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Climate variability in the northeast Asia

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The lecture deals with major patterns of the different scale climate variability in the Northern Asian Pacific based mainly on statistical analyses the climatic oscillations and trends in the sea surface temperature (SST) for the Northwest Pacific, as well as in the monthly mean surface air temperature and precipitation for the Northeast Asia. A portion of attention is focused on the regional features of climate variability of different time scale in the Amur River Basin, and Sea of Okhotsk Ice Extend affected by the large-scale climate change in the Asian Pacific.

The EOF decomposition, wavelet analyses, and methods of linear trend estimation, are applied to study the different scale climate variability. Linear trend of monthly mean precipitation and air/water temperature is estimated by two statistical methods. The first one is the least squares method with the Fisher's test for a significance level. The second method is a nonparametric robust method based on the Theil's rank regression and the Kendall's test for a significance level applicable to the dataset with the abnormal distribution function typical for the precipitation time series.

The climatic oscillations with semi-centennial (50-60 years, Minobe, 1997), interdecadal (15-25 years, Mantua et al., 1997), quasi-decadal (8-15 years), ENSO (4-7 years), and biennial oscillations time scales play a significant role in the Asian-Pacific climate variability. Major effects of both climate change and most of climatic oscillations in the North-East Asia are associated with monsoon system variability similar to the climate variability in China (Li et al., 2001 and India Webster and Yang, 1992; Pai, 2004). This effect is accompanying seasonal anomalies which are usually inversed in winter and summer in the subarctic area like in the ENSO signal in the Northeast Asia (Ponomarev et al. 1999, 2003). Negative statistical relationship between decadal-scale oscillation in the Okhotsk Sea ice extend and Amur River discharge / annual precipitation in the Amur River basin / summer SST in the NW Okhotsk Sea was found by Ogi et al. (2001) for the time series since 1966 till 1994.

Regional features of climate change and dominating oscillations associated with cooling or warming, positive or negative precipitation anomalies in different seasons and large-scale areas are found. High seasonality of both climatic trends and the low frequency variability in the studied area are revealed. It is shown that the semi-centennial summer cooling in a central continental area of Asia accompanies the semi-centennial negative SST anomaly in the offshore region of the western subarctic pacific gyre. At the same time, warming at Kamchatka Peninsula and marginal subtropic area of the Northeast Asia accompanies the positive SST trend in the Kuroshio and Aleutian current systems. Similar alternation and seasonality of positive and negative temperature anomalies are also typical for the El Nino signal in the Northwest Pacific SST.

The significant ENSO signal in the NW Asian-Pacific thermal conditions in the ocean (Hanawa et al. 1988, Ponomarev et al. 2002) and over land including Okhotsk Sea area (Ponomarev et al. 1999a, 1999b, 2002) shows inversed anomalies in winter and summer in the subarctic area. The surface air temperature anomalies in Okhotsk Sea area and SST in the subarctic North Pacific are very sensitive to the extratropic ENSO signal. Both unlagged and 6 month lagged (SOI leading) air temperature relationships with SOI/Nino3 are significant, at least, for the second half of the 20th century (Ponomarev et al. 1999a, 1999b, 2002). Unfiltered seasonal/annual anomalies of precipitation, Amur River Discharge, and Okhotsk Sea Ice Extend have no statistically significant unlagged correlation with SOI/Nino3 for the similar long-term time series. Nevertheless, during significant El Nina in winter the positive anomaly of the Ice Extend occur, and during significant winter La Nino usually negative Ice Extend anomaly takes place in the Okhotsk Sea with rare exception. It is in line with ENSO-scale anomalies in surface air temperature over Northwest Okhotsk Sea area (Ponomarev et al. 1999a, 1999b).

At the same time, for the variability of ENSO-decadal-interdecadal time scales one can found interaction between decadal and ENSO oscillations (Sekine and Yamada 1996), or ENSO like interdecadal variability (Zhang et al., 1997). Frequency drift in some period is also take place in the multiscale variability (Ponomarev 2003). There are many large-scale and regional processes which influence on the Okhotsk Sea Ice Extend (Akagawa, 1977; Ogi et al., 2001; Vasilevskaya et al., 2003; Ustinova et al., 2004 and others), as well as on the Amur River Discharge and precipitations (Mahinov 2004, Ponomarev and Rudykh 2004, and others). Most of the impacts occur through the synoptic scale processes and stormtrack anomalies (Branstator 1995) in the Northeast Asia and Northwest Pacific related to the ENSO, decadal, and interdecadal Monsoon System variability.

Wavelet transforms show the evolution of frequency, amplitude and phase of the climate oscillation of the biennial (2-3years), ENSO (3–7 years), decadal (8–13), bidecadal (18–22 years), and interdecadal time scales. The borderline scale of the dominating oscillation with period 6-8 years which formally combines ENSO and decadal time scale into one band is also found in the subarctic marginal area. Characteristic inhomogeneity and frequency drift within the period of observations is usually explained by the nonlinear dynamics in the ocean-atmosphere system.