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Remote new particle formation dominates the nucleation and Aitken aerosol modes in the central Arctic

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The aerosol budget of the Arctic plays a key role in determining the behaviour of clouds, which are important for the surface energy balance and thus for the region's climate. A key question is the extent to which cloud condensation nuclei in the high Arctic summertime boundary layer are controlled by local emission and formation processes or by transport from outside. Each of these sources is likely to respond differently to future changes in ice cover. Here we use a global model and observations from ship and aircraft field campaigns to understand the source of high-Arctic aerosol in late summer. We find that particles formed remotely are the dominant source of boundary layer Aitken mode particles during the sea ice melt period up to the end of August. Such a remote particle source, mostly entrained from the free troposphere, explains the remarkably stable nucleation mode concentrations of around 100 cm-3. This source from outside the high Arctic declines as photochemical rates decrease towards the end of summer, and is largely replaced by local new particle formation driven by iodic acid associated with freeze up. Such a local source is consistent with strong fluctuations in nucleation mode concentrations that occur in September. Our results suggest a high Arctic aerosol regime shift in late summer, and only after this shift do cloud condensation nuclei become sensitive to local aerosol processes.