Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Direct Numerical Simulation of Coupled Convection and Radiation on Heterogeneous Computing Architectures SIMONE SILVESTRI, RENE PECNIK, DIRK ROEKAERTS, Delft University of Technology — When dealing with high temperature applications, thermal radiation plays an important role in the heat transfer process. In particular, due to its non-locality, radiation causes counter-intuitive interactions with the turbulent temperature field. These so called turbulence-radiation interactions (TRI) greatly modify the well-known patterns of heat transfer and variable property turbulence. The solution of the radiative transfer problem on fine grids is notoriously challenging, especially for optically intermediate systems; we implemented an innovative approach which exploits heterogeneous high performance computing facilities. The Navier-Stokes equations are solved on CPUs, and the radiative transfer equation is solved on GPUs using an optimized Monte Carlo method. With our method it is possible to access the whole description of TRI in a direct numerical simulation framework. We applied the algorithm to a thermally developing turbulent channel flow of high temperature water vapor to study the interaction between the different heat transfer mechanisms. With the obtained results we were able to identify the destruction of turbulent convection caused by radiative damping of thermal fluctuations and relate it to the dimension of the thermal scales within the flow.

Simone Silvestri
Delft University of Technology

Date submitted: 31 Jul 2019 Electronic form version 1.4