Particle Image Velocimetry Measurements of the Flow over Barnacles in a Turbulent Boundary Layer

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HIGHLIGHTS

• High resolution 2d-PIV was employed to study the flow over barnacles immersed in a turbulent boundary layer flow, and measurements were performed in the streamwise—wall-normal plane (x – y).
• Two barnacles configuration were investigated: isolated barnacle and regular, staggered array of barnacles with planform density of \( \lambda_p = 0.20 \).
• Mean flow structures between these two configurations are strikingly similar for the flow near the element
• Quadrant analysis, when only considering the strongest Reynolds shear stress events, highlights important differences between the two investigated configurations.
• This events are linked to larval dispersal and waste removal \((Q_2)\) and food supply and larval settlement \((Q_4)\).

ABSTRACT

Barnacles are suspension-feeding crustaceans found in saline waters. These fouling organisms can grow on the hull of marine ships, thus having a significant impact on their performance. The presence of barnacles dramatically increases the frictional drag and consequently has drastic negative economic implications. High-resolution PIV is used to measure the flow over barnacles immersed into a turbulent boundary layer. Two configurations were investigated - i) single-barnacle configuration and ii) a regular, staggered array of barnacles. Mean flow quantities between these two configurations are strikingly similar when visualizing the flow around an individual element. Quadrant analysis revealed important structural behavior, especially when only considering the strongest Reynolds Shear Stress events. These events are likely linked to contribute to both larval settlement and waste removal.

Fig. 1 Left panel illustrate the barnacle arrangement. Center and right panels show the mean velocity fields for single-barnacle and barnacle array configuration, respectively, where the top shows the streamwise velocity and the bottom the wall-normal velocity.