Regional changes in climate on the North Slope of Alaska, like other high latitude locations, have led to enhanced physical disturbance and thermal perturbation of permafrost, terrain degradation, changing weather patterns, and altered hydrogeologic processes (Fig. 1). These changes can alter surface water chemistry in stream and river systems and constituent fluxes to the coastal Arctic Ocean. The Alaska North Slope Material Flux Study (AKMFS) is a 4-year field research study to investigate how landscape-specific source contributions change surface water chemistry in and material fluxes through the Sagavanirktok River. The AKMFS study area encompasses the main-stem Sagavanirktok River from SAG01 to SAG08, with measurements from SAG05DR and SAG04DR on tributaries, and SAG04 on Schuyler Creek (Fig. 2). AKMFS also includes research on Schuyler Creek and other Arctic Rivers in the region, which can be more variable and change under future warming scenarios.

Discharge data and surface water samples were collected from 5 sites on the Sagavanirktok River (SAG05-08) and 2 transitional tundra streams (Schuyler Creek (SCH01) and Happy Valley Creek (HAP01)) during four open water season sampling events: 03-13 June, 31 July – 07 August, 10-12 September, and 08-11 October 2019. Data and samples were collected from the same sites and two additional sites on the Sagavanirktok River (SAG03, 02, 04) during three sampling events in 2021: 04-13 June, 30 July - 08 August, and 13-16 September 2021 (Fig. 1b). Methods are shown and described in Figure 3.

Discussion

A simple mixing model (Fig. 5) provides an estimate as to whether DOC and dissolved Fe inputs at SCH01 and HAP01 can significantly alter surface water chemistry in the main-stem Sagavanirktok River during high discharge. The model approach provides only a first order estimate since DOC and dissolved Fe do not behave conservatively and there are multiple potential sources for DOC and dissolved Fe inputs to the system. The 2019 modeled results (Table 1) suggest inputs of tundra-sourced DOC from discrete sources like SCH01 and HAP01 coincident with extreme precipitation, higher hydrologic connectivity, and higher discharge (Shagay et al. 2019). Physical disturbance and thermal perturbations of tundra landscapes, permafrost, can enhance solute transport and introduce new hydrologic pathways during high precipitation events (Bryce et al. 2019, Fig. 5a). Unmanned aerial system (UAS) surveys in 2021 revealed physical disturbance and enhanced drainage pathways in the Happy Valley area (Fig. 6b). Results from 2021 show that tundra stream sources may be less significant during peak flow at the spring freshet as compared to 34.1-46.7 t·C and 1511 – 2437 kg·Fe on 09 June 2021 during the spring freshet.

Conclusion

At Arctic climate and Alaska North Slope landscapes change, integrated solute inputs from tundra streams and drainage pathways during the summer thaw season during episodic periods of extreme precipitation and high stream-river discharge may result in pulsed DOC and dissolved Fe fluxes through the Sagavanirktok River that rival those during the spring freshet.

Future Work (2022)

- Collect additional data and samples during the 2022 open water season as part of the 2022 research season
- Include detailed chemical analysis
- Investigate the interaction of precipitation, soil saturation, hydrologic residence time, and biogeochemical processes within the soil active layer in determining dissolved carbon and inorganic constituent inputs from sub-watersheds to larger Arctic rivers

Table 1

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Figure 5. 2-component, steady-state, instantaneous, conservative mixing model (results Table 1) for the main-stem Sagavanirktok River between SCH01 and SAG031 and transitional tundra streams SCH01 and HAP01.

Figure 6. (a) Conceptual model of physical disturbance and thermal perturbation of tundra landscapes and (b) 2021 UAS vertical landscape change detection survey results (1/-1 m) from Happy Valley sub-watershed.