Parameterization of bedform morphology and defect density with fingerprint analysis techniques

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Link to full paper: http://www.sciencedirect.com/science/article/pii/S0278434311002603

Received 27 January 2011; revised 15 July 2011; Accepted 21 July 2011. Available online 28 July 2011.

Abstract

A novel method for parameterizing the morphology of seafloor ripples with fingerprint analysis numerical techniques is presented. This fully automated analysis tool identifies rippled areas in two-dimensional imagery of the seafloor, and returns ripple orientation and wavelength as well as a new morphological parameter, the spatial density of ripple defects. In contrast to widely used manual and spectral parameterization methods, this new technique yields a unique probability distribution for each derived parameter, which describes its spatial variability across the sampled domain. Here we apply this new analysis technique to synthetic and field collected side-scan sonar seafloor images in order to assess the methods capacity to define bed geometry across a wide range of simulated and observed morphological conditions. The resulting orientation and wavelength values compare favorably with those of the existing manual and spectral parameterization methods, and are superior under environmental conditions characterized by low signal to noise ratios as well as high planform ripple sinuosity. Furthermore, the resulting ripple defect density values demonstrate correlation with ripple orientation, wave direction, and the Shields parameter, which is consistent with recent investigations that have theoretically linked this parameter to hydrodynamic forcing conditions. The presented fingerprint analysis method surpasses the capacity of existing methods for ripple parameterization and promises to yield greater insight into theoretical and applied problems associated with the temporal and spatial variability of ripple morphology across a wide spectrum of marine environments.

Highlights

► Fingerprint analysis technique applied to ripple morphology parameterization. ► Method identifies rippled areas in seafloor images. ► Wavelength and orientation results agree with existing parameterization methods. ► Parameter spatial variability correlates with observed hydrodynamic forcing. ► Density of identified ripple defects correlates with observed hydrodynamic forcing.

Keywords: Ripple; Fingerprint; Bedform; Morphodynamics; Sediment; Parameterization

Continental Shelf Research
Volume 31, Issue 16, 15 October 2011, Pages 1688–1700