Detection of Atmospheric River by Satellite Cloud Images in the Antarctic

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1. Introduction

In recent years, Atmospheric Rivers (ARs), formed by convective clouds, have been related to water vapor transport and heavy snow in the Antarctic [1]. Therefore, we have been conducting research for the purpose of automatic identification by deep learning using cloud images that can be discriminated from ARs during snowfall at Syowa Station [2].

We present the results of our study on the contribution of cloud images to water vapor transport and snowfall from a meteorological point of view.

2. Data and Methodology

In this study, we used cloud images acquired by the NOAA/AVHRR sensor (Channel 4), ground-based meteorological data, and radiosondes (2 times/day) received at Syowa Station in 2009. The cloud images were merged with multiple images to obtain the overall structure of the target cloud because the observation area varies with the satellite orbit every hour [2]. For each event where a blizzard and snowfall were observed, the cloud area were calculated as the number of pixels in the area judged to be high height clouds [2]. The difference between events was investigated by calculating the amount of precipitable water from radiosonde data at the time of observation. The precipitable precipitation here is the integrated value up to the altitude where the temperature does not fall below -40℃. The AR events were selected based on the conditions that the clouds were over Showa Station and that the clouds were persistent over a long distance.

3. Results

In 2009, there were 28 blizzard events, 7 of which were detected as AR events based on cloud image features, all observed during Class A blizzards.

Figure 1 shows a plot of cloud area versus precipitable water for each blizzard class. The precipitable precipitation is zero because it cannot be calculated due to missing measurements. The blue, red, and green areas indicate the cloud area for the Grade A, B, and C blizzards, respectively, and all missing measurements were taken during the Grade A blizzard. Figure 2 plots the number of cloud areas for ARs (red) and others (blue), regardless of Grade. It is easy to imagine that the number of cloud areas as a snapshot would be significant.

4. Summary

The next step is calculating IVT [3] using objective meteorological data (e.g., ERA5) to detect cloud features as ARs. As mentioned above, it is difficult to calculate specific humidity up to 300 hPa using radiosonde data due to the temperature problem, so it is necessary to use objective analysis data and to compare the results with those obtained using radiosonde observations.

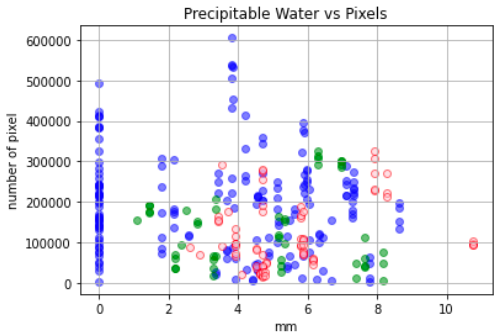

Fig. 1 Number of cloud areas and precipitable water per blizzard class

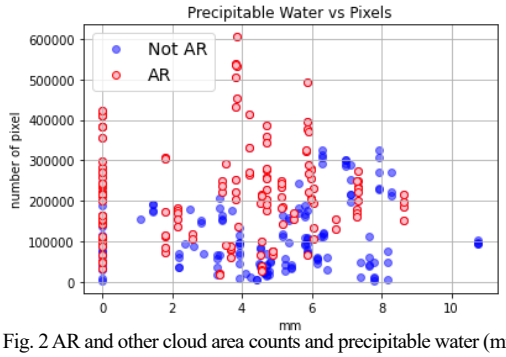

Fig. 2 AR and other cloud area counts and precipitable water (mm).

References

[1] Gorodetskaya et al., GRL, 2014.
[2] Suzuki et al., Advances in Artificial Intelligence, 2021.
[3] Mundhenk et al., J. Clim., 2016.