Wintertime process study of the North Brazil Current rings reveals the region as a larger sink for CO_2 than expected

L. Olivier, **J. Boutin**, G. Reverdin, N. Lefèvre, P. Landschützer, S. Speich, J. Karstensen, M. Labaste, C. Noisel, M. Ritschel, T. Steinhoff & R. Wanninkhof

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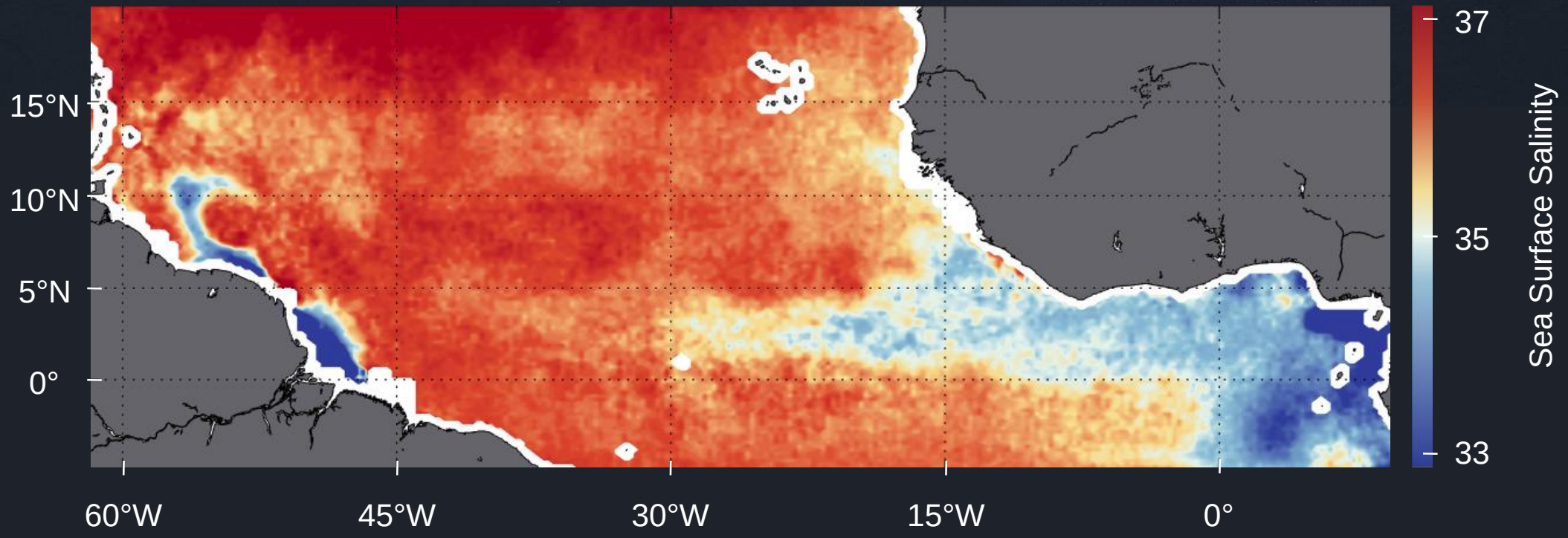
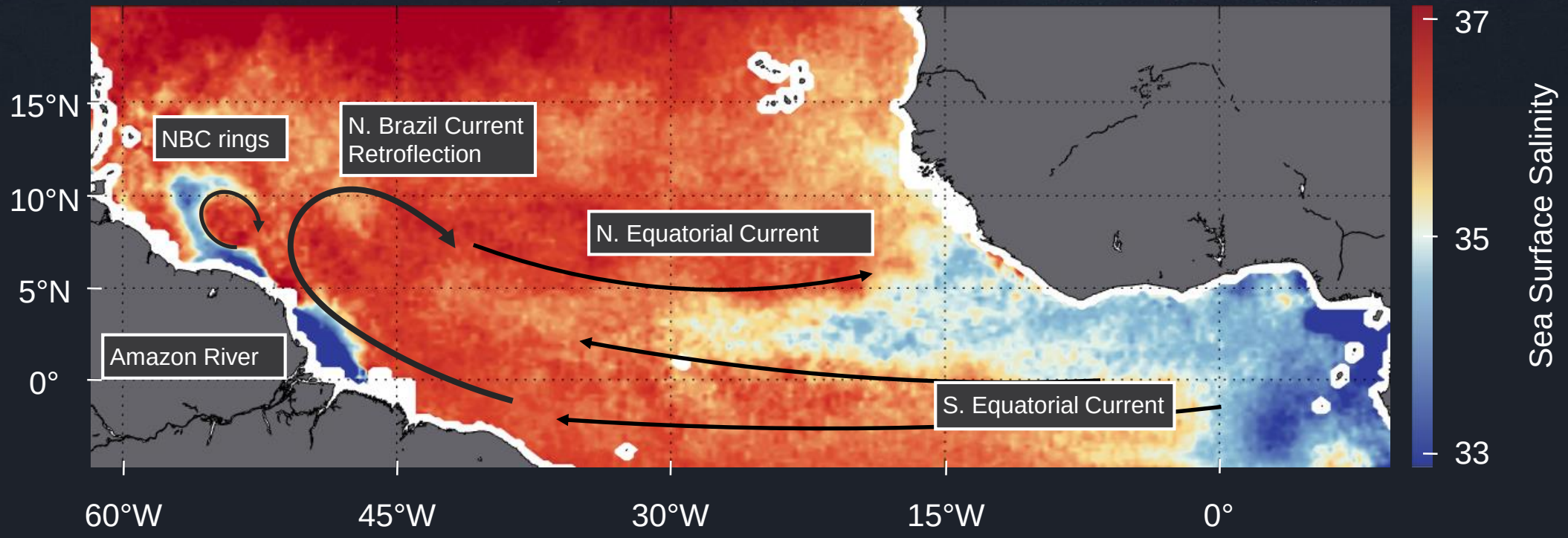
A transition region highly dynamic



February 7th, 2017, CCI+SSS

A transition region highly dynamic



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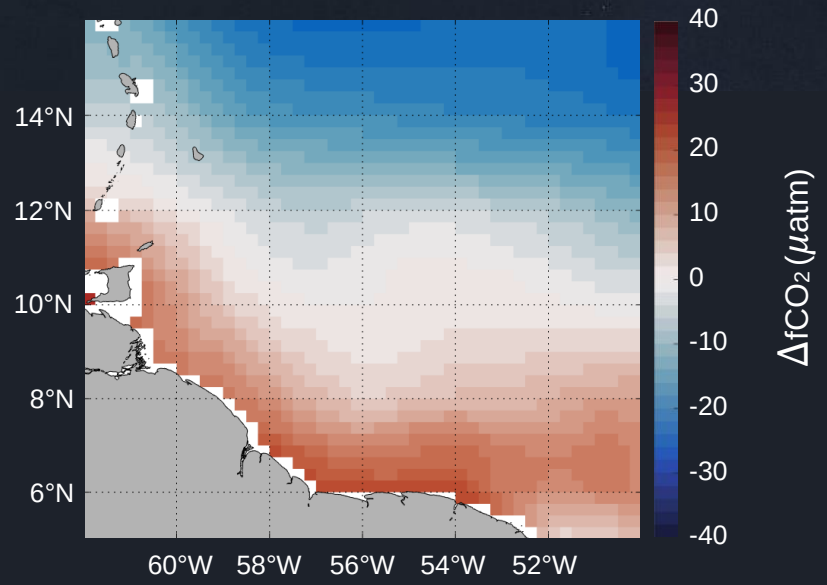
February ΔfCO_2 climatology



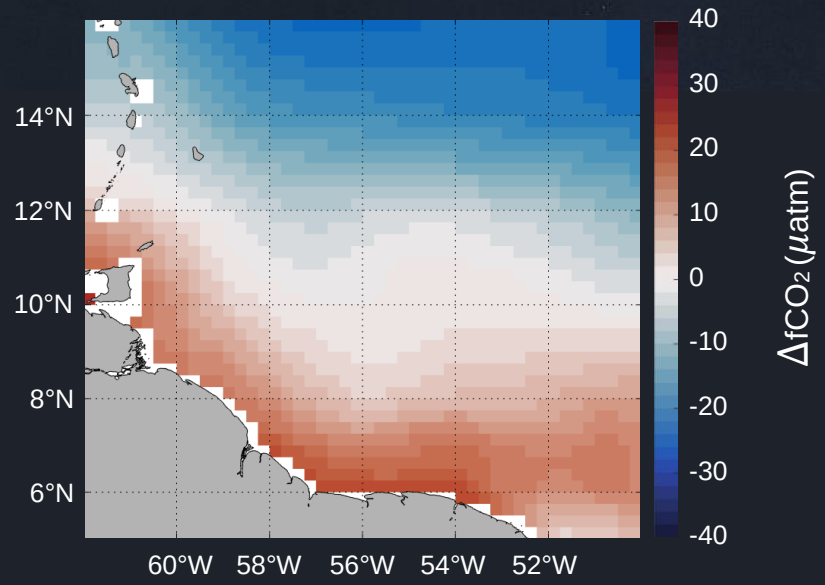
Landschützer at al., 2020

CO_2 sink generated by winter cooling

CO_2 source close to the equator waters rich in CO_2

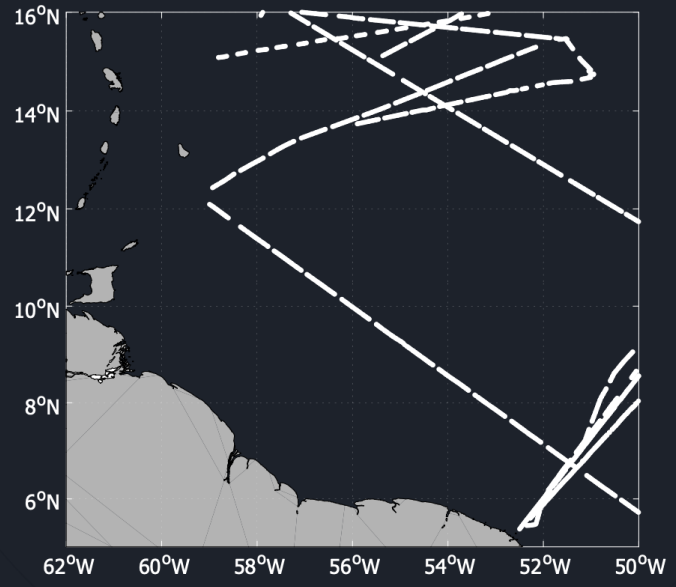
A transition region highly dynamic

February ΔfCO_2 climatology



Landschützer at al., 2020

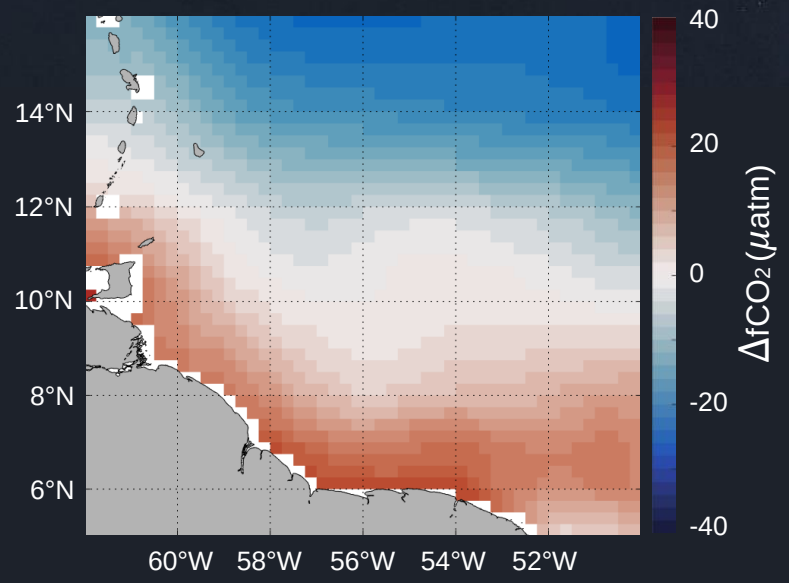
Available data in winter on the SOCAT database



1 transect south of Barbados crossing the region

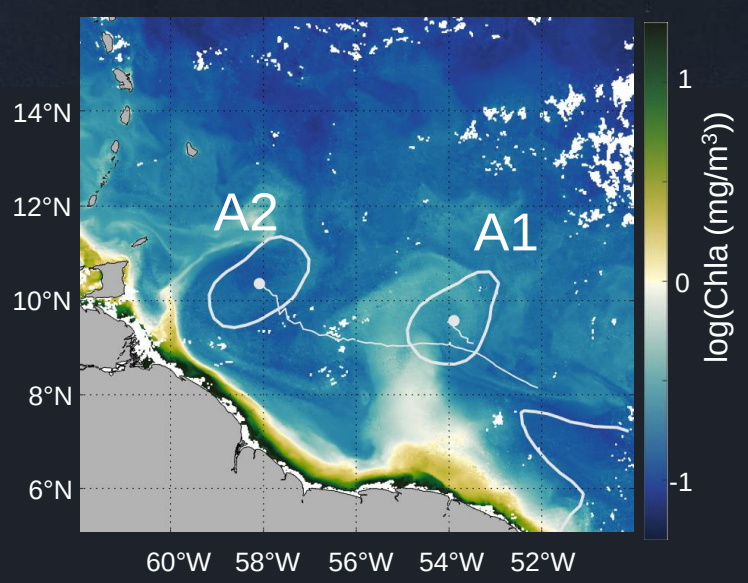
A transition region highly dynamic

February ΔfCO_2 climatology



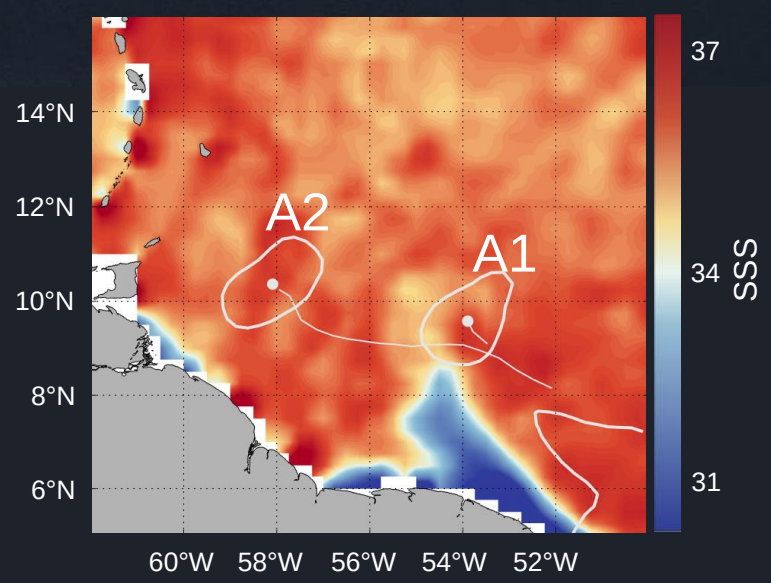
Landschützer at al., 2020

Satellite Chl*a* on Feb 6th 2020



CLS 0.02 km

Satellite SSS on Feb 6th 2020



SMOS CATDS + SMAP RSS ~50km

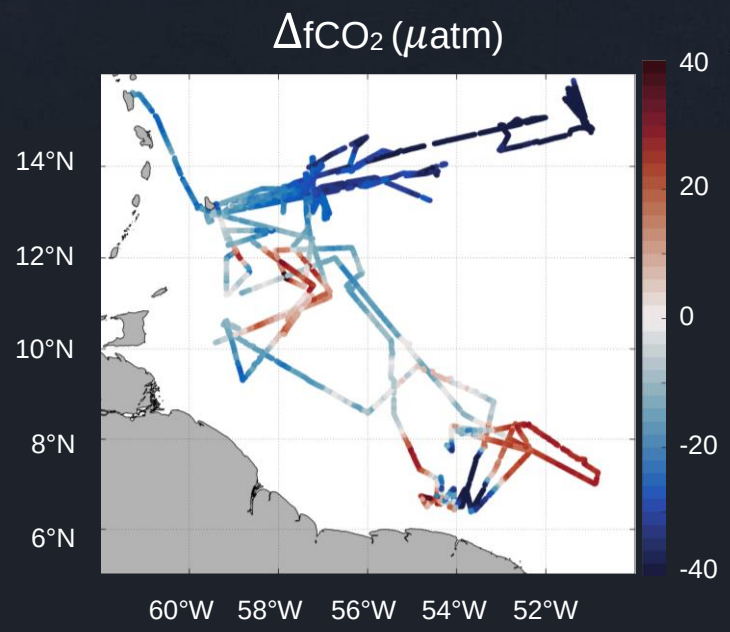
Problematics

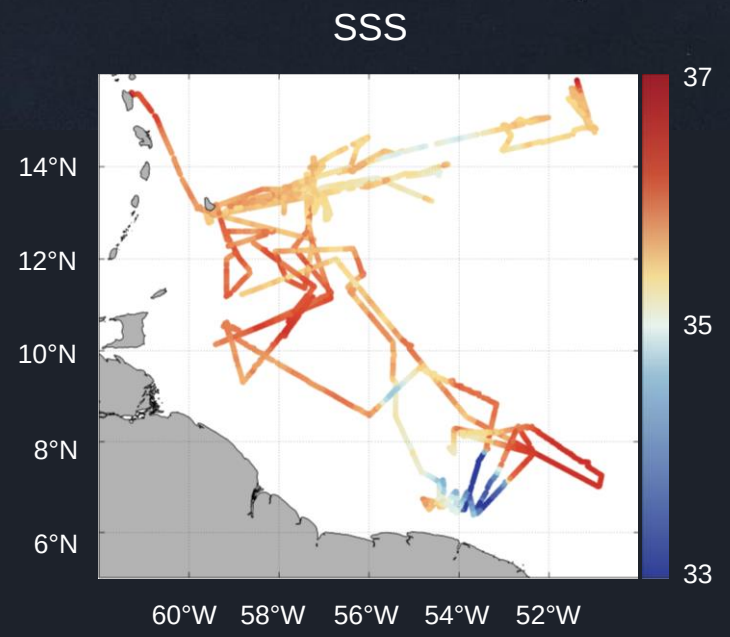
How do mesoscale and sub-mesoscale dynamics influence the regional air-sea CO_2 fluxes ?

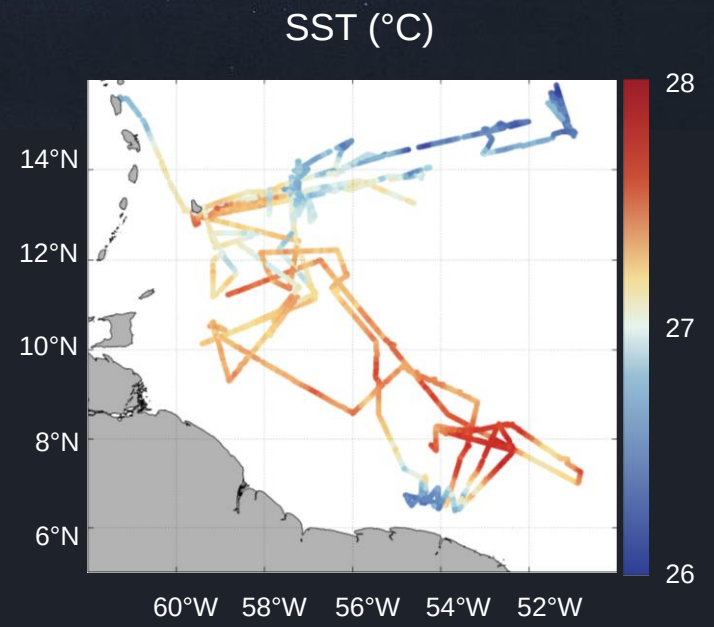
Impact of the amazon plume in a low outflow period ?

What is the impact of NBC eddies on the CO_2 fluxes ?

Data - The EUREC^{4}A-OA cruise

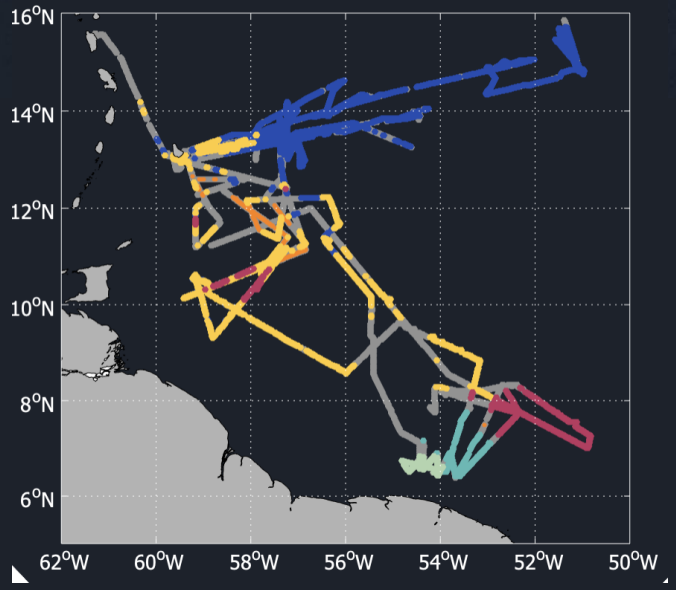


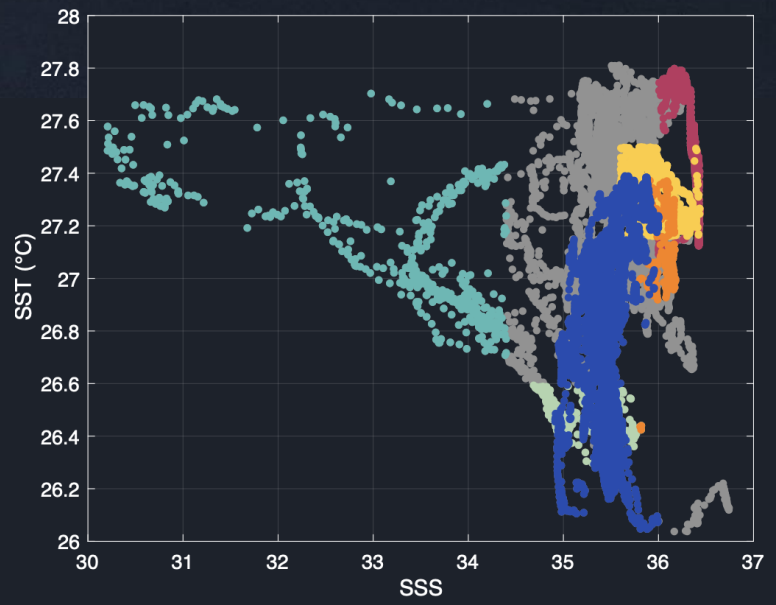




January - February 2020 - 3 ships equipped with CO_2 system - RVs Atalante- Merian- Ron Brown

Water masses identification





Identification using SSS, SST and colocalised satellite Chl*a*

Boundaries varying in space and time

North Atlantic Surface Water

Fresh plume

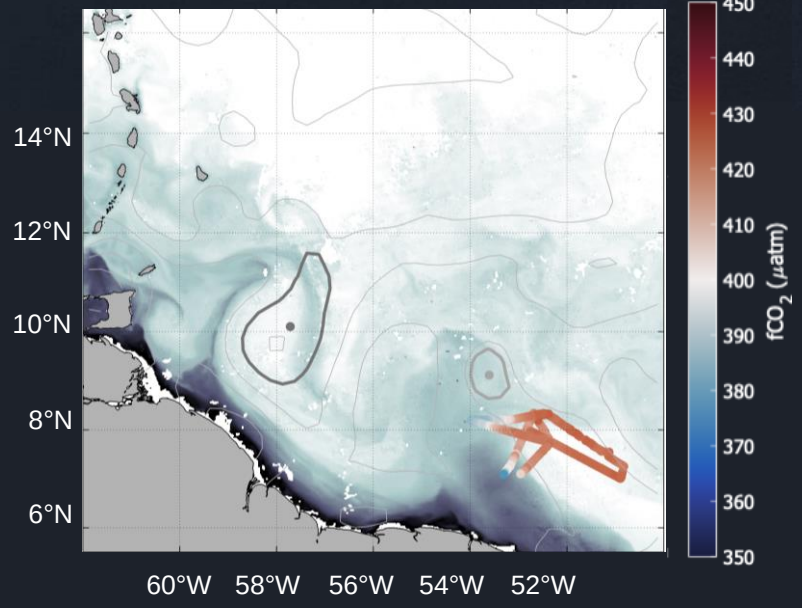
NBC water

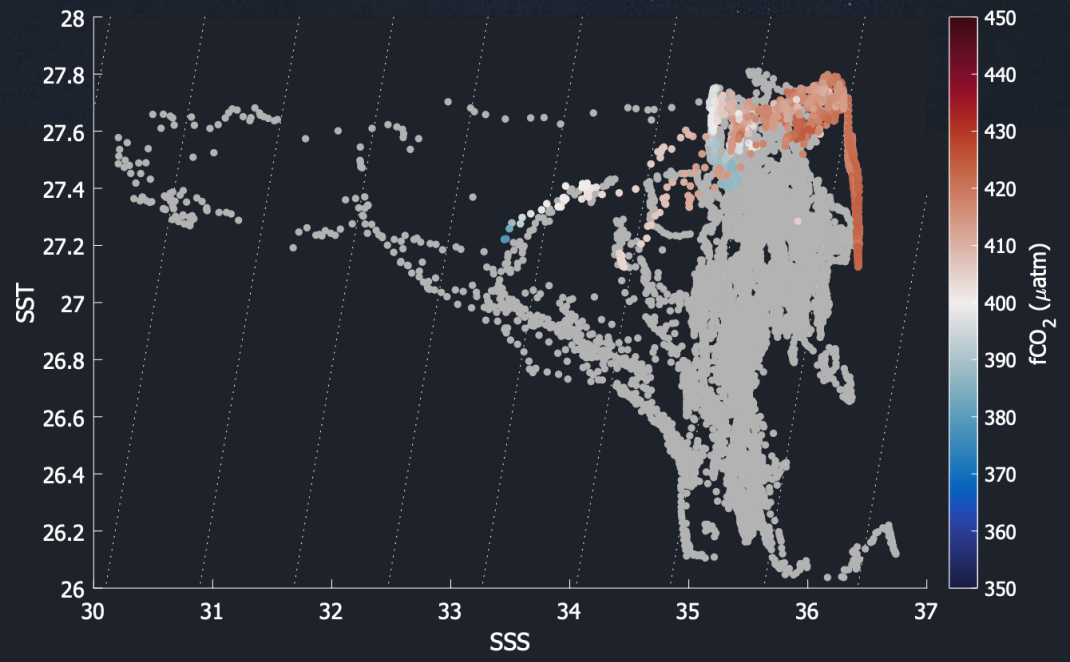
Modified NBC

Shelf

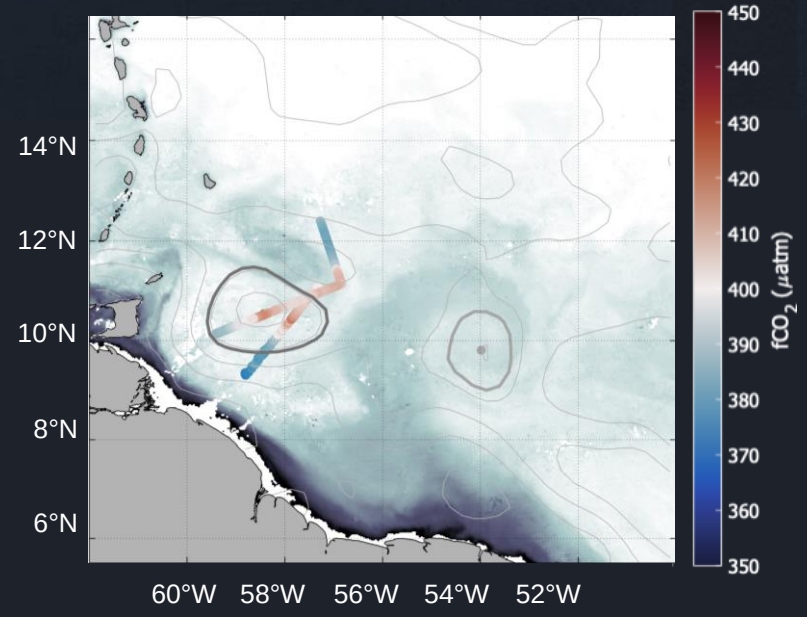
Filament

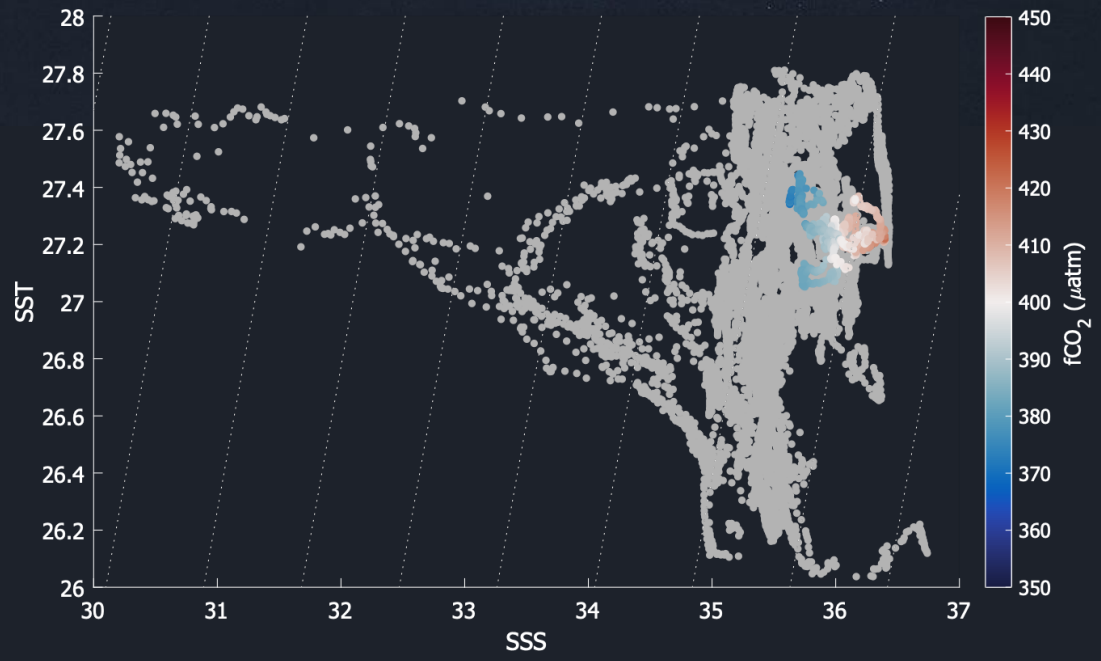
NBC retroflection





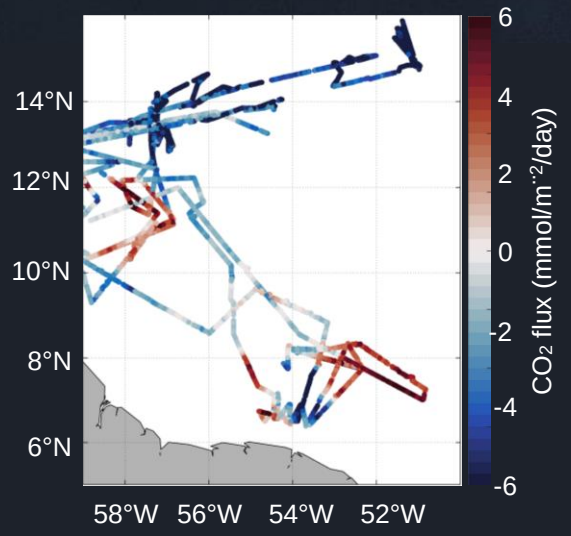
NBC ring A2


14°N
12°N
10°N
8°N
6°N
60°W
58°W
56°W
54°W
52°W
450
440
430
420
410
400
390
380
370
360
350
fCO2 (µatm)

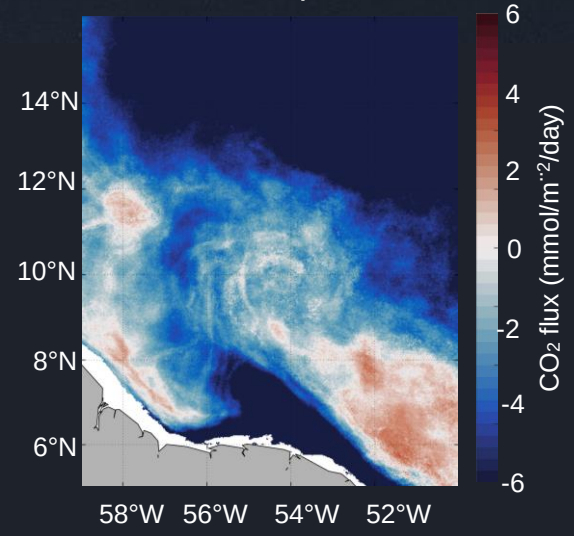

28
27.8
27.6
27.4
27.2
27
26.8
26.6
26.4
26.2
26
SST
30
31
32
33
34
35
36
37
SSS
450
440
430
420
410
400
390
380
370
360
350
fCO2 (µatm)

Air-sea CO_2 flux

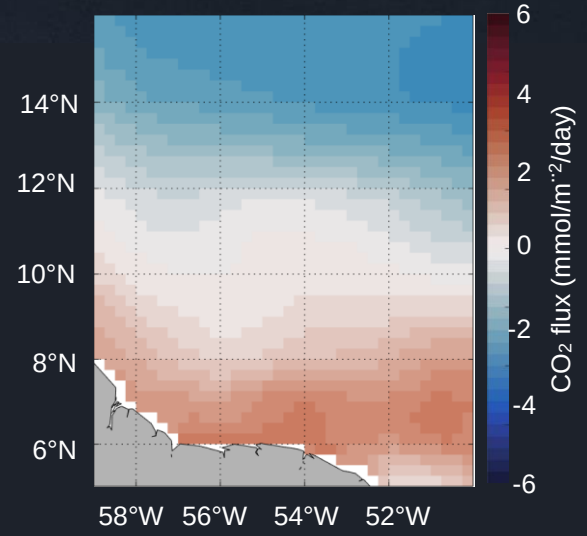
EUREC^{4}A data



Reconstructed from Satellite SSS, SST & Chl*a*

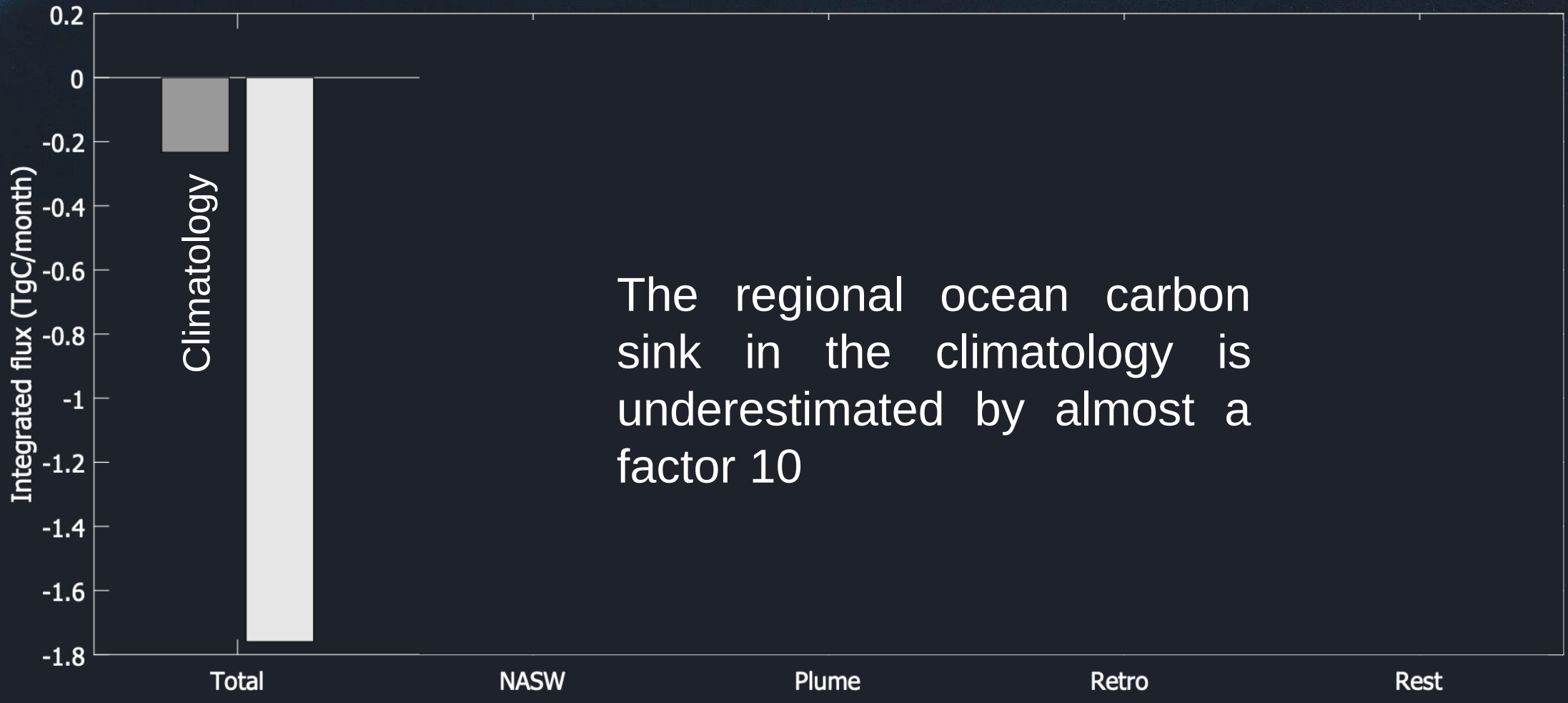


Landschützer at al., 2020



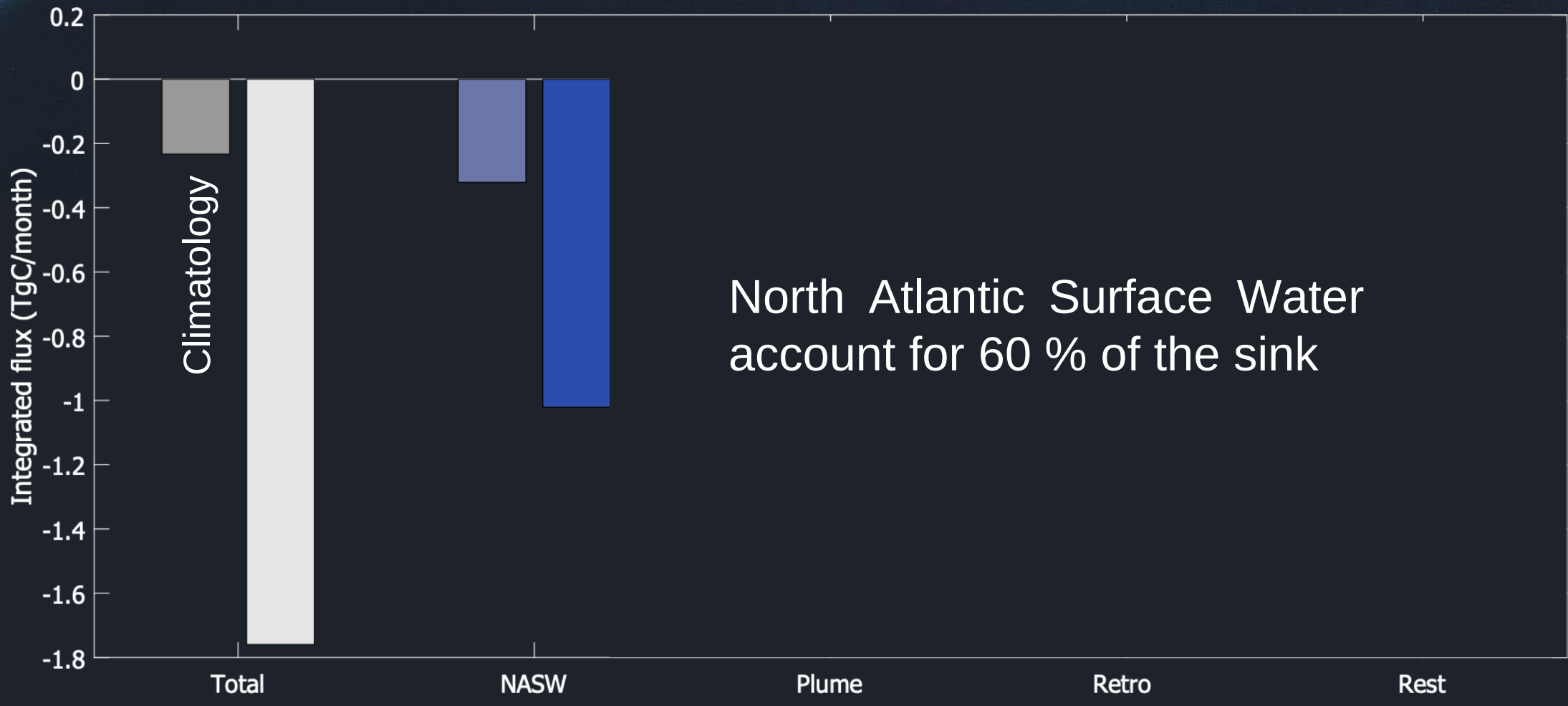
Error on mean flux linked to uncertainty on ship measurments absolute calibration <0.1 mmol/m²/day
Error (noise) on individual pCO_2 estimate linked to interpolation and reconstruction ~4 to 9 µatm

Integrated air-sea CO_2 flux



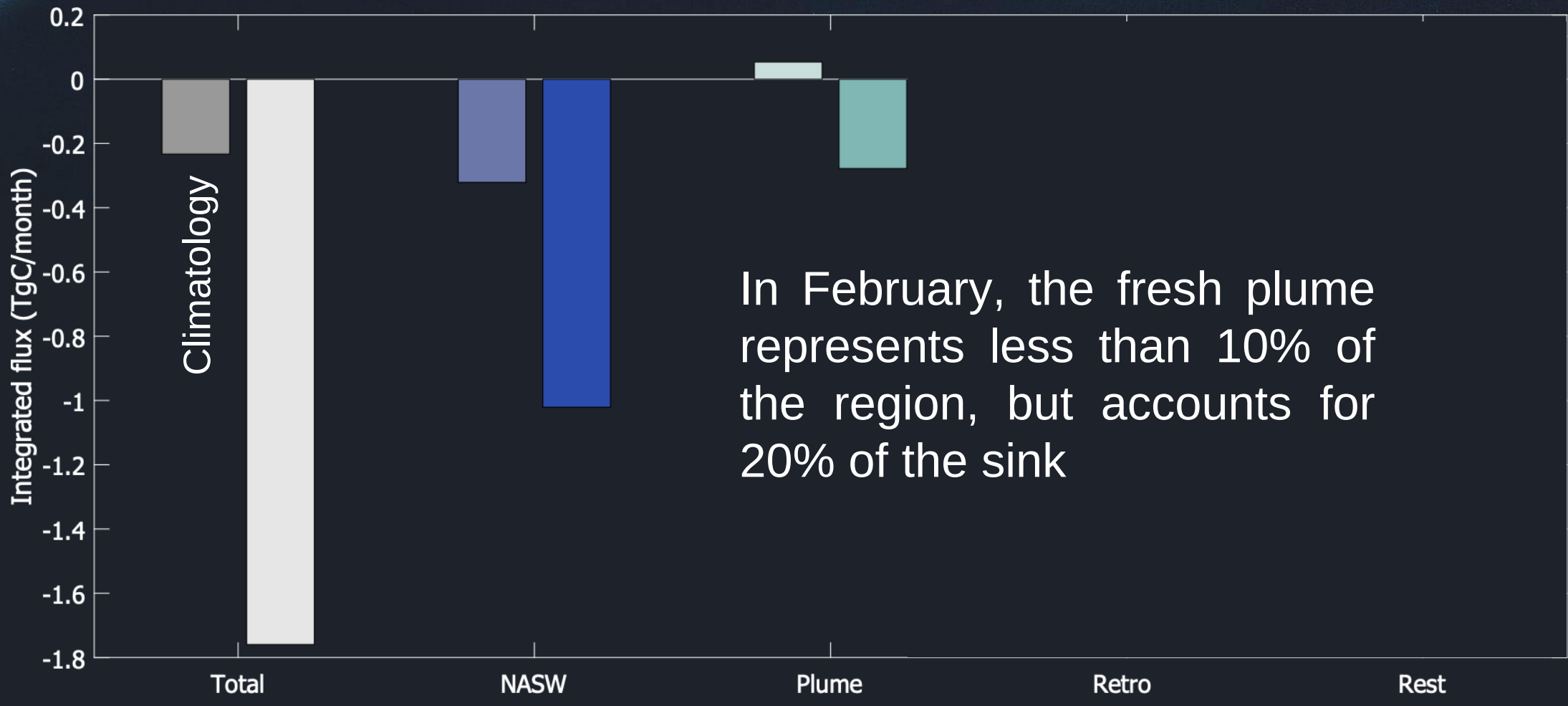
The regional ocean carbon sink in the climatology is underestimated by almost a factor 10

Integrated air-sea CO_2 flux



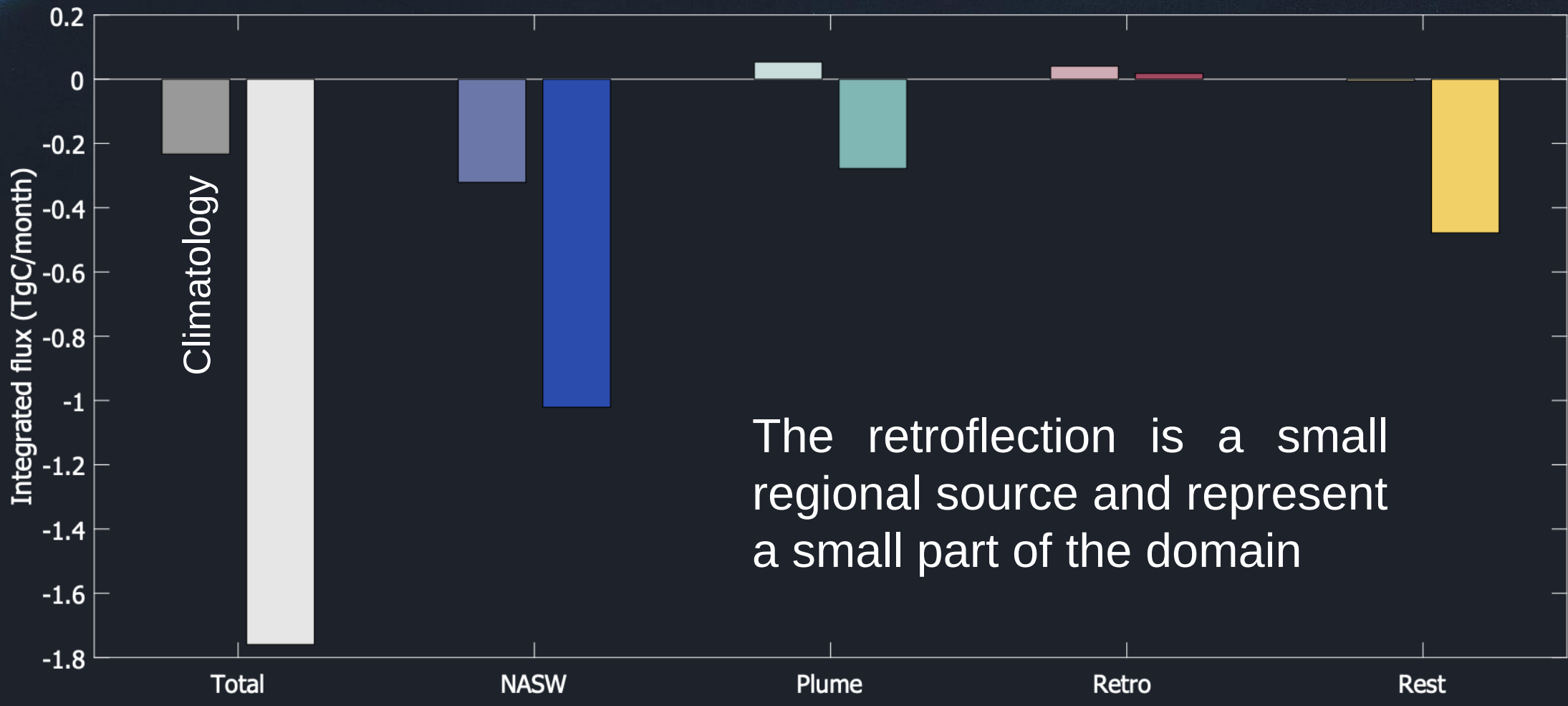
North Atlantic Surface Water account for 60 % of the sink

Integrated air-sea CO_2 flux



In February, the fresh plume represents less than 10% of the region, but accounts for 20% of the sink

Integrated air-sea CO_2 flux

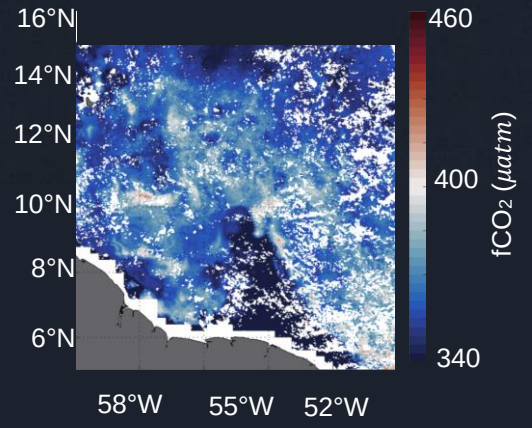


The retroflection is a small regional source and represent a small part of the domain

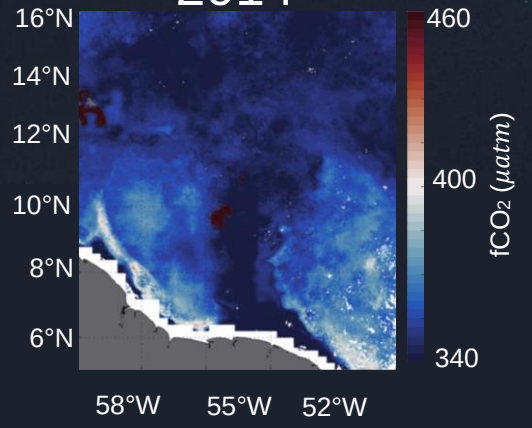
Interannual variability

Freshplume events observed 7 years out of 10 from 2010 to 2019

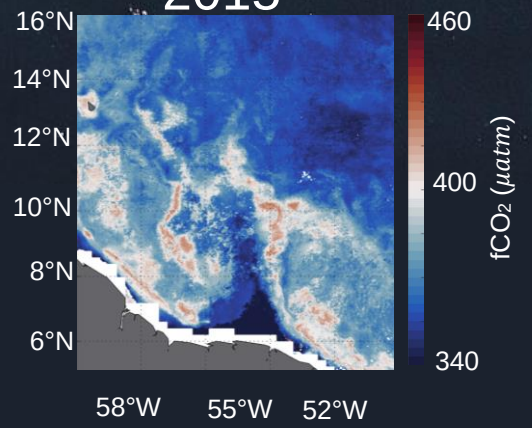
2012



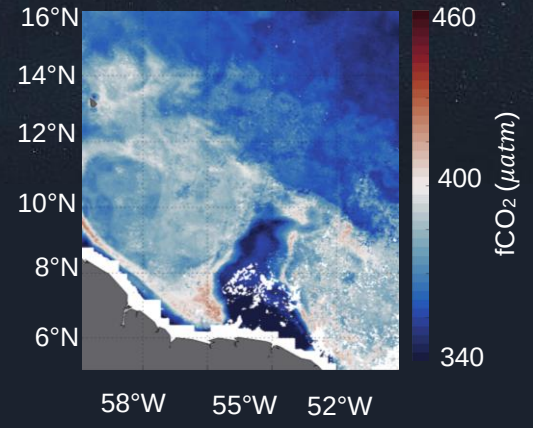
2014



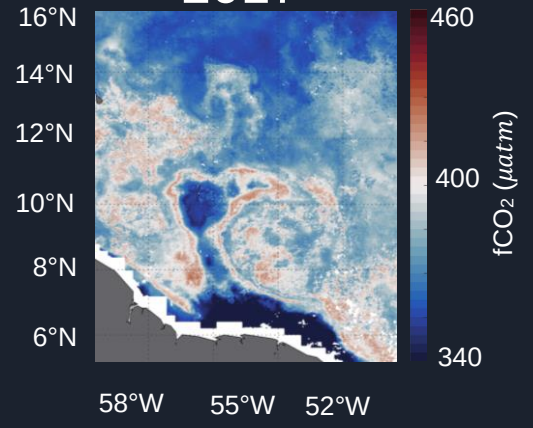
2015



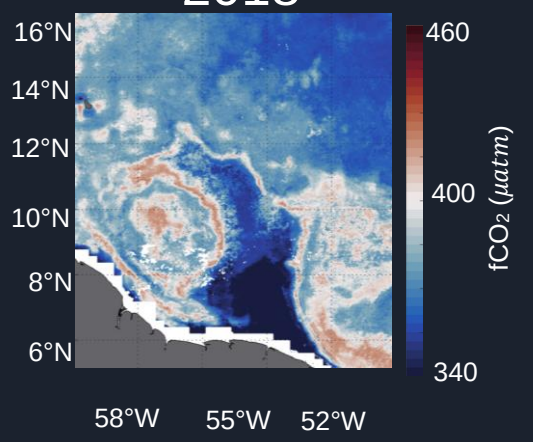
2016



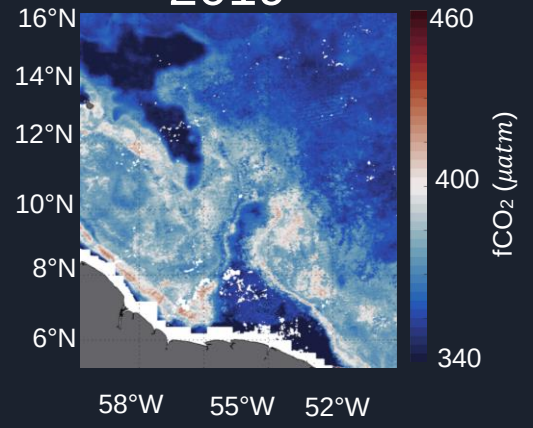
2017



2018



2019



CCI SSS
OSTIA SST
CLS Chla

Conclusions

The NBC retroflection is a source of carbon to the Atmosphere

The signal of the NBC rings is dampened over time, but conserve high fCO_2 near the centre

Conclusions

The main effect of NBC rings is through the filaments they stir, even in period of low Amazon outflow on the shelf

The Fresh plume, often not taken into account, accounts for 20 % of the total sink

Conclusions

The NASW represents 60 % of the total sink

This strong sink compared to the climatology can be due to interannual variability or a lack of data in global datasets

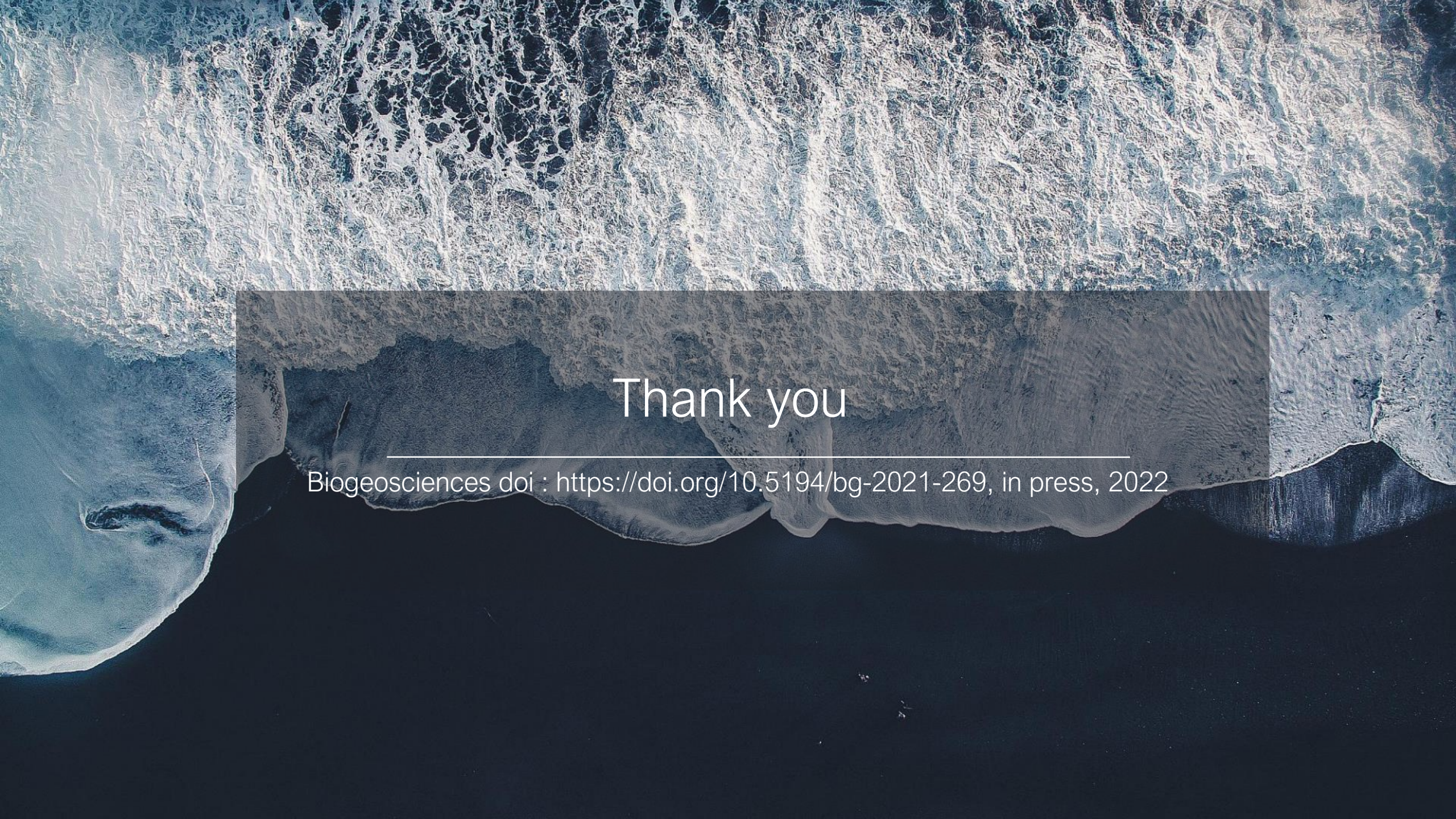
Conclusions

The regional ocean carbon sink is underestimated by a factor 10 in the climatology, due to a lack of data and of small scale representation

Perspectives

Study of the summer season from recently acquired Tara Microbiome data in August-September 2021

Better characterization of the role of the NBC rings and of the Amazon plume in a strong outflow period



Thank you

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