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On the formation of homogeneous regions for regional frequency analysis of extreme marine events

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The estimation of extreme marine events is a key issue in coastal engineering, in order to design effective coastal protections and to defend coastal areas from flooding. However, these extreme events are usually estimated through a local statistical analysis (from a series of observations collected at a given site), which do not allow accurate inference of high return levels through extrapolations.

These uncertainties can be reduced with regional frequency analysis (RFA). When based on the index flood method, RFA states that the sites belonging to a homogeneous region follow the same regional probability distribution, up to a site-dependent scale factor representing the local specificities. The formation of homogeneous regions is a crucial step when performing a RFA and still remains an open question.

For the analysis of extreme marine events, homogeneous regions were essentially formed through statistical considerations. However, the formation of homogeneous regions should also be made upon a physical basis, taking into account the atmospheric mechanisms governing the generation of extreme marine events.

We propose a method to form physically homogeneous regions by finding regions whose extreme marine observations are likely to be generated by the same storm events. This method, based on a criterion of spatial propagation of storms, do not require any other information than the extreme observed values. Regional differences of the spatial extent and intensity of the storms can thus be highlighted.

The proposed method is used to form homogeneous regions from the numerical sea-state database ANEMOC, where wave conditions are hindcasted between 1979 and 2002 for the Northern part of the Atlantic Ocean.