Supplementary Material

Multidecadal Variability and Predictability of Antarctic Sea Ice in GFDL SPEAR_LO Model

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Introduction

This supplementary material provides seasonal cycles of Antarctic sea ice extent (SIE) climatology and decadal sea ice concentration (SIC) variability, the SIC associated with the past two polynya events (1974-1976 and 2016-2017), year-to-year prediction skills of the Antarctic SIC, and seasonal dependence of decadal SIC predictability.

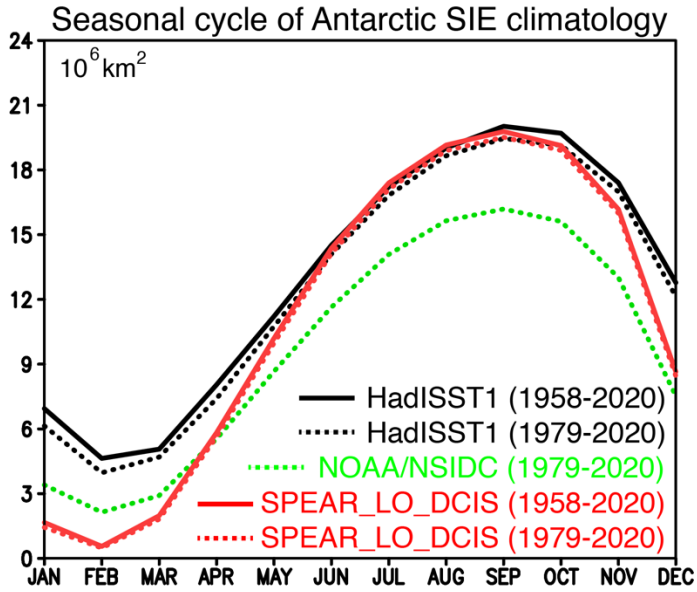

Figure S1 Seasonal cycle of Antarctic sea ice extent (SIE in 10^6 km^2) climatology from the HadISST1 (black), the NOAA/NSIDC (green), and 30 ensemble members average of the SPEAR_LO_DCIS (red). Solid lines indicate the monthly climatology during 1958-2020, while dashed lines represent the climatology during 1979-2020.

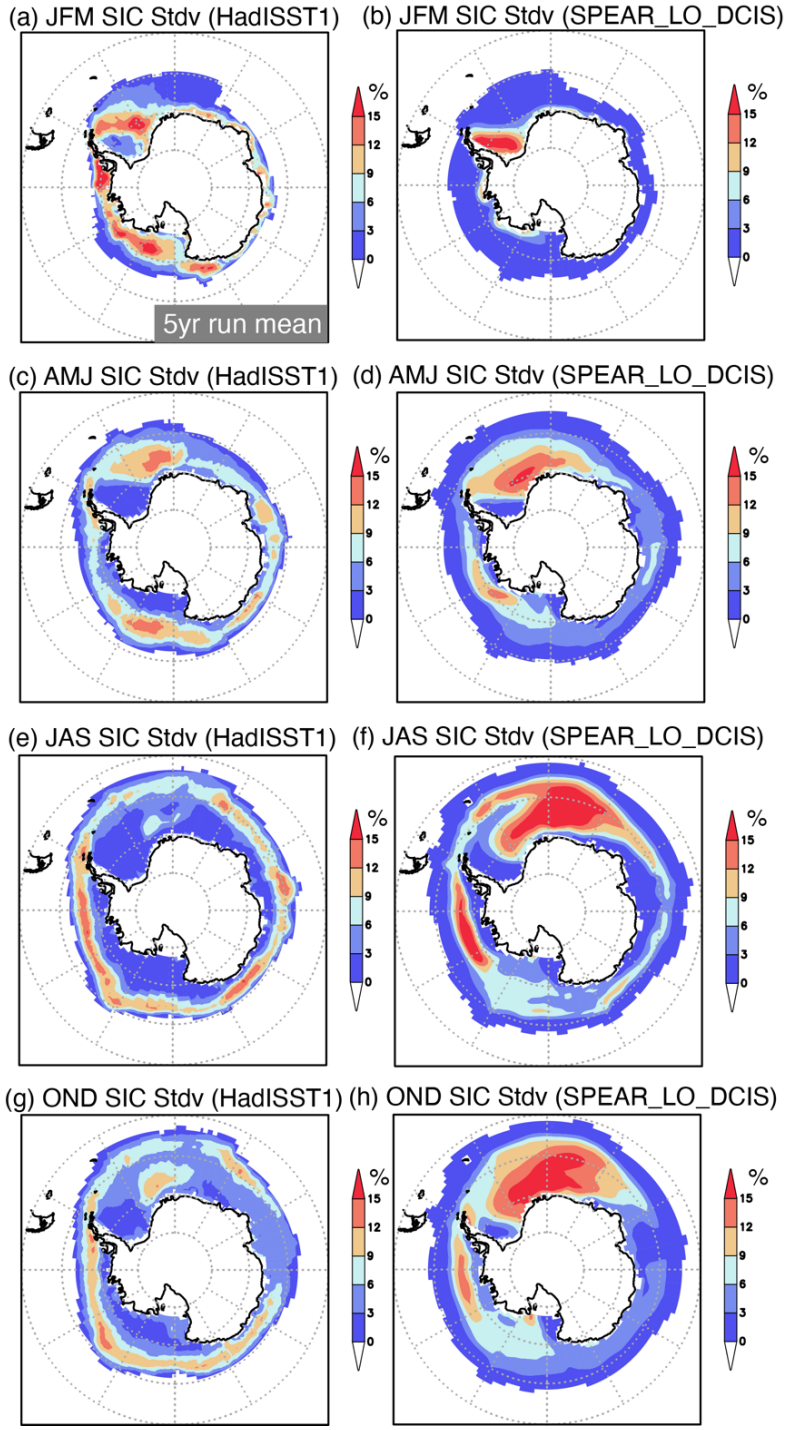

Figure S2 Standard deviation of 5-yr running mean SIC anomalies (in %) during austral summer (January-March; JFM) of 1958-2020 from **(a)** the HadISST1 and **(b)** SPEAR_LO_DCIS. Same as in **(a, b)**, but for **(c, d)** austral autumn (April-June; AMJ), **(e, f)** austral winter (July-September; JAS), and **(g, h)** austral spring (October-December).

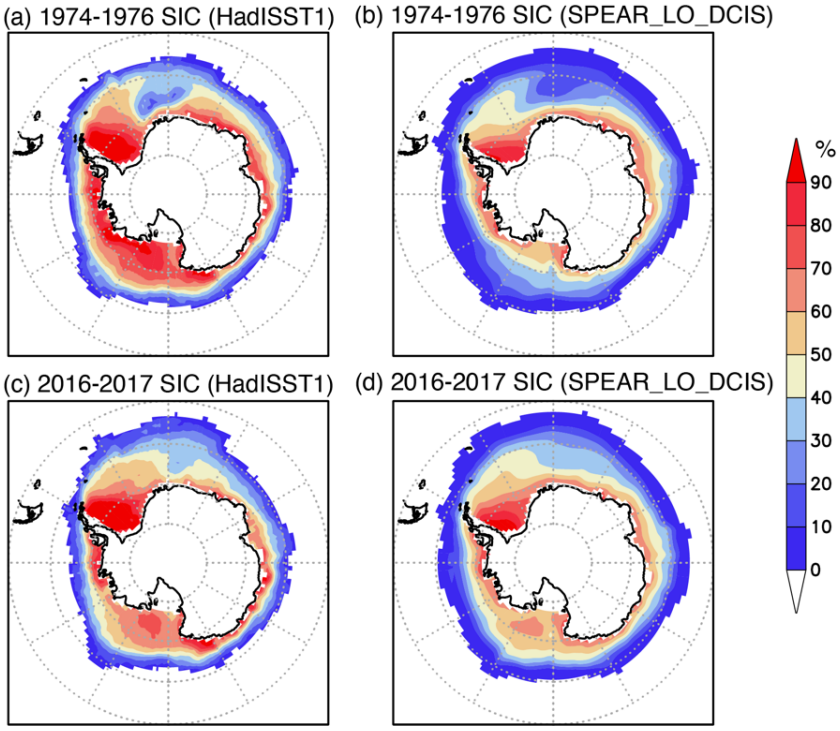

Figure S3 (a) Sea ice concentration (SIC, in %) averaged over 1974-1976 from the HadISST1. **(b)** Same as in **(a)**, but for the SIC from the SPEAR_LO_DCIS. **(c, d)** Same as in **(a, b)**, but for the SIC anomalies averaged over 2016-2017.

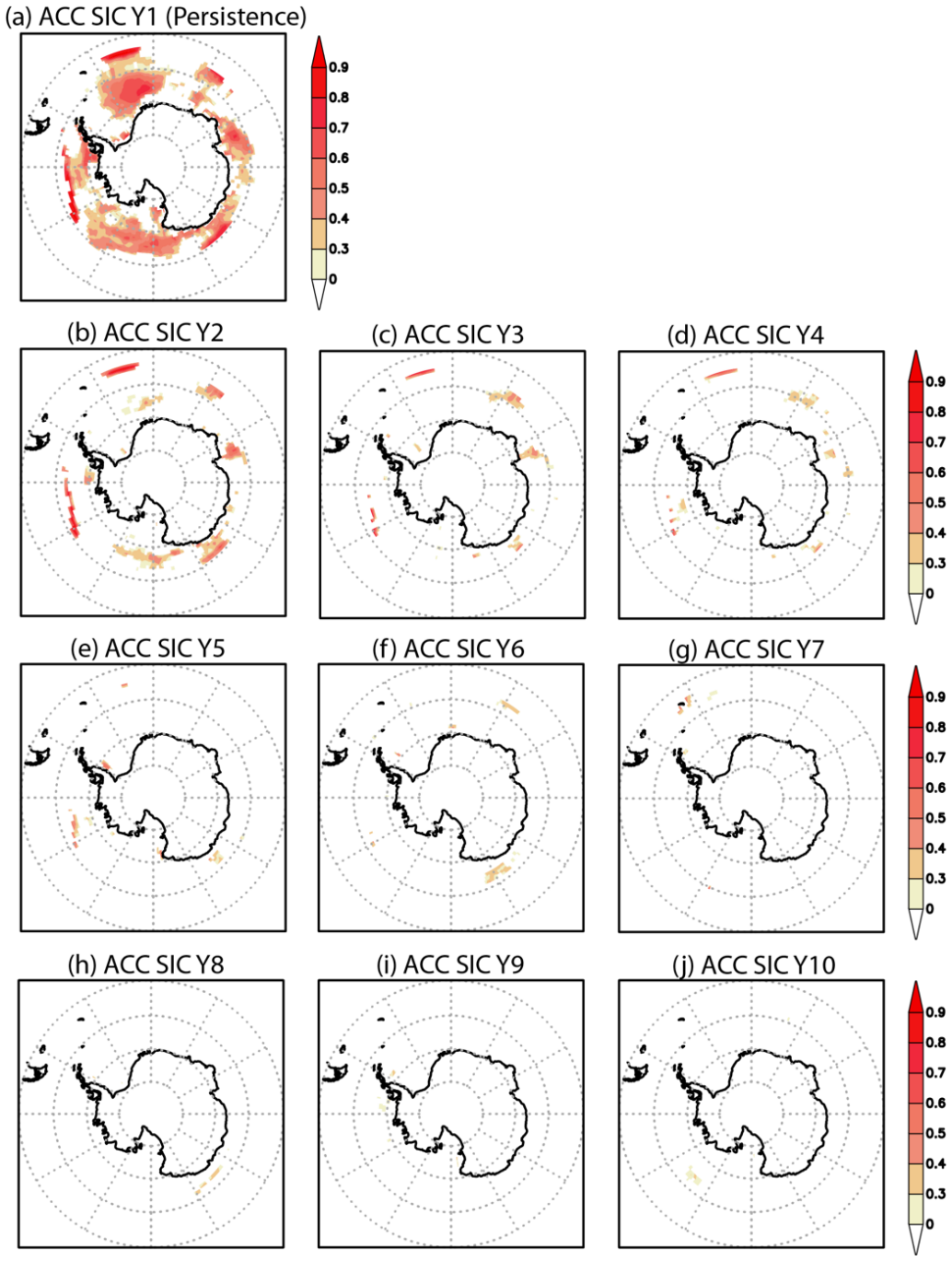

Figure S4 (a) Anomaly correlation (ACC) of the sea ice concentration (SIC) from the persistence prediction based on the HadISST1 during 1961-2020 for the lead time of year 1. Positive ACCs which are statistically significant at 90 % confidence level using Student's *t*-test are colored. **(b-j)** Same as in **(a)**, but for the lead time from year 2 to year 10, respectively.

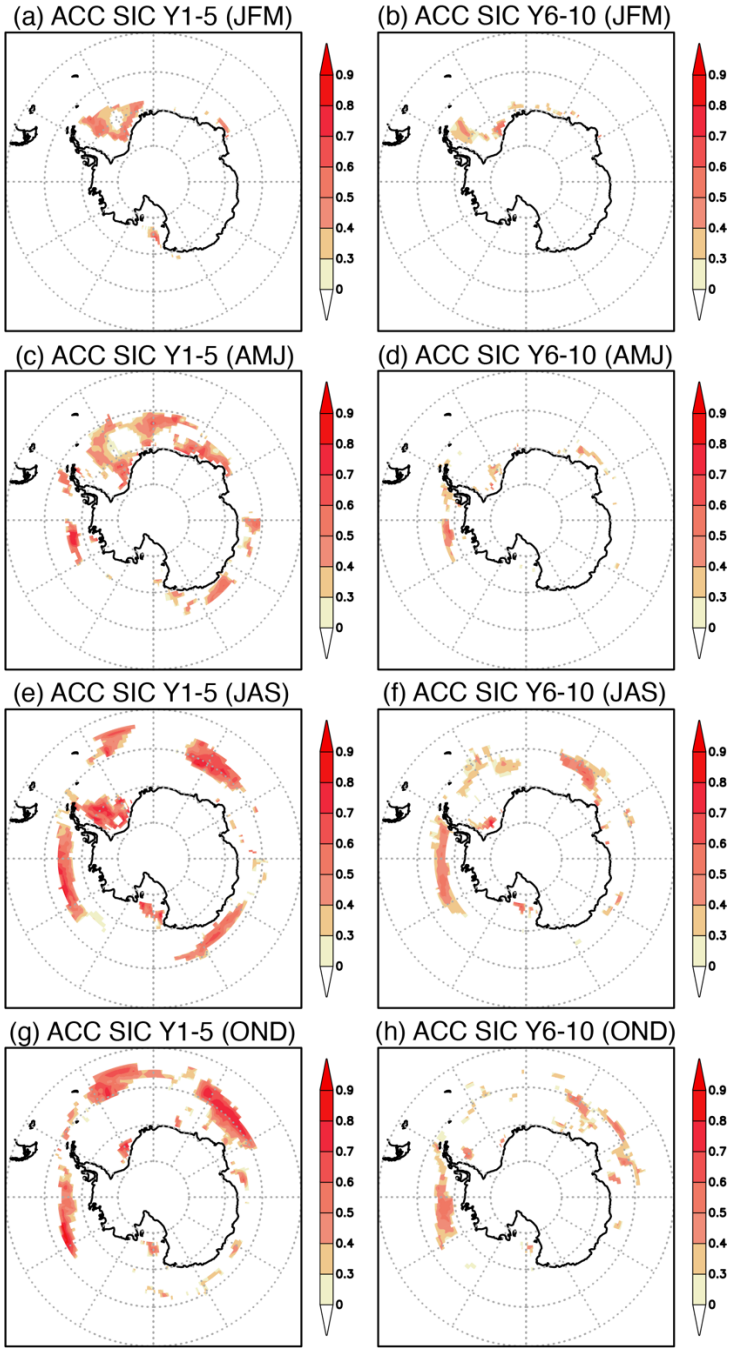

Figure S5 Anomaly correlations between the observed SIC and the predicted SIC from the SPEAR_LO_DRF during austral summer (January-March; JFM) of 1961-2020 for the lead times of **(a)** year 1-5 and **(b)** year 6-10. Positive ACCs which are statistically significant at 90 % confidence level using Student's *t*-test are colored. Same as in **(a, b)**, but for **(c, d)** austral autumn (April-June; AMJ), **(e, f)** winter (July-September; JAS), and **(g, h)** spring (October-December; OND).

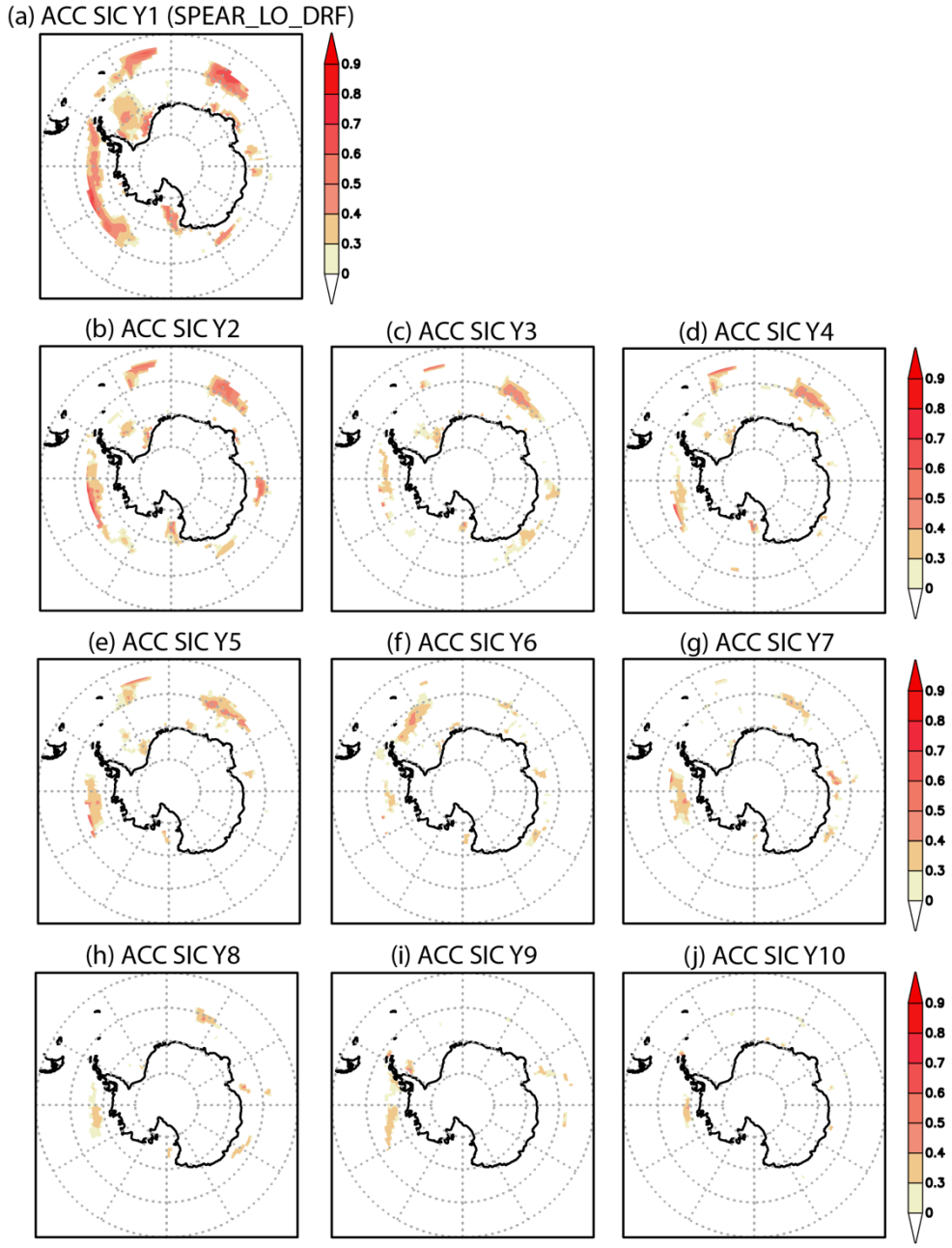

Figure S6 (a) Anomaly correlation (ACC) between the observed SIC and the predicted SIC from the SPEAR_LO_DRF during 1961-2020 for the lead time of year 1. Positive ACCs which are statistically significant at 90 % confidence level using Student's *t*-test are colored. **(b-j)** Same as in **(a)**, but for the lead time from year 2 to year 10, respectively.