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Direct Numerical Simulations of Fully Developed Turbulent Channel Flow with Evaporation of Spatially Resolved Droplets GIANDOMENICO LUPO, KTH, ANDREA GRUBER, SINTEF, CHRISTOPHE DUWIG, KTH — We perform direct numerical simulations (DNS) of more than 14000 cold spherical droplets evaporating in hot turbulent channel flow ($Re_\tau = 180$, 5% initial liquid volume fraction), at conditions representative of industrial applications. Four-way coupling of the droplet motion with the turbulent carrier phase and interface-resolved evaporation dynamics allow us to fully describe the intra- and inter-phase exchange of heat, species and momentum transfer, at all relevant scales of motion. We analyze the modulation of turbulence by the dispersed phase, and the associated migration of the droplets towards the channel centreline. The redistribution of the droplets has a strong impact on the evaporation dynamics, which we characterize by the joint probability density function of the evaporation rate and the droplet distance from the wall. This leads to an inquiry of the feasibility of film theory for modelling the present evaporation regime, and the definition of an appropriate nondimensional parameter for the scaling of the evaporation rate (correlation of Sherwood number). Finally, we investigate the influence of the energy boundary condition (adiabatic vs. isothermal walls) on the evaporation dynamics.

Giandomenico Lupo
KTH

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