Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

AAS23-03 Room:301A Time:May 22 14:18-14:33

The Pacific-Japan teleconnection pattern as an atmospheric internal mode and influence of ENSO

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The Pacific-Japan (PJ) pattern is one of the dominant atmospheric teleconnection patterns that influence East Asian summer climate. The pattern is characterized by meridional dipoles of precipitation and lower-tropospheric circulation over the western North Pacific. While its correlation with decaying El Nino-Southern Oscillation (ENSO) is widely known, recent studies suggested that the PJ pattern is an atmospheric internal mode of variability.

In order to assess this possibility, we have conducted two sets of ensemble experiments based on a coupled general circulation model (CM) and its atmospheric component (AM) developed at U.S. Geophysical Fluid Dynamics Laboratory (GFDL). In CM, sea surface temperature (SST) anomalies are restored toward historical values over the equatorial eastern Pacific, so that the model reproduces historical ENSO. For AM, we have prescribed ensemble-mean SST of the CM commonly to all ensemble members. Thus ensemble-mean anomalies represent variability associated with ENSO, while deviations from ensemble means extract ENSO-independent anomalies in CM and atmospheric internal variability in AM.

Our empirical orthogonal function (EOF) analysis of monthly anomalies detects the PJ pattern as the leading mode both from ensemble-mean and inter-member variance of CM. This result indicates that the PJ pattern exists in the absence of ENSO. Our additional EOF analysis of inter-member AM anomalies reveals that the PJ pattern is an atmospheric internal mode. Yet, the ensemble-mean PJ pattern correlates with both developing and decaying ENSO, and it is revealed that ENSO forces about 40% of the monthly PJ variance. This considerable ENSO forcing is consistent with an interdecadal amplification of the PJ pattern after the mid-1970s climate regime shift and an intensification of ENSO.

Keywords: the summer western North Pacific, GCM, mode of variability