Bubble plumes play a significant role in the air–sea interface by influencing processes such as air–sea gas exchange, aerosol production, modulation of oceanic carbon and nutrient cycles, and the vertical structure of the upper ocean. Using acoustic Doppler current profiler (ADCP) data collected off the west coast of Ireland, we investigate the dynamics of bubble plumes and their relationship with sea state variables. In particular, we describe the patterns of bubble plume vertical extension, duration, and periodicity. We establish a power-law relationship between the average bubble penetration depth and wind speed, consistent with previous findings. Additionally, the study reveals a significant association between whitecapping coverage and observed acoustic volume backscatter intensity, underscoring the role of wave breaking in bubble plume generation. The shape of the probability distribution of bubble plume depths reveals a transition toward stronger and more organized bubble entrainment events during higher wind speeds. Furthermore, we show that deeper bubble plumes are associated with turbulent Langmuir number around 0.3, highlighting the potential role of Langmuir circulation on the transport and deepening of bubble plumes. These results contribute to a better understanding of the complex interactions between ocean waves, wind, and bubble plumes, providing valuable insights for improving predictive models and enhancing our understanding of air–sea interactions.