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Transition from downward to upward air-sea momentum transfer in swell-dominated light wind condition

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Atmospheric and surface wave data from two oceanic experiments carried out on FLIP and ASIS platforms are analysed in order to identify swell-related effects on the momentum exchange during low wind speed conditions. The RED experiment was carried out on board an R/P Floating Instrument Platform, FLIP, anchored north east of the Hawaiian island Oahu with sonic anemometers at four levels: 5.1 m, 6.9 m, 9.9 m and 13.8 m respectively. The meteorological conditions were characterized by north- easterly trade wind and with swell present during most of the time. During swell the momentum flux was directed downwards meaning a positive contribution to the stress. The FETCH experiment was carried out in the Gulf of Lion in the north-western Mediterranean Sea. On the ASIS (air-sea interaction spar) buoy a sonic anemometer was mounted at 7 m above the mean surface level. During strong swell conditions the momentum flux was directed upwards meaning a negative contribution to the stress in this case. The downward momentum flux is shown to be a function of the orbital circulation while the upward momentum flux is a function of wave height. The dividing wind speed is found to be 3.5 m/s
Conclusion: Wind speed > 3.5 m/s creates waves (ripples) and thus roughness. Combination of orbital motion and asymmetric structure of ripples lead to flow perturbation and downward transport of negative momentum.
With low wind speed (no ripples but viscosity) circulations will form above the crest and the trough with opposite direction which will cause a pressure drop in the vertical direction and an upward momentum transport from the water to the air.