Efficient Property Preservation in Tracer Transport

Objectives

- Tracer transport is an important component of global climate models.
- Tracer transport is computationally expensive.
- Solve the key challenge of tracer property preservation to enable speeding up tracer transport.

Approach and Results

- Develop methods and s/w (CEDR) that
  - use exactly one communication round to preserve properties and
  - provide strong bounds on tracer adjustment needed to preserve properties.

Impact

- CEDR has been integrated into E3SM.
- CEDR combined with related work on the interpolation semi-Lagrangian (ISL) method gives accurate, fast transport in E3SM Atmosphere.
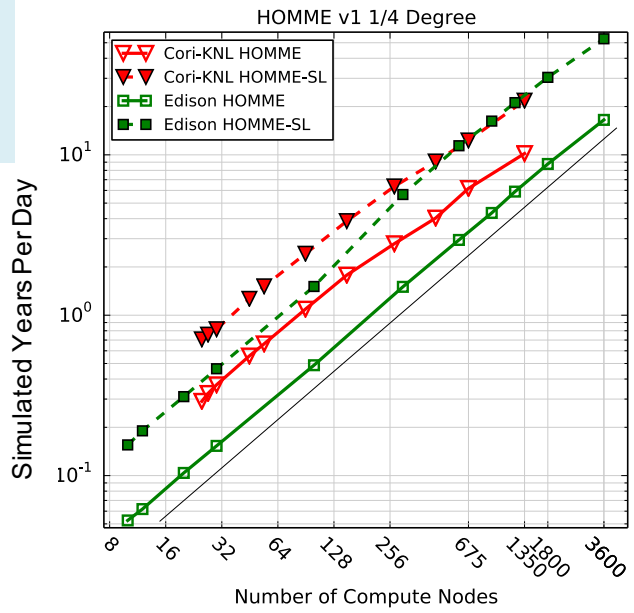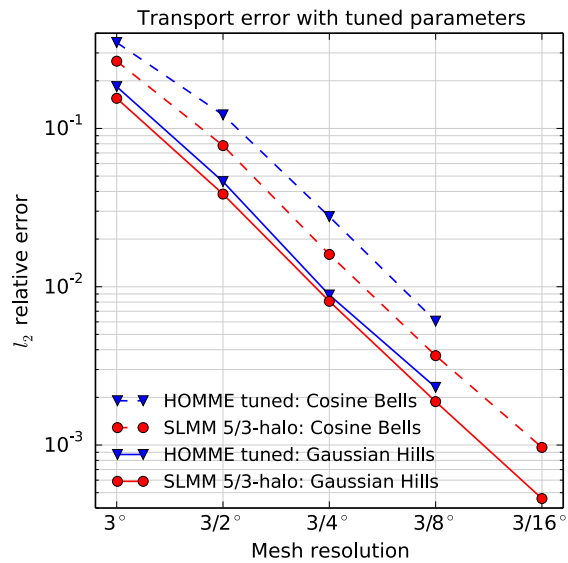

Transport error with tuned parameters

- HOMME tuned: Cosine Bells
- SLMM 5/3-halo: Cosine Bells
- HOMME tuned: Gaussian Hills
- SLMM 5/3-halo: Gaussian Hills

HOMME v1 1/4 Degree

- Cori-KNL HOMME
- Cori-KNL HOMME-SL
- Edison HOMME
- Edison HOMME-SL

Fig 1 (top): ISL+CEDR (labeled as SLMM) is at least as accurate as current best-tuned EAM tracer transport (labeled as HOMME).

Fig 2 (left): EAM dycore with ISL+CEDR (labeled as HOMME-SL) is 2 to over 3 times faster, depending on machine, than EAM dycore with current method, at all levels of scaling.

Bradley, A. M., Bosler, P. A., Guba, O., Taylor, M. A., & Barnett, G. A. (2019). Communication-Efficient Property Preservation in Tracer Transport. *SIAM Journal on Scientific Computing*, *41*(3), C161-C193.