Increasing trend of downward long-wave radiation at the surface in the winter Arctic

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In recent years, observations show that warming in the Arctic is remarkable and rate of the warming after the 1950s is about twice that of the global average. This feature is called "Arctic amplification", and the Arctic warming is especially significant in autumn and winter. According to the previous studies, analysis based on the thermal energy balance on the surface suggests that the warming in the Arctic winter has the largest influence of the downward longwave radiation. On the other hand, factors that increase downward longwave radiation are not necessarily clearly shown. In this study, after analyzing the same as the previous studies, we considered the factor that causes downward longwave radiation increase in winter Arctic warming.

We used the Japanese 55-year Reanalysis (JRA-55) dataset. We analyzed the 30 winter season from 1988 to 2018, taking the average for the three months from November to January, where the influence of solar radiation can be ignored for the Arctic region north of 60 ˚N. It was found that, although it is different dataset and different period from the previous studies, increases in the downward longwave radiation has the largest influence on the surface warming. The downward longwave radiation can be divided into the following two components: clear-sky radiation and cloud radiative forcing (CRF), both of which are consistent with the trend pattern of the surface warming, and the clear-sky radiation has relatively larger influence on the surface warming than the CRF. Increase in clear-sky radiation is brought about by increase either in atmospheric water vapor or well-mixed greenhouse gases. From the diagnosis of radiative forcing due to an increase in greenhouse gas concentration, however, it is suggested that the increase in water vapor dominates. Trend pattern of the precipitable water is also consistent with that of the downward longwave radiation in the clear-sky. In addition, it is suggested that an increase in the CRF is due to that in the low-level clouds. It is also suggested that decreases in sea ice area and increases in net evaporation over the ice-retreated area may cause increases in the atmospheric water vapor and low-level clouds, but due to a problem of the JRA-55, further analysis is necessary.

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