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Deep-water bedforms induced by refracting Internal Solitary Waves

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Subaqueous bedforms (or sand waves) are typically observed in those environments that are exposed to strong currents, characterized by a dominant unidirectional flow. However, sand-wave fields may be also observed in marine environments where no such current exists; the physical processes driving their formation are enigmatic or not well understood. We propose that internal solitary waves (ISWs), induced by tides, can produce an effective, unidirectional boundary flow filed that forms asymmetric sand waves. We test this idea by examining a sand-wave field off the Messina Strait, where we hypothesize that ISWs formed at the interface between intermediate and surface waters are refracted by topography. Hence, we argue that the deflected pattern (i.e. the depth-dependent orientation) of the sand-wave field is due to refraction of such ISWs. Combining field observations and numerical modelling, we show that ISWs can account for three key features: ISWs produce fluid velocities capable of mobilizing bottom sediments; the predicted refraction pattern resulting from the interaction of ISWs with bottom topography matches the observed deflection of the sand waves; and predicted migration rates of sand waves match empirical estimates. This work shows how ISWs may contribute to sculpting the structure of continental margins and it represents a promising link between the geological and oceanographic communities.