

# Supporting Information for “Sea-Ice Reemergence in a Model Hierarchy”

Mitchell Bushuk<sup>1</sup> and Dimitrios Giannakis<sup>1</sup>

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Corresponding author: Mitch Bushuk, Center for Atmosphere Ocean Science, Courant Institute of Mathematical Sciences, New York University, 251 Mercer Street, New York, NY, 10012, USA.  
E-mail: bushuk@cims.nyu.edu

<sup>1</sup>Courant Institute of Mathematical Sciences, New York University, New York, New York, USA.

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### 1. Text S1: Coupled NLSA Details

The reemergence mode families used in this work are constructed using the approach described in *Bushuk et al.* [2015]. For each CCSM4 model, modes were constructed using SIC, SST, and SLP as inputs to the coupled NLSA kernel. Also, for each dataset, we use an embedding window of  $q = 24$  months, which specifies the length of spatiotemporal patterns recovered by coupled NLSA, and mirrors the embedding window used in earlier studies. This embedding window is analogous to the lag window in extended empirical orthogonal function (EEOF) analysis. The main tunable parameters in coupled NLSA are the Gaussian locality parameter  $\epsilon$ , which sets the width of the kernel, and the truncation level  $l$ , which specifies the number of eigenfunctions used to filter the input data. Details regarding the coupled NLSA implementation for each dataset are included below.

#### 1.1. Control

The 1300-yr control run (b40.1850.track1.1deg.006) was downloaded from Earth System Grid website (<http://www.earthsystemgrid.org>). The sea-ice and ocean components share the same grid of  $1^\circ$  nominal resolution. The atmospheric grid is a  $0.9^\circ \times 1.25^\circ$  latitude-longitude grid. The modes were computed using a truncation level of  $l = 21$  eigenfunctions and a Gaussian locality parameter of  $\epsilon = 0.8$ .

## 1.2. CORE-II

The CORE-II run (g40.000) was downloaded from Earth System Grid website (<http://www.earthsystemgrid.org>). This run is 300-yrs long, consisting of five repetitions of the 60-yr CORE-II forcing cycle. We analyze the last 60-yrs of this run to minimize issues related to spin up. Figure 2 of *Danabasoglu et al.* [2014] shows that by the fifth forcing cycle, the CCSM4 CORE-II experiment has equilibrated. The sea-ice and ocean data are defined on the same grid as the control run, and are model output variables. The SLP data was downloaded from <http://data1.gfdl.noaa.gov/nomads/forms/core/COREv2.html> and is the corrected version of the dataset described in *Large and Yeager* [2009]. The SLP data is defined on a T62 grid ( $1.875^\circ$  resolution). Note that the SLP is a forcing field in this model, yet we use it as a variable in the coupled NLSA kernel (along with SIC and SST) analogous to the control run analysis. The modes were computed using a truncation level of  $l = 24$  eigenfunctions and a Gaussian locality parameter of  $\epsilon = 1.0$ .

## 1.3. SOM

The SOM data was obtained from Cecilia Bitz of the University of Washington and is the “CCSM4-NEWSOM” dataset described in *Bitz et al.* [2012]. All components share the same grid as the control run, but SST was not explicitly stored as an output variable. We use the “surface temperature” variable stored in the atmospheric model output, which is equal to SST for fully ocean-covered gridpoints. For gridpoints that are fully covered by sea ice (we define this as  $\text{SIC} > 70\%$ ), we set SST equal to  $-1.8\text{C}$ , the freezing point of saltwater at a salinity of 35 parts per thousand. SST at gridpoints with partial ice coverage was obtained by performing a bilinear (2-D) interpolation between the ice-covered and

ocean-covered gridpoints. The modes were computed using a truncation level of  $l = 23$  eigenfunctions and a Gaussian locality parameter of  $\epsilon = 1.0$ .

We also produced data using a newer version of the CCSM4 SOM with an updated code base. With this dataset, we reached the same qualitative conclusions, but observed some differences in the spatial patterns of the leading modes of variability. In particular, the leading SIC and SST modes have a stronger signal in the Sea of Okhotsk. Correspondingly, the high pressure center in Figure 4 is shifted further West over the Bering Sea, which is consistent with the modified SIC field. In this study, we present the data from the “CCSM4-NEWSOM”, as it provides better contact with the earlier literature of *Bitz et al.* [2012].

## 2. Caption for Movie S1

Movie S1: Monthly composites of SIC, SST, and SLP shown for reemergence families of the control, CORE-II, and SOM. The composites are computed over all times in which  $L_1^{\text{SIC}}$  of each family is active, in positive phase. The movie is best viewed by repeated looping.

## References

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