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# On the persistence and possible prediction of the Arctic/Atlantic THC

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Wolfgang Centre of Excellence

Research

## From 'noise' to chaos via predictability?

NAO → SST/MLD (annual/inter-annual) → AMOC (decadal/inter-decadal) → SST/AMO

Ocean 'integrator'

Bjerknes 1964; Sutton and Allen 1997; Visbeck et al. 2001; Latif et al. 2009

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## Pacemaker gets out of sync?

NAO → SST/MLD (annual/inter-annual) → AMOC (decadal/inter-decadal) → SST/AMO

Ocean 'integrator'

unpredictable(?)

Bjerknes 1964; Sutton and Allen 1997; Visbeck et al. 2001; Hurrell et al 2009; Latif et al. 2009

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## From 'noise' to northern anomalies

NAO → SST/MLD (annual/inter-annual) → AMOC (decadal/inter-decadal) → SST/AMO

Ocean 'integrator'

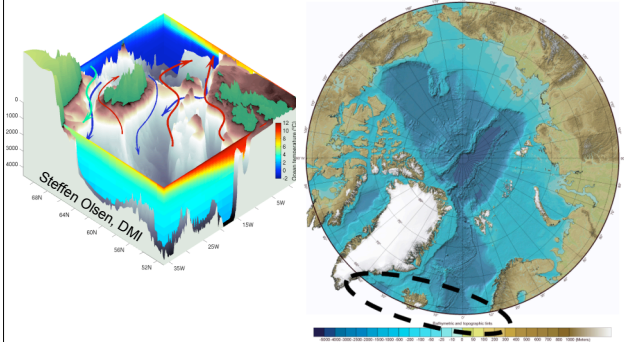
unpredictable(?)

SPG/MLD → Arctic Med

Orvik and Skagseth 2003; Häkkinen and Rhines 2004; Hatun et al 2005; Lohmann et al. 2009

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## GSR – the gateway to the Arctic

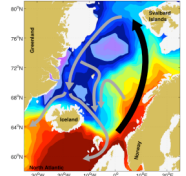


GSR – the Greenland-Scotland Ridge

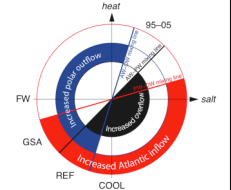
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## Observation-based constraints on northern THC

- **Thermohaline circulation**  
Observed sources and variability of Nordic seas overflow, Eldevik et al., *Nature Geoscience*, 2009.  
– what processes and regions are observed to “control” the overflows (1950-2005)?

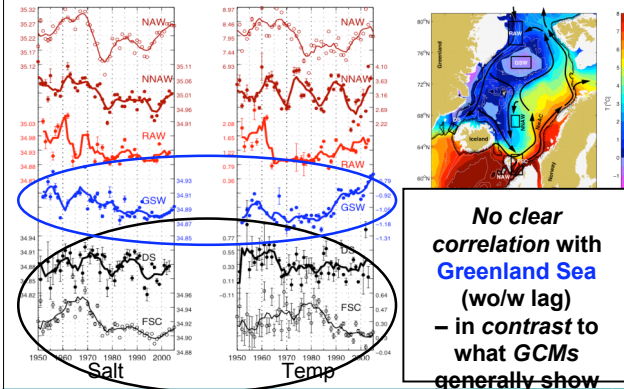


- **Thermohaline circulation**  
Northern constraints on the Atlantic THC, Eldevik and Nilsen, in revision *Nature Geoscience*.  
– quantifying North Atlantic/Arctic Mediterranean exchanges, and their sensitivities



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## The observed hydrography 1950-2005

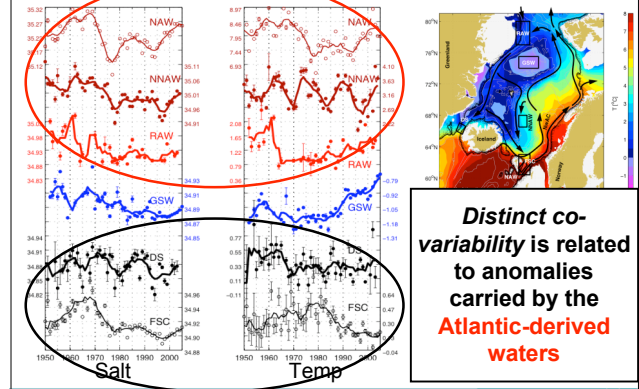


No clear correlation with Greenland Sea (wo/w lag) – in contrast to what GCMs generally show

The NISE data set (Nilsen et al. 2008; Eldevik et al. 2009)

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## The observed hydrography 1950-2005

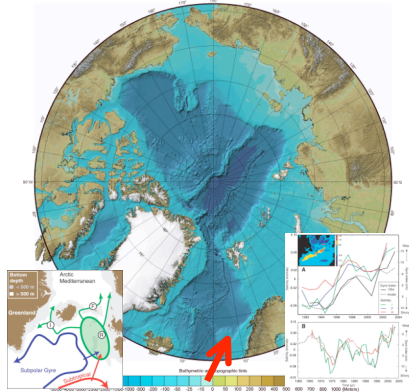


Distinct co-variability is related to anomalies carried by the Atlantic-derived waters

The NISE data set (Nilsen et al. 2008; Eldevik et al. 2009)

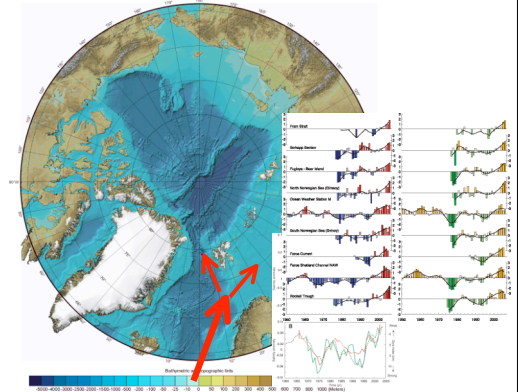
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### Thermohaline anomalies in the Northern Seas



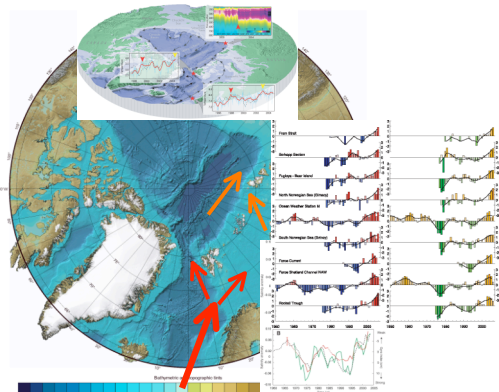
Hatun et al. 2005

### Thermohaline anomalies in the Northern Seas



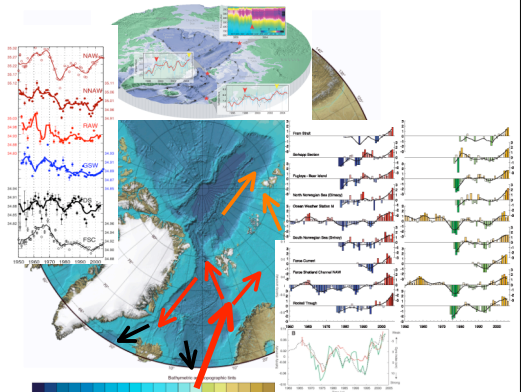
Hatun et al. 2005 => Holliday et al. 2008

### Thermohaline anomalies in the Northern Seas

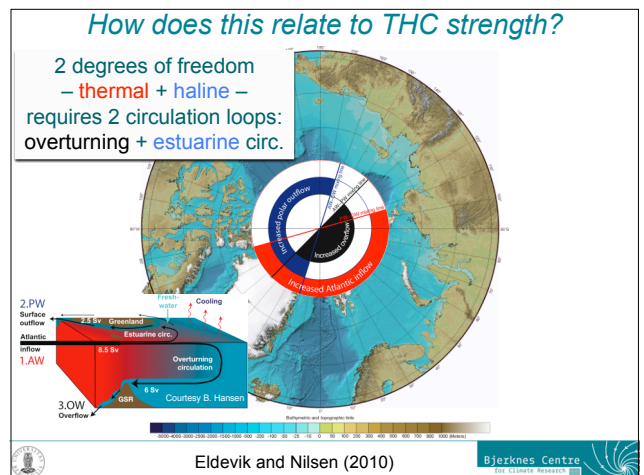
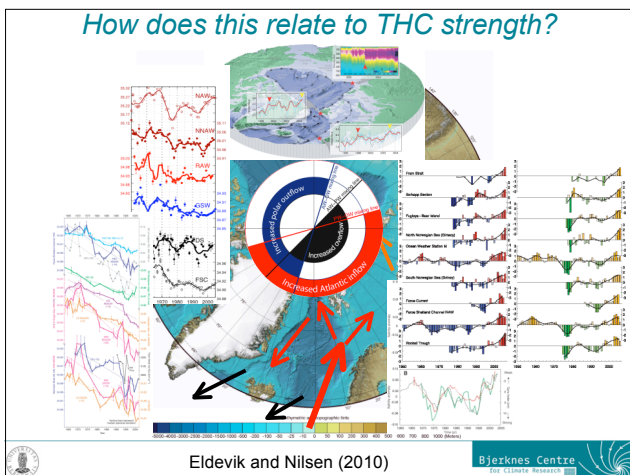
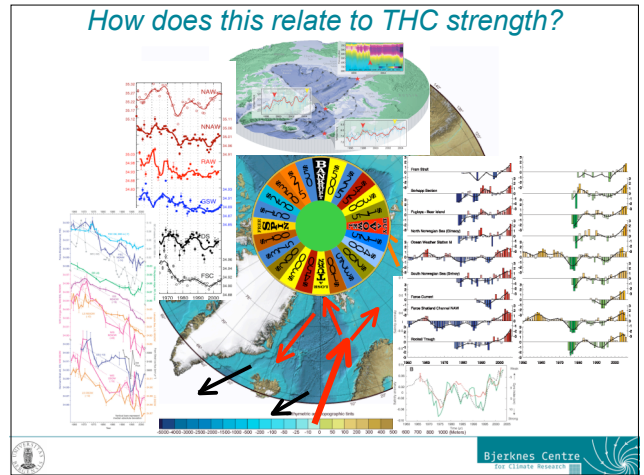
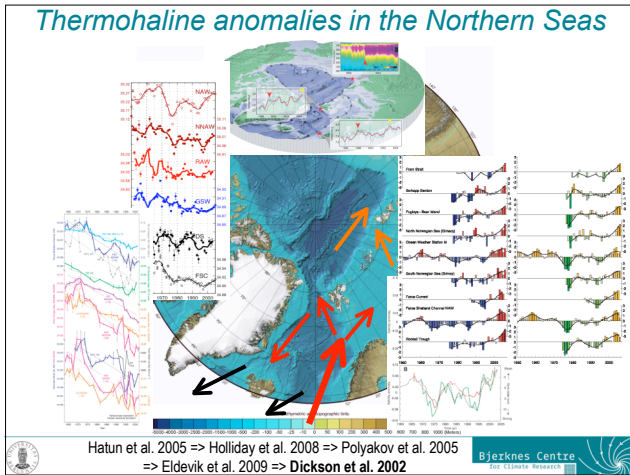


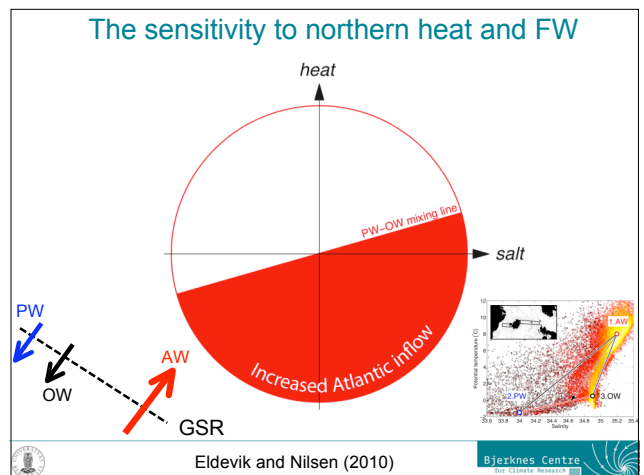
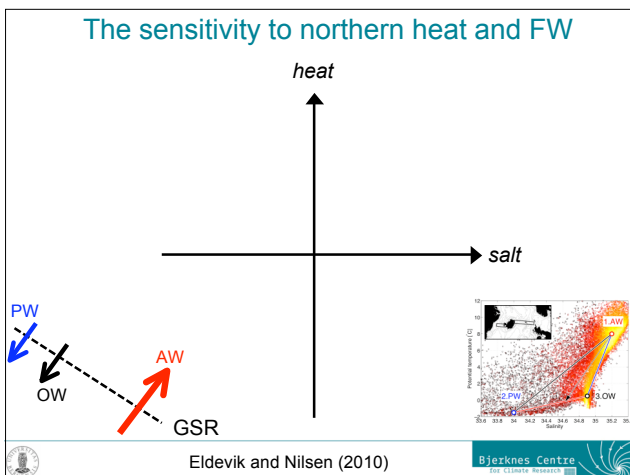
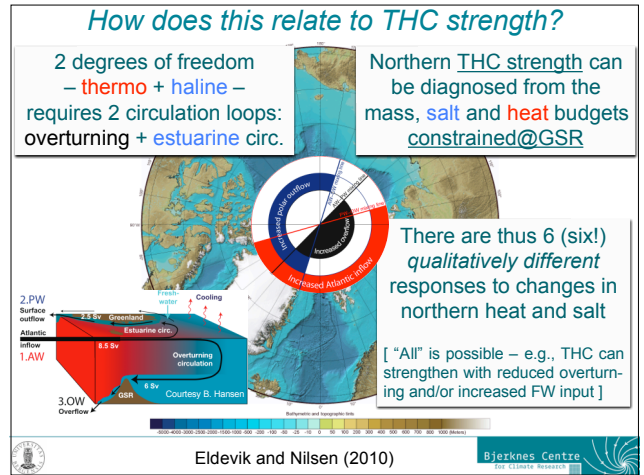
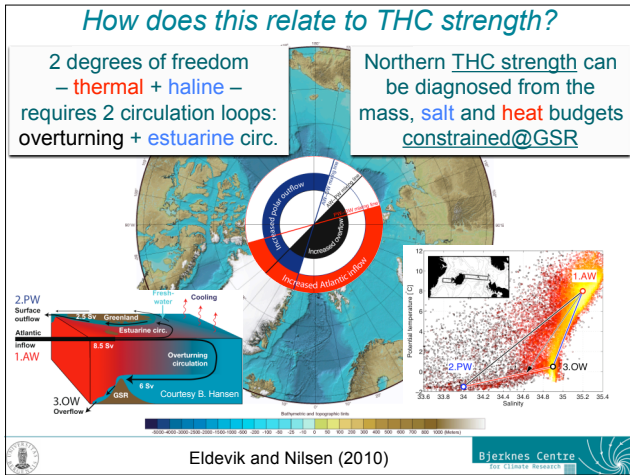
Hatun et al. 2005 => Holliday et al. 2008 => Polyakov et al. 2005

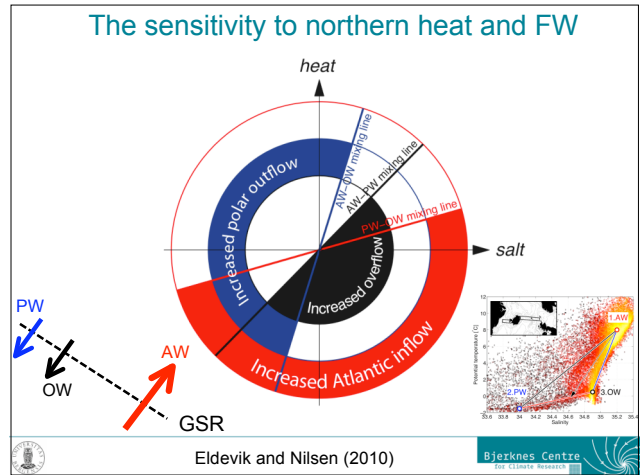
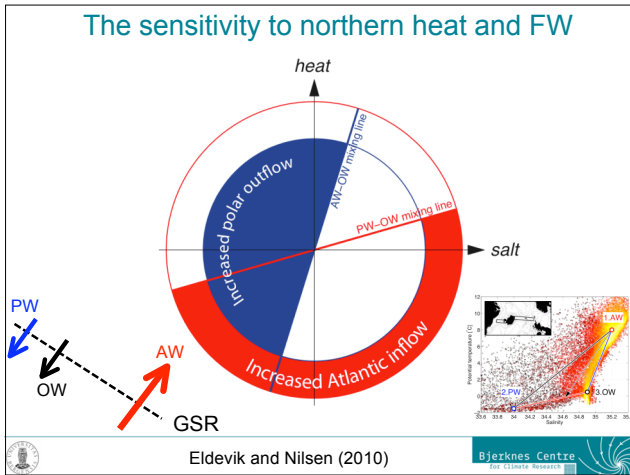
### Thermohaline anomalies in the Northern Seas



Hatun et al. 2005 => Holliday et al. 2008 => Polyakov et al. 2005  
=> Eldevik et al. 2009







### Summary and implications

- Climates – or climate models – that differ distinctly in **water masses at GSR**, would differ distinctly in their northern THC
- Northern THC is **mainly constrained by heat**
- The **relative strength** of estuarine vs overturning reflects FW input
- THC is **heat and salt**; their **combined influence** can only be captured by considering **overturning and estuarine** circulations
- E.g., 40 yrs of **Barents Sea ice retreat** supports ~1.5 Sv (~50 TW) of increased THC

Eldevik and Nilsen (2010)

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### Concluding speculations and questions

1. The **more persistent** the thermohaline anomalies, the **less the interaction** with (atmospheric) climate
  - no interaction for a purely advective signal
  - 'full impact' would consume the anomalies (no persistence)
2. How much **energy is required** (TW?) for ocean anomalies to be projected on (atmospheric) climate?
  - how much is required to perturb northern THC? And where?
  - and to the extent that it again influence climate?
3. What are the possible **predictive mechanisms** from ocean inertia to interannual/-decadal climate variability
4. How much **climate variance** should be explained?

Eldevik and Nilsen (2010)

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*Is this what decadal prediction must capture?*

