Geophysical Research Abstracts
Vol. 14, EGU2012-13890, 2012
EGU General Assembly 2012

On the wavelength of self-organized shoreline sand waves

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Shoreline sand waves are undulations of the shoreline that extend into the bathymetry up to a certain depth. Here we will focus on self-organized sand waves that form due to shoreline instability in case of very oblique wave incidence (Ashton et al., 2001). The model of Ashton and co-authors did not predict any wavelength selection for the emerging sand waves whereas Falqués and Calvete (2005) predicted a wavelength selection in the range 4-15 km. This difference is attributable to that Falqués and Calvete (2005) computed wave refraction and shoaling over the actual curvilinear depth contours while Ashton et al. (2001) assumed locally rectilinear and parallel contours. Although there exist shoreline features at a larger scale (Ashton et al. 2001; Falqués et al. 2011) sand waves at a few km scale are more common (Ruessink and Jeuken, 2002; Davidson-Arnott and van Heyningen, 2003; Falqués et al., 2011; Medellin et al., 2008) . While their characteristic wavelength is a robust model output (Falqués and Calvete, 2005; Uguccioni et al., 2006; van den Berg et al., 2011) the physical reasons for the existence of a wavelength selection are still unknown. Furthermore, the parameter dependence of the dominant wavelength, L_m, is largely unexplored. In particular, the disparity between the large length scale of sand waves and the relevant length scales of the problem: width of the surf zone, water wave wavelength, etc. is intriguing. The aim of the present contribution is to gain insight into those physical reasons and the dependence of L_m on beach profile and water wave properties.

The essence of sandwave behaviour can be captured with the simple one-line shoreline modelling concept by looking at the alongshore position of the maximum in total transport rate Q, which is here investigated with both the linearized model of Falqués and Calvete (2005) and the nonlinear model of van den Berg et al. (2011) . It is found that the position of that maximum is largely controlled by the alongshore distribution of wave energy associated to the sand wave, mainly affected in turn by : A) refractive wave energy spreading and B) refractive energy focusing by the crest. Furthermore, for large L the growthrate decreases to 0 since the gradients in wave energy and hence the gradients in Q decrease. As a result, there is a minimum wavelength, L_c, for growth and an optimum wavelength $L_m > L_c$of maximum growth. Experiments with different bathymetric profiles and different wave conditions are made to investigate the sensitivity of L_m . It is found that L_m scales with λ_0/β where λ_0 is the water wave wavelength in deep water and β the beach slope.

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