Cloudiness and sea ice mutual variations in the Antarctic: dependence on Antarctic oscillation

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Cloudiness and sea ice both act in polar amplification feedbacks. Moreover, changes of cloudiness characteristics and sea-ice extent in the polar regions are closely tied. Cloudiness changes may depend on sea ice variability and vice versa. In particular, in the Atlantic part of the Arctic, cloudiness and sea-ice show statistically significant negative correlation with each other for the last 80 years with the correlation coefficient –0.38 (Chernokulsky et al., 2017).

Variations of clouds and sea ice display significant differences in the Antarctic and Arctic. The largest changes (trends and variability) of total cloud fraction (TCF) from satellite observations (PATMOS-x and CM SAF satellite data) were noted during last decades in summer in both Hemispheres (July-August-September in the Arctic and January-February-March in the Antarctic). Sea-ice extent (SIE) decreased in the Arctic and increased in the Antarctic during the last four decades in all seasons (according to NSIDC data). For the Arctic (mean for the region 70N-90N), negative SIE-TCF correlation coefficient (R) was noted from satellite observations, while in the Antarctic (mean for the region 55S-70S) the sign of SIE-TCF correlation depends on season (Mokhov and Chernokulsky, 2014).

We found that SIE-TCF correlation depends on the phase of the Antarctic Oscillation (AAO). In particular, it is negative and significant in the negative phase of AAO (AAO–) ($R_{\text{NSIDC–PATMOS-x}} = –0.64$; $R_{\text{NSIDC–CMSAF}} = –0.5$), while in positive phase (AAO+) the correlation is insignificant (Fig.1) (Mokhov and Chernokulsky, 2016).

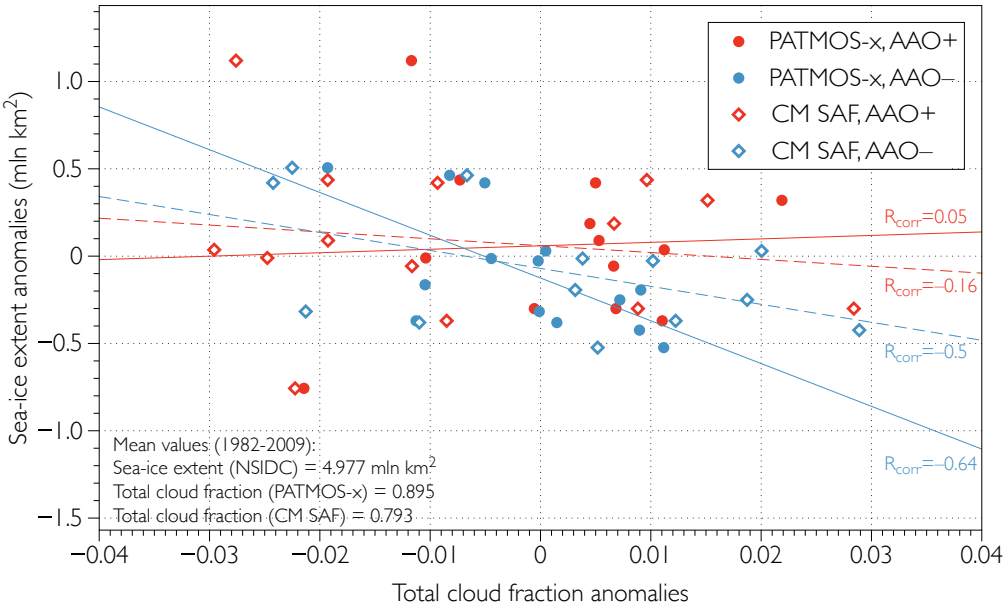

Figure 1. Sea-ice extent (NSIDC) and total cloud fraction (PATMOS-x and CM SAF) anomalies in the Antarctic region (55S-70S) in February-March-April (1982-2009) for AAO positive and negative phases (1982-2009).

The major changes of SIE and TCF, that associated with AAO, are noted in the Weddell, Ross and Bellingshausen Seas, and in the Southern Ocean to the north of

Victoria Land (Figure 2). Difference of sea-ice concentration (SIC) between AAO+ and AAO– reaches 30–40% (up to 50% near Victoria Land). This may be associated with opposite changes of TCF and associated with it cloud-radiative effect (CRE) (changes of radiative fluxes at the top of the atmosphere (TOA) between clear-sky and cloudy conditions) (Figure 2).

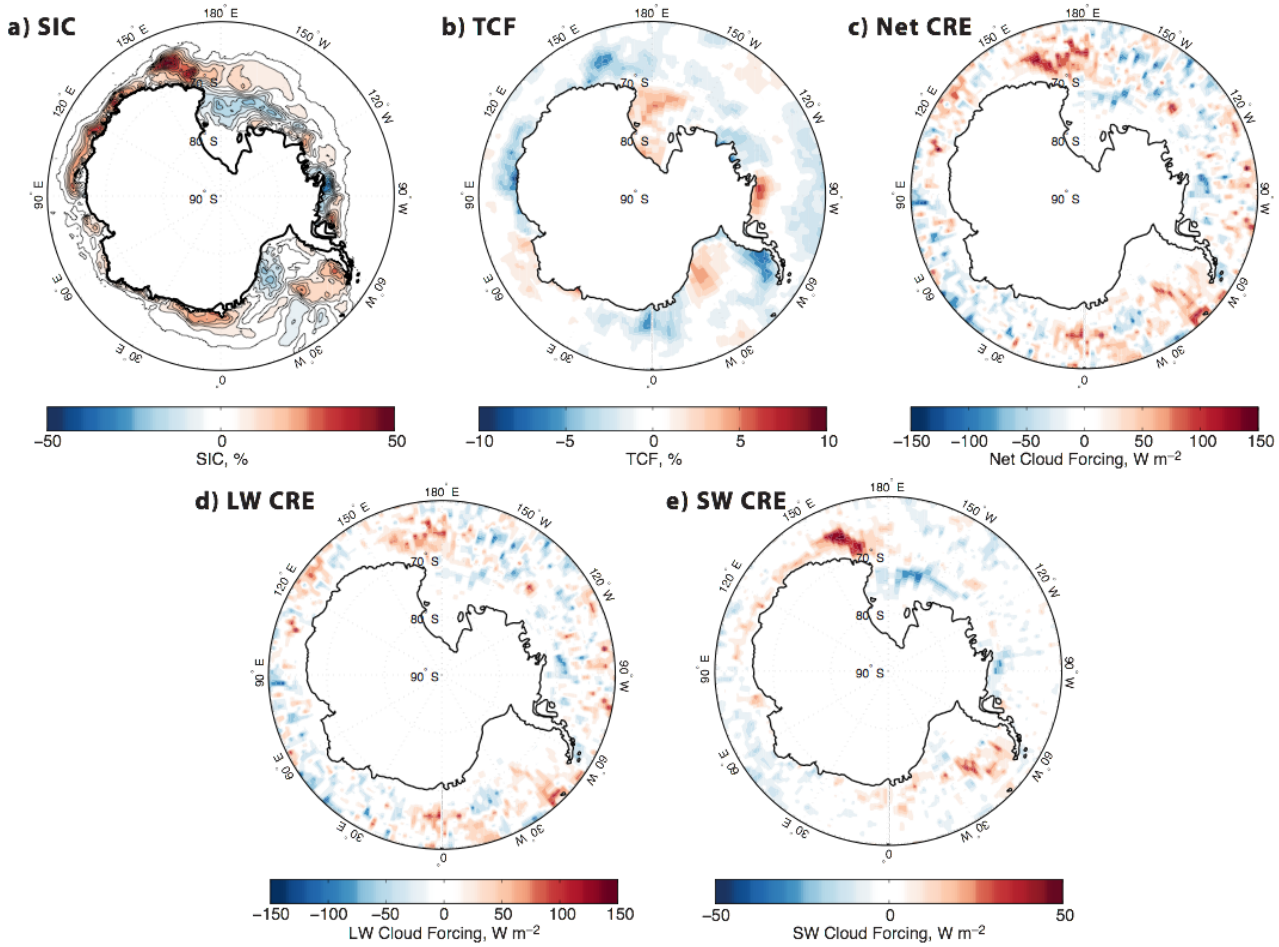

Figure 2. Difference between 4 years of AAO+ (2005, 2009, 2013, 2014) and 4 years of AAO– (2002, 2003, 2004, 2007) in February-March-April of SIC (NSIDC) (a), TCF (CERES) (b), TOA net CRE (CERES) (c), TOA short-wave (SW) CRE (CERES) (d), TOA long-wave (LW) CRE (CERES) (e).

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