

Supplementary Figures for

Pacific contribution to the early 20th century

warming in the Arctic

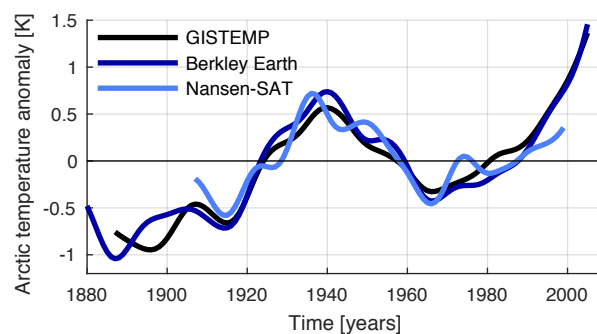
Lea Svendsen¹, Noel Keenlyside^{1,2}, Ingo Bethke³, Yongqi Gao^{2,4} and Nour-Eddine Omrani¹

¹Geophysical Institute, University of Bergen, and Bjerknes Centre for Climate Research,
Bergen, Norway

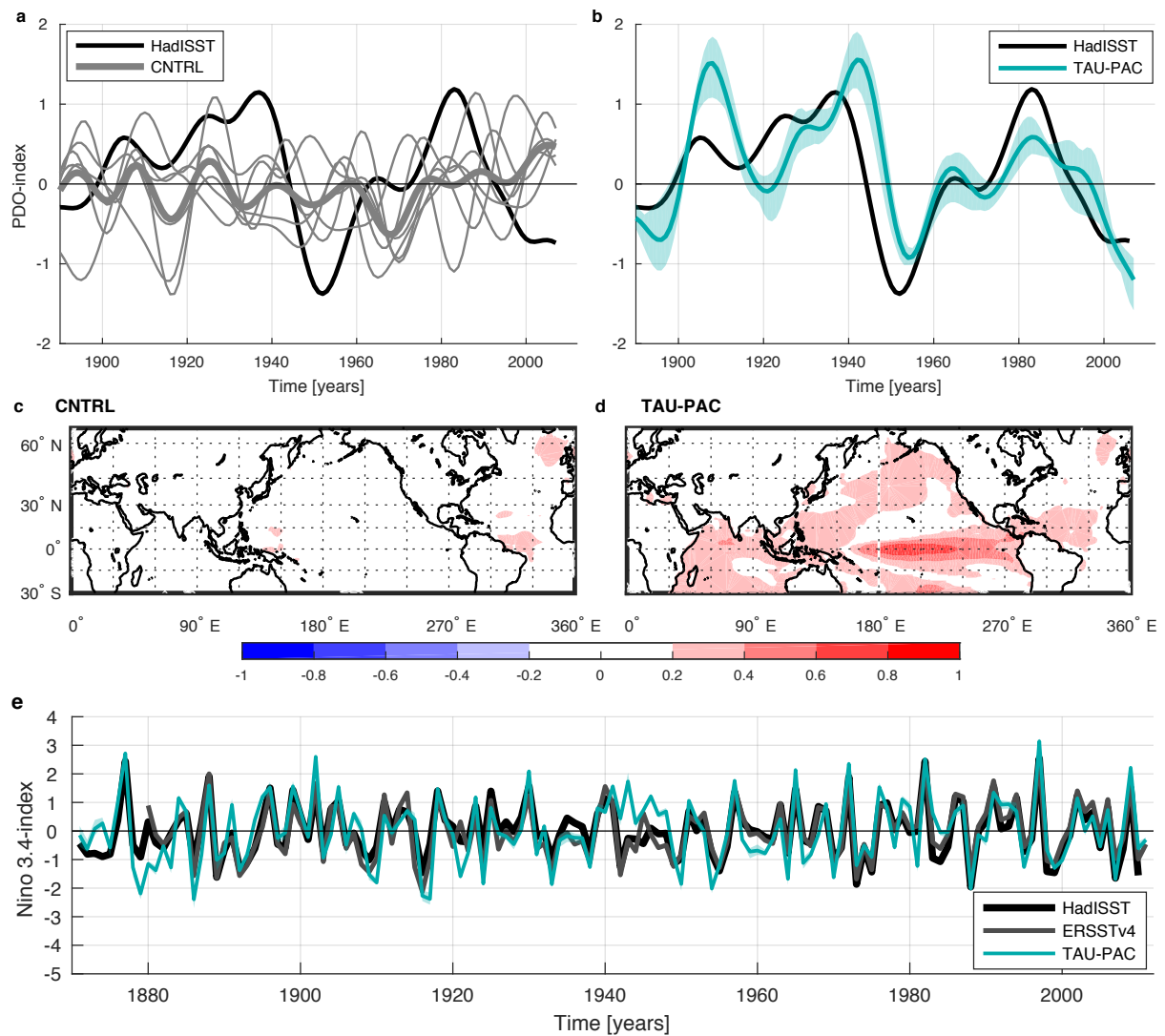
²Nansen Environmental and Remote Sensing Center and Bjerknes Centre for Climate
Research, Bergen, Norway

³Uni Research Climate and Bjerknes Centre for Climate Research, Bergen, Norway

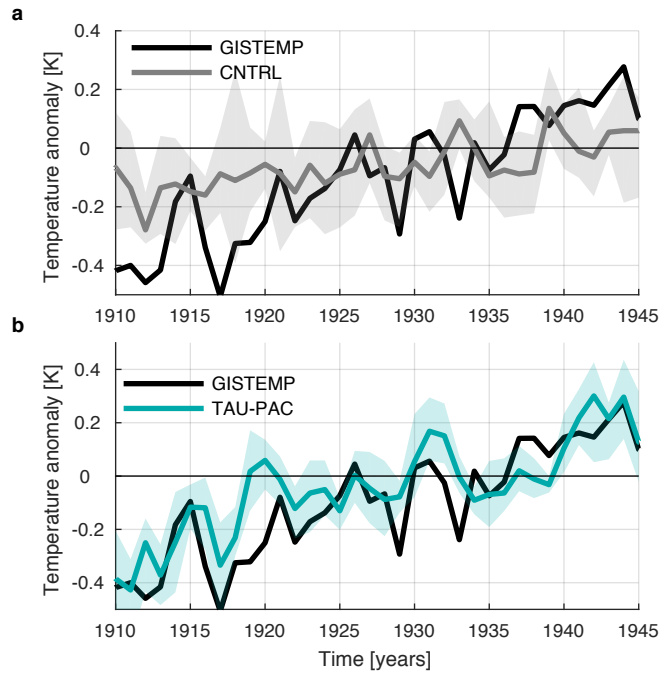
⁴Nansen-Zhu International Research Center, Institute of Atmospheric Physics, Chinese
Academy of Science, Beijing, China



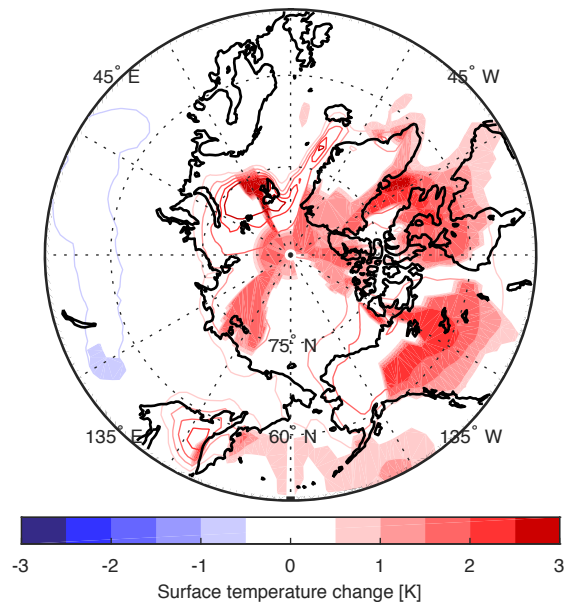
Supplementary Figure 1 Observed Arctic surface temperature. Low-frequency filtered annual Arctic (70-90°N) surface temperature from observational data products: GISTEMP³⁰ (black line), Berkley Earth⁴² (dark blue line), and Nansen-SAT⁴³ (light blue line).



Supplementary Figure 2 Phasing of SST. PDO-index, given by the low-frequency filtered first principle component of detrended SSTs between 20°N-60°N and 120°E-120°W, in observations calculated from HadISST⁴¹ (black) and for **a**, the ensemble mean of CNTRL (thick grey line) and individual ensemble members (thin grey lines), and for **b**, the ensemble mean of TAU-PAC (thick green line) and the ensemble range in green shading. **c**, Significant ($\alpha=5\%$) correlation between HadISST⁴¹ and simulated monthly SST anomalies for CNTRL and **d**, TAU-PAC. **e**, Nino 3.4-index (area-averaged tropical Pacific SST covering 5°S-5°N and 170°-120°W) from observations^{41,40} (black and gray lines) and TAU-PAC (green line) for the cold season (ONDJF). Green shading indicates the ensemble range of TAU-PAC.



Supplementary Figure 3 Northern Hemisphere surface temperature. Annual area-averaged Northern Hemisphere (0-90°N) surface temperature from GISTEMP³⁰ (black solid line) and the ensemble simulations **a**, CNTRL (grey line) and **b**, TAU-PAC (green line). Green (grey) shading indicates the ensemble range of TAU-PAC (CNTRL).



Supplementary Figure 4 Change in surface temperature. Change in surface temperature north of 50°N in K given by the difference between the average over two periods 1936-1945 and 1911-1920 in TAU-PAC for the cold season (ONDJF). Filled contours indicate where the change in TAU-PAC is significantly different from CNTRL at a 10% level. Contour levels are shown for every 0.5 K.

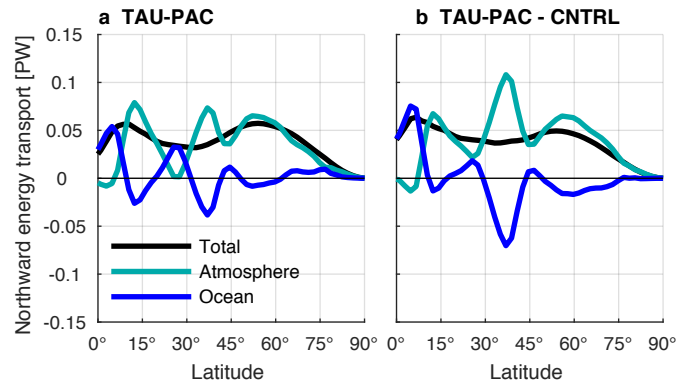
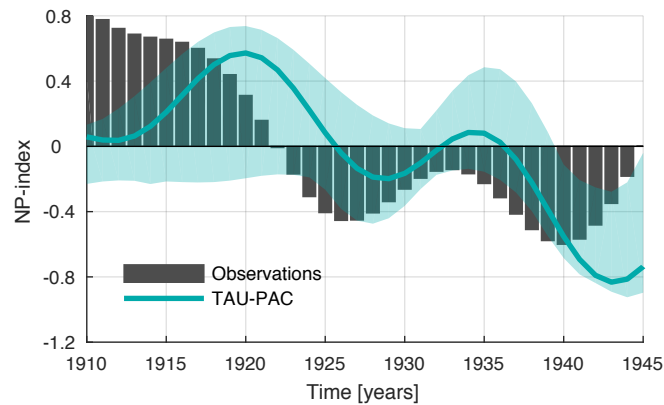


Figure 5 Energy transport. a, Change in northward energy transport between the average over two periods 1936-1945 and 1911-1920 in the ocean (blue line), atmosphere (green line) and the total (black line) in TAU-PAC. **b**, The difference between TAU-PAC and CNTRL in change in northward energy transport between the average over two periods 1936-1945 and 1911-1920 in the ocean (blue line), atmosphere (green line) and the total transport (black line).



Supplementary Figure 6 NP-index. Low-frequency filtered NP-index, defined as area-averaged winter (November to March) SLP over midlatitudes (30°N-65°N and 160°E-140°W) in the North Pacific, from observations²⁰ (black bars) and from TAU-PAC (green line). Green shading indicates the ensemble range of TAU-PAC.

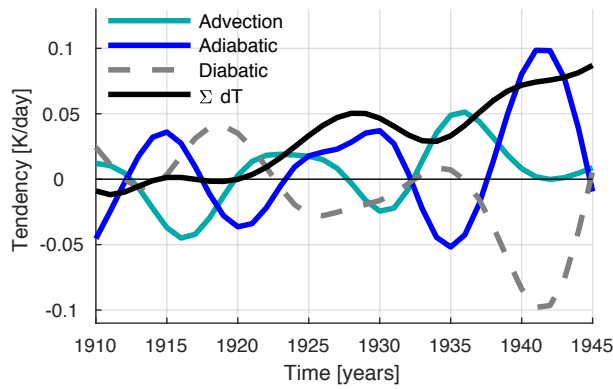
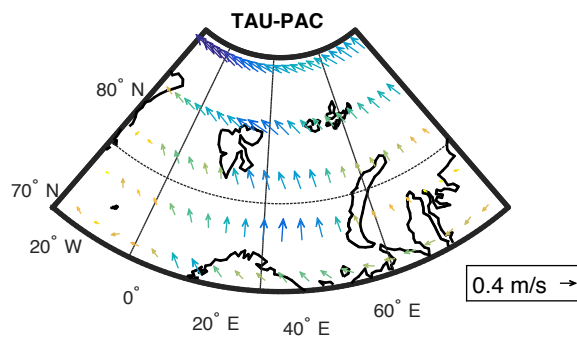
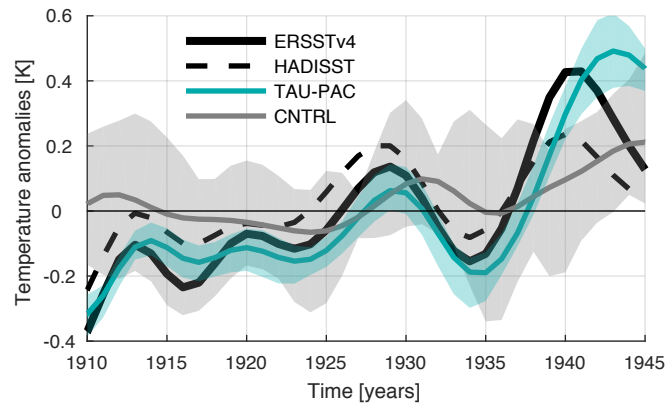


Figure 7 Heat budget. Low-frequency filtered (cut-off frequency of 9 years) ensemble mean difference between TAU-PAC and CNTRL in low level (below 700hPa) heat advection (green line), adiabatic heating (blue line), diabatic heating (grey dashed line), and the cumulated temperature tendency (black line) over the Arctic (north of 70°N) for the cold season (ONDJF).



Supplementary Figure 8 Change in winds in the Barents Sea. Change in winds at the lowest model level in TAU-PAC in the Barents Sea given by the difference between the average over two periods 1936-1945 and 1911-1920 for the cold season (ONDJF).



Supplementary Figure 9 Tropical Pacific SST. Low-frequency filtered (cut-off frequency of 9 years) tropical Pacific SSTs area-averaged over the region 25°S-25°N and 180°E-90°W in observations^{41,40} (black dashed and solid lines), CNTRL (grey line) and TAU-PAC (green line) for the cold season (ONDJF). Green (grey) shading indicates the ensemble range of TAU-PAC (CNTRL).