The inter-relationship between subtropical western-central Pacific sea surface temperatures (STWCPSST), Arctic sea ice concentration (SICBS), and the North Atlantic Oscillation (NAO) is investigated for the last 37 summers and winters (1980–2016). Lag-corrected time series of the STWCPSST(t−1) in spring with the NAO phase and SICBS in summer increases over the last two decades, reaching r = 0.4–0.5 with significance at 5 percent, while winter has lag correlations in 1985–2005. Observational analysis and the atmospheric general circulation model experiments both suggest that STWCPSST warming acts to increase the Arctic geopotential height and temperature in the following season. This atmospheric response extends to Greenland, providing favorable conditions for developing the negative phase of the NAO. SIC and surface albedo tend to decrease over the Beaufort Sea in summer, linked to the positive surface net shortwave flux. Energy balance considering radiative and turbulent fluxes reveals that available energy that can heat surface is larger over the Arctic and Greenland and smaller over the south of Greenland, in response to the STWCPSST warming in spring.

Abstract

The inter-relationship between subtropical western-central Pacific sea surface temperatures (STWCPSST), sea ice concentration in the Beaufort Sea (SICBS), and the North Atlantic Oscillation (NAO) are investigated for the last 37 summers and winters (1980–2016). Lag-corrected time series of the STWCPSST(t−1) in spring with the NAO phase and SICBS in summer increases over the last two decades, reaching r = 0.4–0.5 with significance at 5 percent, while winter has lag correlations in 1985–2005. Observational analysis and the atmospheric general circulation model experiments both suggest that STWCPSST warming acts to increase the Arctic geopotential height and temperature in the following season. This atmospheric response extends to Greenland, providing favorable conditions for developing the negative phase of the NAO. SIC and surface albedo tend to decrease over the Beaufort Sea in summer, linked to the positive surface net shortwave flux. Energy balance considering radiative and turbulent fluxes reveals that available energy that can heat surface is larger over the Arctic and Greenland and smaller over the south of Greenland, in response to the STWCPSST warming in spring.

Data and Model experimental design

SIC data: HadISST2 (http://www.metoffice.gov.uk/hadobs/hadisst2/data/download.html)

Atmospheric reanalysis: MERRA-2 (0.625° × 0.5° longitude-latitude resolution)

Global model: NASA GEOS-5 AGCM

Experiments:
1) Exp CTL: Climatological SST is prescribed globally.
2) Exp SPW: forced by the same SST as Exp CTL, except over the subtropical western-central Pacific (130°–200°E, 0°–35°N) where 1°C warming has been added to climatology.
3) Warming is imposed only for spring (MAM) and fall (SON) to explore their warming impact on temperature in the following season. This atmospheric response extends to Greenland, providing favorable conditions for developing the negative phase of the NAO. SIC and surface albedo tend to decrease over the Beaufort Sea in summer, linked to the positive surface net shortwave flux. Energy balance considering radiative and turbulent fluxes reveals that available energy that can heat surface is larger over the Arctic and Greenland and smaller over the south of Greenland, in response to the STWCPSST warming in spring.

STWCPSST variation in spring could explain about 25% of the variance of summer SICBS. c) High correlation between NAO and SICBS at both positive and negative lag implies possibility of their strong linkage and positive feedback.

In winter, statistically significant lag-correlations between STWCPSST and NAO/SICBS are found at the moving windows centered in 2000.

Model experiment: Exp SPW – Exp CTL, and Discussion

Since 2006, seasonal mean NAO was in negative phase in 10 summers (out of 11). The SICBS co-vary with the NAO phase in the 21st century summers. STWCPSST (AMJ) shows a negative relationship with the summer NAO phase in the 21st century.