Changes of Net Community Production in the Western Arctic Ocean Uncovered by Machine-Learning-based Mapping

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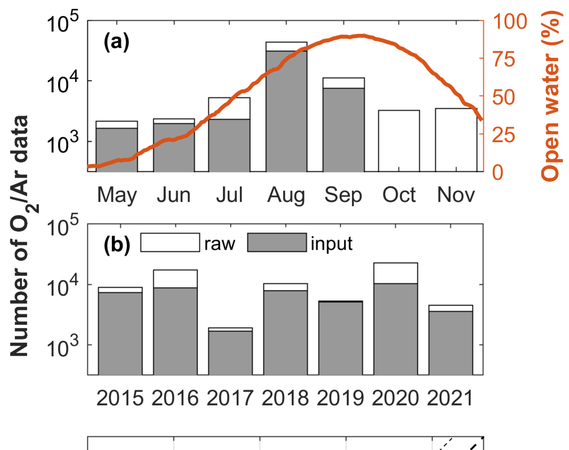
1. Background and Research Questions

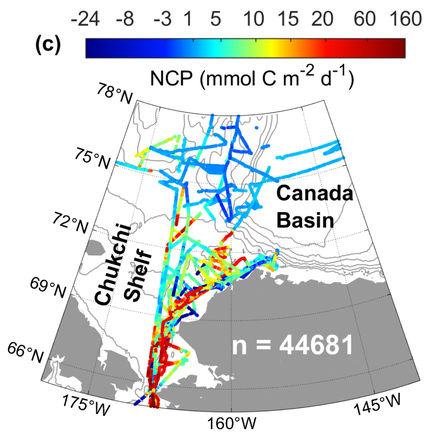
The Arctic Ocean (AO) contributes approximately 5-14% of the global oceanic CO_2 sink, much of which benefits from low water temperature and biologically mediated carbon uptake. Associated with sea ice reduction, larger amount of organic carbon has been produced over years (Lewis et al., 2020), but questions remain on the export of the organic carbon (**Net Community Production; NCP**):

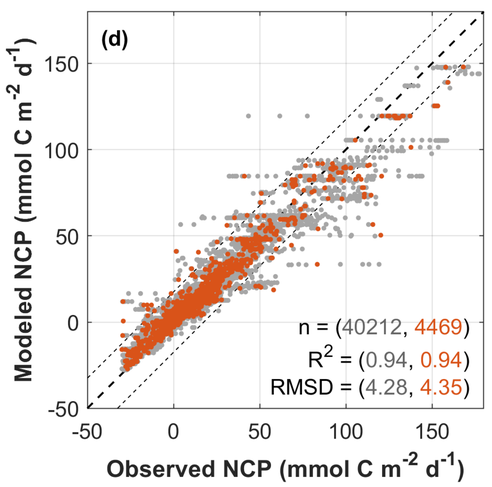
1. **How much** of the bio-produced carbon was exported out of the euphotic zone?
2. **Were there any hot spots** dominant in the overall carbon export?
3. **Did the export efficiency stay constant or strongly vary** from year to year?

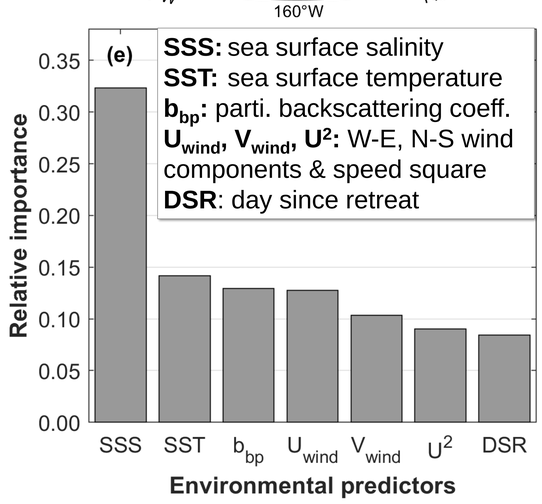
2. Machine Learning Model: Data and Performance

- *In situ* data covers May-Nov over 2015-2021 and all major geographic locations.
- High model performance for NCP training (90%) and testing (10%) sets.





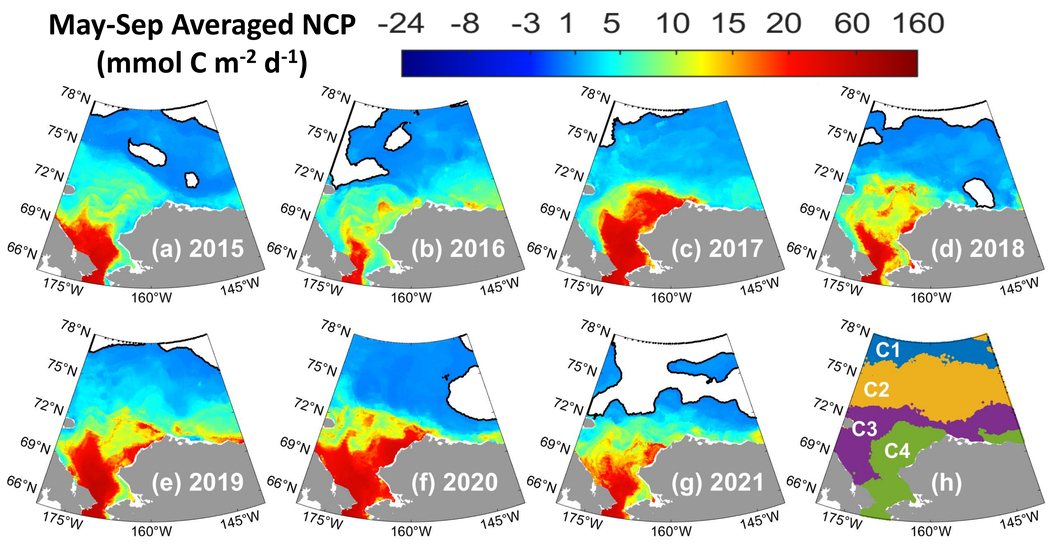




SSS: sea surface salinity
SST: sea surface temperature
b_{bp}: parti. backscattering coeff.
U_{wind}, V_{wind}, U^2: W-E, N-S wind components & speed square
DSR: day since retreat

3. Spatial and Temporal Patterns of NCP: 2015-2021

- A wide range of sea ice (white shade) conditions.
- Shelf-basin contrasts, and poleward expansion of high NCP in recent years.
- Regional coherence grouped into four K-means subdivisions.

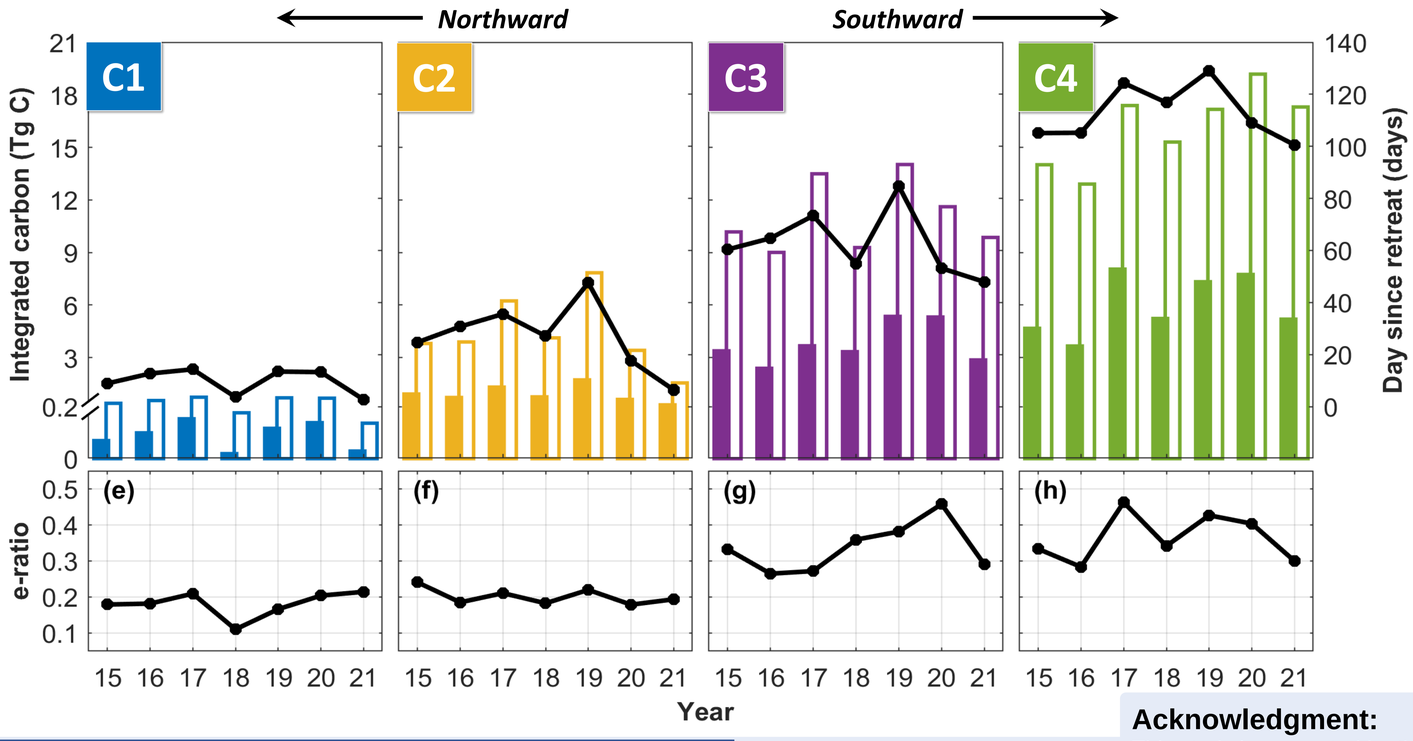


Key Points:

- **Multiyear, gap-free** distribution of NCP is reconstructed by machine learning.
- The e-ratio (export/production) is **predominantly affected by export** in the inflow shelf region.
- In recent years, **carbon export has increased along with** sea ice loss.

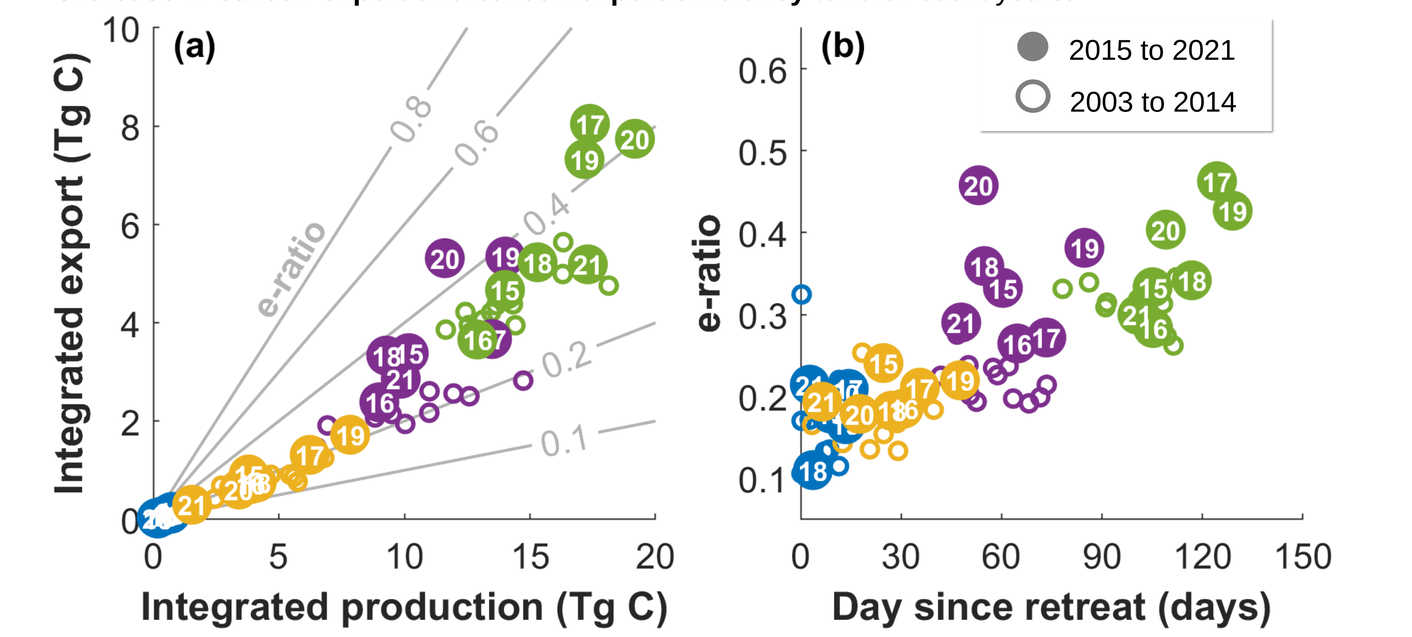
4. Regional Carbon Production (NPP) and Export (NCP)

- Spatially, carbon production (open bars) and export (filled bars) increase southward from C1 to C4.
- Temporally, variations of open water timing and duration affect carbon production and export.
- Export efficiencies (e-ratio = export/production) are relatively unchanged in the northern regions but predominantly affected by carbon export in the southern regions.



5. Discussions: Carbon Export Regimes

- **Stronger export efficiency** in low sea ice years (e.g., 2017, 2019, and 2020).
- **Increase in carbon export and carbon export efficiency** toward recent years.



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References: [**Δ(O_2/Ar) data sources**: Juranek (Arctic Data Center); Juranek et al. (2019); Ouyang et al., (2021); Cynar et al. (2022); Kwon et al. (2022)]

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