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Flow over and within large-scale porous topography: Impact of surface heterogeneity on turbulence structure ALI M. HAMED, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, PRATEEK RANJAN, MATTHEW J. SADOWSKI, University of Illinois at Urbana-Champaign, HEIDI M. NEPF, Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, LEONARDO P. CHAMORRO, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign
— An experimental investigation of the flow within and above model canopies was carried out to determine the effect of canopy height heterogeneity on the structure and spatial distribution of the turbulence. Two 800 mm long models with 20% blockage were placed in a 2.5 m long refractive-index-matching channel. The first model (base case) is constituted of equal height (h) square bar elements arranged in a staggered configuration. The other model bars had two heights (h+1/3h and h-1/3h) alternated every two rows. Particle image velocimetry was used to map the flow field at three locations spanning the length of the canopy under three confinement ratios H/h=2, 3, and 4, where H is the free surface height. The experiments were performed at Reynolds number Re_H = 6800, 10200, and 13600. Refractive index matching renders the canopy invisible and grants full optical access allowing the flow field within the canopy to be measured by PIV. Turbulence statistics complemented with POD, quadrant analysis, and LES decomposition reveal the distinctive effect of the height heterogeneity on the shear layer that forms on top of the canopy, and on the free flow over the canopies.

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