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Quantifying the spatial and temporal influence of infrastructure on seasonal snow melt timing and its influence on vegetation productivity and early season surface water cover in the Prudhoe Bay Oilfields

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Increased industrial development in the Arctic has led to a rapid expansion of infrastructure in the region. Past research shows that infrastructure in the form of roads, pipelines and various building types impacts the surrounding landscape directly and indirectly by changing vegetation patterns, locally increasing ground temperatures, changing the local hydrology, introducing road dust into the natural environment, and affecting the distribution and timing of seasonal snow cover. Localized impacts of infrastructure on snow distribution and snow melt timing and duration feedbacks into the coupled Arctic system causing a series of cascading effects that remain poorly understood. In this study, we quantify spatial and temporal patterns of snow-off dates in the Prudhoe Bay Oilfields (PBO), North Slope, Alaska using multispectral remote sensing data from the Sentinel-2 constellation. The Sentinel-2 satellite constellation provides good spatial and temporal coverage of Arctic regions with adequate spatial resolution to quantify and monitor infrastructure impacts on the natural environment in polar regions. We derive the Normalized Difference Snow Index (NDSI) to quantify the presences and absences of snow on a pixel-by-pixel basis between 2015 and 2020. Additional indices, like the Normalized Difference Vegetation Index (NDVI) and the Normalized Difference Water Index (NDWI) were derived to understand linkages between patterns in vegetation and surface hydrology, respectively, to patterns in snow-off dates that are influenced by the presence and type of infrastructure on a regional basis at PBO. Newly available infrastructure data sets derived from Sentinel-1 and 2 data were employed to quantify differences in snow melt patterns in relation to distance to roads and other types of infrastructure. Near-surface ground temperature measurements from multiple transects oriented in a perpendicular direction from the road up to 100 m provided ground-truth observations for snow-off timing derived from the remote sensing analysis. Our results from the regional remote sensing analysis show a relationship between snow-off date and distance to different types of infrastructure that vary by their use and traffic load during the snowmelt period as well as their orientation relative to

the prevailing wind direction. Results from field data observations indicate that the early onset of snowmelt near heavily traveled infrastructure corridors impacts near-surface soil freezing degree days, vegetation productivity, and waterbody surface cover.