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Random Walks through Climate Networks: Sea Ice Prediction with Bayesian Inference

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Spatial predictions of the Arctic sea ice cover are becoming of paramount importance for Arctic communities and industry stakeholders. However, with sea ice variability likely to increase under continued anthropogenic warming, increasingly complex tools are required in order to make accurate forecasts. In this study, predictions of both Arctic and Antarctic summer sea ice extents are made using a complex network statistical approach. This method exploits statistical relationships within geo-spatial time series data in order to construct regions of spatio-temporal homogeneity -- nodes, and subsequently derive teleconnection links between them. The nodes and links of the networks here are generated from monthly sea ice concentration fields in June(November), July(December) and August(January) for Arctic(Antarctic) forecasts, hence lead times extend from 1 to 3 months. Network information is then utilised within a linear Gaussian Process Regression forecast model; a Bayesian inference technique. Network teleconnection weights are used to generate priors over functions in the form of a random walk covariance kernel; the hyperparameters of which are determined by the empirical Bayesian approach of type-II maximum likelihood. We also show predictions of all other months in order to ascertain the presence of a spring predictability barrier in observational data, for both hemispheres.

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