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Supplement of

Multi-decadal pacemaker simulations with an intermediate-complexity climate model

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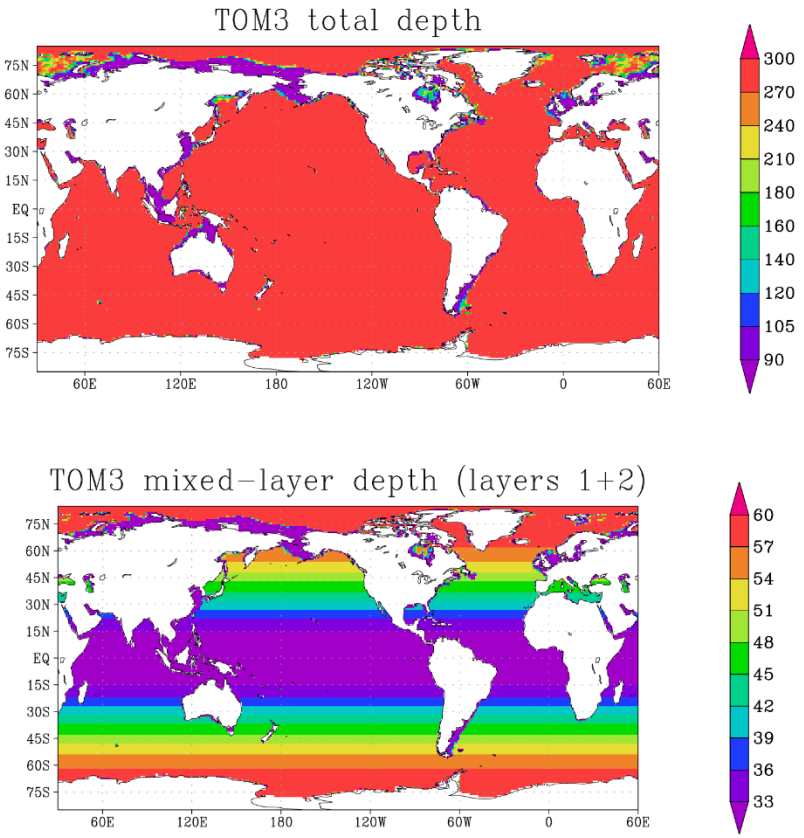

Figure S1: Total depth (top) and mixed-layer depth (bottom), in metres, in the TOM3 model used for the coupled ensembles.

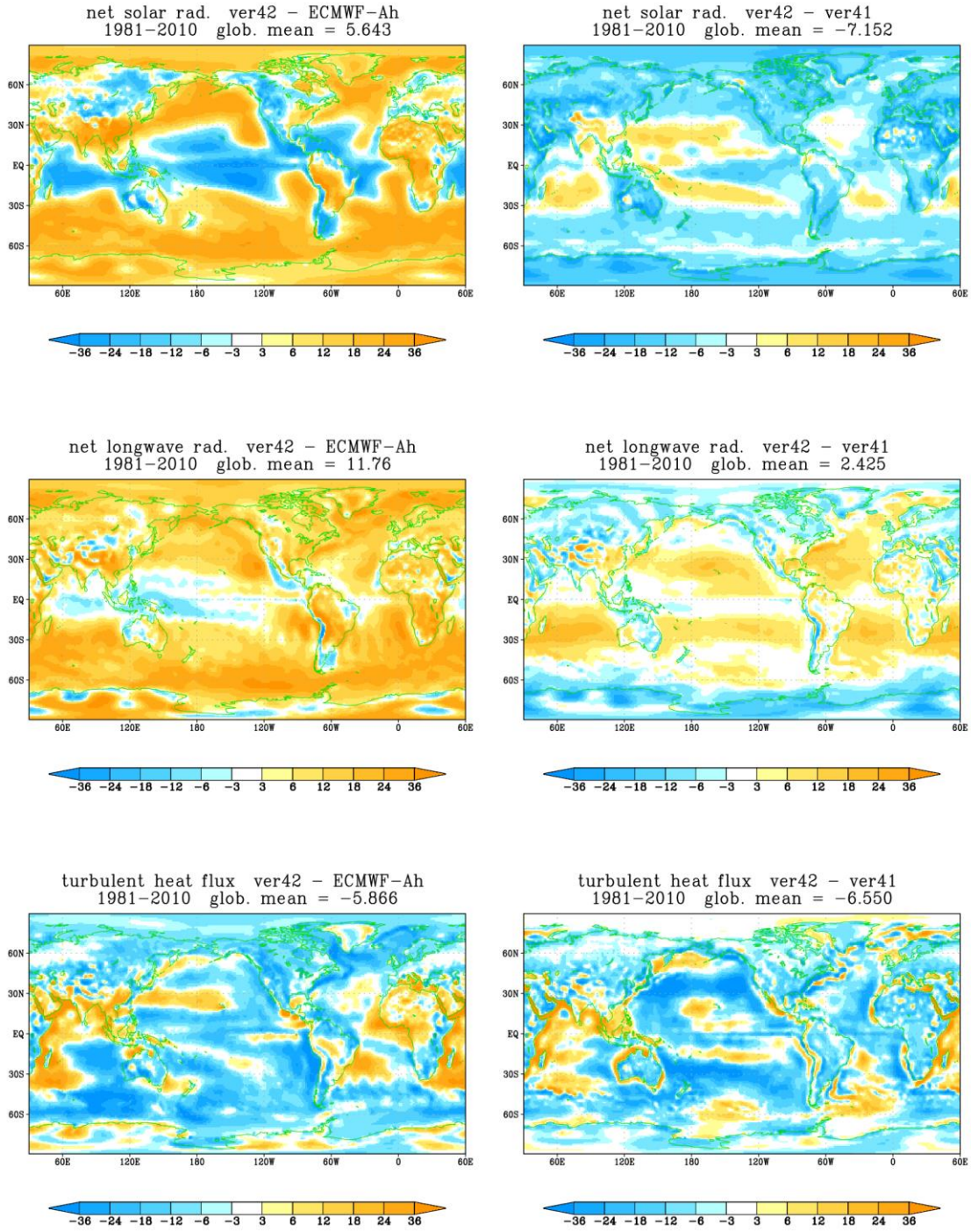

Figure S2: Difference between annual-mean surface heat fluxes from SPEEDY and ECMWF ensembles with prescribed SST. Left: SPEEDY v.42 minus ECMWF historical ensemble (Roberts et al. 2018); right: SPEEDY v.42 minus SPEEDY v.41. Top: net solar radiation; centre: net longwave radiation; bottom: turbulent (sensible + latent) heat flux. Global-mean values are listed above each panel. Unit: W/m^2.

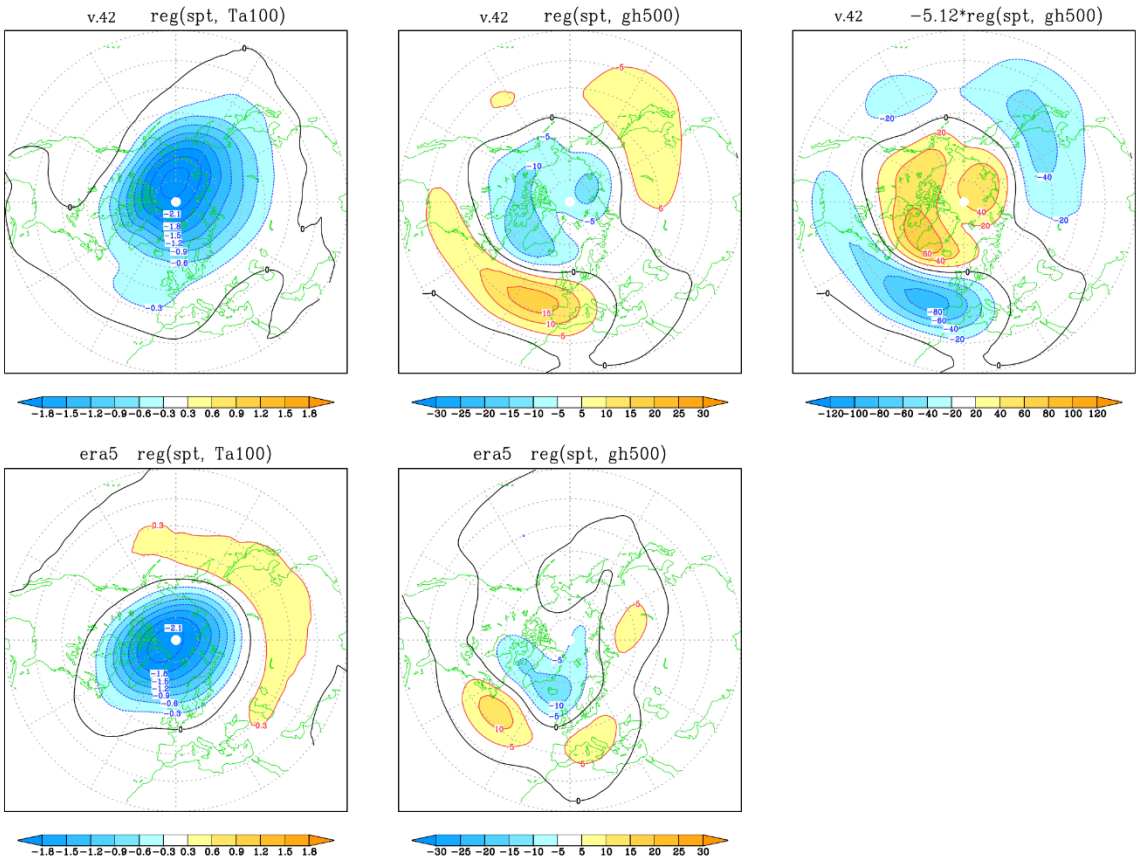

Figure S3: Regression maps against the stratospheric polar temperature (SPT) index defined in Sect. 3.2, for 100-hPa temperature (left, in $^{o}K/^{o}K$) and 500-hPa height (centre, in $m/^{o}K$), from the ensemble with prescribed SST (v.42, top) and ERA5 data (bottom), for JF 1981-2020. The top-right panel shows the model 500-hPa regression multiplied by the difference in the SPT index between the climatologies of two ensembles with v.42 and v.41 parametrizations respectively. This represents the linear contribution of the stratospheric changes to the difference in 500-hPa height climatology shown in Fig. 8f.

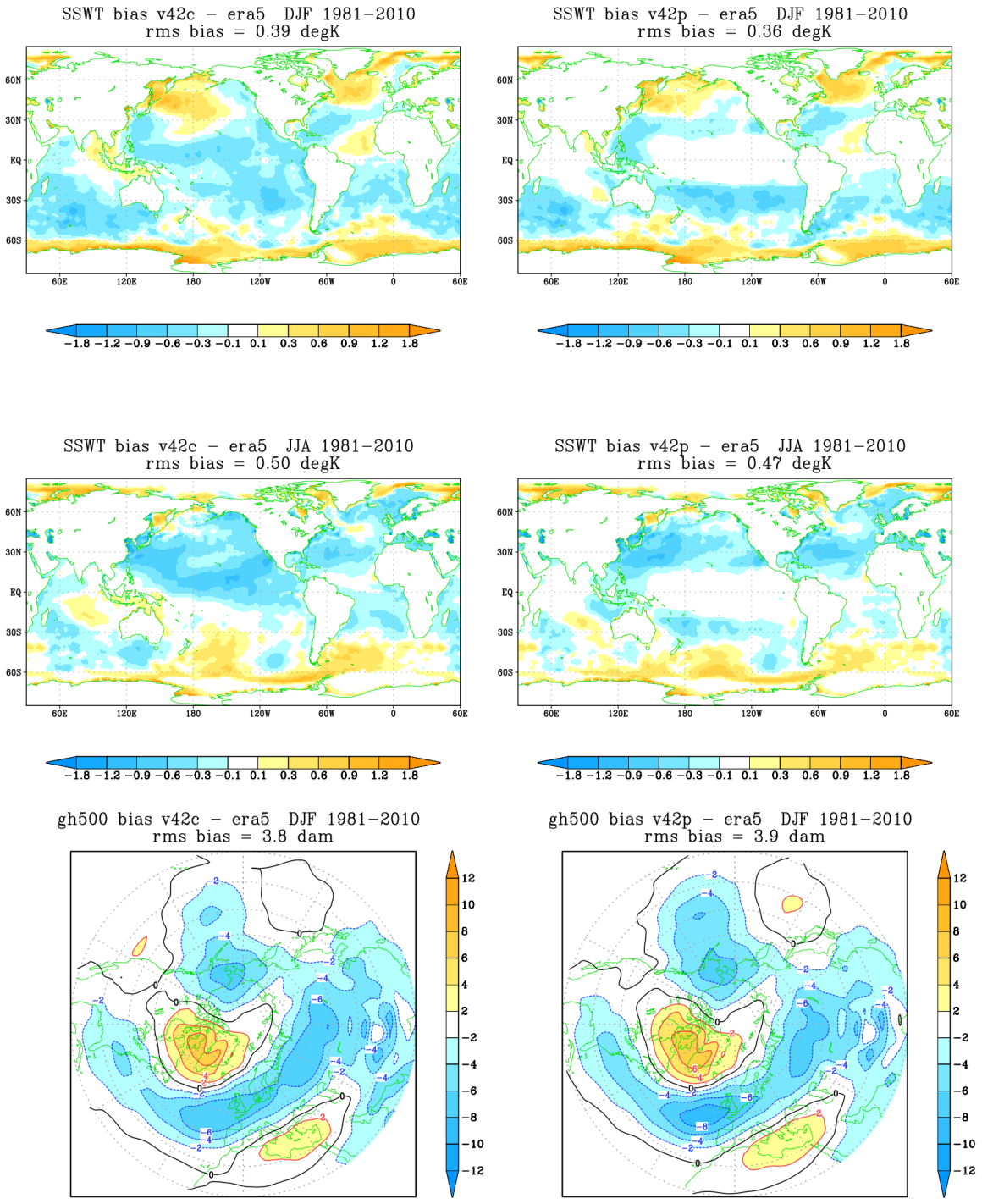

Figure S4: Average biases of SSWT in December-February (top, in ^{o}K), SSWT in June-August (centre, in ^{o}K), 500 hPa height in December-February (bottom, in dam) with respect to ERA5 data in years 1981 to 2010, for the SPEEDY coupled ensemble without SST relaxation (v.42c, left) and the pacemaker ensemble (v.42p, right).

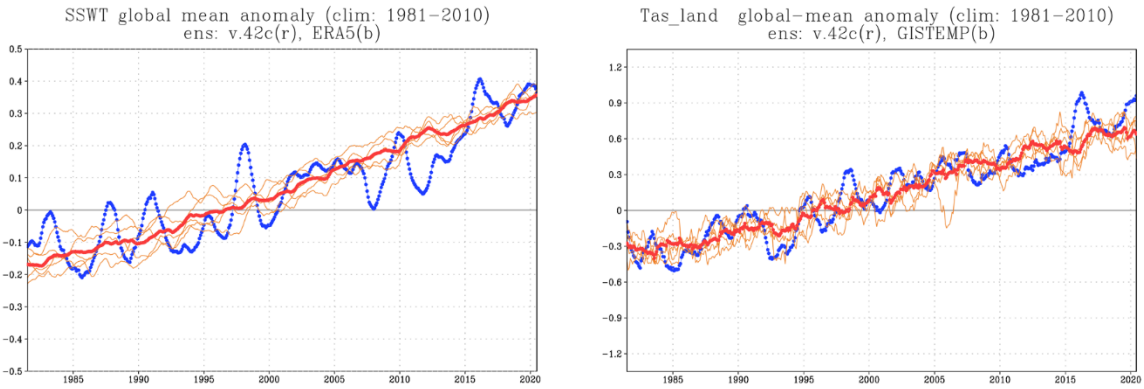

Figure S5: Time series of global and annual-mean variability of surface sea-water temperature (SSWT, left), and SAT over land (right), from a SPEEDY-TOM3 coupled ensemble for 1980-2020 without relaxation to observed tropical SST (v.42c). All data are anomalies from a 1981-2010 climatology, in ^{o}K. Red curve: ensemble mean; orange curves: individual ensemble members; blue curve: observational data from ERA5 (for SSWT) and GISTEMPv4 (for land SAT).

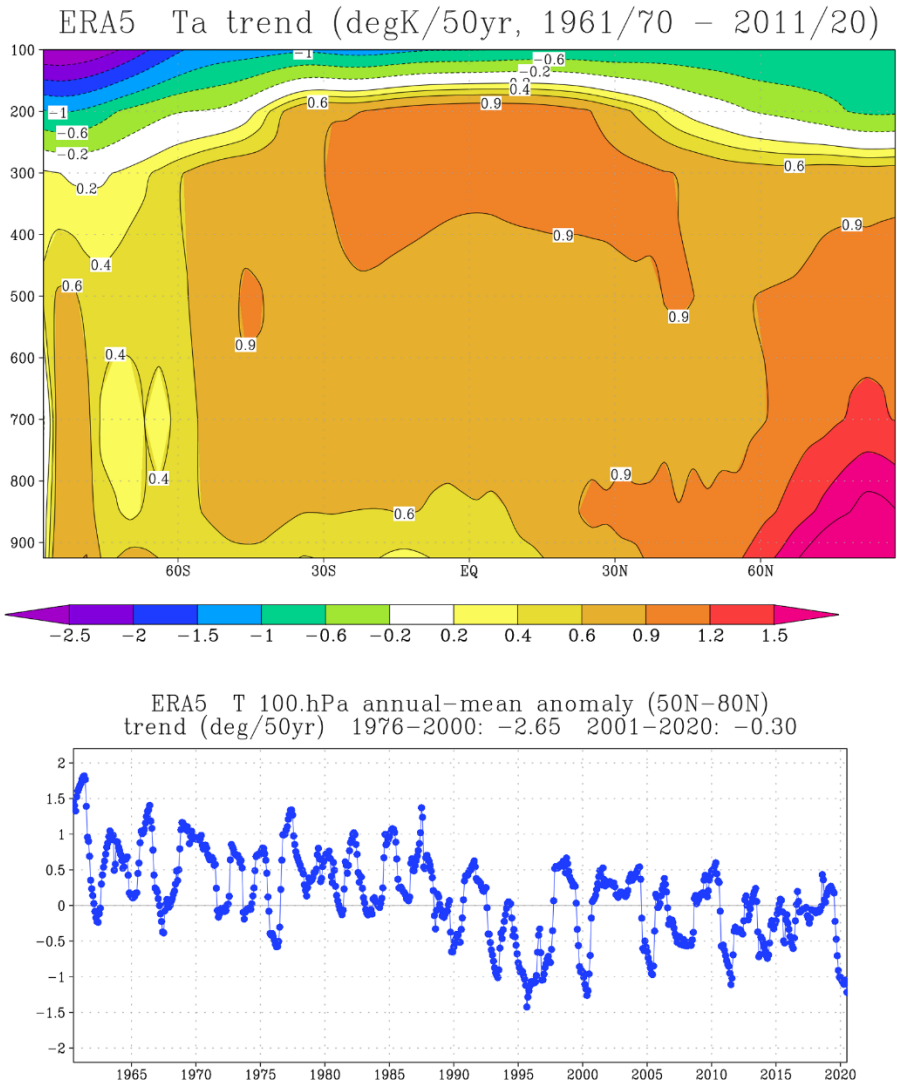

Figure S6: Top: Cross section of the linear trend of atmospheric temperature in the ERA5 re-analysis, computed from overlapping 10-yr means from 1961/70 to 2011/20. Units: ^{o}K/50-yr. Bottom: time series of annual-mean anomaly (w.r.t. 1981-2010) of 100-hPa temperature in ERA5, averaged between 50N and 80N. Trends in specific periods (rescaled to ^{o}K/50-yr) are listed above the panel.

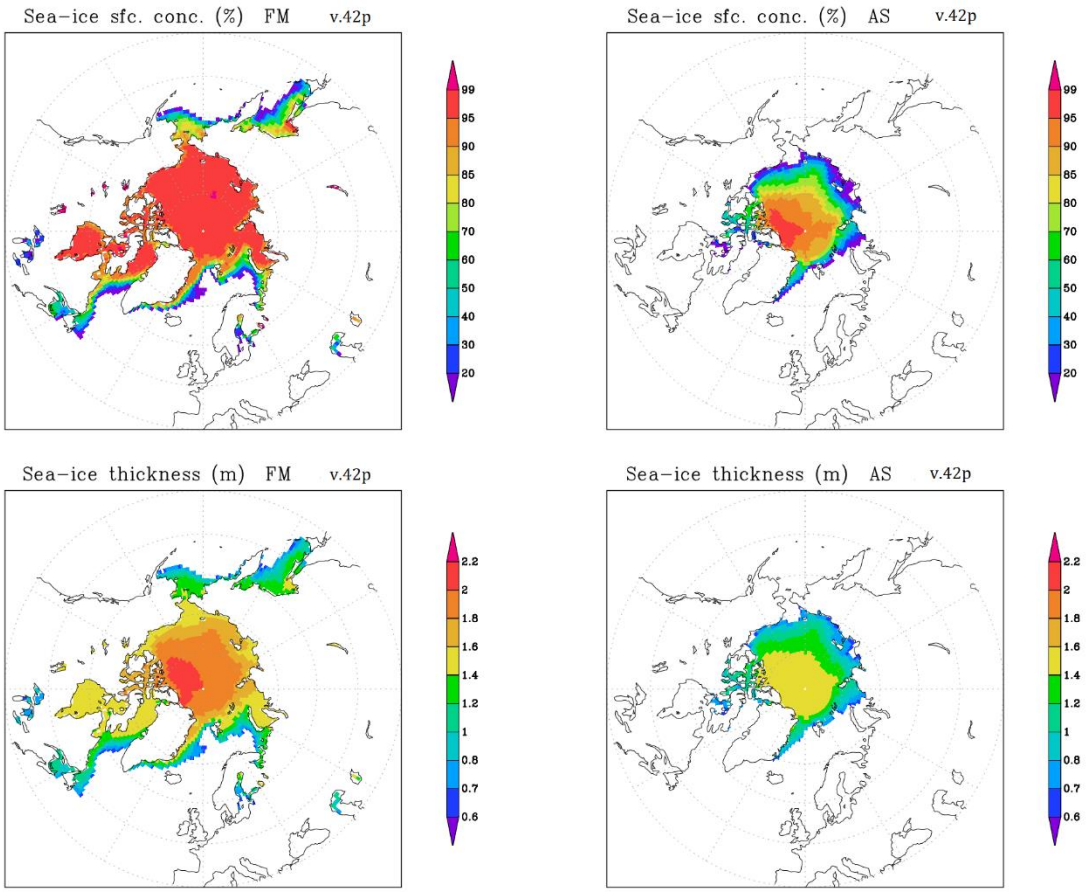

Figure S7: Climatology of sea-ice properties in February-March 1981-2010 (left) and August-September 1981-2010, derived from ERA5 data and used in the TOM3 simulations with prescribed ice mass (as in the pacemaker ensemble v.42p). Top row: surface concentrations from ERA5. Bottom row: estimates of ice thickness derived from ice concentration and surface temperature data, as described in the Appendix.