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Data-adaptive Harmonic Decomposition and Real-time Prediction of Arctic Sea Ice Extent

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Decline in the Arctic sea ice extent (SIE) has profound socio-economic implications and is a focus of active scientific research. Of particular interest is prediction of SIE on subseasonal time scales, i.e. from early summer into fall, when sea ice coverage in Arctic reaches its minimum. However, subseasonal forecasting of SIE is very challenging due to the high variability of ocean and atmosphere over Arctic in summer, as well as shortness of observational data and inadequacies of the physics-based models to simulate sea-ice dynamics. The Sea Ice Outlook (SIO) by Sea Ice Prediction Network (SIPN, http://www.arcus.org/sipn) is a collaborative effort to facilitate and improve subseasonal prediction of September SIE by physics-based and data-driven statistical models.

Data-adaptive Harmonic Decomposition (DAH) and Multilayer Stuart-Landau Models (MSLM) techniques [Chekroun and Kondrashov, 2017], have been successfully applied to the nonlinear stochastic modeling, as well as retrospective and real-time forecasting of Multisensor Analyzed Sea Ice Extent (MASIE) dataset in key four Arctic regions. In particular, DAH-MSLM predictions outperformed most statistical models and physics-based models in real-time 2016 SIO submissions. The key success factors are associated with DAH ability to disentangle complex regional dynamics of MASIE by data-adaptive harmonic spatio-temporal patterns that reduce the data-driven modeling effort to elemental MSLMs stacked per frequency with fixed and small number of model coefficients to estimate.