On relaxation due to nonlinear transfer in the wind-wave spectra

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We inspect the role of nonlinear transfer for different stages of wind-wave development and different conventional parameterizations of spectral shapes and angular distributions (e.g. *Hasselmann et al.*, 1973). The snapshots of the term of nonlinear transfer S_{nl} in the Hasselmann equation (*Hasselmann*, 1962) for spectral density of wave action $N_{\mathbf{k}}$ written as

$$\frac{\partial N_{\mathbf{k}}}{\partial t} + \nabla_{\mathbf{k}}\omega_{\mathbf{k}}\nabla_{\mathbf{r}}N_{\mathbf{k}} = S_{in}\left[N_{\mathbf{k}}\right] + S_{diss}\left[N_{\mathbf{k}}\right] + S_{nl}\left[N_{\mathbf{k}}\right] \tag{1}$$

are compared with ones of wind input S_{in} and wave dissipation S_{diss}. The key point of our analysis is representation of S_{nl} in the form of relaxation term (see *Zakharov*, 2010; *Zakharov and Badulin*, 2011)

$$S_{nl} = F_{\mathbf{k}} - \Gamma_{\mathbf{k}}N_{\mathbf{k}}$$

($F_{\mathbf{k}}$ – nonlinear forcing, $\Gamma_{\mathbf{k}}$ is nonlinear damping) and comparison of relaxation rate $\Gamma_{\mathbf{k}}$ with its quasi-linear counterparts of wind generation and dissipation. It is shown that the relaxation rate is generally one order higher as compared to ones of generation/dissipation for growing waves. Surprisingly, this is a case of fully-developed (mature) sea represented by the Pierson-Moskowitz spectrum as well. Even for mature seas when wind input and wave dissipation are responsible for arrest of wave spectra downshift and integral growth the relaxation due to nonlinear transfer continues to dominate and determine spectra shaping.

References

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