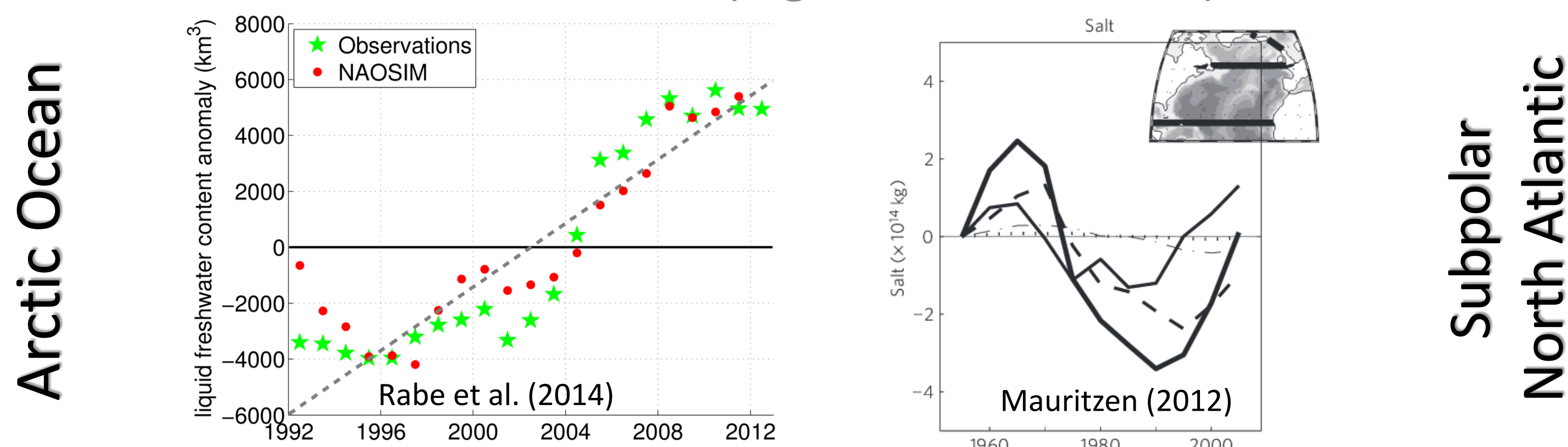


# Freshwater variability in the AO and SPNA: a Comparison from the 1990s to Present

## Introduction

A rapid increase in liquid freshwater content has been observed in the **Arctic Ocean (AO)** in the past two decades (e.g. Rabe et al., 2014). At the same time a significant part of Arctic sea ice volume has been lost to melt (e.g. Haine et al., 2015). In contrast to the AO, the **subpolar North Atlantic (SPNA)** and the **Nordic Seas (NS)** became more saline since the 1990s (e.g. Mauritzen, 2012).



## Data & Method

### Arctic Ocean (1992-2013):

- Upper ocean liquid freshwater content of the deep basins ( $z > 500\text{m}$ ) from Rabe et al. (2014) extended to 2013 ( $S_{ref}=35$ ,  $h$ =depth of 34 isohaline)
- solid freshwater content from Haine et al. (2015) derived from PIOMAS Assimilation Product

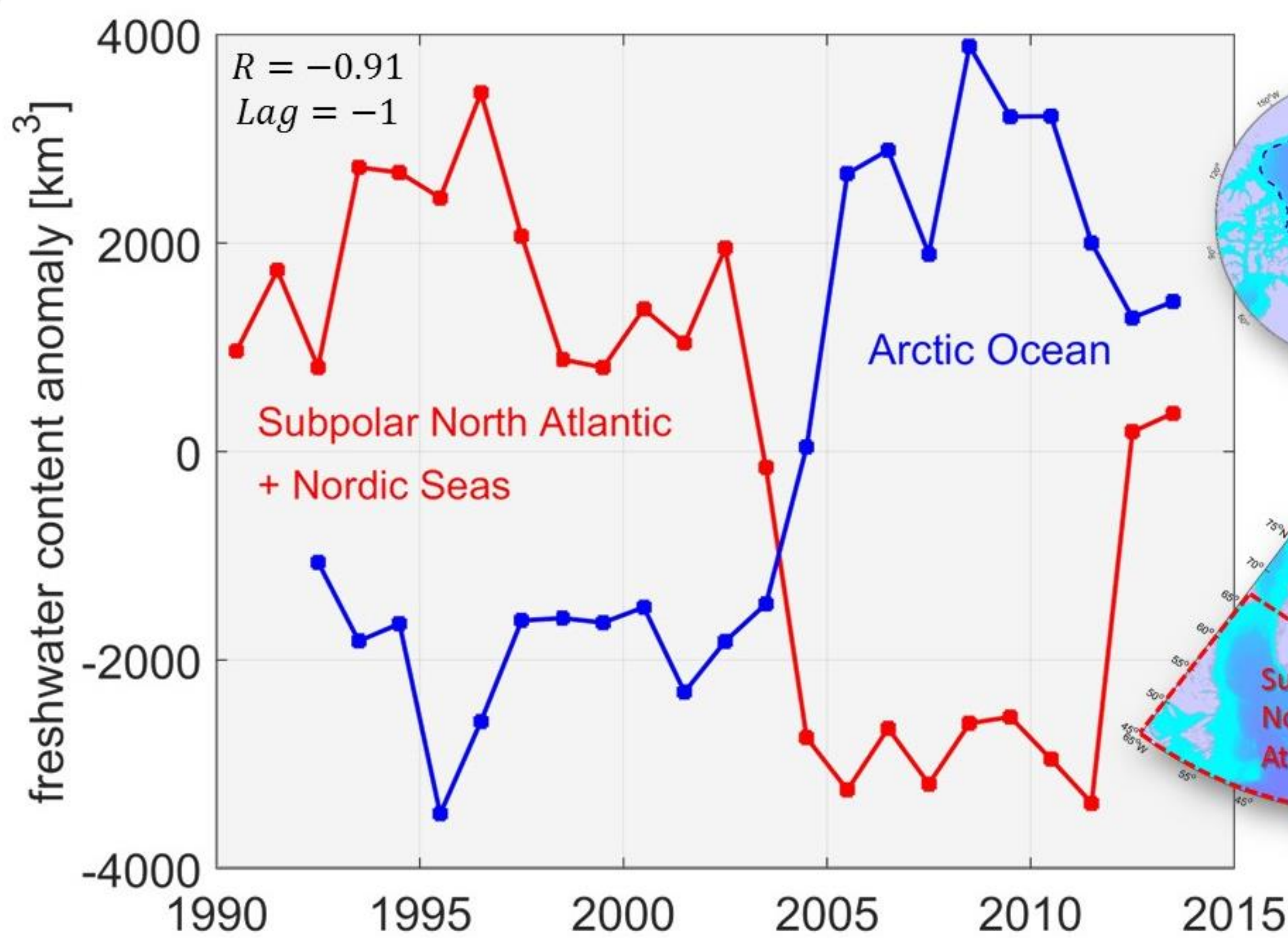
### Subpolar North Atlantic & Nordic Seas (1990-2013):

- Liquid freshwater content calculated from CORA 4.1 salinity fields ( $S_{ref}=35$ ,  $h=2000\text{ m}$ )

Inventory of liquid freshwater    Liquid freshwater content

$$LFWI = \int_{z=0\text{m}}^h \frac{S_{ref}-S}{S_{ref}} dz [m] \quad LFWC = \oint LFWI dA [km^3]$$

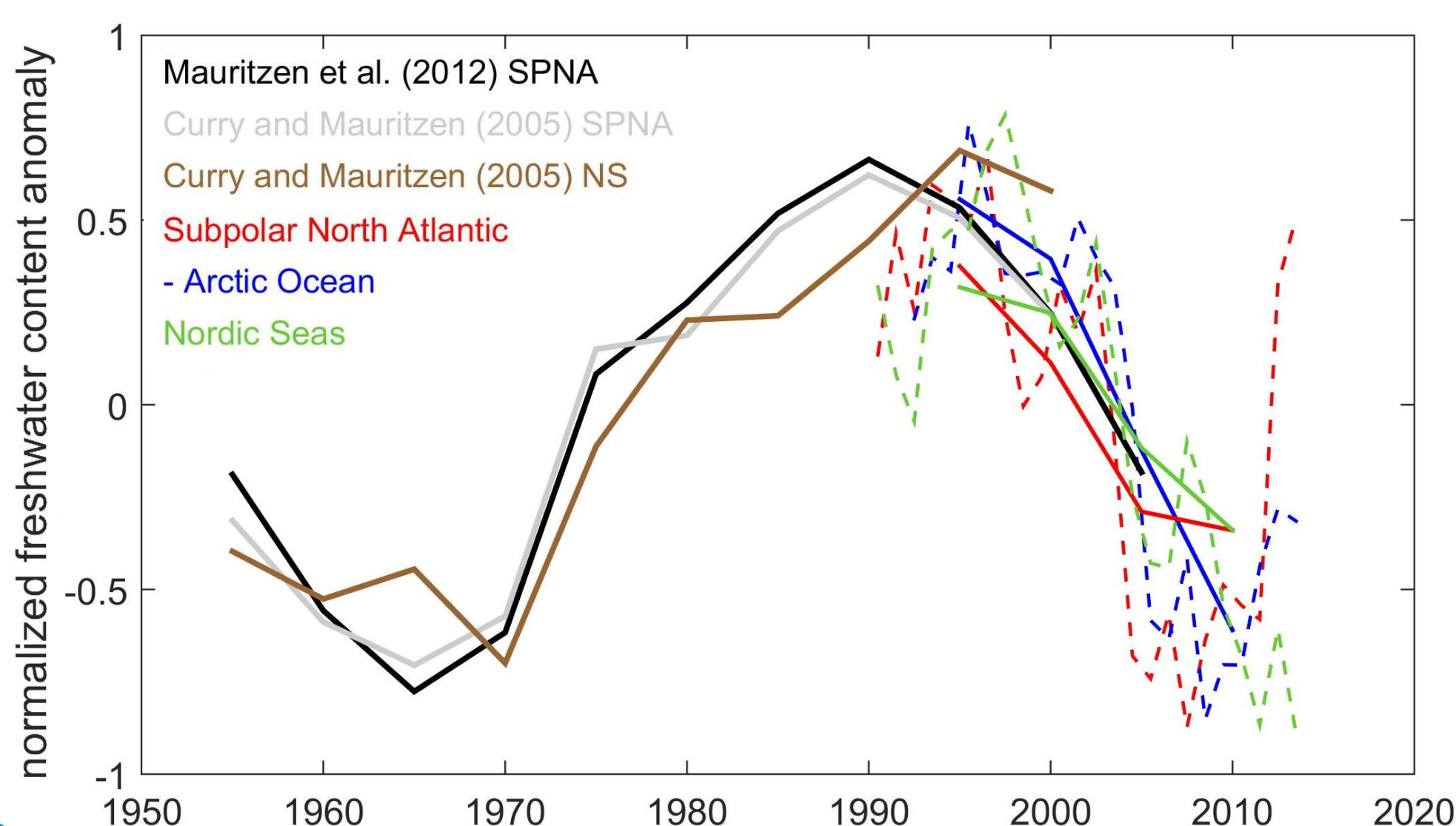
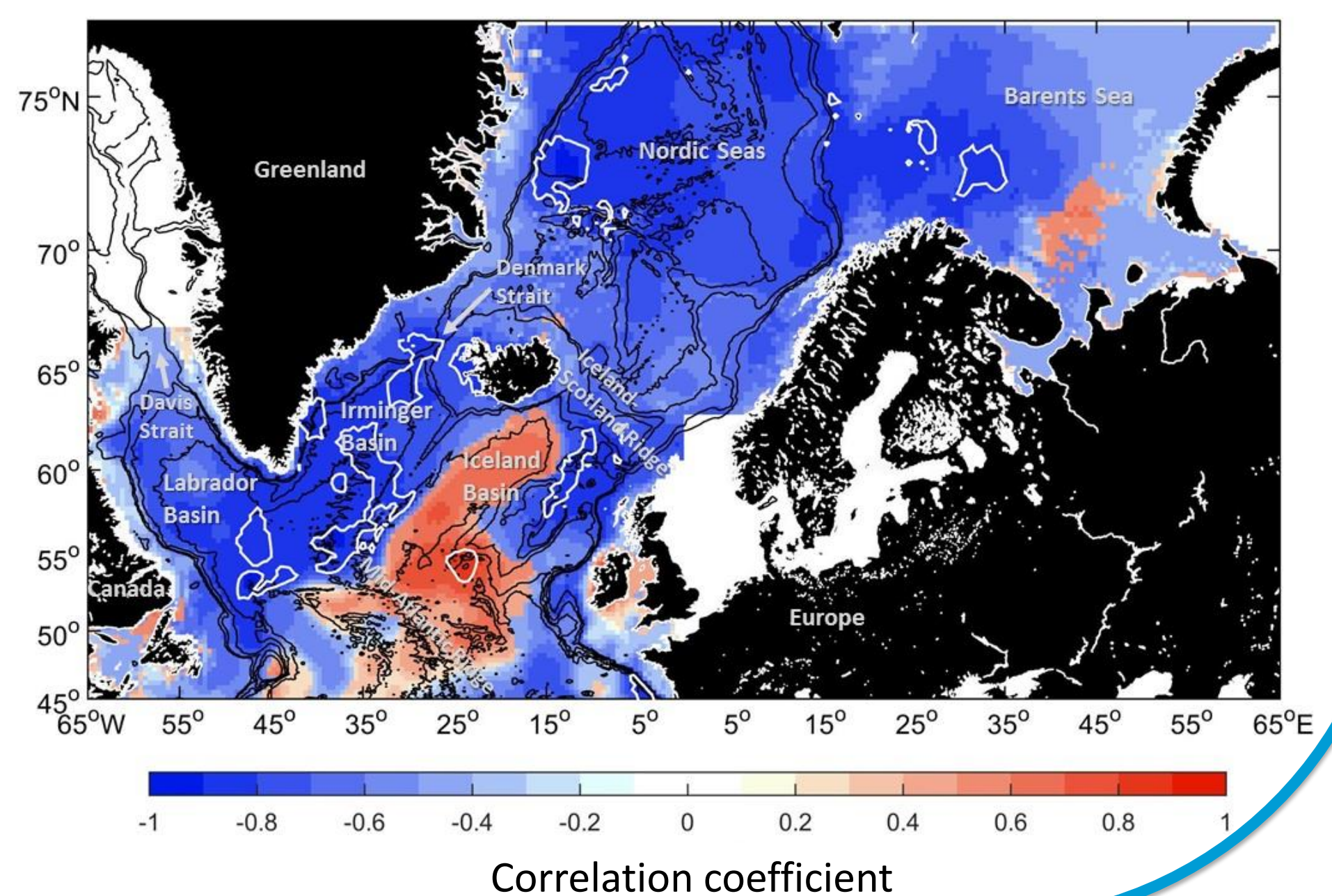
## How do the freshwater contents of the two regions compare?



Significant anti-correlation (95 % significance) of the SPNA & NS **liquid freshwater content anomalies** and the AO **total freshwater content anomalies** with a 1-year lag of the AO freshwater content.

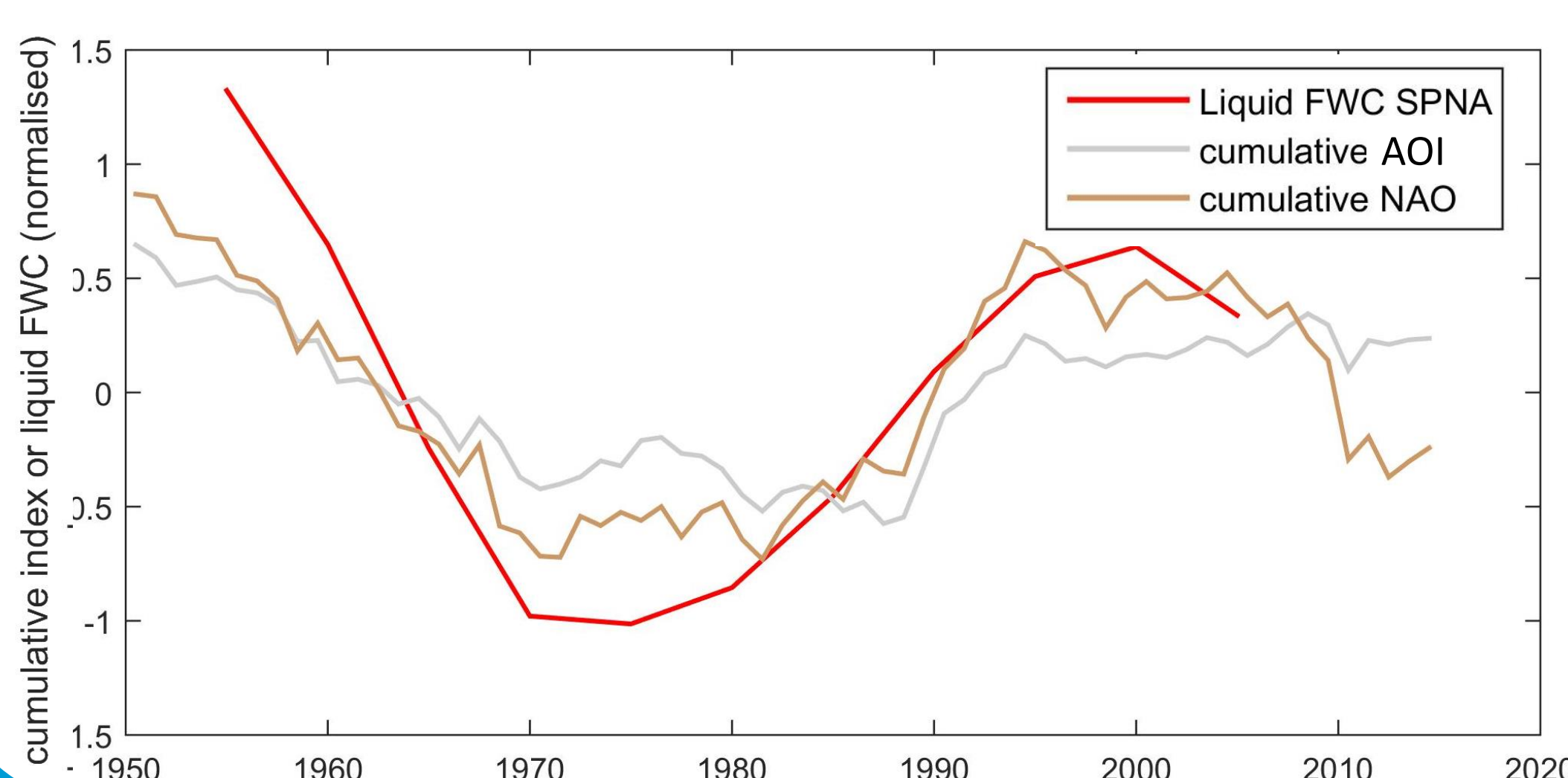
Cross correlation of the liquid freshwater inventories of the SPNA & NS with the AO total freshwater content. White contours enclose areas of significant correlations (95% significance).

- Positive correlations: salinity changes in the North Atlantic Current are advected into the AO
- Negative correlations: different circulation modes in the AO lead to accumulation or a sudden release of freshwater



Comparison of the **SPNA**, **NS** and **inversed AO** freshwater contents to previously published time series (black, gray, and brown). Solid lines display pentadal means and dashed lines annual means. All time series have been normalized by twice their standard deviation.

## Arctic and North Atlantic Oscillation



Significant correlation (95 % significance) of the **SPNA liquid freshwater content** from Mauritzen et al. (2012), the cumulative Arctic Oscillation Index (AOI), and the cumulative **North Atlantic Oscillation Index (NAO)**. All time series have been normalized by twice their standard deviation, detrended, and demeaned.

## Conclusions

- Freshwater changes in the AO and the SPNA & NS have been anti-correlated during the last 20 years and suggest a multidecadal oscillation.
- Decadal scale changes of the FWC in the subpolar Seas are likely to originate in the AO.

### References

- Rabe, B. et al. Arctic Ocean basin liquid freshwater storage trend 1992-2012. *Geophys. Res. Lett.* **41**, 961-968 (2014).  
Haine, T. W. N. et al. Arctic freshwater export: Status, mechanisms and prospects. *Global Planet Change* **125**, 13-35 (2015).  
Mauritzen, C., Melsom, A. & Sutton, R. T. Importance of density-compensated temperature change for deep North Atlantic Ocean heat uptake. *Nat. Geosci.* **5**, 905-910 (2012).  
Curry, R. & Mauritzen C. Dilution of the Northern North Atlantic Ocean in Recent Decades. *Science* **308**, 1772-1774 (2005).