

1 **Supplemental Material for**
2 **Global Air–Sea CO₂ Flux in 22 CMIP5 Models: Multiyear Mean and**
3 **Interannual Variability**

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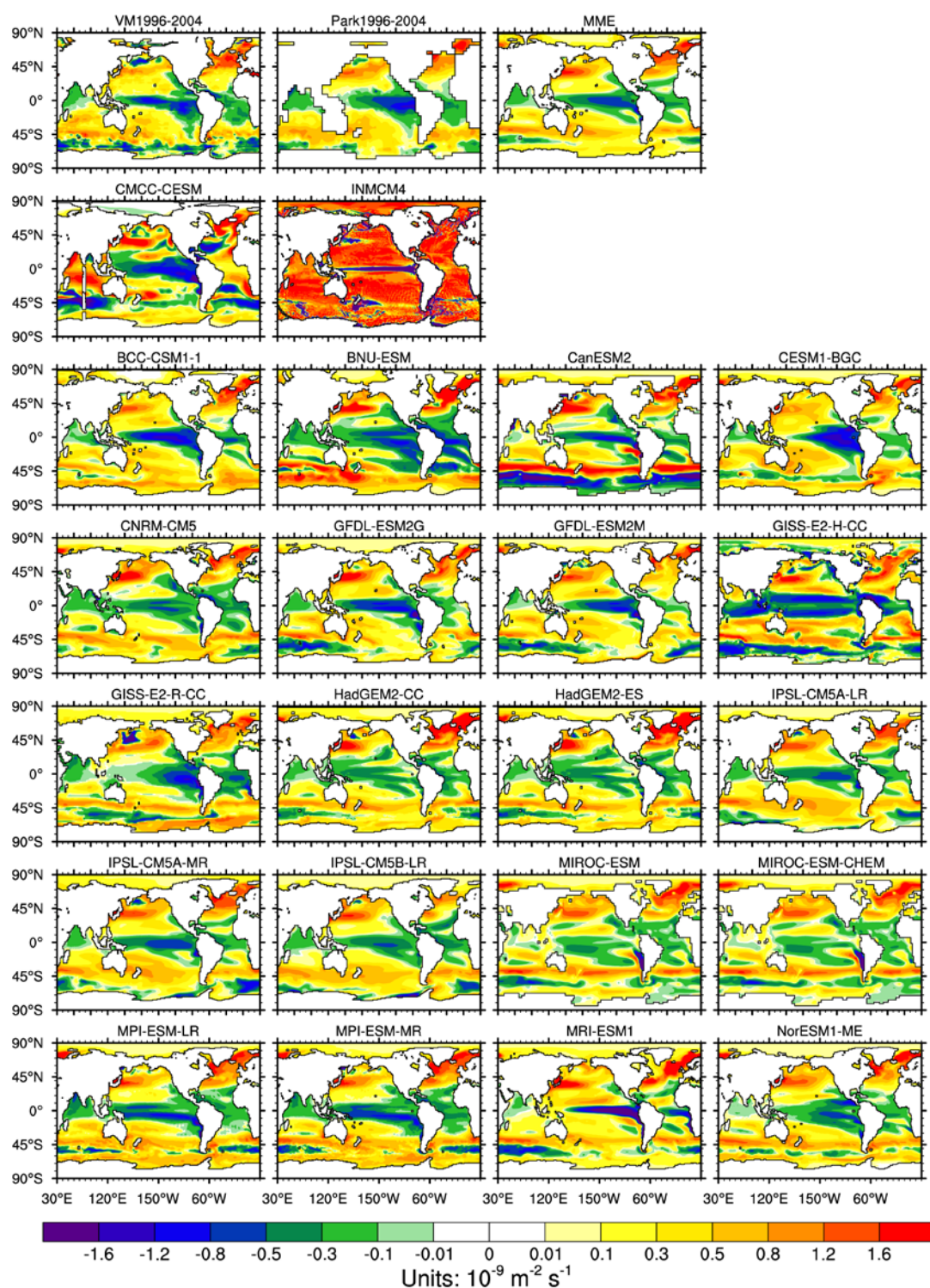
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21 Supplemental Figures



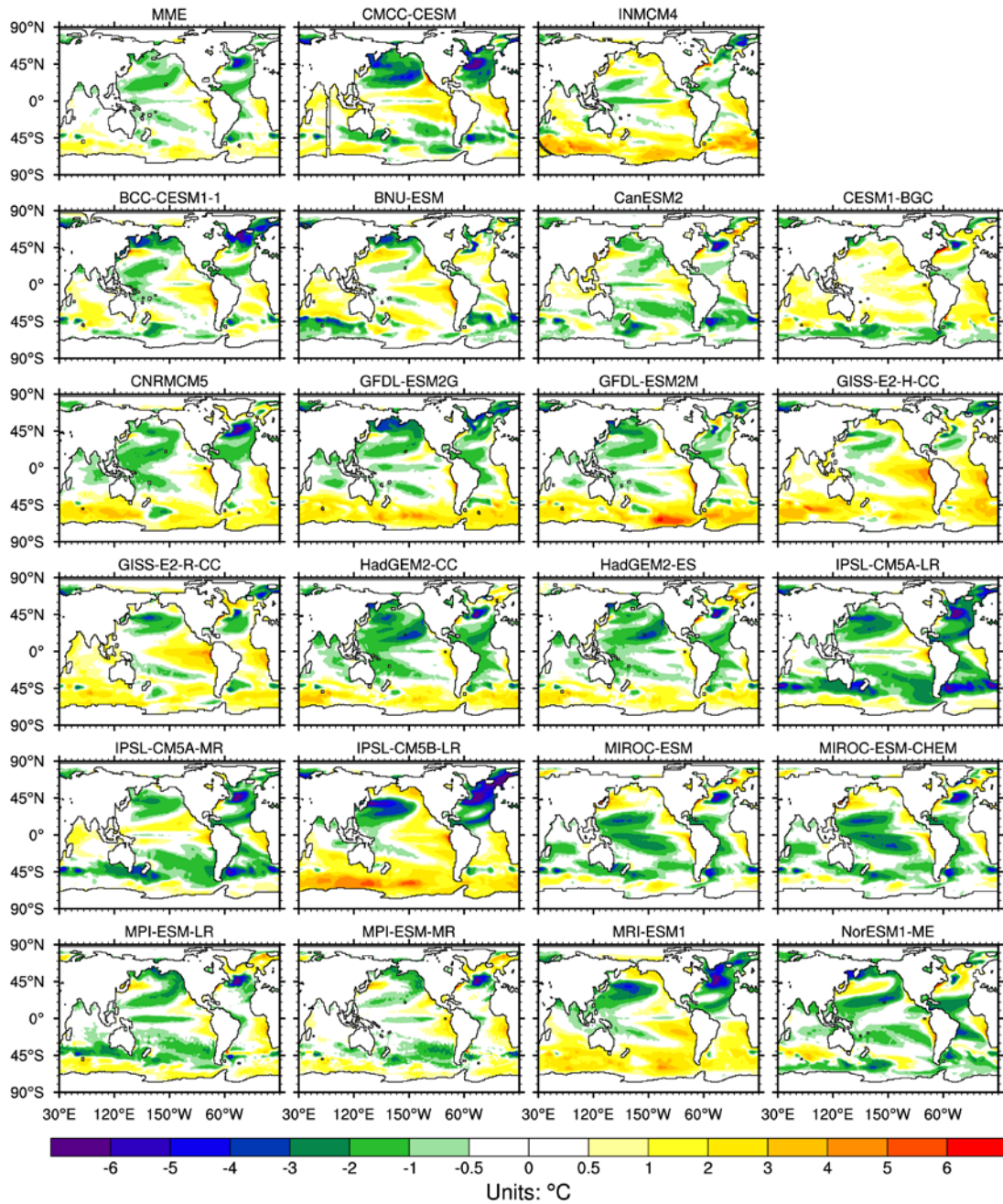
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23 FIG. S1. Climatology of air-sea CO_2 flux (units: $10^{-9} \text{ kg m}^{-2} \text{ s}^{-1}$) during 1996-2004

24 based on observations and model outputs. The first panel is the climatology from the

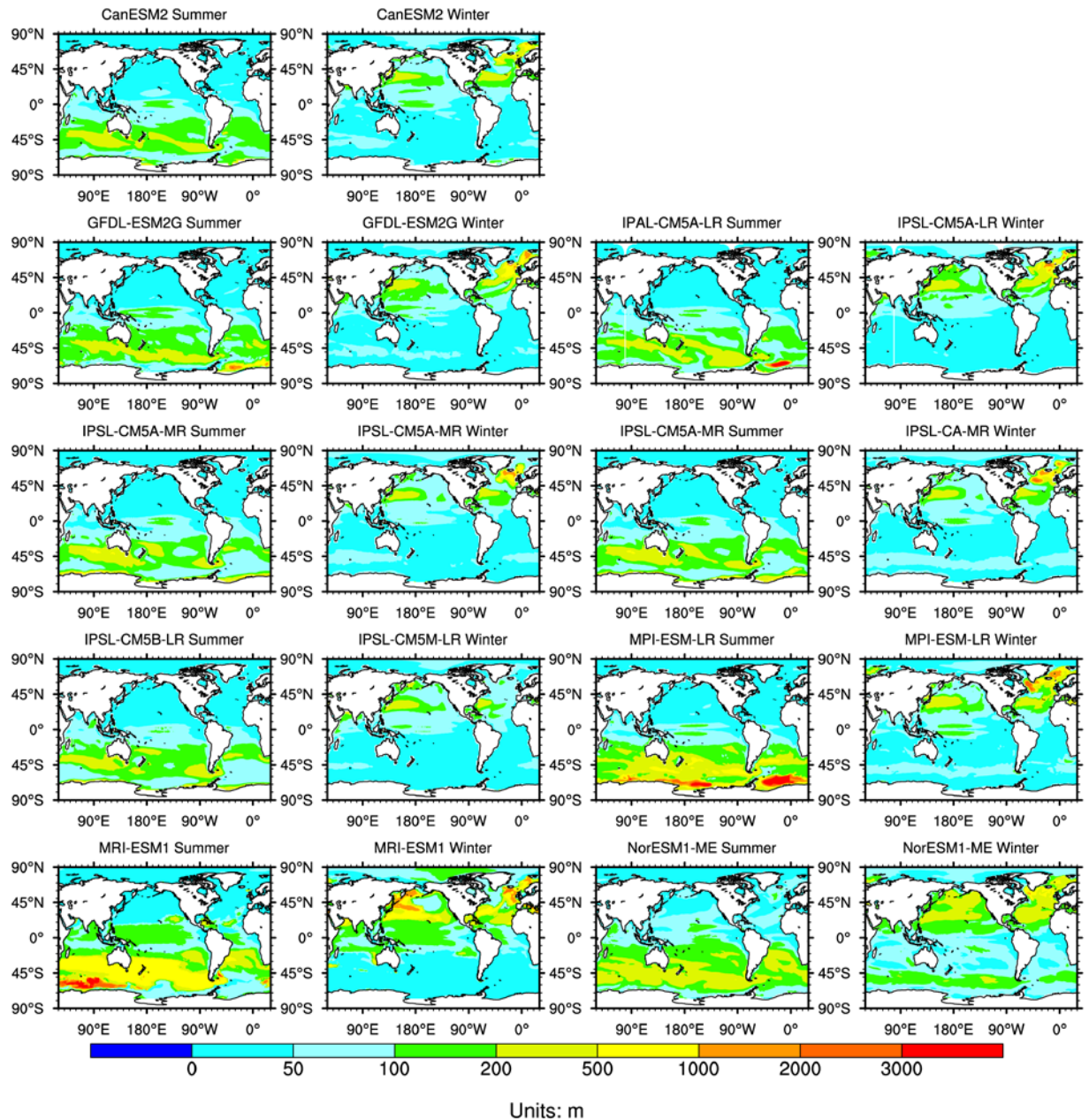
25 observationally-based results of Valsala and Maksyutov (2010). The second panel is
26 the climatology from the observationally-based results of Park et al. (2010). The third
27 panel indicates the multi-model ensemble (MME) mean of the 18 models (excluding
28 two models with higher root-mean-square errors (RMSEs; units: 10^{-9} kg m⁻² s⁻¹) and
29 lower spatial correlation coefficients (SCCs) compared to the observationally-based
30 results, and two models with underestimated flux, namely, CMCC-CESM, INM-CM4,
31 and GISS-E2-H/R-CC). The other panels are from individual models, with the model
32 name given at the top of each panel. Positive value means the flux is into the ocean.

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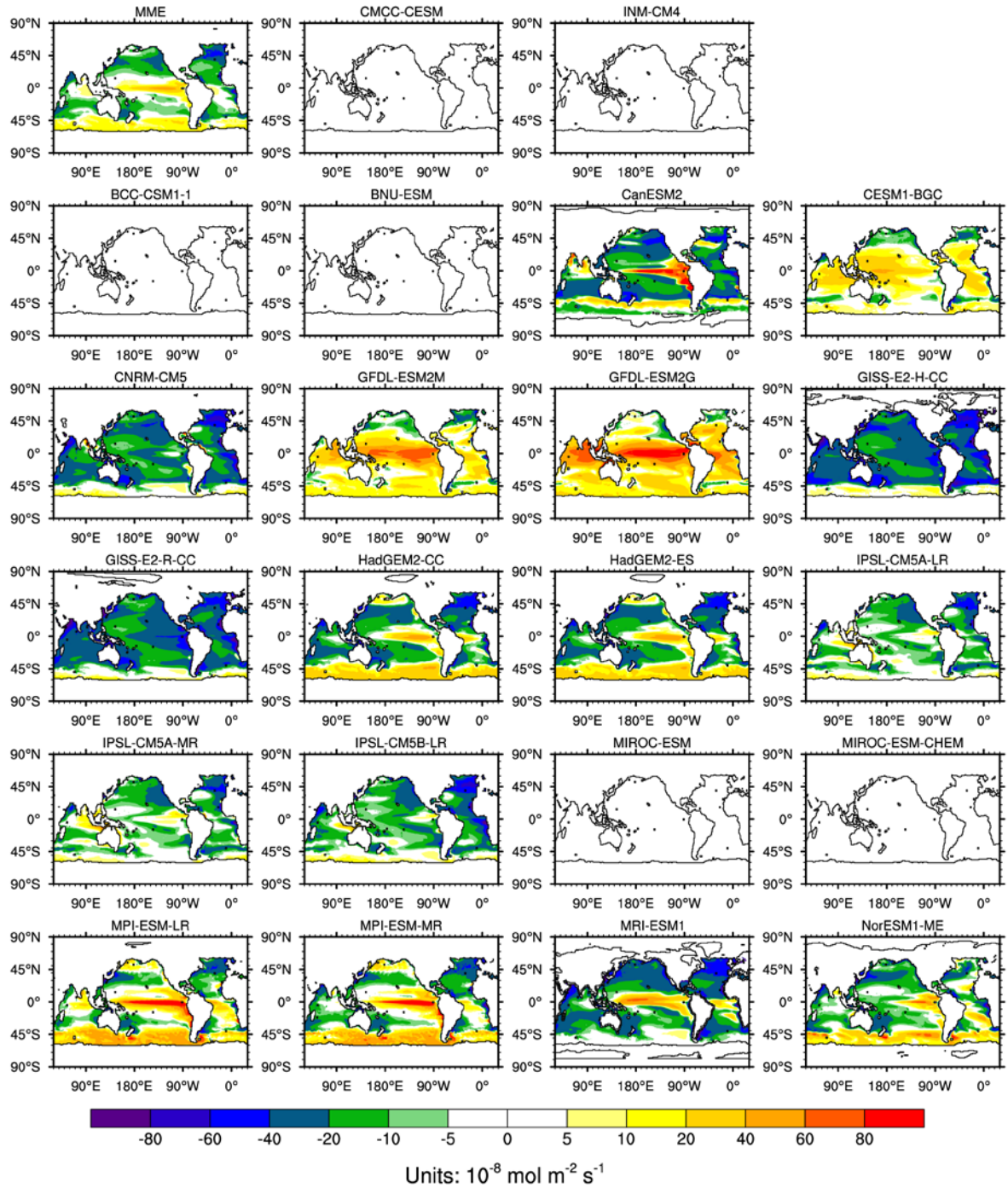
35 FIG. S2. Model sea surface temperature (SST) biases (units: °C) with respect to the
 36 HadiSST (Rayner et al. 2003) during 1996-2004. The first panel indicates the biases
 37 between the MME mean of the 18 models (excluding two models with higher RMSEs
 38 and lower SCCs compared to the observationally-based results, and two models with
 39 underestimated flux, namely, CMCC-CESM, INM-CM4, and GISS-E2-H/R-CC) and
 40 the HadiSST results.



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42 FIG. S3. Model maximum mixed layer depth (MLD) biases (units: m). The MLD is a
 43 direct output from CMIP5 models. Summer means the average MLD of August during
 44 1996-2004, and winter means the average MLD of February during 1996-2004. The
 45 blank panel means the model output of MLD is not available.

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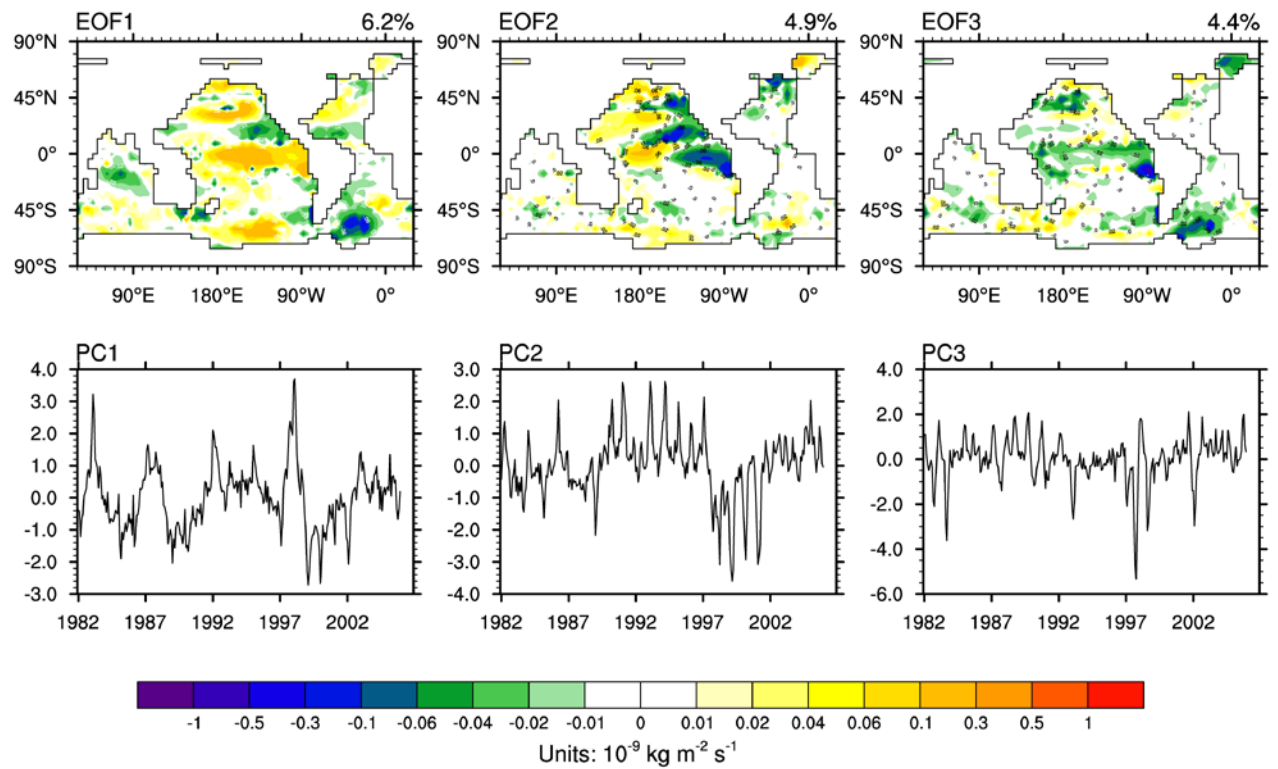


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48 FIG. S4. Model biases of multi-year-mean net primary production by all kinds of
 49 phytoplankton (intpp; units: $10^{-8} \text{ mol m}^{-2} \text{ s}^{-1}$) with respect to the satellite product intpp
 50 (SeaWiFS;

51 <ftp://ftp.icess.ucsb.edu/pub/org/oceancolor/MEaSURES/NPP/8day/VGPM/Seawifs/>).

52



53

54 FIG. S5. The first three modes in empirical orthogonal function decomposition (EOFs)

55 of observationally-based air-sea CO_2 flux (units: $10^{-9} \text{ kg m}^{-2} \text{ s}^{-1}$) from Park et al.

56 (2010) over the global ocean during 1982-2005. Variance explained is given at the top

57 right of each panel. EOFs are based on monthly data. To show the variation better, we

58 use nonlinear color scaling.

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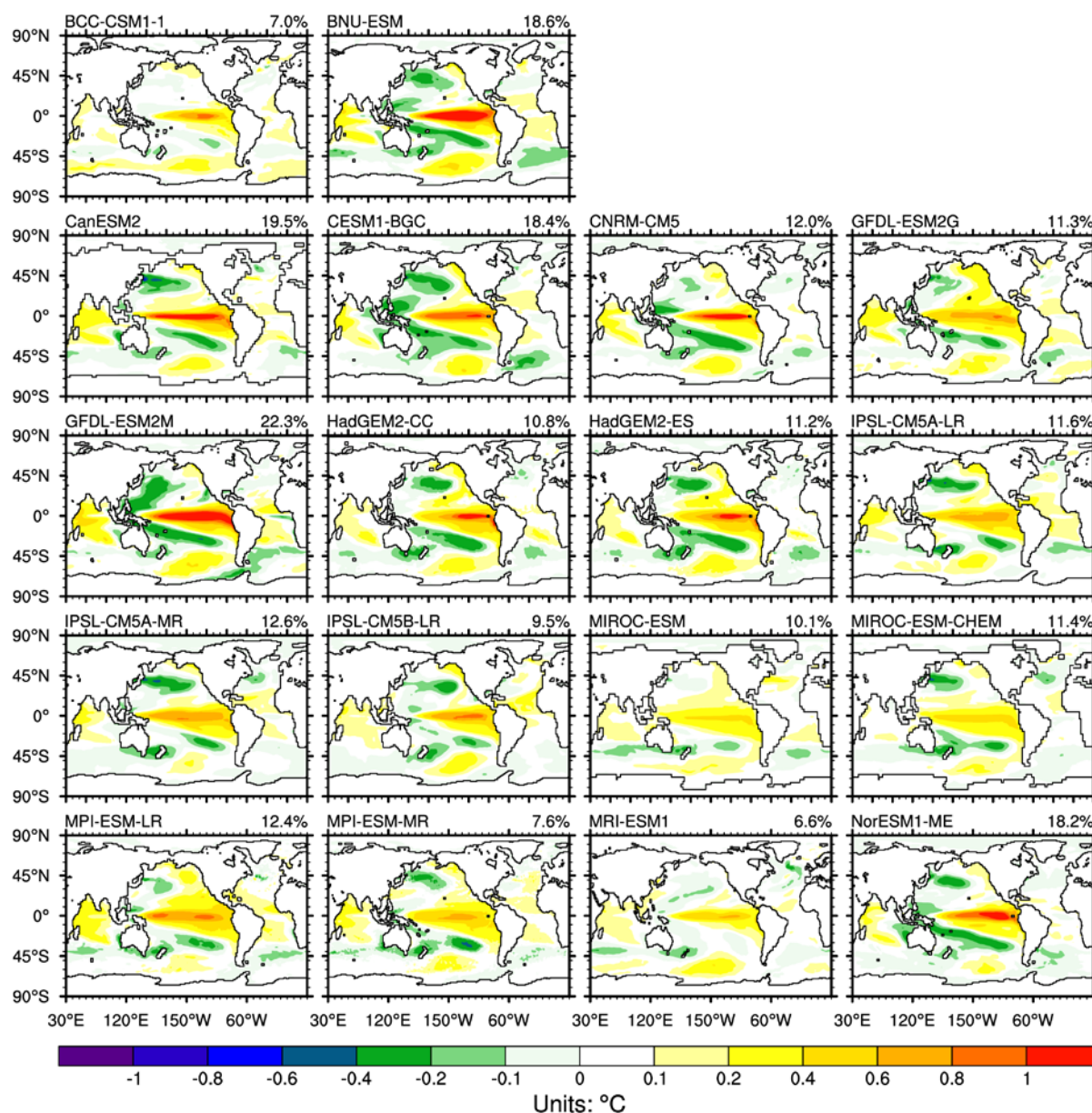
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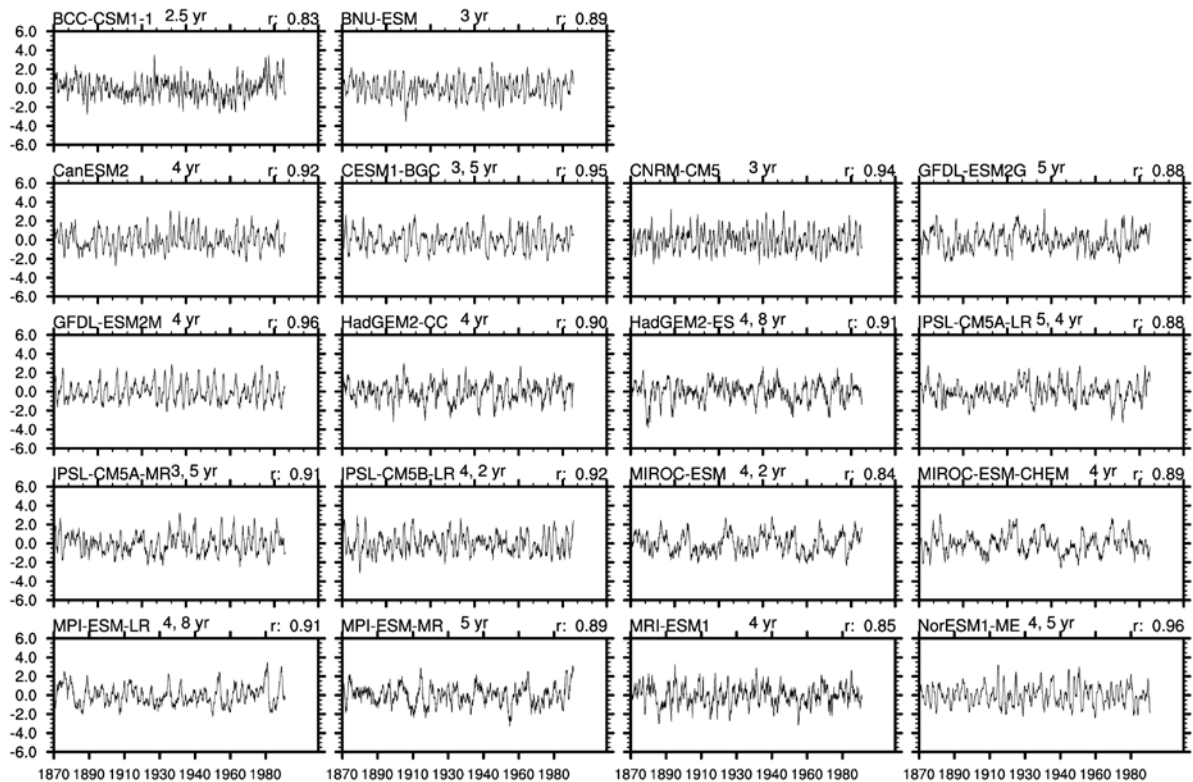


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66 FIG. S6. The first mode in empirical orthogonal function decomposition (EOF1) of
 67 model SST (units: °C) over the global ocean during 1870-2000. Variance explained by
 68 each mode is given at the top right of each panel. EOFs are based on monthly data.

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72 FIG. S7. Time series normalized by the standard deviation corresponding to the EOF1
 73 (PC1) of SST over the global ocean during 1870-2000. The number at the middle
 74 above each panel is the period of PC1. The number at the right above each panel is the
 75 correlation coefficient between PC1 and El Niño–Southern Oscillation (ENSO) index.
 76 The ENSO index is defined as the area-mean SST anomalies in the region of 5°S-5°N,
 77 120°-170°