Radiation, the fundamental energy source for all atmospheric motions, is a particularly important parameterization in an earth system model. The radiation parameterization in version 0 and 1 of the E3SM, known as RRTMG, has become increasingly dated with respect to both the scientific content and the computational practices. Its successor, RTE+RRTMGP, is the default treatment of radiation for the MMF version of the E3SM and is fully integrated into the very high resolution Simple Cloud-Resolving E3SM Atmosphere Model and is being considered for inclusion in v2 or v3 of the E3SM.

This project will implement key improvements to the computational efficiency and capabilities of RTE+RRTMGP to ensure that the radiation code in the E3SM is efficient, accurate, and allows users to address key scientific priorities of the CESD. As in our past DOE-funded work on RTE+RRTMGP, our development will involve extensive interactions with the E3SM computational and scientific staff and will proceed collaboratively with the E3SM team. We will focus on the following tasks:

* Develop and/or collaborate on new computational kernels, including CUDA and OpenMP, to improve efficiency with existing hardware and meet new computational platforms as they are acquired or considered by DOE
* Extend and maintain a C++ front end to RTE and RRTMGP suitable for use in SCREAM (Simple Cloud-Resolving E3SM Atmosphere Model), the ultra high-resolution version of E3SM
* Develop alternative sets of spectral data with varying spectral detail and sensitivity so that users of E3SM can balance computational cost against application-specific needs
* Enhance the accuracy of RTE+RRTMGP by
* treating the first-order effects of a spherical atmosphere, including refraction and extended path lengths, in calculations of the direct solar beam
* accounting for correlations between gases and clouds in the spectral dependence of scattering and absorption
* Investigate alternative spectral band structures for RRTMGP to better represent radiation within vegetation canopies and the ocean
* Potentially regenerate gas absorption data used by RRTMGP to be consistent with updated spectroscopic knowledge.