Recent increase of extreming snowfall events in Kanto and its relation to the shift of surrounding fields

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The number of snowfall in the Kanto region (Pacific Ocean side), where one-third of population in Japan lives, are few times in a year, and the amount of snowfall is less than that of Japan Sea side. Therefore, countermeasures against heavy snowfall are inadequate, and once heavy snowfall occurs, it will have social and economic impacts, for example traffic jam. It is important to forecast the amount of future snowfall in the Kanto region for consideration of future measures. Numerical model experiments indicate that the total amount of snowfall will decrease in most parts of Japan at the end of the 21th century compared to the present[1]. However, due to the uncertainty of prediction in numerical models, it is important to consider long-term changes using reanalyzed data based on observation data. Previous studies have included case studies[2] and statistical analysis over the period[3][4], but none have seen long-term changes. Therefore, the purpose of this study is to investigate the long-term changes in the snowfall in the Kanto region and the surrounding atmospheric and oceanic fields, using reanalysis data. The analysis period was 58 years from 1961 to 2018, and we focused on January and February. In addition, the Aleutian Low has weakened after 1988/89, and the temperature has risen near Japan[5], and the winter monsoon in East Asia has weakened in the latter half of the 1980s, and the activity of storm tracks in the northwestern Pacific has become active[6]. Therefore, we divided the period from 1961 to 1988 (past) and from 1989 to 2018 (recent), and the differences in the surrounding fields were compared by composite diagram analysis. First, we compared the total amount of snowfall per year between the past and recent years, the past is 99 cm and the recent is 92 cm, which is not significantly different. However, the years when the amount of snowfall is heavy stand out in recent (Fig. 1a), and the number of heavy snow cases increased in recent years. Therefore, we investigated the changes in the storm tracks in order to find out the cause that heavy snowfall cases increase in recent years, it was strengthened from the south to the east sea of Japan (Fig. 1b), and the meridional temperature gradient of the sea surface temperature was also strengthened at the same area. From the above results, it is considered that the increase in number of heavy snowfall cases have contributed to be the heavy snowfall years in recent. In addition, it was suggested that the storm tracks were strengthened as a factor of the increase in the number of extreme snowfall cases.

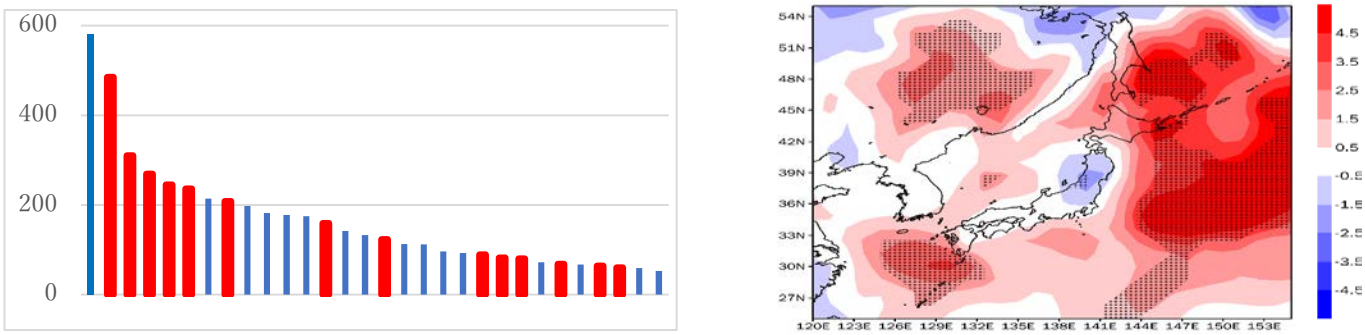

Fig. 1 **(a)** Total snowfall in Jan and Feb in the Kanto region [cm]. Top 30years are listed in descending order of volume out of 58 years. Thick red line: recent years (1989-), thin blue line: past (-1988). **(b)** Jan and Feb Changes in climatological storm tracks at 850 hPa (Jan and Feb)
The storm tracks were calculated by $\overline{v^2} - \bar{v}^2$ (v is the daily average of meridional wind, $^-$ is the monthly average) Color: Recent-Past[m²/s²], Dots: Indicate statistical significance exceeding 90% by *t*-tests

References

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