

# Extremely Cold Weather in Japan and Anomalous Atmospheric Circulations in December 2005

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## 1. Introduction

In December 2005, it was extremely cold over Japan. According to the observation data averaged at 17 points in Japan which were used for monitoring the global warming, monthly mean temperature for the whole Japan was the lowest since 1948. Additionally, significantly heavy snow fell broadly in the Japan Sea side of Japan, and the records of maximum snow depth in December were set at 106 meteorological observatories out of 339, including automated stations, of JMA. In this report, large scale atmospheric circulation anomalies associated with the cold month are examined.

## 2. Predominantly negative phase of the Arctic Oscillation (AO)

In December 2005, the Siberian High and the Aleutian Low were both very strong, and the northerly wind over the western part of the Sea of Japan was the strongest since 1979. The anomalous pressure systems brought very cold month in Japan.

From the view point of hemispherical scale circulations, the anomalous pressure systems are considered to be a part of the negative phase of the Arctic Oscillation (AO). It was observed that positive and negative sea-level pressure anomalies in the Arctic area and the middle latitudes in the Northern Hemisphere, respectively: the predominantly negative phase of the AO persisted through the month.

At CPD/JMA, hemispherical scale circulations in winter are monitored by the leading EOFs of DJF mean 500hPa height in the northern hemisphere. In the month, negative EOF1 scores, which are corresponding to negative phase of the AO, were persisted, and the monthly mean score was the lowest for December since 1979. The zonal mean of zonal wind anomalies showed the typical pattern which is observed when the negative phase of the AO prevails.

## 3. Strong convective activities across the Bay of Bengal to the Philippine Sea

A stationary Rossby wave train forced by very strong convective activities across the Bay of Bengal to the Philippines also caused the cold month in Japan.

In December 2005, convective activities were much stronger than normal over the Bay of Bengal, the South China Sea and the Philippine Sea. The anomalies of the active convection were about triple of its standard deviations and the largest for December since 1979. Meanwhile, in the upper troposphere north of the active convection areas, there was an anti-cyclonic circulation anomaly, followed by cyclonic and anti-cyclonic ones centered east off Japan and over the mid-Pacific, respectively. The set of the anomalies form a stationary Rossby wave train. The stationary Rossby wave train seems to be forced by the strong convective activities and propagate along the Asia jet which acts as a wave guide. It caused the large-scale southward shift of the jet over Japan, which brought the extremely cold weather in and around Japan.

The mechanism of the influence of the active convection across the Bay of Bengal to the Philippine Sea on the cold weather in Japan was supported by the results of the numerical simulation conducted (Watanabe, 2006). The simulation is an examination of the linear steady response to hypothetical heating anomalies over those areas by using a linearized Global Circulation Model (Watanabe and Kimoto, 2000) around three-dimension climatological circulation fields in December. The results show that simulated circulation anomalies in the upper and lower troposphere are quite similar to those observed.

## 4. Conclusion

From the diagnostic analyses and numerical simulation, it was found that, besides the influence of the persistency of the negative phase of the AO, extremely active cumulus convection over the Bay of Bengal, the South China Sea and the Philippine Sea was deeply related to the extremely cold weather in and around Japan in December 2005.