Geophysical Research Abstracts
Vol. 14, EGU2012-3903, 2012
EGU General Assembly 2012

Hemispheric Circulation Regimes Associated with Predominant Anomaly Patterns of Wintertime Temperature Distribution over the Far East

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Characteristics of extratropical planetary flow regimes in the Northern Hemisphere associated with prevailing spatial patterns of temperature anomaly distribution in the winter season (DJF) over the Far East are examined based on 2D phase space spanned by the leading two EOFs of the Far East low-frequency temperature variation by the use of ERA-40 reanalysis dataset from 1957/58 to 2001/02 winter and NOAA OLR dataset from 1979/80 to 2001/02 winter.

The first EOF of 10-day low-pass filtered 850-hPa temperature anomaly in the winter season over the Far East (25˚N-50˚N, 120˚E-150˚E) represents a coherent temperature variation over the whole domain while the second EOF corresponds to a meridional dipole pattern with a node around 40˚N. These two leading EOFs explain 76% of the total temperature variance over the Far East. Regression analysis of 250-hPa height anomaly with respect to the corresponding PCs shows that EOF1 and EOF2 are related to the Eurasian (EU) and the West Pacific (WP) pattern, respectively.

The PDF of 850-hPa low-frequency temperature anomaly is estimated by the kernel density estimation method of Kimoto and Ghil (1993) in 2D phase space spanned by the leading 2 PCs. Inhomogeneity of the observed PDF from the bivariate Gaussianity is evaluated by a nonparametric method, and we find the existence of two distinct regimes with significantly greater PDF than the Gaussianity: One regime (regime A) represents an atmospheric state with low temperature anomaly over the whole Far East region, especially over Western Japan. The other regime (regime B) corresponds to a state with a prevailing weak positive temperature anomaly over the Far East.

Finally, a composite analysis of 250-hPa height anomaly associated with regime A based on the 2D phase space reveals its time evolution as follows: Blocking developing over the Alaska 15 days (day -15) before the mature phase of regime A has a retrograde phase velocity and resides over the Sea of Okhotsk. After day -10, the EU pattern emanating from cyclonic anomaly over Europe creates a cyclonic anomaly over Western Japan and an anticyclonic anomaly over East Siberia. The anticyclonic anomaly is also amplified through the superposition of the retrograding blocking. Then, regime A comprising the EU pattern and the WP pattern with a dominant negative height anomaly over Western Japan causes a strong cold surge in Southeast Asia. Moreover, the analysis on the OLR dataset reveals that an upper-tropospheric Rossby wave train emanating from the Bay of Bengal due to an anomalous convective activity over the South China Sea also plays an important role in forming the cyclonic anomaly over Western Japan. We will discuss the recent high occurrence probability of regime A in connection with the warming trend of the SST over the western Pacific due to the global warming.