

Mineral dust emission and dispersion over population centers in southcentral Alaska

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Introduction

Mineral dust emissions in Alaska remain unquantified and unaccounted for in global estimates (Crusius et al. 2024). In southcentral Alaska frequent dust events have been reported colloquially and through ADEC (Alaska Department of Environmental Conservation) reporting; ~45% of Alaska’s population live < 80 km downwind of these known dust sources, with multiple daily PM10 exceedances attributed to wind-blown glacial silt from the Knik, Matanuska, and other rivers. We evaluated dust activity with available ADEC monitoring records and work towards emission estimates from these proglacial valleys with atmospheric dispersion modeling.

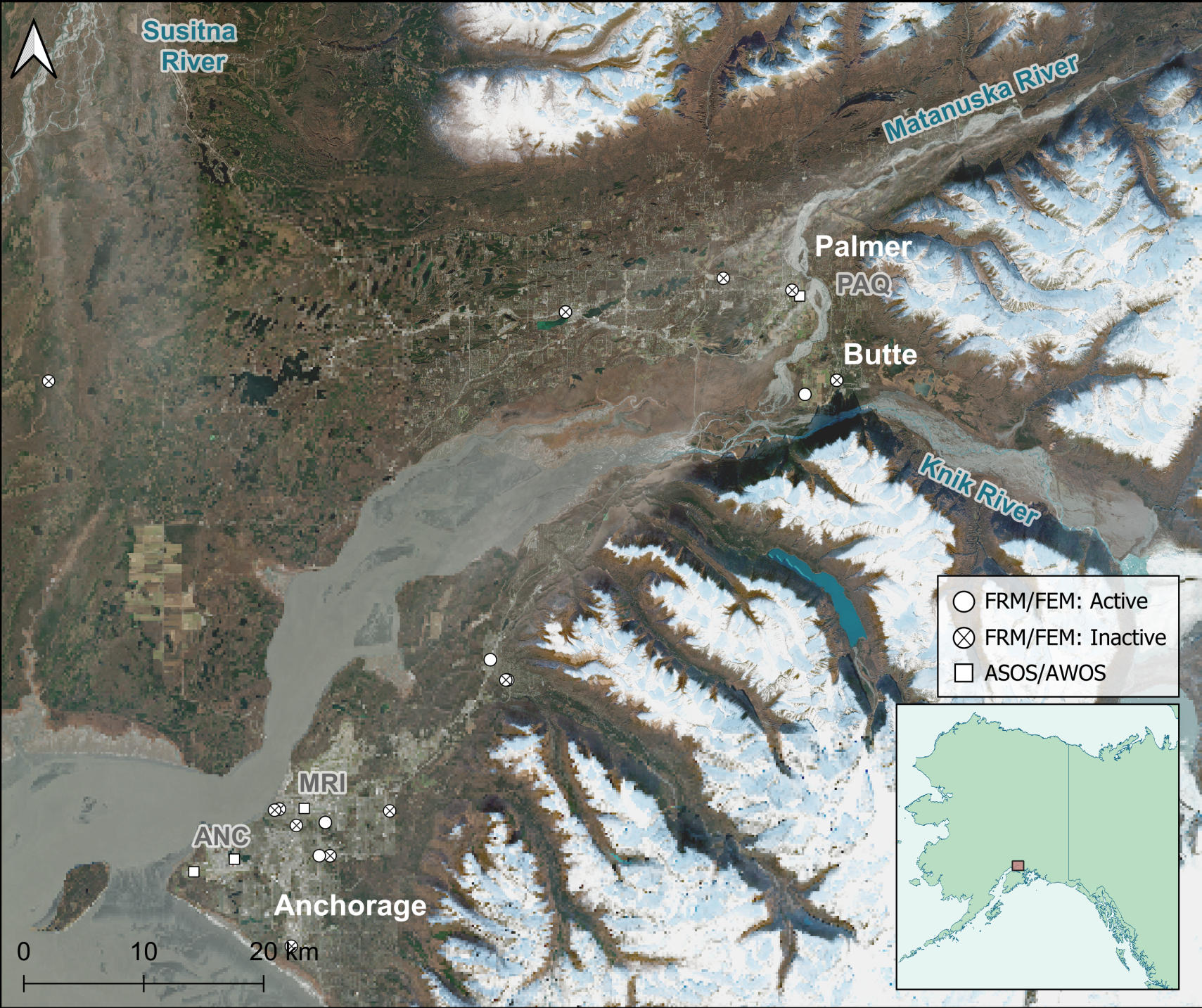


Figure 1. Overview of southcentral Alaska; True Color Optimized Sentinel-2 L2A – 2024-10-18.

Methodology

Station data

Dust emission events were indexed based on Palmer and Butte station records. Indexing criteria was daily PM₁₀ > 40 µg m⁻³ PM_{2.5}/PM₁₀ < 0.35 after Tong et al. (2012). For qualitative records, we aggregate present weather reporting from ASOS/AWOS stations and review identified events in ADEC reporting to catalogue dust events in the region.

FLEXPART-WRF

With monitoring stations immediately adjacent to each source, the FLEXPART-WRF dispersion model was tuned to hourly PM₁₀ concentration for low-cost dust emission estimates, with meteorological fields prepared with WRF.

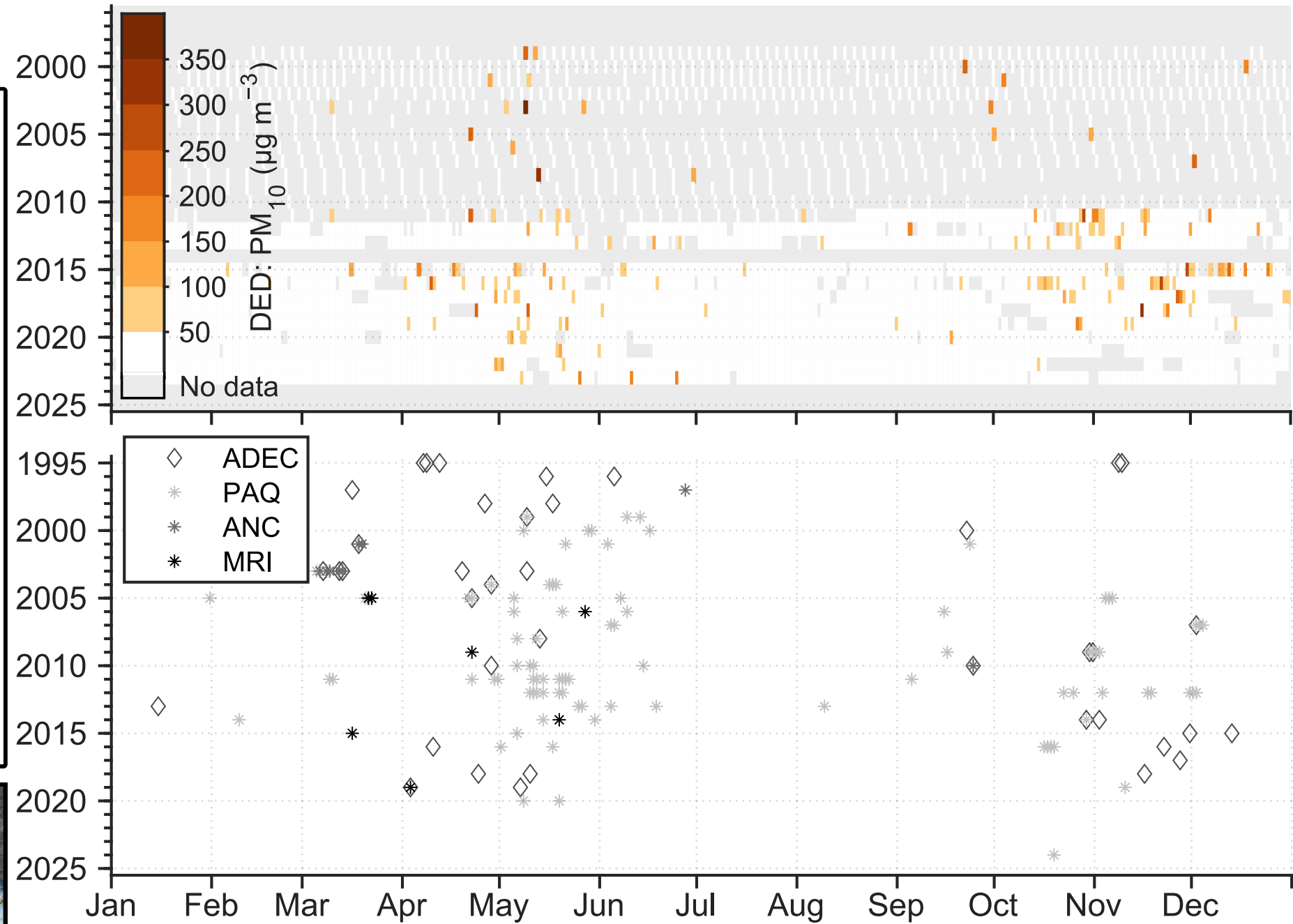


Figure 2. (top) Daily PM10 concentration during dust event days (DED) as indexed at Butte and Palmer monitoring stations. (bottom) ASOS/AWOS dust-related daily present weather codes at regional airports (PAQ/ANC/MRI). ADEC: extreme PM10 events attributed to wind-blown dust in ADEC reporting.

Dust activity summary

Between 1999 and 2023, indexing based on FRM records identified 197 dust event days at Palmer and Butte, from the Matanuska/Knik rivers, respectively (Figure 2). ASOS/AWOS identified 111 days with dust-related activity between 1995-2011. A review of ADEC reporting identified 39 major PM10 events attributed to wind-blown glacial silt, with a maximum of 605 µg m⁻³, and 95% of which exceeded the daily PM10 NAAQS threshold.

Dispersion modeling

Figure 3 displays average PM10 concentrations due to emissions simulated from the Matanuska and Knik rivers during 2011-11-02. Daily PM10 values of 383 µg m⁻³ and 126 µg m⁻³ were measured at Butte and Palmer, respectively. Simulated daily PM10 indicates exceedance of the daily PM10 NAAQS threshold for ~400,000 individuals.

Next steps

With this proof of concept complete, next steps will focus on running simulations for the ~190 dust event days during 2011-2019 to arrive at a multi-year total emission estimate for the region. *Support for this work was provided by NASA HAQAST grant (Grant Number 80NSSC25K0211).*

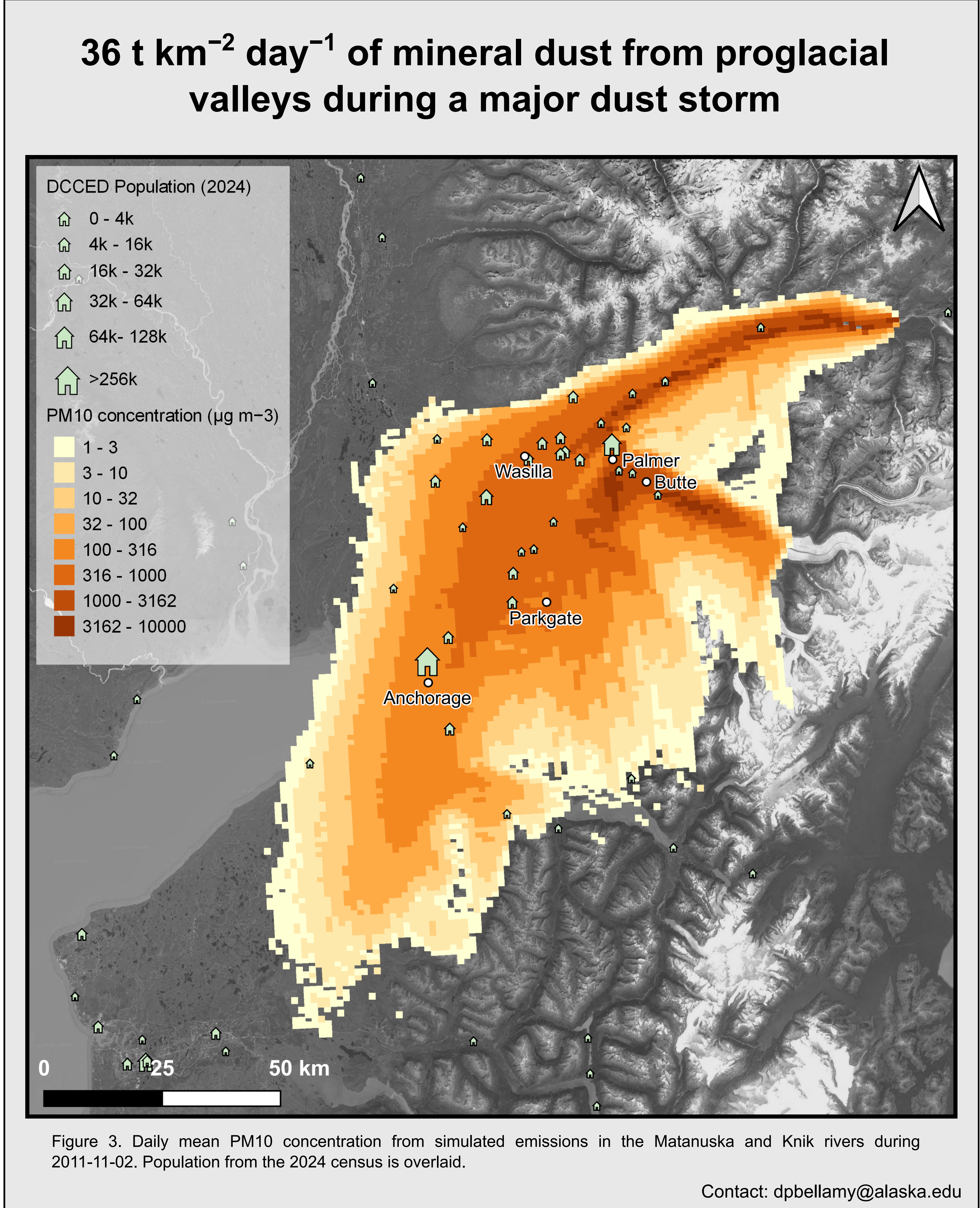


Figure 3. Daily mean PM10 concentration from simulated emissions in the Matanuska and Knik rivers during 2011-11-02. Population from the 2024 census is overlaid.