Supporting Information for "Improvements in September Arctic sea ice predictions via assimilation of summer CryoSat-2 sea ice thickness observations"

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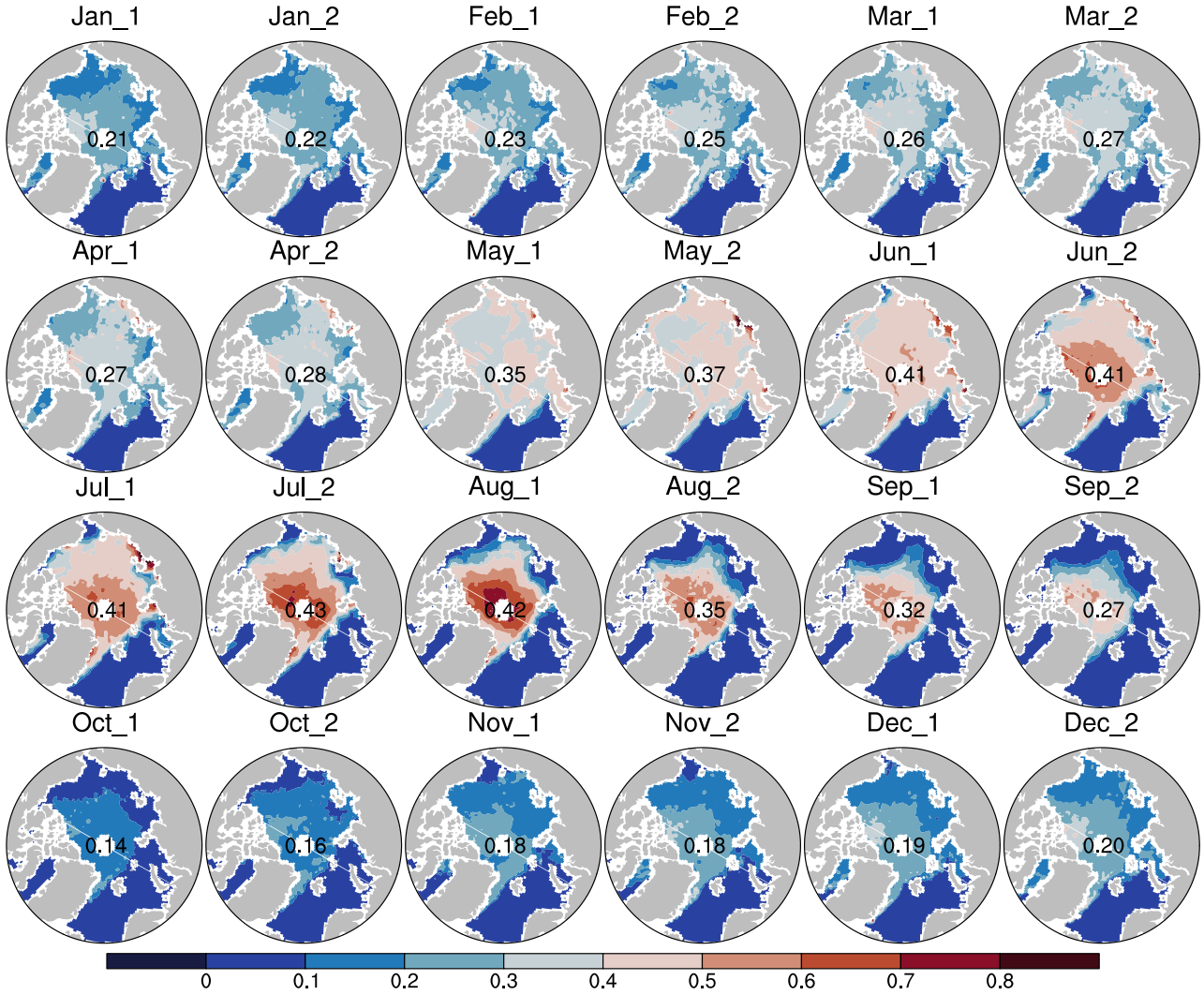

Figure S1. Uncertainties of the biweekly sea ice thickness (SIT) data from CryoSat-2. The numbers on the plots are the pan-Arctic area-weighted average of the uncertaintes.

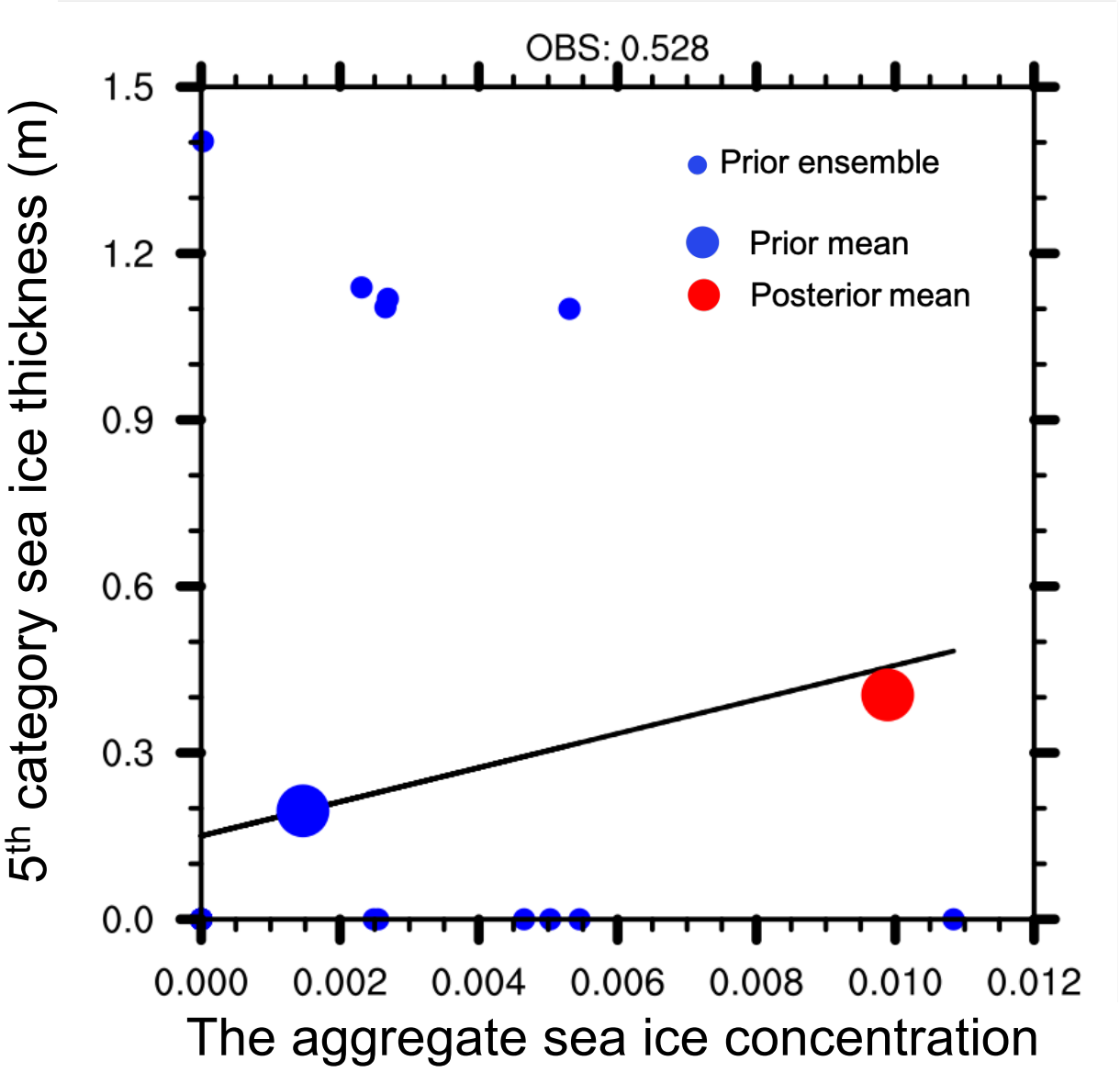

Figure S2. The unrealistic update of the 5th category sea ice thickness (SIT) by assimilating a sea ice concentration observation of 0.528 on a selected grid cell. The small blue dots are the prior ensemble of the 5th category SIT, the big blue dot the prior ensemble mean of the 5th category SIT, and the big red dot the posterior mean of the 5th category SIT. The black line is a linear regression fit of the small blue dots.

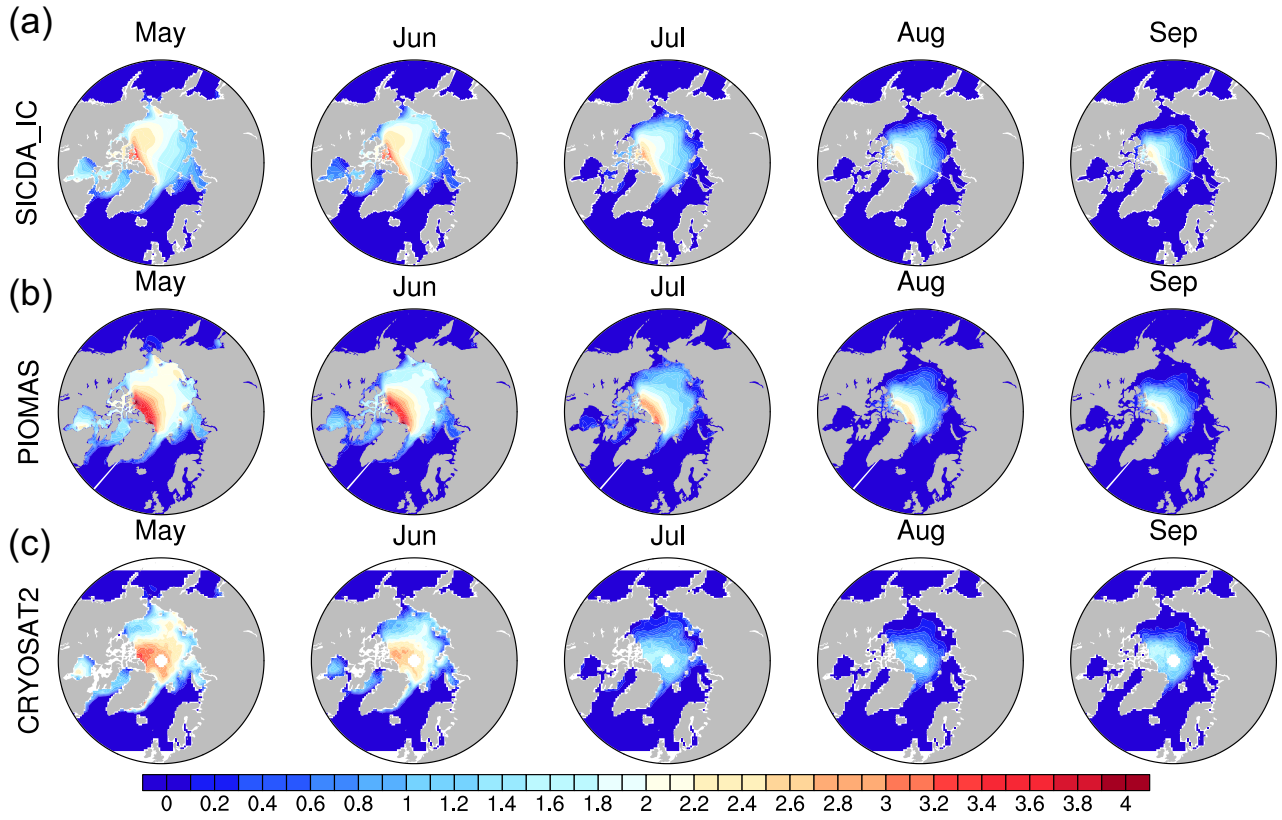

Figure S3. The 10-year mean (2011–2020) monthly SIT for May to September (from left to right) from (a) SICDA_IC, (b) PIOMAS, and (c) CryoSat-2.

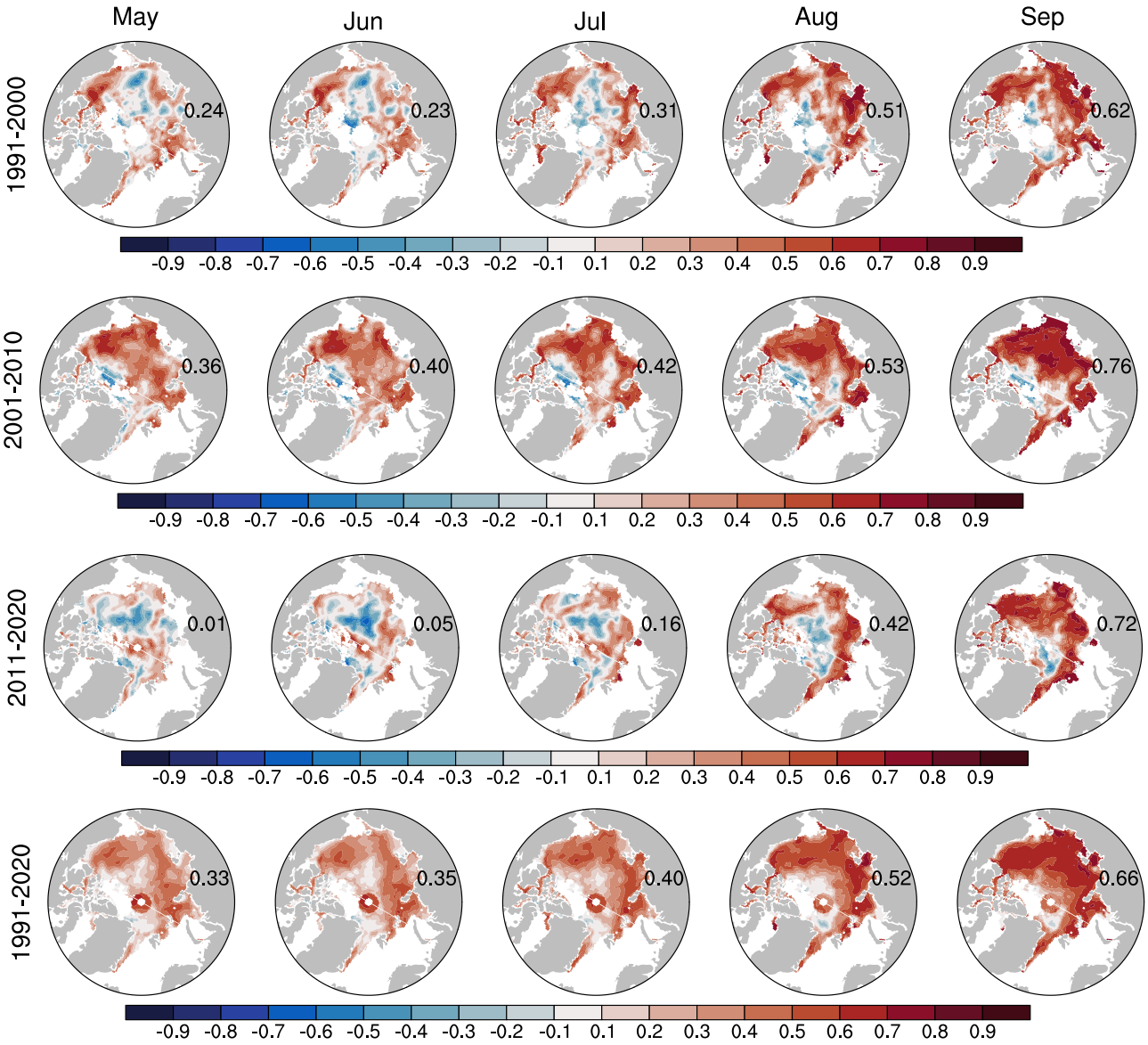

Figure S4. Correlation between the observed September SIC and SIV from the 1st day of May, June, July, August, and September from the experiment SICDA_IC in different decades: (a) the 1990s, (b) the 2000s, (c) the 2010s, and (d) 1991–2020. The number on each plot indicates the pan-Arctic area-weighted average average of the SIV-SIC correlation values excluding the grid cells where the September SIC variability is less than 10%.

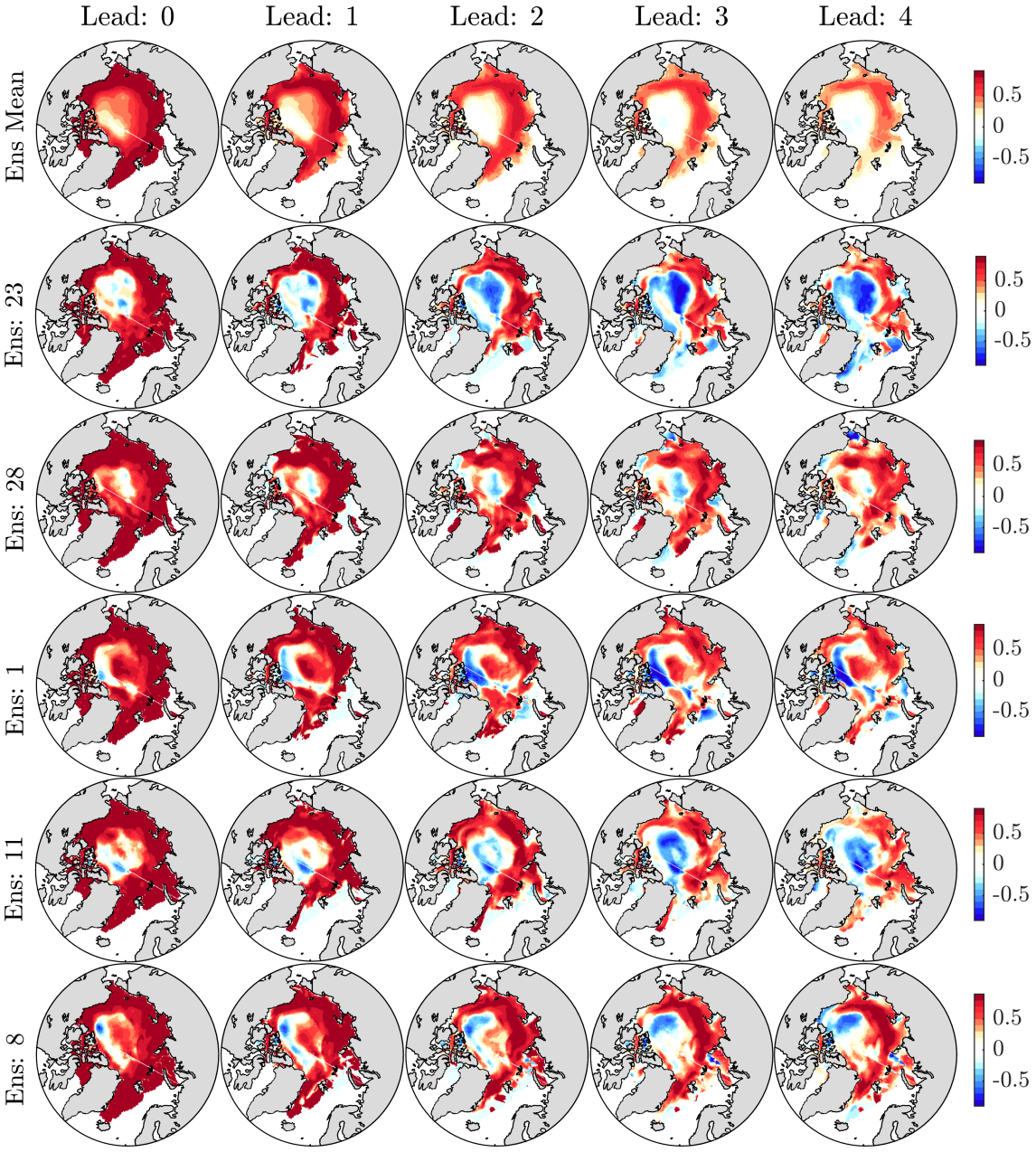

Figure S5. Correlation between September SIC and SIV at different lead times from 5 randomly selected SPEAR_LO ensemble members and the SPEAR_LO ensemble mean, computed over the period 2011–2020. Lead 0–4 corresponds to September, August, July, June, and May, respectively.

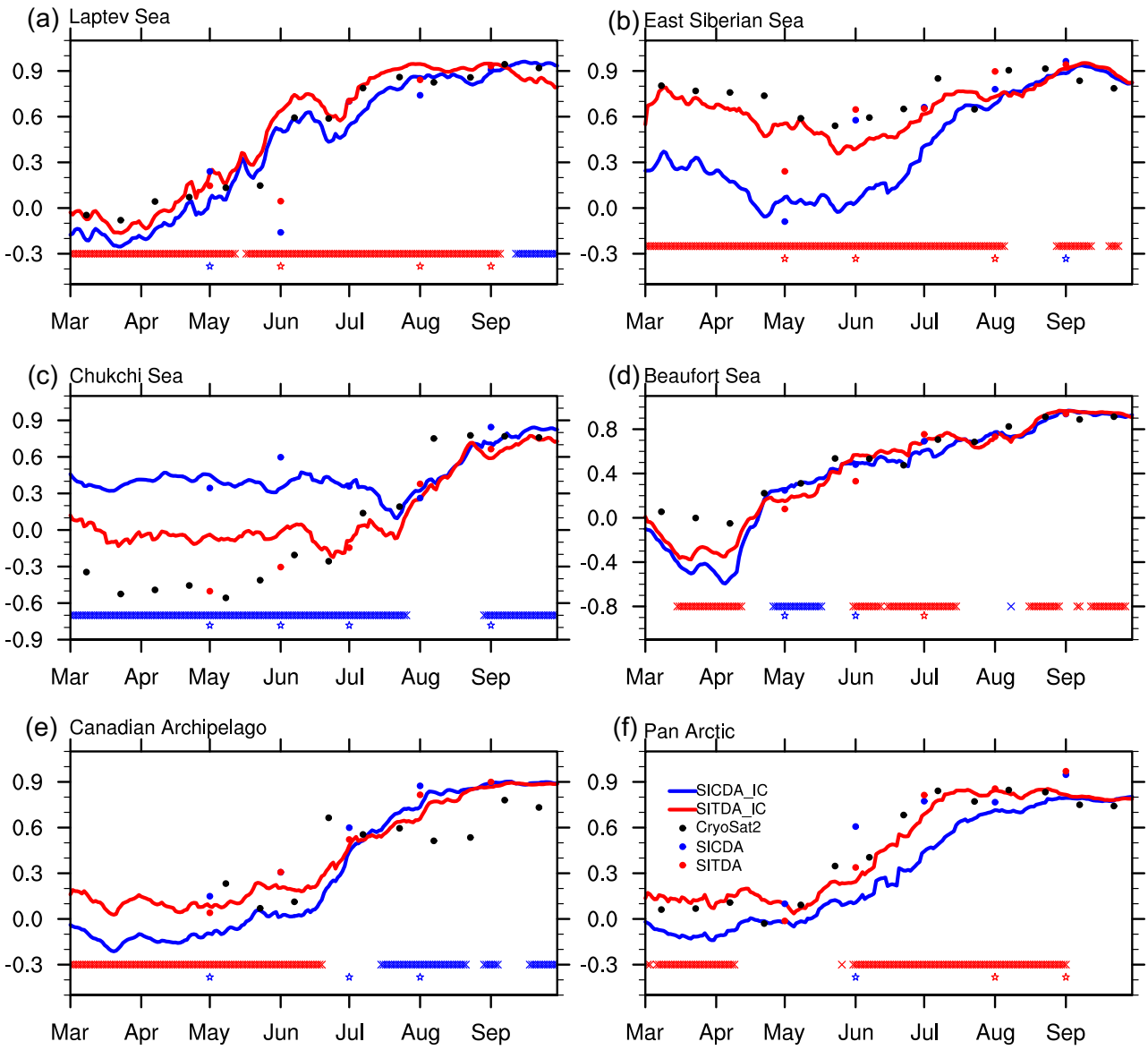

Figure S6. The correlation between the observed September SIE and the SIV from March to September from SICDA_IC (blue line), SITDA_IC (red line), the CryoSat-2 biweekly observations (black dots), and the ACC of the predicted September SIE from SICDA (blue dots) and SITDA (red dots) for the summer sea ice regions. The red crosses indicate that SIT_IC has significantly higher correlation with SIE than SICDA_IC. The blue pentagrams indicate SICDA has significantly higher ACC than SITDA and the red pentagrams indicate SITDA is significantly better than SICDA.

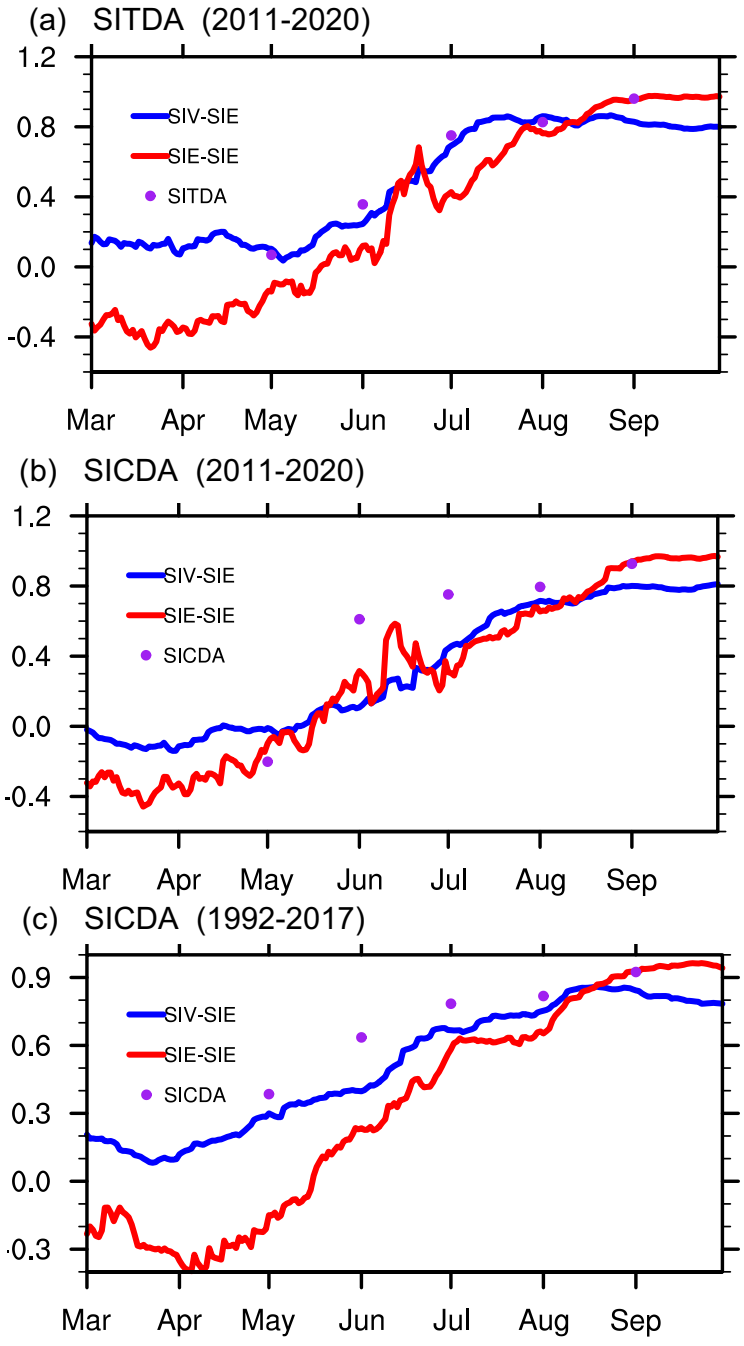

Figure S7. The SIV-SIE (blue line) and SIE-SIE (red line) correlations and the ACC of the predicted September SIE from (a) SITDA with the experiment time period of 2011–2020, (b) SICDA from 2011 to 2020, and (c) SICDA from 1992 to 2017.

Table S1. Percentage of area that has negative SIT-SIC correlation values.

	May	June	July	August	September
SICDA_IC	43%	41%	30%	24%	11%
SITDA_IC	32%	27%	18%	12%	10%
CryoSat-2	34%	29%	21%	17%	6%
SPEAR-LE	14–52%	15–44%	16–42%	10–32%	0–10%