How Carbon Travels - A Nearshore Zone Odyssey -

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WHY?

Organic carbon (OC) released by permafrost thaw or coastal erosion first enters the Arctic Ocean in the shallow nearshore zone (0 to 20m water depth). This is where the pathways of OC are decided: OC can be converted to greenhouse gas and **released to the atmosphere**, in a positive feedback loop, or OC can be transported further offshore and **buried in marine sediments**. Several studies have attempted to quantify these pathways, yet none has ever resolved the **variability associated with winds over the course of a summer season**. This is the objective of this study.

WHERE?

Herschel Island - Qikiqtaruk (HIQ) (N69.6°, W139.0°) is situated off the Yukon coast in Northern Canada (Figure 1). The island consists of continuous ice-rich permafrost and features permafrost thaw landforms such as retrogressive thaw slumps (Lantuit & Pollard, 2006).

We focused on two transects in the nearshore zone off the **southeastern coast of HIQ**. The nearshore zone is the coastal zone closest to the coast with a water depth up to 20 m.

Figure 1. Overview study area southeast of HIQ. Graphic is modified from Encyclopaedia Britannica, Inc. (edited June 2023).

In A Nutshell

Wind direction and speed greatly affect the amount of organic carbon in the nearshore zone, with variations occurring on a daily basis!

The most prominent wind directions were northwest (NW) and southeast (SE) (Figure 5). We found **statistically significant correlations between wind direction and the amount of OC**, as well as between **wind speed and salinity and water temperature**. During periods of NW winds, the nearshore waters experienced greater mixing, whereas SE winds resulted in the formation of higher waves and a more distinct stratification within the water column (Figure 6). This stratification was caused by the displacement of ocean water and brackish water into the study area by SE winds.

In our statistical analysis, we considered winds that had been blowing for a **minimum duration of 12 hours** from a single direction.

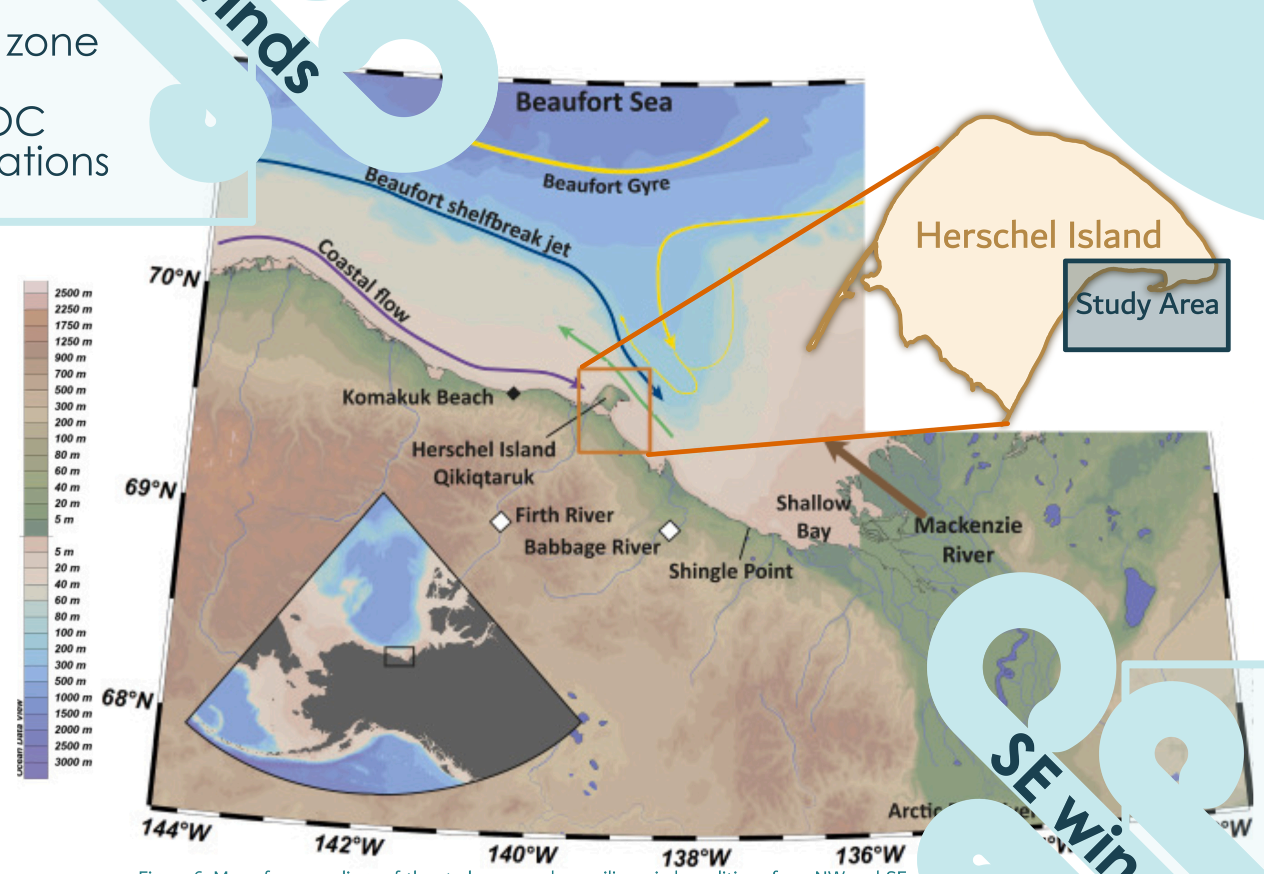

Figure 6. Map of surroundings of the study area and prevailing wind conditions from NW and SE. Graphic is modified from Falardeau et al. (2023).

WIND INFLUENCE

ERA5 wind data for July 2022 was used to correlate our geochemical parameters (especially OC) with wind direction and wind speed.

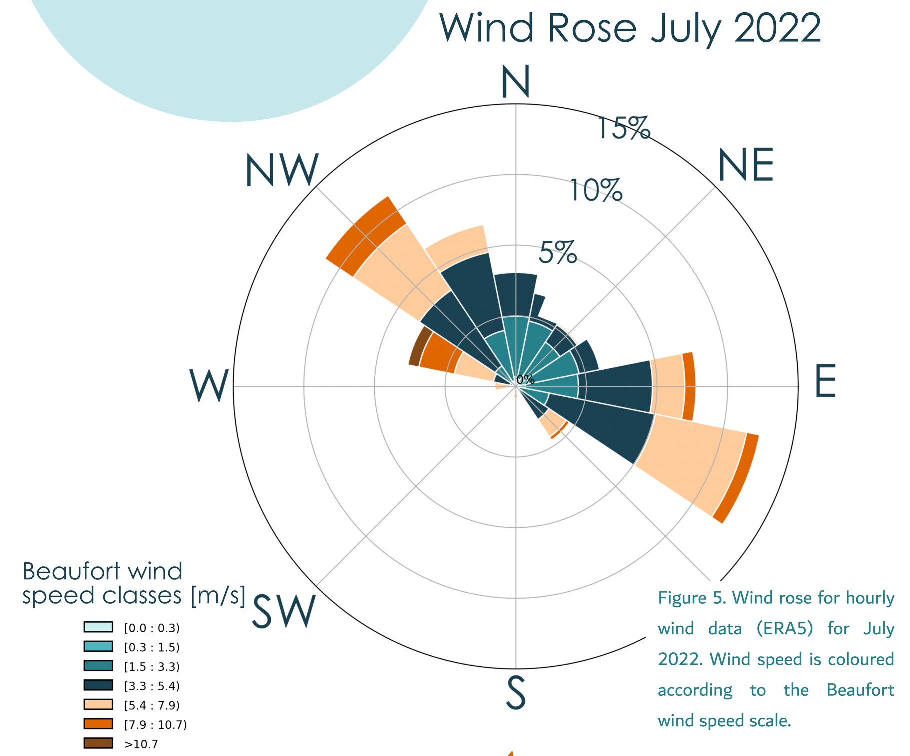

Figure 5. Wind rose for hourly wind data (ERA5) for July 2022. Wind speed is coloured according to the Beaufort wind speed scale.

HOW?

The temporal variability of organic carbon content in the nearshore waters was accessed by **repeated sampling** over a period of two weeks in **July 2022** (Figure 2).

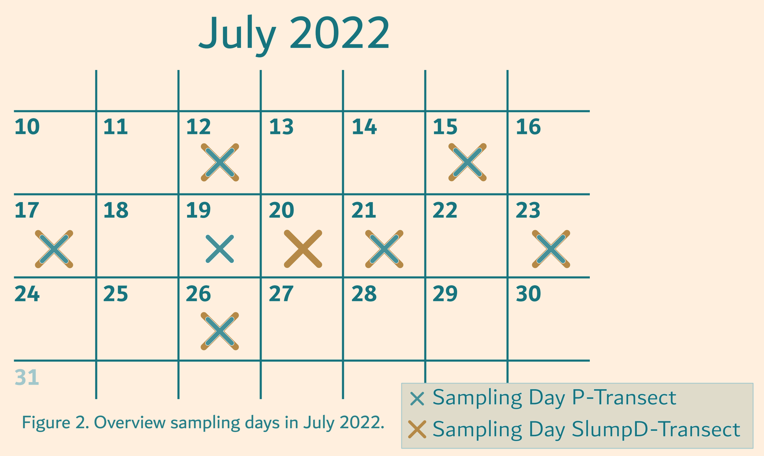

Figure 2. Overview sampling days in July 2022.

Samples were taken **in the water column** (Figure 3) (surface, thermocline, and bottom waters) for **OC, temperature, salinity, and turbidity measurements**.

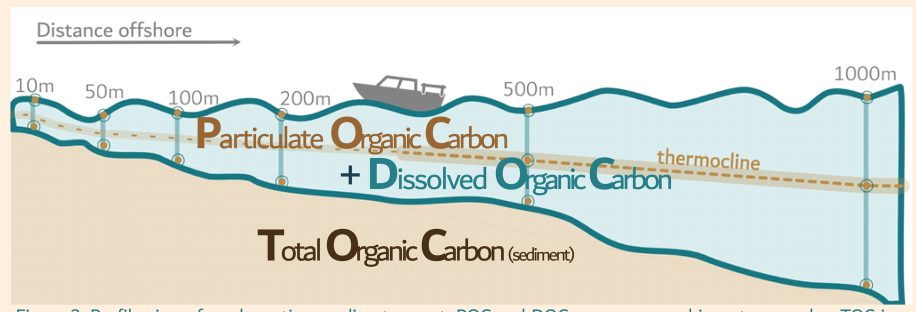

Figure 3. Profile view of a schematic sampling transect. POC and DOC were measured in water samples, TOC in marine sediments.

ORGANIC CARBON IN THE NEARSHORE ZONE

The distribution of particulate organic carbon **POC**, dissolved organic carbon **DOC** and total organic sediment **TOC (sediment) in the nearshore zone exhibited distinct patterns** (Figure 4). POC concentrations were highest near the coast, while DOC concentrations were highest in the surface waters along each transect. TOC concentrations were found to be highest in sediments situated further offshore. **Resuspension events** were characterised by a high turbidity and high POC concentrations in the vicinity of the coast.

OC concentrations were found to be higher in the nearshore zone in front of the outlet of a **retrogressive thaw slump** in comparison to the nearshore zone in front of a **permafrost cliff coast**. However, it should be noted that this observation may not be representative for the entire season, as sampling was conducted at the beginning of the open water season.

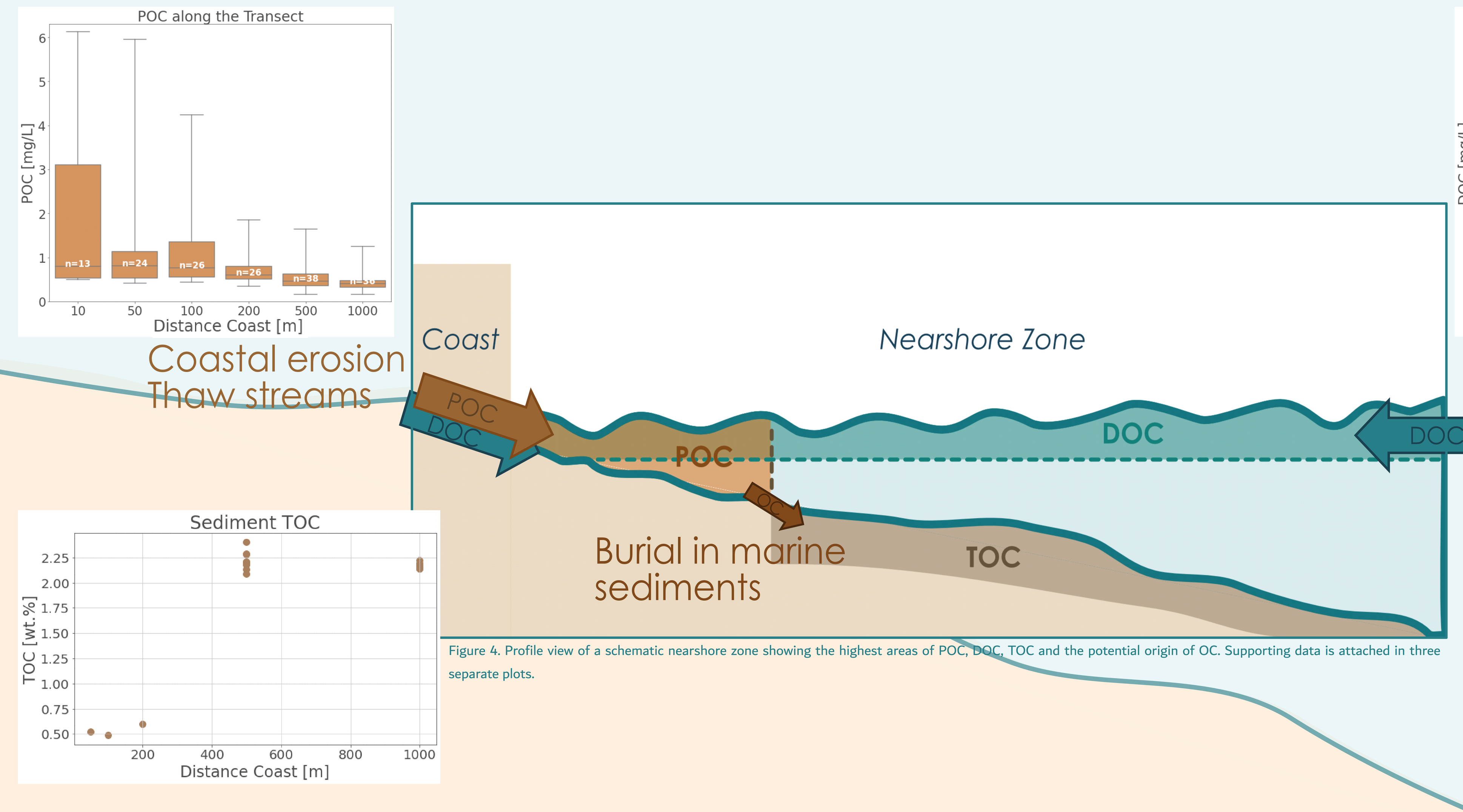

Figure 4. Profile view of a schematic nearshore zone showing the highest areas of POC, DOC, TOC and the potential origin of OC. Supporting data is attached in three separate plots.

You want to know more?

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