Relationship between the Arctic Oscillation and Surface Air Temperature in Multi-Decadal Time-Scale

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In this study, a simple energy balance model (EBM) was integrated in time, considering a hypothetical long-term variability in ice-albedo feedback mimicking the observed multi-decadal temperature variability. A natural variability was superimposed on a linear warming trend due to the increasing radiative forcing of CO2. The result demonstrates that the superposition of the natural variability and the background linear trend can offset with each other to show the warming hiatus for some period. It is also stressed that the rapid warming during 1970 to 2000 can be explained by the superposition of the natural variability and the background linear trend at least within the simple model.
The key process of the fluctuating planetary albedo in multi-decadal time scale is investigated using the JRA-55 reanalysis data. It is found that the planetary albedo increased for 1958 to 1970, decreased for 1970 to 2000, and increased for 2000 to 2012, as expected by the simple EBM experiments. The multi-decadal variability in the planetary albedo is compared with the time series of the AO mode and Barents Sea mode of surface air temperature. It is shown that the recent AO negative pattern showing warm Arctic and cold mid-latitudes is in good agreement with planetary albedo change indicating negative anomaly in high latitudes and positive anomaly in mid-latitudes. Moreover, the Barents Sea mode with the warm Barents Sea and cold mid-latitudes shows long-term variability similar to planetary albedo change. Although further studies are needed, the natural variabilities of both the AO mode and Barents Sea mode indicate some possible link to the planetary albedo as suggested by the simple EBM to cause the warming hiatus in recent years.

Keywords: Arctic Oscillation, Arctic Amplification, Energy Balance Model, Planetary Albedo, Multi-decadal Variability