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Indirect Radiative Warming Effect in the Winter and Spring Arctic Associated with Aerosol Pollution from Mid-latitude Regions

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Different from global cooling effects of aerosols and aerosol-cloud interactions, anthropogenic aerosols from mid-latitude are found to play an increased warming effect in the Arctic in later winter and early spring. Using four-year (2000-2003) observation of aerosol, cloud and radiation at North Slope of Alaska, it is found that the aerosols can increase cloud droplet effective radius 3 um for fixed liquid water path, and increase cloud thermal emissivity about 0.05-0.08. In other words, aerosols are associated with a warming of 1-1.6 degrees (3-5 W/m2) in the Arctic during late winter and early spring solely due to their first indirect effect. Further analysis indicates that total aerosol climate effects are even more significant (8-10 W/m2), with about 50% contribution from aerosol first indirect effect and another 50% contribution from complicated feedbacks. It also shows strong seasonal distribution of the aerosol indirect radiative effects, with warming effects in seasons other than in summer. However, only the significant warming effect in winter and spring passes through the significance test. The strong warming effect due to aerosol indirect effect could be further strengthened through following feedbacks involving the surface albedo (early ice melting).