Interannual variability in the ocean CO_2 uptake along the West Antarctic Peninsula:

A decade of year-round observations

Elise S. Droste, Dorothee C. E. Bakker, Hugh J. Venables, Mario Hoppema, Giorgio Dall'Olmo, Bastien Queste, Elizabeth Jones, Gareth Lee

University of East Anglia

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

PML | Plymouth Marine Laboratory

ENV EAST Doctoral Training Partnership

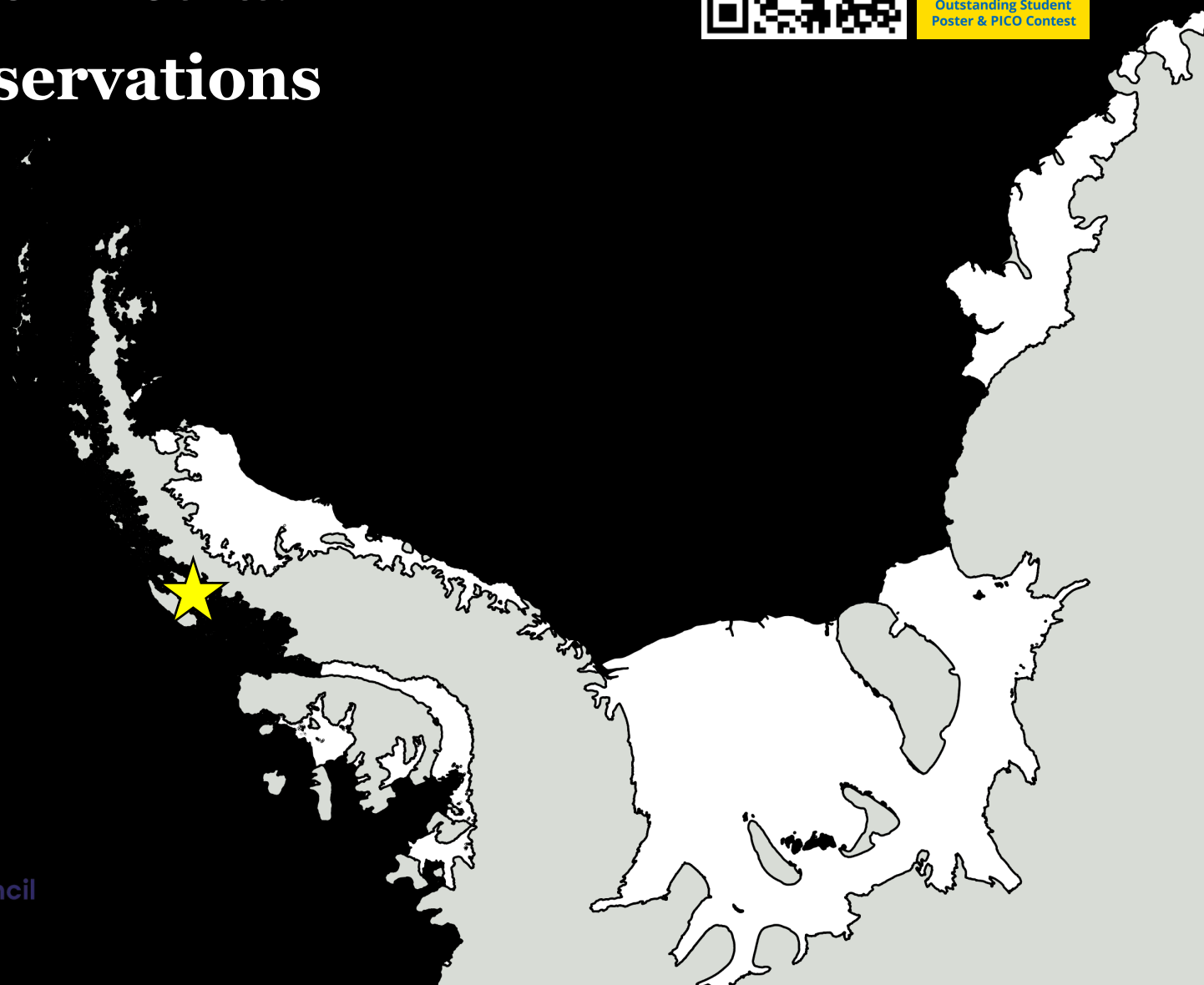
GÖTEBORGS UNIVERSITET

HAVFORSKNINGSINSTITUTTET

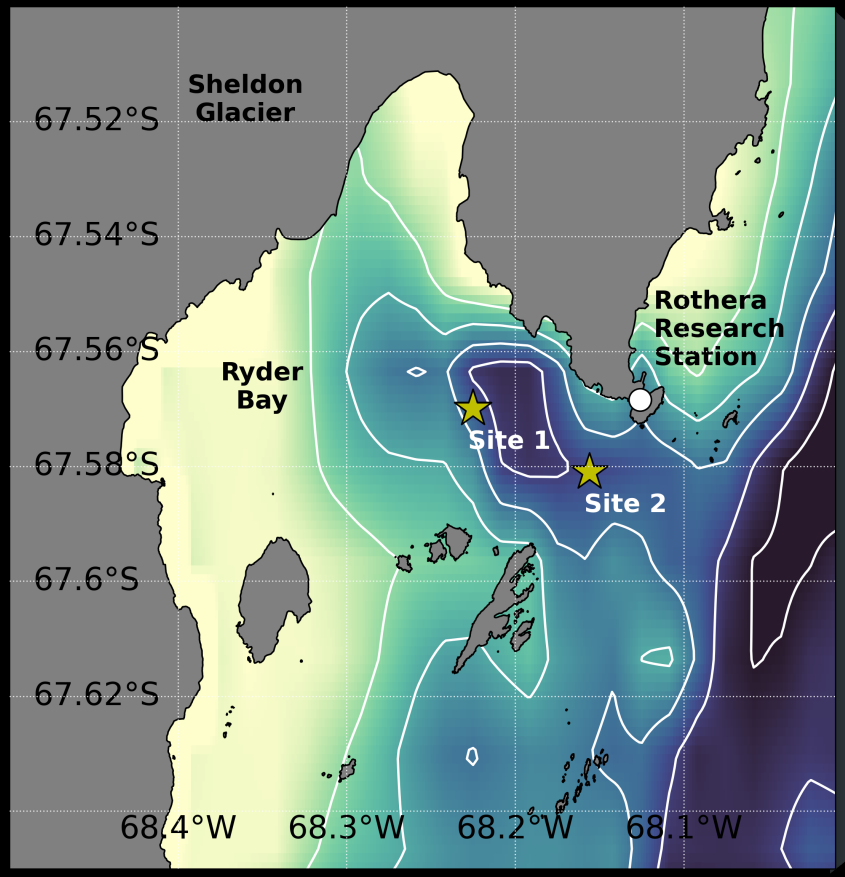
UKRI Natural Environment Research Council

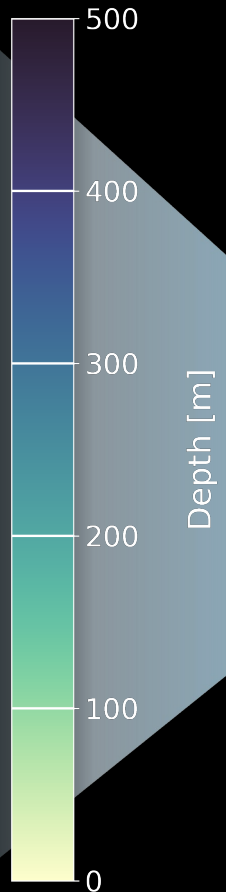
This presentation participates in OSPP

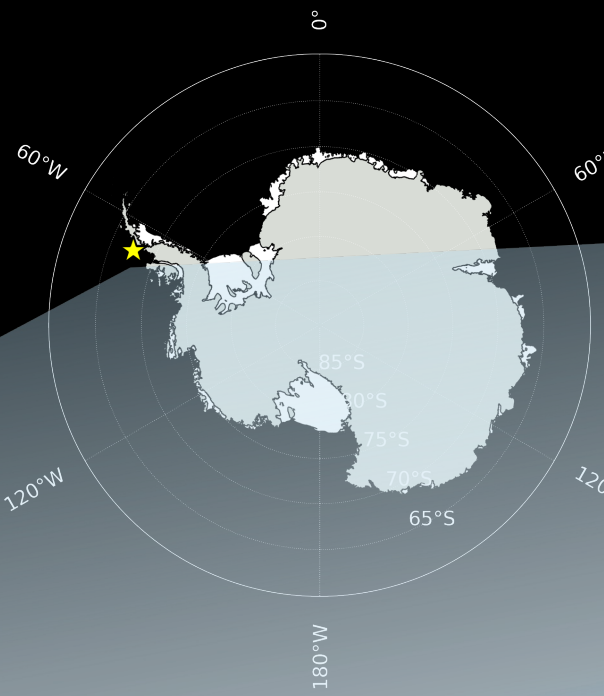
EGU Outstanding Student Poster & PICO Contest



Rothera, Ryder Bay

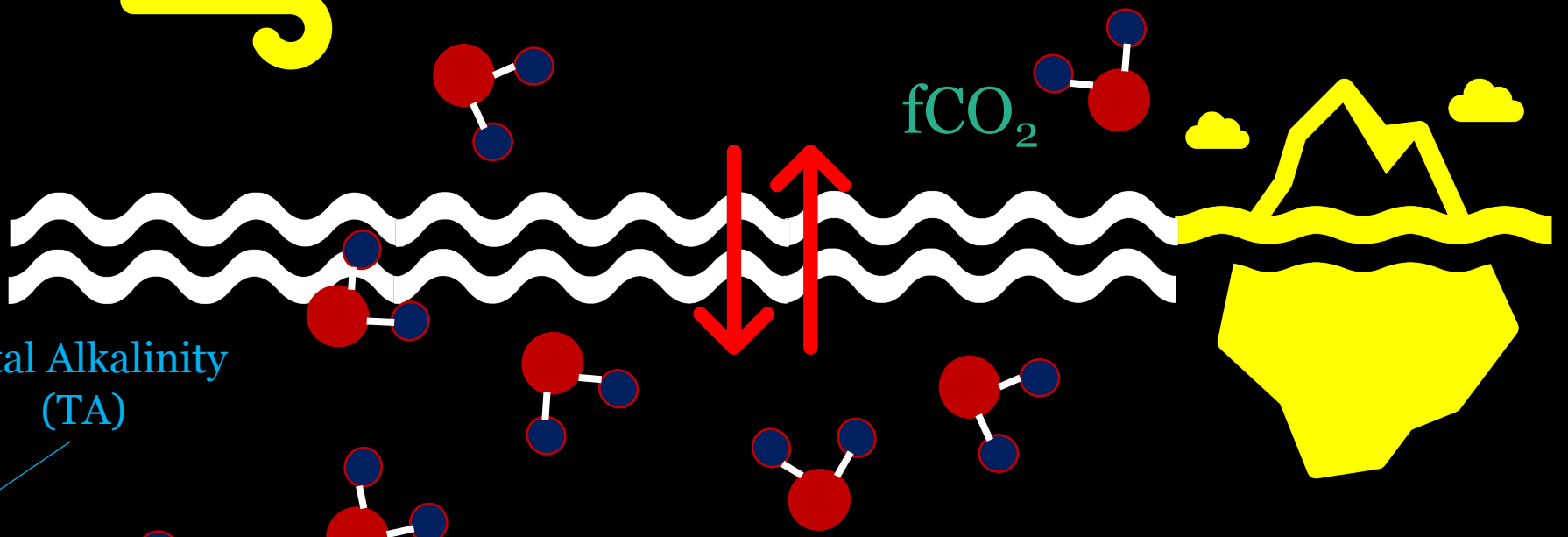






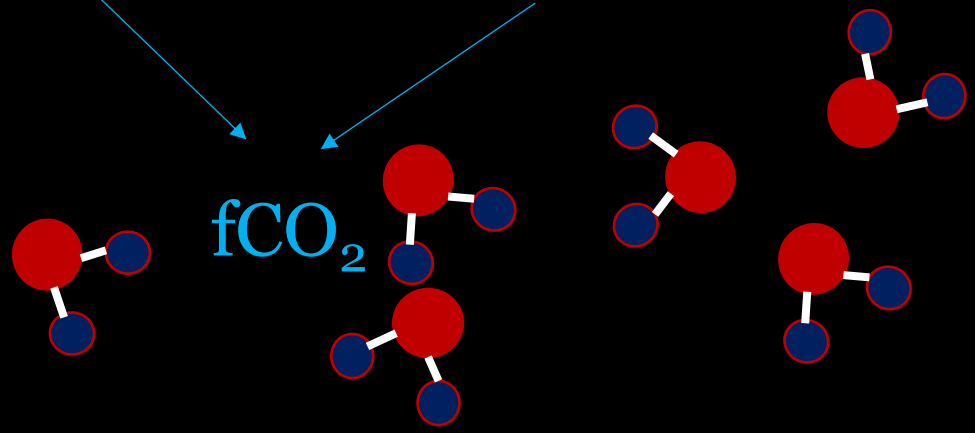
Arnt et al., 2013 https://doi.org/10.1594/PANGAEA.805734

$$CO_2\ Flux = kK_0(fCO_2 - fCO_2)$$



Dissolved inorganic carbon (DIC)

Total Alkalinity (TA)



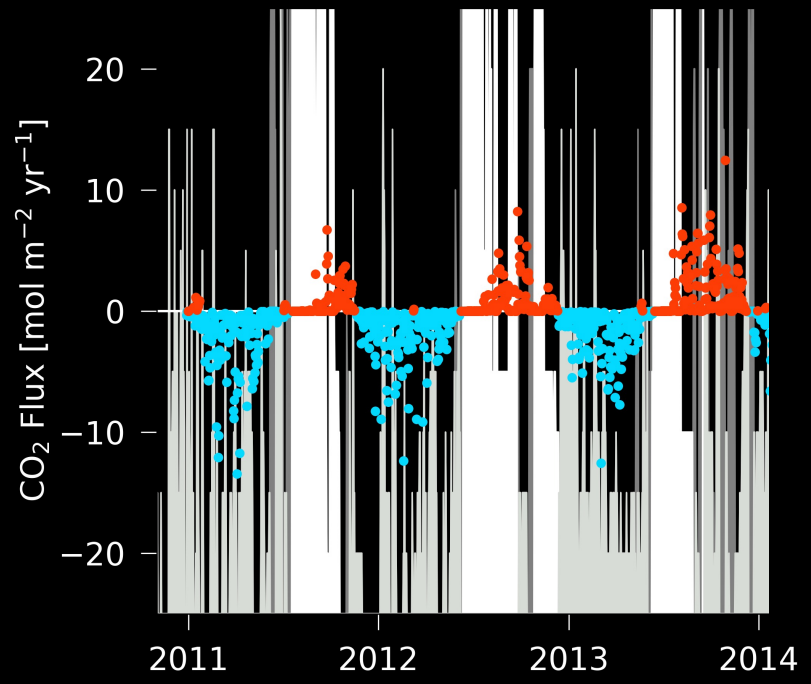
Seawater samples are collected at 15 m depth every ~ 2 weeks, year round. Samples are analysed for DIC and TA from which we can calculate fCO_2. Flux is calculated from CO_2 solubility (K_0) and the gas transfer velocity, which is based on a parameterisation including wind speed and scaled by the fraction of open water.

① Interannual variability in summer CO_2 uptake and winter outgassing

Sea ice and stratification play key roles

CO_2 Outgassing

CO_2 Uptake



👇

👉 Dominant seasonal drivers:

Biological carbon uptake in summer
Mixing with deep water in winter

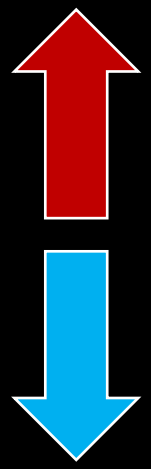
Legge et al. (2015; 2017)

① Interannual variability in summer CO_2 uptake and winter outgassing

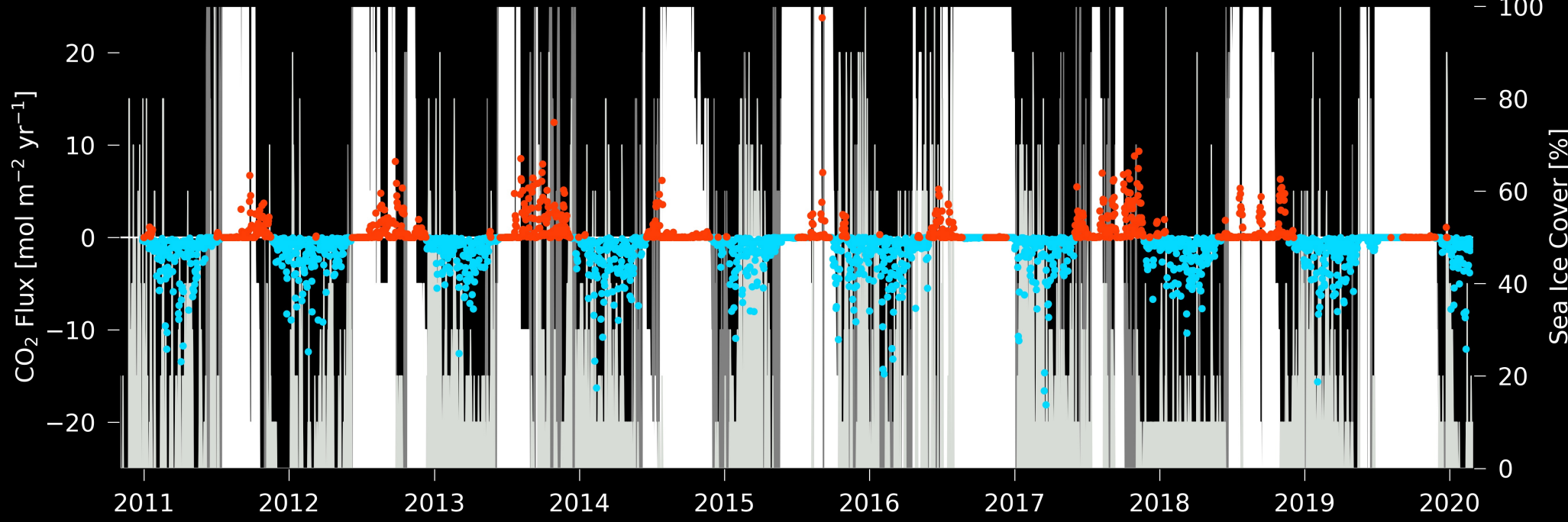
Sea ice and stratification play key roles

👇

CO_2 Outgassing



CO_2 Uptake



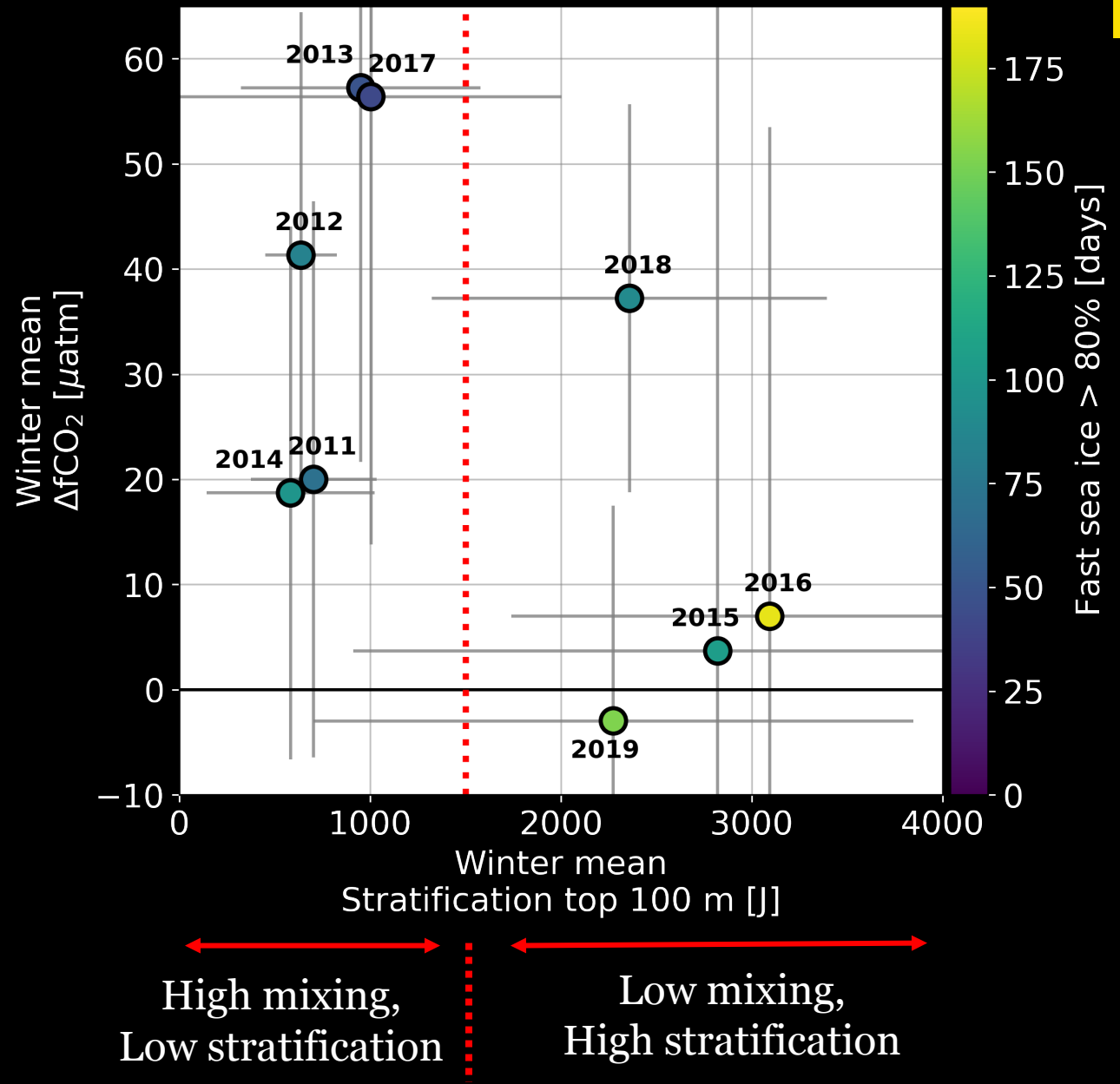
In winter…

Sea ice cover reduces wind-induced mixing with mCDW (= older carbon-rich water)

and therefore reduces CO_2 outgassing in winter.

CO_2 outgassing

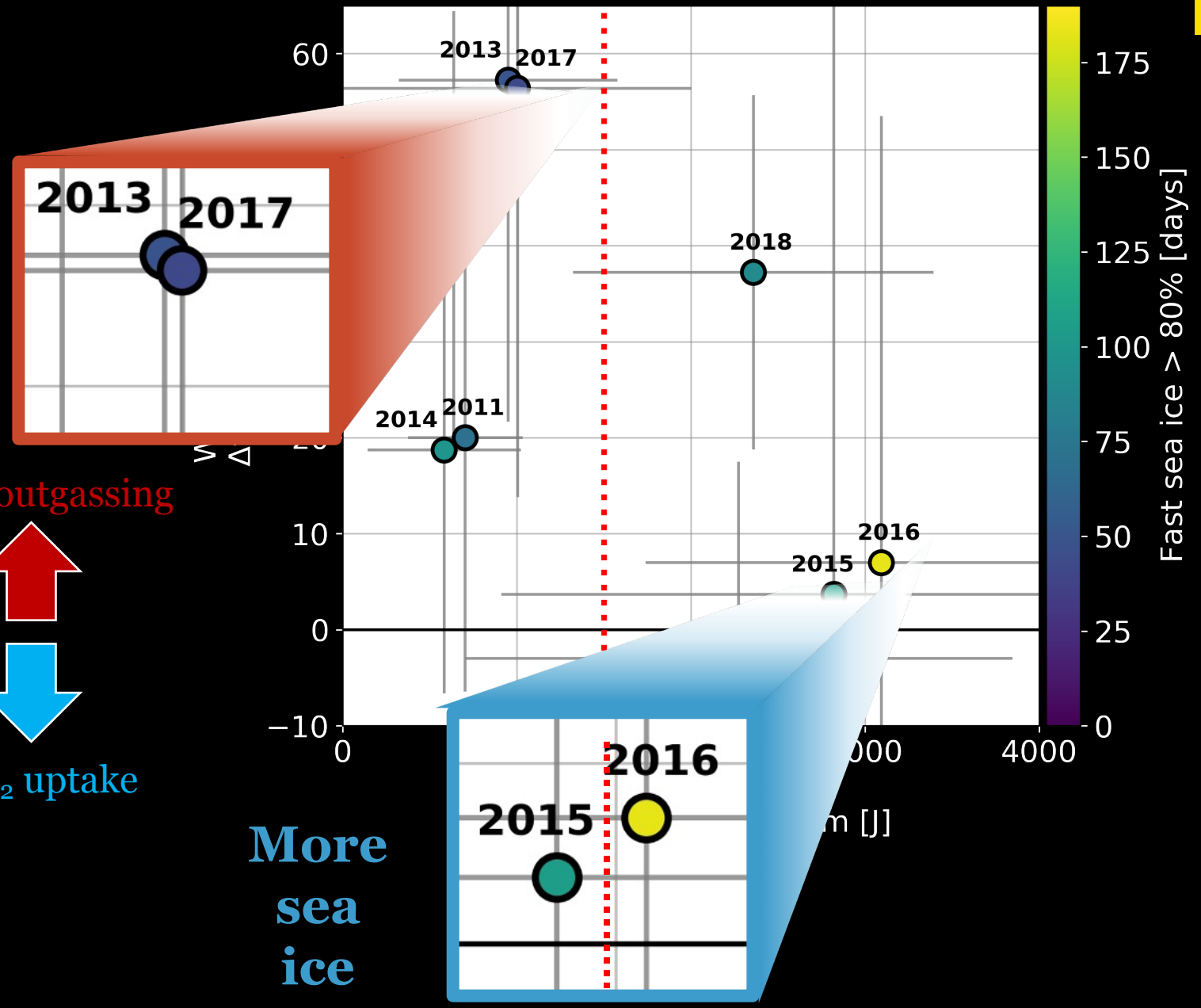
CO_2 uptake



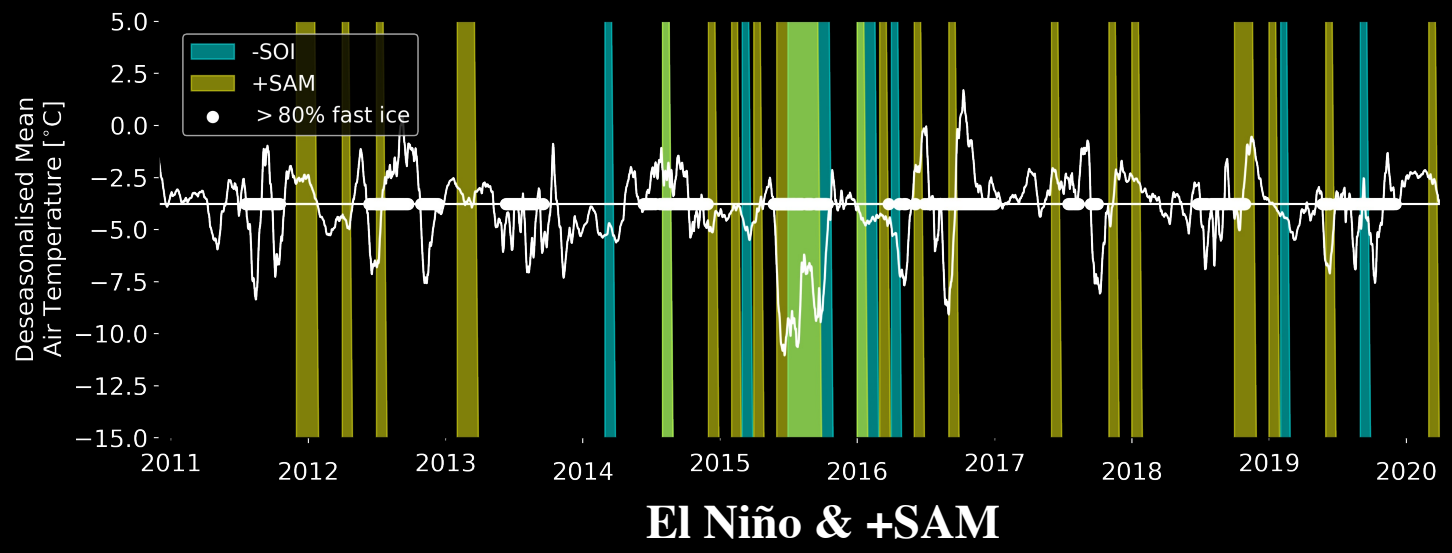
In winter…

Sea ice cover reduces wind-induced mixing with mCDW (= older carbon-rich water)

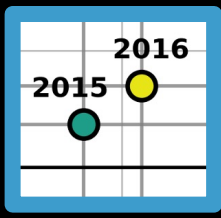
and therefore reduces CO_2 outgassing in winter.



② Winter variability driven by connectivity to deep water, which is sensitive to sea ice



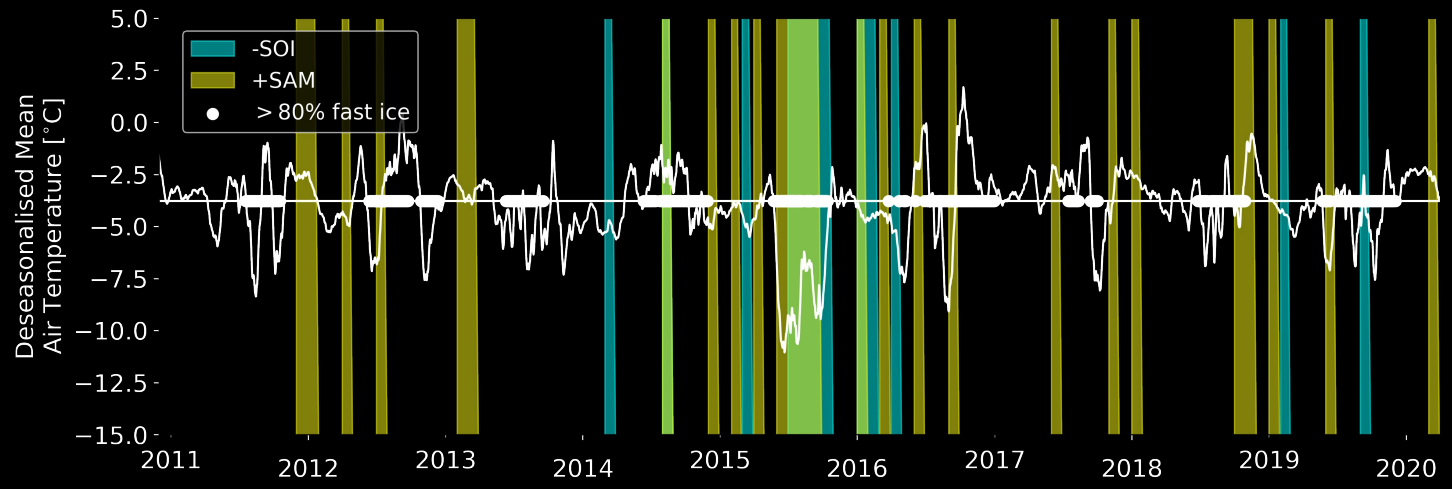
El Niño & +SAM

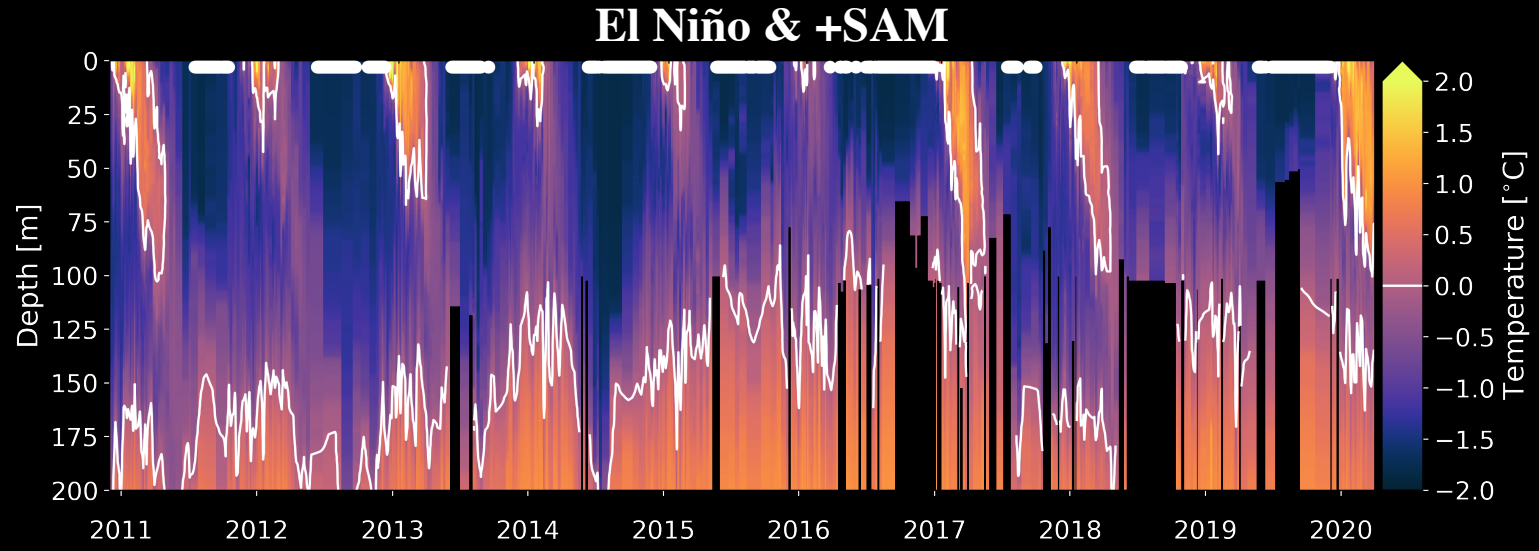


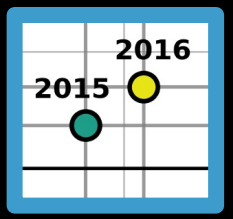
El Niño & +SAM led to strong **cooling** event in 2015 and 2016, enhancing sea ice cover and stratification.

Containment

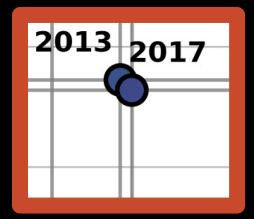
② Winter variability driven by connectivity to deep water, which is sensitive to sea ice





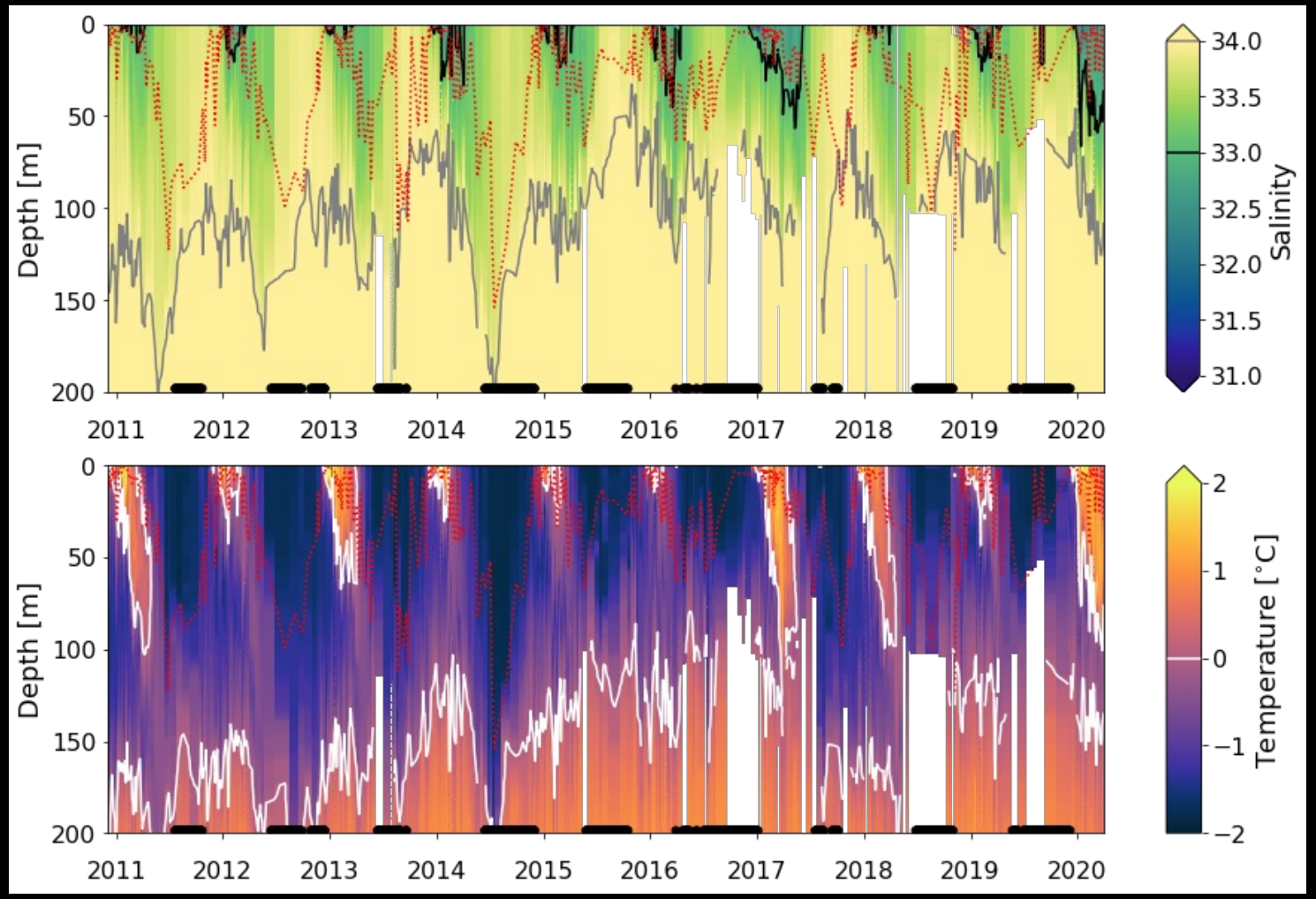


El Niño & +SAM led to strong **cooling** event in 2015 and 2016, enhancing sea ice cover and stratification.
Containment



Heat uptake in 2017 delayed and reduced sea ice cover, enhancing mixing with carbon-rich deep water.
Outgassing

Salinity and temperature at Ryder Bay 2011-2020



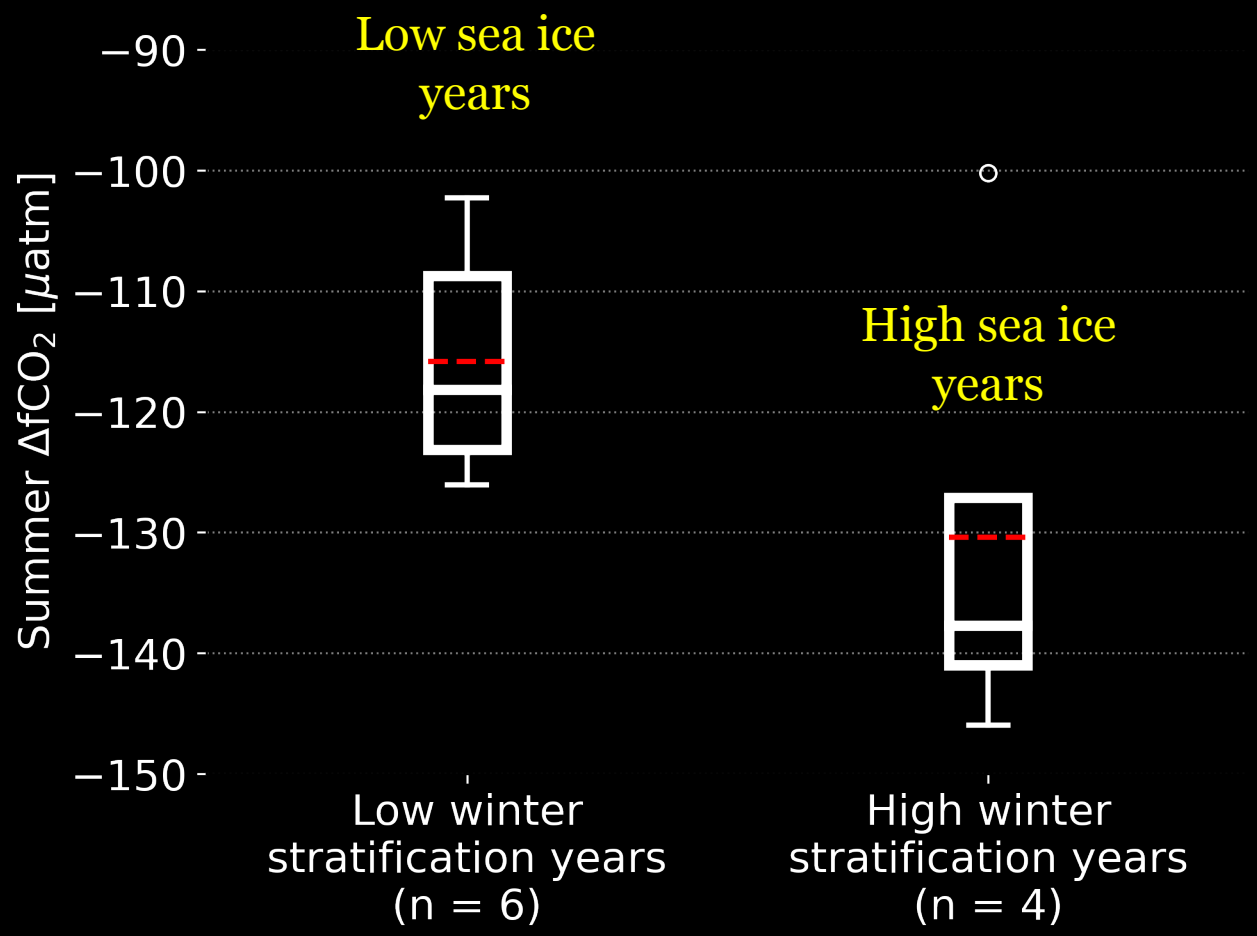
Mixed layer depth in red dotted line.

Days with >80% fast sea ice are indicated with black markers at the bottom of the plots.

③ Winter sea ice affects potential CO_2 uptake in the following summer

Less CO_2 uptake

More CO_2 uptake



Interannual variability in the ocean CO_2 uptake along the West Antarctic Peninsula

This presentation participates in OSPP

EGU

Outstanding Student Poster & PICO Contest

1. **Interannual variability in summer CO_2 uptake and winter outgassing**

2. **Winter variability is driven by connectivity to deep water, which is sensitive to sea ice**

3. **Winter sea ice affects potential CO_2 uptake in the following summer**

Please contact me for questions, comments, and discussions!

@Elise_Droste13

e.droste@uea.ac.uk

Hugh Venables