Supplement of Atmos. Chem. Phys., 26, 5653–5677, 2026
https://doi.org/10.5194/acp-26-5653-2026-supplement
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Atmospheric Chemistry and Physics
Open Access

Supplement of

Satellite-based evidence of dust emission over Northern Canada

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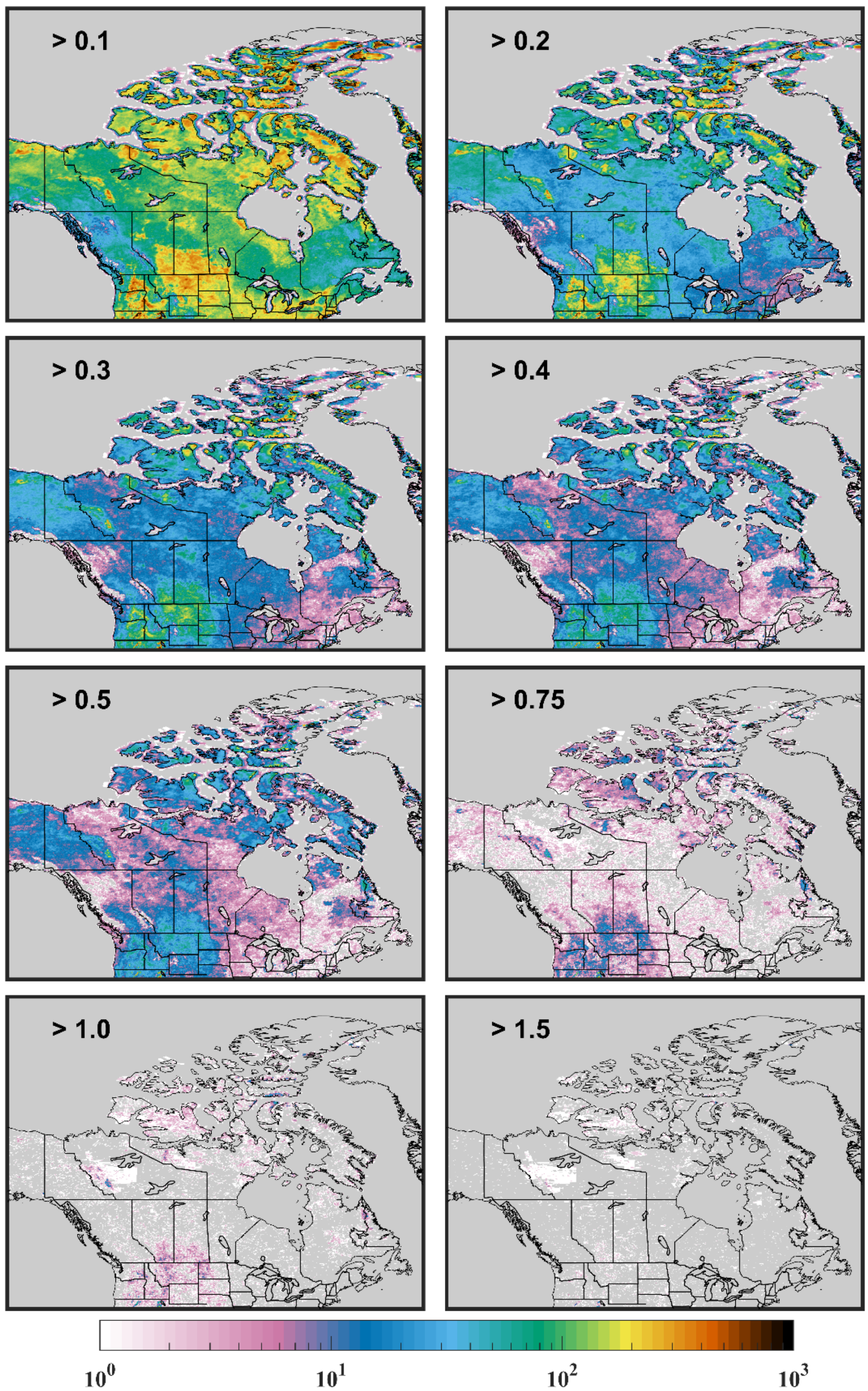

Figure S1. Effect of Dust Optical Depth (DOD) thresholds on the Frequency of Occurrence (FoO) in summer (JJA) MODIS data (2003–2022). Relative fraction of dataset at thresholds of DOD > 2.0, > 1.5, > 1.0, > 0.75, > 0.5 equals, respectively, 0.008%, 0.02%, 0.09%, 0.34%, 1.6%. Map of DOD > 2.0 not shown.

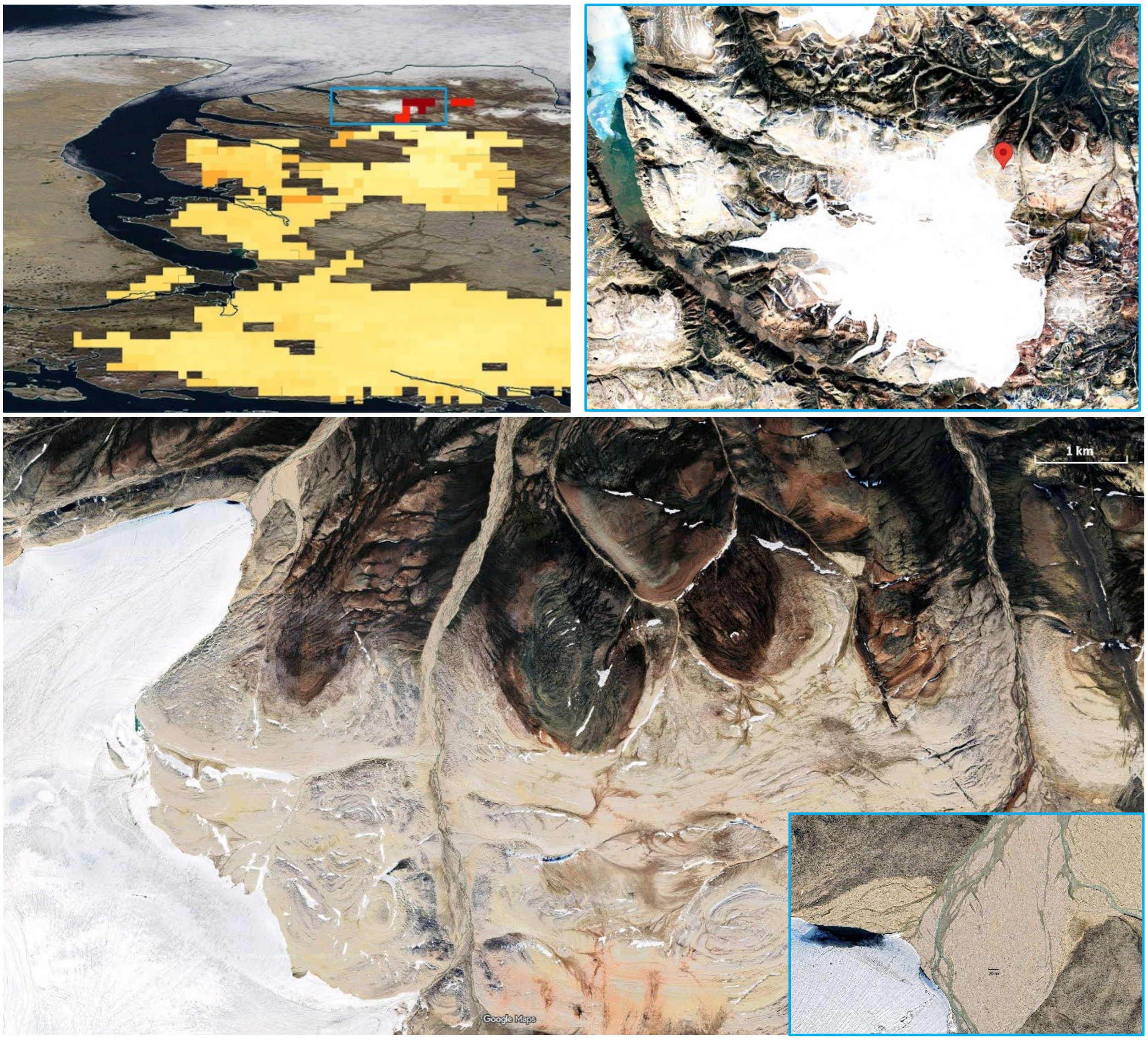

Figure S2. A single event (Aug 17, 2011, Baffin Island) of active dust source emission (targeted by our DOD > 0.5 approach) shown in the context of regional-scale aerosol optical depth (AOD) signals (top left panel) from MODIS Terra and Aqua on NASA Worldview (link); darkest red AOD values are 1.130 – 1.560 while the lightest yellow AOD values are 0.030 – 0.035. The region approximately within the blue rectangle is expanded (top right panel) using Google visible imagery (link) to show (not on the same day) a fjord, a glacier, and a glacial outwash plain, which is further expanded in the bottom panel (1-km resolution) and its inset (20-m resolution). While NASA Worldview does not show DOD values, they are always smaller in the Pu and Ginoux (2016) formulation, meaning that in this scene our DOD_{PG16} > 0.5 criterion selects only the extreme dust loading events consistent with a strong dust emission source, i.e., this glacial outwash plain.

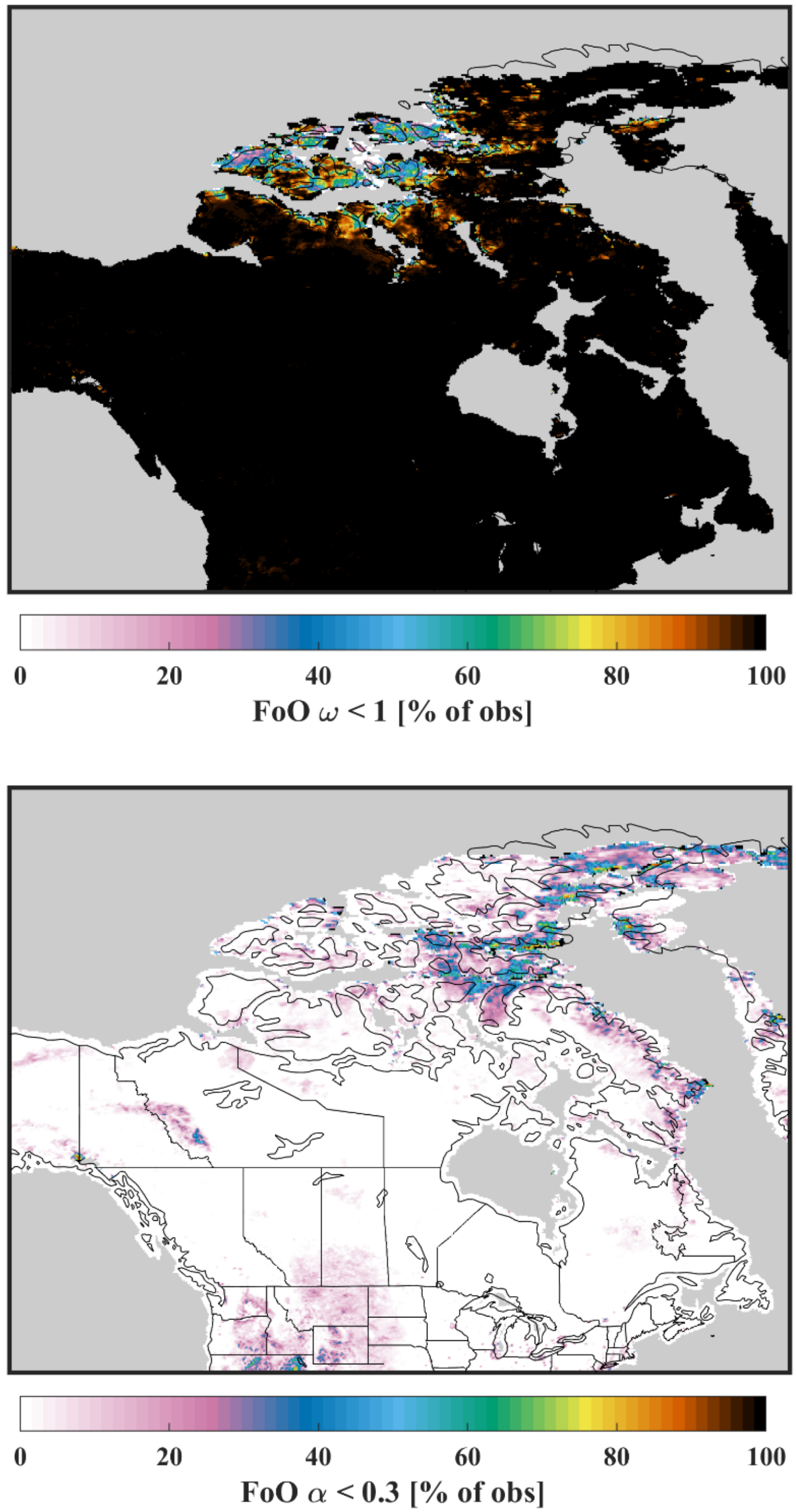

Figure S3. Relative Frequency of Occurrence (FoO) of (top panel) single scatter albedo indicative of not purely scattering particles ($\omega < 1$) and of (bottom panel) the Ångström exponent indicative of large particles ($\alpha < 0.3$), in MODIS data spanning 2003–2022.

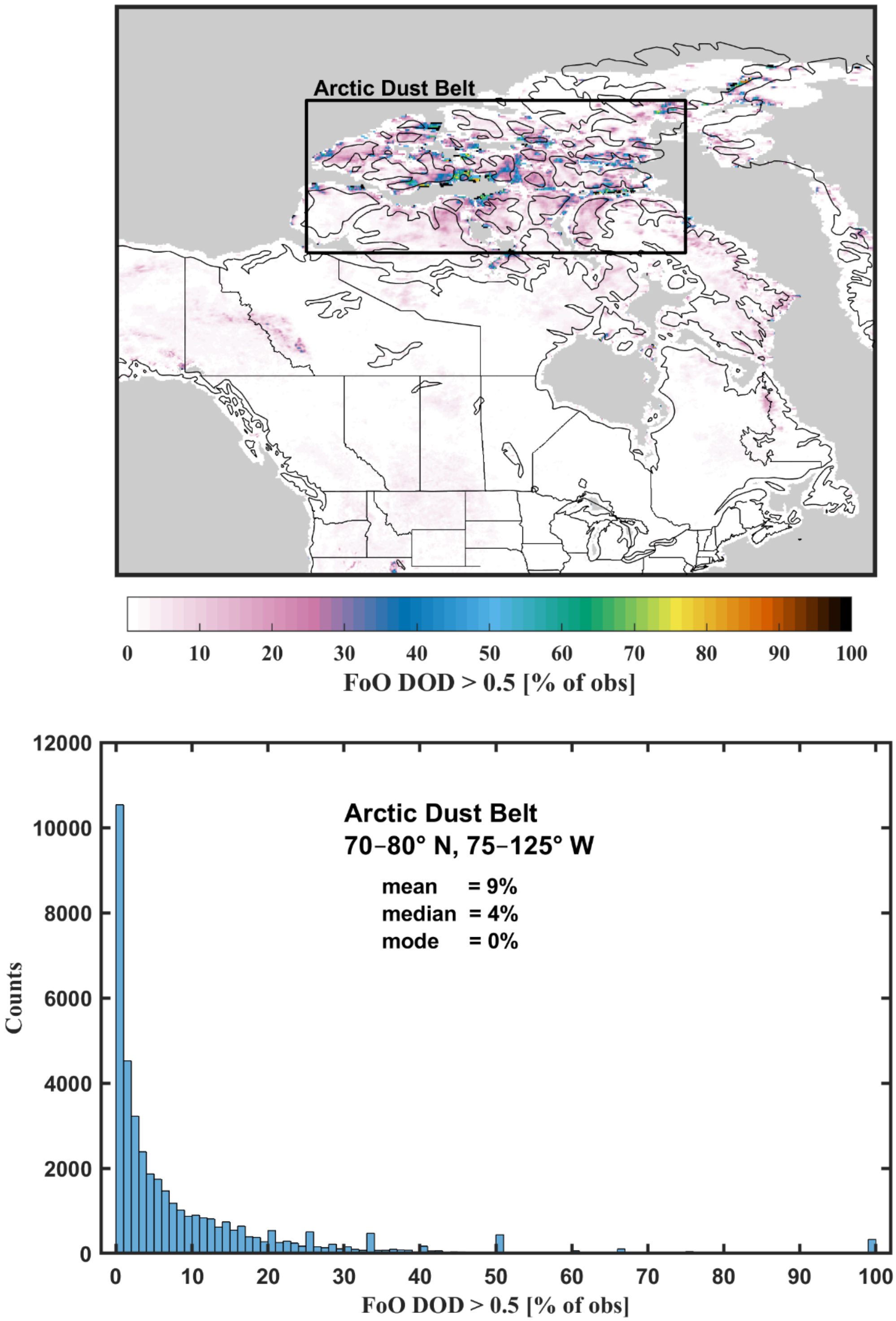

Figure S4. Top panel: relative Frequency of Occurrence (FoO) of dust DOD > 0.5 (Pu and Ginoux formulation) in the Arctic Dust Belt area of analysis used for the bottom panel (70°N – 80°N, 125°W – 75°W). Bottom panel: Distribution of relative FoO values within the Arctic Dust Belt over a 20-year period of MODIS data.

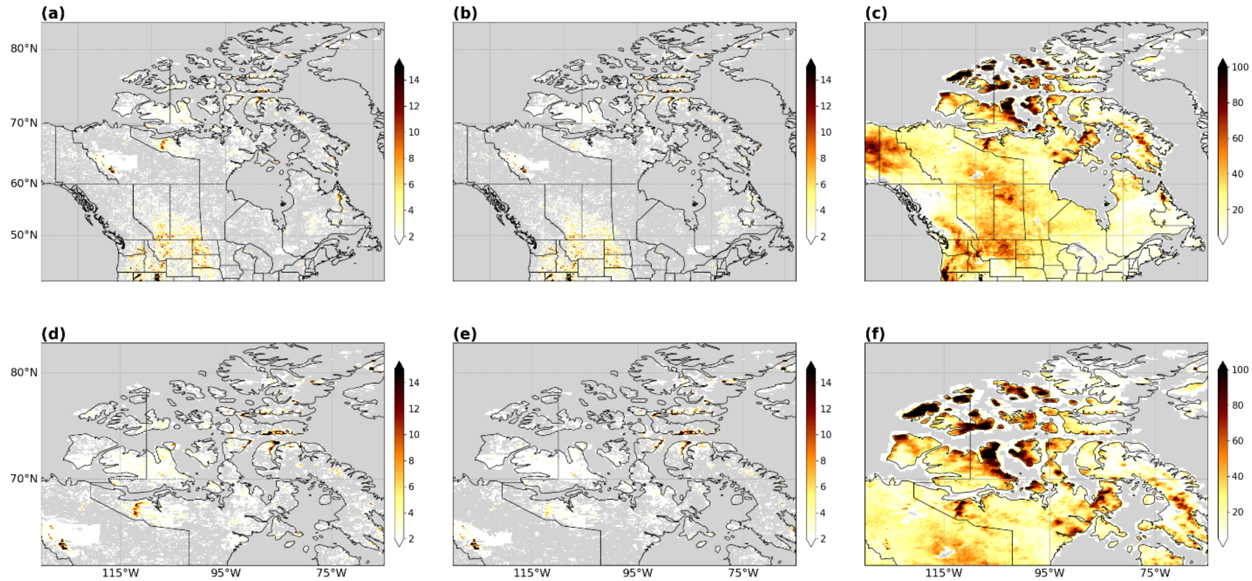

Figure S5. a) Frequency of Occurrence (FoO) of $DOD_{PG16} > 1$. **b)** FoO $DOD_{B16} > 1$. **c)** FoO AOD > 1. **d-f)** as a–c but zoomed in to better highlight northern DOD hotspots. All quality levels included in MODIS data.

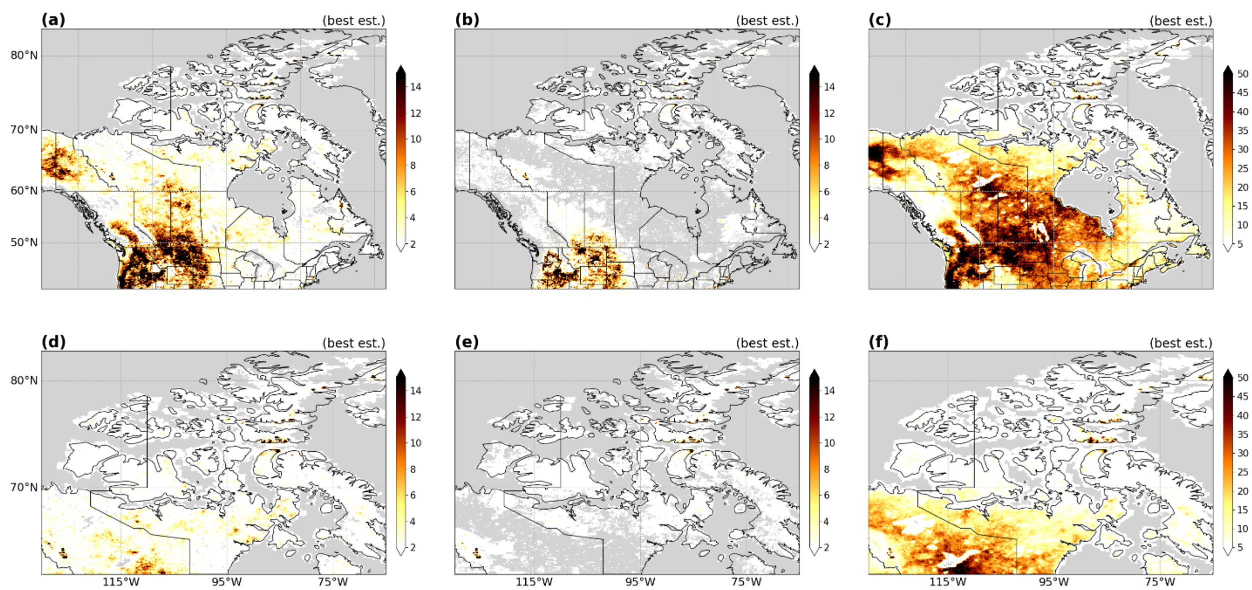

Figure S6. a) Frequency of Occurrence **(**FoO) of $DOD_{PG16} > 0.5$, using data screened for "best estimate" quality flag. **b)** FoO $DOD_{B16} > 0.5$, using data screened for "best estimate" quality flag. **c)** FoO AOD > 0.5, using data screened for "best estimate" quality flag. **d–f)** as a-c but zoomed in to better highlight northern DOD hotspots.

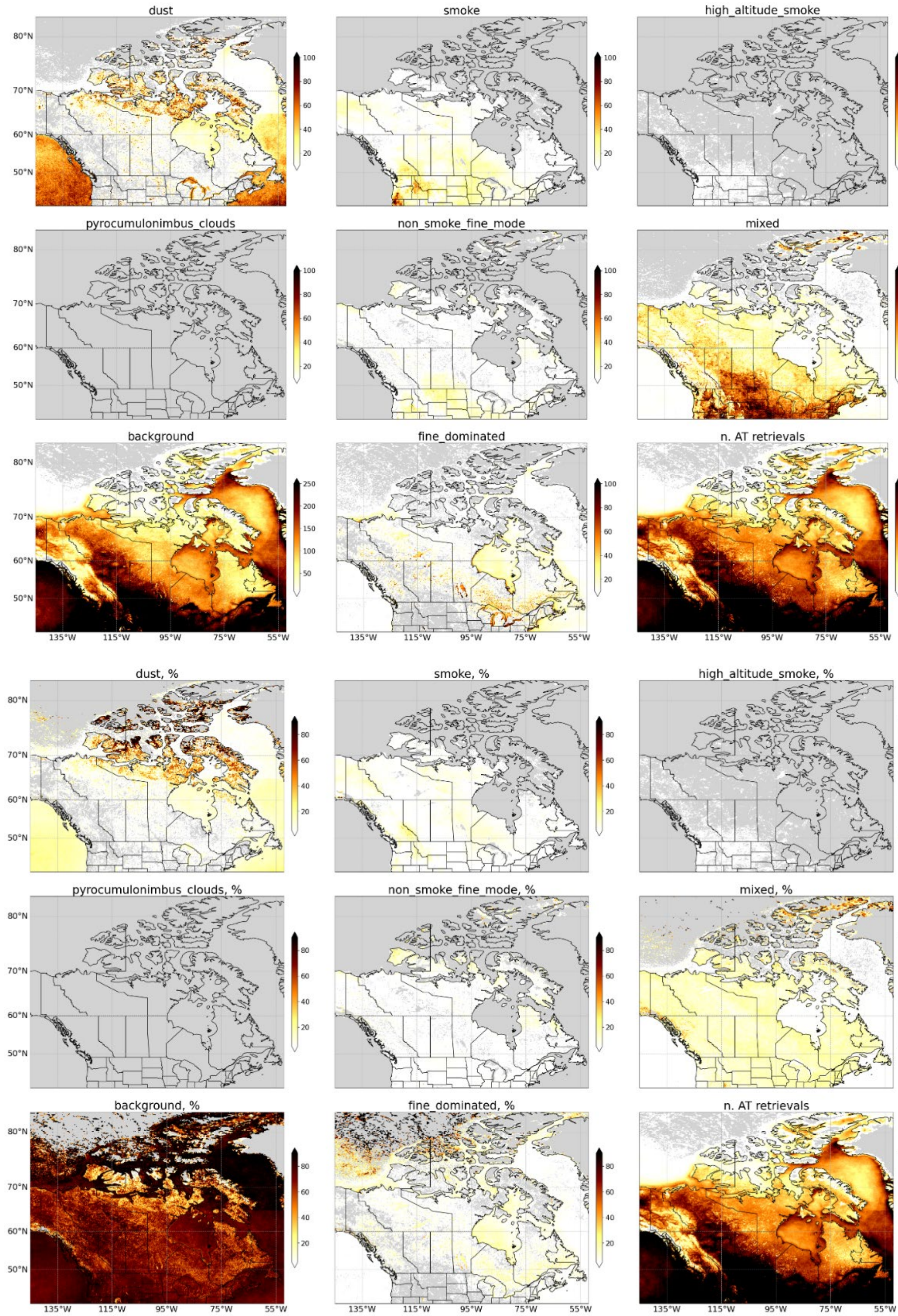

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Figure S7. Absolute (top half) and relative (%) (bottom half) Frequency of Occurrence (FoO) of VIIRS aerosol type (AT) classifications, for the period 2020–2022 inclusive, and the total number of AT retrievals available. AT is given in the title of each panel. Note different colour scales used for AT = "background" and number of AT retrievals.

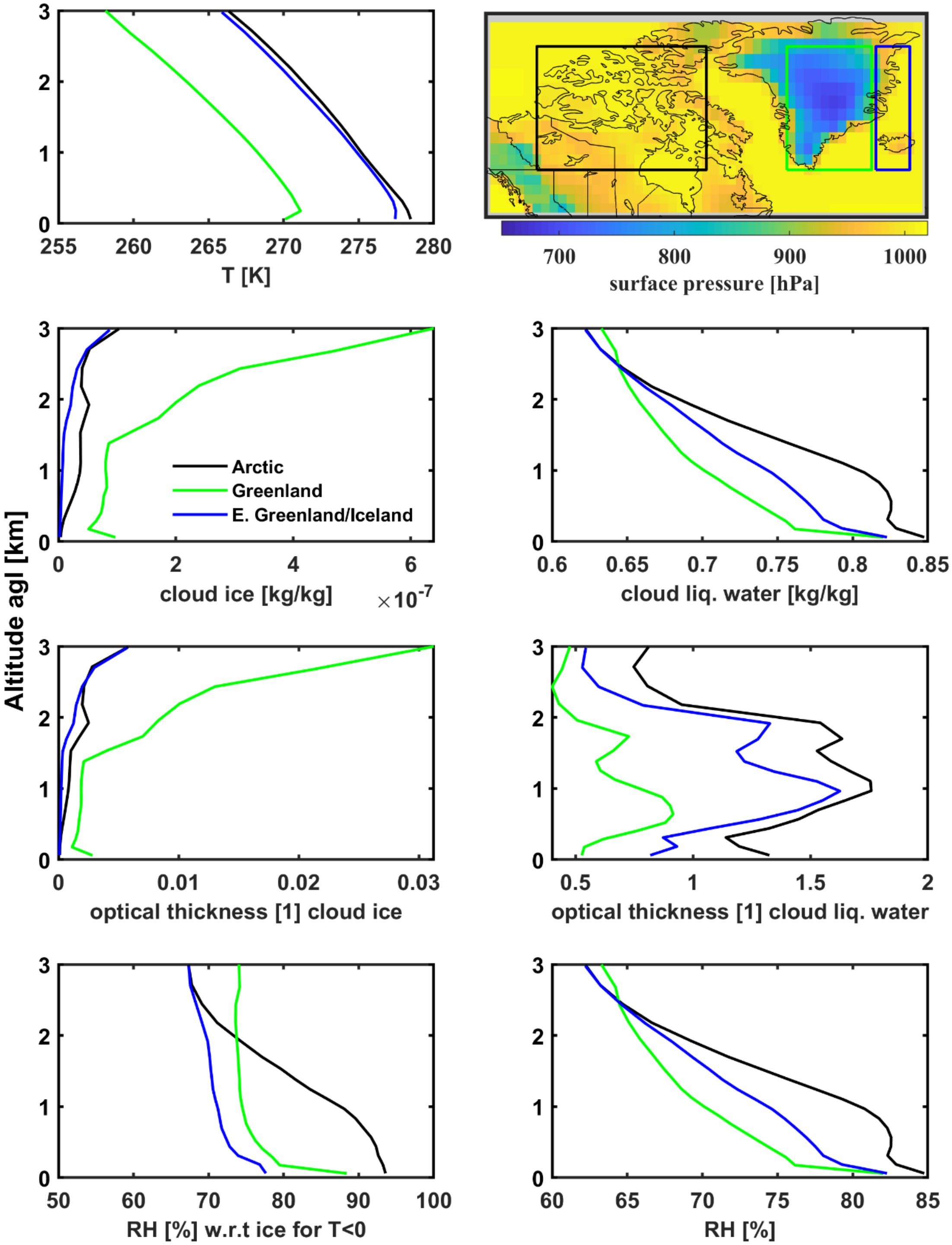

Figure S8. Regional summertime (JJA) mean (2006–2020) vertical profiles of ice formation-relevant quantities in the regions depicted in the upper right map of surface pressure (JJA, 2006–2020) and described in relation to Figure 5 (CALIOP) in the main text. Meteorological reanalysis fields were taken from Modern-Era Retrospective analysis for Research and Applications Version 2 (MERRA-2; https://gmao.gsfc.nasa.gov/gmao-products/, last access: 17 December 2025).RH w.r.t. ice was computed from RH and T fields according to Zamora et al. (2022).

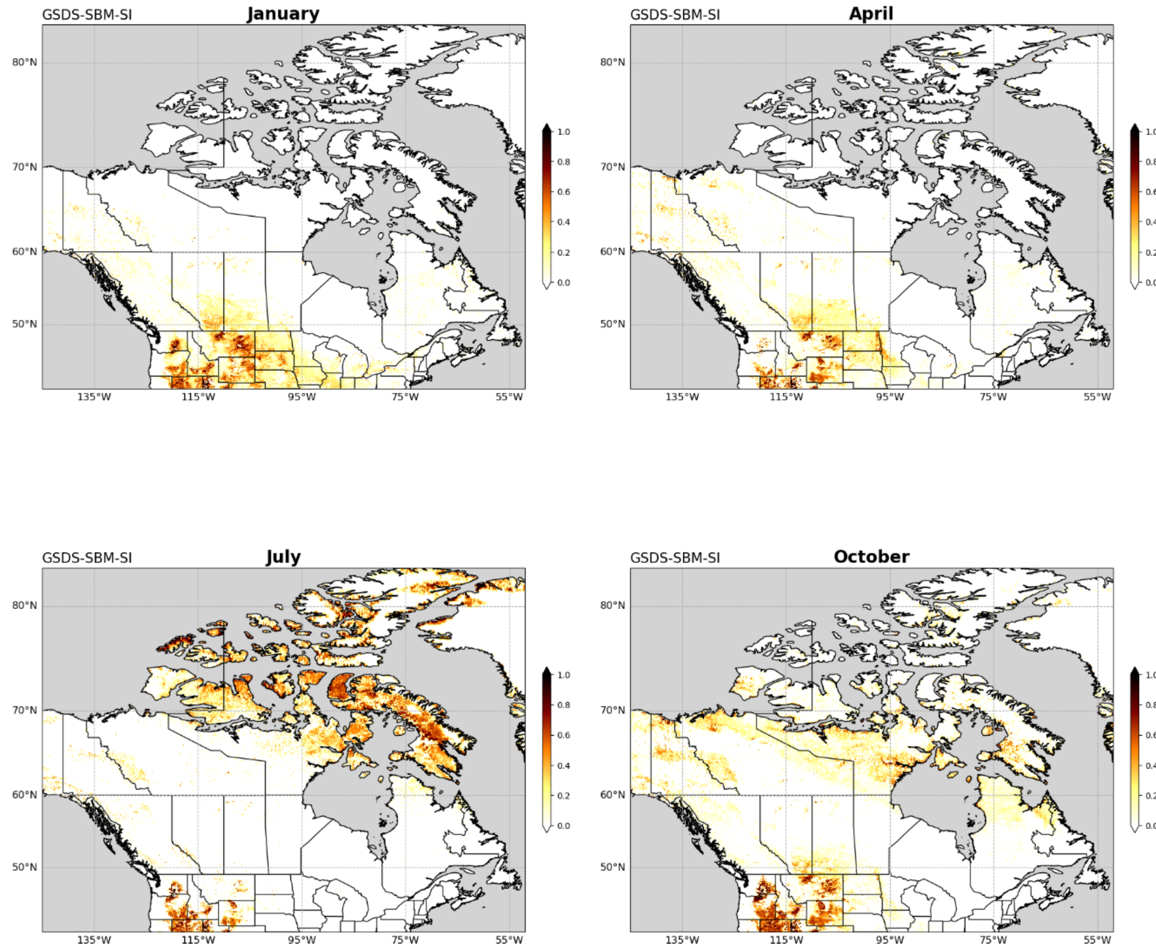

Figure S9. Source intensity (SI) from the G-SDS-SBM dataset for January, April, July, and October.

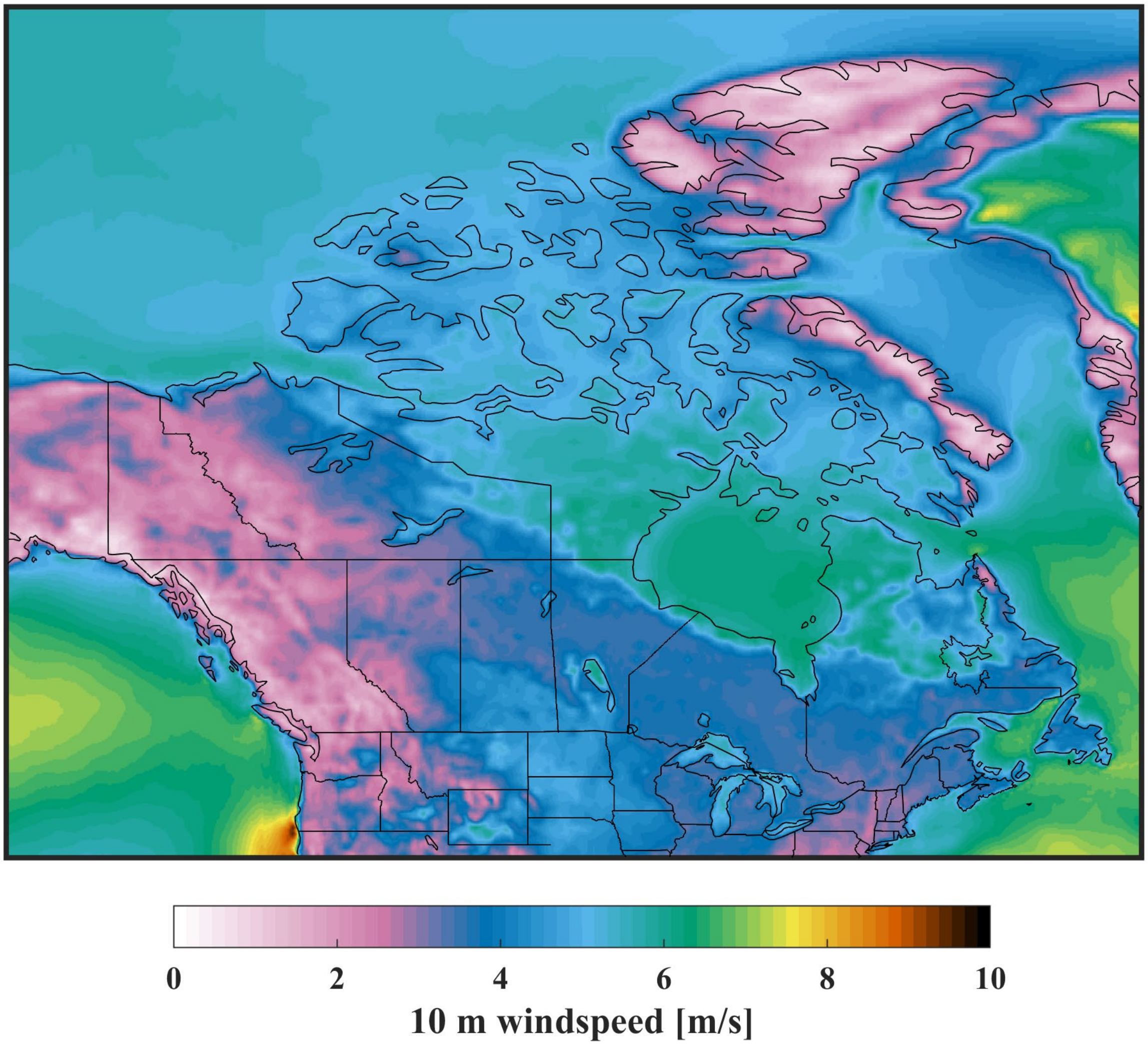

Figure S10. Climatological (2003–2022) summertime (JJA) windspeed (10 m agl) at 1300h LST from ERA5 reanalysis data at 0.25° × 0.25° regridded to the 0.1° × 0.1° grid used to analyze DOD in the main text.

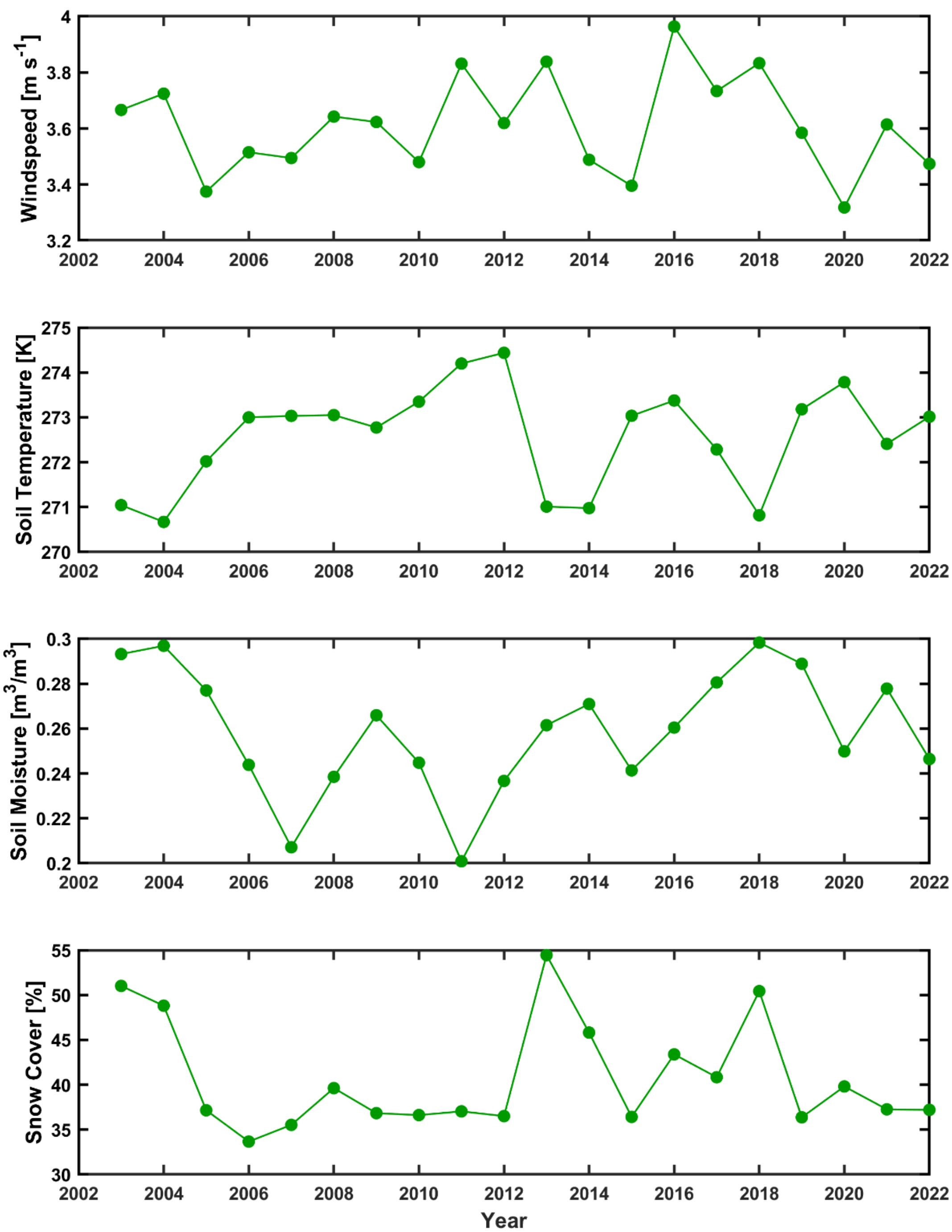

Figure S11. Climatological (2003–2022) warm season (JJAS) annual means of (daily) meteorological fields of relevance to Fig.7 (same geographic area), which showed some increase of dustiness in 2nd decade of FoO ($DOD_{PG16} > 0.5$) data. ERA5-Land reanalysis fields at 0.1° × 0.1° were used (https://cds.climate.copernicus.eu/datasets, last access: 18 December 2025).