGMA
  - MAGMA: linear algebra library developed by Dr. Jack Dongarra
  - Objective: further speed up E3SM
  - Task: port atmospheric chemistry module to GPU with MAGMA