ACES4BGC

Applying Computationally Efficient Schemes for BioGeochemical Cycles

The ACES4BGC Project seeks to advance the predictive capabilities of Earth System Models (ESMs) by reducing two of the largest sources of uncertainty, aerosols and biospheric feedbacks, with a highly efficient computational approach. In particular, this project will implement and optimize new computationally efficient tracer advection algorithms for large numbers of tracer species; add important biogeochemical interactions between the atmosphere, land, and ocean models; and apply uncertainty quantification (UQ) techniques to constrain process parameters and evaluate uncertainties in feedbacks between biogeochemical cycles and the climate system.

ACES4BGC Objectives: To advance predictive capabilities of Earth System Models, uncertainties must be reduced while sustaining computational performance. The ACES4BGC project will reduce two of the largest sources of uncertainty, aerosols and biospheric feedbacks, with a highly efficient computational approach. The resulting upgrades to the Community Earth System Model (CESM) will deliver new scientific capabilities, offer unprecedented accuracy in representing biogeochemical interactions, and yield improved predictive skill and computational performance. Specifically, we will 1) develop and deploy a new tracer advection scheme, supporting thousands of reactive and non-reactive chemical species and particles, in atmosphere and ocean models; 2) develop a new reactive transport scheme for land surface and sub-surface water and nutrients; 3) implement new emission schemes for organic compounds, bioparticles, ammonia and other aerosol precursors from the ocean and land models; 4) design and test new methods for multi-phase aerosol chemistry in the atmosphere model, including formation and aging of organic aerosols; and 5) utilize advanced uncertainty quantification (UQ) techniques for parameter sensitivity testing and comparison with observational data sets, including DOE's GOAmazon2014 field campaign. SciDAC Institute researchers will provide scalable geometric transformations, computationally efficient solvers, UQ methods, and tools and techniques for computer performance engineering.

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