Interannual variation in top-of-atmosphere upward shortwave flux over the Antarctic region

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Sea ice cover in the Antarctic region has been changing. Since sea ice has a high albedo, these changes significantly impact the Antarctic energy budget, especially shortwave flux. In the component of the energy budget, we focus on top-of-atmosphere upward shortwave flux (TOA SW). TOA SW is influenced by atmospheric properties (e.g., clouds, aerosol, and water vapor) in addition to surface properties (e.g., ice and water). Several studies have investigated the controlling factors to TOA SW variation in the Antarctic region. These studies have shown that the controlling factors are sea ice over the ocean and clouds or surface albedo over the land (e.g., Previdi et al. 2013; Jian et al. 2018; Wu et al. 2020). Antarctic TOA SW shows a clear seasonal variation linked to the seasonal cycle of incoming solar radiation, ice, and clouds. These seasonal variations influence the interannual variation in TOA SW. However, the interannual variation in the seasonal cycle of TOA SW over the Antarctic is not well evaluated. Therefore, this study investigates the interannual variation in the annual mean and seasonal cycle of TOA SW over the Antarctic from July 2000 to June 2022. It analyzes TOA SW separately for land and ocean to investigate the difference between land and ocean. Using our previous work (Amma and Hayasaka 2023), we also discuss the difference in TOA SW variation between the Antarctic and Arctic regions. We use satellite observations (CERES EBAF Ed 4.2) and define the Antarctic as 60°–90°S.

Over the Antarctic, TOA SW shows no significant trend from 2001 to 2014 but decreases after 2014. TOA SW variability over the Antarctic is mainly related to TOA SW variability over ocean. TOA SW variability over ocean is strongly related to sea ice cover from November to January. TOA SW over land shows a relatively small interannual variation and a decreasing trend during this analysis period (-0.5 W m^{-2} $decade^{-1}$). The interannual variation in TOA SW over land is mainly related to cloud fraction and cloud optical depth from October to December. The decreasing trend of TOA SW over land is significant in January and February. However, explaining the controlling factor to the TOA SW trend over land is difficult because most factors show no significant trend.

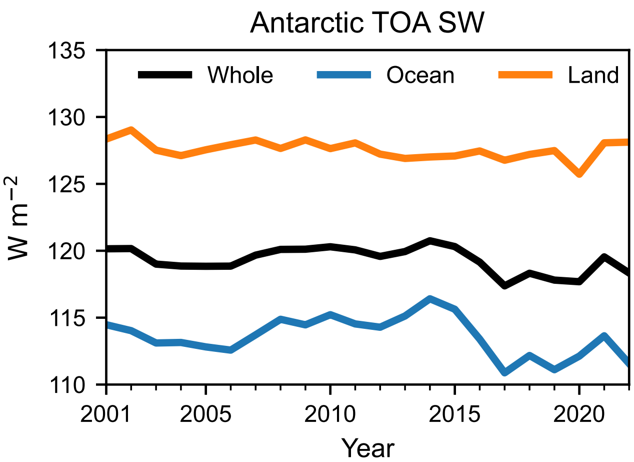

Figure 1. Time series of annual mean all-sky TOA SW for the Antarctic over the whole region, ocean, and land.

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