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Modelling the seasonal cycle of aerosol characteristics in the Arctic: the importance of wet deposition

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The seasonal cycle of aerosol in the Arctic is characterised by high concentrations of large aged anthropogenic particles transported from lower latitudes in the late winter and early spring, followed by a sharp transition to low concentrations of smaller, locally sourced particles during the Arctic summer. This cycle is believed to be controlled by seasonal variations in transport routes and precipitation patterns, and is poorly simulated by many chemical transport models.

We have examined the effect of varying global precipitation patterns on the Arctic aerosol seasonal cycle using the Global Model of Aerosol Processes (GLOMAP). GLOMAP was developed at the University of Leeds and traces both the aerosol size distribution and particle mass concentrations. Meteorological fields (including convective and dynamic rainfall) were taken from analyses of the ECMWF model while primary aerosol emissions were sourced from the AEROCOM hindcast emission database. Two new wet deposition parameters were applied to the model: low cloud precipitation (drizzle), which introduced local nucleation scavenging in specific regions (including the Arctic), and ice cloud scavenging, which reduced nucleation scavenging in cold clouds.

Adding the new deposition parameters shifted the modelled cycle in warm (liquid) precipitation above 60N, resulting in a maximum precipitation rate in summer as opposed to the almost uniform rain rate prescribed in baseline simulations. This dramatically improved the agreement between the modelled and observed seasonal cycle in elemental carbon and sulphate mass concentrations, increasing the correlation coefficient from -0.21 to 0.77 and from -0.26 to 0.71 respectively over 5 years of surface concentration data from Alert, Point Barrow and Zeppelin Mountain on Svalbard. We suggest that the most significant process controlling the Arctic Boundary layer aerosol cycle is the seasonal change in warm precipitation rates over the Arctic region.