Contribution of Time-varying Discharge from Greenland and Rivers to Regional Sea Level Change in the Arctic Ocean

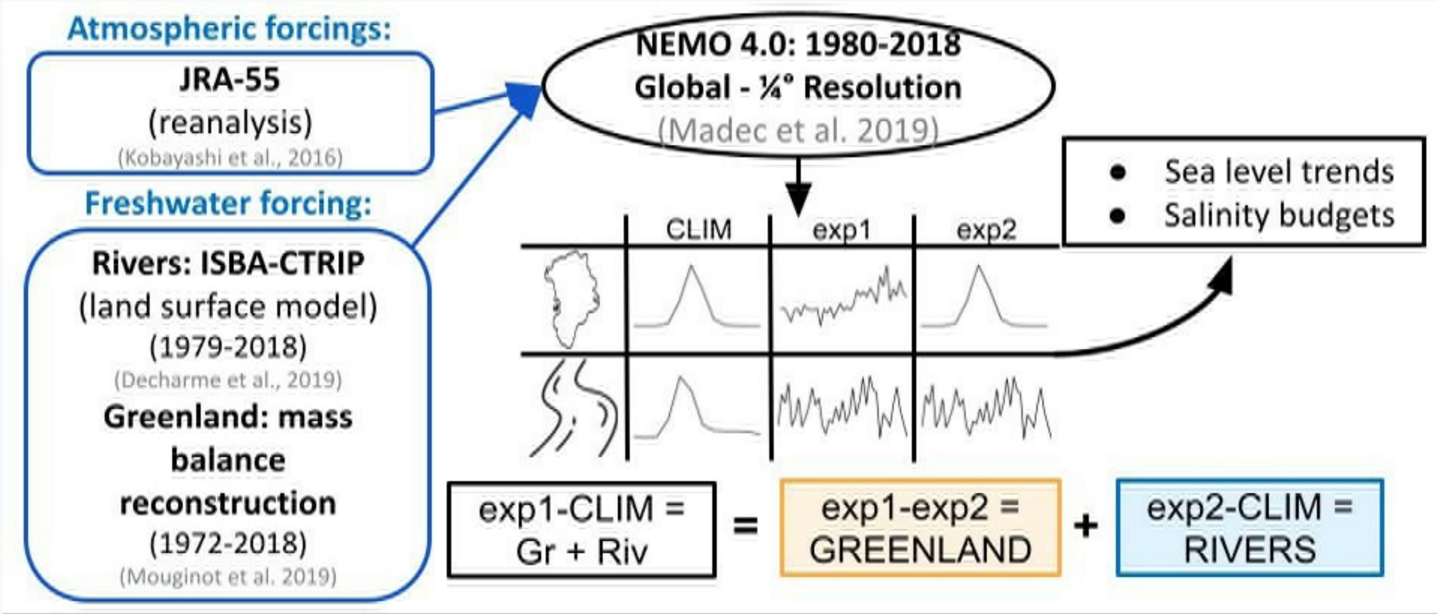
soumaia.tajouri@ifremer.fr

Soumaïa Tajouri(1), William Llovel(1), Florian Sévellec(1), Thierry Penduff(2), Jean-Marc Molines(2), Stéphanie Leroux(2)
(1) LOPS, Plouzané, France. (2) IGE, Grenoble, France.

INTRODUCTION

Motivation: Sea level is rising globally but not at the same rate everywhere. In the Arctic Ocean, sea level change is controlled by salinity that depends primarily on continental freshwater runoff. Forced ocean models are commonly using seasonal discharge climatology as forcing. But in reality, Greenland and rivers discharge varies strongly in time.
Question: What is the impact of Greenland and global rivers discharge temporal variability on regional sea level trends in the Arctic Ocean ?

METHOD: Ocean/sea-ice/iceberg sensitivity simulations



The simulations differ only by the discharge temporal variability, either climatological or time-varying of Greenland and rivers. We evaluate the individual and cumulative impacts of Greenland and rivers variability on the regional ocean.

Validation of the reference run in the Beaufort Gyre Region

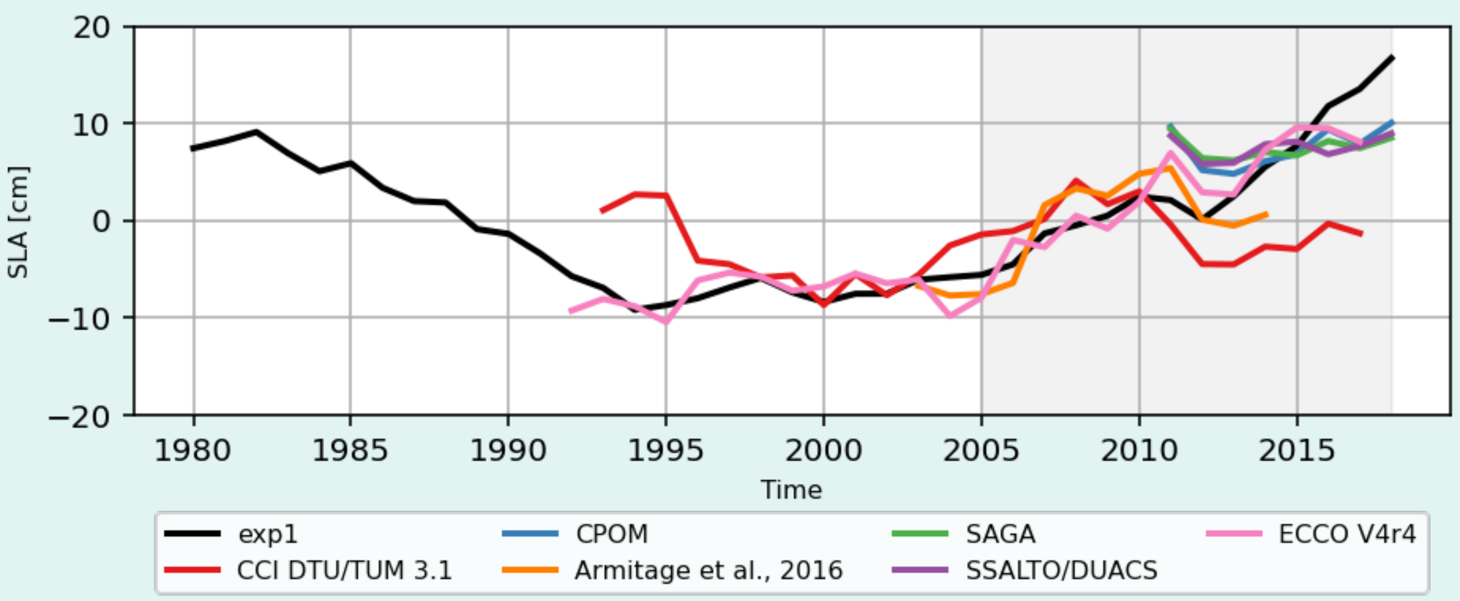


Figure 1: SLA time series of the run exp1, of altimetry products, and of the state estimate ECCO V4r4.

Overall, exp1 SLA is in good agreement with the altimetry and ECCO V4r4.

RESULTS

1- Sea level change in the Beaufort Gyre Region

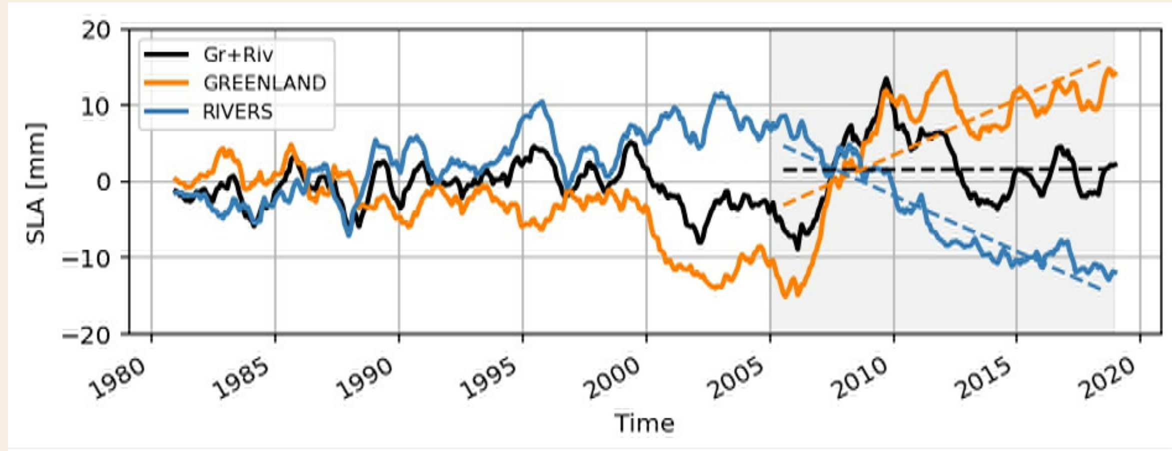


Figure 2: Monthly mean SLA time series with 12-month running mean.

- Greenland and rivers have an opposite impact with fairly the same magnitude.
- Greenland and rivers counterbalance each other in this region.
- From 2005, Greenland and rivers change rapidly.

2- Sea level trend maps over 2005-2018

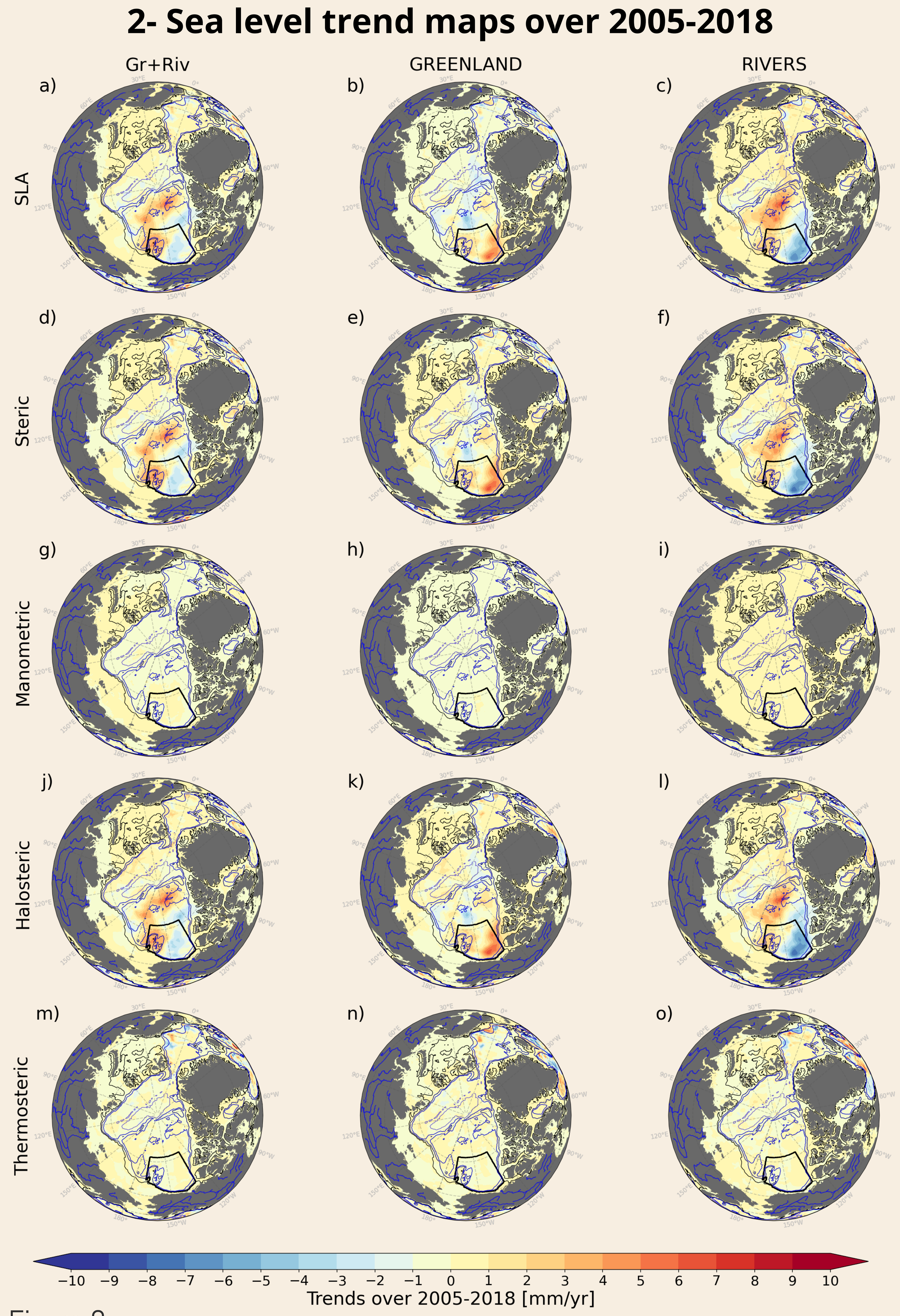


Figure 3

- Large trends in the Amerasin basin and the Beaufort Gyre.
- Rivers dominate the signal in the Beaufort Gyre Region.
- The dipole in the Amerasian basin is of opposite sign in Greenland and rivers.
- Fully-varying freshwater discharge impact regional sea level change by changing the salinity.

3- Cumulative sea level trends over 2005-2018 from top to bottom in the Beaufort Gyre

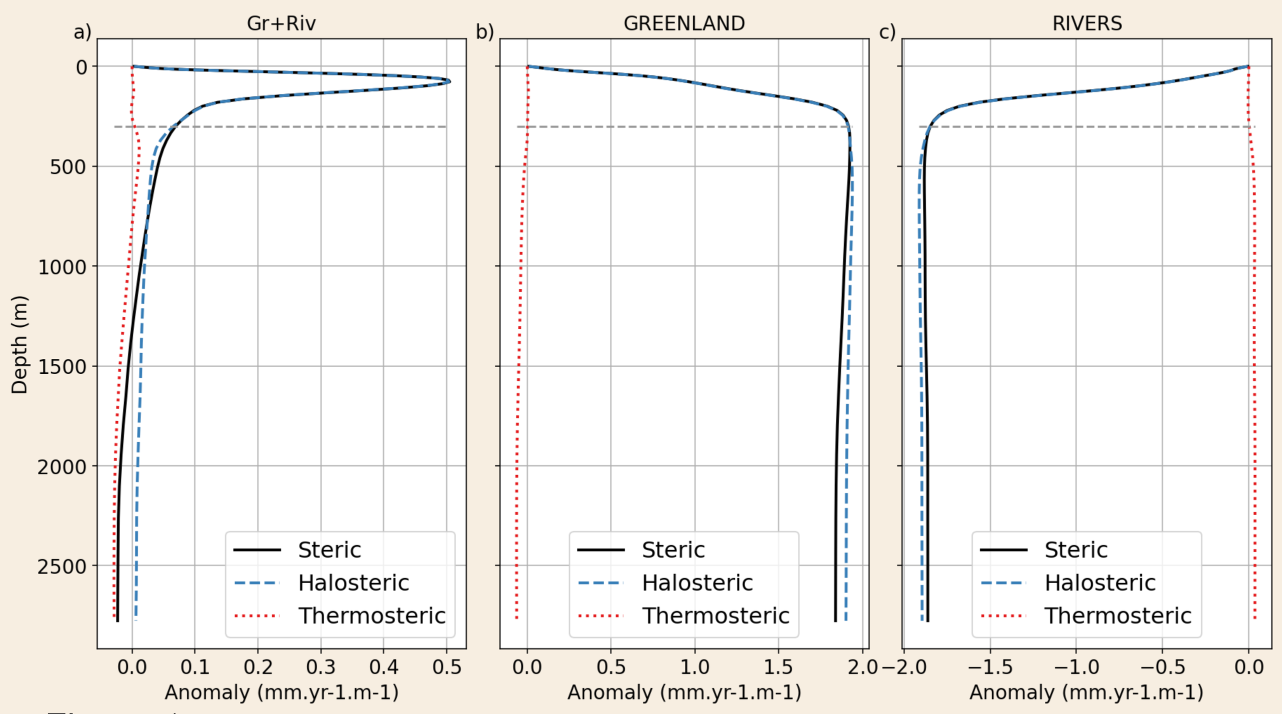


Figure 4

- Halosteric changes are mainly restricted to the upper 300 m.
- Thermosteric changes are minor and deeper.
- Greenland and rivers mirror each other well except in the 300 upper meters.

4- Full-depth salinity budget of the Beaufort Gyre Region

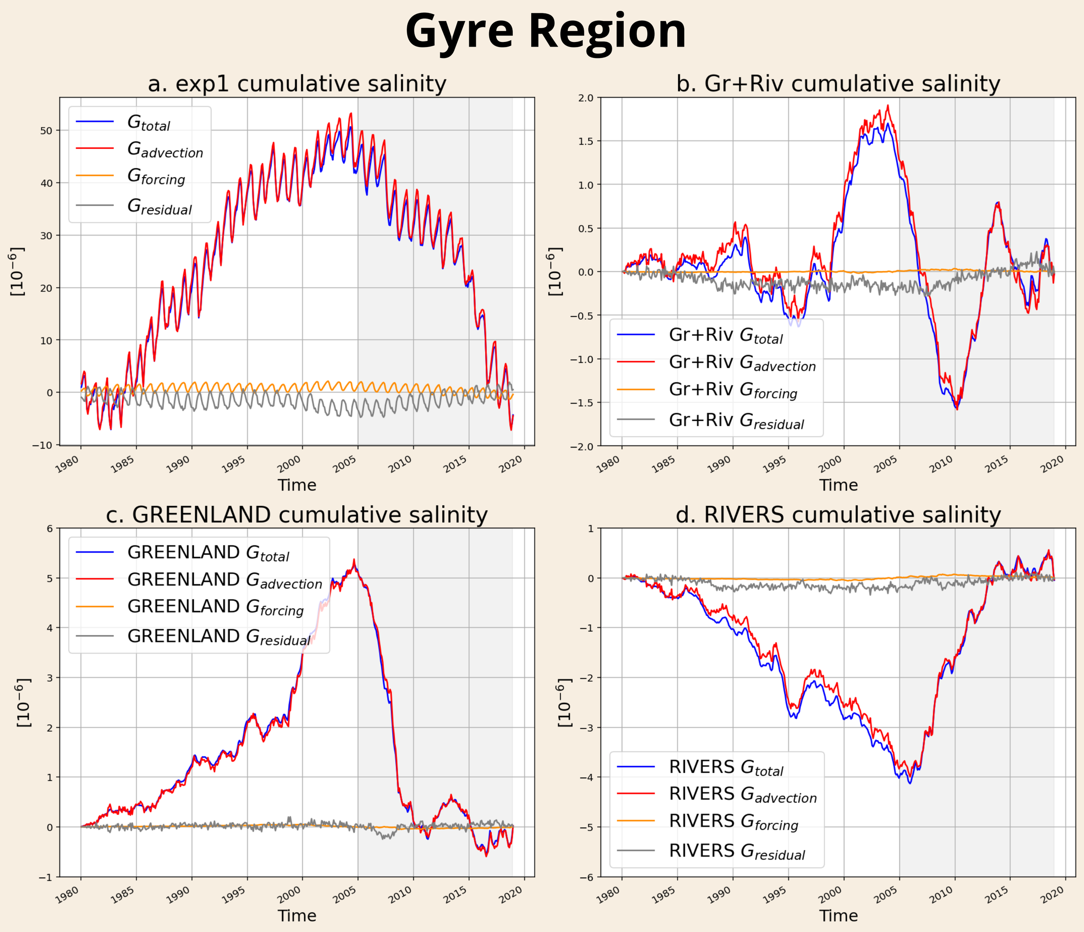


Figure 5: Gtotal is the total salinity tendency, Gadvection is the lateral and vertical advection, Gforcing is the salt flux with sea ice, Gresidual is the residual term.

- The salinity evolution is dominated by the advection term.
- The contribution from local sea-ice is minor.

5- Decomposition of the salinity advection

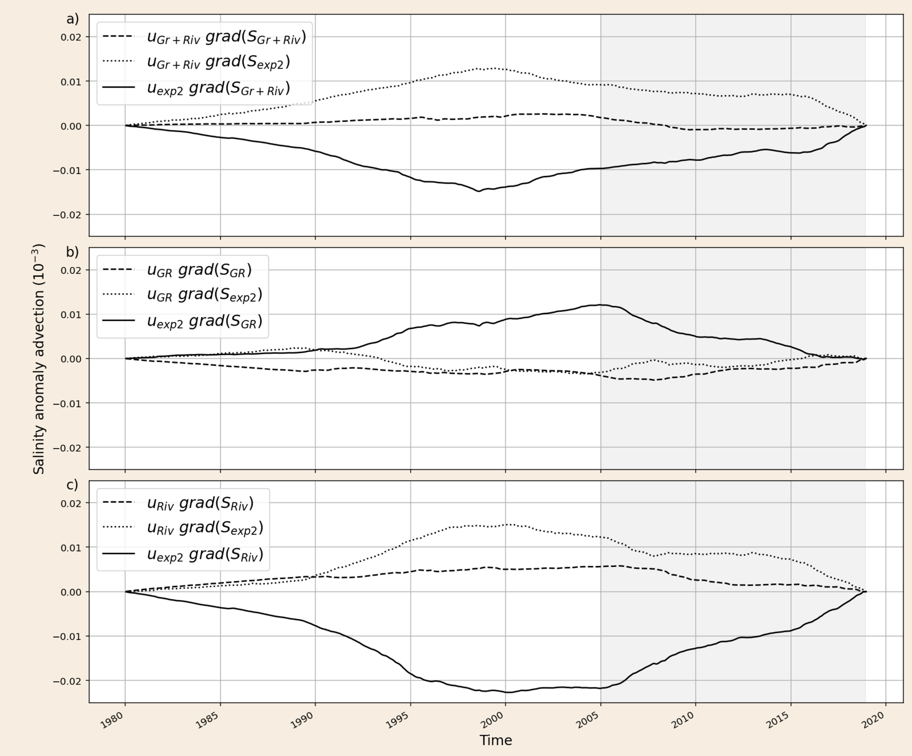


Figure 6: the non linear advection (dashed curve), the advection of the main salinity by the circulation change due to the change in freshwater discharge (dotted curve), and the advection by the main ocean circulation of the salinity change due to the change in freshwater discharge (solid curve).

The major component is the advection of the salinity changes by the main circulation.

CONCLUSION

The temporal variability of Greenland and rivers discharge produce an **opposite impact on sea level trends** in the Beaufort Gyre Region, the former driving an increase, while the latter, a decrease. Their combined impact leads to fairly no sea level trend. The sea level response is **primarily driven by salinity variations in the 300 upper meters,** themselves mainly due to **convergence of salinity changes by the main ocean circulation.**
This study supports the idea of including freshwater discharge variability in forced global ocean models to better represent regional sea level.

PERSPECTIVES

- Investigations to find the paths from Greenland and rivers estuaries to the Beaufort Gyre Region.
- Specific simulations to assess the role of and feedbacks from sea-ice.