Influence of extra-tropical oceanic variability on the interannual-to-decadal variability of the midlatitude atmosphere

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Evidence is mounting that the interannual-to-decadal variability of midlatitude western boundary currents and associated mesoscale eddies can have discernible impacts on the variability of large-scale atmospheric circulations. However, it is still unclear how such extra-tropical oceanic influences interfere with the dominant remote influences from tropics, under the intense intrinsic variability in the midlatitude atmosphere. To examine this, we perform a series of 20-member ensemble AGCM experiments with a horizontal resolution about 100km for the period 1982-2013, forced with (1) global, time-varying, satellite-observed high-resolution sea ice concentration (SIC) and sea surface temperature (SST) (Global Ocean-Global Atmosphere, GOGA) and (2) time-varying SST only in tropics and daily climatological mean SST and SIC elsewhere (Tropical Ocean-Global Atmosphere, TOGA).

We here focus on modulation of extra-tropical atmospheric circulation response to El Niño-Southern Oscillation (ENSO) by decadal variability of extra-tropical North Pacific. As an index for the latter, we choose the Kuroshio Extension (KE) index (KEI) as it represents the decadal bimodal states of the major western boundary current that are accompanied by basin-scale SST anomalies in the North Pacific (Qiu et al. 2014). While GOGA ensemble mean well reproduces the observed, wintertime mid-tropospheric geopotential height anomalies associated with Nino3.4 index that resemble the Pacific North American (PNA) pattern for the entire analysis period, the composite analysis with respect to the KEI shows that the PNA-like response to ENSO is stronger (weaker) during the period when the KE is in its unstable (stable) state. This decadal modulation of ENSO teleconnection vanishes in TOGA ensemble, indicative of extra-tropical SST variability playing a role in the modulation. Further KEI-composite analysis in GOGA ensemble mean shows that the upper tropospheric jet shifts northward and extends further east over Northeastern Pacific through the American continent, suggesting that decadal change in the background atmospheric state caused by the extratropical oceanic variability modulates the extra-tropical atmospheric circulation response to ENSO.

Key words: ENSO teleconnection, decadal-scale modulation, PNA pattern, ensemble AGCM runs

References

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