On the origin and propagation of Denmark Strait Overflow Water Anomalies in the Irminger Basin

Kerstin Jochumsen\(^1\), Detlef Quadfasel\(^1\), Manuela Köllner\(^1,\^2\), Stephen Dye\(^3,\^4\), Bert Rudels\(^5\) and Heðinn Valdimarsson\(^6\)

\(^1\) University of Hamburg, ZMAW, Germany
\(^2\) now at GEOMAR, Kiel, Germany
\(^3\) CEFAS, Lowestoft, UK
\(^4\) University of East Anglia, Norwich, UK
\(^5\) FMI, Helsinki, Finland
\(^6\) Marine Research Institute, Reykjavik, Iceland
Motivation
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Which water masses are responsible for the variability observed in the near-bottom Deep Western Boundary Current?

East Greenland Shelf Water contributes to overflow south of Denmark Strait?
Observations

Temperature

Salinity

Cross-section velocity

Summer 2012, cruise P437-1
Observations

Denmark Strait sill (DS sill) – DSOW entrainment region (ER) – DSOW at Angmagssalik (Angmag)
Observations

Mooring arrays

Denmark Strait sill (DS sill) – DSOW entrainment region (ER) – DSOW at Angmagssalik (Angmag)
Temperature time series (daily)

2010-2011 example

DS sill

ER

Angmag

r < 0.25

low correlation in the daily data

single eddies do not survive the descend of the plume
Pot. temperature fluctuations are similar within the mooring arrays

**DS sill**
- mean: \(-0.08°C \pm 0.13°C\)
- \(r=0.8\)

**ER**
- mean: \(1.10°C \pm 0.21°C\)
- \(r>0.9\)

**Angmag**
- mean: \(1.45°C \pm 0.16°C\)
- \(r>0.7\)
Salinity fluctuations are small at DS sill and increase downstream.

**Salinity time series (lp filtered)**

- **DS sill**
  - Mean: 34.898 ± 0.003
  - Correlation: r = 0.6

- **ER**
  - Mean: 34.897 ± 0.008
  - Correlation: r > 0.8

- **Angmag**
  - Mean: 34.895 ± 0.009
  - Correlation: r > 0.9

Mean salinity values and their respective standard errors are provided for each location.
Velocity fluctuations are dependent on the plume position.

**DS sill**

Velocity time series (lp filtered)

- **r<0.4**

**Angmag**

- **r=-0.3**
**Signal propagation**

*pot. temperature*

- DS sill
  - r=0.8, 2d lag

- ER
  - r=0.8
  - 11d lag

- Angmag
  - 15d lag

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Pot. temperature signals are advected (mean speed: approx. 45 cm/s)
Signal propagation

**Salinity**
- DS sill
- Not significant
- ER
- n.s.
  - $r = 0.9$
  - 11 d lag
- Angmag

**Potential temperature** signals are advected (mean speed: approx. 45 cm/s), **salinity** signals are strongly modified by entrainment.
Mixing of Water Masses
Mixing of Water Masses

Other possibilities:
- ISOW or NEADW (more saline than DSOW)
- LSW (not found near DSOW)
- LDW (not found near DSOW)

Here, we use a very simple approach!
About 75% of the water at Angmagssalik is of northern origin!

Good agreement with other studies (e.g. Falina et al, 2012; Koszalka et al., 2013).

Overflow volume transport is about doubled from DS sill to Angmagssalik due to entrainment (Dickson et al., 2008):

→ About 2.5 Sv from Spill Jet needed!
Conclusions

✓ good correlation of temperature time series
  → temp. signals are advected from the sill
✓ low/no significant correlation in salinity and velocity
  → entrainment processes strongly modify salinity

✓ East Greenland current water is needed to obtain low salinities
✓ entrainment is dominant between DS sill and DS 5-7
  EGC spill jet plays a minor role for DSOW south of 64°N
  intermittent spill events likely combine to long term effects
✓ downstream DSOW properties do not necessarily reflect Nordic
  Seas conditions (especially in salinity), mixing ratio is a major
  contributor to salinity variance
Conclusions

Will Arctic temperature/salinity variability be seen in downstream DSOW measurements?

Only if the signals are very pronounced.

Which water masses are responsible for the variability observed in the Deep Western Boundary Current?

The original deep overflow crossing the GSR, but also the Atlantic Water in the Irminger Sea, as well as the EGC spill jet waters.

Open questions

Where exactly does the spilling take place (~2.5 Sv)?
Kangerdlugssuaq Trough?

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Where exactly does the spilling take place? Kangerdlugssuaq Trough?

Plans

Cruise POS486 in summer 2015
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RACE race.zmaw.de