# Early melt-season inorganic carbon and nutrient sediment-water fluxes in the Bering and Chukchi Seas

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## 1. MOTIVATION

- The Arctic Ocean is <5% of the global ocean surface, but accounts for >10% of sea surface carbon dioxide ($CO_2$) uptake.[1]
- Ice-free Septembers predicted for as early as the 2040's.[2]
- Changes to carbon sink challenging to predict:
  - Less sea ice = more sea surface area for $CO_2$ exchange and phytoplankton growth?[3]
  - Meltwater freshens surface water and ↓ $CO_2$ uptake and C export?[4]

## 2. STUDY AREA

- **Bering and Chukchi Seas** are shallow (<60m)
- High rates of export production[5]
- Benthic-pelagic coupling of biologically-relevant solutes ($CO_2$, nutrients)

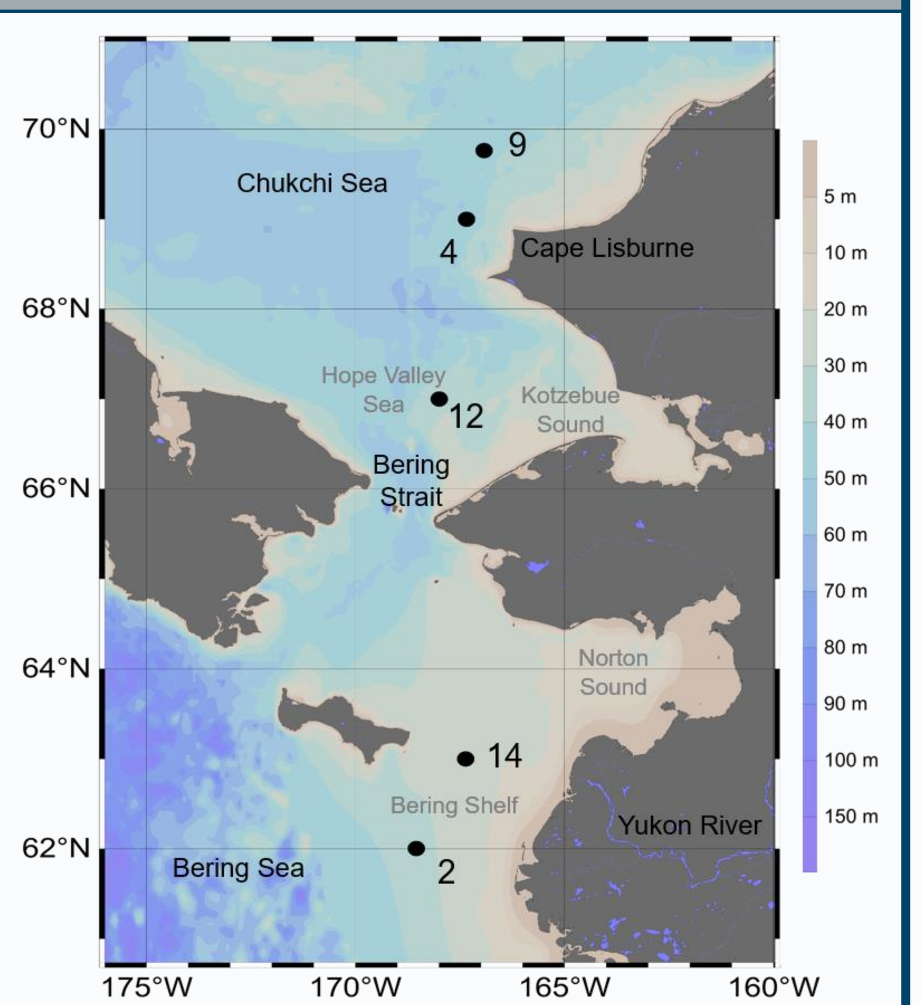
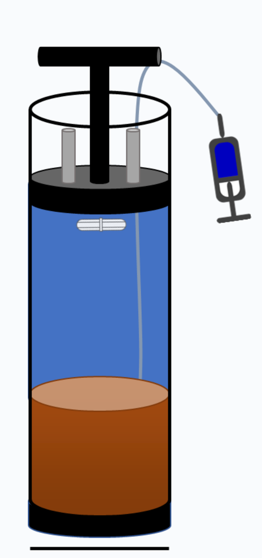



Figure 1 (right). Sediment core locations with station and regional identifiers.

## 3. APPROACH

- Samples collected between 20 May and 14 June 2021 aboard the *R/V Sikuliaq*
- Duplicate gravity cores collected via a multi-core and incubated following [6]
- Time-series samples of **dissolved inorganic carbon (DIC)**, $pH_T$, dissolved nutrients, and radon-222 ($^{222}Rn$) collected from the **overlying water (OLW)**




## 4. RESULTS AND DISCUSSION

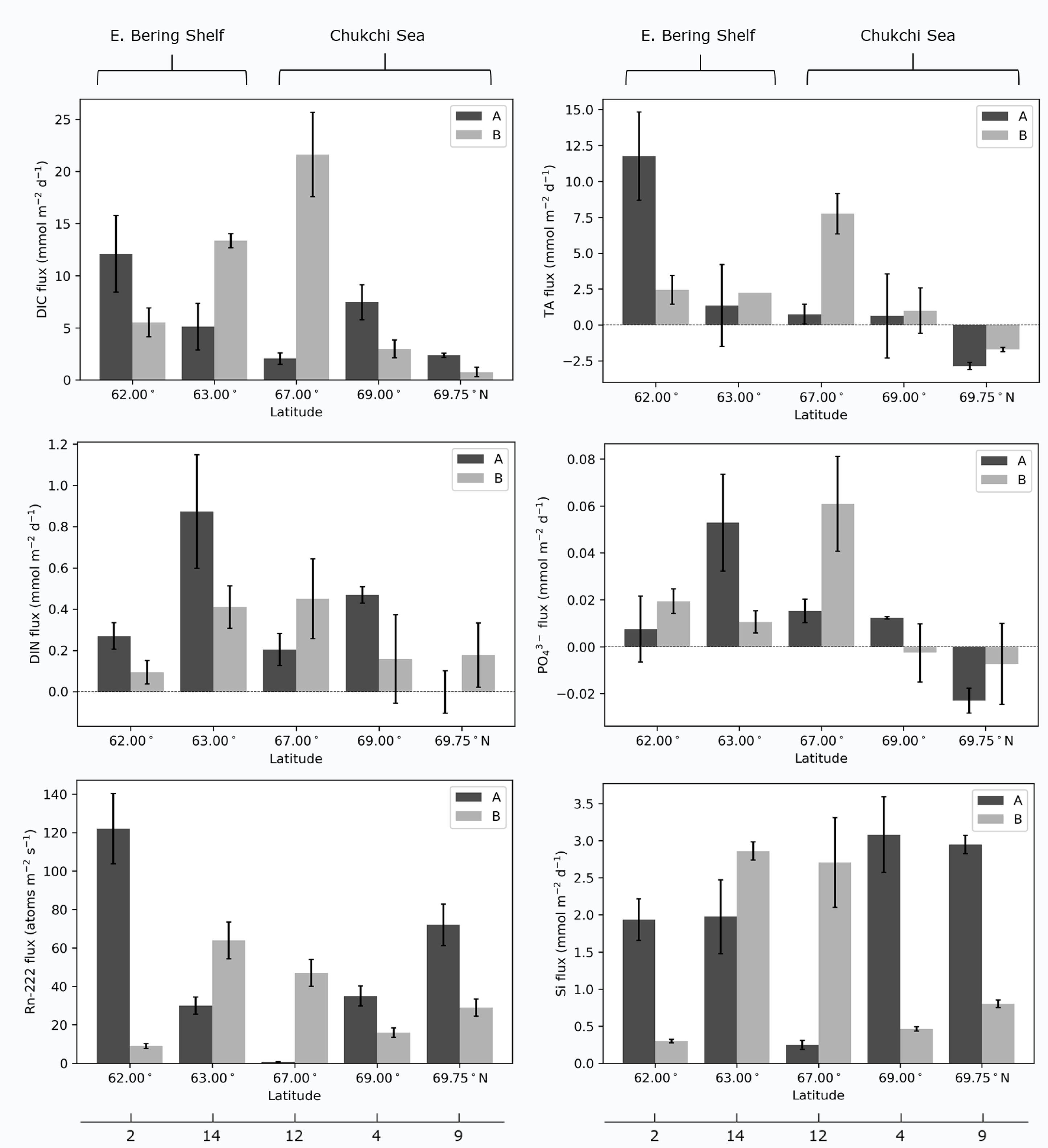



Figure 2. Sediment-water fluxes from the sediments to the water column. Positive values = sediment efflux, negative values = sediment influx.

### SEDIMENT-WATER FLUXES

- Northward ↓ in fluxes of dissolved inorganic carbon (DIC) and nutrients in the Chukchi Sea
- **Effluxes inhibited in most recently ice-covered stations**
- DIC concentrated at stations with low effluxes → **bottom water accumulation during the ice-covered season**
  - DIC efflux inhibited by ↓ diffusive gradients in N Chukchi Sea

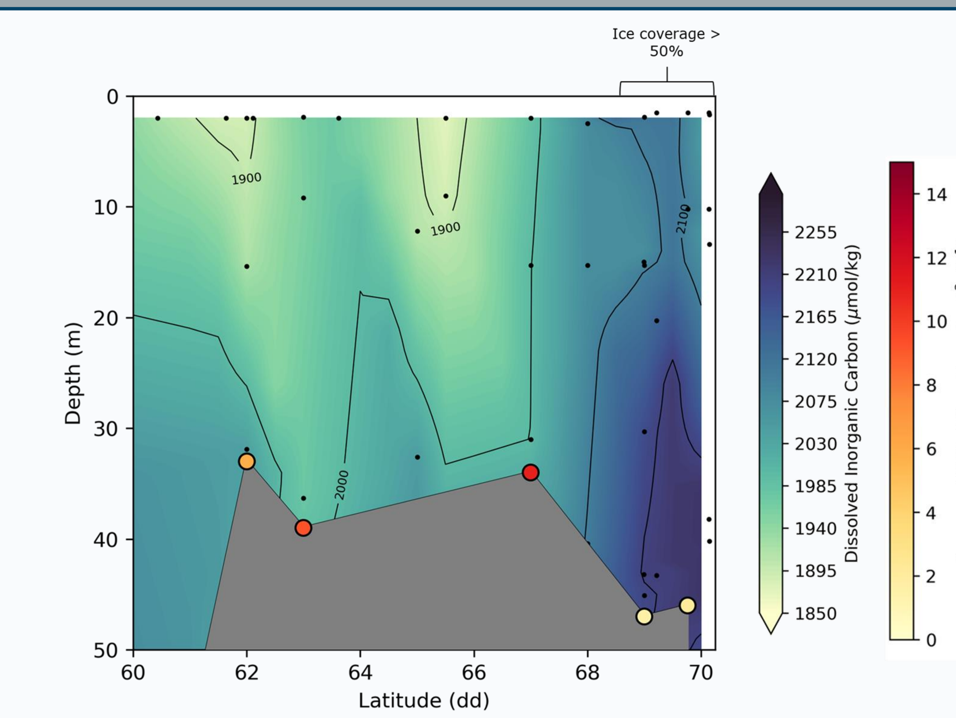



Figure 3. Cross-section of water column DIC and sediment efflux of DIC (circles).

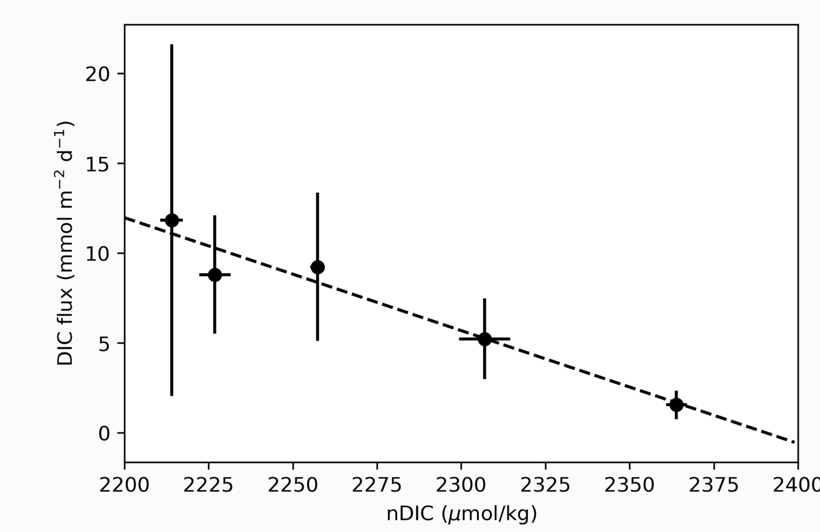


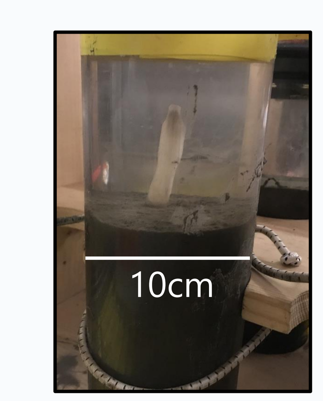

Figure 4. DIC efflux vs overlying water salinity-normalized DIC (nDIC). R = -0.97, p = 0.006.

### ICE COVER DURING SAMPLING

- Bering Sea ice-free >1 month
- S. Chukchi Sea ice-free ~1 month
- E Chukchi ice-free for <1 week

### REPLICATE HETEROGENEITY

- Large replicate flux heterogeneity, especially in the Bering and S Chukchi Seas.
- DIC & nutrient fluxes corresponded to $^{222}Rn$ (a proxy for bio-irrigation) → **macrofauna accelerated sediment-water efflux**
- A cnidarian emerged from core 2A during the incubation; this core had the highest $^{222}Rn$ flux




## 5. SUMMARY AND IMPLICATIONS

- Sediment effluxes of respiration products (DIC, nutrients) lowest at most recently ice-covered stations with the highest bottom water concentrations.
- Arctic Ocean sea ice melt onset is expected earlier by several days per decade.[7]
- Ice coverage inhibits primary and export productivity, decreasing benthic respiration and the efflux of respiration products.
- Macrofauna facilitated sediment effluxes of $CO_2$ and nutrients via irrigation
- **Future sediment effluxes of DIC and DIN may ↑ due to an earlier onset melt-season;** the impact on sediment carbon storage should be explored.

## 6. SUPPORTING

### References

[1] Yasunaka et al. (2018) *Biogeosci.* [2] Overland and Wang (2013) *Geophys. Res. Lett.* [3] Bates et al. (2006) *J. Geophys. Res.* [4] Woosley and Millero (2020) *Limnol. Oceanogr.* [5] Campbell et al. (2009) *Deep-Sea Res. II* 6] Hammond et al. (2004) *Limnol. Oceanogr.* [7] Stroeve et al. (2014) *Geophys. Res. Lett.*

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