Seasonal variability in warm-water inflow towards Kangerdlugssuaq Fjord

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ABSTRACT

Seasonal variability in pathways of warm water masses toward the Kangerdlugssuaq Fjord-Glacier system (KF/KG), southeast Greenland, is investigated by backtracking Lagrangian particles seeded at the fjord mouth in a realistic high resolution regional ocean model simulation in the ice-free (summer months JASON) and the ice-covered (winter months JFMAM) seasons. We find that seasonal differences in pathways double the fraction of southern origin particles in winter, causing the seasonal warming and salinification below 200 m depth. Upstream seasonal T/S variations have a negligible impact on temperature variations near the fjord.

1. Motivation

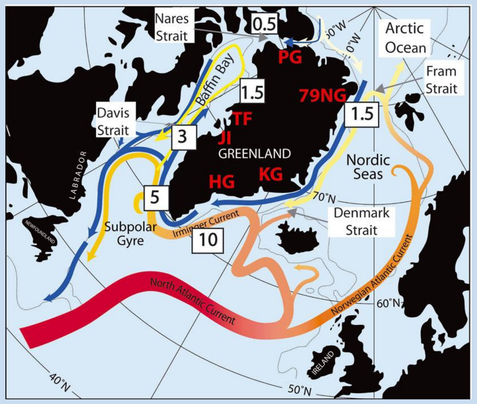

Figure 1: Warm ocean currents surrounding Greenland can affect glacier melt. **KG**=Kangerdlugssuaq Glacier. Boxed numbers denote mean temperature (°C) of the current. Source: [1]

2. Models

(1) MITgcm ocean/sea ice model

- open boundaries (HYCOM), ERA-I atmosphere
- 2km res; 2-15m layers
- hindcast: Jun 2007-May 2008
- 6-hr snapshot output

(2) Particle-tracking algorithm

- Numerical 4-D interpolation with Matlab ODE-solvers [2] [3]
- Boundary-sliding implementation

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4. Pathways

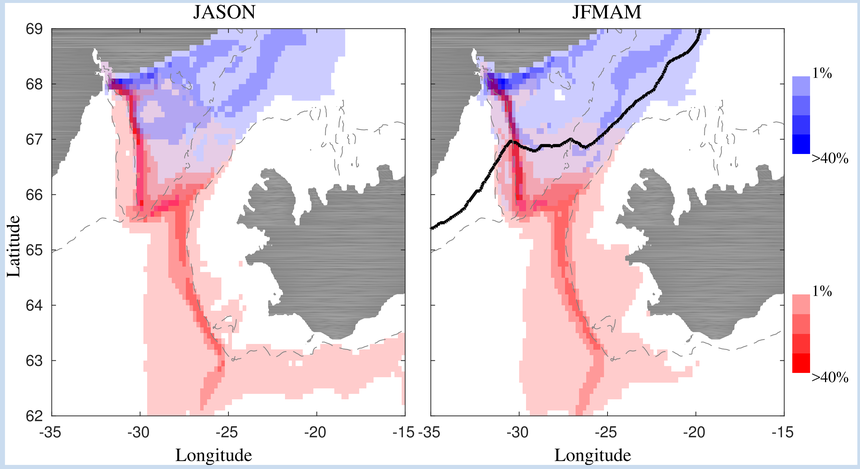
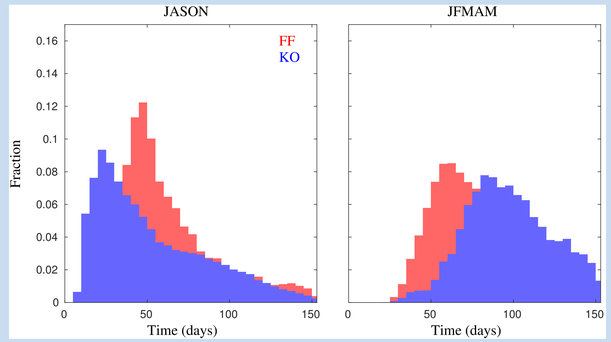
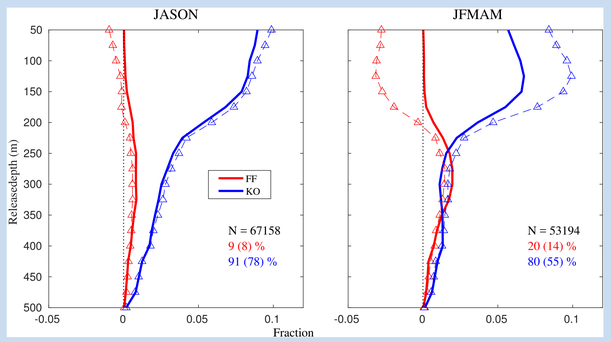


Figure 3: Pathways to KS for both seasons. Offshore KO pathway follows the slope in JFMAM, while it crosses the shelf in JASON. [4]

[Lower left] Figure 4: Transit time distributions between FF/KO section and KS. [4]

[Lower right] Figure 5: Particle distribution in depth.[4]





3a. Setup

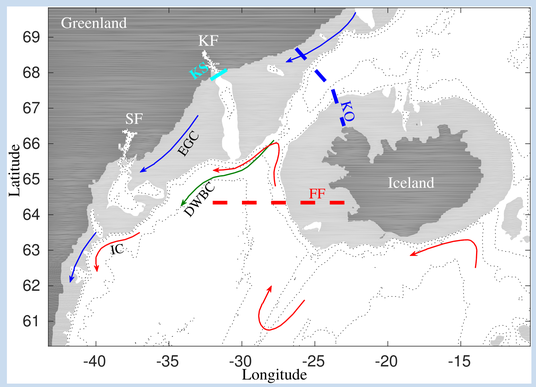


Figure 2: Control sections used in the particle-tracking simulations. KS=Kangerdlugssuaq Section; KO=Köger section; FF=Faxaflói section; IC=Irminger Current; EGC=East Greenland Current; DWBC=Deep Western Boundary Current. [4]

3b. Setup

Particles are **released at KS** in both seasons and **backtracked to KO and/or FF** (Figure 2). Over 120000 particle trajectories were analyzed.

References

[1] F. Straneo et al. *An. of Glac.*, 53(60):202–210, 2012.

[2] I. M. Koszalka, T.W.N. Haine, and M.G. Magaldi. *JPO*, 43:2611–2628, 2013.

[3] R. Gelderloos, A. S. Szalay, T. W. N. Haine, and G. Lemson. In *12th IEEE Int. Conf. on e-Science*, pages 381–388, 2016.

[4] R. Gelderloos, T.W.N. Haine, I.M. Koszalka, and M.G. Magaldi. Seasonal variability in warm-water inflow towards Kangerdlugssuaq Fjord. 2017. *Under review.*

5. Water-mass transformation

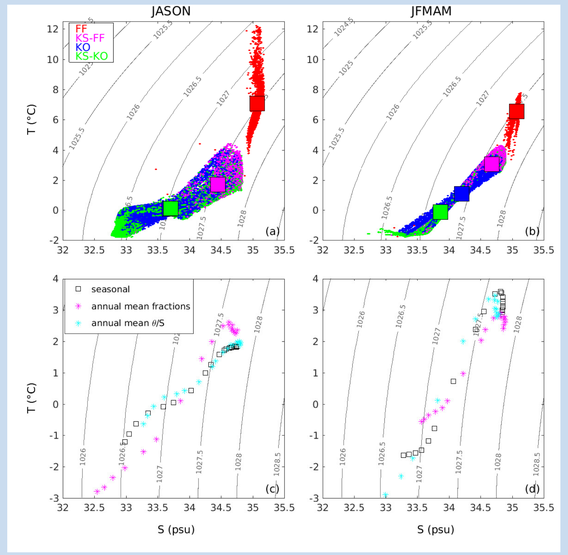


Figure 6: TS diagram showing TS transformation. Bottom panels show the importance of en-route mixing vs variability in source waters. [4]

Water masses from various source regions mix en route to the fjord. The strong mixing dominates over seasonal variability in the T/S properties of the source waters.

6. Conclusions

1. Subsurface water entering Kangerdlugssuaq Fjord (**Figure 2**) is warmer in the ice-covered season (winter; JFMAM) than in the ice-free season (summer; JASON).
2. This difference is caused by a larger fraction of water coming from the Irminger basin in that season (FF) than northern source waters (KO) (**Figure 5**),
3. which in turn is caused by a different (longer) pathway taken by the water coming from the North (**Figures 3 and 4**).
4. These seasonal differences in mixing rates determine the T/S properties at the fjord; variations in upstream water properties play a minor role (**Figure 6**).