Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

An Assessment of the Reynolds Analogy in Predicting Heat Transfer in Turbulent Flows of Low Prandtl Numbers MATTHIAS ZIEFUSS, AMIRFARHANG MEHDIZADEH, Civil and Mechanical Engineering Department, School of Computing and Engineering, University of Missouri-Kansas City — Heat transfer modeling plays a major role in design and optimization of modern and efficient cooling systems. However, currently available models suffer from a fundamental shortcoming: their development is based on the general notion that an accurate prediction of the flow field will guarantee an appropriate prediction of the thermal field, known as the Reynolds Analogy. This analogy works reasonably well when applied to fluids with a Prandtl number around unity to obtain first order statistics. Concerning fluids with non-unity Prandtl number, there is no comprehensive assessment available. Thus, this investigation presents an introductory assessment of the capability of the Reynolds Analogy when applied to turbulent shear flows of fluids with small Prandtl number. The assessment includes steady and unsteady state simulations. In case of steady state simulations, it turns out that the Reynolds Analogy is not able to predict the mean temperature at an acceptable level of accuracy, while second order statistics are severely mispredicted. In case of unsteady simulations, it is shown that the Reynolds Analogy cannot be considered as an appropriate sub-grid scale model as it fails to feature basic properties of a reliable sub-grid scale model.

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Date submitted: 01 Aug 2019 Electronic form version 1.4