Session: C39 Poster: TH106B

Changing marine storminess from VOS (1880-2009): observed climate variability in extreme wave characteristics

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Voluntary observing ship (VOS) data provide the longest global time series of wind wave characteristics, such as wave heights (prior the late 1950s) and heights, periods and directions of wind sea and swell (starting from the late 1950s). These data form the basis for the regularly updated global wind wave climatology maintained at IORAS. We present the results of the analysis of centennial-scale climate variability of mean and extreme SWH from 1880 onwards. Time dependent biases associated with inadequate sampling were homogenized and the trends and interdecadal changes are considered to be free of artifacts. During the last 130 years our analysis identified upward changes in the mean wave height over North Pacific (up to 7 cm/decade) and the absence of significant linear trends in the North Atlantic. However, after 1950 waves are growing up over Northern Hemisphere mid latitudes showing the strongest increase in the North Atlantic of 12 cm/decade. Extreme waves were estimated from initial value distribution and using peak over threshold methods. In order to apply extreme value statistics to heavily and inhomogeneously undersampled VOS data, we used 6-hourly snapshots of wave characteristics from ERA-40-WAM hindcast covering the period from 1958 to 2002. These model data were subsampled in order to simulate VOS sampling density. We found statitically significant changes in wave extremes, implying growing tendency in both Atlantic and Pacific. Interestingly, for the last 5-6 decades in the Pacific changes in extreme SWH are clearly coordinted with the increase of extreme seas, while in the North Atlantic changes in extreme SWH do not show correlation with extremes in wind sea, but rather linked to the changes in swell. For the period after 1970 our analysis also includes wave periods and directions. Secular increase of wind sea periods in both Northern and Southern Hemispheres is not, however proportional to the changes in wind sea heights, implying statistically significant trend in the wind sea steepness. Furthermore, data for the last 40 years clearly show that extreme waves become more steep for most areas. Results of the analysis of visual VOS data provide the ground for extensive validation of model hindcasts of wave parameters using state of the art wave modelling platforms and forcing functions from reanalyses and climate models.