# An Intuitive Error Analysis Framework for Process Coupling Methods

with the PAESCAL Earth System Model Development SciDAC BER/ASCR Partnership

## Scientific Achievement

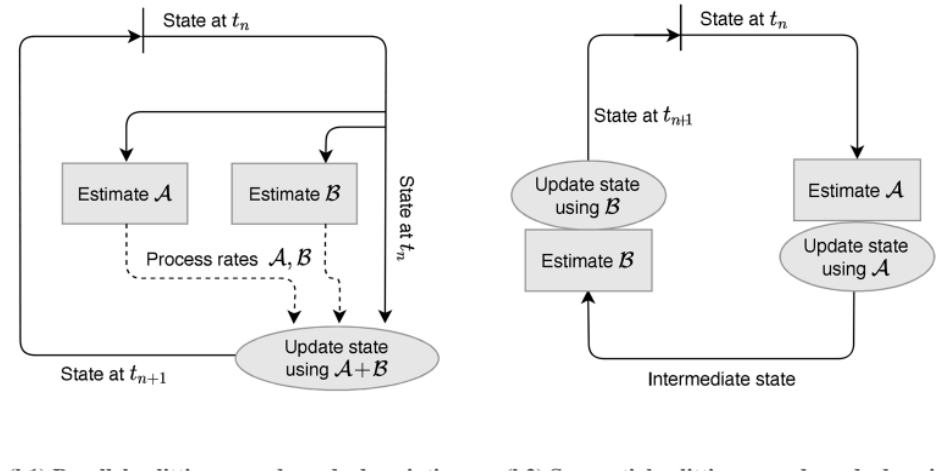
A truncation error analysis framework is introduced to the Earth system modeling community to provide guidance on choosing numerical methods for coupling physics processes in complex models, including DOE's Energy Exascale Earth System Model (E3SM).

## Significance and Impact

- The framework justified a recent change in the numerical coupling of aerosol processes within E3SM that improved the simulated dust lifetime.
- The framework is approachable by Earth scientists, enabling them to evaluate numerical coupling methods by combining their understanding of the physics with rigorous mathematical methods.
- Addressing process coupling error, an important source of numerical error in Earth system models, helps improve the trustworthiness of E3SM's climate predictions.

## Technical Approach

- Treat model equations in a semi-discrete manner that distinguishes splitting error from integration errors of individual processes.
- Demonstrate the impact of two fundamental sources of splitting error: (1) treating processes in isolation and (2) using input that contains error.
- Use estimates of the two fundamental errors as building blocks to derive numerical errors in complex problems




*The analysis framework provides deep insights into the sources of splitting error, and the possible interactions thereof, for coupling methods widely used in Earth system modeling. The insights can be then used as building blocks to assess and design additional methods.*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