Wind-driven freshwater export at Cape Farewell

Elodie Duyck[1], Renske Gelderloos[2], M. Femke de Jong[1]

[1]*NIOZ Royal Netherlands Institute for Sea Research*, Ocean Systems (OCS) and [2]Johns Hopkins university

Cross-shelf exchanges at Cape Farewell

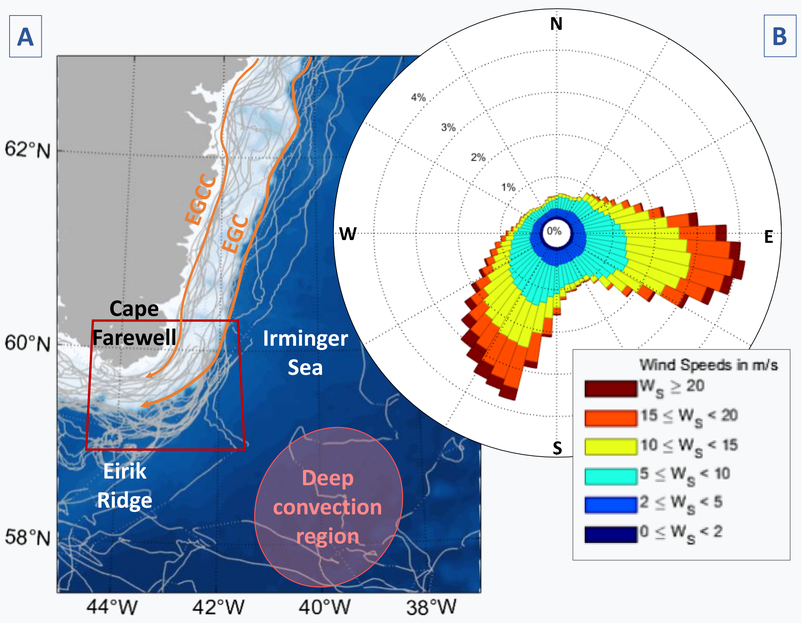
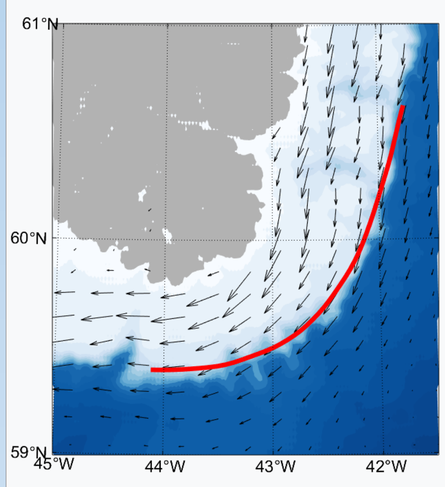


***Figure 1**: A. Circulation over the south-eastern Greenland shelf and EGC-DrIFT drifter trajectories (grey); B. winds at Cape Farewell. **EGC:** East Greenland Current; **EGCC**: East Greenland Coastal Current*

- Influx of freshwater from the Arctic and Greenland into the East Greenland Current could affect local deep convection if exported to neighboring seas.
- We need a better understanding of cross-shelf exchanges at the south-east Greenland shelf
- At Cape Farewell strong westerly winds could contribute to off-shelf export.
- A drifter deployment showed export of shallow anchored drifters at Cape Farewell.

<u>Hypothesis:</u> Winds are a primary driver for freshwater export across the Greenland shelfbreak at Cape Farewell

Methods



- We use results from a high-resolution simulation based om MIT-gcm: 2 to 4 km resolution, 09/2007 – 08/2008
- We define the shelfbreak as the smoothed 800m isobath (red line)

***Figure 2**: Surface circulation from MIT-gcm model results, and smoothed 800m isobath defined as the shelfbreak for computations (red line)*

Extreme wind events and across shelf export

Strong wind events are identified using timeseries of wind speed and wind direction in the area of interest:

- Strong wind event: stronger than 17m/s, longer than 12h, more than 1 day between 2 events
- Direction criteria tip-jets: [-45° 45°]; North-easterlies: [-90° 90°]
- 11 tip jets & 5 North-Easterlies

***Figure 4**: A. Across-shelf Ekman transport and across shelf volume transport in the first 100m. B. Across-shelf freshwater transport at the surface and 25m. Dark grey lines indicate tip jets, light grey lines indicate mild westerly winds (>10m/s)*

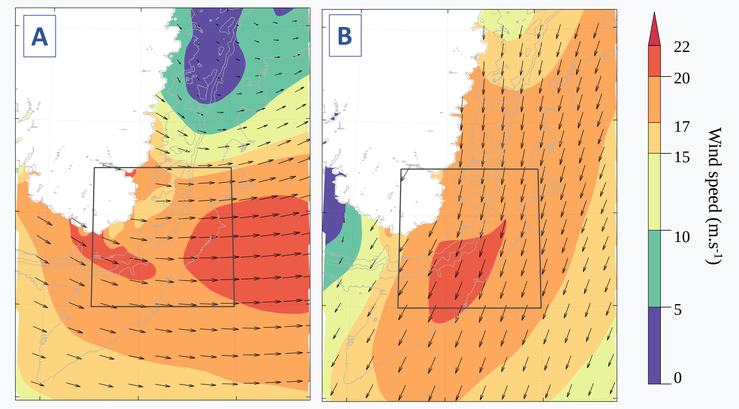


***Figure 3**: A. Tip jet composite. B. Strong north-easterlies composite. Grey box is computation area.*

- Across-shelf volume transport in the first 100m is mostly wind-driven and shows peak export during tip jets
- At 25m depth, only tip jets lead to freshwater export, while at the surface, strong freshwater export is also observed during mild westerlies
- Mild westerlies could be as important as tip jets since they are much more frequent and lead to export in summer when the surface layer is very fresh.
- In total, during the model year, tip jets lead to 38 km³ and mild westerlies 78.4 km³ of freshwater export

Response of the front

- Tip jets move the salinity front offshore and create a freshwater extension over Eirik Ridge
- Wind events mainly impact the position of the front south of Cape Farewell
- In the first 100m isohalines extend offshore during westerly winds and straighten during north-easterlies.

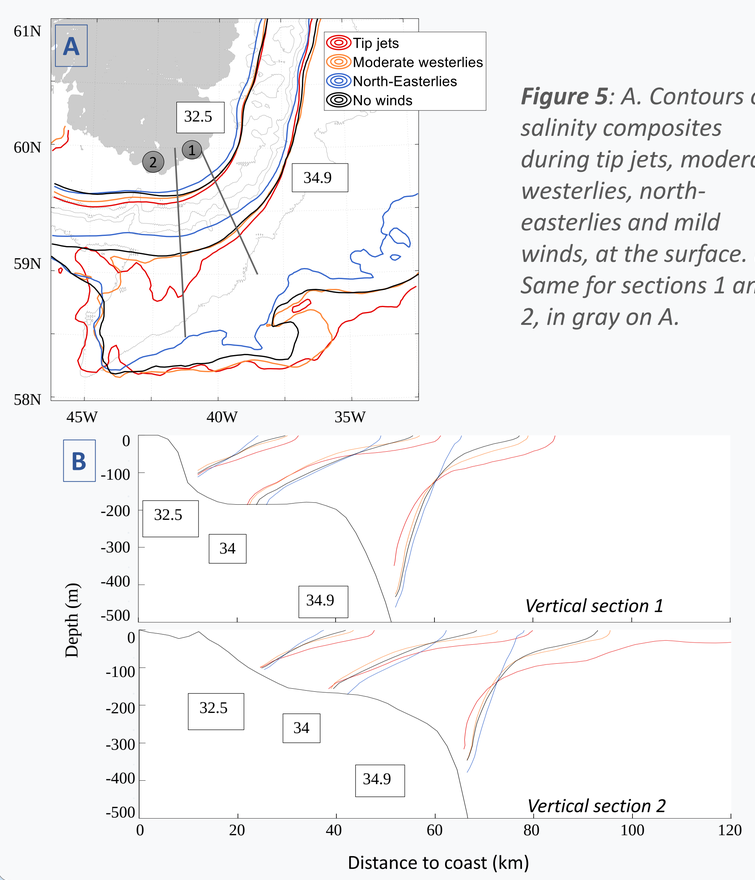


***Figure 5**: A. Contours of salinity composites during tip jets, moderate westerlies, north-easterlies and mild winds, at the surface. B. Same for sections 1 and 2, in gray on A.*

Particle deployment

- Particles deployed during tip-jets can get exported towards the Irminger Sea and over Eirik Ridge
- 50% of particles deployed at the surface during tip jets do not cross to west-Greenland
- Particles deployed at 25m are only exported during the most intense tip jet events, and tend to exit over Eirik Ridge
- During north-easterly events nearly all virtual particles enter the West-Greenland current

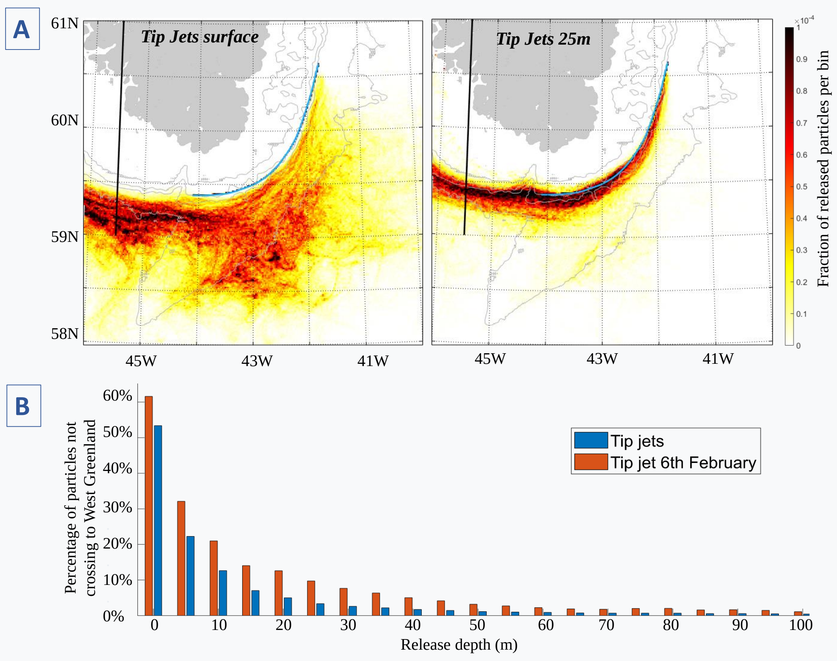
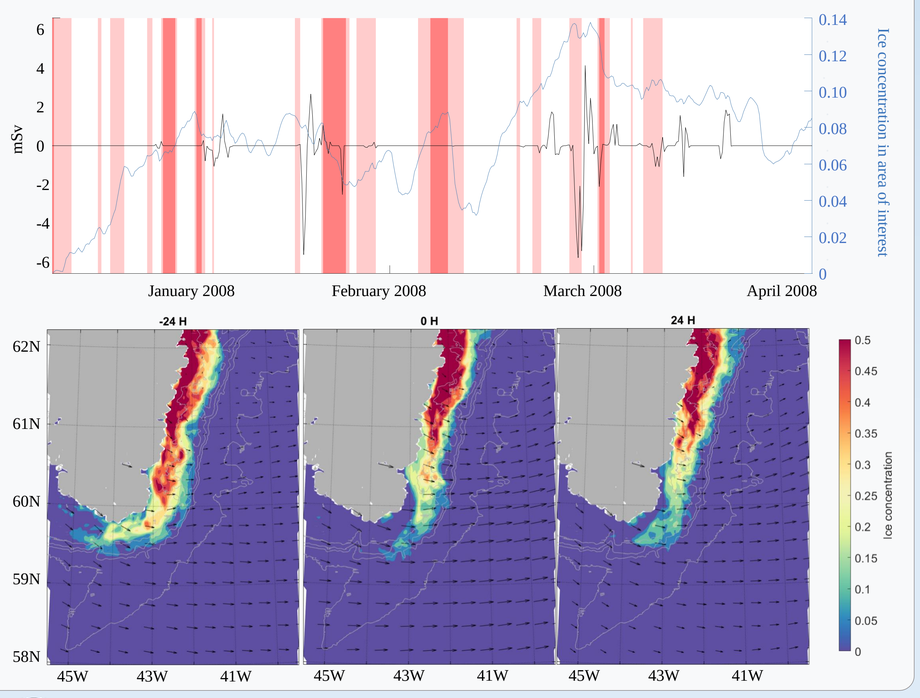


***Figure 6**: Density maps of particles deployed during tip jet events at the surface and 25m for the first 2 weeks; B. Fraction of particles which do not cross to West Greenland within 2 weeks after deployment*

Extreme wind events and sea-ice export

- There is little correlation between strong wind events and sea ice export, partly due to sparse and variable sea ice cover at Cape Farewell
- Strong westerly winds push ice off the coast towards the shelf but ice remains at the shelf and shelfbreak
- Satellite imagery during tip jet events show that sea-ice can extend into the Irminger Sea, but is then broken up and forms fine filaments
- Total freshwater export from sea ice at the shelfbreak is 0.3 km³, several orders of magnitude less than liquid freshwater export, 207 km³

***Figure 7**: A. Freshwater equivalent of sea-ice exported at the shelfbreak, with tip jets (red) and moderate westerlies (pink); B. Composite of sea-ice concentration 24h before, during and 24h after peak tip jet*



Summary and way forward

- **Strong westerly winds, especially winter tip-jets, drive freshwater export off the East Greenland shelf, pushing the salinity front offshore**
- **During the strongest events, part of the surface liquid freshwater is exported towards the Irminger Sea and over Eirik Ridge**
- **Tip jet events can also cause sea-ice export but the contribution to total freshwater export is very small**

Going further

How has the amount of exported freshwater been evolving in the last decades?
Can the exported freshwater affect convection in the Irminger Sea and south of Cape Farewell?
Are similar processes observable elsewhere along the south-east Greenland shelf?

NIOZ is an institute of NWO in cooperation with Universiteit Utrecht

This project is funded by NWO VIDI Grant