Geophysical Research Abstracts,
Vol. 11, EGU2009-1546, 2009
EGU General Assembly 2009

Regularized reconstruction of wave fields from refracted images of water

K. Roy Choudhury (1), F. O'Sullivan (1), M. Samanta (1), V. Shrira (2), and G. Caulliez (3)

(1) University College Cork, Statistics, Ireland (kingshuk@stat.ucc.ie), (2) Dept. of Mathematics, Keele University, U.K., (3) IRPHE, Marseille, France

Refractive imaging of wave fields is often used for observation of short gravity and gravity-capillary waves in wave tanks and in the field. A light box placed under the waves emits light of spatially graduated intensity. The refracted light intensity image recorded overhead can be related to the wave slope field using a system of equations derived from the laws of refraction. Previous authors have proposed a two stage reconstruction strategy for the recovery of wave slope and height fields: i) estimation of local slope fields ii) global reconstruction of height and slope fields using local estimates. Our statistical analysis of local slope estimates reveals that estimation error variability increases considerably from the bright to the dark ends of the imaging area, with some concomitant bias. The reconstruction problem behaves like an ill posed inverse problem in the dark areas of the image. Illposedness is addressed by a reconstruction method that imposes Tikhonov regularization of directional wave slopes using penalized least squares. Other refinements proposed include a) bias correction of local slope estimates b) spatially weighted reconstruction using estimated variability of local slope estimates and c) more accurate estimates of reference light profiles from time sequence data. A computationally efficient algorithm that exploits sparsity in the resulting system of equations is employed to evaluate the regularized estimator. Simulation studies show that the refinements can result in substantial improvements in the mean squared error of reconstruction. The algorithm is applied to obtain wave field reconstructions from video recordings. Analysis of various video sequences demonstrates distinct spatial patterns at different wind speed and fetch combinations.