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Theoretical description of breaking crests distributions measured in field conditions

Alexey Mironov
LATMOS, CNRS/Université de Versailles Saint Quentin, Guyancourt, France

Breaking wind waves play an important role for the majority of upper-ocean processes. Detailed description of physics related to breaking waves is necessary for the correct description of heat, mass, air exchange, wind wave dissipation, sea spray generation etc. Breaking waves and whitecap foam are also important source of information for the ocean remote sensing methods.

"Lambda distribution" ($\Lambda(c)$) concept introduced by Phillips (1985) provides a way to link wind wave spectra and various important measures of the air-sea interface processes related to wave breaking. Radar backscattering due to wave breaking, turbulent mixing in the uppermost sea layer, production of sea drops in the near water atmospheric layer and other phenomena were recently studied on the basis of this approach.

However, results of field measurements of visible breaking crests appeared to be different from the form predicted by Phillips (1985). Most of the experimental $\Lambda(c)$ has clear maximum (phase velocities $c \approx$ 1.5 - 2 m) and decay with phase velocity at the short scale spectral bandwidth. The descending c^{-6} shape only observed at the large scales.

Current work represents an attempt to describe experimental whitecap distributions in terms of Phillips's (1985) equilibrium spectrum approach. Significant part of small scale breaking events do not produce visible foam patch and can not be detected with traditional video observation methods. At this work modified $\Lambda(c)$ function proposed which describes only visible breaking events and can be directly compared with available field observations.

All theoretical calculations were compared with empirical $\Lambda(c)$ distributions obtained during experimental campaigns on the Black Sea research platform of Marine Hydrophysical Institute (National Academy of Sciences of Ukraine). Simultaneous whitecap video observations and wave 2D-spectra measurements were obtained under variety of wave and wind conditions.

Breaking crests distributions and total breaking crests length values calculated from the spectrum of wind waves are in a good quantitative agreement with experimental data. Phase velocity of breaking waves of the maximum of $\Lambda(c)$ distributions is proportional to friction velocity. This analytical result fully confirmed by present experimental data and supported by previously published experimental works.