Using ROMS to model the overflow of brine-enriched shelf water from Storfjorden

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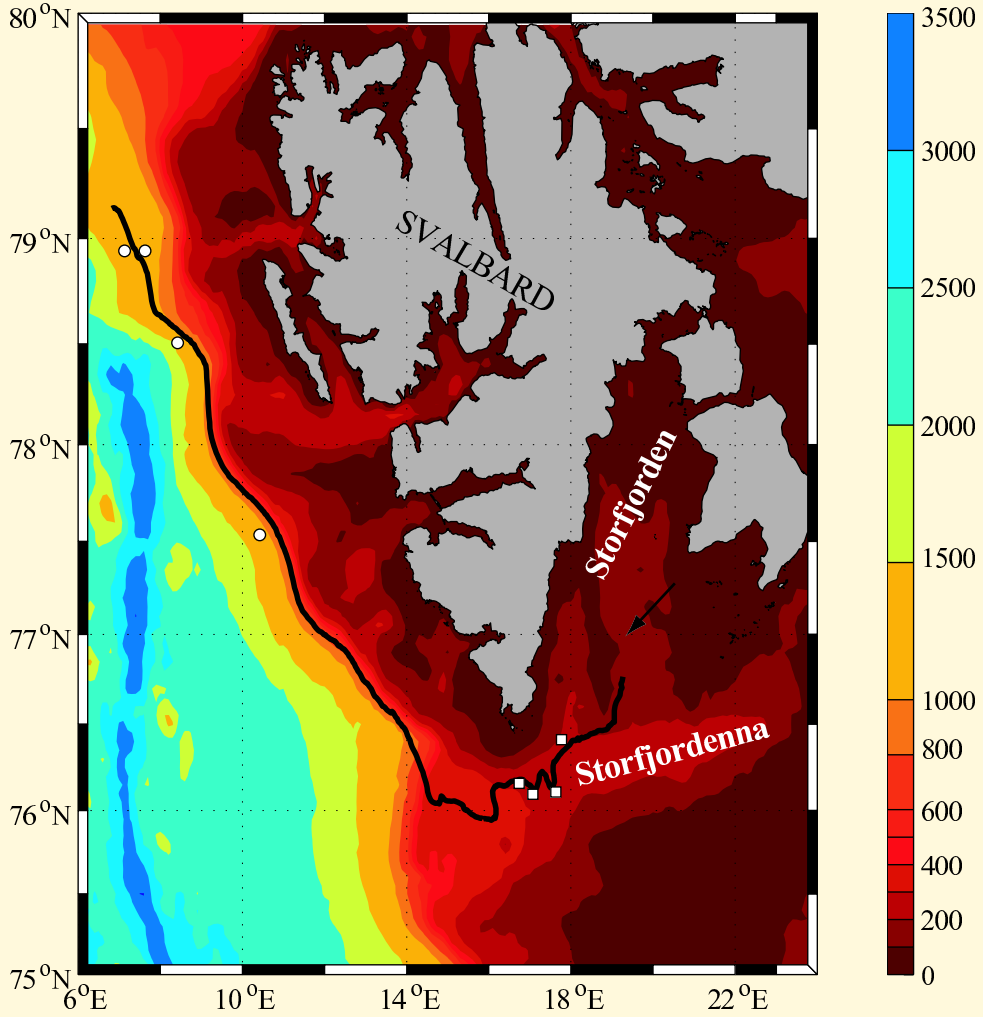
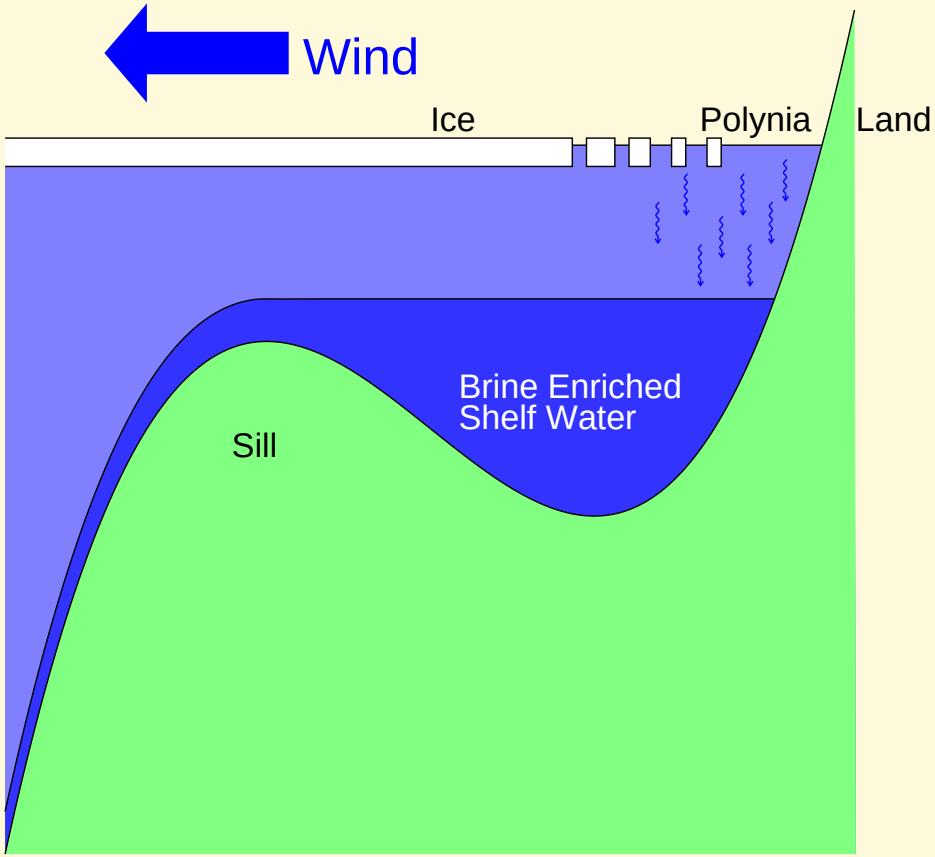
Map of Svalbard with Storfjorden

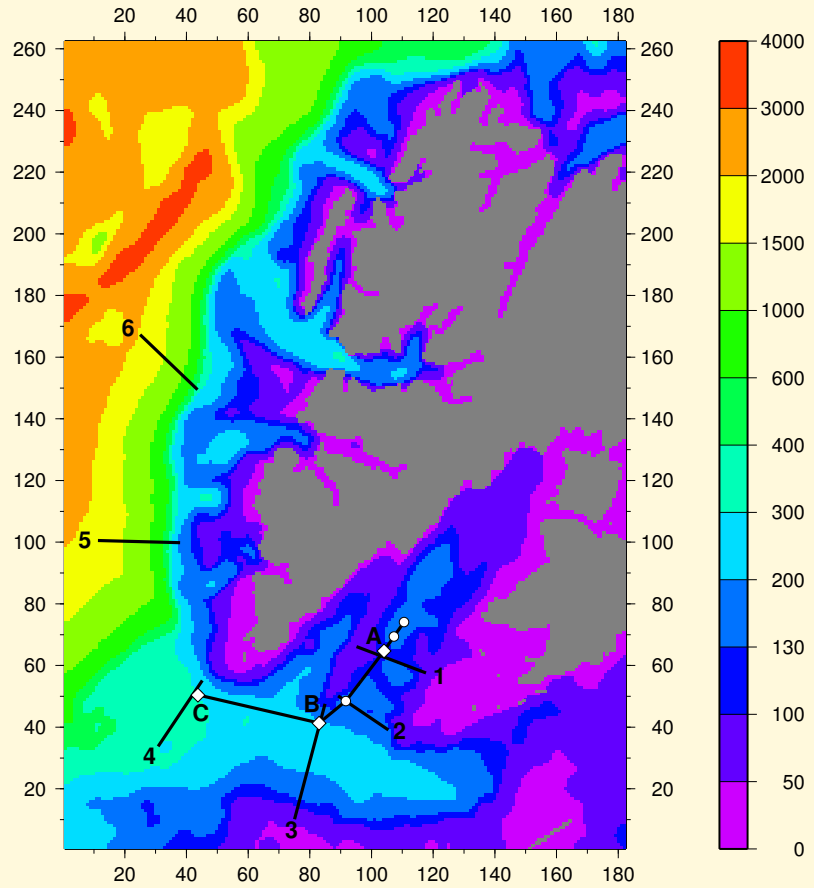


The white marks indicate plume observations
The black curve is the Killworth curve of constant descent

The process of Brine Enrichment



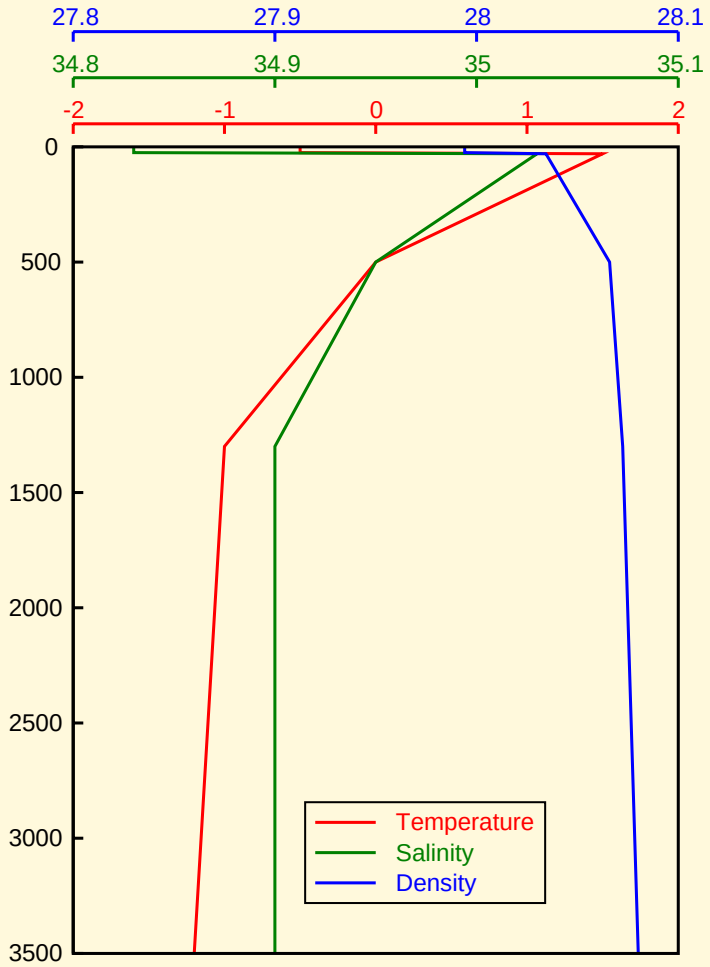
Model domain



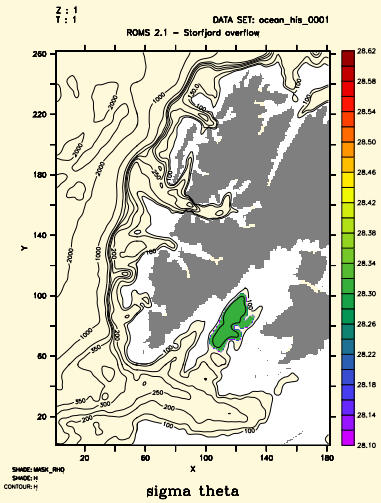
Model set-up

- Idealized ambient hydrographic profile, no horizontal gradients, following Jungclaus *et al.* (1995).
- Start with a minor reservoir of dense water from last winter
- Continuous supply of dense bottom water by the ROMS' river mechanism: Salinity 35.5 and temperature -1.8°C at lowest s-level.
- Modified bottom topography upstream of sill to guide the brine "rivers"
- Brine production starts at 0.1 Sv, decreases to 0 after 150 days. The simulation continues for another 150 days.
- No other forcing

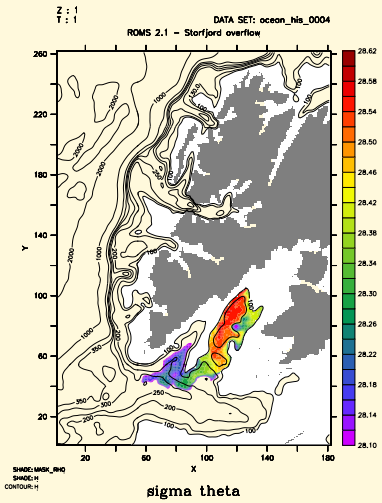
The ambient density profile



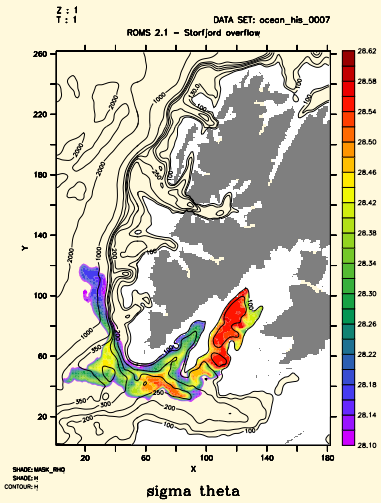
Plume development



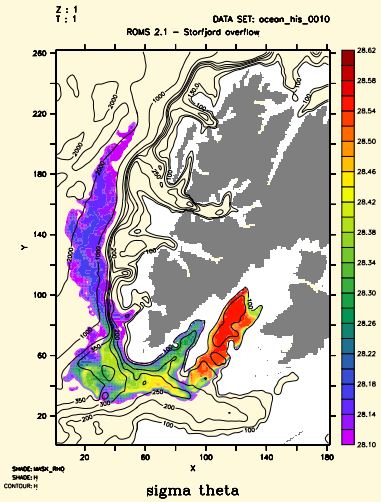
0 days



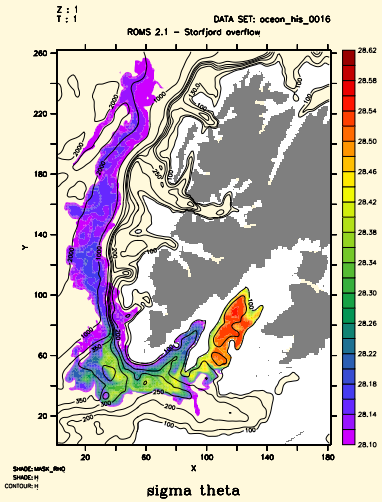
30 days



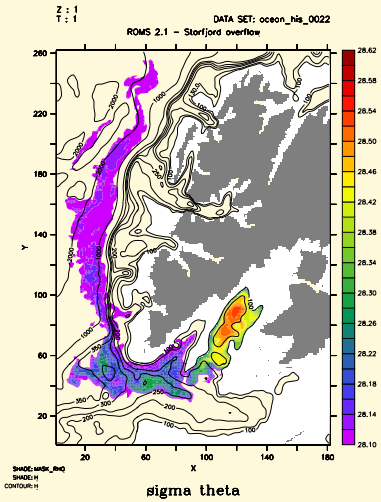
60 days



90 days

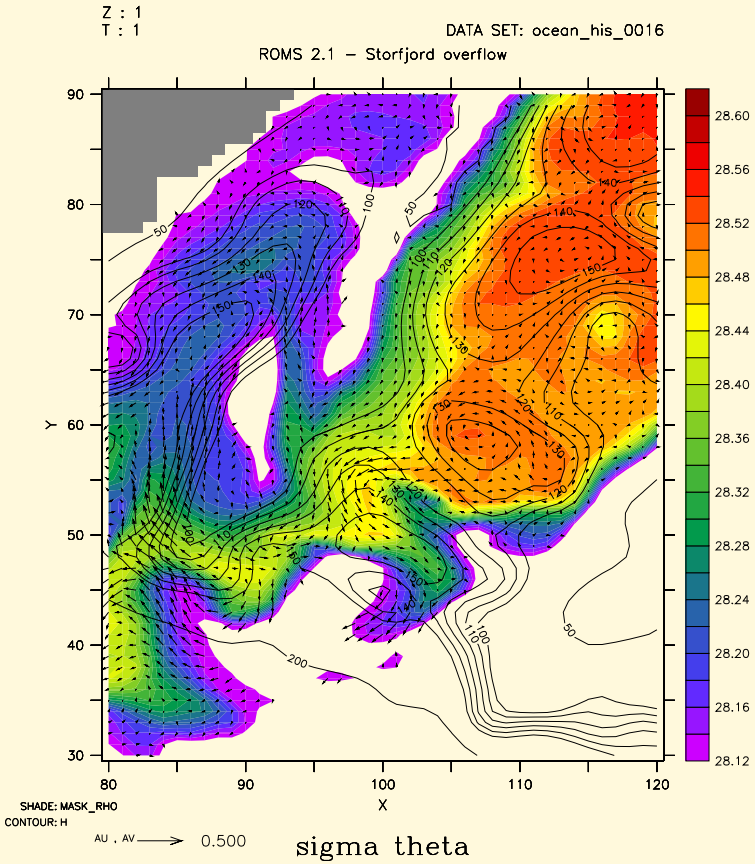


150 days

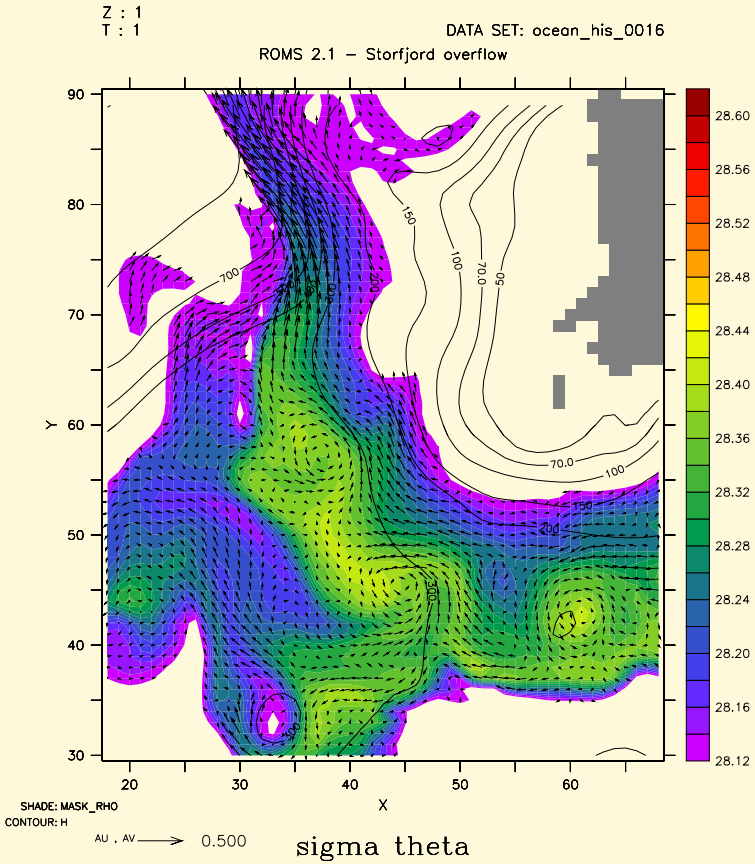


210 days

Overflow bottlenecks (day 150)

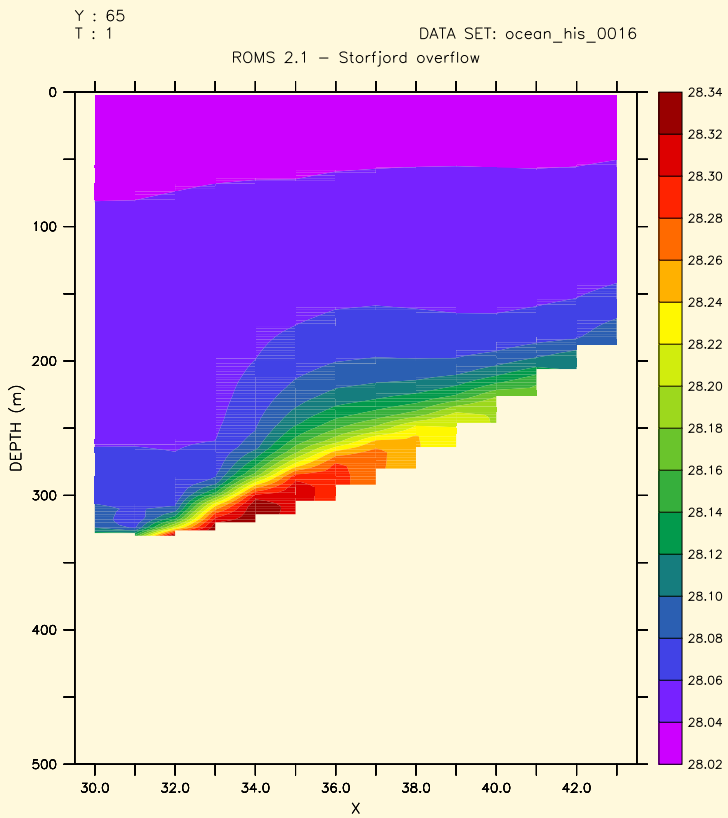


Sill overflow

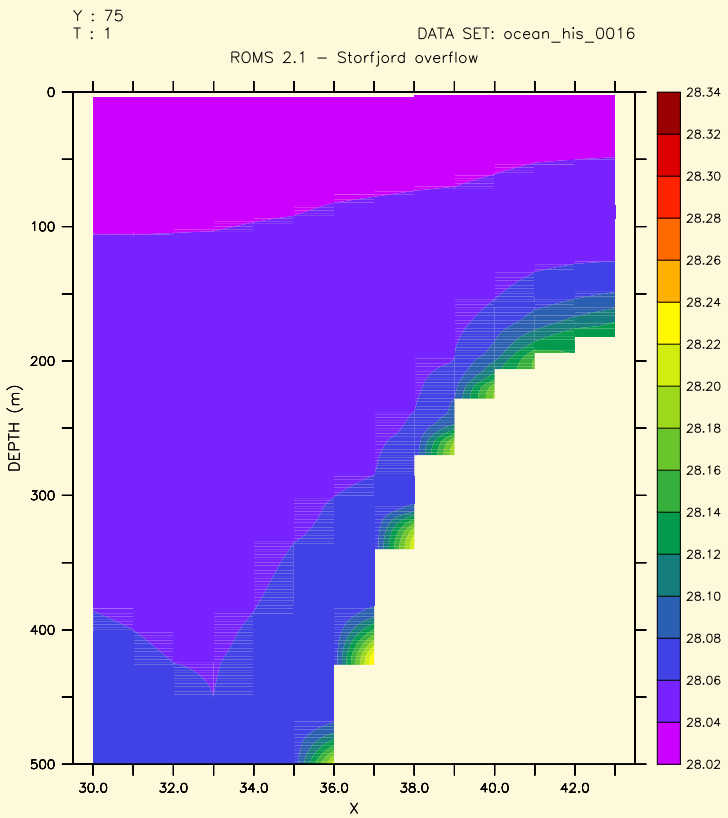


West of Sørkapp

Details around pinch point (day 150)

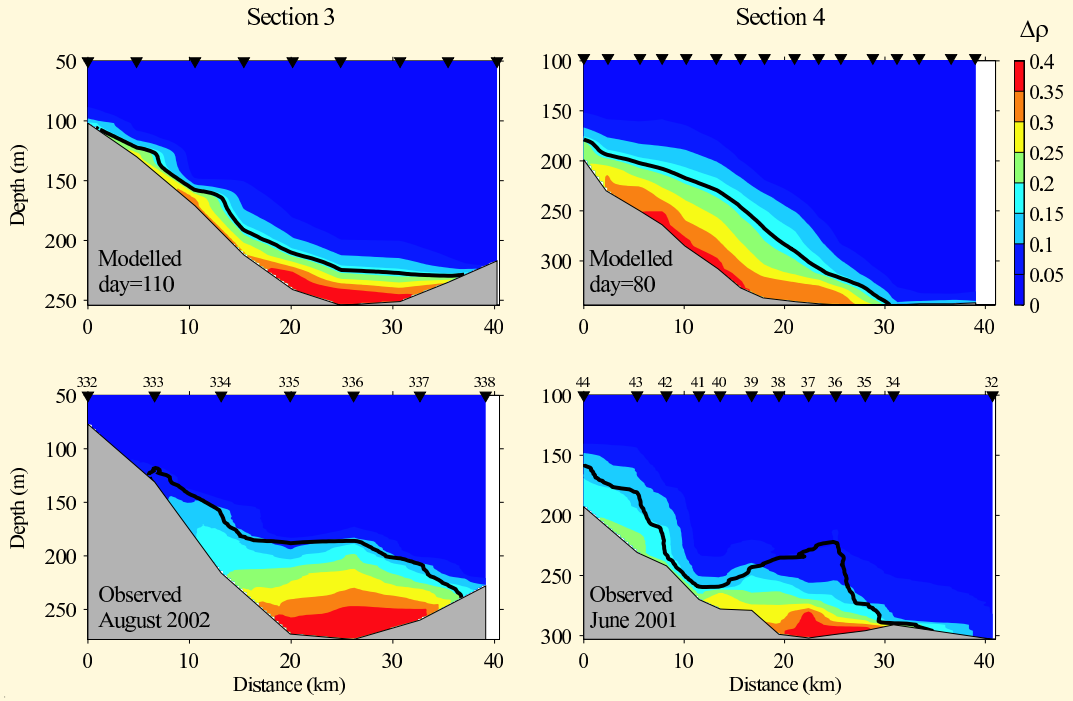


South of pinch point



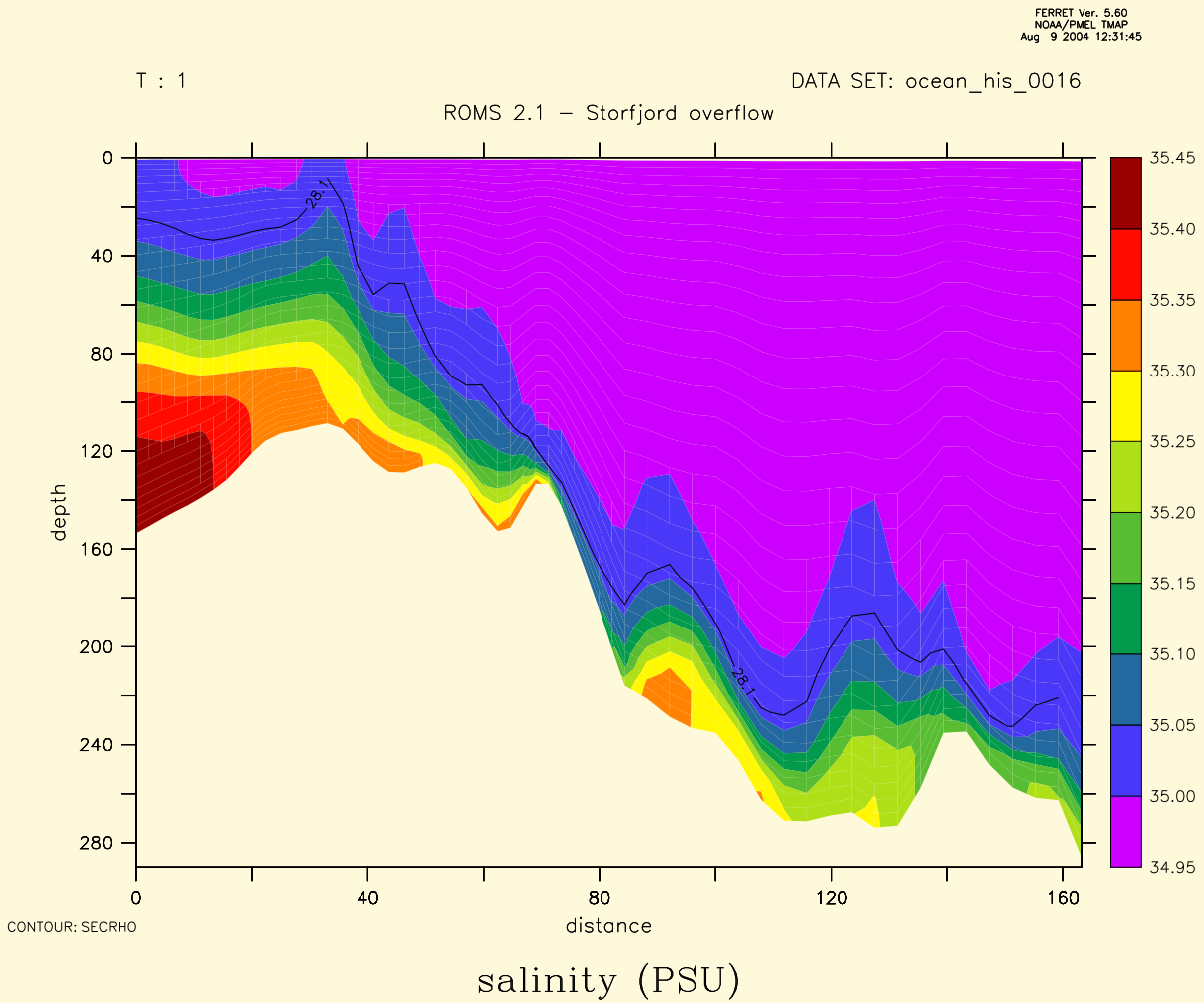
North of pinch point

Comparison with observations



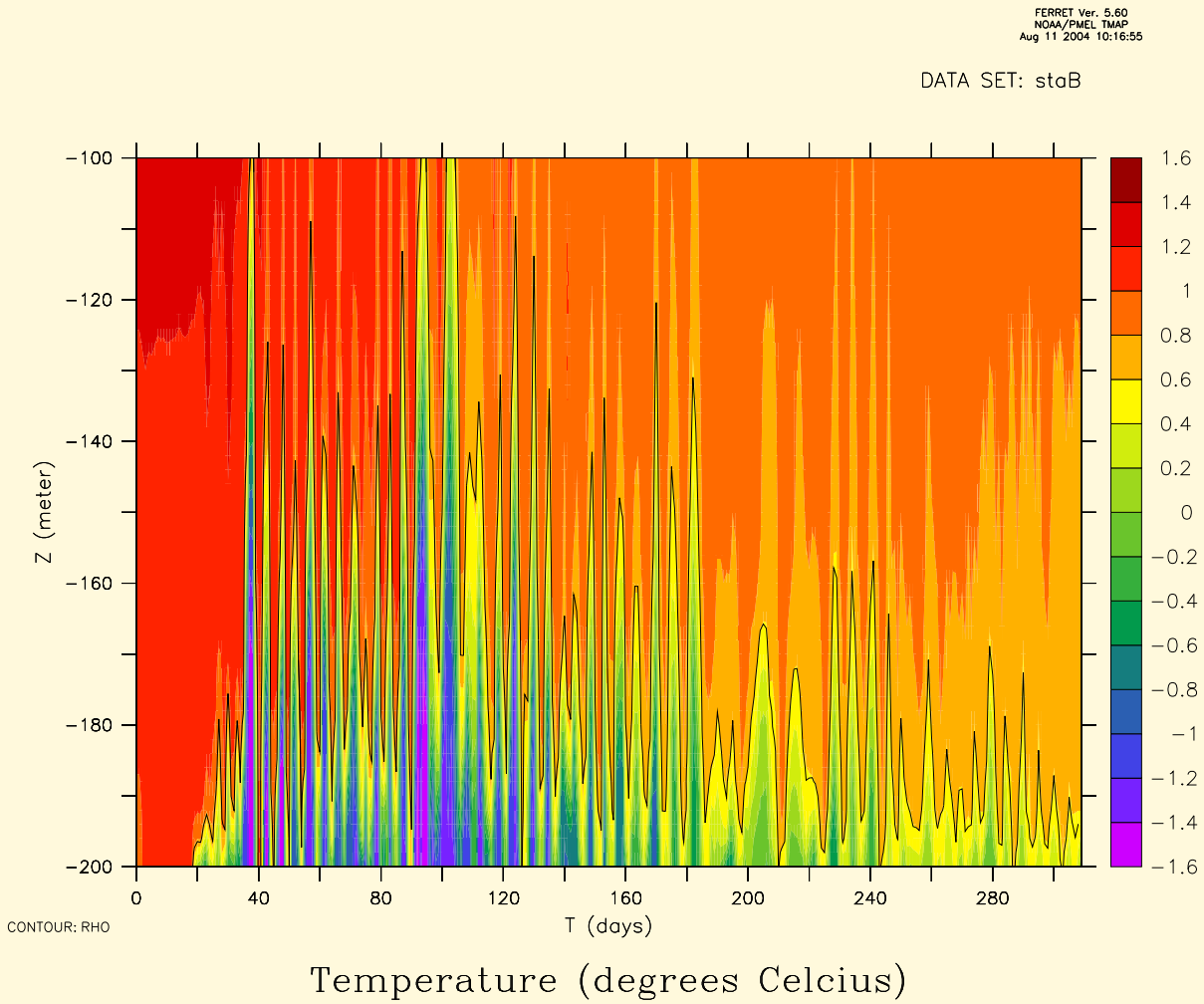
Modelled and observed density anomalies at two cross sections.
The black line is the zero isotherm

Downstream section



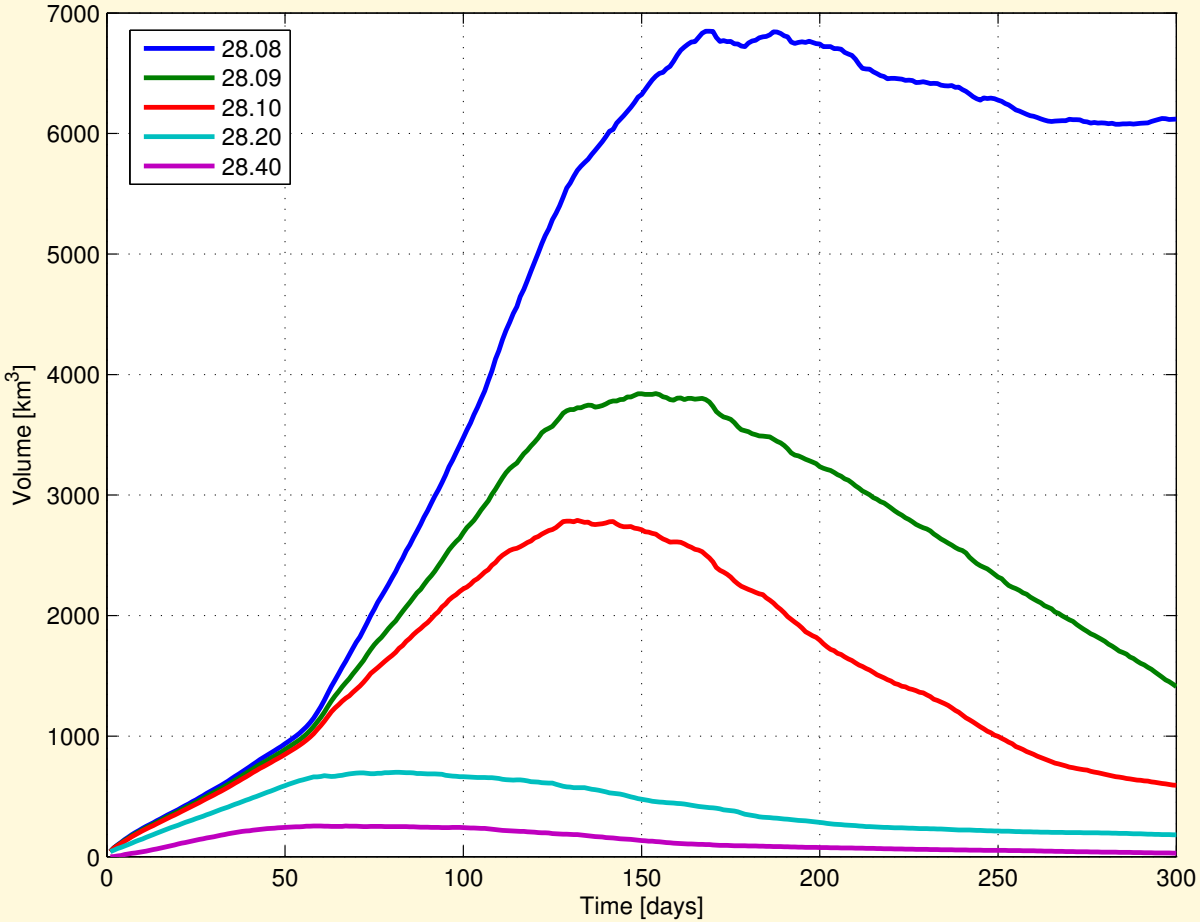
The figure shows the salinity and the 28.1 isopycnal along the downstream section at simulation day 150.

Temperature at station B



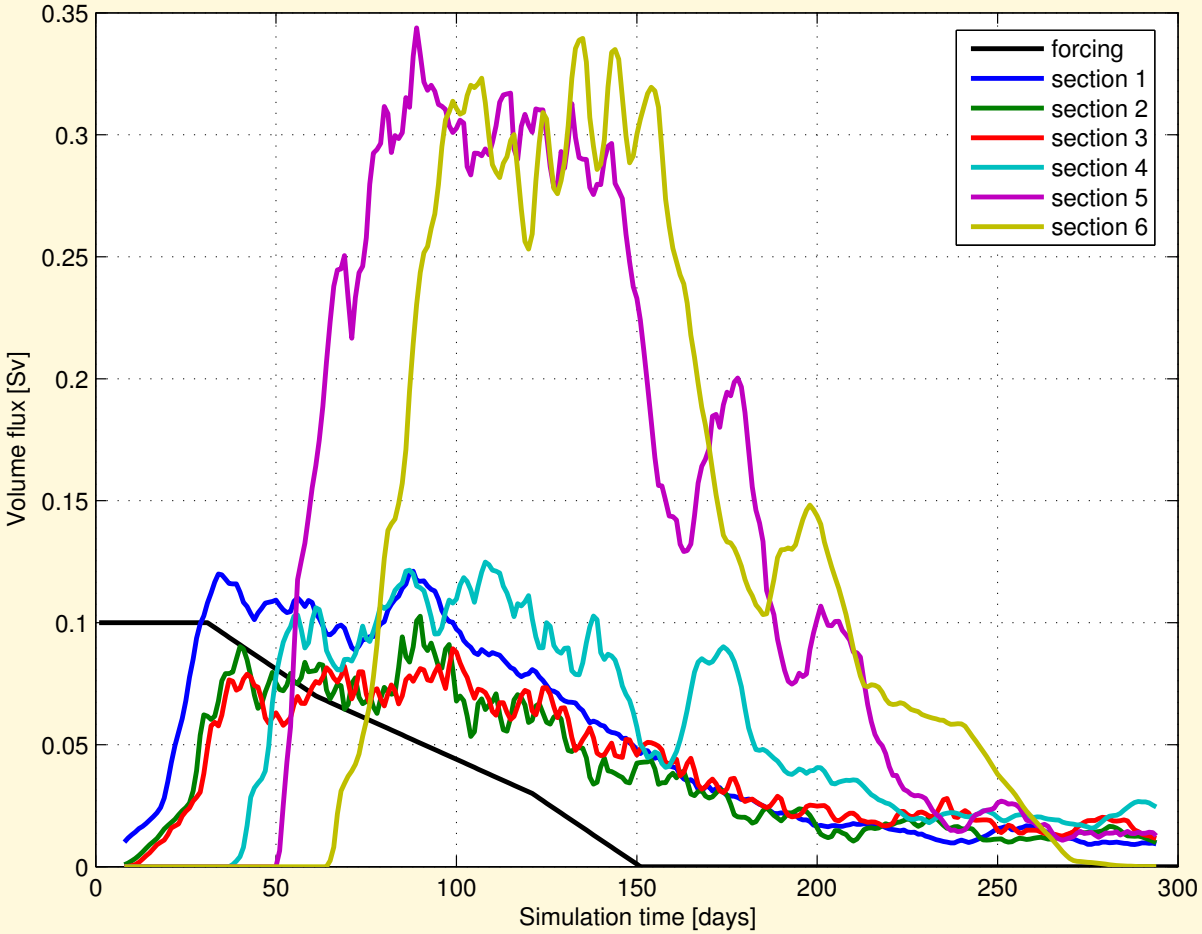
Temperature development at the bottom 100 meter at station B.
The contour line indicate the 28.1 isopycnal.

Volumetric analysis



Time development of total volume of brine enriched water

Volume flux



Flux of water with density above 28.10, smoothed by 15 days moving average

Concluding remarks

- The path of the model-generated plume agrees with observations
- The hydrography is too much idealized for easy comparison with observations, but the mixing and entrainment seems realistic.
- The overflow is strongly pulsating, with periods of 4–10 days.
- The area with converging isobaths west of Sørkapp limits the volume and density of the plume before it reaches the west Spitzbergen slope.