Geophysical Research Abstracts
Vol. 19, EGU2017-767, 2017
EGU General Assembly 2017

Flow and Turbulence Structure of a Shallow Mixing Layer Developing over 2-D Dunes

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Results of a high resolution Detached Eddy Simulation (DES) are used to characterize the evolution of a shallow mixing layer developing between two parallel streams in a long open channel over two-dimensional (2D) dunes. The study discusses the vertical non-uniformity in the mixing layer structure and provides a quantitative characterization of the growth of the large-scale quasi 2D coherent structures with the distance from the splitter plate. The presence of large-scale roughness elements in the form of an array of two-dimensional dunes with a maximum height of 0.25D (D is the channel depth) induces a very rapid and larger shift of the centerline of the mixing layer due to the increased influence of the bottom roughness. Results show that in streamwise sections situated after 100D (D is the channel depth) from the splitter plate, the width of the mixing layer close to the free surface stays constant. The tilting of the mixing layer interface toward the low speed stream is observed as the free surface is approached in all vertical sections. Consistent with visualizations of the mass transport of a passive scalar within the mixing layer, close to the free surface, the estimated streamwise length of the quasi 2D mixing layer eddies is about 1.5 to 2.0 times larger than the local width of the mixing layer.