

Kongsfjorden Ecosystem - a Nitrogen Sink during the Arctic Summer

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Introduction

A nitrogen budget for Kongsfjorden (Svalbard) (Fig. 1) is calculated for the Arctic summer, to establish whether this fjord is a nutrient sink or source. This ecosystem may be seen as a harbinger of change and available research and knowledge about it is of utmost importance to understand what the future trends will be elsewhere in Arctic coastal systems.

Study area and methods

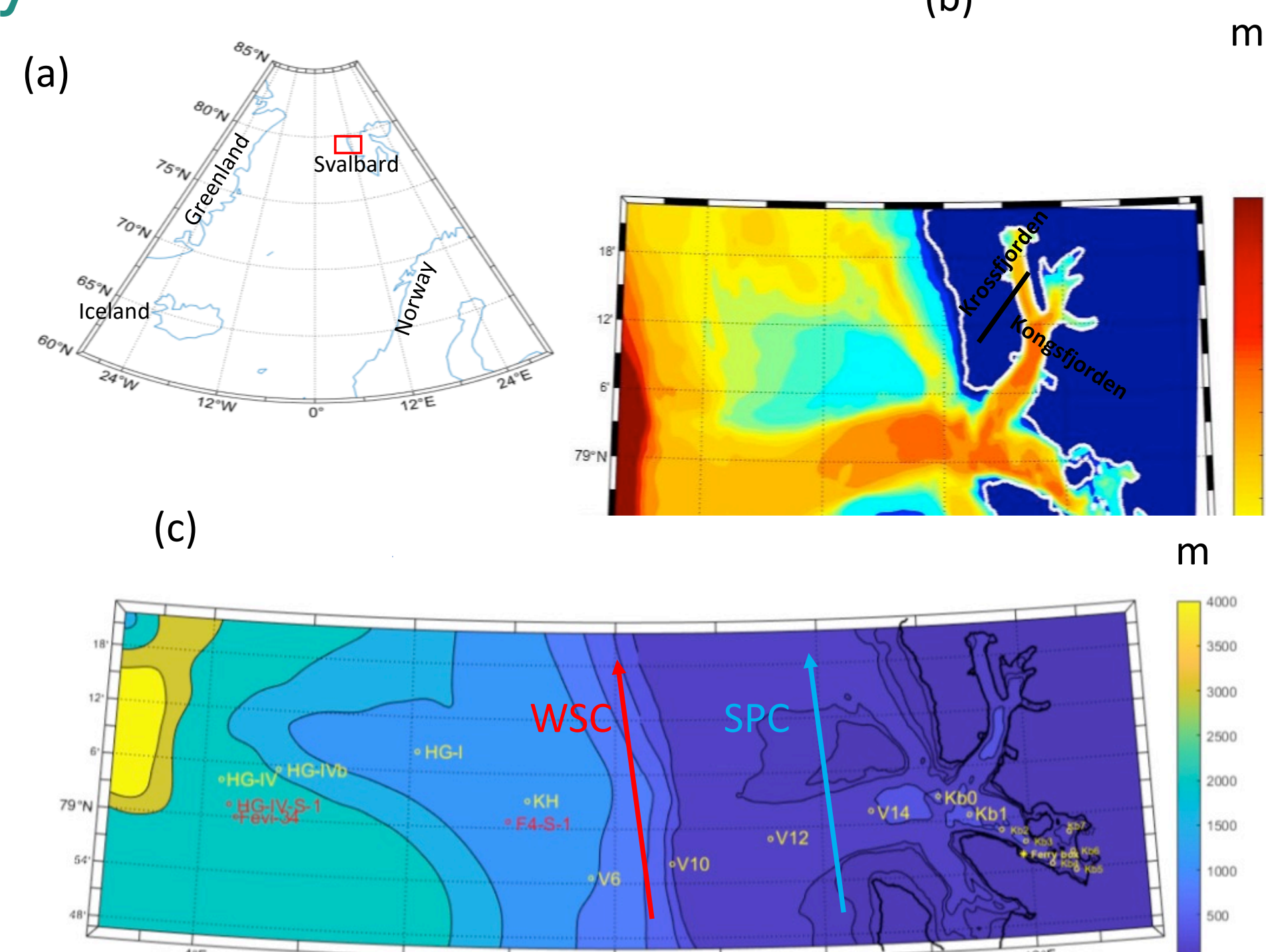


Fig. 1 (a) Kongsfjorden in Svalbard archipelago; (b) K160 model domain and bathymetry (color scale). (c) Location of sampling sites. The two arrows indicate the approximate position of the cold Spitsbergen Polar Current (SPC) and the warm West Spitsbergen Current (WSC).

Historical data combined with results from the K160_bgc model (coupled physical-biochemical 3D model of Kongsfjorden) were used to estimate the magnitude of nitrogen fluxes to/from the fjord.

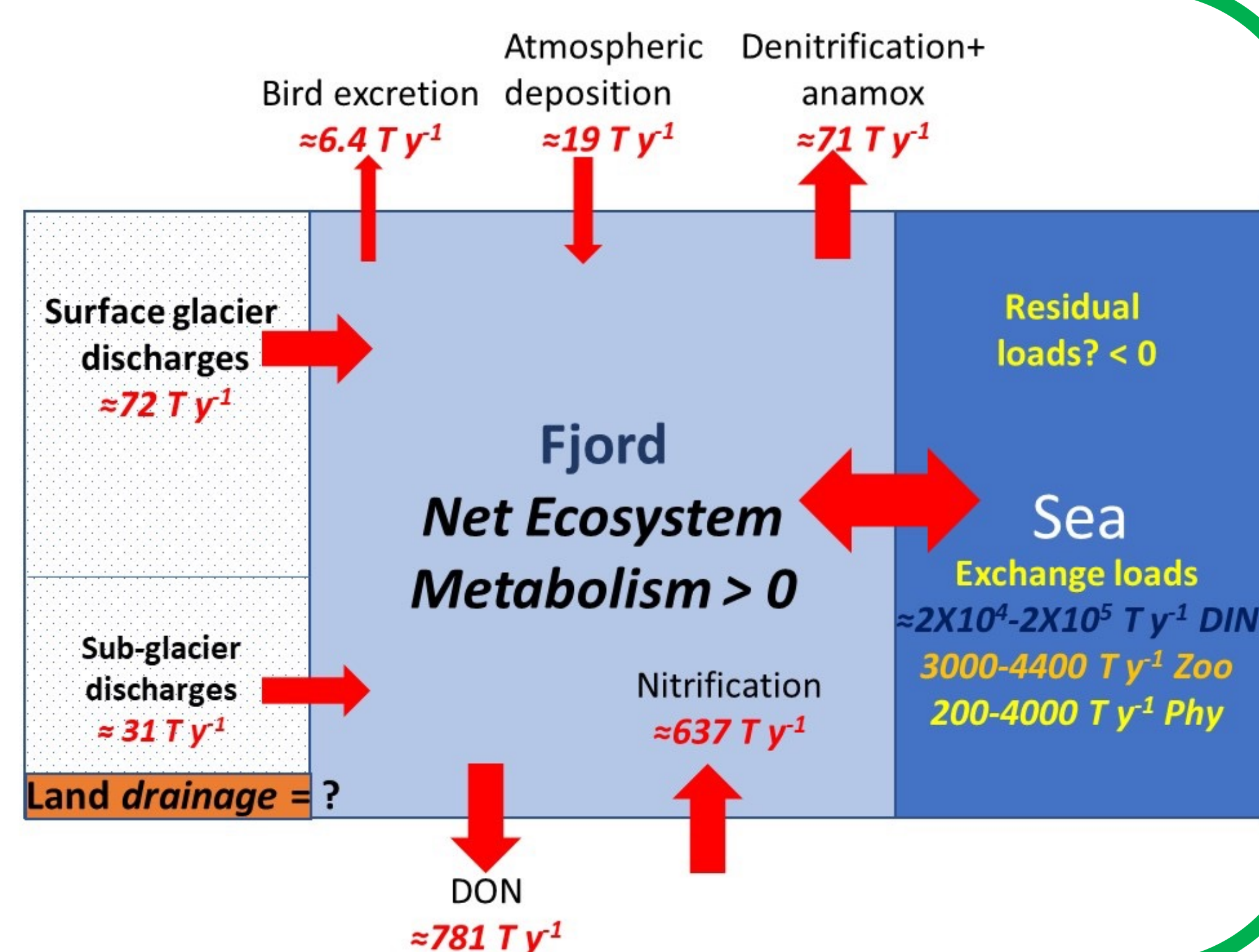
Using summer data collected between 2011 and 2020 along a transect from inner Kongsfjorden, across the shelf and into the Fram Strait (Fig. 1), we estimated nitrogen and inorganic carbon concentrations of sea water (C_{AW}) and freshwater (C_0) endmembers. The differences between the concentrations in the end-members and those in the fjord were used to determine whether Kongsfjorden is a sink or a source of nitrogen and carbon:

$$\text{Sources} - \text{Sinks} = C - C_{AW} \frac{S}{S_{AW}} - C_0 \left(1 - \frac{S}{S_{AW}}\right)$$

S_{AW} and S are salinities in the sea water over the shelf and within Kongsfjorden, respectively.

Results

Fig. 2 Nitrogen fluxes estimated from literature data and model simulations. A negative/positive budget indicates that the fjord is a sink/source of N, and that Net Ecosystem Metabolism is autotrophic/heterotrophic.



Results (cont.)

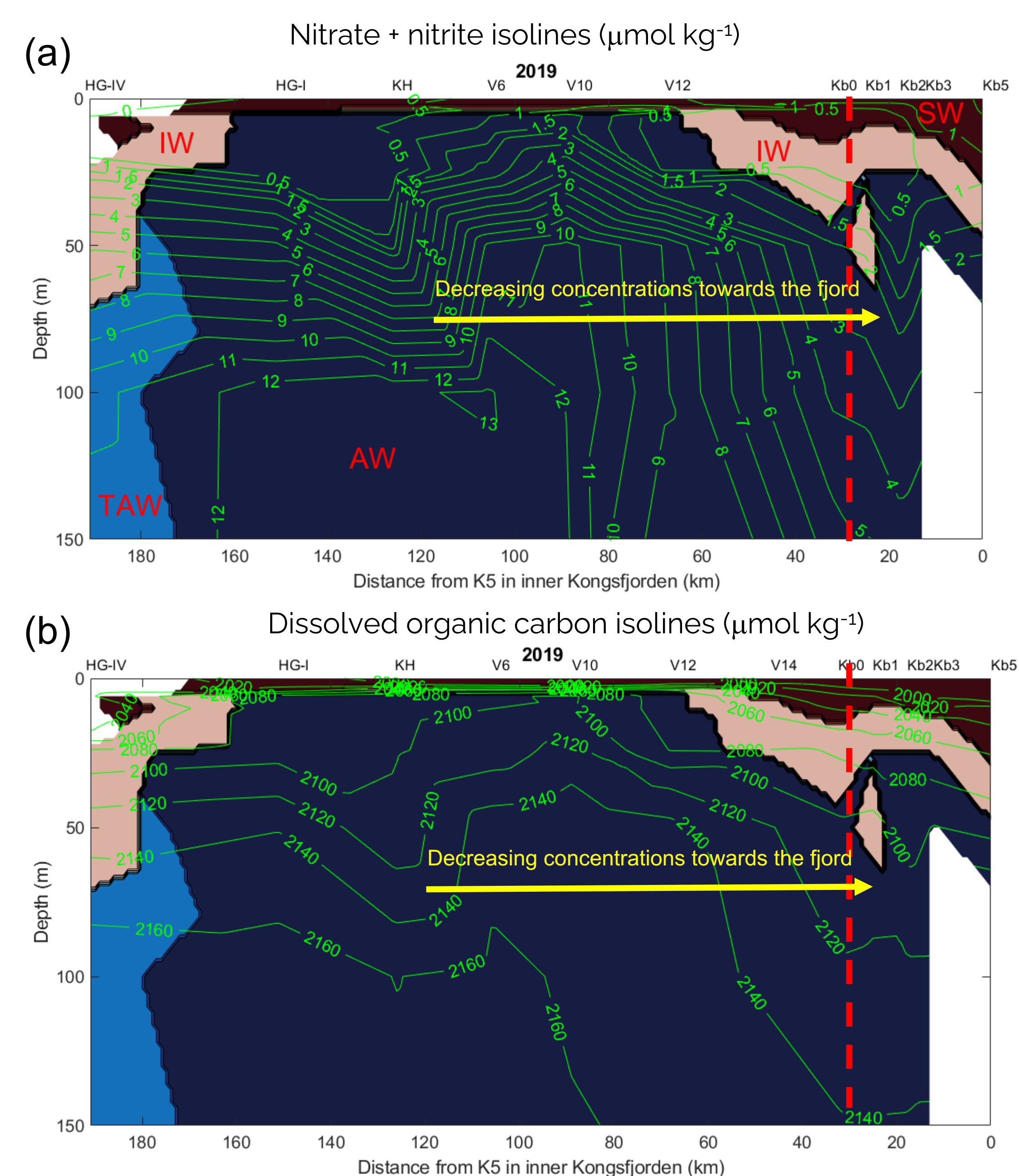


Fig. 3 Results obtained for 2019 (patterns are similar for the whole period 2011-2020), from the MOSJ dataset for the Kongsfjorden summer transect and the upper 150 m (see Fig. 1). Water masses following Cottier et al. (2005) are shown in different colors in both panels: Atlantic Water (AW), Intermediate Water (IW), Surface Water (SW) and Transformed Atlantic Water (TAW). The dashed line in both panels marks the mouth of the fjord.

Table 1. Nitrate + nitrite and dissolved inorganic carbon (DIC) Sources-Sinks for the period 2011-2020 based on concentration and salinity differences. Sources-Sinks < 0 => nutrients are consumed to a greater extent than they are regenerated and imported. Atlantic Water is the sea water endmember (see Fig. 3).

Year	Nitrate + nitrite	DIC
	(μmol kg ⁻¹)	
2011	-0.8	-
2012	-5.1	-24
2013	-4.4	-10
2014	-4.2	-28
2015	-7.8	-81
2016	-5.2	-42
2017	-3.3	-24
2018	-2.0	-36
2019	-4.1	-13
2020	-5.4	-24

Conclusion

- Kongsfjorden nitrogen budget is dominated by exchanges of nitrate with the sea,
- The fjord is a nitrogen and carbon sink during summer
- The C:N molar ratio of the Source-Sink term is 7.3, which is close to the expected Redfield ratio (6.6)
- Negative nutrient and carbon sink indicate autotrophic metabolism
- Next step is computing the rate of decrease of nutrients and inorganic carbon along with the mixing of AW with SW and IW

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