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The year-to-year variation of snowfalls in Japanese islands as related to the variation of large-scale atmospheric circulation

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The western part of Japanese islands is a most snowy region in the northern Hemisphere in spite of being located in relatively lower latitudes (35 - 45 N). This is because Japanese islands are exposed in winter to the very cold, northwesterly monsoon from the Eastern Siberia. The northwesterly monsoon shows significant inter-annual variations and, consequently, the snowfall amount considerably varies from year to year. It is generally accepted that the snowfall in Japanese islands is greatly influenced by the variation in atmospheric circulation or by the activities of the Siberian High and/or Aleutian Low. In recent years, on the other hand, many authors have studied about the Arctic Oscillation (AO) in connection with the planetary-scale variation of atmospheric circulation and abnormal weathers in Northern Hemisphere.

The objective of this paper is to study about what is responsible for the year-to- year variation in snowfalls in Japanese islands. For this purpose, we use the data of monthly snowfall amounts for December, January, and February at Iwamizawa, Aomori, Shinjo, and Takada, together with NCEP/NCAR reanalysis data of monthly means of the sea level pressure (SLP) and the 500 hPa height (Z500) for the period December 1962 - February 2006. Also, monthly AO indexes are obtained from the Climate Prediction Center, USA. In general, the Aleutian Low (AL) and Icelandic Low (IL) at the sea level are associated with deep depressions or troughs at the 500 hPa level over the Sea of Okhotsk or Canadian Northwest Territories, respectively. The mean pressures of AL and IL pressures are calculated as the mean pressure over the area in which surface pressures are less than 1000 hPa in the Pacific and Atlantic sectors, respectively. Also, the mean heights of the Okhotsk Depression (OD) and Canadian Depression (CD) are defined as the mean 500 hPa heights over the area bounded by 45 - 65 N and 130 - 180 E, and by 55 - 80 N and 45 - 105 W, respectively.

It has been found that there are positive correlations between OD and AL and between CD and IL, while negative correlations exist between AL and IL and between OD and CD. Moreover, the year-to-year variation of monthly snowfall amounts in Japanese islands is negatively correlated with that of AL minus IL and with OD minus CD. This means that the snowfall amounts generally vary with the change of atmospheric circulation which is well characterized by the Cross-Arctic Oscillation (representing both the AL-IL seesaw at the sea surface level and the OD-CD seesaw at the 500 hPa level). In addition, the Cross-Arctic Oscillation is substantial part of the Arctic Oscillation whose spatial pattern is defined statistically.