The North Pacific as a Regulator of Summertime Climate over Eurasia and North America

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ABSTRACT

The role of the North Pacific as a regulator of boreal summer climate over Eurasia and North America is investigated using observational data. Two summertime interannual climate modes associated with sea surface temperature (SST) variability in the North Pacific are identified. The first mode shows an elongated zone of warm (cold) SST anomalies in the central North Pacific along 40°N, with temporal variability significantly correlated with El Niño during the preceding spring, but its subsequent evolution is quite different from El Niño. The second mode exhibits a seesaw SST variation between the northern and southern North Pacific and is independent of El Niño. Both modes are linked to coherent SST anomalies over the North Atlantic, suggesting the presence of an "atmospheric bridge" linking the two extratropical oceans.

Using the principal component of the most dominant mode as the North Pacific index (NPI), composite analyses show that the positive (negative) phase of NPI features a warm (cold) North Pacific associated with the formation of contemporaneous low-level stationary anticyclones (cyclones) over the North Pacific and North Atlantic, respectively. The anticyclones (cyclones) are linked by quasi-zonally symmetric circulation anomalies in the middle to upper troposphere spanning Eurasia and North America, accompanied by a poleward (equatorward) shift of the subtropical jet and storm tracks. Associated with the positive (negative) phase of NPI, are hot/dry (cool/wet) summers over Japan, Korea, and eastern-central China, which are linked to hot/dry (cool/wet) conditions in the Pacific Northwest, western Canada, the U.S. northern Great Plains, and the Midwest. Cumulative probability computed from pentad temperature and rainfall data show that the odds of occurrence of extreme events are impacted consistently with the mean climate shift during opposite phases of the NPI. The possible roles of air–sea interaction and transient-mean flow interaction in exciting and sustaining the climate modes are discussed.

1. Introduction

In the past several years, the influence of the North Pacific on the climate variability of the United States has received much attention, mainly due to the identification of the so-called Pacific decadal oscillation (PDO) and its possible long-term modulation of El Niño impacts on the climate of the nation (Trenberth and Hurrell 1994; Kawamura 1994; Deser and Blackmon 1995; Zhang et al. 1997; Gershunov and Barnett 1998; Mantua et al. 1997, and others). However, it is worth noting that the importance of the North Pacific in regulating extratropical climate on a wide range of time scales had been known for a long time. In numerous papers dating back to the 1960–70s, Namias and collaborators (e.g., Namias 1959, 1976, and others) observed that SST and atmospheric circulations over the North Pacific had a strong influence on weather and climate over North America. Yet, atmospheric general circulation model studies of the impact of the North Pacific on extratropical climate were generally incon-

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