Methane Concentration at the outlet of Castner Glacier, Alaska Range, 2023

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Methane is the second most influential greenhouse gas after carbon dioxide, and its release in the Arctic land is mostly from permafrost. Glaciers have not been considered a source of methane emissions. Recently, a large amount of methane has been observed at the terminus of large glaciers in Greenland, associated with methane-saturated meltwater runoff (e.g., Christiansen and Jorgensen, 2018: Lamarche-Gagnon et al., 2019). The objective of this study is to see if methane emission is from small mountain glaciers. We observed several glaciers in Alaska starting in 2019 and found methane emissions from the runoff water (Konya et al., 2022). We conducted field observations at Castner Glacier in the Alaska Range in 2023 to reveal the fluctuation of methane concentration at the terminus.

The Castner glacier is debris-covered, about 54 km^2 in area and 20 km in length, located between 790 and 2940 m above sea level. A tunnel was formed at the terminus of the glacier, whereas the shape and the position were different from year to year due to the melting of the terminus. The observation period was June 3-9 and August 21-22, 2023, which was the beginning and end of the ablation season for the glacier. We measured methane and CO2 concentrations in ambient air over the water surface with a portable gas analyzer G4301 (Picarro, Inc.). Dissolved methane concentrations in runoff water were measured by the method of Morishita et al. (2015). Also, the analysis of $\delta^{13}C$ and δD isotope ratios for dissolved methane, microbial, TOC, and $\delta^{18}O$ and δD isotope ratio of runoff water were conducted from the collected water samples. Water quality, such as pH, conductivity, water temperature, water pressure (water level), dissolved oxygen, and turbidity, were measured by the sensor (AquaTROLL500 Multiparameter Sonde, In-Situ Inc.) in the runoff water. Meteorological observation was conducted at the sampling site during the former observation period (June 3-9) to measure air temperature, relative humidity, wind speed, radiation, and precipitation.

The maximum ambient air methane concentration value near the runoff water was clearly higher than the background level. The concentration decreased as the gas scouter moved away from the tunnel, suggesting that dissolved methane was released from the water flow in the tunnel. Atmospheric methane and CO_2 concentrations measured with a gas analyzer at Castner Glacier showed similar trends. This trend is the same as the previous study in Greenland, where methane and CO_2 concentrations changed synchronously. The concentration was clearly higher than the background at the beginning of the observation period and almost the same as the background at the end. The water level of the runoff increases toward the end of the observation period. The dissolved methane concentration showed diurnal and daily fluctuation, which supports the concentration change in the ambient air.

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