Extratropical Ocean Warming and Winter Arctic Sea Ice Cover since the 1990s

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Arctic Warming (Amplification)

✓ Sea ice
✓ Heat and moisture transport
✓ Inflows of Atlantic and Pacific waters
✓ Local radiative effect
✓ Increased emittance of blackbody
✓ Reduced air pollution et al.
Motivation

(a) ET-SST EOF1 (1870-2012)

(b) ET-SST PC1

The period from 1994 to 2013
Teleconnection of ET warming (detrended)

**Air temperature at 2 m**

(a) T2m

**Arctic sea ice cover**

(b) ASIC

1994–2013
Differences in zonal wind (blue contours), E–P flux (vectors), and its divergence (red contour) between high and low ET-SST PC-1.
NCAR-CAM$_3$
Experimental design (Exp. 1)

1 CAM$_3$ is forced by climatological and monthly-mean SST and sea ice (1979–2010)
2 For extra-tropical oceans ($20^\circ$N–$70^\circ$N), the model is forced by the observed 35-yr (from January 1979 to December 2013, $35 \times 12$ months).
3 10 members
Simulated quantities regressed to ET-SST PC-1 during 1994–2013
NCAR-CAM$_3$

Experimental design (Exp. 2, 3 and 4)

- Exp. 2, control simulations in which CAM$_3$ is forced by climatological monthly mean SST and sea ice (1979–2010)
- Exp. 3, sensitivity simulations in which CAM$_3$ is forced by perturbed winter ET-SST ($20^\circ$N–70$^\circ$N)
- Exp. 4, sensitivity simulations in which CAM$_3$ is forced by perturbed winter NP-SST ($110^\circ$E–110$^\circ$W, 20$^\circ$–70$^\circ$N);
Simulated impact of ET-SST (Exp. 3 minus Exp. 2)
Simulated impact of NP-SST
(Exp.4 minus Exp.2)
The winter extra-tropical warming (in particular, the warming in the Pacific) can influence the winter Arctic warming by strengthening the polar vortex and modulating the near surface atmospheric heat and moisture transport.

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