

Air-sea fluxes in Antarctica InSync

Marcel du Plessis, University of Gothenburg

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ANTARCTICA
INSYNC



SOOS
SOUTHERN OCEAN OBSERVING SYSTEM

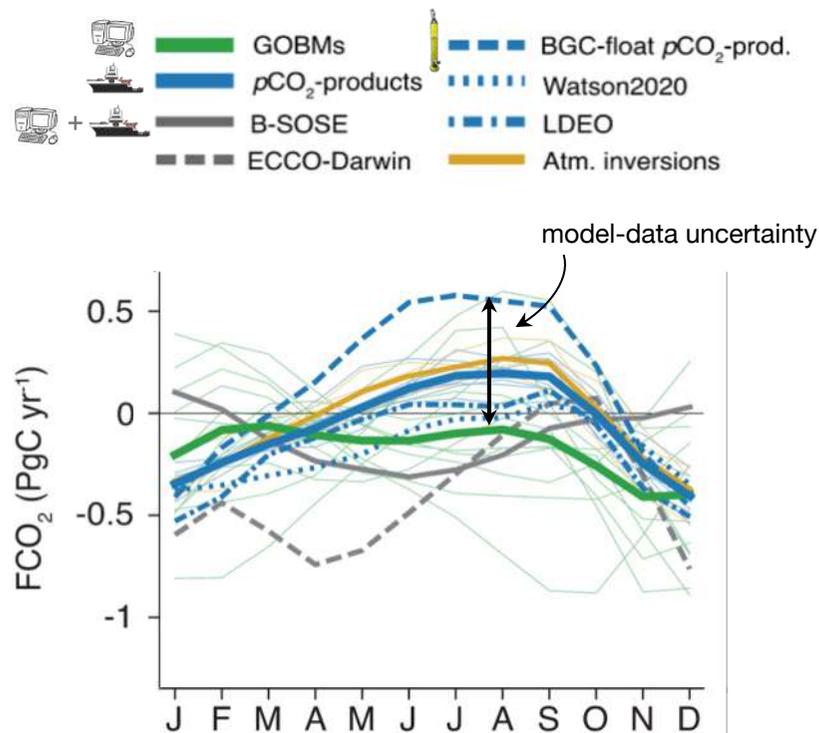
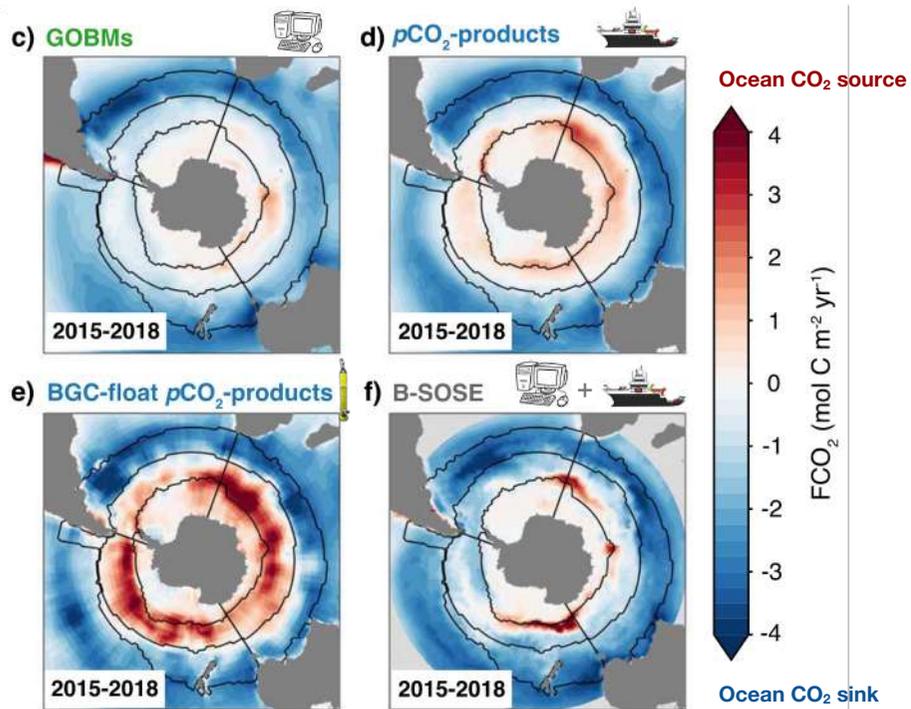


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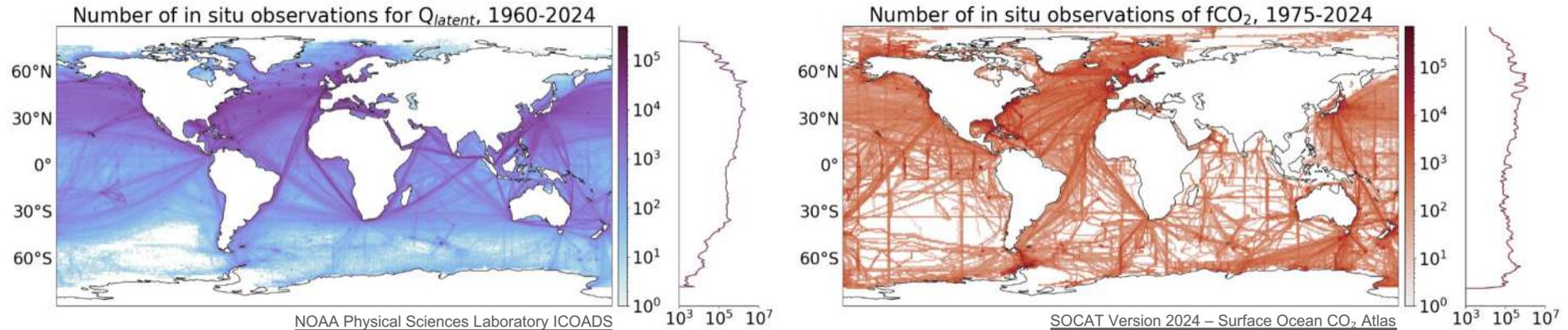


Uncertainties in Ocean CO₂ uptake

Models & data-products differ in the sign of uptake in polar Southern Ocean

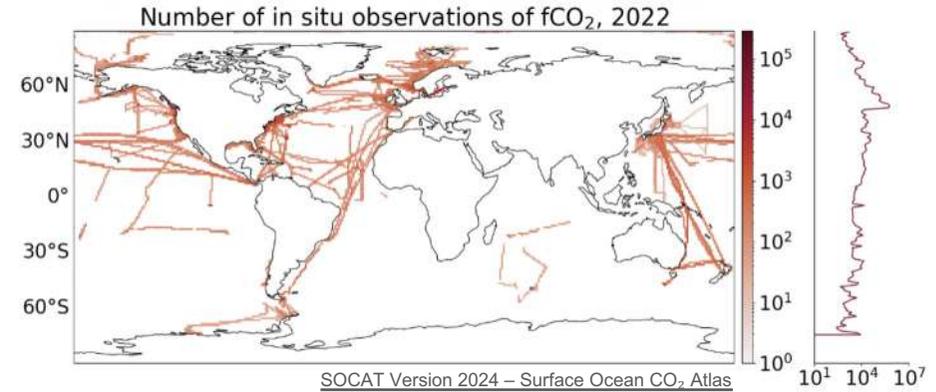
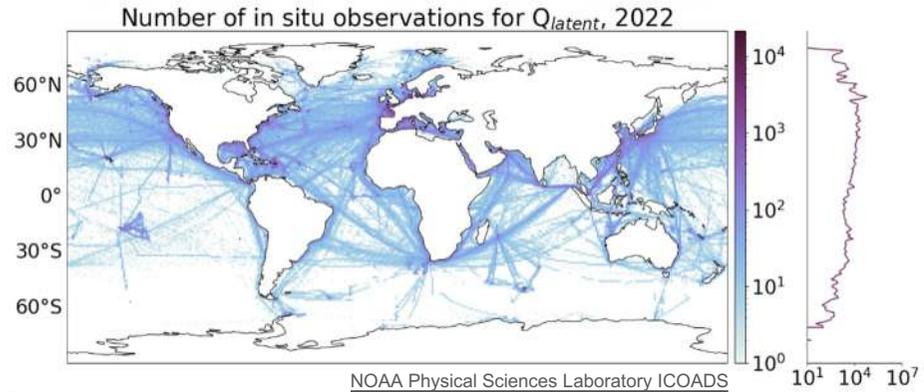


Southern Ocean “data desert”



- Data distribution of key observations for heat and carbon fluxes is severely lacking in the Southern Ocean
- Regions as large as countries that have not been sampled.

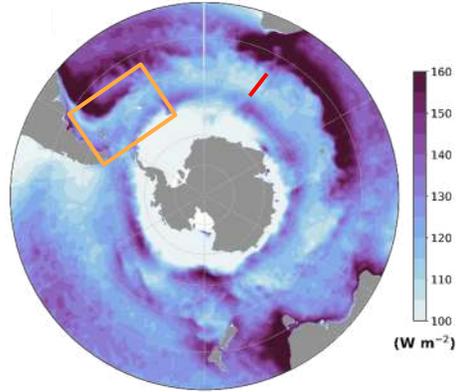
Southern Ocean “data desert”



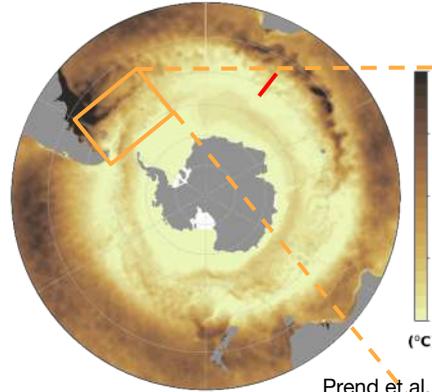
- Data distribution of key observations for heat and carbon fluxes is severely lacking in the Southern Ocean
- Regions as large as continents that have not been sampled.

Small processes have big impacts!

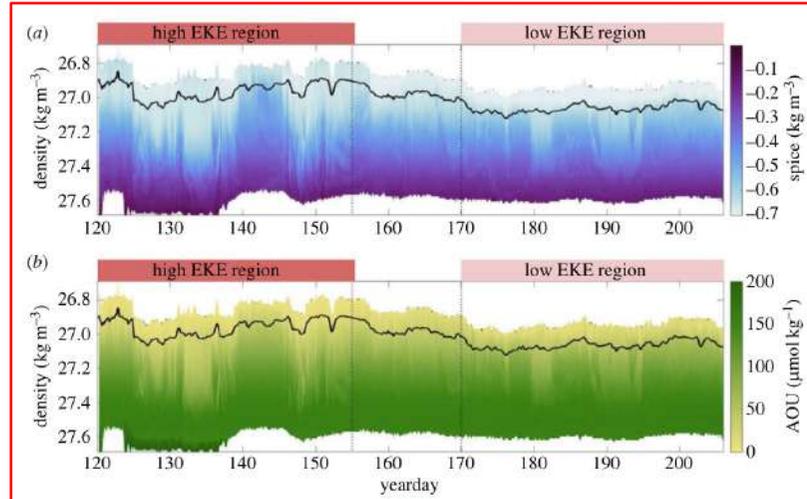
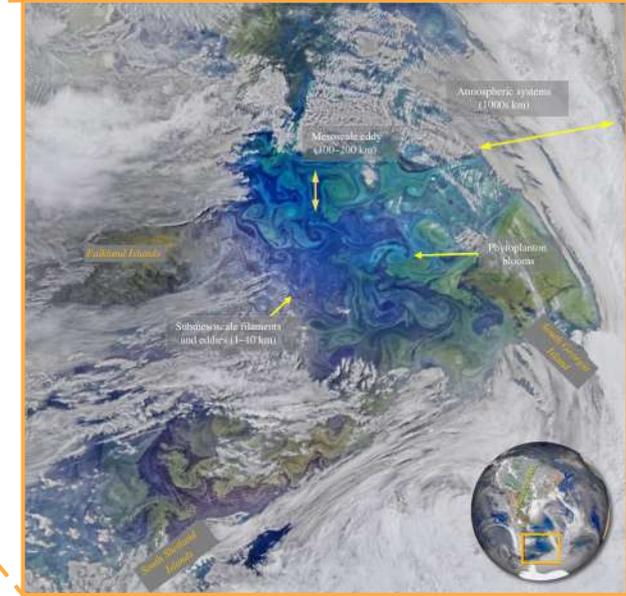
Heat flux variance



Surface temperature variance



Prend et al. *in prep*



Swart et al. 2023 *Royal Soc*

We need an understanding of the long-term impacts of small-scale processes.

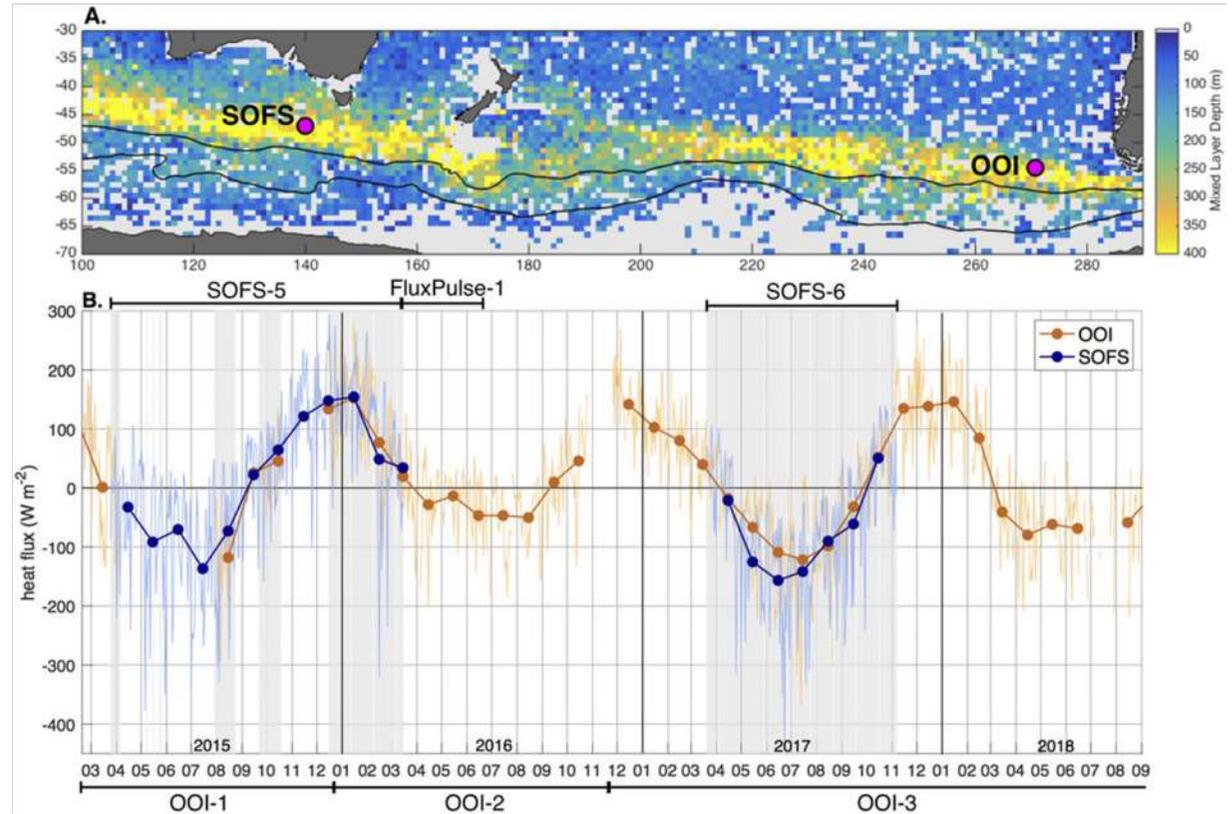
Intermittent and extreme events govern air-sea exchange

At Southern Ocean flux moorings, highly episodic heat loss from the ocean

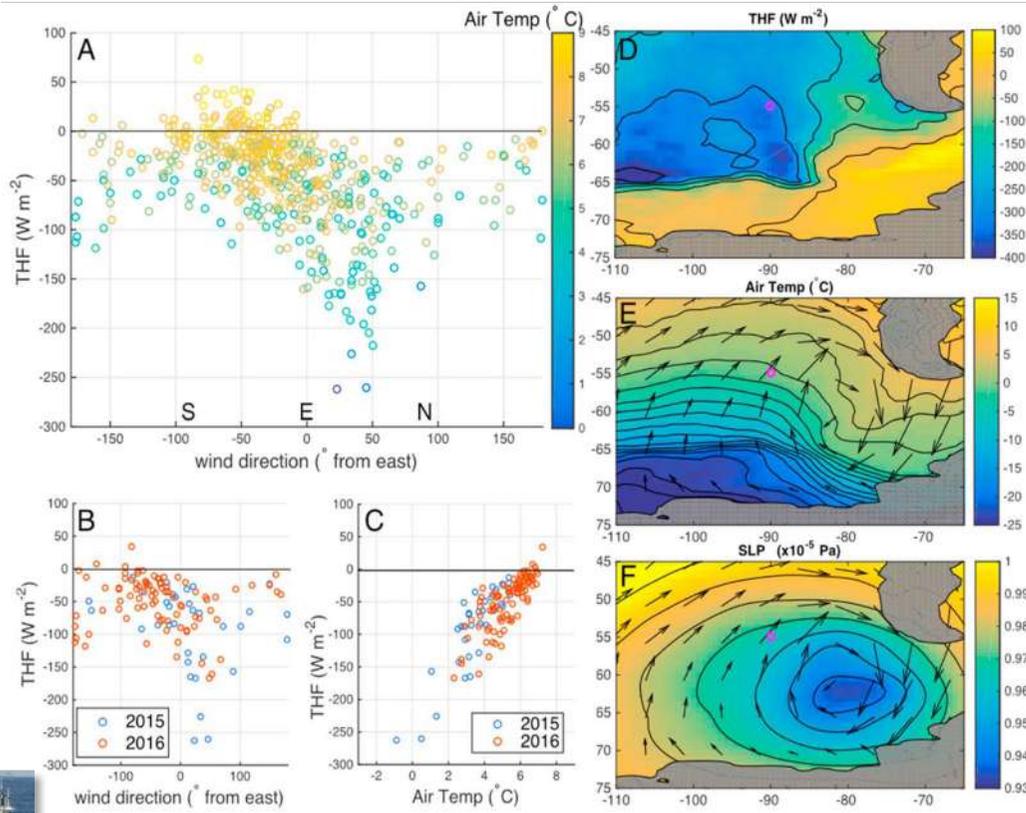
Heat loss leads to deep mixed layers, and drives air-sea exchange with ocean interior

Heat loss events linked to strong winds from the south

If we want to understand how the ocean sequesters heat or CO₂, need to understand events

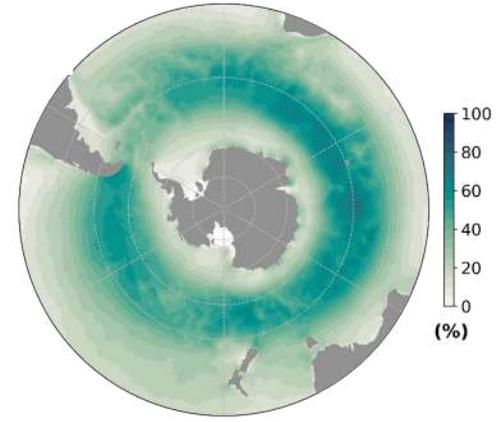


Intermittent and extreme events govern air-sea exchange

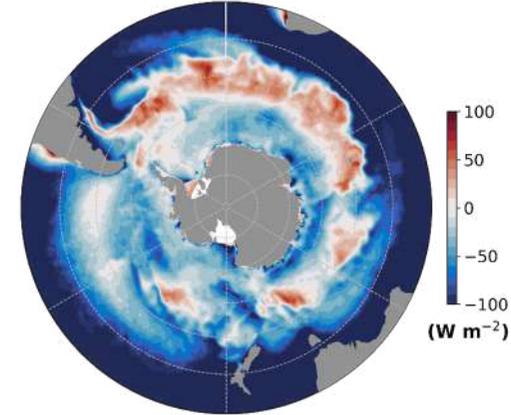


Ogle et al. 2018 GRL

Storm Occurrence (%)



Net heat flux during storms

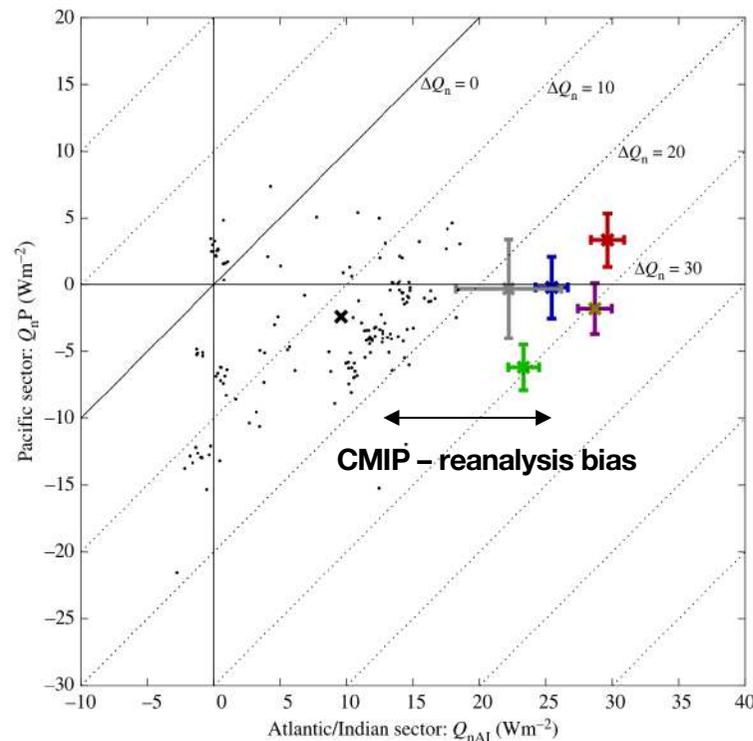
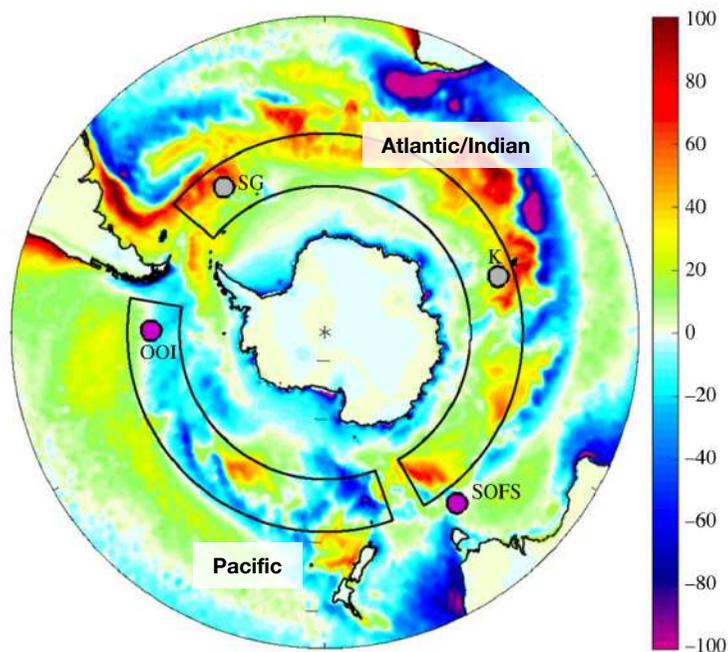


Prend et al. *in prep*

Intermittent and extreme events govern air-sea exchange

Reanalysis models show increased heat uptake in the Atlantic/Indian sector compared to CMIP models

The role of storms and small-scale processes is not accounted for and need better constraining



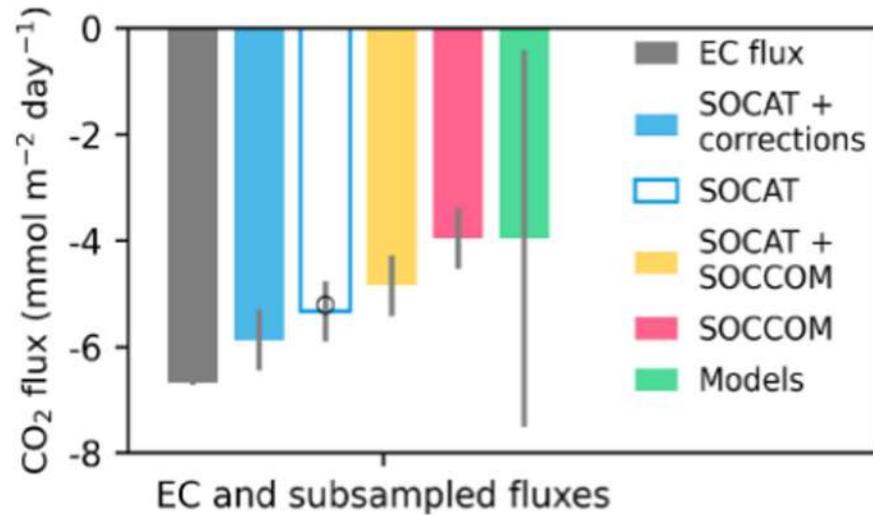
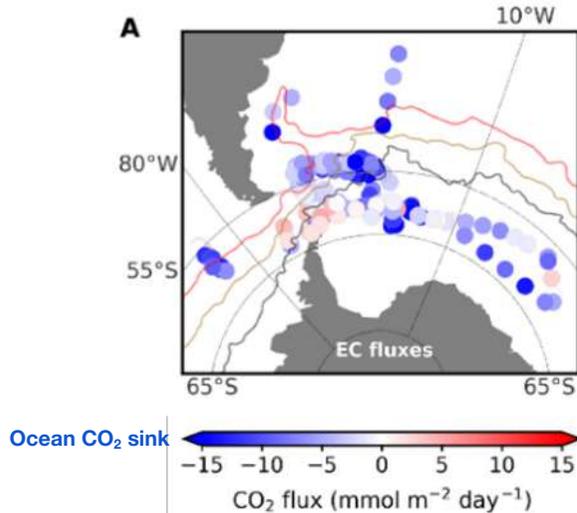
Importance of direct flux observations



Plymouth Marine Laboratory

Direct flux observations show an improved flux representation by correcting for cool skin and warm biases.

Southern Ocean uptake stronger than data-products and models



In the pipeline:

- *Harmony* (ESA) scheduled to launch in 2029: momentum fluxes in small regions with 20 km x 20 km patches for waves)
- *CIMR* (high-resolution microwave SST, the first satellite to launch in time for AA InSync),
- *ODYSEA* (Phase A proposal to NASA with CNES support) with winds (5 km) and currents (~25 km). In about a year, NASA expects to select 2 of the 4 Phase A concepts for flight, with launch dates anticipated in 2030 and 2032.

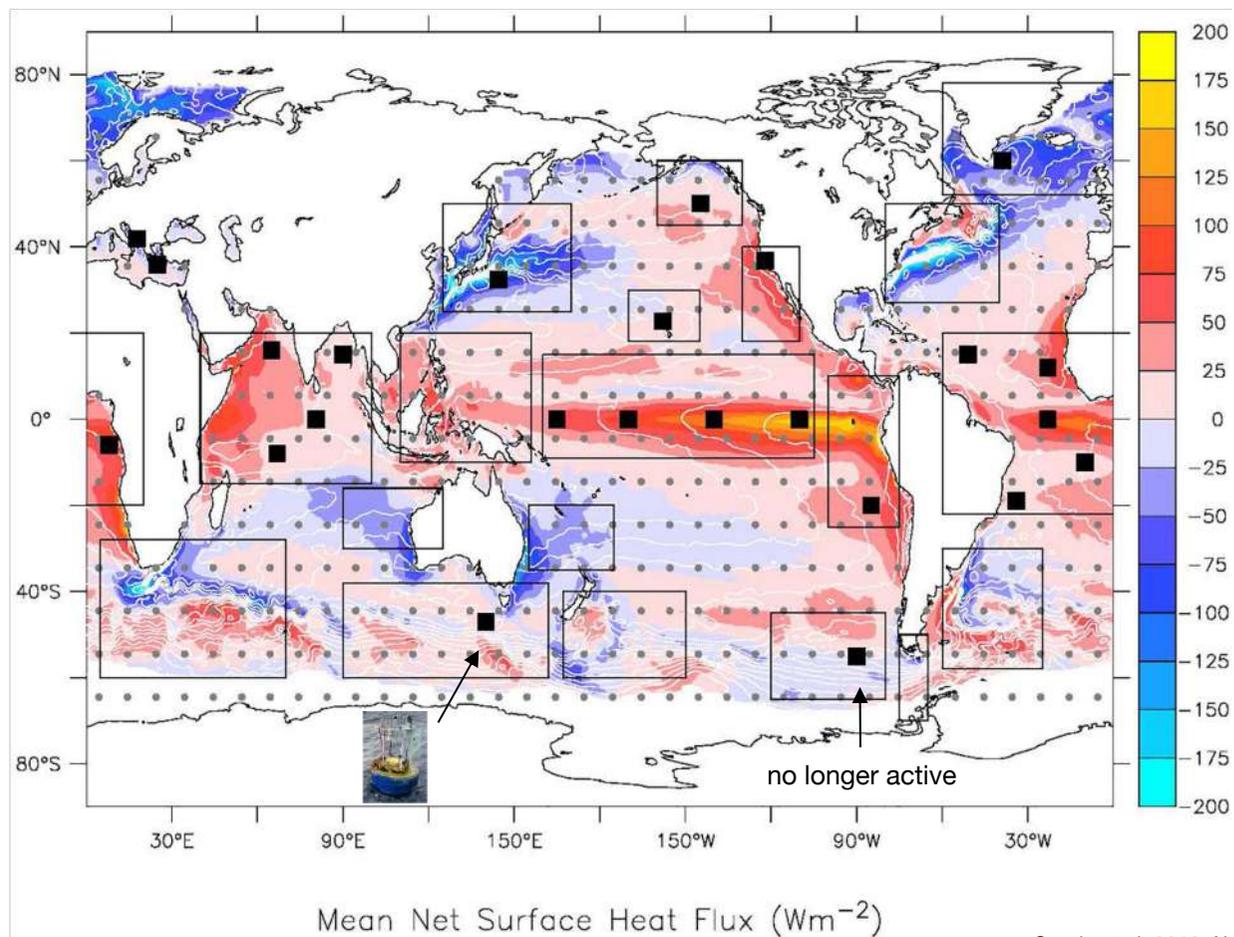


Image: ESA Harmony

Concepts for future proposals:

- *Butterfly*: near-surface temperature and humidity (turbulent heat fluxes using bulk parameterization, in development)
- *SeaSTAR* (high-resolution winds, waves, and currents using SAR and targeting coastal regions)

Ocean Obs '19 vision for a flux observing system



Observing Air-Sea Interactions Strategy (OASIS)

2021-2030 United Nations Decade of Ocean Science for Sustainable Development

Anderson et al. (2019)
Ardhuin et al. (2019a)
Bange et al. (2019)
Bax et al. (2019)
Canonico et al. (2019)
Domingues et al. (2019)
Estes et al. (2021)
Penny et al. (2019)
Pinardi et al. (2019)
Powers et al. (2019)

Observing Air-Sea Interactions Strategy (OASIS) is harmonizing community recommendations from OceanObs'19 and UN Decade Laboratories...

...into three Grand Ideas

Arco et al. (2021)
Bax et al. (2018)
Benson et al. (2018)
Cronin et al. (2019)
Cronin et al. (2021)
Fennel et al. (2018)
Foltz et al. (2019)
Hermes et al. (2019)
Maximenko et al. (2019)
Smith et al. (2019)
Speich et al. (2019)
Wanninkhof et al. (2019)

Improved Earth system (including ecosystem) forecasts for a predicted, clean, accessible, healthy, safe & productive ocean

Centurioni et al. (2019)
Grooms et al. (2019)
Harcourt et al. (2019)
Jamet et al. (2019)
Muelbert et al. (2019)
Muller-Karger et al. (2018)
Newman et al. (2019)
Lombard et al. (2019)
Marandino et al. (2022)
Kent et al. (2019)
O'Carroll et al. (2019)
Sequeira et al. (2021)
Steinhoff et al. (2019)
Subramanian et al. (2019)
Swart et al. (2019)
Villas Bôas et al. (2019)
Ardhuin et al. (2019b)
Bourassa et al. (2019)
Gentemann et al. (2020)
Gommenginger et al. (2019)
Morrow et al. (2019)
Rodriguez et al. (2019)
Shutler et al. (2020)
Vinogradova et al. (2019)

Grand Idea #3
Improved models & understanding of air-sea interaction processes

Meinig et al. (2019)
Pearlman et al. (2020)
Sabine et al. (2020)
SCOR Working Group 154 (2020)
Smith et al. (2019)
Wang et al. (2019)

Grand Idea #2
Satellites optimized for air-sea fluxes

Grand Idea #1
A globally distributed in situ air-sea observing network built around an expanded array of time series stations

Image: Sarah Battle/NOAA visit: airseaobs.org

We will need to bring in all technologies

