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Comment

Interactive comment on “Imbalance of energy and momentum source terms of the sea wave transfer equation for fully developed seas” by G. V. Caudal

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The paper shows that when integrated over the whole wave spectrum standard models of wave growth and decay cannot conserve both energy and momentum. It then proposes a non-linear transfer process, which by itself cannot conserve both energy and momentum, to give overall conservation.

My problem with this is that energy and momentum are quantities which must be conserved in each stage of the process. We also have the fact that at a given wavenumber the ratio of the energy to the momentum of the wave is fixed. So if one physical process is adding energy at this wavenumber and another is taking it away at the same wavenumber the ratio of the energy to momentum transfers must be the same.

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It means that at a given wavenumber, momentum and energy should always be compatible. So when integrated over the whole spectrum they should still be compatible.

So where is the catch?

I think that the clue is in the proposed solution - which is to add another term transferring energy to low wavenumbers. If I remember the theory correctly this will transfer a large fraction of the energy to low wavenumbers but only a small fraction of the momentum. For a proper physical process there would need to be another term transferring the remaining energy and momentum either to short waves or to the mean current. In the latter case there will be some residual energy showing up as turbulence and heat.

However this is just what the non-linear terms do anyway. So I suspect that if they have also been calculated in this paper, the situation at low wavenumbers would be better balanced but there would then be too much energy at high wavenumbers.

The paper's conclusion might then be that the spectrum is wrong or that a new short wavelength wave damping mechanism is required. Of the two I would suspect that the standard theory underestimates the decay rate of short waves. In wave prediction models any unwanted short wavelength energy is probably damped out by the numerics. At sea I see many short breaking waves (usually on the crests of long waves) which probably have too short a lifetime to be captured by wave spectra.

In conclusion I think that the paper is useful in that it points out the problems that can arise in conserving both momentum and energy when using off the shelf formula. However I do not think the proposed new mechanism is correct. Also before publication I think that it needs to include the non-linear terms and to show in wavenumber space where the imbalances are occurring.

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