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Wave statistics in seasonally ice-covered seas

Kimmo K Kahma (1), Laura Tuomi (2,1), and Heidi Pettersson (1)

(1) Marine Research, Finnish Meteorological Institute, Helsinki, Finland (Kimmo.Kahma@fmi.fi), (2) Marine Reaserch Centre, Finnish Environment Institute, Helsinki, Finland (Laura.Tuomi@ymparisto.fi)

In seasonally ice-covered seas there are several ways to present the annual wave statistics. We discuss five different ways to present the statistics: measurement statistics (type A), ice included time statistics (type B), ice-free time statistics (type C), exceedance hour statistics (type BC), and hypothetical no-ice statistics (type D). No one of these types can be said to be correct in the sense that they would give results that would be equivalent to corresponding results in a sea that is ice free throughout the year. Each one will have biases to one direction or other and choice of the type depends on the application the statistics are used for.

Type A is a straightforward way to make statistics from measurement data. In this type no adjustments will be made to compensate the possible bias introduced by the correlation of the seasonal variation of the wave climate and the possible gaps in the measurements. In seasonally ice-covered seas the wave buoys have to be recovered well before the freezing to avoid the damage to the buoy. The gaps in the data caused by ice are not random and thus affect the statistics.

Hypothetical no-ice statistics (type D) are calculated to represent the wave climate under the assumption that the sea remains ice-free throughout the year. This is a simple way to calculate wave statistics by wave modelling. In seasonally ice covered seas it has the tendency to overestimate the annual mean values and exceedance probabilities of significant wave height. Type D statistics has also another potential source of bias if he atmospheric model which is forcing the wave model uses ice roughness during the ice season. The roughness of ice in the atmospheric model is usually higher than that of the sea surface roughness above waves. Thus the modeled wind speed in the ice-covered sea is usually lower than it would be, when the sea is ice free.

A well justified way to include ice in the wave statistics is to set the wave height to zero in the presence of ice. This type B statistics, however, gives misleading impression of the wave climate of the ice-free time, and if the ice fee time is very short the bias can be huge. Another option is to use the statistics that is based on the ice-free time data (statistics type C). If either type B or type C statistics are presented in hours during a year instead of the percentage of hours per year, they are equal, except for the time when the wave height is zero. We denote this type as BC statistics.

As an example: in the Baltic Sea the differences in the annual mean values of significant wave height can be over 0.5 m between the different types of statistic which is large compared with the mean value of the significant wave height which is of the order of one meter.