Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Modeling wall-bounded flows at transcritical conditions PETER MA, XIANG YANG, MATTHIAS IHME, Stanford Univ — At supercritical pressures, the transition of a fluid from a liquid-like state to a gas-like state occurs continuously, during which process all fluid properties change drastically. In this work, we conduct direct numerical simulation of a channel flow at transcritical conditions with two walls kept at temperatures above and below the pseudo-boiling temperature, which is defined as the temperature of maximum heat capacity. The density change is up to a factor of 20 from the cooled wall to the heated wall. Using the DNS data, we test the usefulness of the mixing length theory and the Townsend attached eddy hypothesis in the context of variable property flows, both of which have received considerable empirical support at regular conditions. It is found that the mean flow can still be modeled with the conventional mixing length model if the fluid density at the wall is used for computing the eddy viscosity. Besides, the streamwise energy spectrum exhibits the celebrated $1/k$ scaling across an extended range of scales where k is the streamwise wave number, which provides strong support to the attached eddy model at transcritical conditions.

Peter Ma
Stanford Univ

Date submitted: 30 Jul 2017 Electronic form version 1.4