The summary of the atmospheric circulation in summer 2007

From early to mid July, the subtropical high was weaker than normal around Japan, and the subtropical jet shifted more southward than normal. Consequently, the Bai-u front was located over Japan. One of the causes for the weaker subtropical high around Japan was suppressed convection near the Philippines. It is pointed out that the subtropical high near Japan is strengthened when the convective activities near the Philippines are enhanced (Nitta, 1987). In early July, the active phase of the Madden-Julian Oscillation (MJO) propagated from the Maritime Continent to the western Pacific and Typhoon “Man-yi” formed near the Mariana Islands. It passed over the eastward off the Philippines but the convective activities near the Philippines were generally suppressed during July.

Fig.2 shows the distribution of eigen vector calculated from rotated EOF analysis of monthly mean 200hPa zonal wind in July and the time series of its monthly mean EOF score, respectively. The distribution of eigen vector indicates that the subtropical jet over the Far East shifts more southward or northward than normal. The time series of EOF score suggests that Japan tends to experience colder-than- normal climate in the case of remarkable plus score (e.g. 1993, 2003). In the first half of July, Asian jet near Japan shifted more southward than normal. Consequently, the EOF score in July marked around +0.9 and the monthly mean temperatures were lower than normal over the wide area of Japan.

In late July, quasi-stationary Rossby wave packets clearly propagated along the Asian jet (Fig.1(c)). The packets reached near the eastern region of Japan in the beginning of August and enhanced the anti-cyclone over the region in the upper troposphere. In early August, the active convection area associated with the active phase of the MJO moved northward from near the Maritime Continent to the north of the Philippines and the anti-cyclone in the south of Japan was enhanced.

In mid-August, the quasi-stationary Rossby wave propagation along the Asian jet and polar front jet over Eurasia became clear (Fig.1(a) and (c)) and enhanced the trough over the eastern China and the ridge near Japan. At 200hPa height, the northern edge of Tibetan high was remarkably waved and Tibetan high was stronger than normal to its northeast region. The anti-cyclone centered in the upper troposphere covered over Japan and caused extremely high temperature anomalies. Fig.3 shows the distribution of 360K isentropic potential vorticity over the North Pacific. The potential vorticity map is a natural diagnostic tool well suited to making dynamical processes directly visible to the human eye (Hoskins et al, 1985). In Fig.3, the contours over Eurasia clearly meandered, the low potential vorticity broke into near Japan and caused the wave breaking. These are consistent with the meandered Asian jet and strengthened Tibetan high over Japan. In midsummer, thus, stationary Rossby wave packets sometimes propagate along the Asian jet and strengthen the anti-cyclone centered in the upper troposphere over Japan and cause extremely high temperature anomalies there (Enomoto, 2004).

To estimate the contribution of the advection, the adiabatic and diabatic heating to the temperature change, the heat budget analysis was executed for the period of 8-12 Aug. and 12-16 Aug. at 925hPa (Fig.4 and Fig.5). Fig.4 (a) shows the total heating was strong around northern Japan on 8-12 Aug. Fig.4 (c) suggests the horizontal advection mainly contributed to the heating. On the other hand, the strong heating was observed around eastern and western Japan on 12-16 Aug. (Fig.5 (a)), to which the adiabatic heating associated with the descent in the barotropic anti-cyclone mainly contributed (Fig.5 (d)).

In mid-August, the westerly jet remarkably meandered over the northern hemisphere. In late August, the zonal flow became dominant. At the same time, Tibetan high near Japan were weakened and the remarkably high temperature in northern and eastern Japan subsided. However, the western Japan continued to be covered with the barotropic anti-cyclone and the remarkably high temperature persisted.

References

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Hoskins, B.J., M. E. McIntire, and A. W. Robertson, 1985: On the use and significance of isentropic potential vorticity maps. Quart. J. Roy. Meteor. Soc., 111, 877-946.

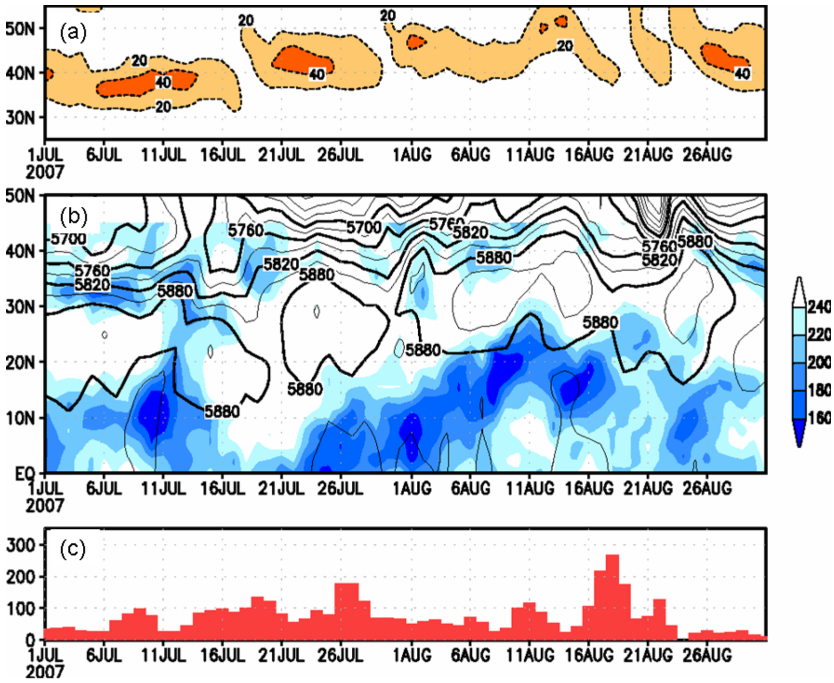

Fig.1 (a) 200hPa zonal wind (m/s, 130-150°E mean), (b) Contours: 500hPa height (m, 130-150°E mean), Shadings: latitude-time cross section of OLR (W/m^2, 110-140°E mean, drawn for south region of 45°N), (c) Time series of the zonal component of 200hPa wave activity flux (m^2/s^2, 60-120°E, 40-50°N mean).

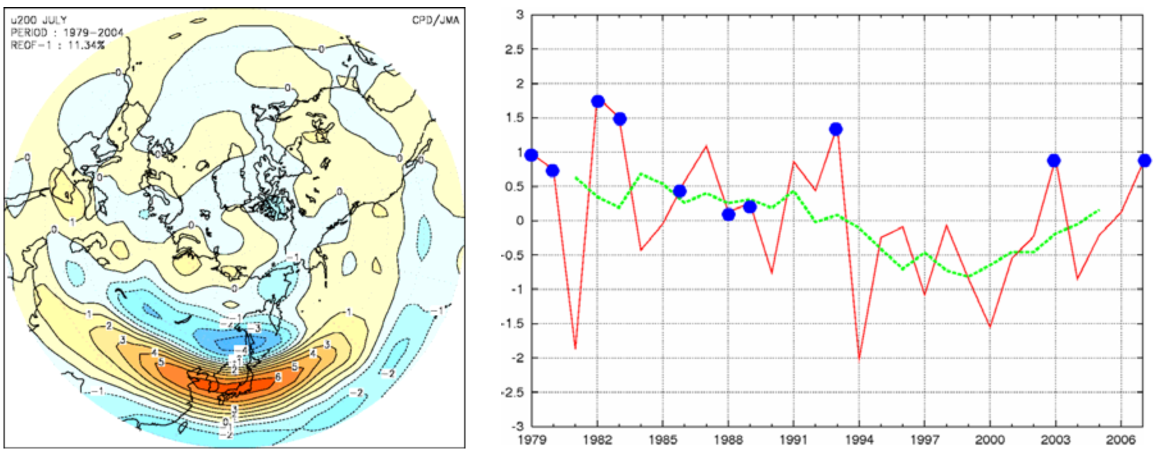

Fig.2 (Left) Distribution of eigen vector calculated from rotated EOF analysis of monthly mean 200hPa zonal wind in July (m/s, 1979-2004). (Right) Time series of its monthly mean EOF score in every July (red-line: values of every years, green-line: 5-year running mean, blue circles show the years when eastern Japan was colder than normal).

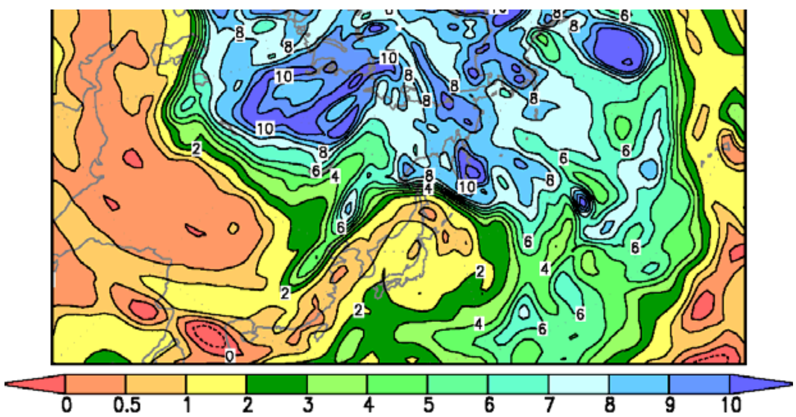

Fig.3 360K isentropic distribution of potential vorticity (PUV).

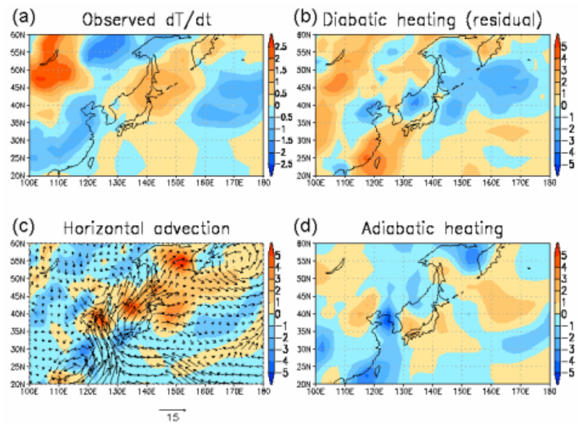

Fig.4 (a) Total heating at 925hPa for 8-12 Aug. (K/day), (b) Diabatic heating (K/day), (c) Horizontal advection (K/day), and averaged wind at 925hPa for the period (m/s), (d) Adiabatic heating (K/day).

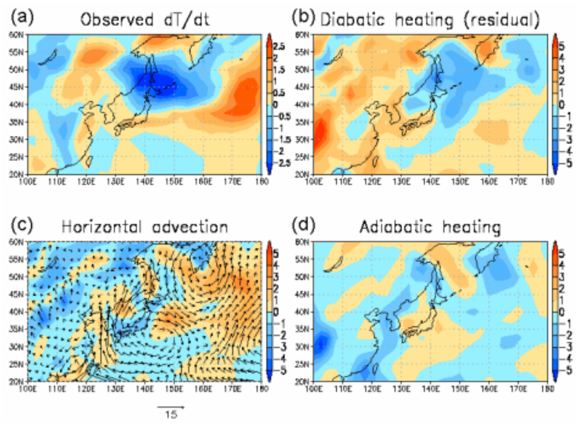

Fig.5 Same as in Fig.4 but for 12-16 Aug.