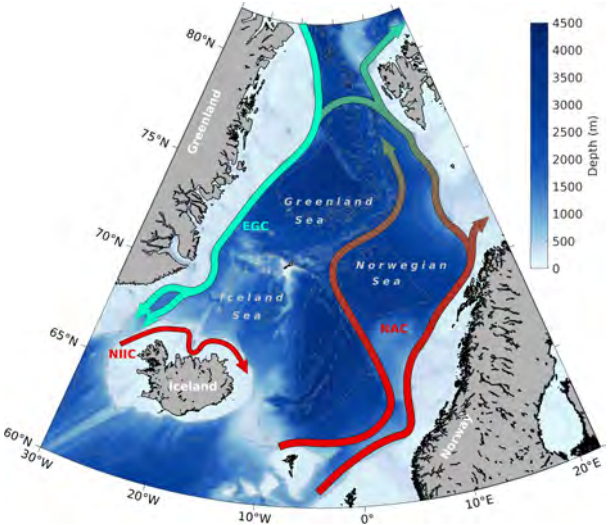
Formation and circulation of dense water from a two-year moored record in the northwestern Iceland Sea

Stefanie Semper
Kjetil Våge
Ilker Fer
Silje Skjelsvik
Linda Latuta
Robert Pickart

Photo: Chris Barrell, UEA

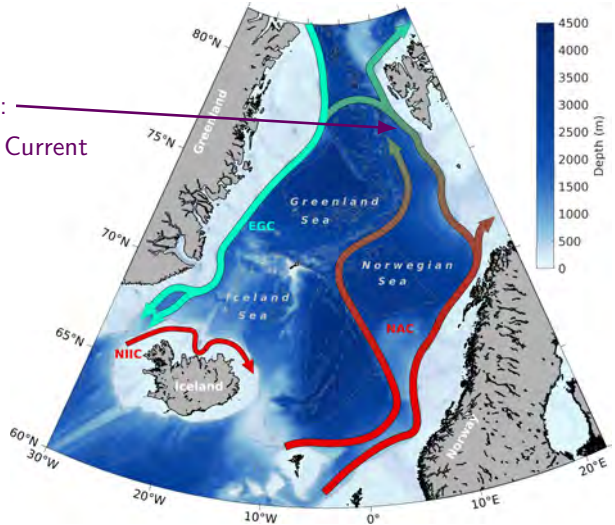
Water mass transformation in the Nordic Seas is crucial for the climate



Two main formation mechanisms of overflow water

rim current system:

→ East Greenland Current



Two main formation mechanisms of overflow water

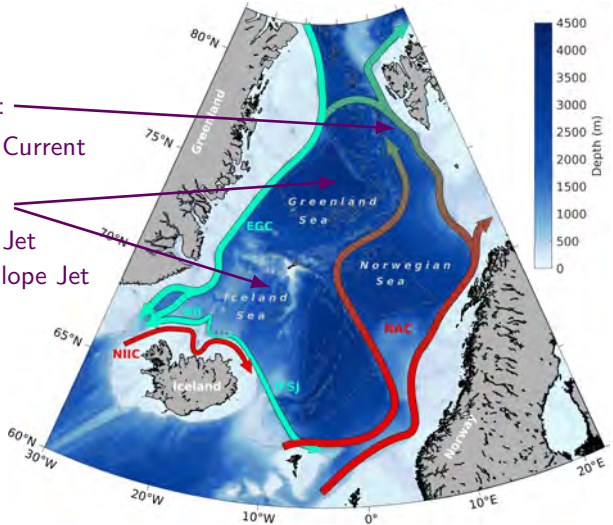
rim current system:

→ East Greenland Current

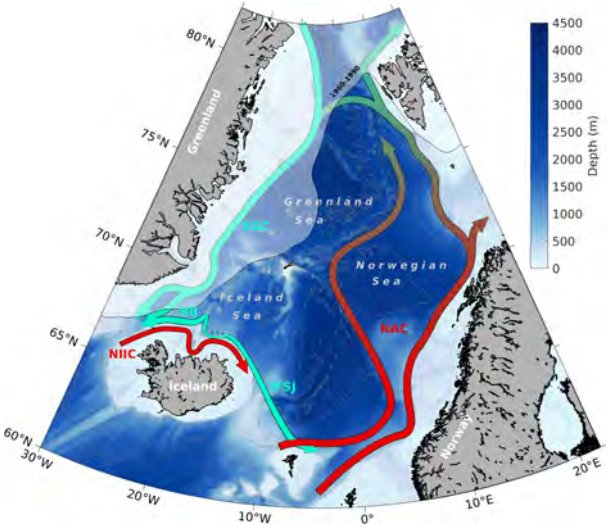
interior basins:

→ North Icelandic Jet

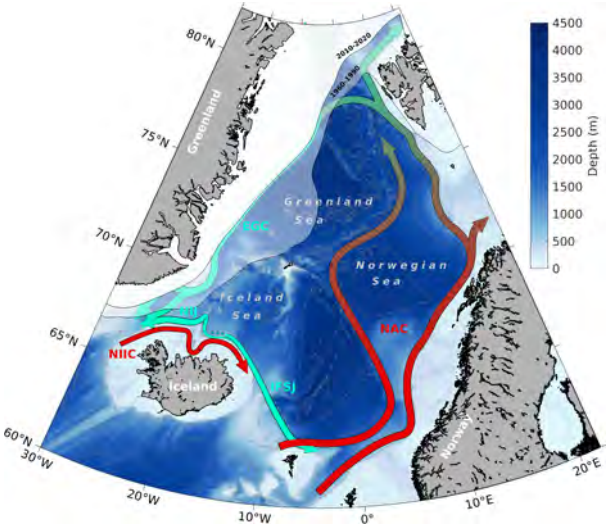
→ Iceland–Faroe Slope Jet



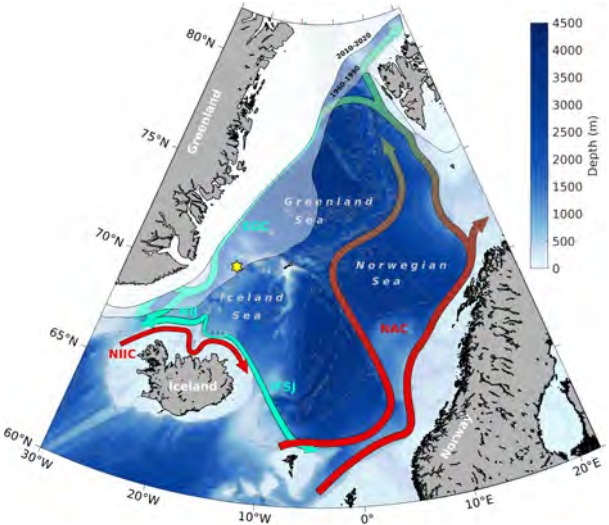
High heat loss near the sea-ice edge facilitates open-ocean convection



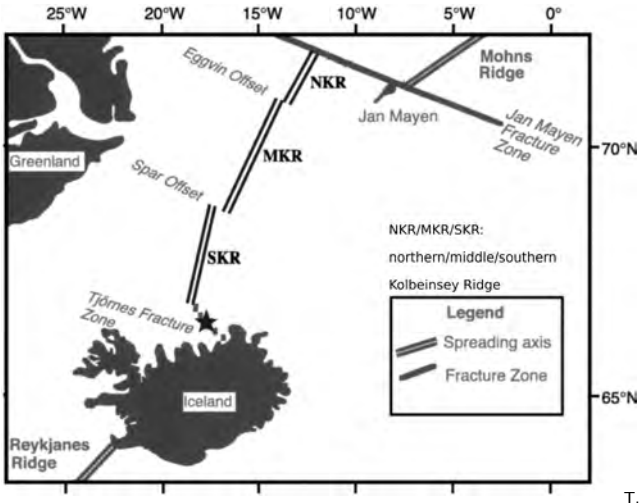
Sea-ice retreat opens up new areas for dense-water formation



A mooring in the now ice-free northwestern Iceland Sea



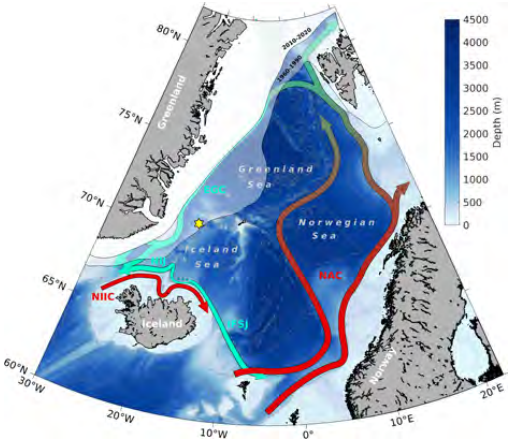
Eggvin Offset – a gap in the mid-Atlantic ridge



T. Barreyre

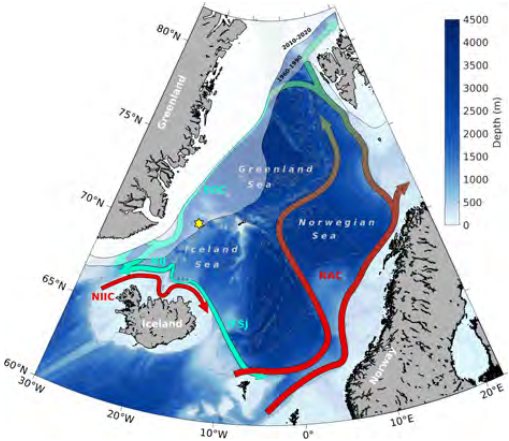
Outline

- How dense overflow water is formed in Eggvin Offset?



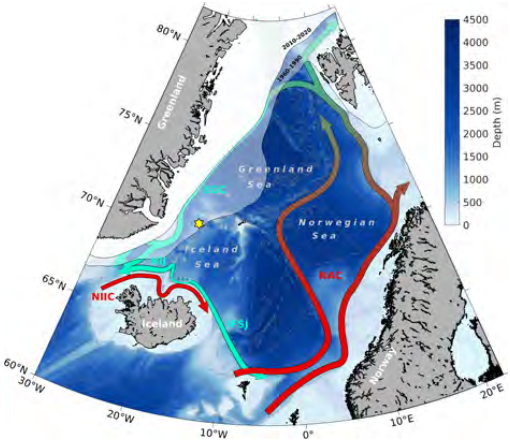
Outline

- How dense overflow water is formed in Eggvin Offset?
- What are the processes affecting the mixed-layer evolution?

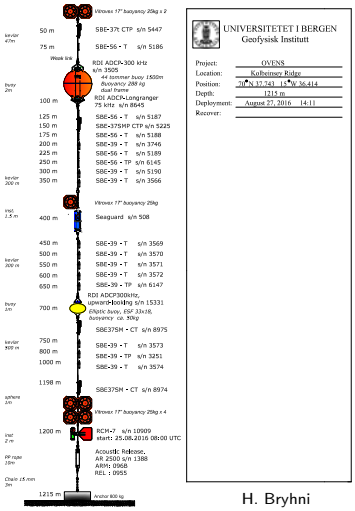


Outline

- How dense overflow water is formed in Eggvin Offset?
- What are the processes affecting the mixed-layer evolution?
- Is Eggvin Offset a major passage for dense-water exchange between the Greenland and Iceland Seas?



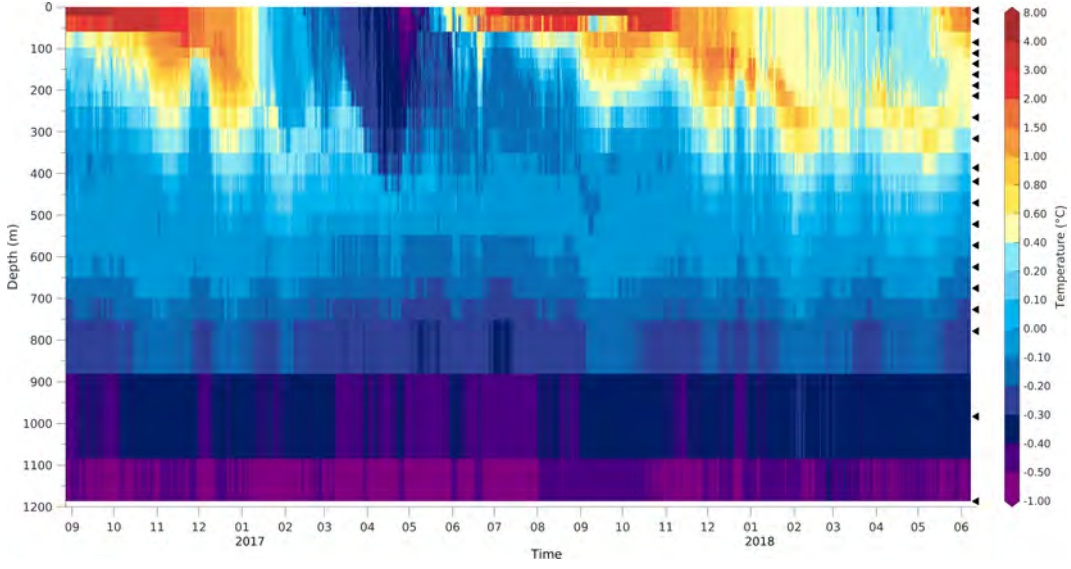
A unique data set from a sparsely sampled region



H. Bryhni

- two-year long record: August 2016 – June 2018
- 25 instruments: 21 x temperature, 4 x salinity, 6 x pressure, 4 x velocity
- 15 min temporal resolution (5 x temperature loggers: 30 s)
- uppermost instrument at 8 m depth

Temperature evolution reveals two different winters



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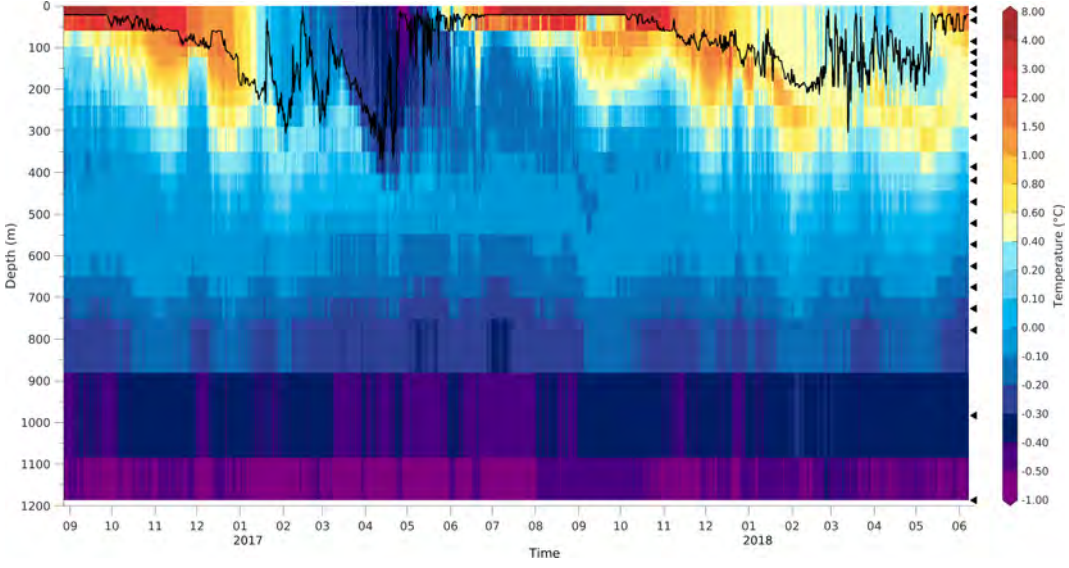
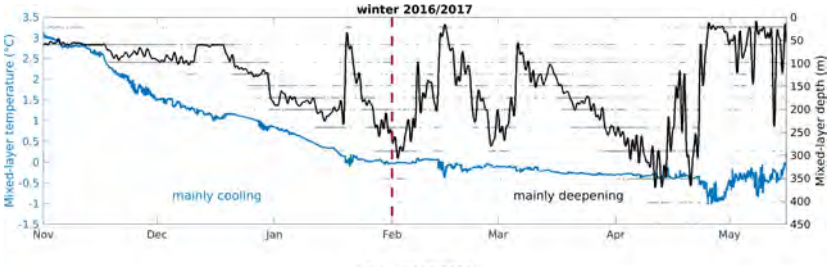


Two stages of mixed-layer evolution: I) cooling, II) deepening



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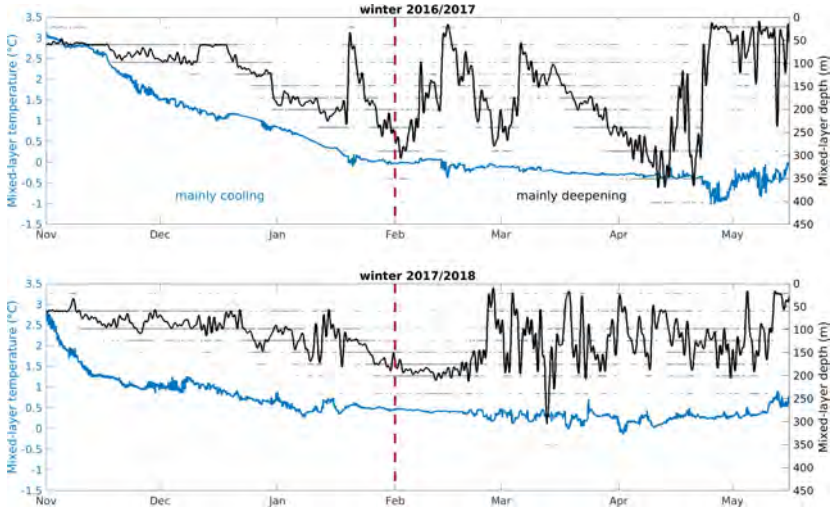
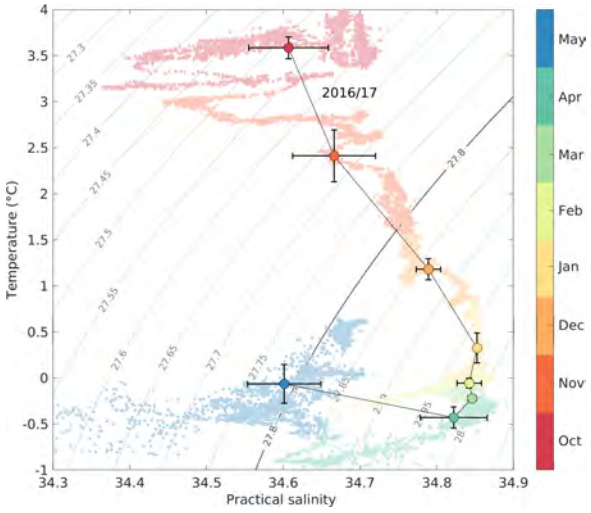


Formation of denser water during winter 2016/2017



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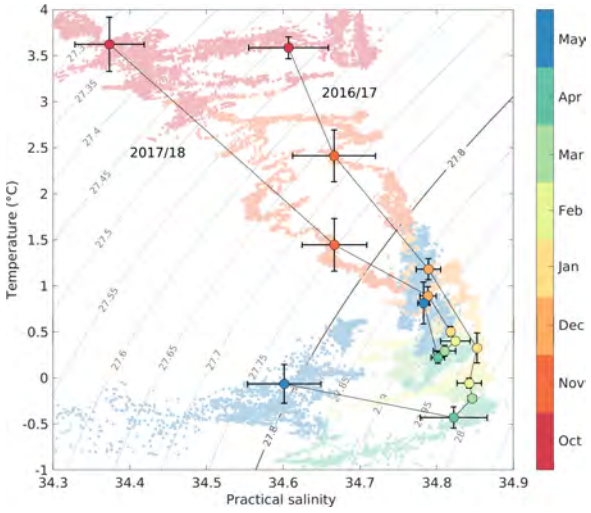

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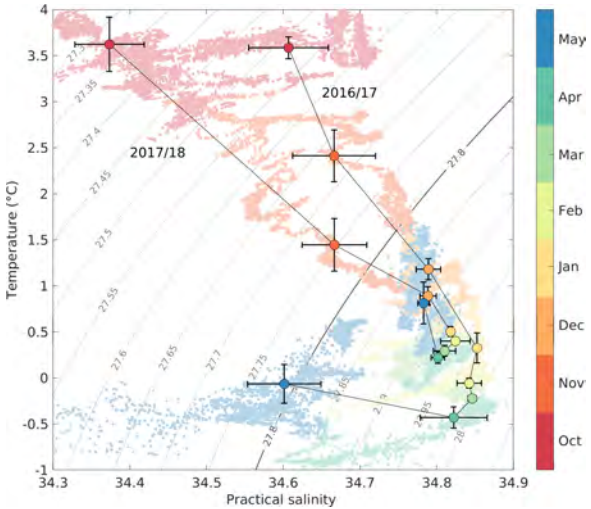

- maximum densities:
  σ_θ =28.03 kg m^{-3} (winter 2016/17)
  σ_θ =27.97 kg m^{-3} (winter 2017/18)

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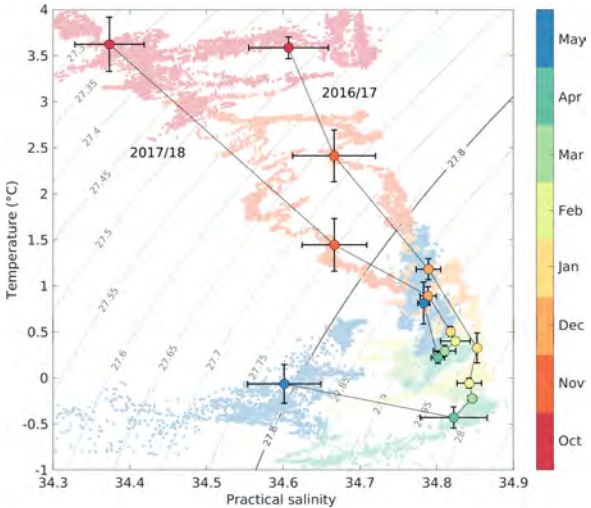
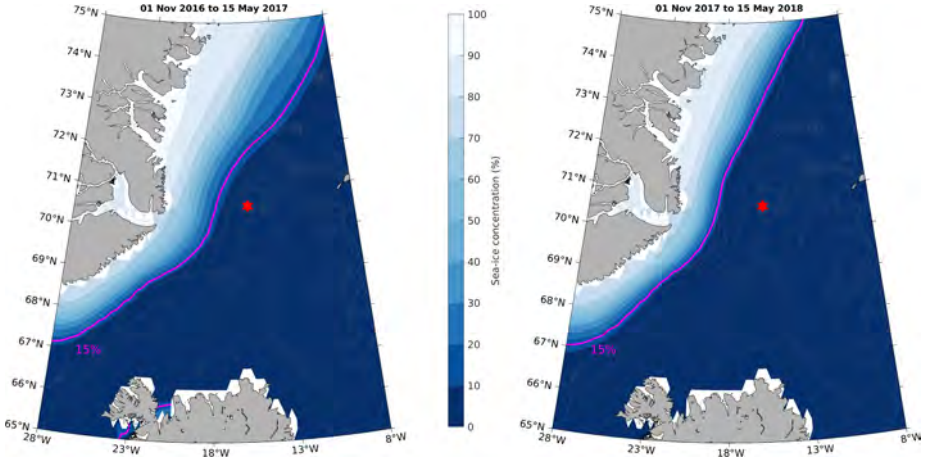


- maximum densities:
  $\sigma_\theta = 28.03\,\mathrm{kg\,m^{-3}}$ (winter 2016/17)
  $\sigma_\theta = 27.97\,\mathrm{kg\,m^{-3}}$ (winter 2017/18)
- similar mixed-layer densities as in the central Iceland Sea several decades ago

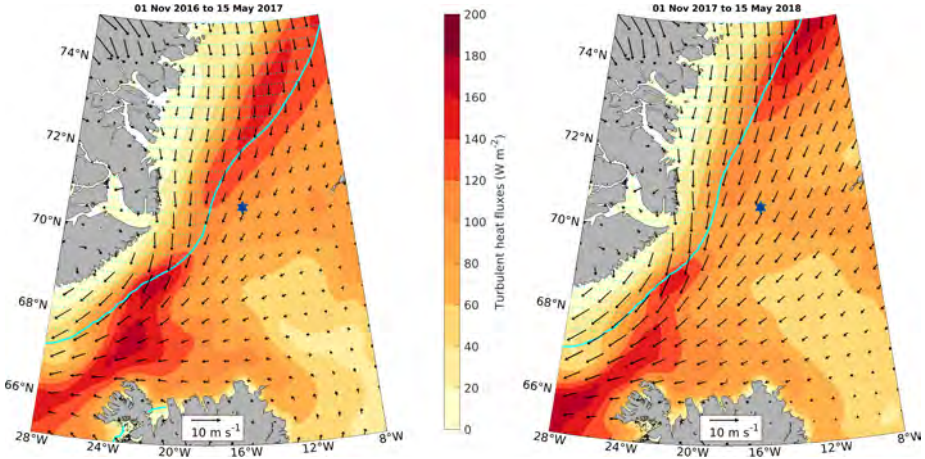
  $\rightarrow$ shifting locus of dense-water formation

Closer sea-ice edge in winter 2016/2017



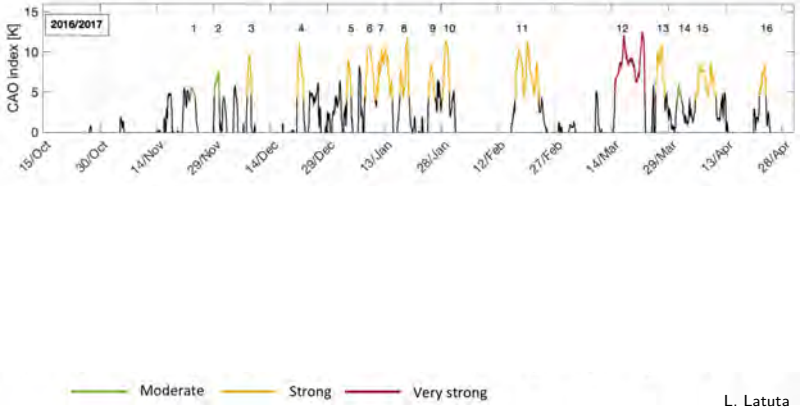
- mean distance ice edge–mooring: 99 km (winter 2016/17); 126 km (winter 2017/18)

Higher turbulent heat fluxes in winter 2016/2017



- mean turbulent heat flux: 104 W m^{-2} (winter 2016/17); 88 W m^{-2} (winter 2017/18)

Varying distribution of cold-air outbreak (CAO) forcing



CAO contribution to wintertime heat loss:

54 %

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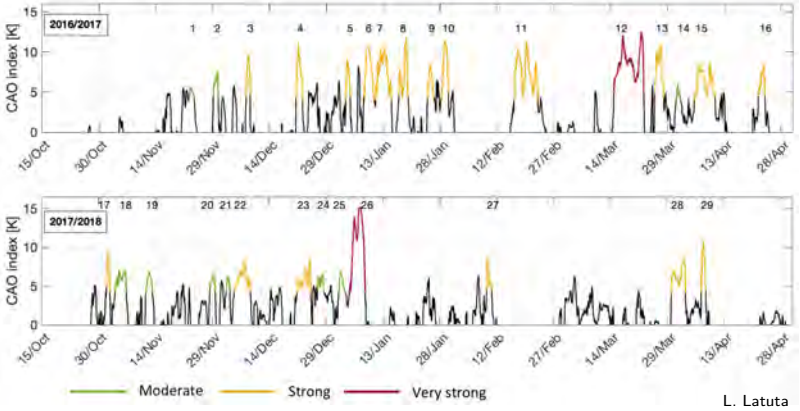

L. Latuta

CAO contribution to wintertime heat loss:

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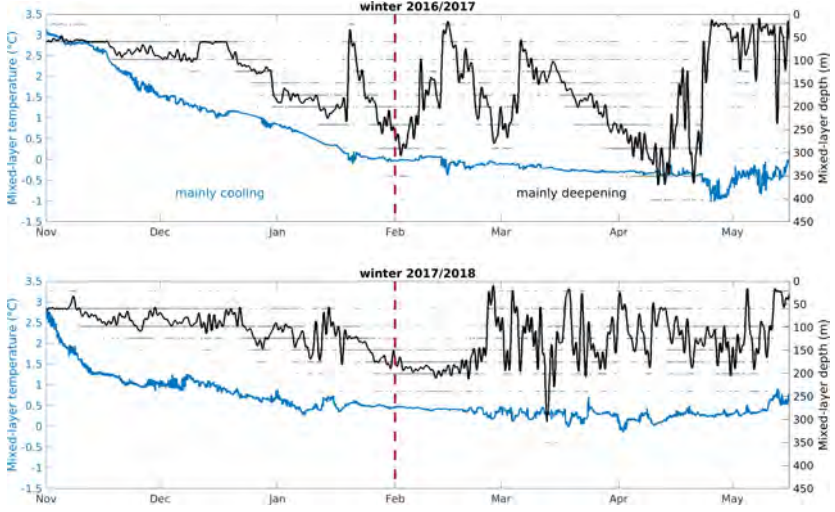
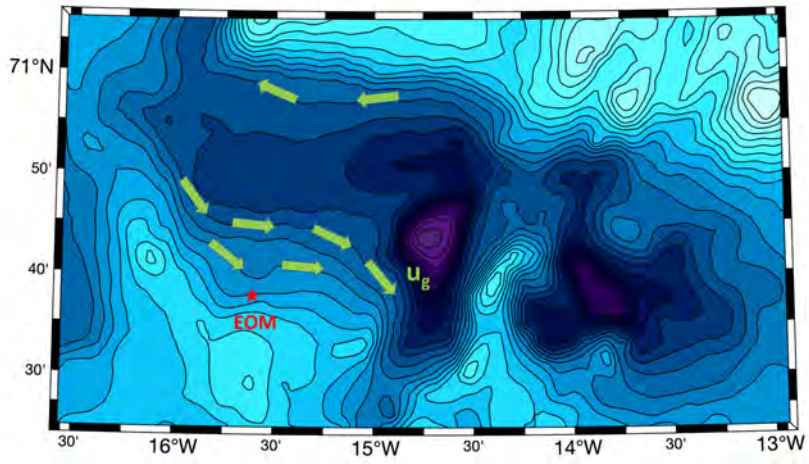
38 %

Two stages of mixed-layer evolution: I) cooling, II) deepening



Expected geostrophic flow through Eggvin Offset



S. Skjelsvik

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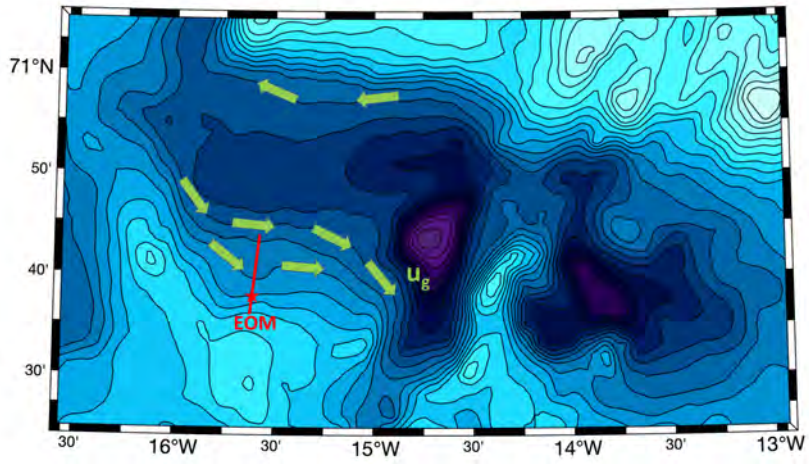

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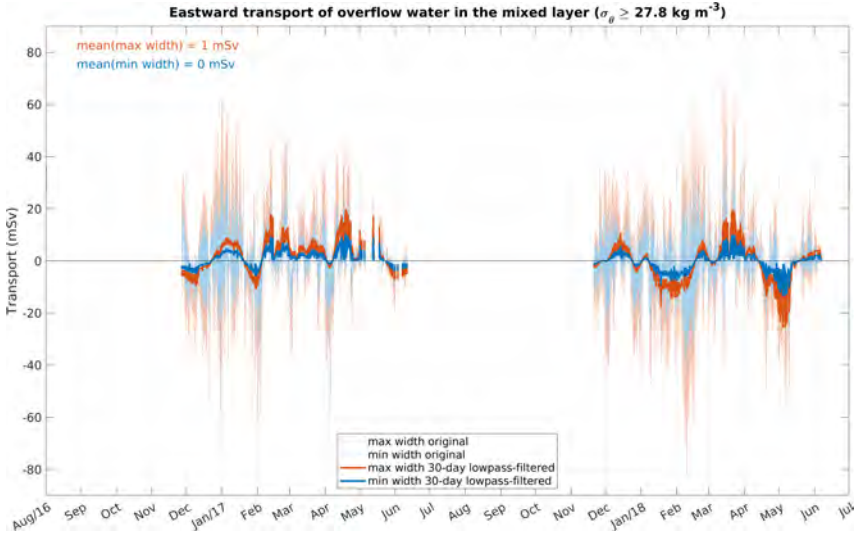
Little transport into the Iceland Sea through Eggvin Offset



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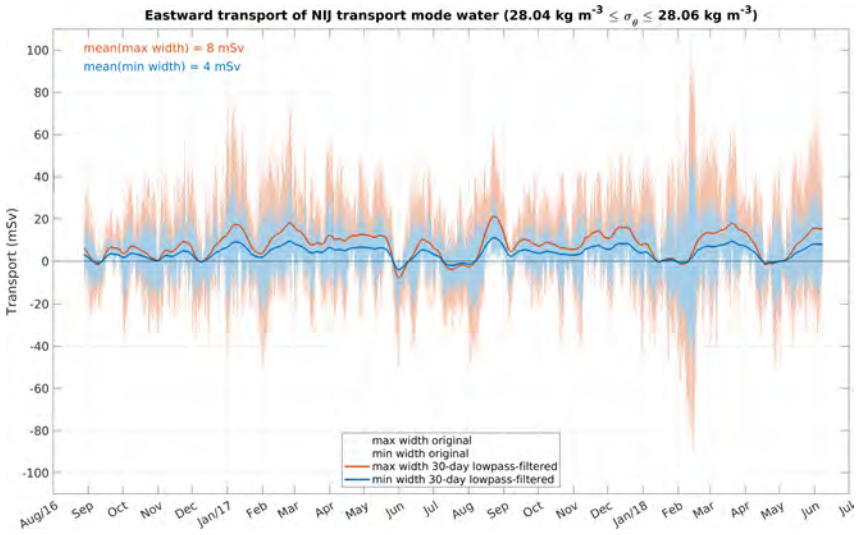
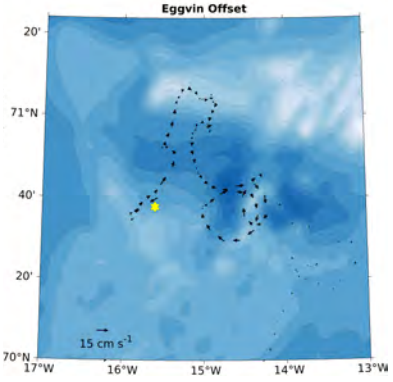


Argo demonstrates a connection to the north Iceland slope



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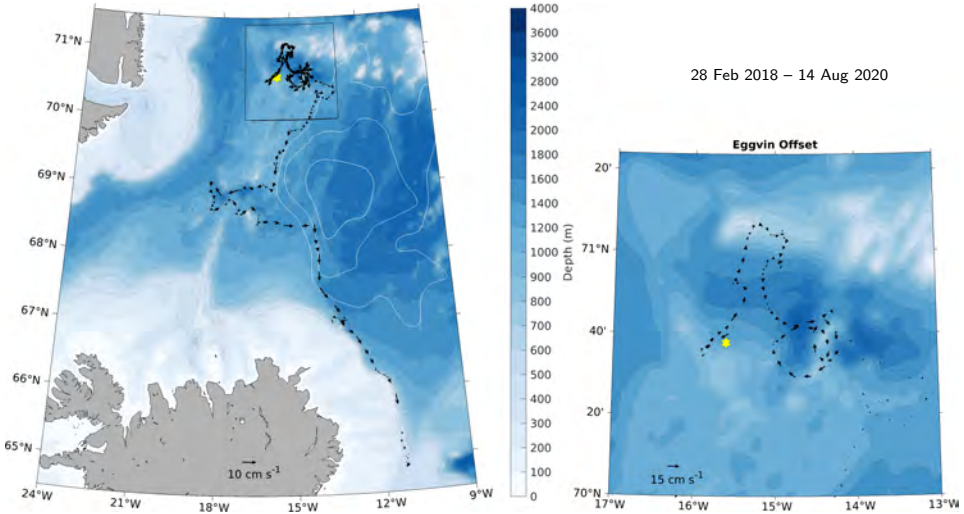
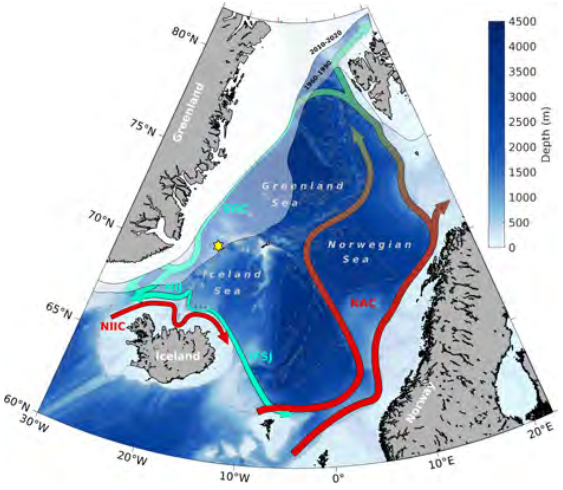


Summary

- **Dense-water formation transitions** from the central to the western Iceland Sea due to retreating sea ice.



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- **Dense-water formation transitions** from the central to the western Iceland Sea due to retreating sea ice.
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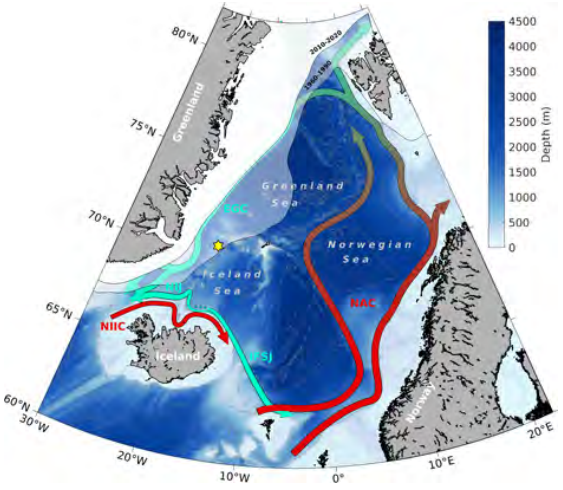

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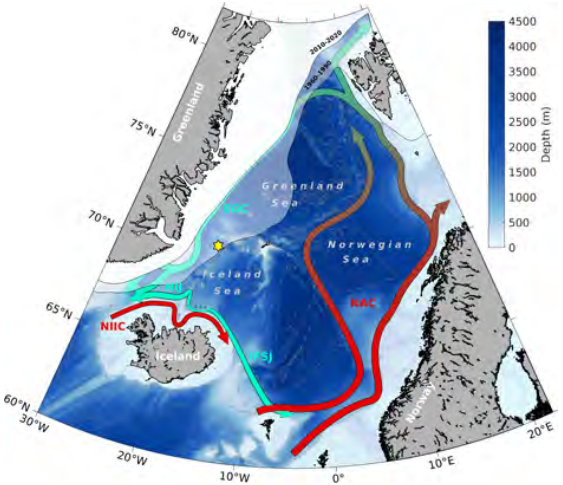

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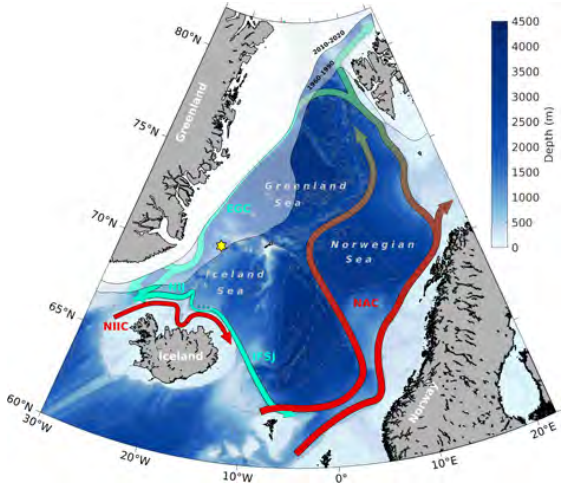

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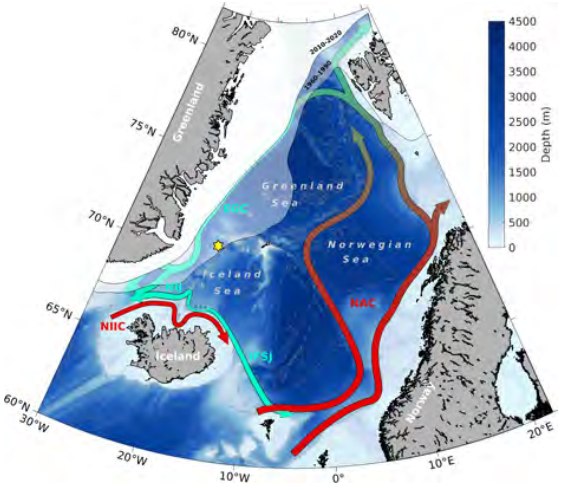
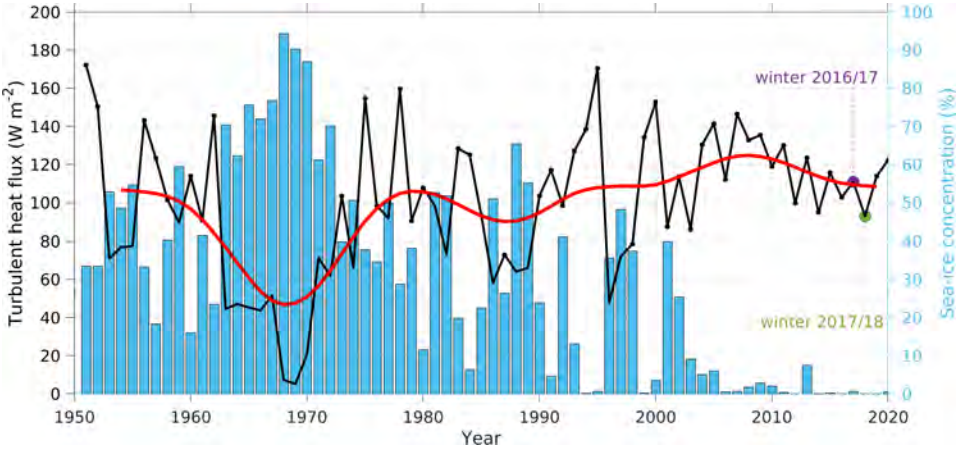
Thank you!

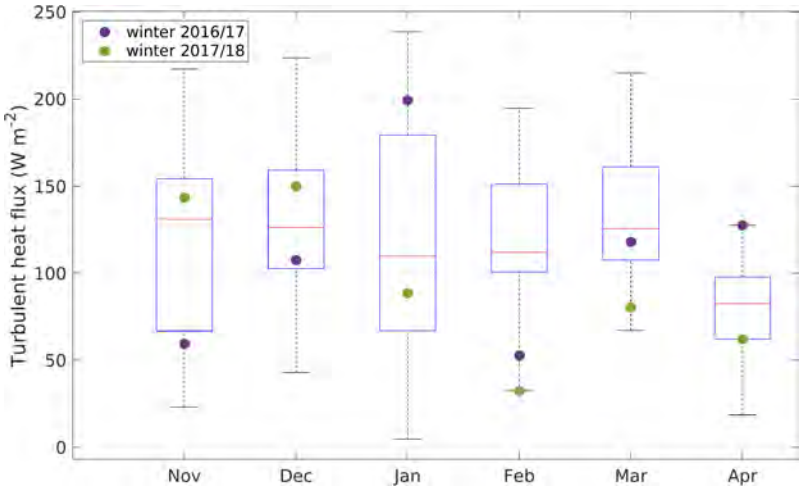


Contact: stefanie.semper@uib.no

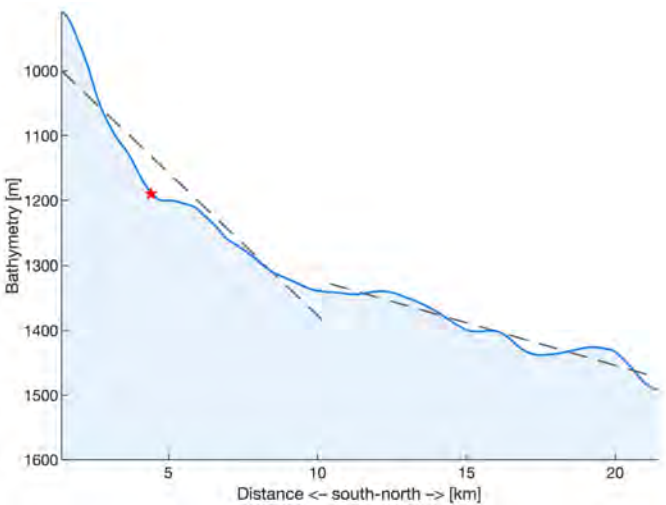
Climatology of turbulent heat fluxes and sea-ice concentration



Seasonality of turbulent heat fluxes (winter 2002/03 – winter 2020/21)

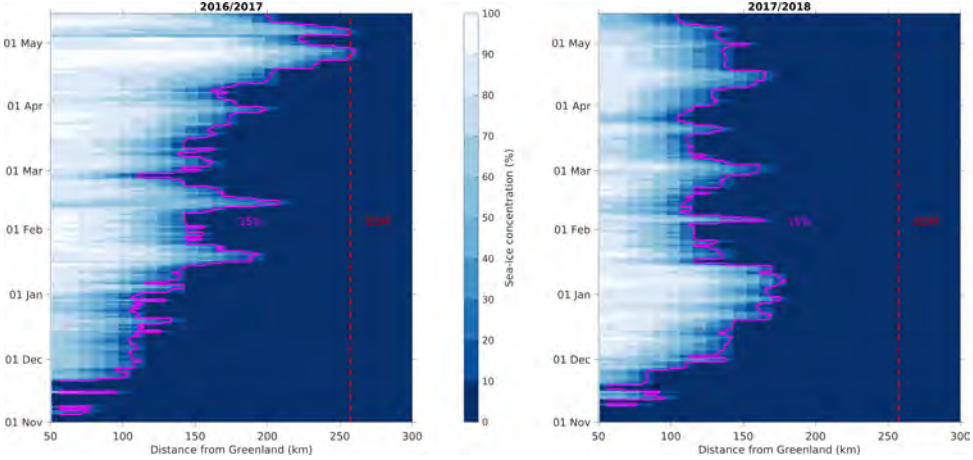


Bathymetry of the southern slope of Eggvin Offset



S. Skjelsvik

Closer sea-ice edge in winter 2016/2017



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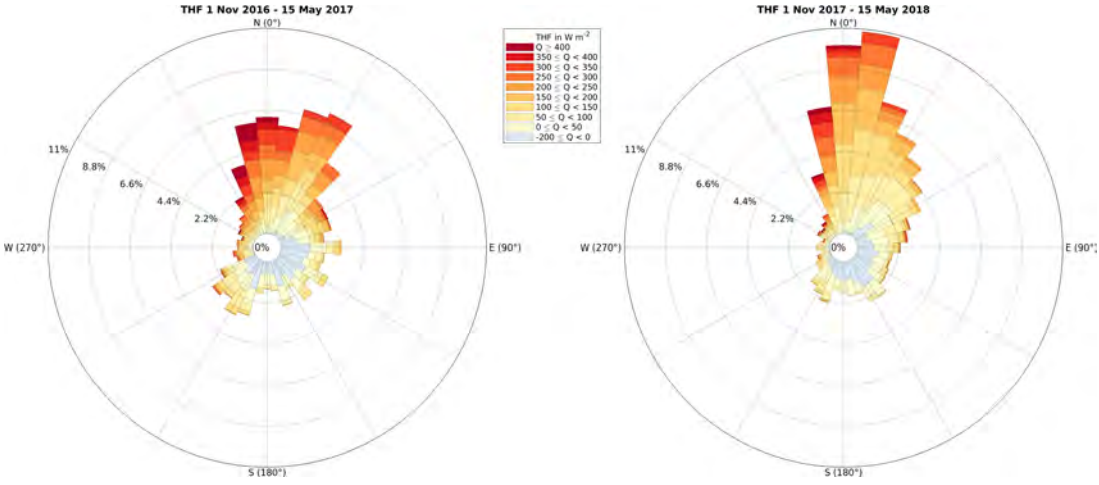
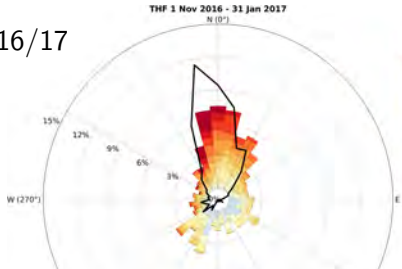
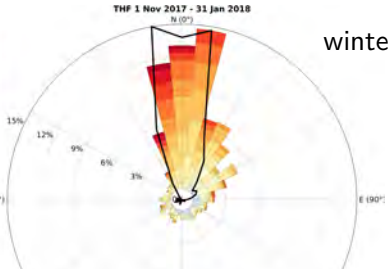
Northerly winds associated with high heat fluxes



Looking beyond the mean

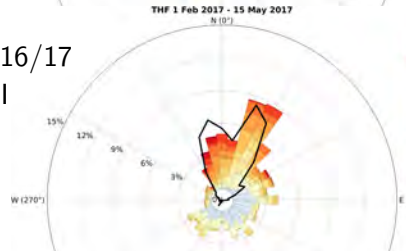
winter 2016/17
stage I

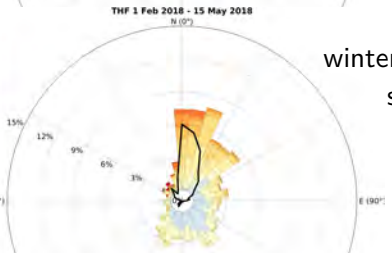




winter 2017/18
stage I

winter 2016/17
stage II





winter 2017/18
stage II