Tiramisu snow and the weakening of surface albedo

Siyu Chen[1], *Hongru Bi[1]

1. Lanzhou University

Since 1850, Earth's cryosphere has shown a global shrinking trend. The retreat of snow and ice had strongly impact on the hydrological cycle and the energy balance of the Earth system. And the melting of snow and ice attributed to the variation in snow albedo caused by LAIs deposited on the snow surface. These LAIs absorbed solar radiation, accelerated snow aging process, reduced albedo of the snow surface, and enhanced the melting of snow. However, the uncertainty of the emission of LAIs and the differences in research methods and regions, as well as the lack of observation data, resulted in the surface radiation forcing caused by LAIs, especially dust, still very uncertain. Dust is as a key factor in controlling albedo and subsequent glacier melting within the global warming perspective. Thus, quantitative studies on reduction of dust on snow surface albedo from synoptic scale are very important. On December 1, 2018, a rare weather event occurred in Urumqi, China, where snow accumulating on the land surface was covered with a layer of yellow dust. This rare weather event provided an excellent natural experiment for quantifying the effect of dust in snow on surface albedo. Based on ground observation data and reanalysis data such as MERRA-2 and ERA5, it was found that the dust snow was mainly caused by the large-scale strong cold caused by the Siberian trough and the southeast transport of dust-storms particles under the influence of the westerly jet. The generation dust particles reduced reflected radiation 20 W m^{-2} approximately. Compared with the changes of solar radiation under similar historical conditions, it was found that the cloud cover resulted in the surface albedo increase by about 0.23, when snow lead to counterpart increase about 0.28. But dust particles in the snow significantly reduced the surface albedo. Compared to historical conditions with the same snow depth and cloud cover, snow albedo caused by dust in snow decreased by approximately 28% and up to 34%.

Keywords: surface albedo, solar radiation, dust snow