

Impact of the arctic glacier melting on benthic habitats in Kongsfjorden (Svalbard)

PhD project (2020-2023) of Corentin GUILHERMIC*

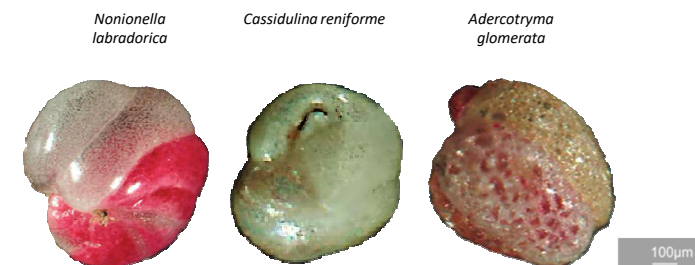
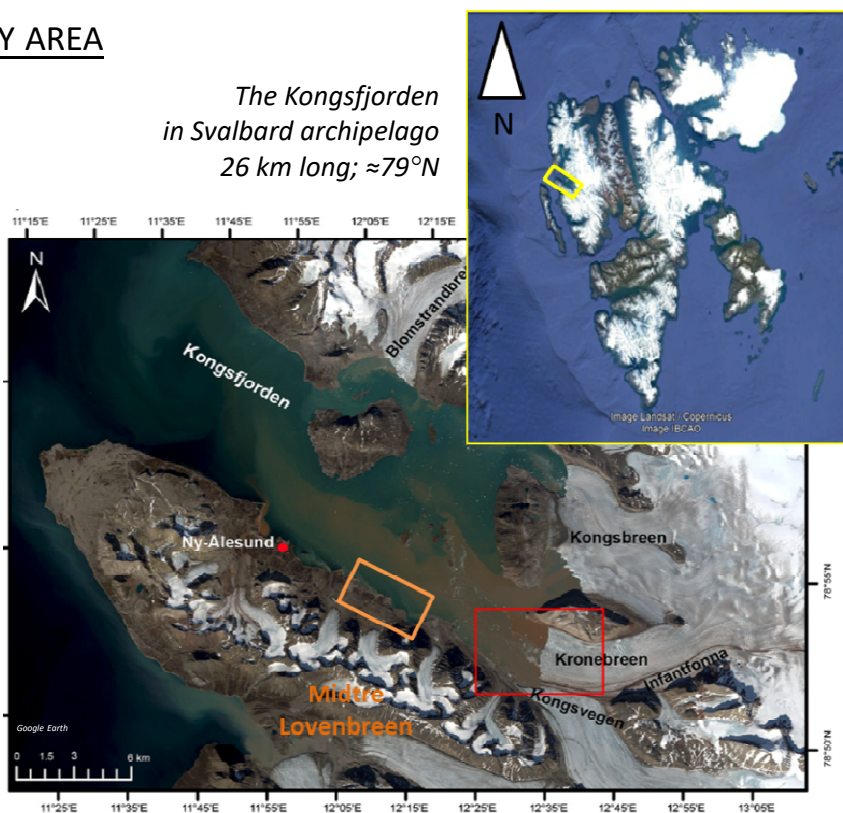
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STUDY AREA

The Kongsfjorden
in Svalbard archipelago
26 km long; $\approx 79^\circ\text{N}$



Common benthic foraminiferal species
in Kongsfjorden, from Jernas et al. (2018)

AMBITION OF THE PROJECT

- ✓ Evaluate the impact of massive seasonal sedimentary deposits on benthic habitats, by using **benthic foraminifera** as **biological model**
- ✓ Understand part of the interactions between sedimentary flux and trophic networks

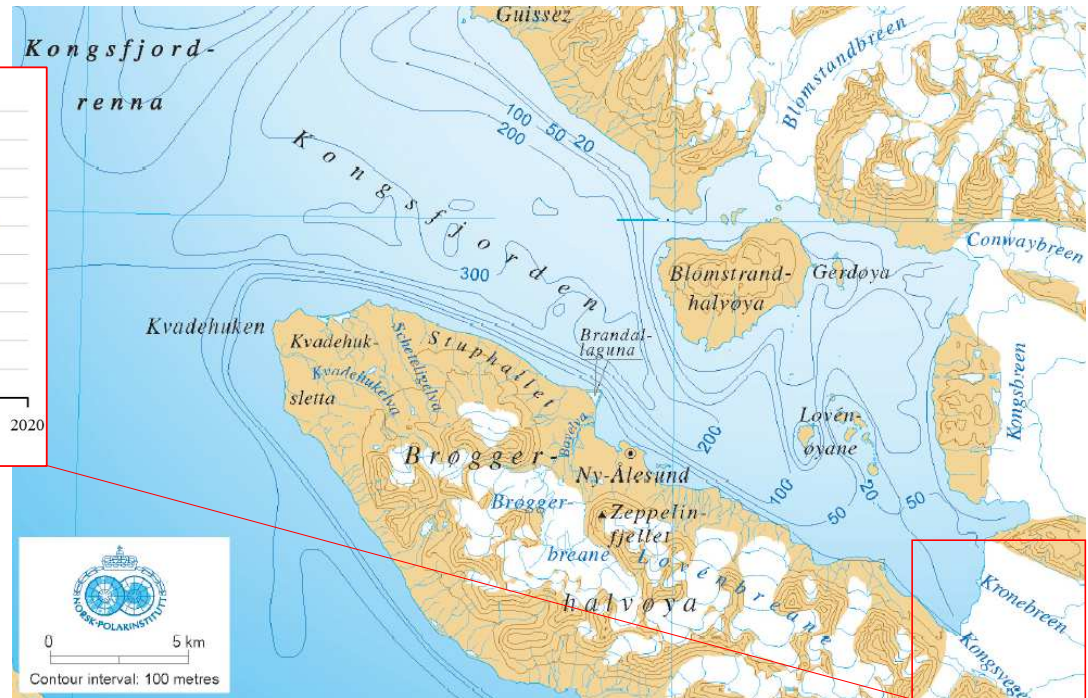
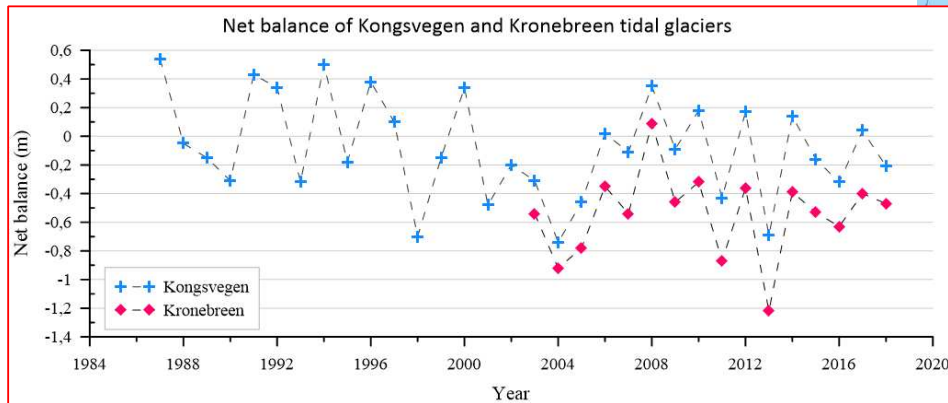
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Yearly net balance of the two most important tidal glaciers contributing to meltwater and Suspended Particulate Matter import into the fjord (map and data from the Norwegian Polar Institute)

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Water masses in Kongsfjorden

AW: Atlantic water

SW : Surface water

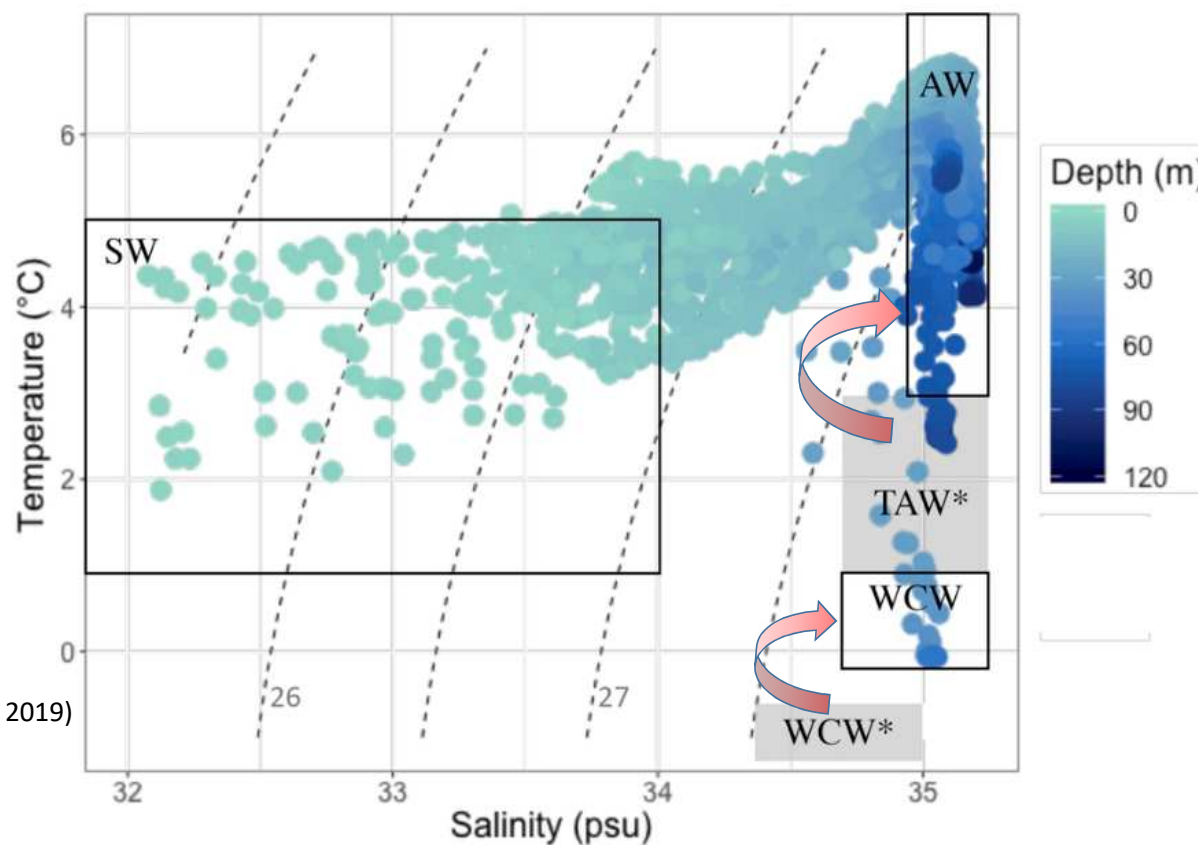
WCW : Winter cooled water

TAW : Transformed Atlantic water

T-S diagram of water masses in Kongsfjorden

Black boxes : water masses measured in 2014 (Payne and Roesler., 2019)

Grey boxes : historical ranges (Svendsen et al., 2002)



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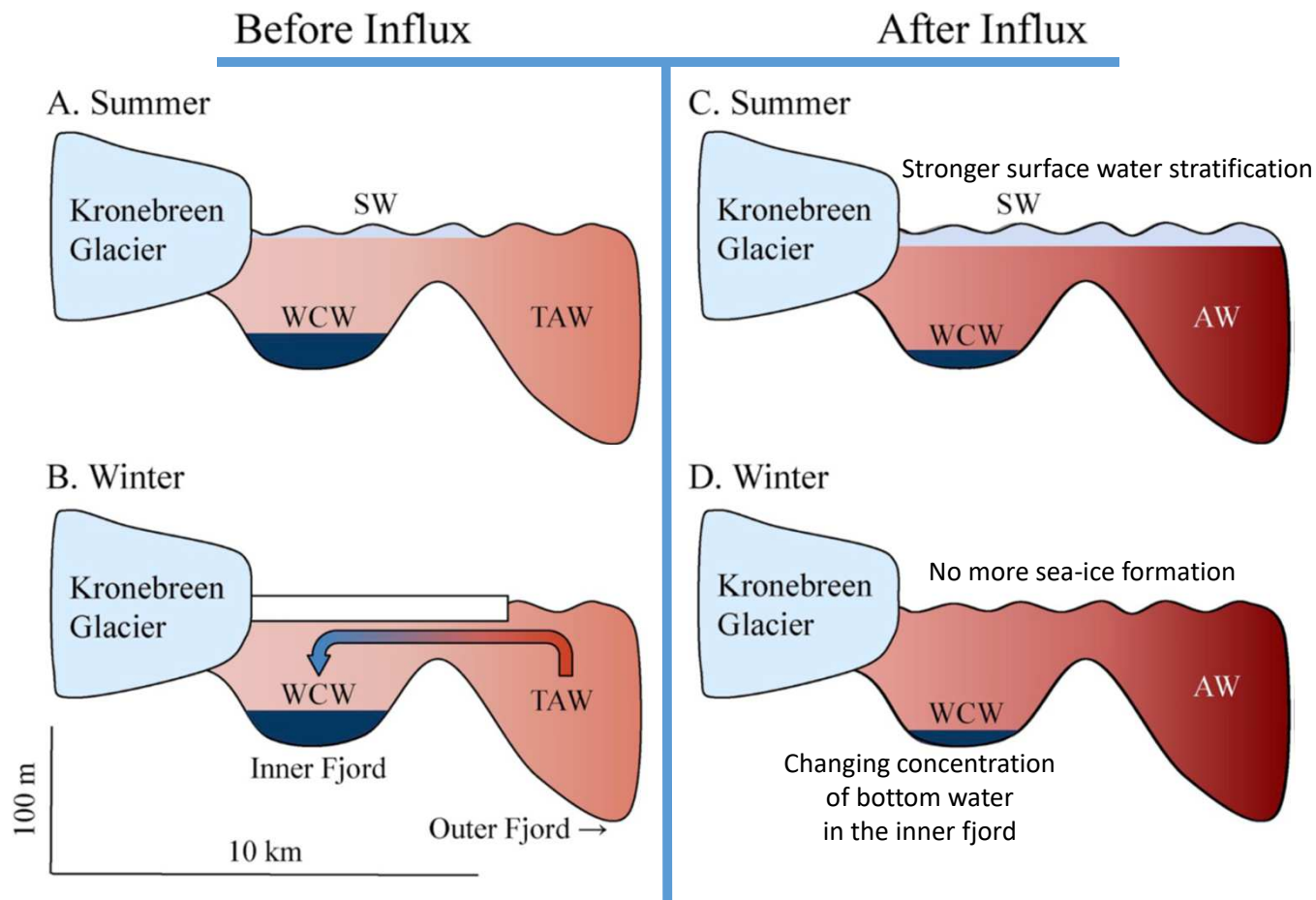
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Water masses in Kongsfjorden

AW: Atlantic water
 SW : Surface water
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In Kongsfjorden, the intrusion of Atlantic Water, rather than a mixture of Atlantic and Arctic waters, warmed subsurface waters by 4 – 5.5°C in a mere 15 years



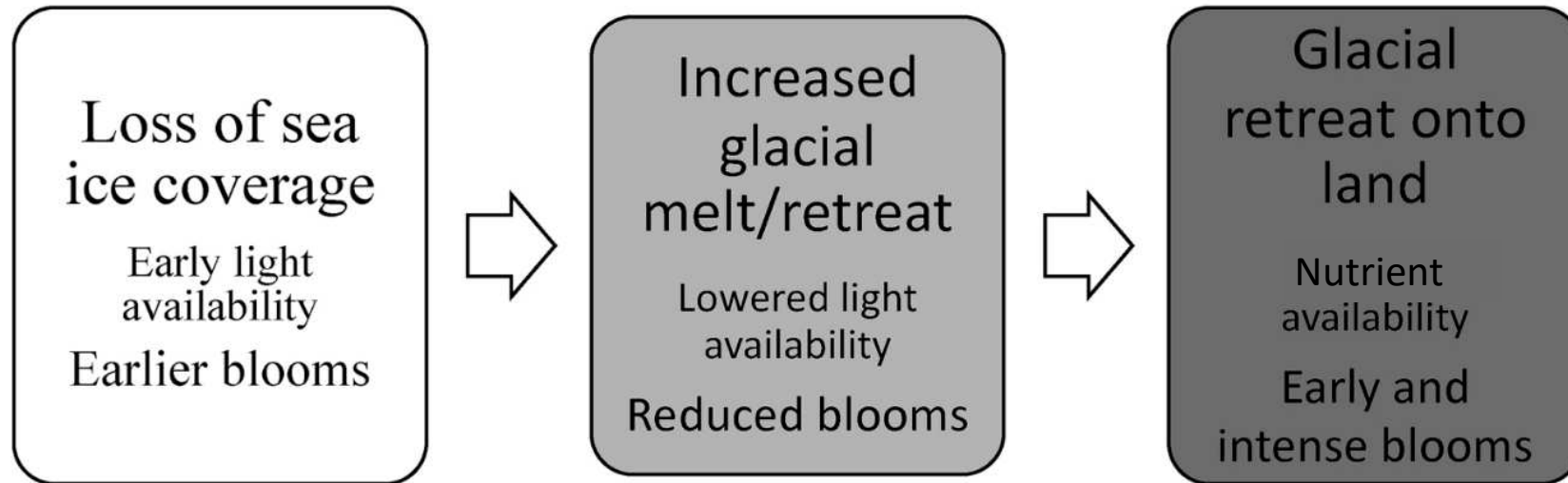
Payne and Roesler (2019)

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Conceptual model of the impacts of warm-water intrusion on water characteristics, the optical light field, and primary production within 10 km of tidewater glaciers

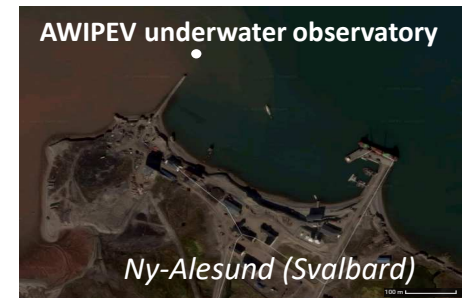
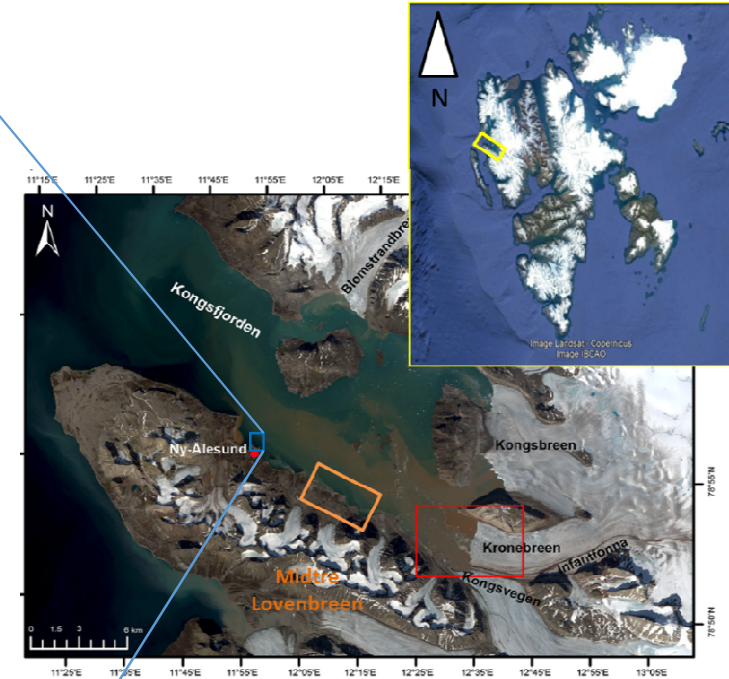
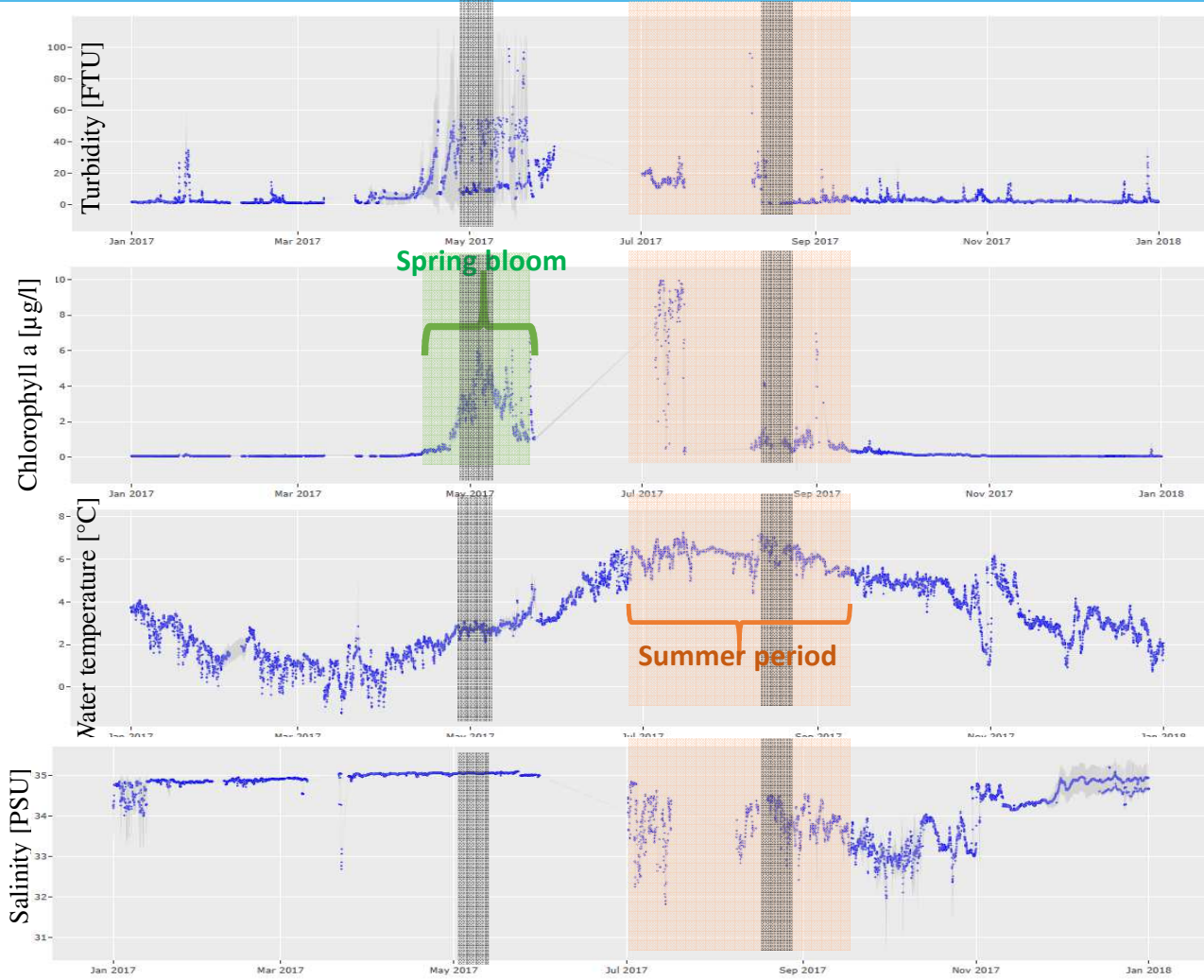
Modified from Payne and Roesler. (2019)

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Fischer et al. (2018)

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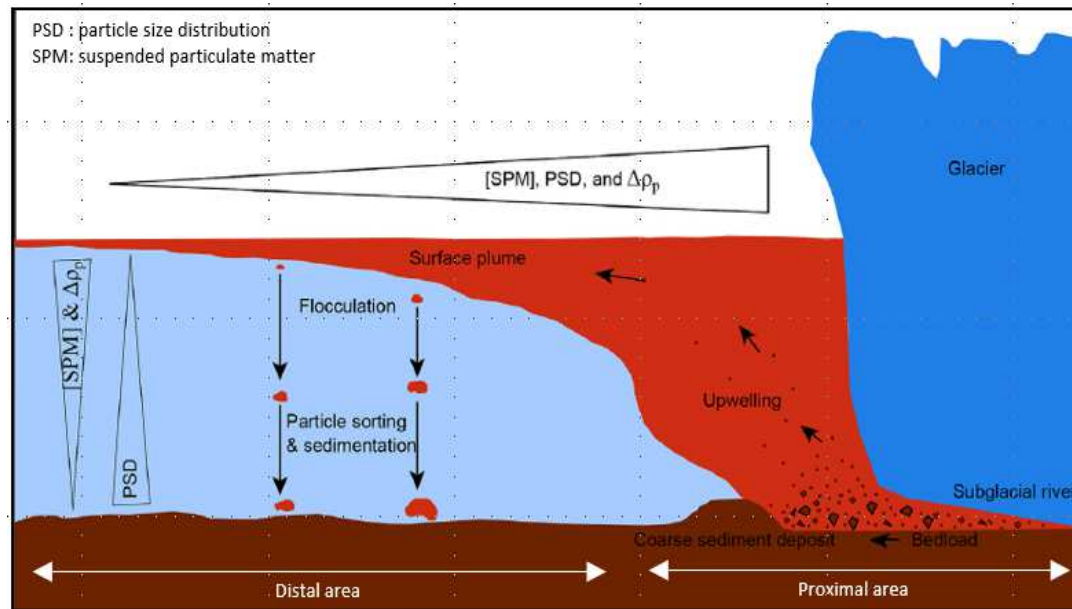
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INVESTIGATION of the response of benthic foraminifera to pulses of **massive continental sediment inputs** that imply :

- direct **physical forcing** (high sedimentation rates and instability of the substrate)
- **geochemical pressure** (disturbance from allochthonous elements to the vertical distribution of redox fronts)
- expected **reduction of primary productivity** and subsequent **modification of the benthic food web**



Meslard et al. (2018)

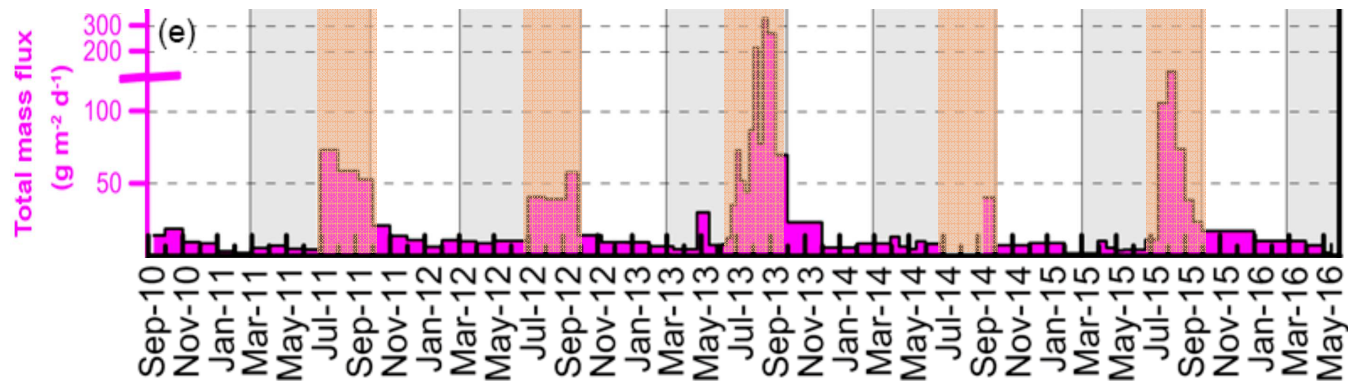
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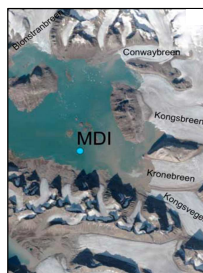
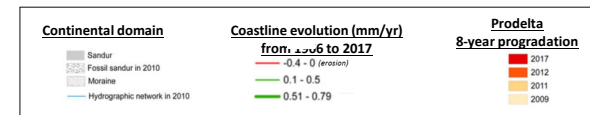
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Time series of total mass flux (TMF) particles flux in the inner fjord. The summer seasons are notified in orange. Light grey bands represent polar day period of each year (D'Angelo et al., 2018)

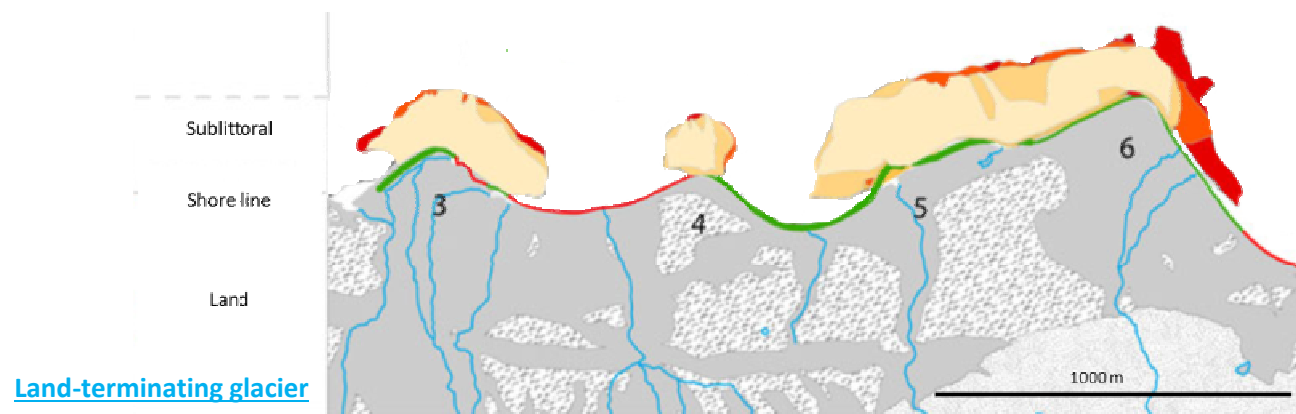
Massive sedimentary inputs in the fjord generate **shoreline and prodelta progradation** in front of the Midtre Lovénbreen glacier system, modified from Bourriquen et al. (2018)



Mooring Dirigible Italia (MDI) site

water depth: 100 m
7 km from the Kronebreen front
1,7 km from the southern coast

Tidal glacier



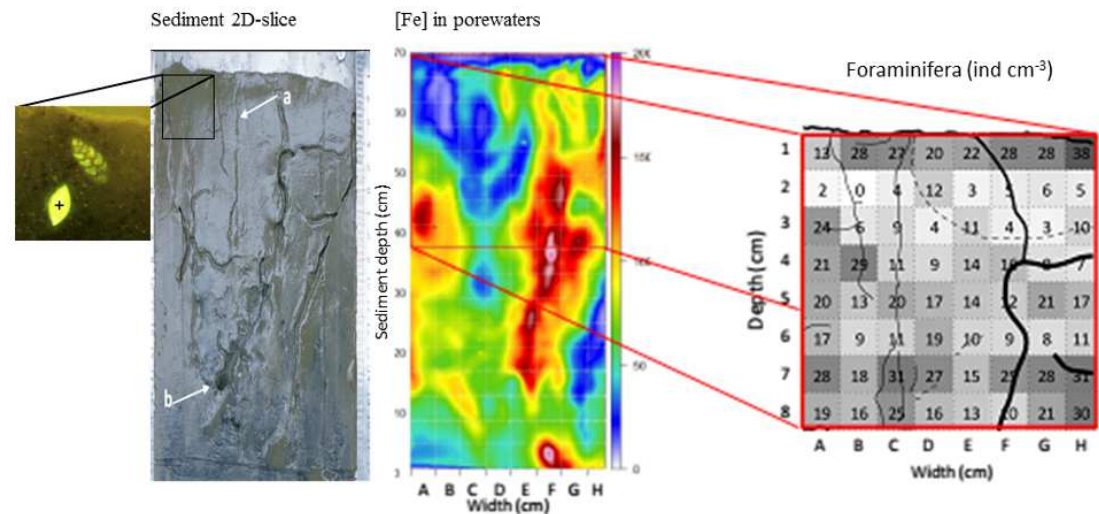
Land-terminating glacier

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STRATEGY : A DOUBLE APPROACH

1) ***In vitro* experimentations**: simulation of different sediment input frequencies to observe microhabitat resilience and re-colonisation after recurrent depositional events

2) ***In situ* sampling**: Intra and interannual survey of benthic geochemical gradients and associated foraminiferal fauna along the fjord axis, and vertical 2D characterization (cm scale) of the microhabitats (redox fronts in the sediment) and associated benthic foraminifera distribution



Thibault et al. (2015)

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DELIVERABLE

- ✓ **benthic foraminiferal proxy** for sedimentary depositional events



to track the historical acceleration of ice melting (*tidal and land-terminating glaciers*)

Thank you for your attention

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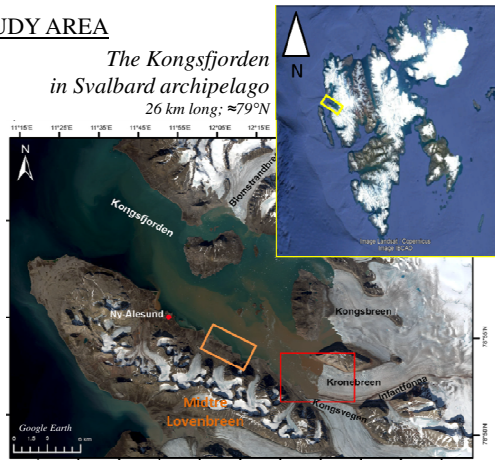
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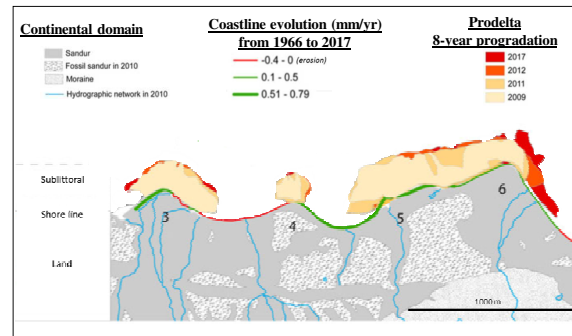


STUDY AREA



INVESTIGATION of the response of benthic foraminifera to pulses of **massive continental sediment inputs** that imply :

- direct **physical forcing** (high sedimentation rates and instability of the substrate)
- **geochemical pressure** (disturbance from allochthonous elements to the vertical distribution of redox fronts)
- expected **reduction of primary productivity** and subsequent **modification of the benthic food web**

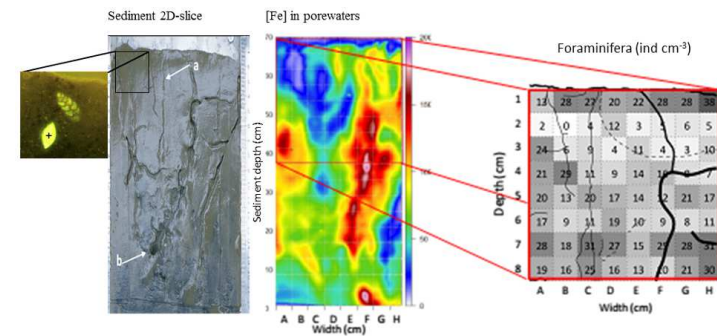


Massive sedimentary inputs in the fjord generate shoreline and prodelta progradation in front of the Midre Lovénbreen glacier system (orange square on the map), modified from Bourriquen et al. (2018)

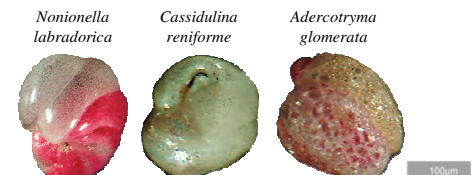
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1) **In vitro** experimentations: simulation of different sediment input frequencies to observe microhabitat resilience and re-colonisation after recurrent depositional events

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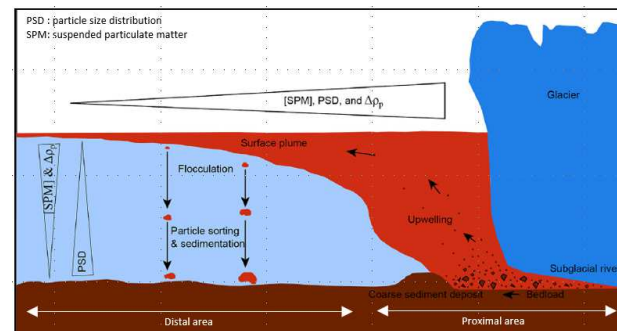


Example of results of the 2D cm scale method (Thibault et al., 2015)



Common benthic foraminiferal species in Kongsfjorden, from Jernas et al. (2018)

Particle dynamic conceptual model at the front of the Kronebreen tidal glacier (red square on the map), from Meslard et al. (2018)



AMBITION OF THE PROJECT

- ✓ Evaluate the impact of massive seasonal sedimentary deposits on benthic habitats, by using benthic foraminifera as biological model
- ✓ Use of benthic foraminifera as a proxy for historical depositional events due to accelerated ice melting
- ✓ Understand the interactions between sedimentary flux and trophic networks

REFERENCES :
 Bourriquen C., Mercier D., Baltzer A., et al., 2018. Paraglacial coasts responses to glacier retreat and associated shifts in river floodplains over decadal timescales (1966-2016), Kongsfjorden, Svalbard. Land degradation and Development, 29,11, 4173-4185.
 Jernas et al., 2018. Annual changes in Arctic fjord environment and modern benthic foraminiferal fauna: Evidence from Kongsfjorden, Svalbard. Global and Planetary Change, 163:119-140
 Thibault de Chanvalon et al., 2015. Two-dimensional distribution of living benthic foraminifera in anoxic sediment layers of an estuarine. Biogeosciences, 12, 6219-6234.