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Global sea state variability from new multivariate multi-mission satellite altimeter products, reanalyses and wave buoys

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Accurate knowledge and understanding of the sea state and its variability is crucial to numerous oceanic and coastal engineering applications, but also to climate change and related impacts including coastal inundation from extreme weather and ice-shelf break-up. An increasing duration of multi-decadal altimeter observations of the sea state motivates a range of global analyses, including the examination of changes in ocean climate. For ocean surface waves in particular, the recent development and release of products providing observations of altimeter-derived significant wave height make long term analyses fairly straightforward. In addition, advances in imaging SAR processing for some missions have made available multivariate observations of sea state including wave period and sea state partition information such as swell wave height. Records containing multivariate information from both Envisat and Sentinel-1 are included in the version 3 release of the European Space Agency Climate Change Initiative (CCI) for Sea State data product.

In this study, long term trends and variability in significant wave height spanning the continuous satellite record are intercompared across high-quality global datasets using a consistent methodology. We make use of products presented by Ribal et al. (2019), and the recently released products developed through Sea State CCI. In particular, making use of long term and continuous time series from moored data buoys, we demonstrate the impact of steadily increasing altimeter sample density on trend estimation. In addition to wave height, global climatologies for wave period are also intercompared between the recent Sea State CCI product, ERA 5 reanalysis and in situ observations. Results reveal good performance of the CCI products but also raise questions over methodological approach to multivariate sea state analysis. For example, differences in computational approach to the derivation of higher order summaries of wave period, such as the zero-crossing period, lead to apparent discrepancy between satellite products and reanalysis and modelled data. It is clear that the broadening diversity of reliable sea state observations from satellite, such as provided by the Sea State CCI project, thus motivates new intercomparisons and analyses, and in turn elucidates inconsistencies that have been previously overlooked.

We discuss these results in the context of both the current state of knowledge of the changing wave climate, and the on-going development of CCI Sea State altimetry and imaging SAR products.