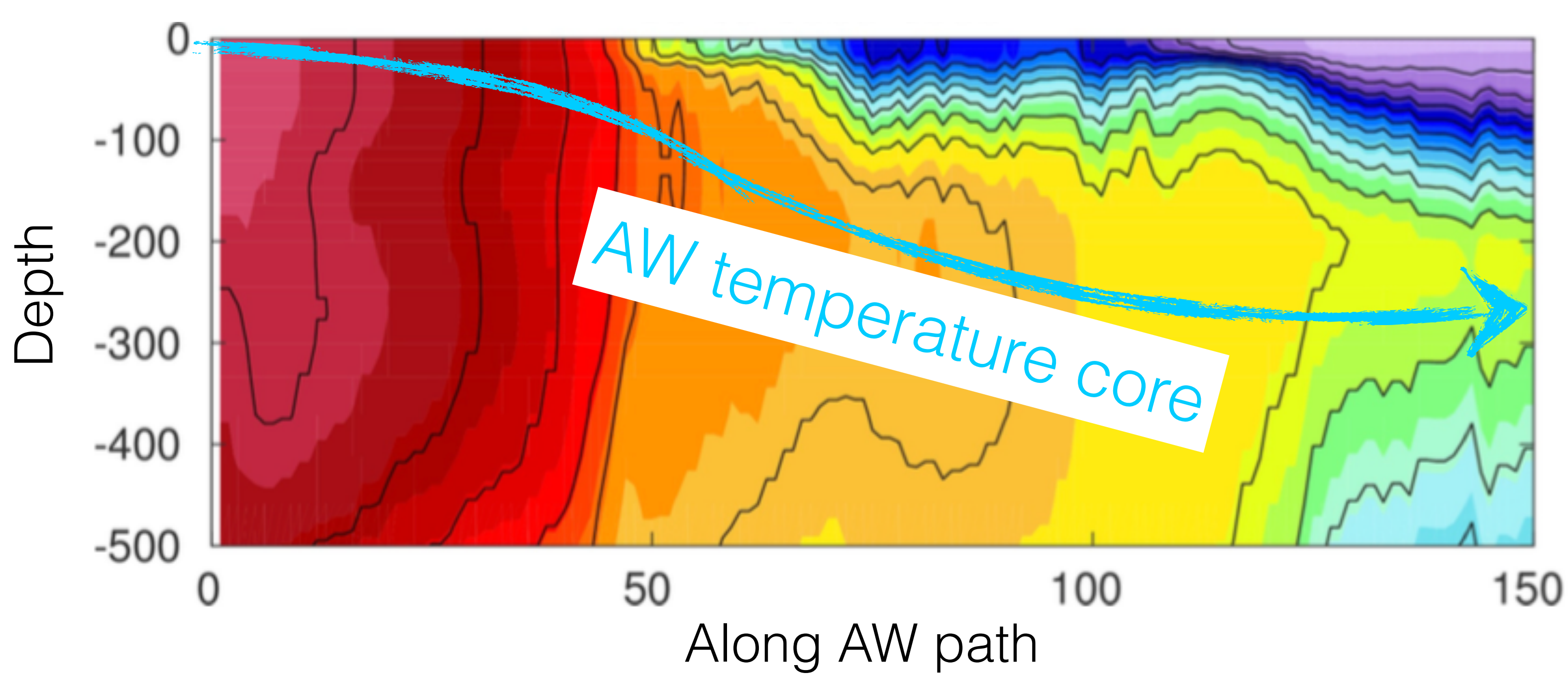
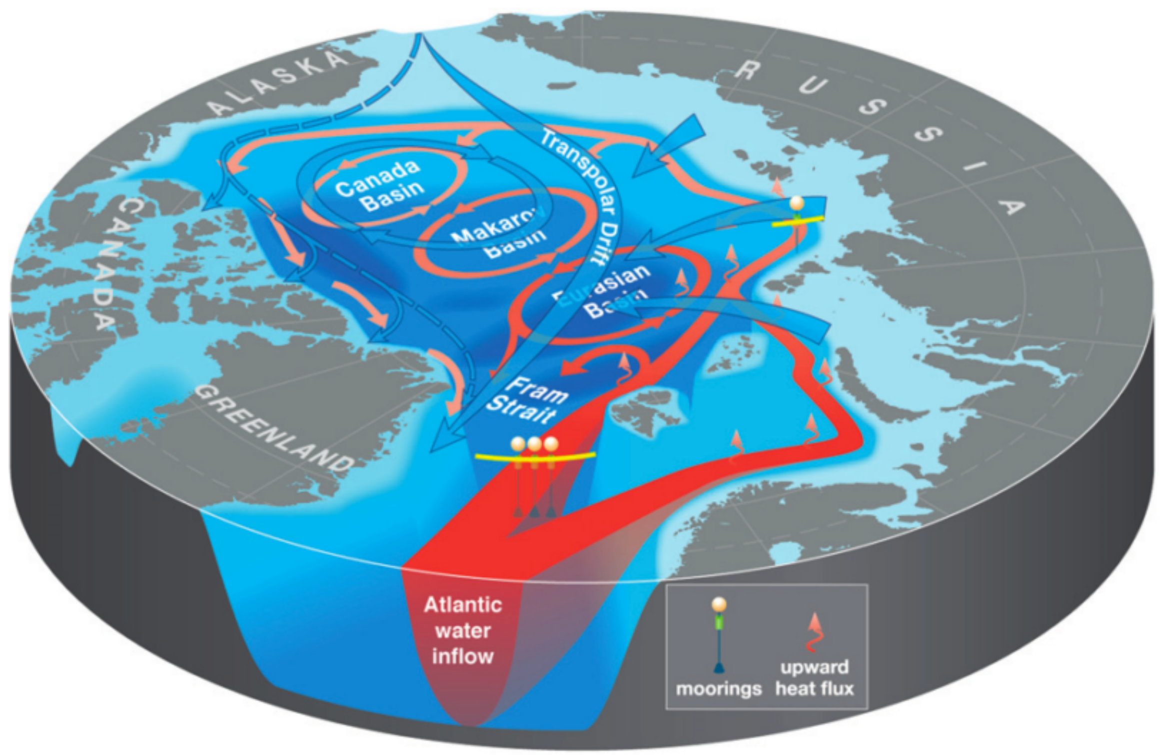
# The Atlantic Water subduction process sensitivity to sea-ice model parameters

**C. Talandier, C. Lique, V. Haid**
Laboratoire d'Océanographie Physique et Spatiale (LOPS)
Univ. Brest, CNRS, IRD, Ifremer



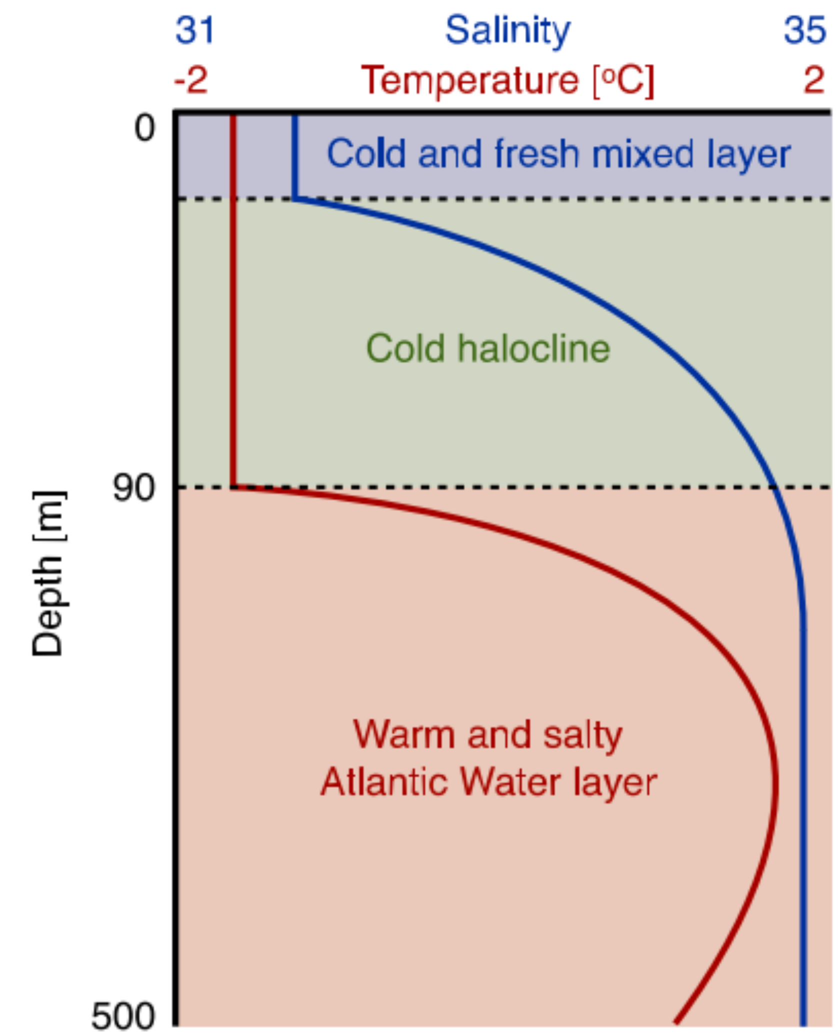
# INTRODUCTION

The Arctic circulation




After Polyakov et al. Journal of Climate 2013

Schematic of the Arctic vertical stratification in the Eurasian basin

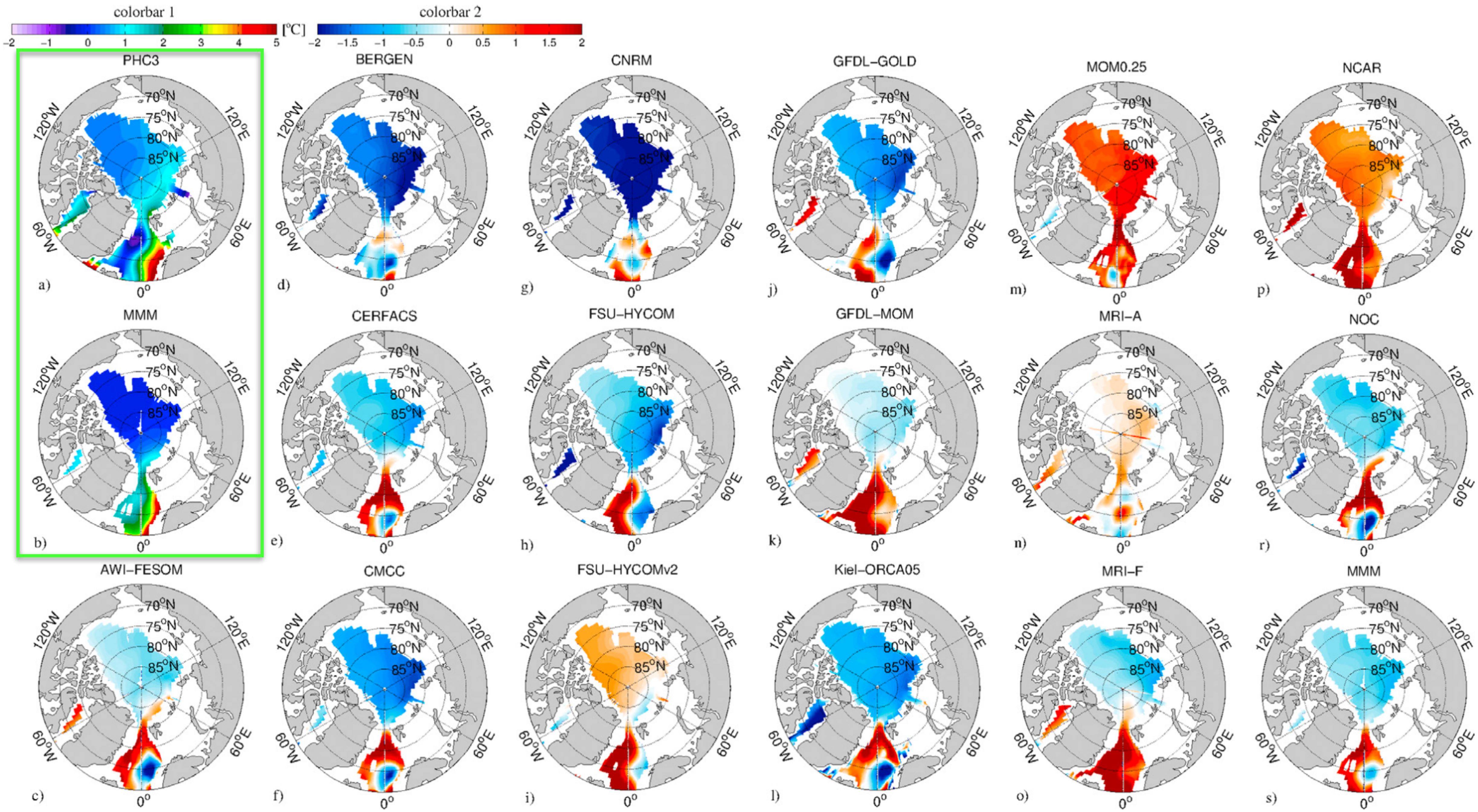



After Davis et al. JPO 2016

- AW inflow through Fram strait is the largest oceanic heat source to the Arctic basin
- Representation of the AW is key to address the Arctic dynamics
- While being crucial for the Arctic basin, representing the AW is still challenging in a large set of numerical simulations …..

# Atlantic Water (AW) biais

Models - climatology T° differences at z=400m




After Ilicak et al. Ocean Modelling 2016

Large discrepancies against climatologies in those low resolution ocean models …

# Objectives

- Underline key processes controlling the AW subduction

- Show how adjusting some LIM3.0 model parameters can lead to significant changes in the AW representation

*Work in progress …..*

# CREG configuration

**Code:**
NEMO OPA+LIM3 version: v3.6_STABLE

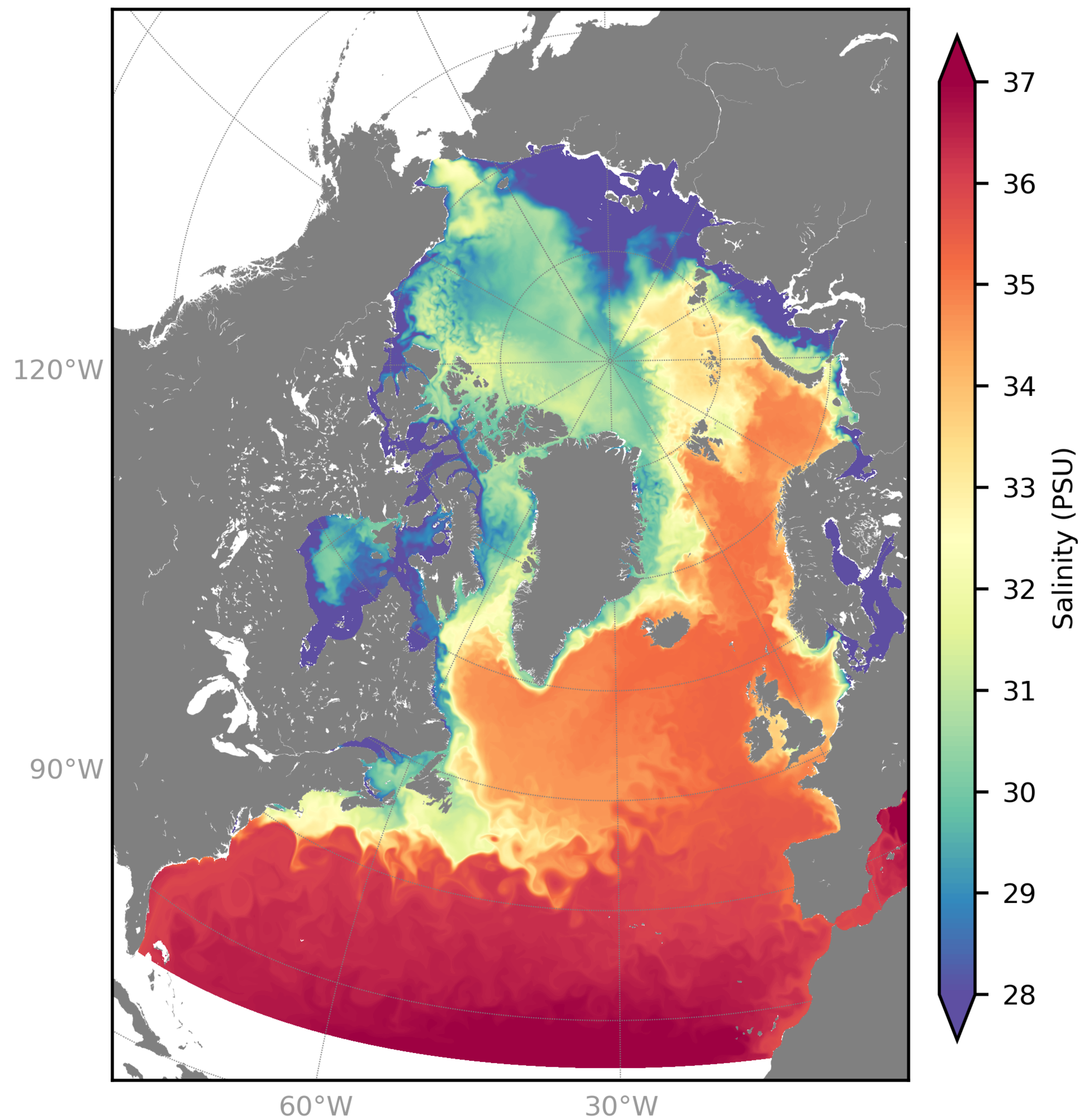
**Regional configuration CREG:**

- 1/4° horizontal resolution
- 75 vertical levels

- Initial state: WOA 2009
- Surface forcing: Inter. Annual DFS 5.2
- Runoffs : Dai_Trenberth_Bamber
- North/South bdys: Seasonnal cycle

**Set of 3 experiments (1959-2015):**

- Reference
- increase the sea-ice strength P*
- decrease the ocean/ice drag



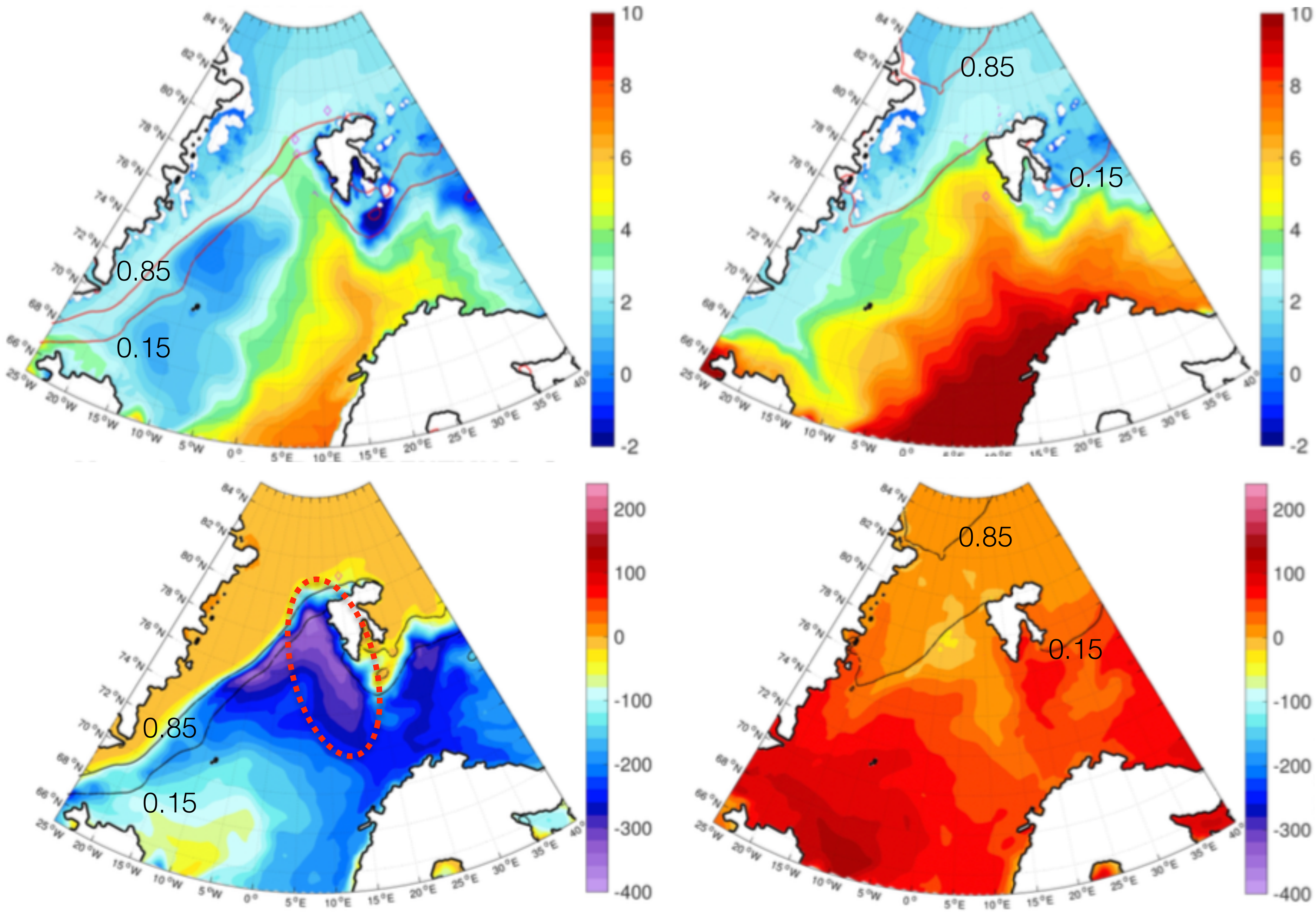
**<u>Identify</u> physical processes controlling the AW T° changes**

Mean JFM 2006-2015

Mean JAS 2006-2015

Atlantic Water max. T° [°C]

Surface heat fluxes [W m-2]

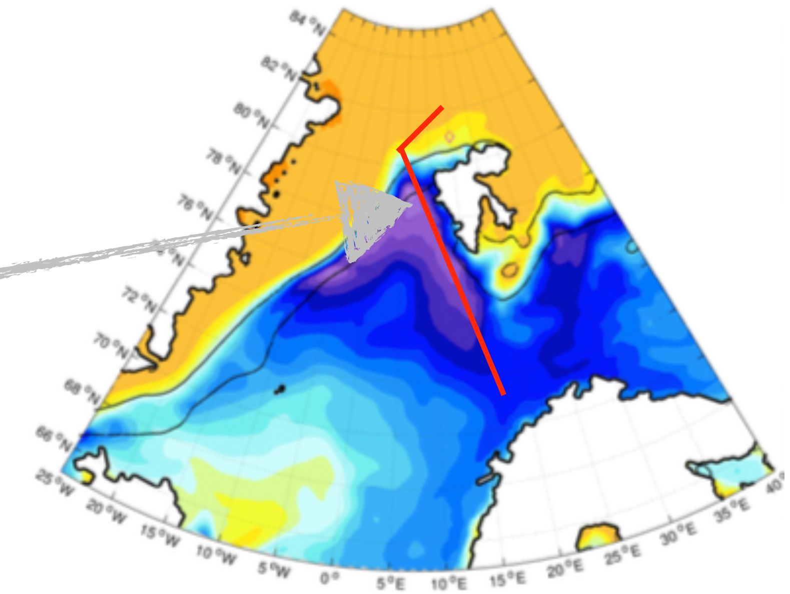



#1 Small area where strong AW T° changes occurs west to Svalbard

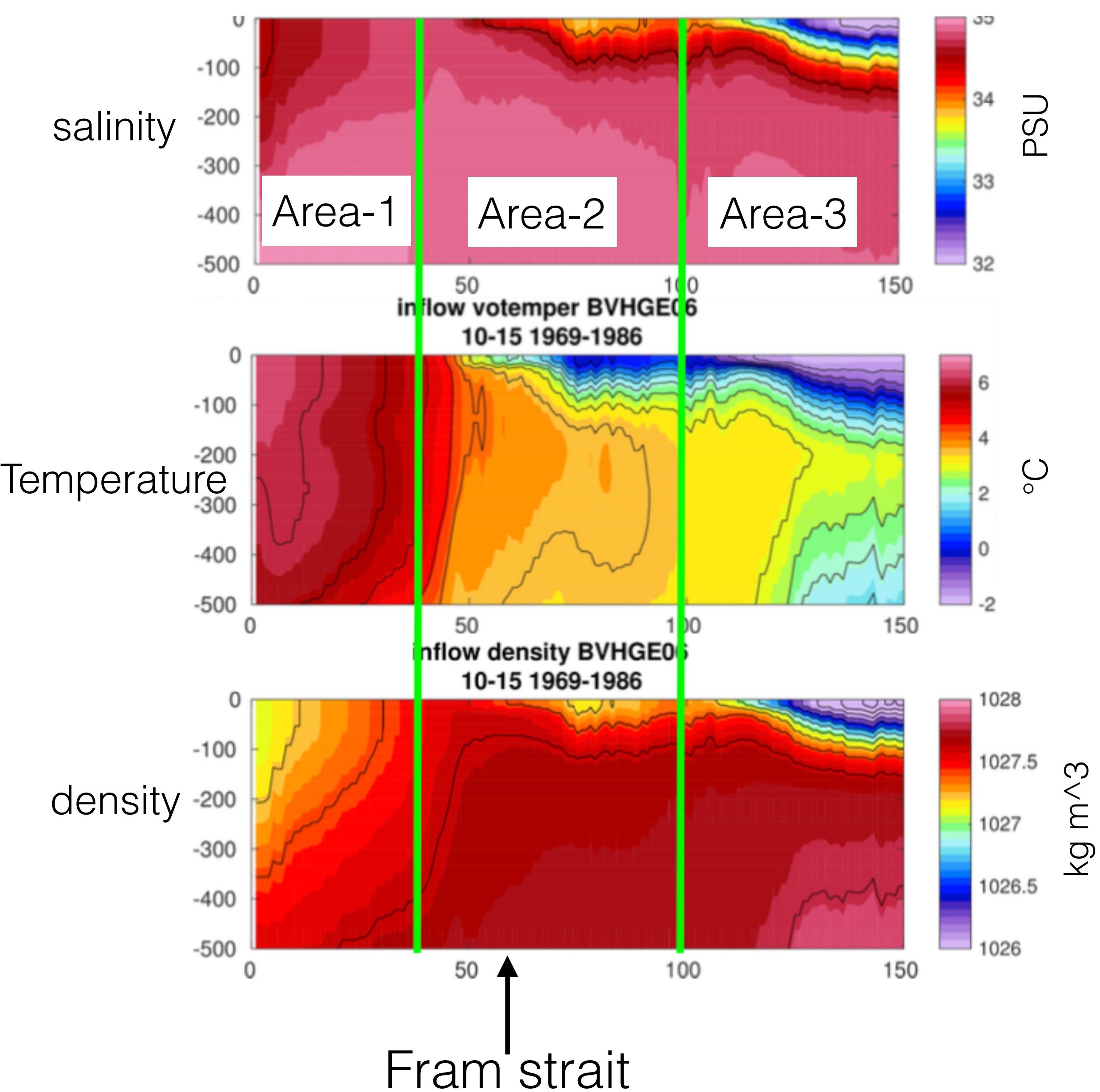
#2 Winter surface heat fluxes influence the AW T° changes

#3 The AW properties are set in this area & almost do not changes downstream from Fram strait

# <u>Identify</u> physical processes controlling the AW T° changes



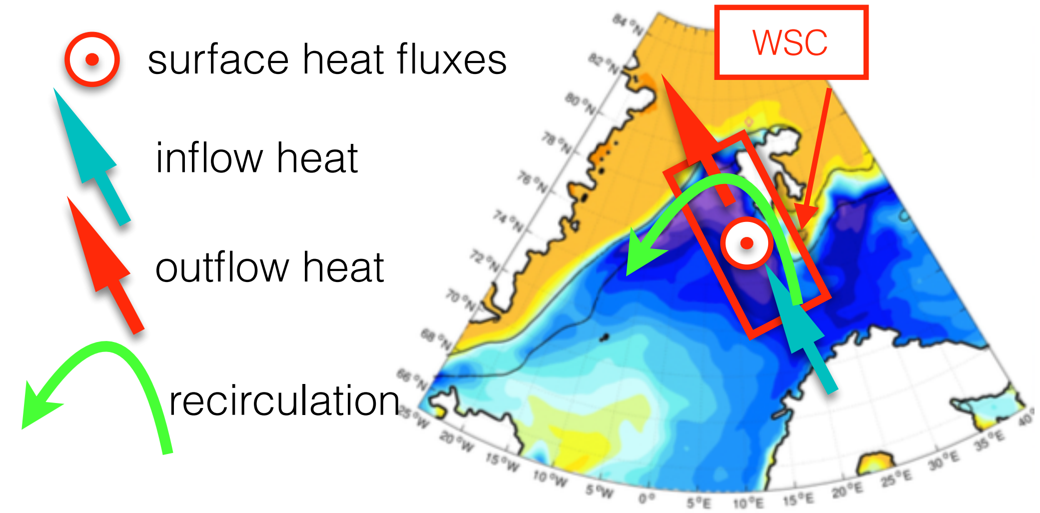
Vertical section along the AW path from upstream Fram strait until north of Svalbard




- 3 distincts areas located west and north of Svalbard:
  - Area-1 : ice-free area
  - Area-2 : the Marginal Ice Zone (MIZ)
  - Area-3 : full ice area
- Sea-ice mediates the heat lost by the AW to the atmosphere

Sea ice extent upstream from Fram strait is determinant for the AW subduction process to occur

**<u>Quantify links</u> between processes implied in the AW T° changes**

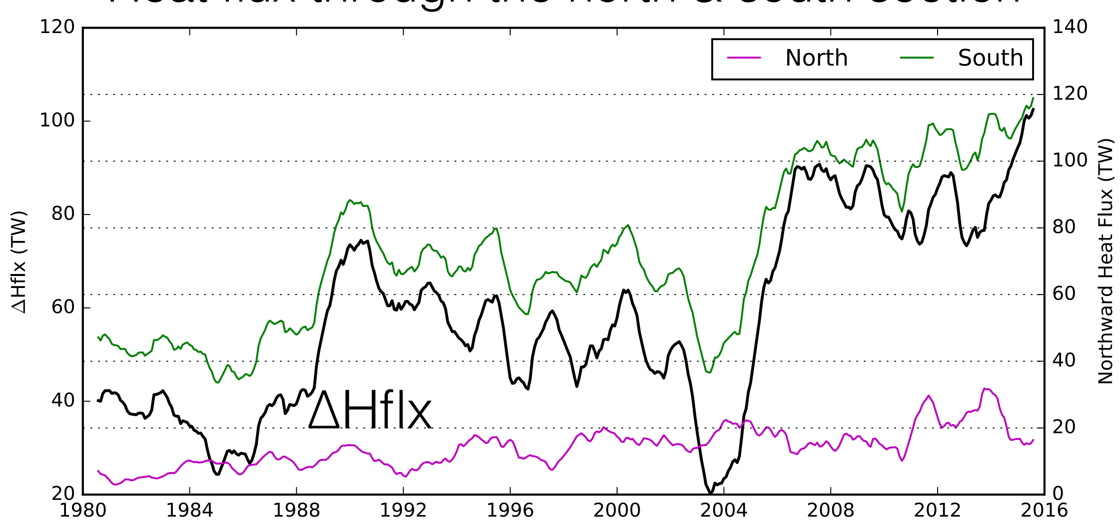



Are there any links in the WSC box between :
- ΔHflx & Qt (surface heat flux) ?
- ΔHflx & Ice area ?

ΔHflx = heat lost between the south and north sections

In the reference experiment

Heat flux through the north & south section




The WSC area behaves like a buffer zone

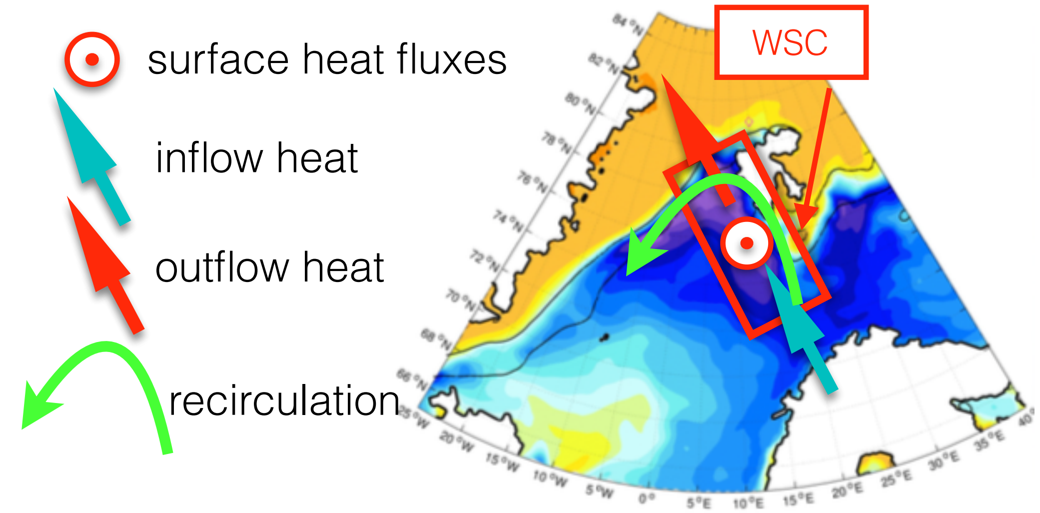
Large differences between the south (marked inter annual variability and north (reduced variability)

## <u>Quantify links</u> between processes implied in the AW T° changes

Are there any links in the WSC box between :

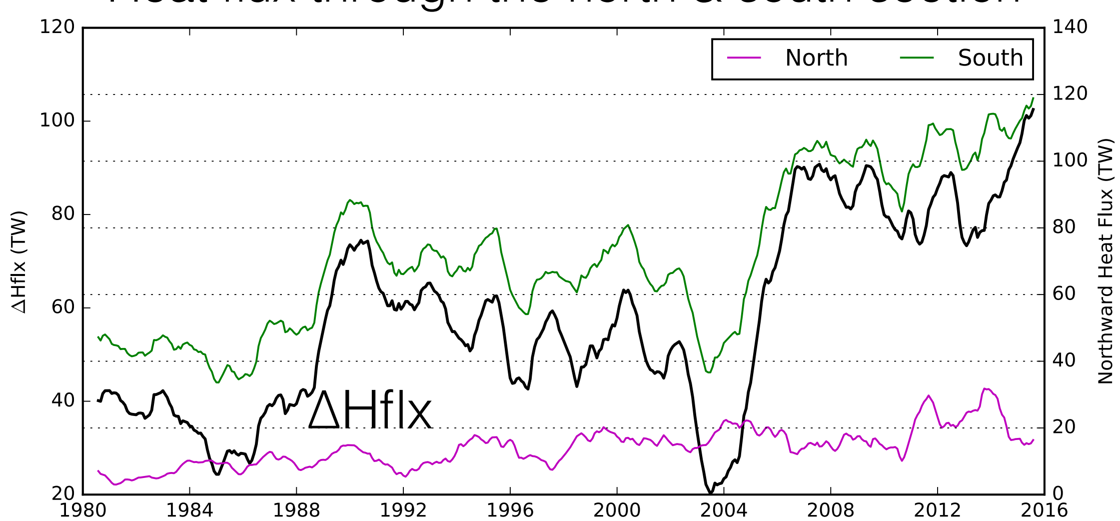
- ΔHflx & Qt (surface heat flux) ?
- ΔHflx & Ice area ?

ΔHflx = heat lost between the south and north sections

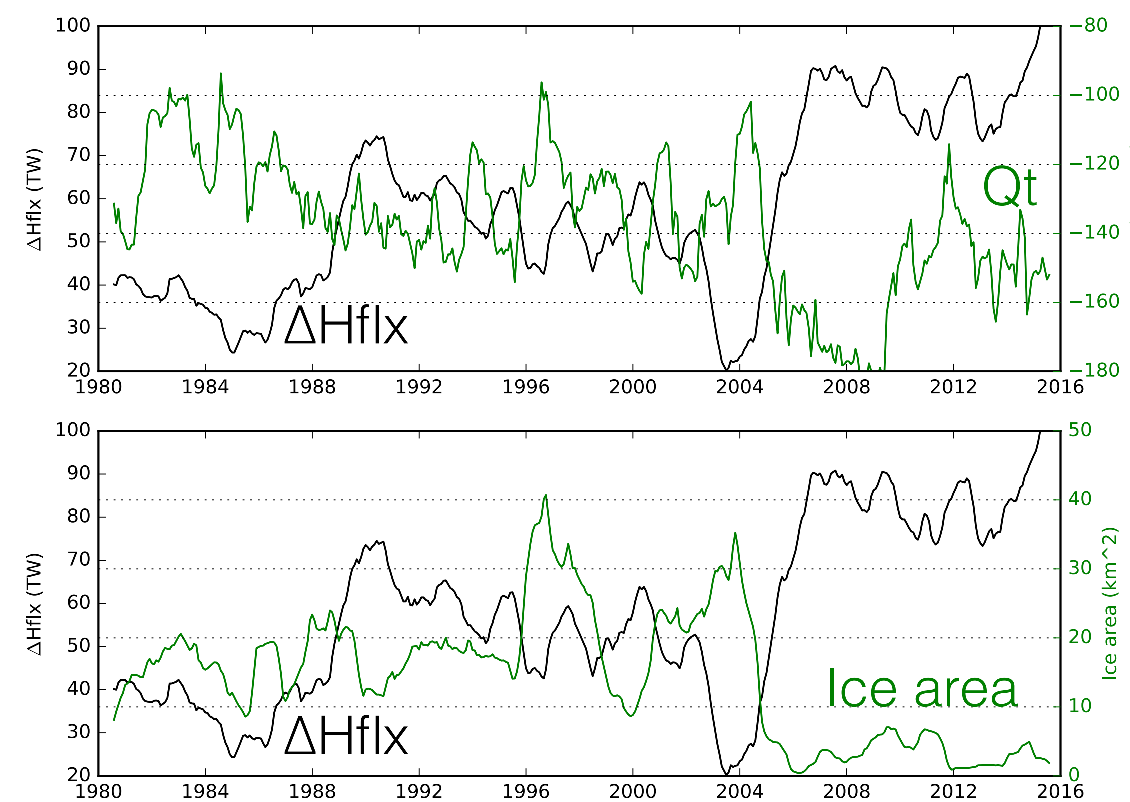



In the reference experiment

Heat flux through the north & south section




R(Qt/ΔHflx)= -0.72




R(Ice/ΔHflx)= -0.68

- The WSC area behaves like a buffer zone
- Large differences between the south (marked inter annual variability and north (reduced variability)

- large ΔHflx —> large Qt (<0)

  large ΔHflx —> small ice area

**<u>Quantify links</u> between processes implied in the AW T° changes**

# The AW max T° horizontal structure

(1990-1999 mean field after 30 years)

In the sensitivity experiments

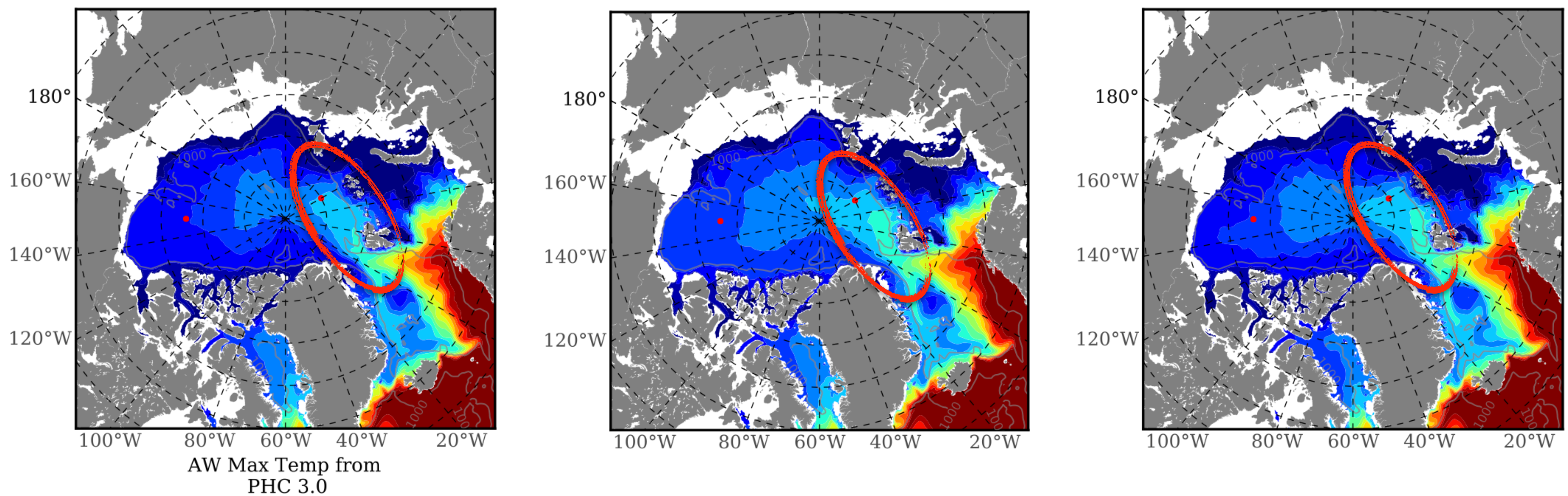
from **1.e-02** down to **5.e-03**

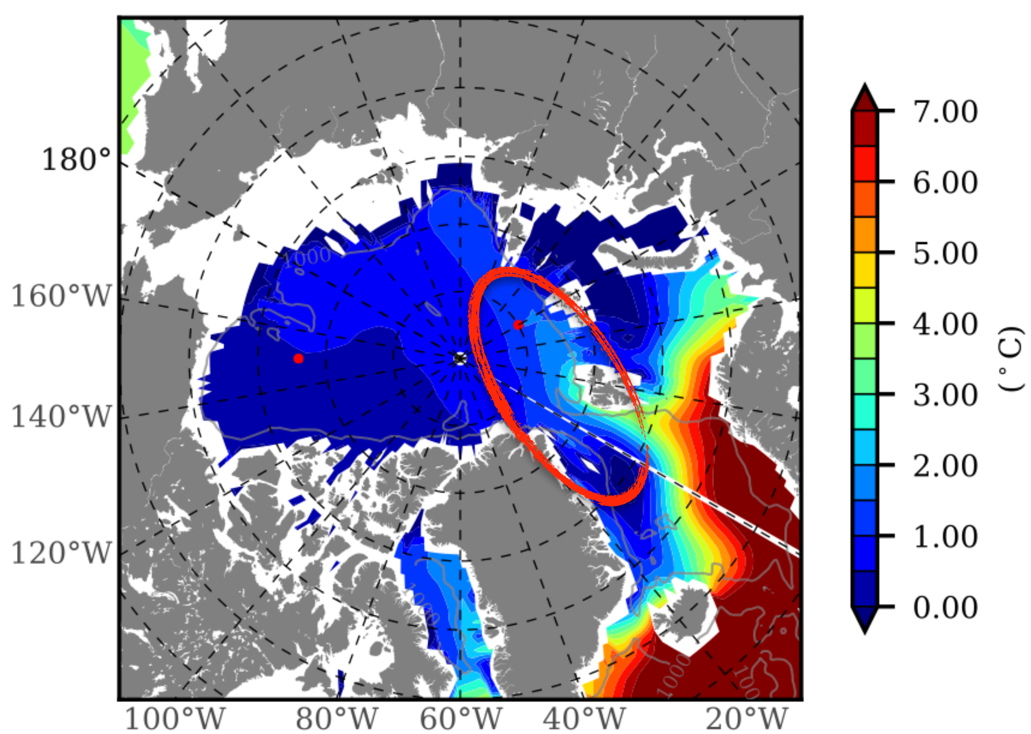
from **2.e+04** N m-2 to **4.e+04** N m-2

## Ref

## P*

## Ice/Ocean drag

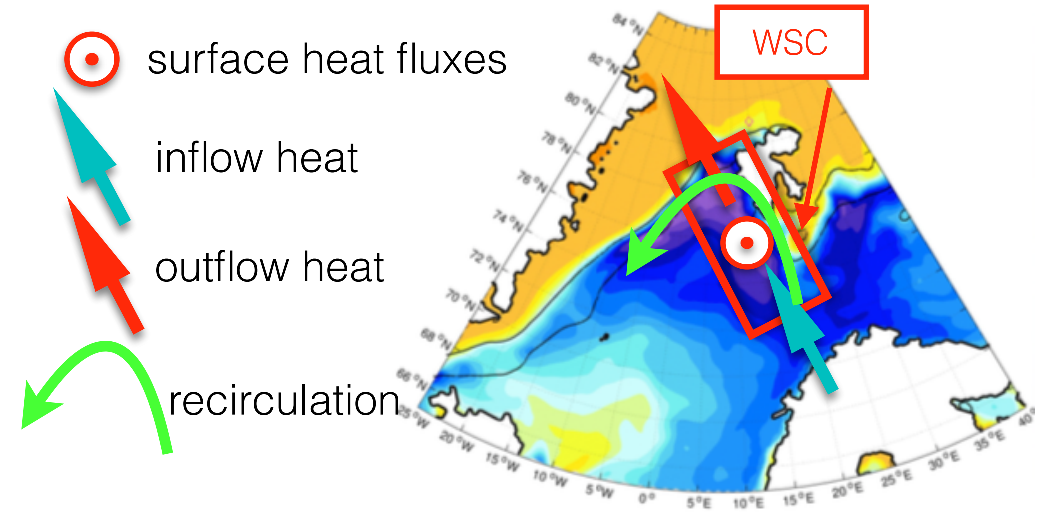


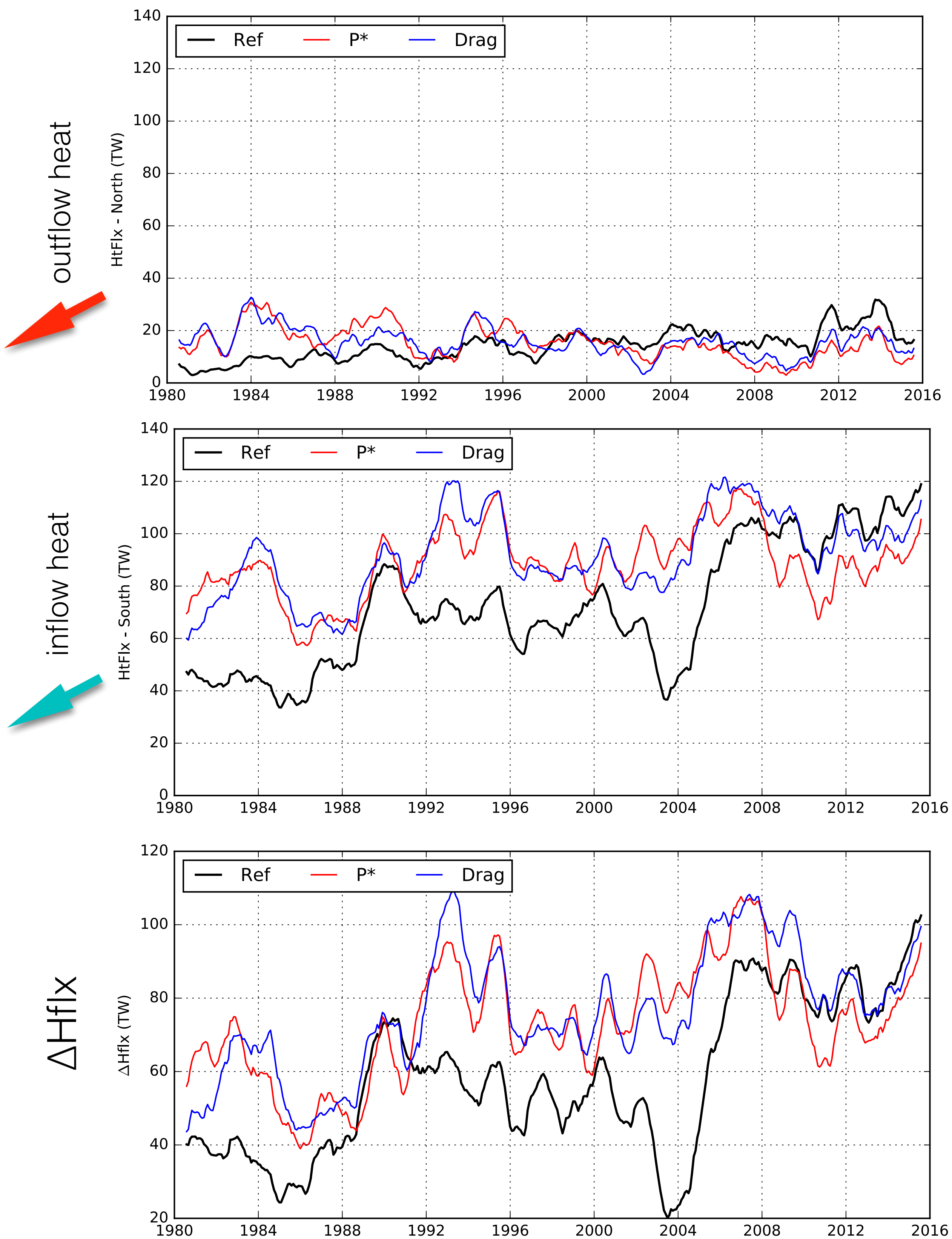




➤ Changing one of this parameter leads to a worse AW max T° (by more than 0.5°C north to Svalbard)

➤ The ocean is sensitive to those sea-ice parameters

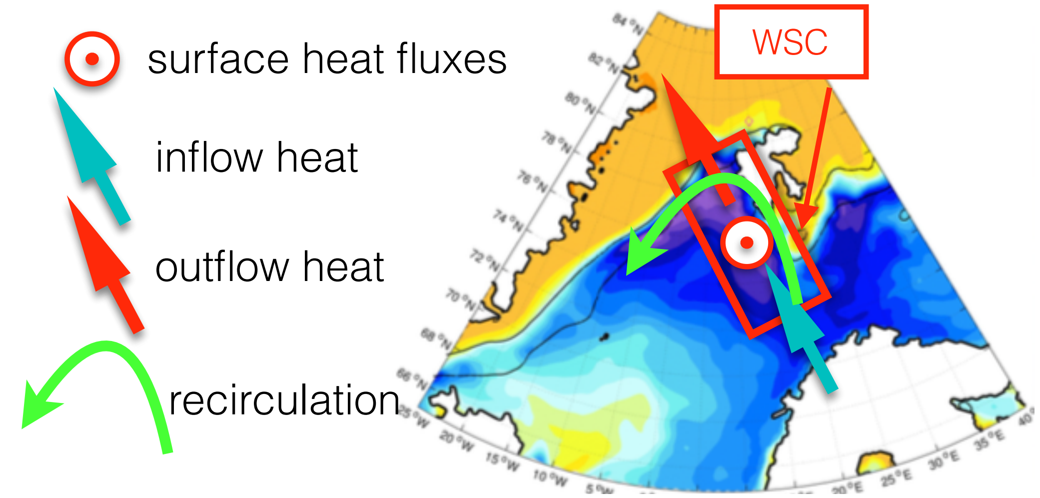
# <u>Quantify links</u> between processes implied in the AW T° changes



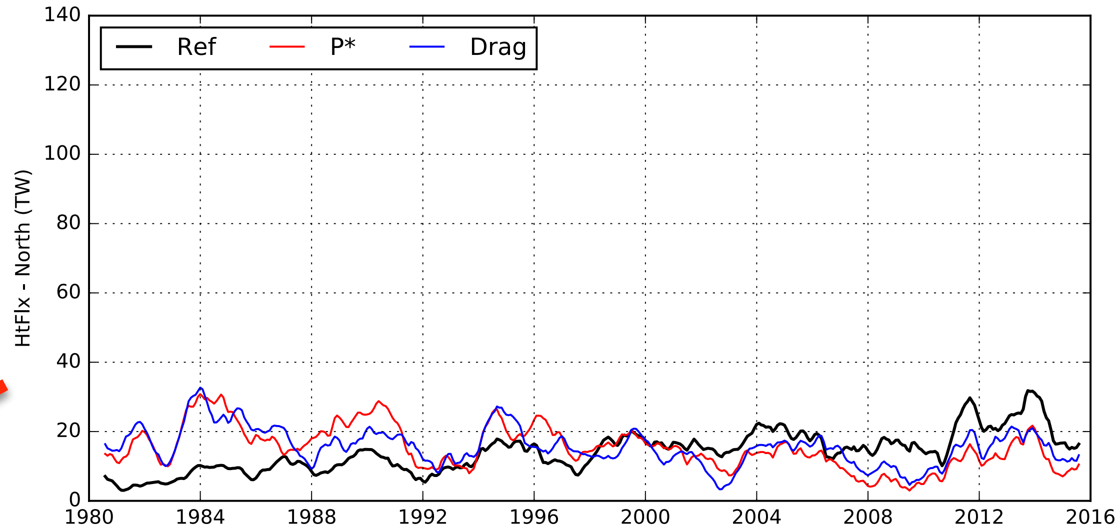




increase inflowing heat in the 2 sensitivity exp.

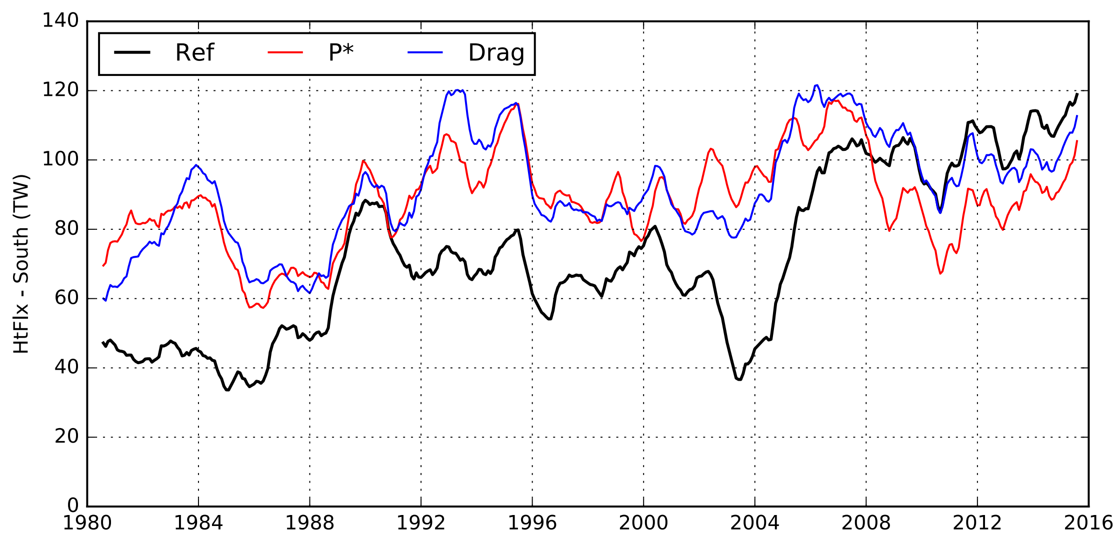
# <u>Quantify links</u> between processes implied in the AW T° changes



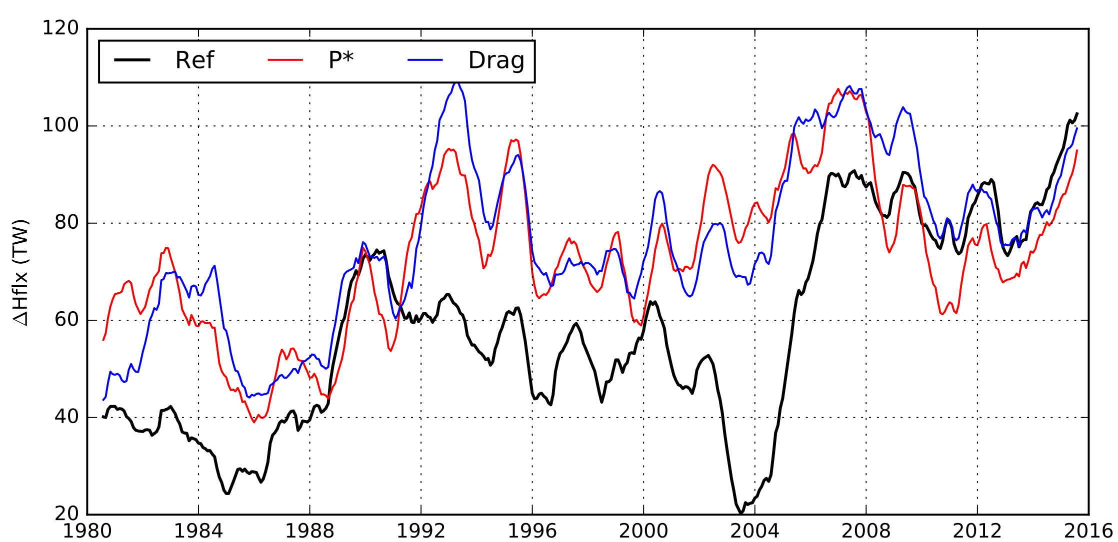

outflow heat




inflow heat



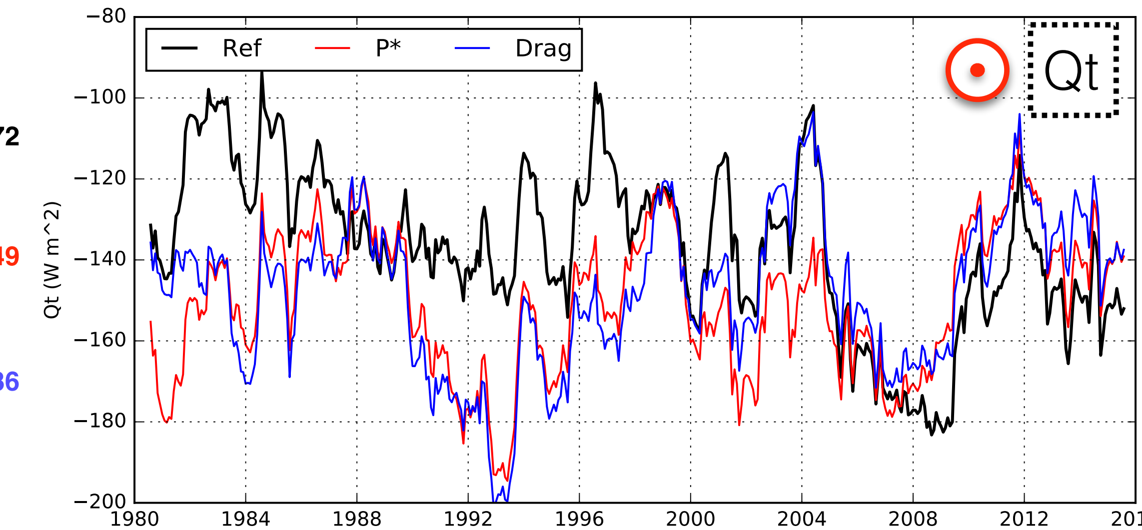

ΔHflx




R(Qt/ΔHflx)= -0.72

R(Qt/ΔHflx)= -0.49

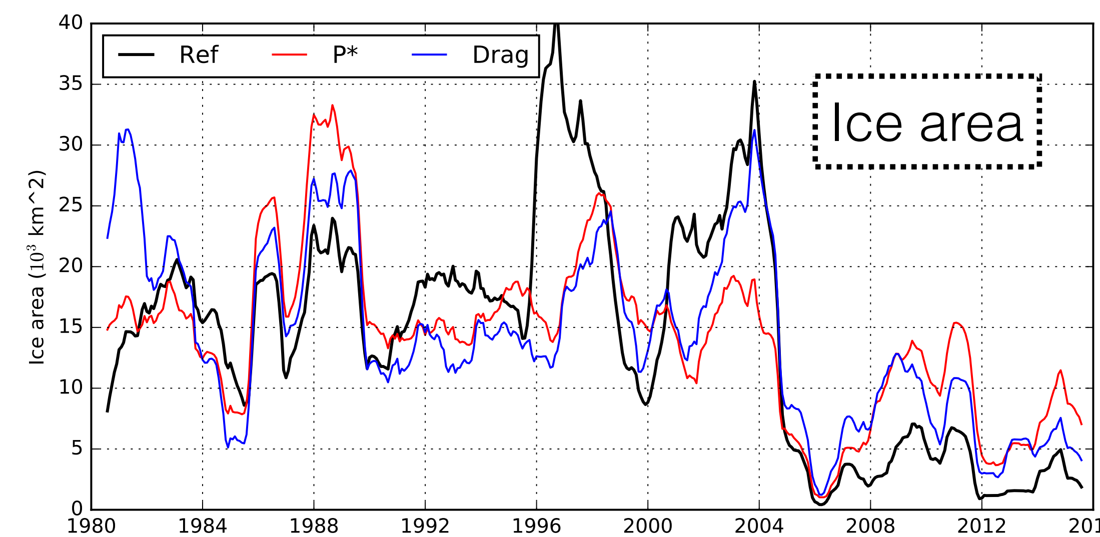
R(Qt/ΔHflx)= -0.36




R(Ice/ΔHflx)= -0.68

R(Ice/ΔHflx)= -0.51

R(Ice/ΔHflx)= -0.57



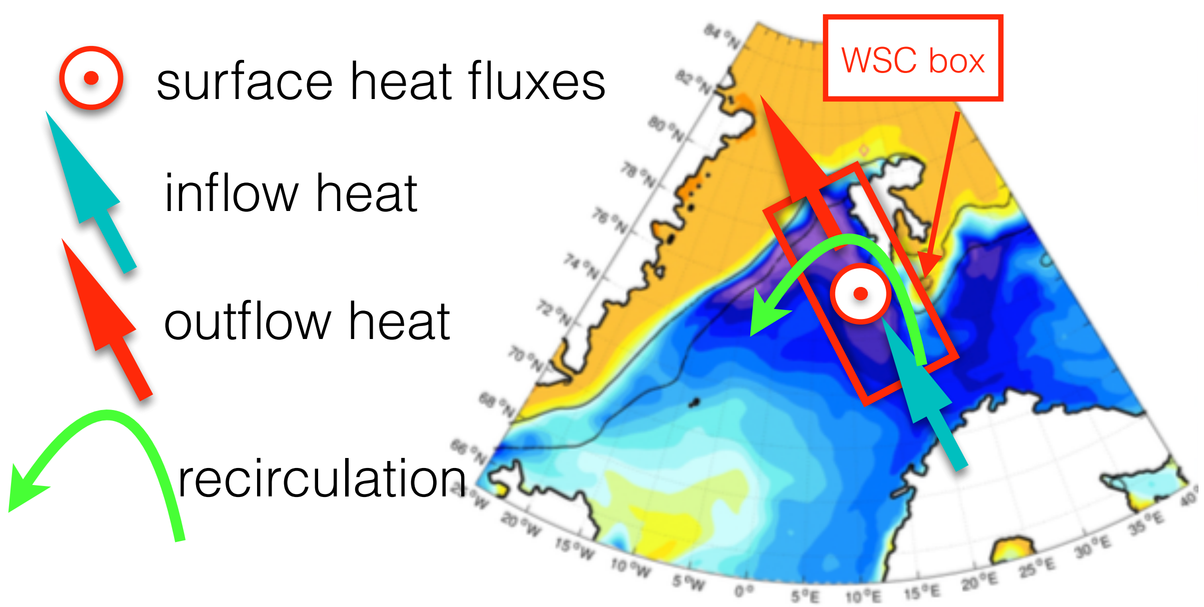

- increase inflowing heat in the 2 sensitivity exp.
- R is decreasing in the 2 sensitivity exp. against Ref
- recirculation more intense ?

# Conclusions

- Large difficulties to well simulate the AW subduction process in numerical simulations

- the AW subduction process occurs in a small area located west of Svalbard
- Surface heat fluxes and sea-ice extent upstream the Fram strait are key for the AW subduction process to realistically occur

- P*, ocean/sea-ice drag parameters of  LIM 3. lead to large changes on the AW representation with consequences for the Arctic ocean dynamics




on-going work

perfectly close the heat budget to assess the recirculation impact

understand the AW sensitivity to those 2 sea ice parameters