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Experimental validation of the linear dispersion relation, application to the interpretation of radar images

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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.

Recently we carried out numerical simulations 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 (Krogstad & Trulsen 2010). We found that components above the spectral peak can have larger phase and group velocities than anticipated by linear theory, and the spectrum does not maintain a thin dispersion surface.

We have tested this numerical prediction with laboratory experiments designed to give sufficient resolution in space and time to validate the dispersion relation directly for nonlinear wave fields.

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