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Radiative heating of inertial particles in a turbulent square duct flow ANDREW BANKO, LAURA VILLAFANE, CHRISTOPHER ELKINS, JOHN EATON, Stanford University — The coupled dynamics of small inertial particles, turbulence, and radiative heating is examined experimentally. A vertically downward airflow with Reynolds number of order 10,000 is laden with disperse Nickel particles which are smaller than all flow length scales. The particles have Stokes numbers of order 10 and the thermal time constant is similar to the aerodynamic time constant. This particle-air mixture is exposed to monochromatic near infrared radiation through one wall of the duct. While the gas and walls are nearly transparent to the incident radiation, the particles absorb energy and heat the gas with a spatial distribution dependent on the particle concentrations. The mass loading ratio of particles is varied in order to study the effect of increasing optical depth on the gas temperature rise. A fine wire thermocouple is used to measure the mean gas temperature variation along the full width of the duct, including the near wall region where particle concentrations mildly increase. Total energy absorption is inferred from measurements of transmitted light intensity. Comparisons are made to a 1-D model which assumes homogeneity of all flow quantities, low optical depth, and ignores preferential concentration.

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