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A Bayesian approach towards daily pan-Arctic sea ice freeboard estimates from combined CryoSat-2 and Sentinel-3 satellite observations

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Observations of sea ice freeboard from satellite radar altimeters are crucial in the derivation of sea ice thicknessestimates, which in turn inform on sea ice forecasts, volume budgets, and productivity rates. Current spatio-temporalresolution of radar freeboard is limited as 30 days are required in order to generate pan-Arctic coverage fromCryoSat-2, or 27 days from Sentinel-3 satellites. This therefore hinders our ability to understand physical processesthat drive sea ice thickness variability on sub-monthly time scales. In this study we exploit the consistency betweenCryoSat-2, Sentinel-3A and Sentinel-3B radar freeboards in order to produce daily gridded pan-Arctic freeboardestimates between December 2018 and April 2019. We use the Bayesian inference approach of Gaussian Process Regressionto learn functional mappings between radar freeboard observations in space and time, and to subsequently retrievepan-Arctic freeboard, as well as uncertainty estimates. The estimated daily fields are, on average across the 2018-2019season, equivalent to CryoSat-2 and Sentinel-3 freeboards to within 2 mm, and cross-validation experiments show thaterrors in predictions are, on average, within 3 mm across the same period. This method presents as a robust frameworkwhich can be used to model a wide range of statistical problems, from interpolation of altimetry data sets, to timeseries forecasting.