Geophysical Research Abstracts
Vol. 15, EGU2013-8143, 2013
EGU General Assembly 2013

Direct measurement of nonlinear dispersion relation for water surface waves

Tore Magnus Arnesen Taklo (1), Karsten Trulsen (1), Harald Elias Krogstad (2), Odin Gramstad (1), José Carlos Nieto Borge (3), and Atle Jensen (1)

(1) University of Oslo, Department of Mathematics, Norway, (2) Department of Mathematical Sciences, Norwegian University of Science and Technology, Norway, (3) Department of Signal Theory and Communications, University of Alcalá, Spain

The linear dispersion relation for water surface waves is often taken for granted for the interpretation of wave measurements. High-resolution spatiotemporal measurements suitable for direct validation of the linear dispersion relation are on the other hand rarely available. While the imaging of the ocean surface with nautical radar does provide the desired spatiotemporal coverage, the interpretation of the radar images currently depends on the linear dispersion relation as a prerequisite, (Nieto Borge et al., 2004).

Krogstad & Trulsen (2010) carried out numerical simulations with the nonlinear Schrödinger equation and its generalizations demonstrating that the nonlinear evolution of wave fields may render the linear dispersion relation inadequate for proper interpretation of observations, the reason being that the necessary domain of simultaneous coverage in space and time would allow significant nonlinear evolution. They found that components above the spectral peak can have larger phase and group velocities than anticipated by linear theory, and that the spectrum does not maintain a thin dispersion surface.

We have run laboratory experiments and accurate numerical simulations designed to have sufficient resolution in space and time to deduce the dispersion relation directly. For a JONSWAP spectrum we find that the linear dispersion relation can be appropriate for the interpretation of spatiotemporal measurements. For a Gaussian spectrum with narrower bandwidth we find that the dynamic nonlinear evolution in space and time causes the directly measured dispersion relation to deviate from the linear dispersion surface in good agreement with our previous numerical predictions.

This work has been supported by RCN grant 214556/F20.

Krogstad, H. E. & Trulsen, K. (2010) Interpretations and observations of ocean wave spectra. Ocean Dynamics 60:973-991.

Nieto Borge, J. C., Rodríguez, G., Hessner, K., Izquierdo, P. (2004) Inversion of marine radar images for surface wave analysis. J. Atmos. Ocean. Tech. 21:1291-1300.