Boulder Fluid and Thermal Sciences Seminar Series

Tuesday, November 10, 2015
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado, Boulder

Estimation of Flame Speed Model Parameter Using Ensemble Kalman Filter Algorithm

Xinfeng Gao, *Colorado State University*

It is extremely challenging for CFD modeling to accurately predict the combustion system and its evolution, due to uncertainties of the numerical algorithms, the physical models, and the model parameters used in the equations governing combustion. In addition, initial and boundary conditions are also a source of significant uncertainties that can accumulate over time. This talk will discuss an emerging method by applying data assimilation to the combustion science and engineering for model parameter estimation, and thus the predictions can be improved. Data assimilation, originated from meteorology, oceanography, and climatology, has had dramatic impacts on the improvement of weather forecasts. For CFD modeling of combustion, we believe, by melding observation with model prediction, our understanding of combustion physics and relevant model parameters will be improved. However, numerical challenges arise when applying data assimilation techniques to engineering fluids with combustion, and issues on conservation and preservation of positivity become critical. This talk will illustrate the application by using the Ensemble Kalman Filter (EnKF) algorithm to perform parameter estimation for a flame propagation model. Through this investigation, we have established the proper workflow, identified numerical challenges, and developed techniques to overcome the numerical difficulties. The modified EnKF algorithm will be presented for maintaining conservation and preserving positivity.

Global Climate Impacts of Southern Ocean Shortwave Radiation

Jen Kay, *University of Colorado, Boulder*

A large, long-standing, and pervasive climate model bias is excessive absorbed shortwave radiation (ASR) over the mid-latitude oceans, especially the Southern Ocean. We investigate both the underlying mechanisms for and climate impacts of this bias within a single climate model (CESM-CAM5). Excessive Southern Ocean ASR in CESM-CAM5 results in part because low-level clouds contain insufficient amounts of supercooled liquid. In a present-day atmosphere-only run, an observationally motivated modification to the shallow convection detrainment increases supercooled cloud liquid, brightens low-level clouds, and substantially reduces the Southern Ocean ASR bias. Tuning to maintain global energy balance enables reduction of a compensating tropical ASR bias. In the resulting pre-industrial fully coupled run with a brighter Southern Ocean and dimmer Tropics, the Southern Ocean cools and the Tropics warm. As a result of the enhanced meridional temperature gradient, poleward heat transport increases in both hemispheres (especially the Southern Hemisphere) and the Southern Hemisphere atmospheric jet strengthens. Cross-equatorial heat transport increases in the ocean, but not in the atmosphere. As a result, a proposed atmospheric teleconnection that links Southern Ocean ASR bias reduction and cooling with northward shifts in the Intertropical Convergence Zone is not found. Our work illustrates the power of using observationally constrained climate models to understand the impact of clouds on the large scale atmosphere and ocean circulation.