Geophysical Research Abstracts
Vol. 21, EGU2019-6511, 2019
EGU General Assembly 2019

Persistent atmospheric anomalies causing the intensity variation of wintertime basin-scale North Pacific subtropical oceanic front

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The basin-scale subtropical frontal zone (STFZ) in the North Pacific is a key region for midlatitude air-sea interaction. With reanalysis and observational data, this study has investigated the atmospheric anomalies that cause the intensity variation of wintertime basin-scale North Pacific subtropical oceanic front, and found three atmospheric modes that are associated with STFZ's wintertime intensity variation: Arctic Oscillation (AO), Pacific-North American teleconnection (PNA) and North-Atlantic Oscillation (NAO). Lead-lag correlations show that prior to the enhanced STFZ, there exist persistent atmospheric anomalies characterized by negative-phase AO and positive-phase PNA, lasting for up to 80-days and 50-days, and peaking at 20-days and 8-days, respectively. Although NAO correlates with STFZ, it seems more like a regional representation of AO. Furthermore, it's found that the long-lasting negative-phase AO benefits for stronger low-tropospheric baroclinicity around 40°N over the North Pacific where there is a climatological baroclinic region. This stronger baroclinicity tends to induce more transient eddy (TE) activities, acting to promote an equivalent barotropic geopotential low anomaly north of STFZ via the TE vorticity forcing. This anomalous geopotential low propagates downstream through wave activity flux (WAF) in a great circle path, triggering a PNA-like anomaly. Under above atmospheric internal wave-flow feedback promoted by AO, the regional PNA mode is intensified and embedded in the annular AO mode. The intensified Aleutian Low and surface westerly wind which peak at an 8-day lead, precondition a persistent atmospheric forcing on STFZ. The surface westerly anomaly predominantly favors to drive a southward cold Ekman current and increase upward surface heat flux through amplified wind speed and sea-air temperature difference, amplifying underneath negative SST anomaly and cross-frontal meridional SST gradient, ultimately intensifying STFZ.