North-south contrast in radiative forcing due to warm-moist air intrusion into the polar regions

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We had pointed out that the warm-moist air intrusion from low latitude greatly contributed to the warming in the Arctic (Yamanouchi, 2019). Clouds activated by intrusion and also with water vapor and high temperature increased downward longwave radiation (LD) about 160 W/m^2 at Svalbard in winter 2015/16 just as explained by Yoshimori et al. (2017) using climate model. Deformation of polar vortex – meandering of jet stream – formation of strong ridge - was the major source. On the other hand, similar increase of LD was found in occasions of warm and moist air intrusion into the Antarctic. One example of 130 W/m^2 increase in LD was found at Dome Fuji Station in 1997, when abrupt temperature rise (+40°C) was caused by the strong ridge due to the blocking formation (Hirasawa et al., 2000), and LD also increased at Syowa Station, 120 to 150 W/m^2. Intrusion of warm moist air was just comparable with the Arctic case. These intrusions also brought large amount of water vapor and contributed to the accumulation so called "Atmospheric river" (Gorodetsukaya et al., 2014).

Looking at the similar abrupt LD increase in the Arctic and Antarctic in these 20 years (BSRN) (examples are in Fig. 1), the most pronounced was the one in July 2015, when LD increased 180 W/m^2 with temperature 35°C. As for the data of LD, these data were only from particular stations, and also we need to notice the latitude difference between these stations. However, even in these cases, intrusion was not so steep and warming events seemed not so special in the Antarctic compared to the Arctic. So it could be concluded that single isolated intrusions are rather stronger in the Arctic. There are several reason why intrusions are stronger in the Arctic compared to the Antarctic.

1) The deep intrusion is to be caused by blocking (Welker et al., 2014). Blocking is rather frequent in the Arctic, which will make the stronger intrusions much popular in the Arctic. This is a general character of the large scale atmospheric circulation, or polar vortex in the both hemispheres.
2) Due to the topography – high ice sheet surface of the Antarctic continent – warm-moist air mass could not penetrate deep into the continent and limited only to the coastal region (Hirasawa and Yamada, 2019).

These items make the differnce in the circulation pattern, polar vortex, and jet stream and then lead to the difference in the intrusions. And this difference is one of the causes bringing the warming suppression in the Antarctic compared to the warming amplification in the Arctic.

References

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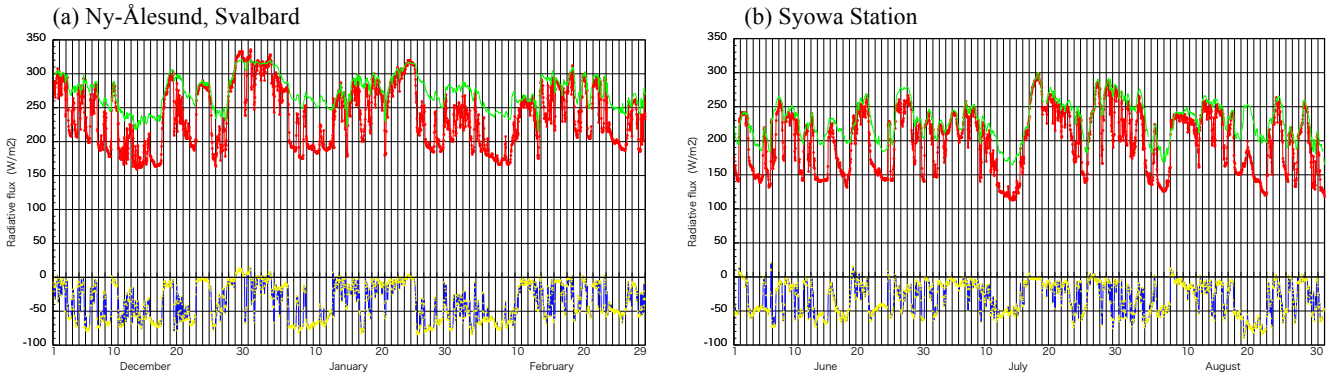

Fig. 1 Longwave radiative fluxes (from BSRN) at (a) Ny-Ålesund, Svalbard in DJF 2015/16 and (b) Syowa Station in JJA 2015.