Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Parameterization of Turbulence, Heat Transfer and Spatial Characterization for Utility-Scale Solar Farms[1] SARAH E. SMITH, ANDREW GLICK, Portland State University, BROOKE J. STANISLAWSKI, University of Utah, NASEEM ALI, JULIAAN BOSSUYT, Portland State University, MARC CALAF, University of Utah, RAL BAYON CAL, Portland State University — Solar panels suffer efficiency loss from high panel temperatures with extended sun exposure and internal heating. Studies show convective mitigation is achieved with induced turbulence and altered array configuration. However, current understanding oa array flow behavior lacks quantification to fully inform solar farm design. This work explores parametrization of flow dynamics and thermal effects in solar arrays toward predictive model development related to spatial variation and experimental data. Wind tunnel experiments were performed on 4x10 panel solar arrays, varying unit height and angle, subjected to imposed panel heating (Φ_q = 450-1050 W/m^2) and inflow conditions ($Re_L = 2.7 * 10^3$-$12 * 10^3$; TI =11%-18%). Thermal data were obtained via panel-mounted thermocouples, and flow behavior was captured with particle image velocimetry (PIV). Inspired by forest canopy research, variations of K-ε modeling are applied to flow parameters, finding scale-dependent closure quantities tailored to solar farms. Results are related to spatial heterogeneity via two-dimensional (2D), lacunarity-based analysis projected in 3D space. Continued work compares spatial distribution to configuration-dependent convective behavior, determining relative effects on panel cooling.

[1]This material is based on work supported by U.S. Dept of Energy

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Date submitted: 03 Aug 2020 Electronic form version 1.4