Title: Verification of sea-ice prediction by using distance measures

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Sea-ice is characterized by a coherent spatial structure, with sharp discontinuities and linear features (e.g. leads and ridges), the presence of spatial features, and a multi-scale spatial structure (e.g. agglomerates of floes of different sizes). Traditional point-by-point verification approaches do not account for this complex spatial structure and the intrinsic spatial correlation existing between nearby grid-points. This leads to issues (such as double penalties), and an overall limited diagnostic power (e.g. traditional scores are insensitive to distance errors).

This work explores the use of binary image distance measures of the Hausdorff and Baddeley family for the verification of sea-ice extent and sea-ice edge. The metrics are illustrated for the Canadian Regional Ice Ocean Prediction System evaluated against the Ice Mapping System analysis. The distance measures account for the sea-ice coherent spatial structure, are sensitive to the overlapping and similarities in shape of observed and predicted sea-ice extent: they reveal to be a robust and suitable set of verification measures, complementary to the traditional categorical scores. Moreover, these measures can provide distance errors, e.g. of observed versus predicted sea-ice edge, in physical terms (i.e. km), thereby being informative and meaningful for user-relevant applications.