Supplementary information: Air mass history influences the development of mixed-phase clouds

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Figure S1 shows the evolution of the ice phase fraction as a function of time since ice and cloud-top temperature. At longer times from the ice edge and low temperatures (below -23°C), the clouds shift from predominantly mixed-phase (Figure 2) to more ice-only clouds.
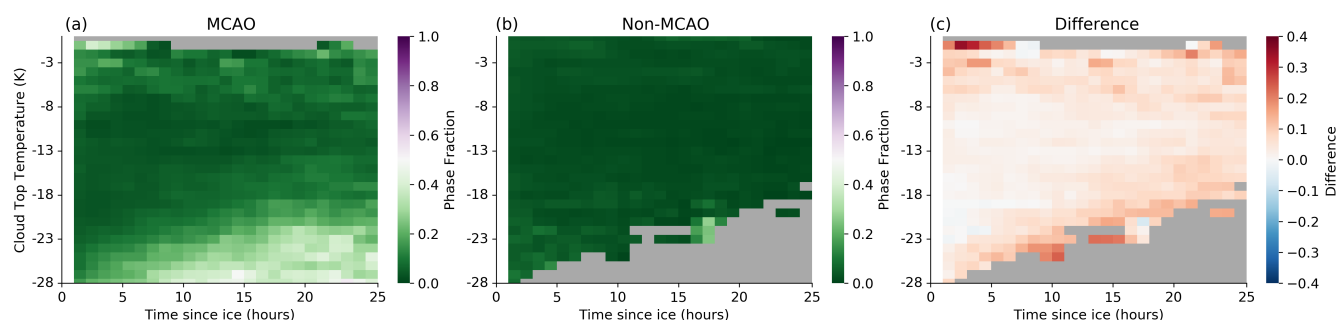
Figure S1. Evolution of ice phase fraction as a function of time and cloud top temperature for (a) MCAO, (b) non-MCAO. (c) is the difference between them. Grid points with fewer than 500 successful retrievals are coloured in grey.

Figure S2 shows the fraction of the surface covered by snow, sea or lake ice or bare land over the Arctic region, averaged between 2008 and 2015. The data comes from the Interactive Multisensor Snow and Ice Mapping System (IMS) Daily Northern Hemisphere Snow and Ice Analysis at 1km Resolution, Version 1 product (U.S. National Ice Center, 2008). Snow cover is highest in winter, with almost complete snow coverage. Spring and autumn also experience relatively high snow coverage over land, with average coverage above 80% and 60%, respectively. In contrast, with the exception of Greenland, JJA is relatively snow-free. As expected, the reverse trend is true for the snow-free land. The sea ice coverage follows the expected pattern of maximum coverage in winter and spring, particularly in March, declining to a minimum in September Parkinson (2014). These plots suggest that if air parcels travel over land before reaching the sea ice, they are more likely to travel over ice and snow covered surfaces and therefore pick up fewer aerosols. Conversely, in summer and autumn, with less snow cover, more INP may be picked up from bioloigcal sources or bare land as mineral dust (Pereira Freitas et al., 2023; Tobo et al., 2019).
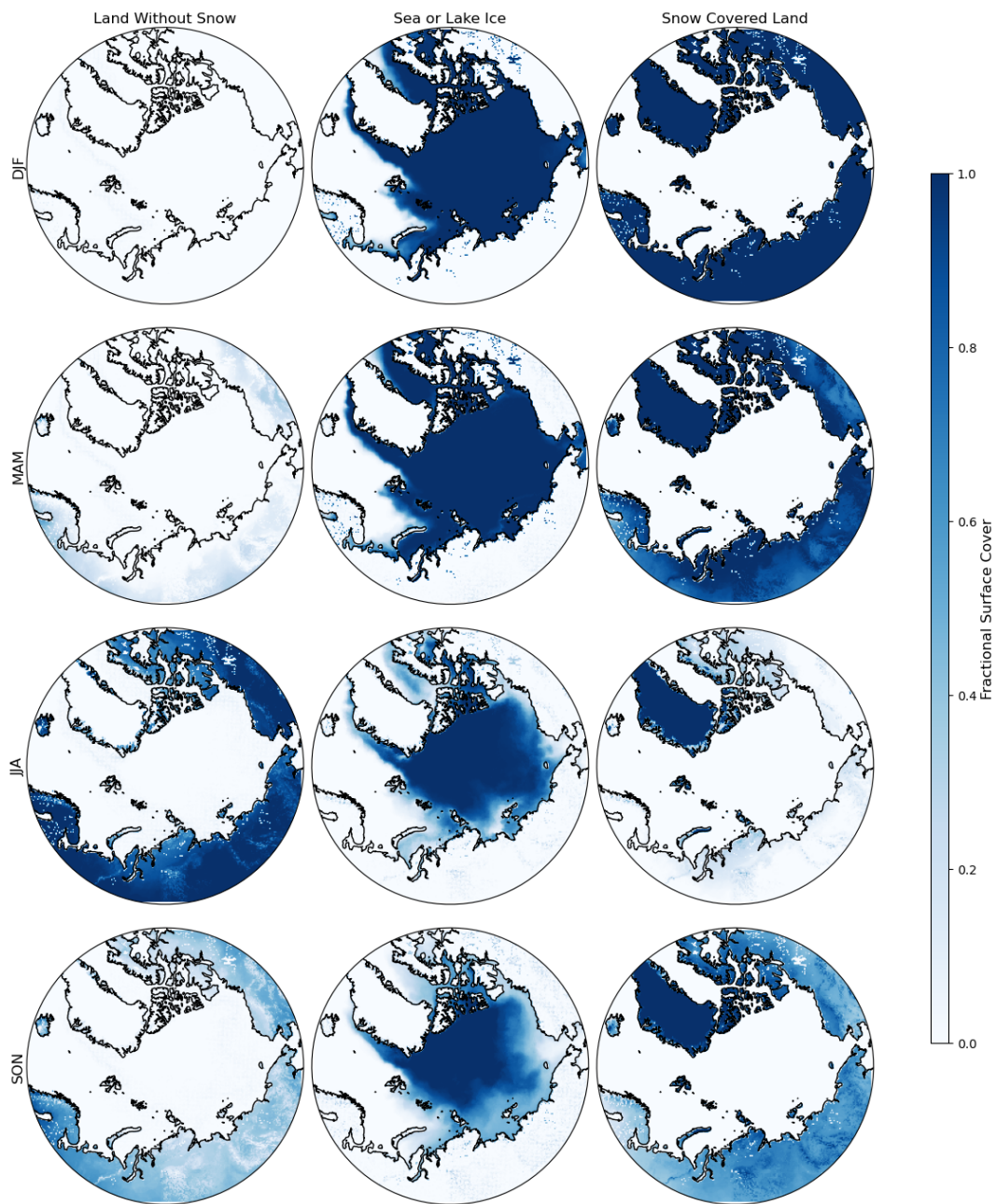
Figure S2. Seasonal climtaologies of the fractional cover for different surface types; land without snow, sea or lake ice and snow covered land. Data from the Interactive Multisensor Snow and Ice Mapping System (IMS) Daily Northern Hemisphere Snow and Ice Analysis at 1km Resolution, Version 1 product is used (U.S. National Ice Center, 2008).

References

15   Parkinson, C. L.: Global Sea Ice Coverage from Satellite Data: Annual Cycle and 35-Yr Trends, Journal of Climate, 27, 9377 – 9382, https://doi.org/https://doi.org/10.1175/JCLI-D-14-00605.1, 2014.

Pereira Freitas, G., Adachi, K., Conen, F., et al.: Regionally sourced bioaerosols drive high-temperature ice nucleating particles in the Arctic, Nat Commun, 14, 5997, https://doi.org/https://doi.org/10.1038/s41467-023-41696-7, 2023.

Tobo, Y. et al.: Glacially sourced dust as a potentially significant source of ice nucleating particles, Nature Geoscience, 12, 253–258,
20   https://doi.org/10.1038/s41561-019-0314-x, 2019.

U.S. National Ice Center: IMS Daily Northern Hemisphere Snow and Ice Analysis at 1 km, 4 km, and 24 km Resolutions, Version 1, https://doi.org/10.7265/N52R3PMC, date Accessed 09-18-2023, 2008.