



Can solar cycle modulate the ENSO effect on the Pacific/North American pattern?

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The ENSO effect on the Pacific/North American pattern (PNA) is well-known robust. Recent studies from observations and model simulations have reported that some important atmospheric circulation systems of extratropics are markedly modulated by the 11-year solar cycle. But less effort has been devoted to revealing the solar influence on the PNA. We thus hypothesize that the instability and uncertainty in the relationship between solar activity and PNA could be due to the ENSO impacts. In this study, the solar cycle modulation of the ENSO effect on the PNA has been statistically examined by the observations from NOAA and NCEP/NCAR for the period 1950–2014. The results indicate that during high solar activity (HS) years, the PNA has stronger relevance to the ENSO, and the response of tropospheric geopotential height to ENSO variability is broadly similar to the typical positive PNA pattern. However, in the case of low solar activity (LS) years, the correlation between ENSO and PNA relatively decreases and the response has some resemblance to the negative phase of Arctic Oscillation (AO). Also, we find the impacts of solar activity on the middle troposphere are asymmetric during the different solar cycle phases, and the weak PNA-like response to solar activity only presents in HS years. Closer inspection suggests that the higher solar activity have a much more remarkable modulation on the PNA-like response to the warm ENSO (WE) than that to the cold ENSO (CE), particularly over the Northeast Pacific region. The possible cause of the different responses might be the solar influence on the subtropical westerlies of upper troposphere. When the sea surface temperature (SST) of east-central tropical Pacific is anomalous warm, the upper tropospheric westerlies are significantly modulated by the higher solar activity, resulting in the acceleration and eastward shift of the North Pacific subtropical jet, which favors the propagation of WE signal from the tropical Pacific to the North Pacific, and consequently the relationship between ENSO and PNA is evidently strengthened. Thus, it seems that solar cycle can significantly modulate the WE effect on the PNA under HS background.