

# Constraints on the variability of the oceanic CO<sub>2</sub> sink from observations and theory

Nicolas Mayot\*, E. T. Buitenhuis, R. Wright, and C. Le Quéré

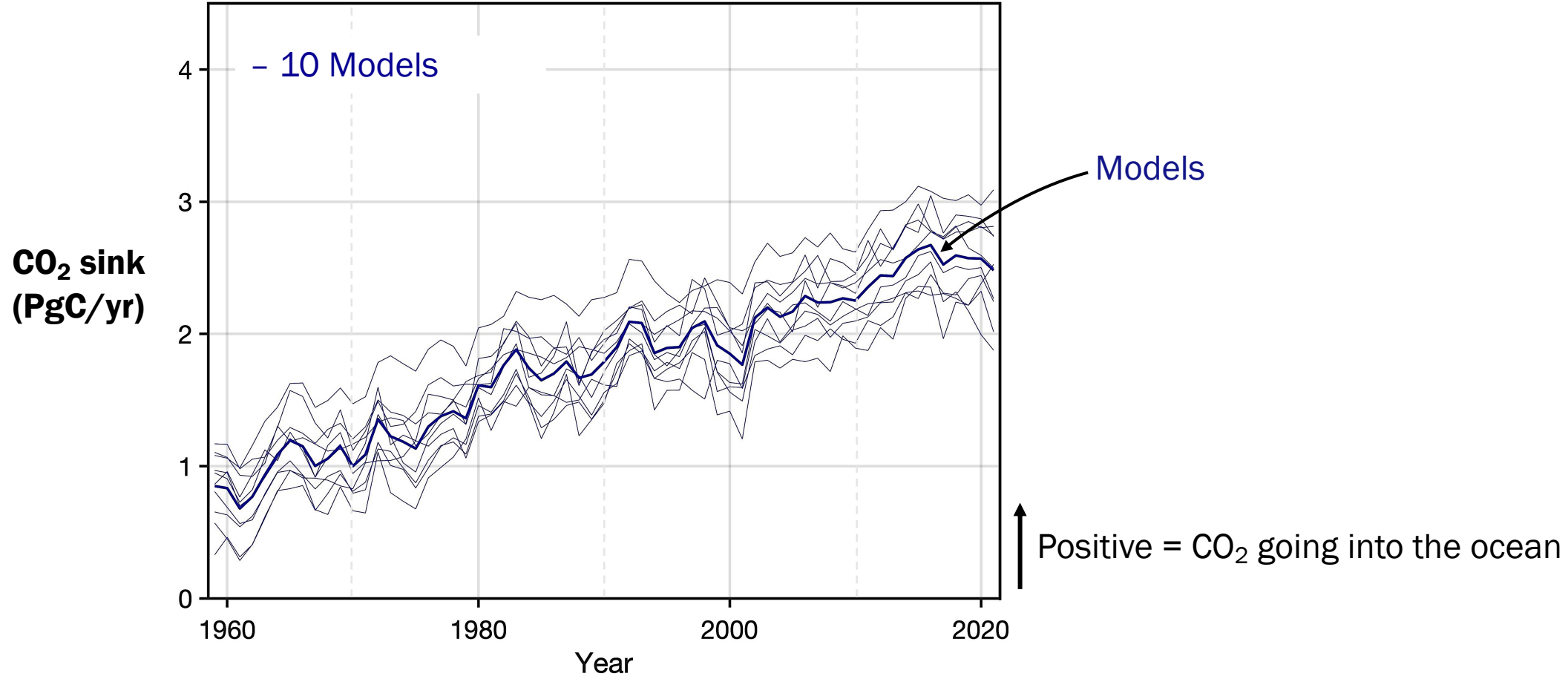
\*University of East Anglia, Norwich (UK) – n.mayot@uea.ac.uk

EGU General Assembly 2023

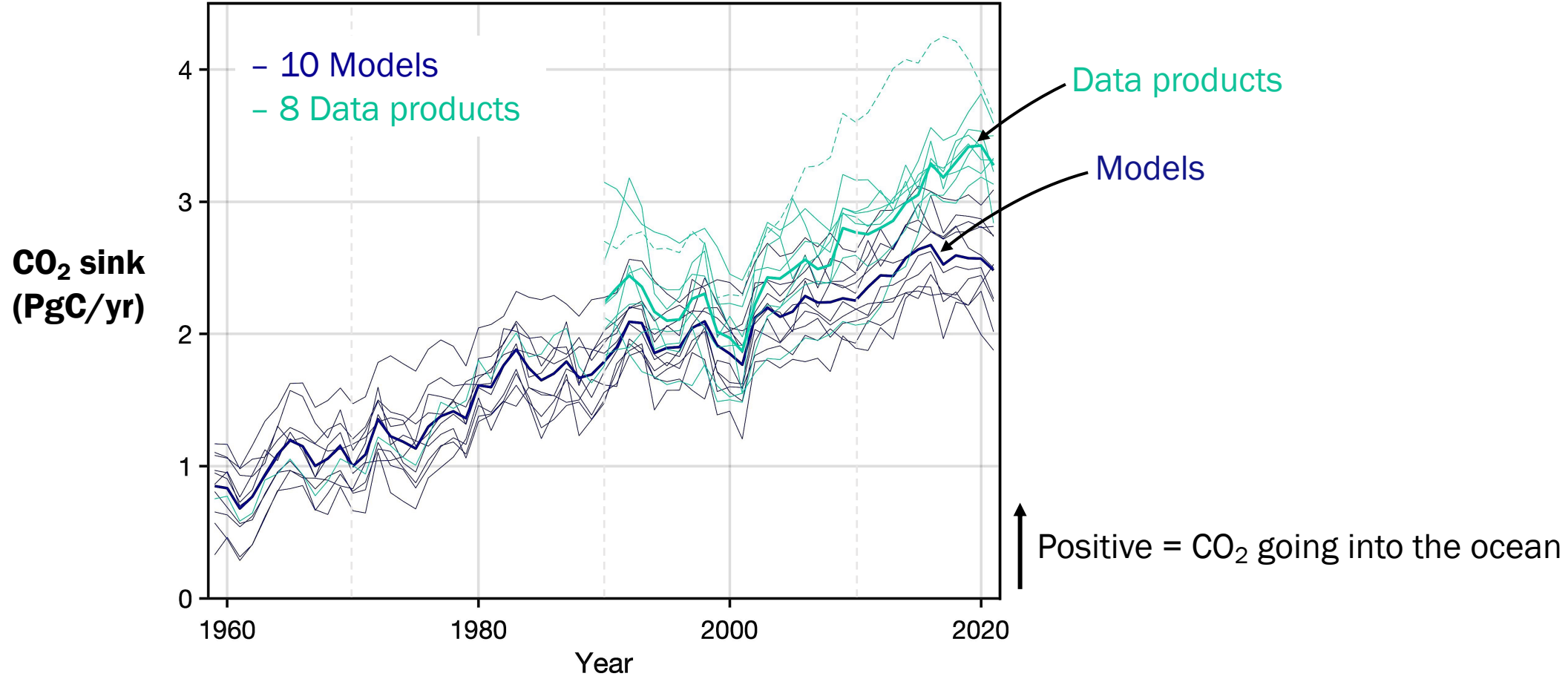
Session OS3.5: Recent advances in constraining the marine carbon cycle  
Friday, 28 April – 16:40 | Room L3



Carbon flux from the Atmosphere to the Ocean

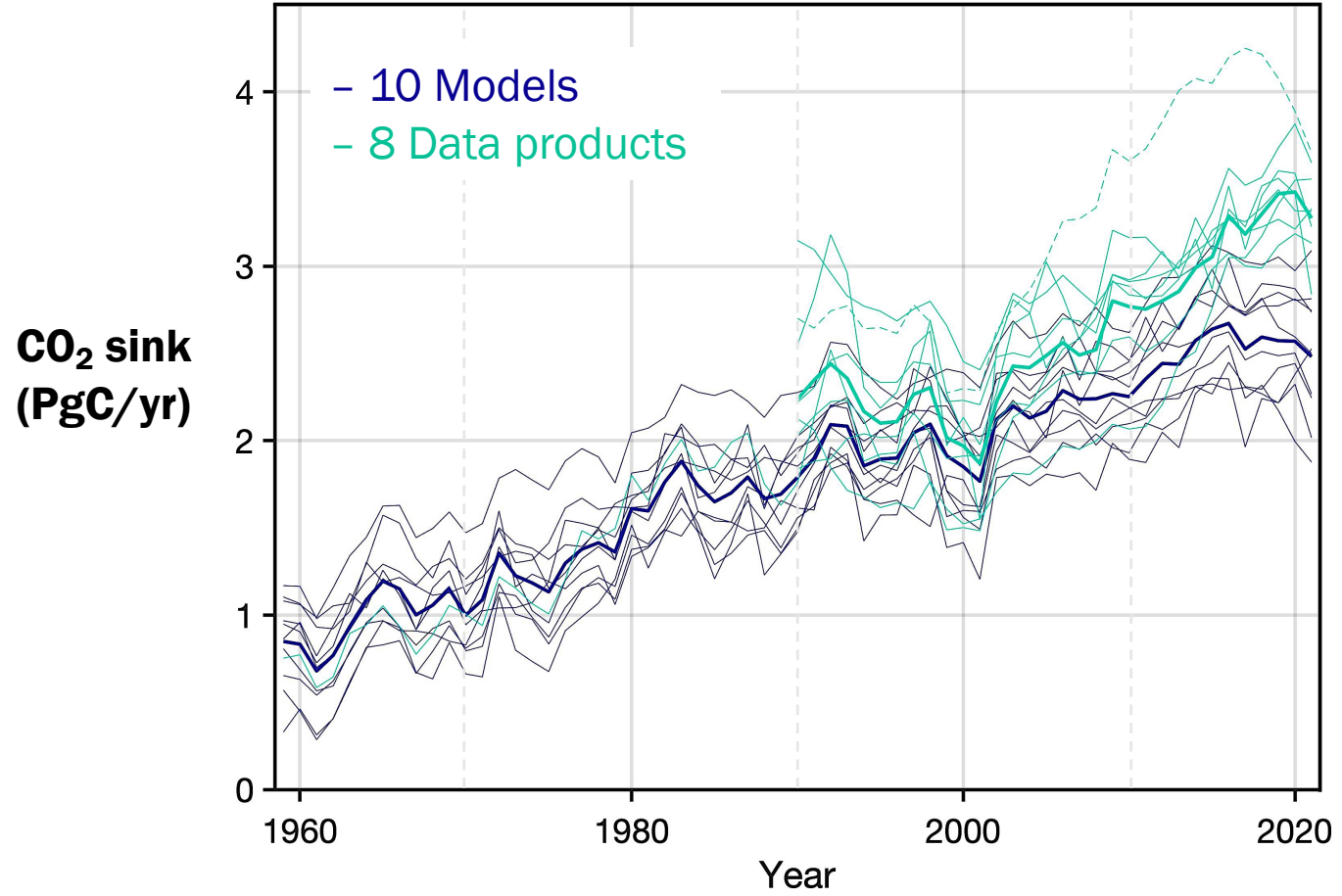


Carbon flux from the Atmosphere to the Ocean



- Substantial variabilities in ocean CO<sub>2</sub> sink inferred from data products are not reproduced by models

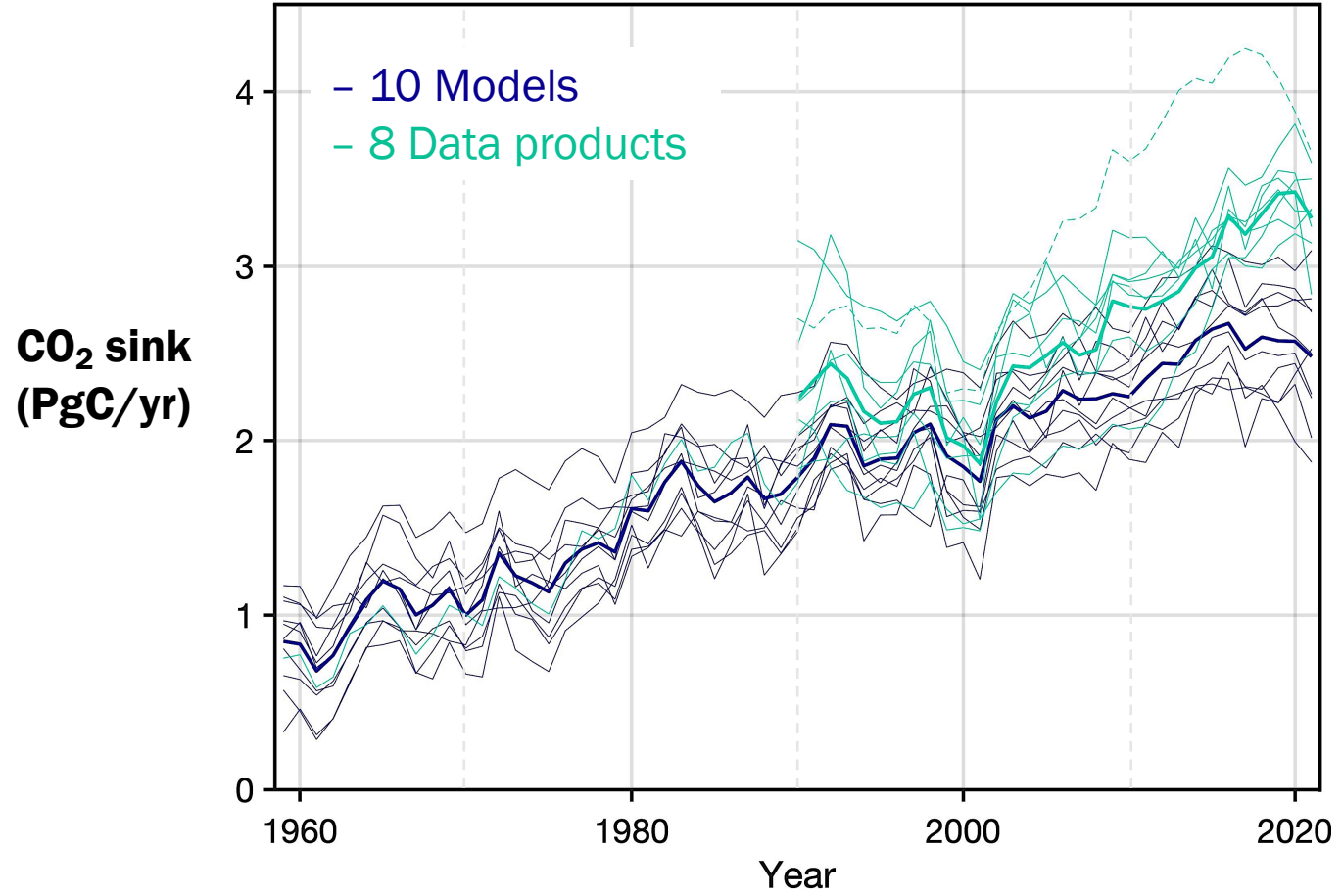
### Carbon flux from the Atmosphere to the Ocean



Amplitude of interannual variability between 1990-2019 (PgC/yr)	
Models	0.14 ± 0.03
Data products	0.25 ± 0.08

- Substantial variabilities in ocean CO<sub>2</sub> sink inferred from data products are not reproduced by models
  - Ocean CO<sub>2</sub> sink estimates from data products and models diverge in 2010s

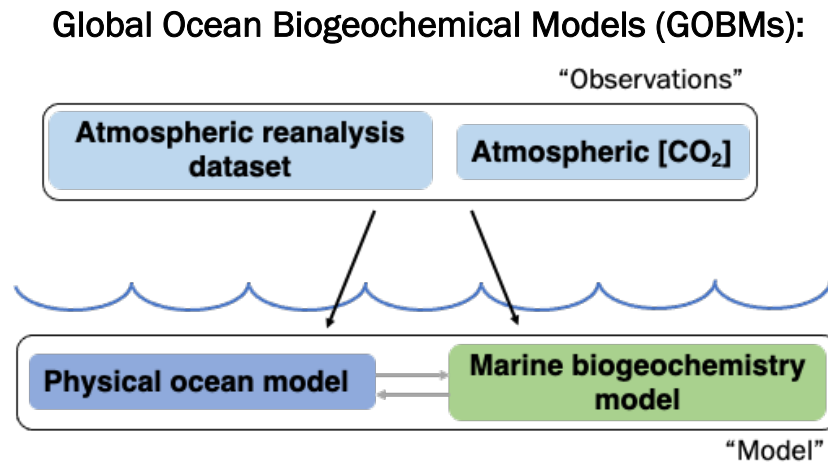
### Carbon flux from the Atmosphere to the Ocean



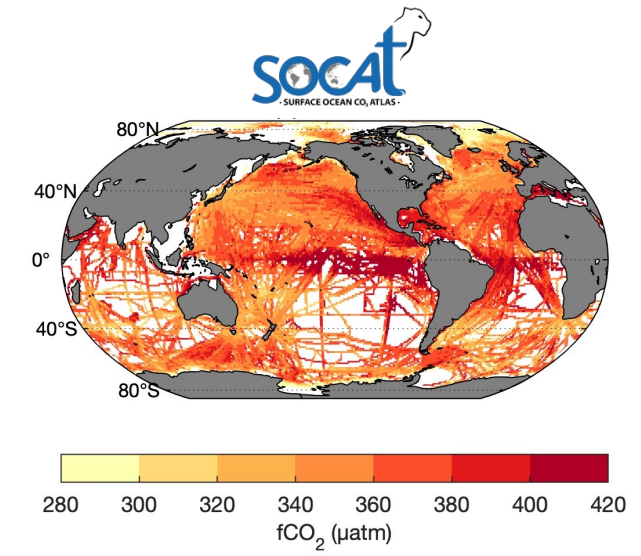
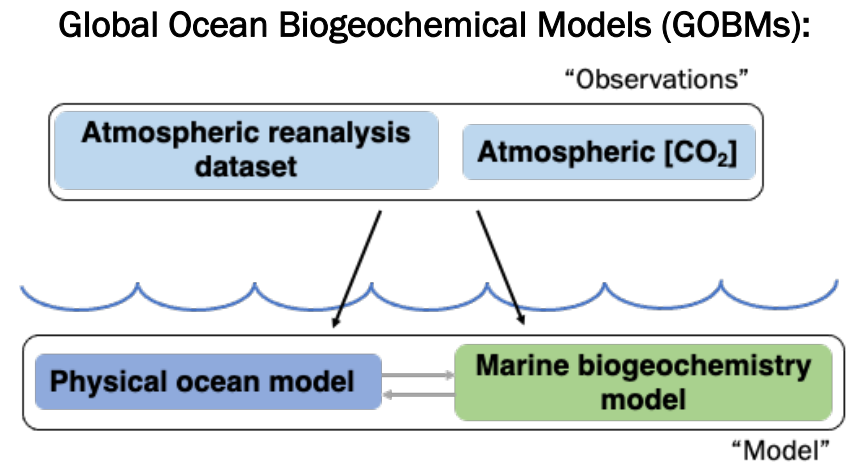
	Amplitude of interannual variability between 1990-2019 (PgC/yr)	Trend in 2010s (PgC/yr/decade)
Models	0.14 ± 0.03	0.34 ± 0.10
Data products	0.25 ± 0.08	0.77 ± 0.38

- **Global Ocean Biogeochemical Models underestimate interannual variability (-39%)**
  - **Refutes a strong decadal trend in the 2010s**
- **Data products might be sensitive to a lack of data and overly amplify the 2010s trend**

We used a state-of-the-art Global Ocean Biogeochemical Models (i.e., NEMO-PlankTOM12)

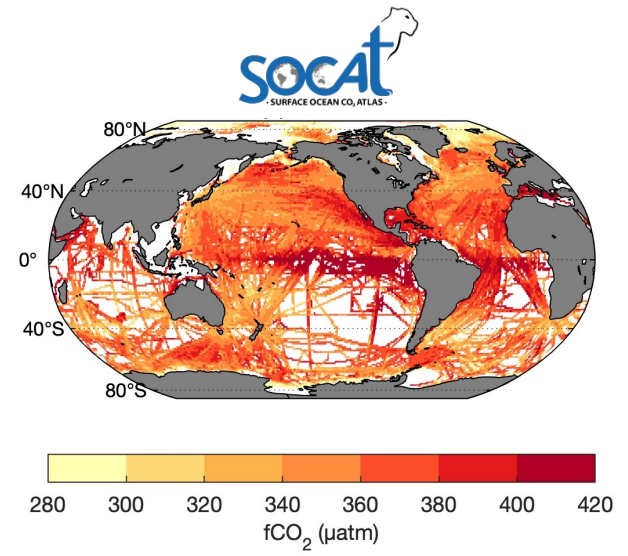
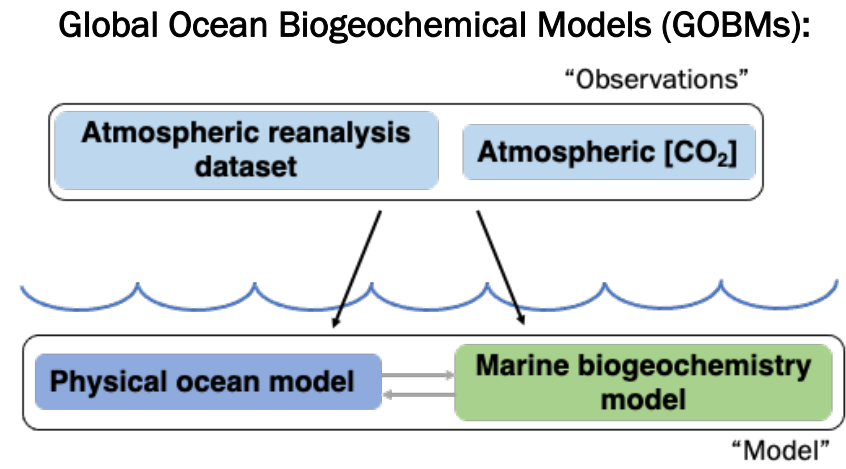


We used a state-of-the-art Global Ocean Biogeochemical Models (i.e., NEMO-PlankTOM12) and data of CO<sub>2</sub> fugacity at the sea surface (fCO<sub>2</sub>) from SOCAT





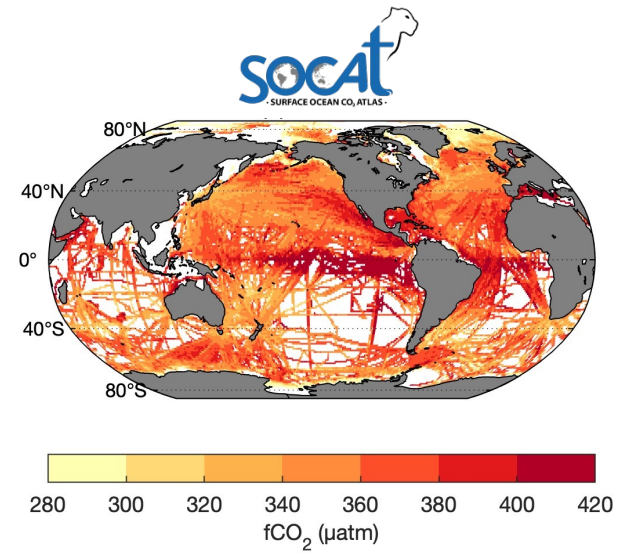
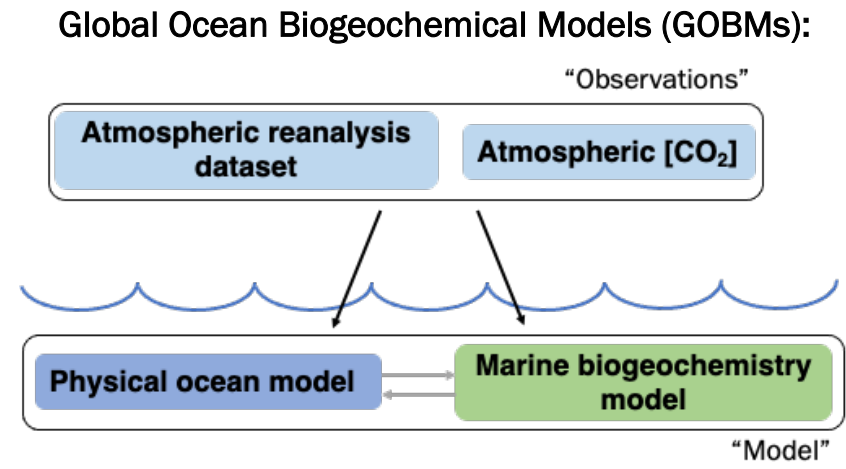
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Step 1: Optimisation of model parameters

Step 2: Constrain the simulated CO<sub>2</sub> sink based on fCO<sub>2</sub> observations

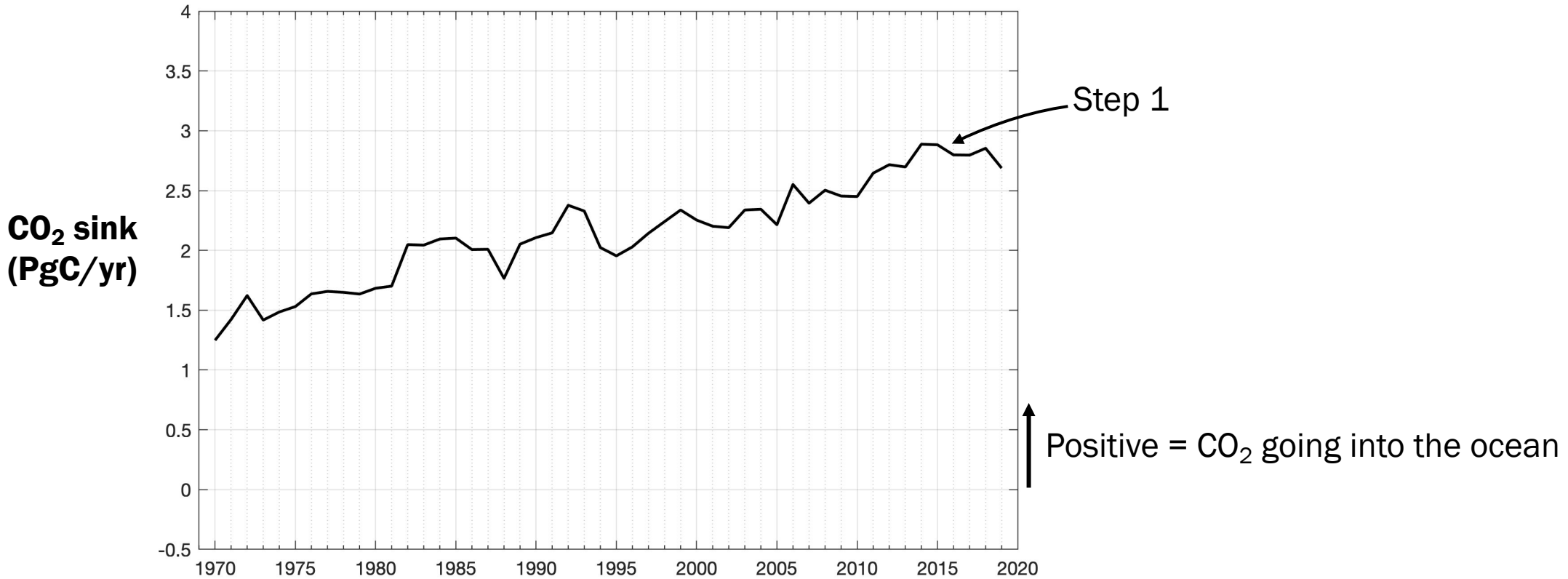
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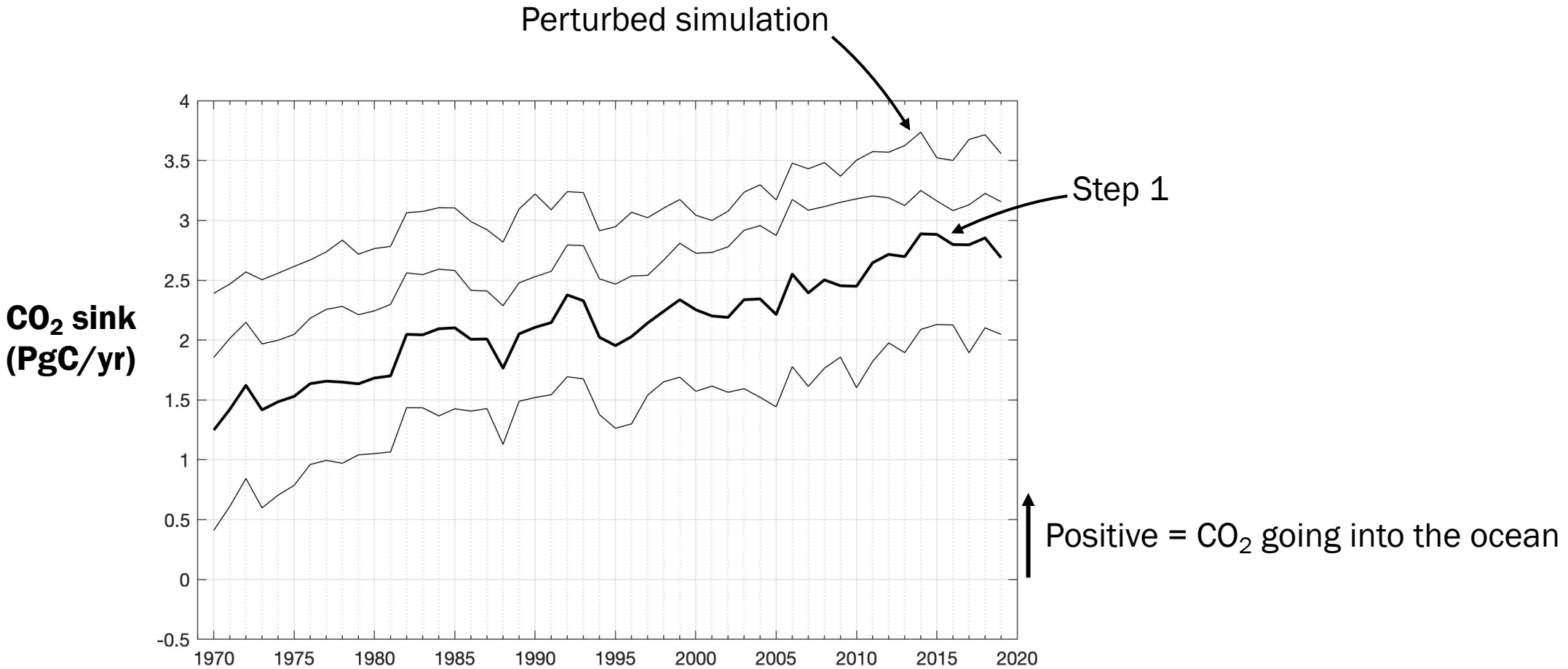
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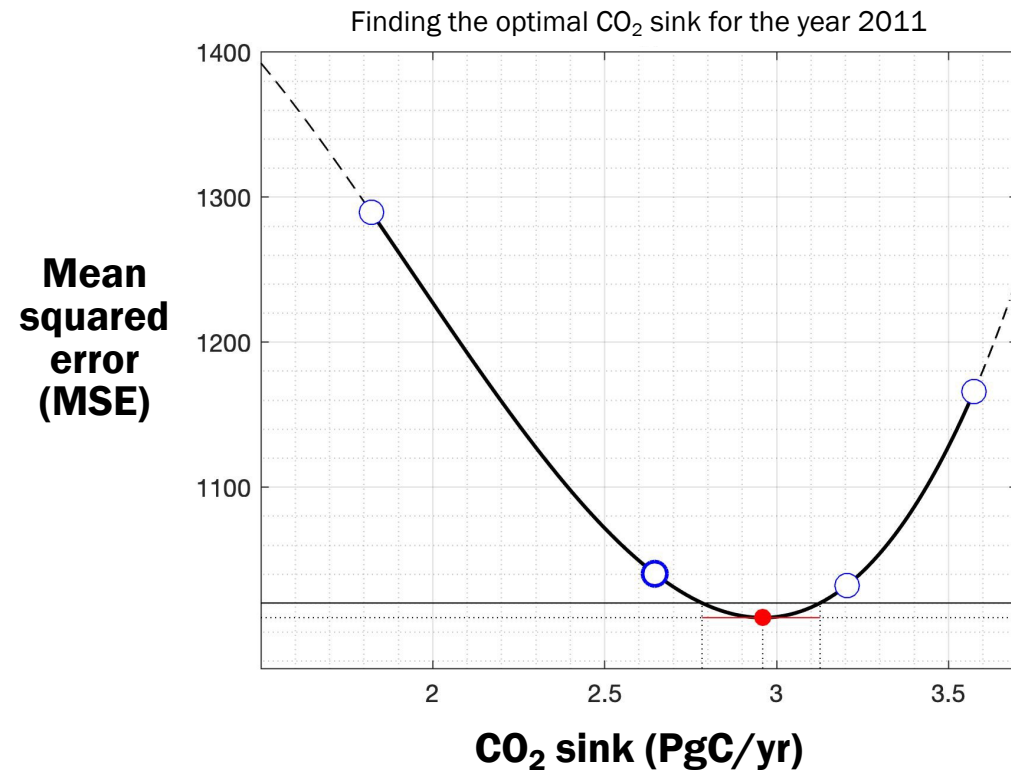
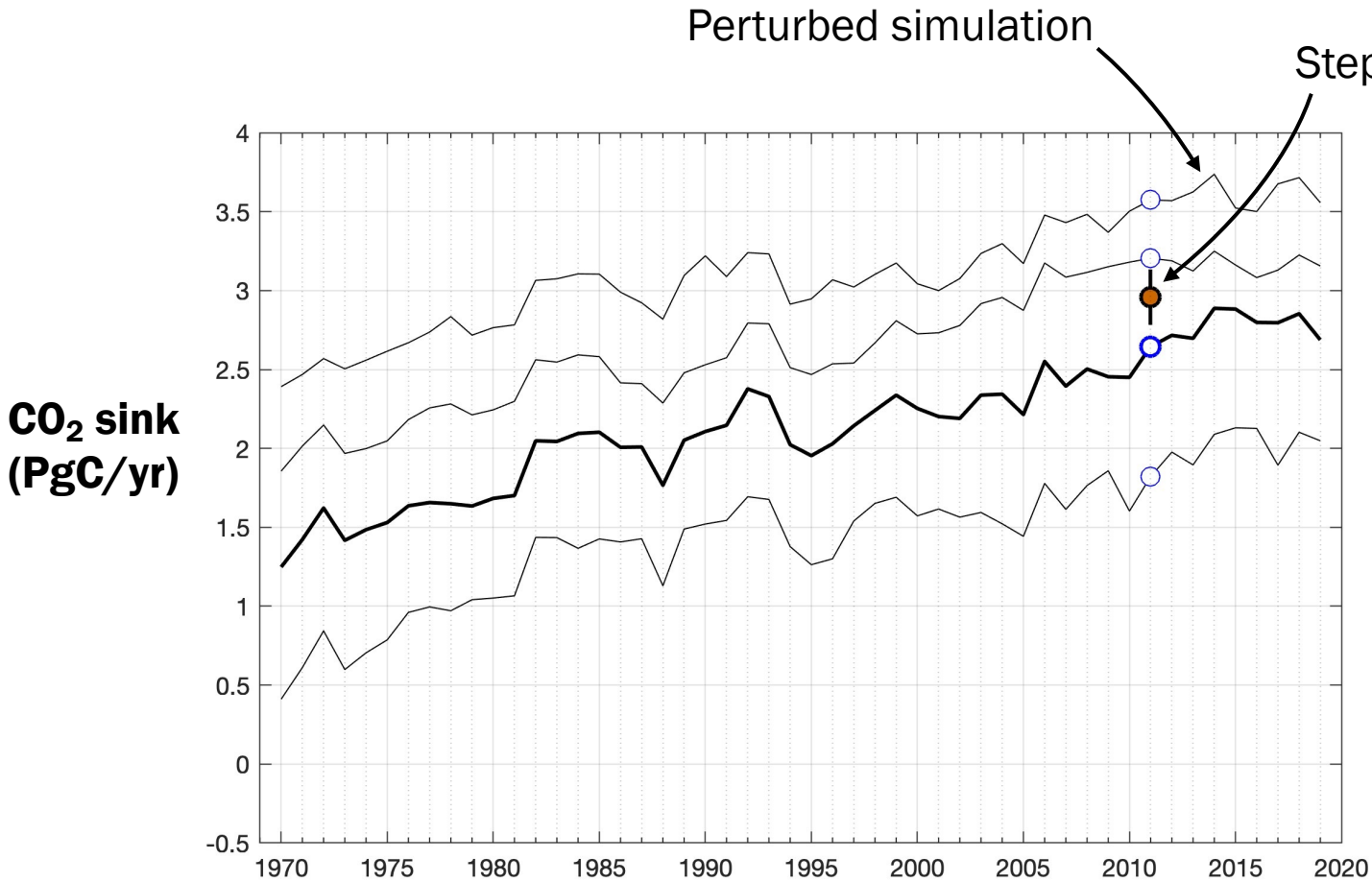
Constrain the simulated CO<sub>2</sub> sink based on fCO<sub>2</sub> observations



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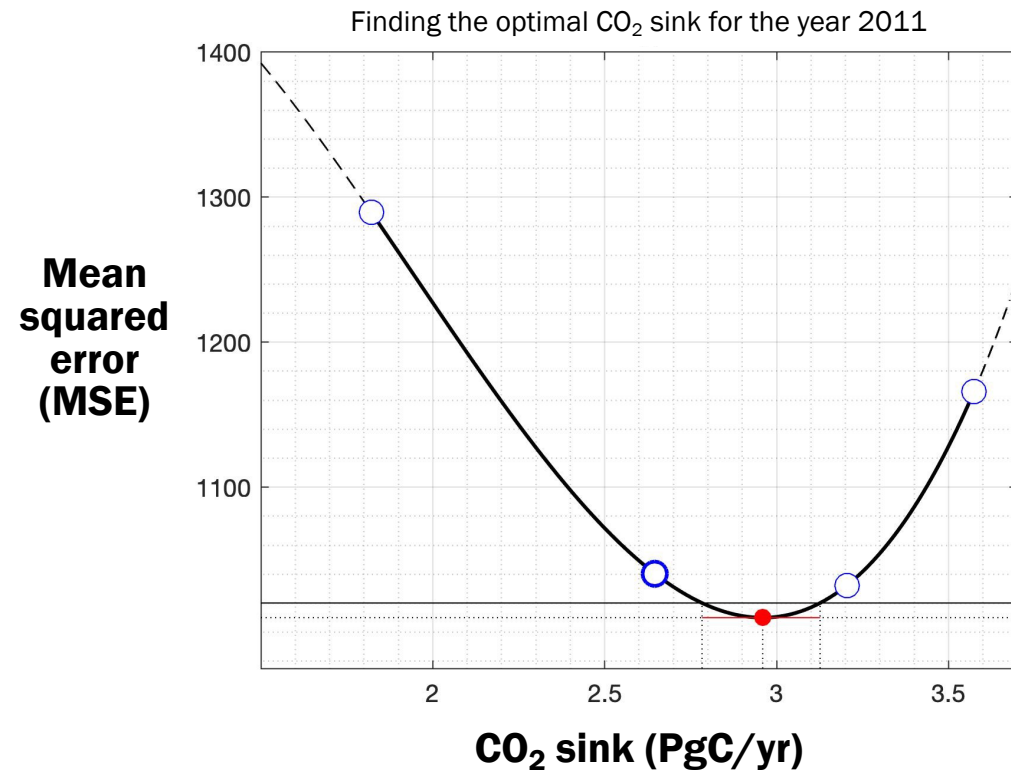
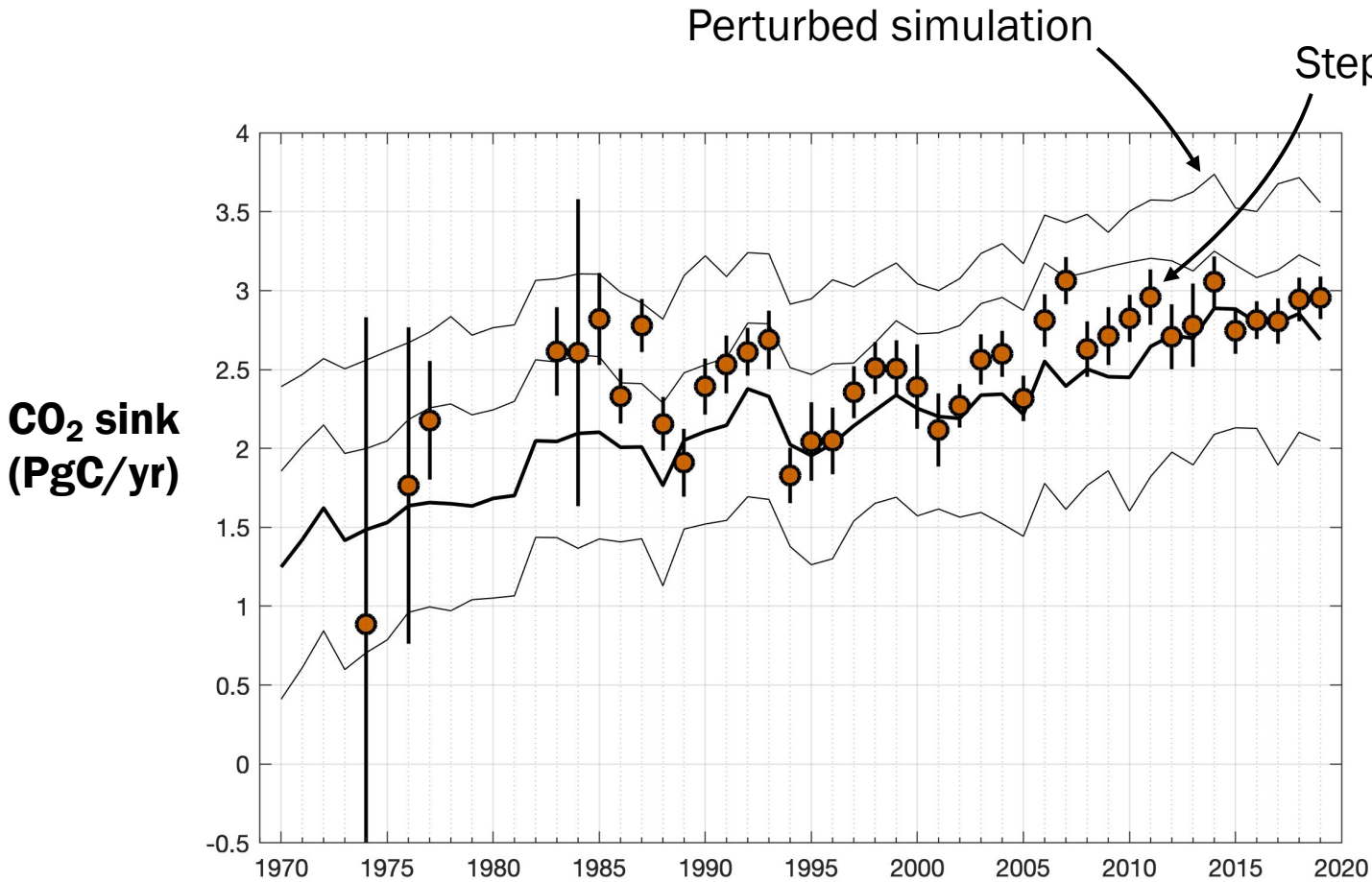


### Constrain the simulated CO<sub>2</sub> sink based on fCO<sub>2</sub> observations



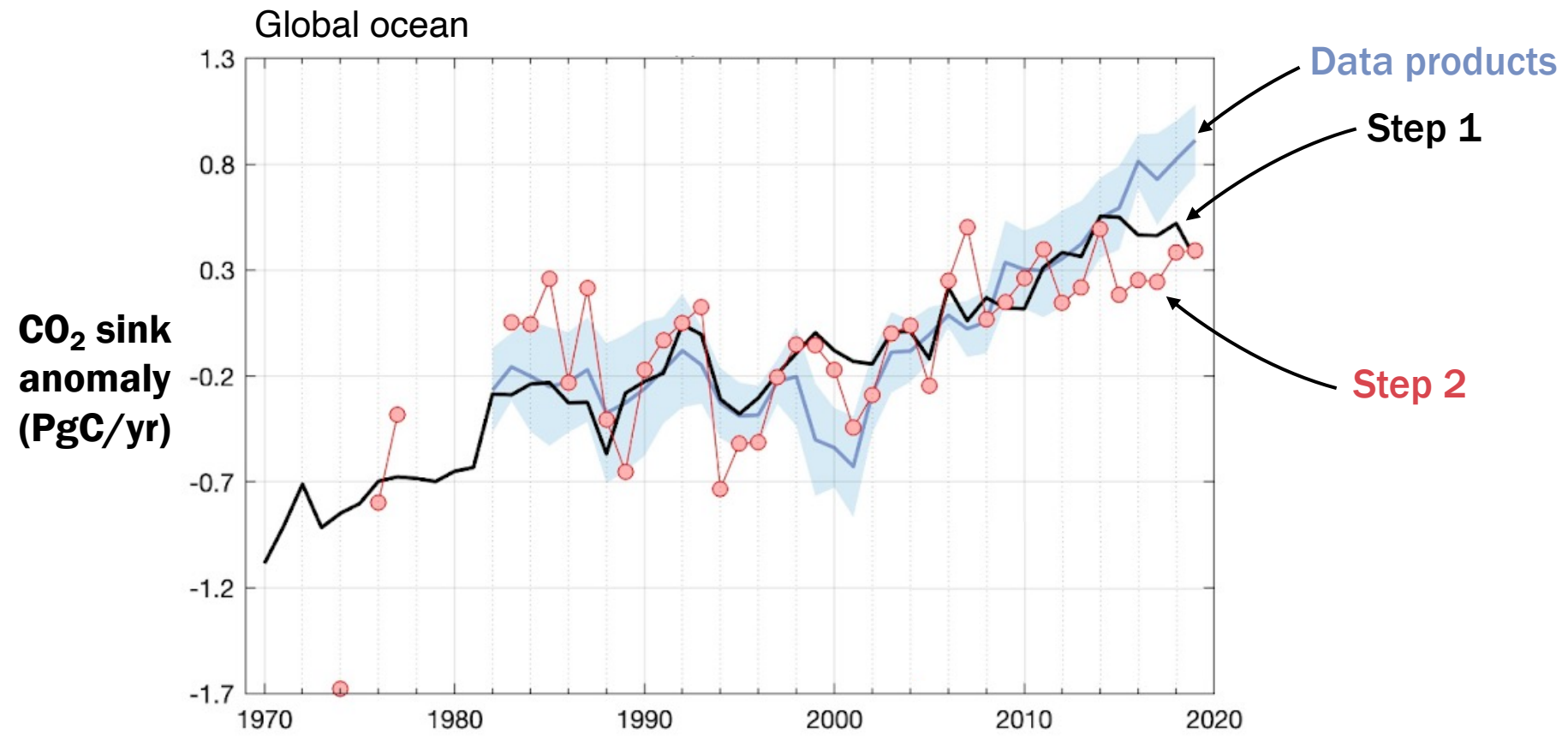
$$MSE = \frac{1}{n} \sum_{i=1}^n (SOCAT - PlankTOM)^2$$

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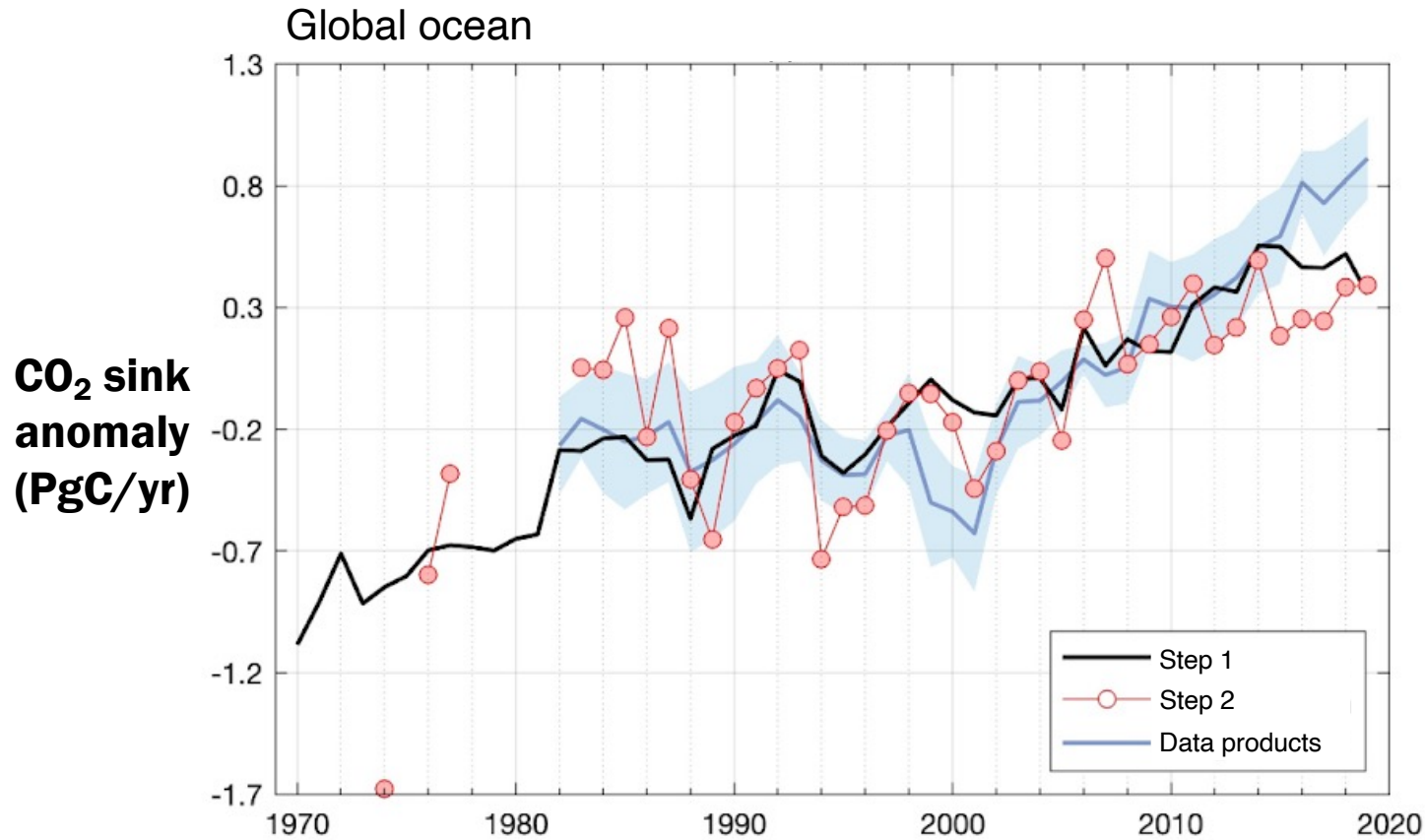
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# Variability of the global ocean CO<sub>2</sub> sink



# Variability of the global ocean CO<sub>2</sub> sink

- The hybrid approach suggests that the model underestimates the amplitude of the interannual variability



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Amplitude of interannual variability between 1990-2019 (PgC/yr)	
Step 1	0.13
Data products	0.25 ± 0.08
Step 2	0.23

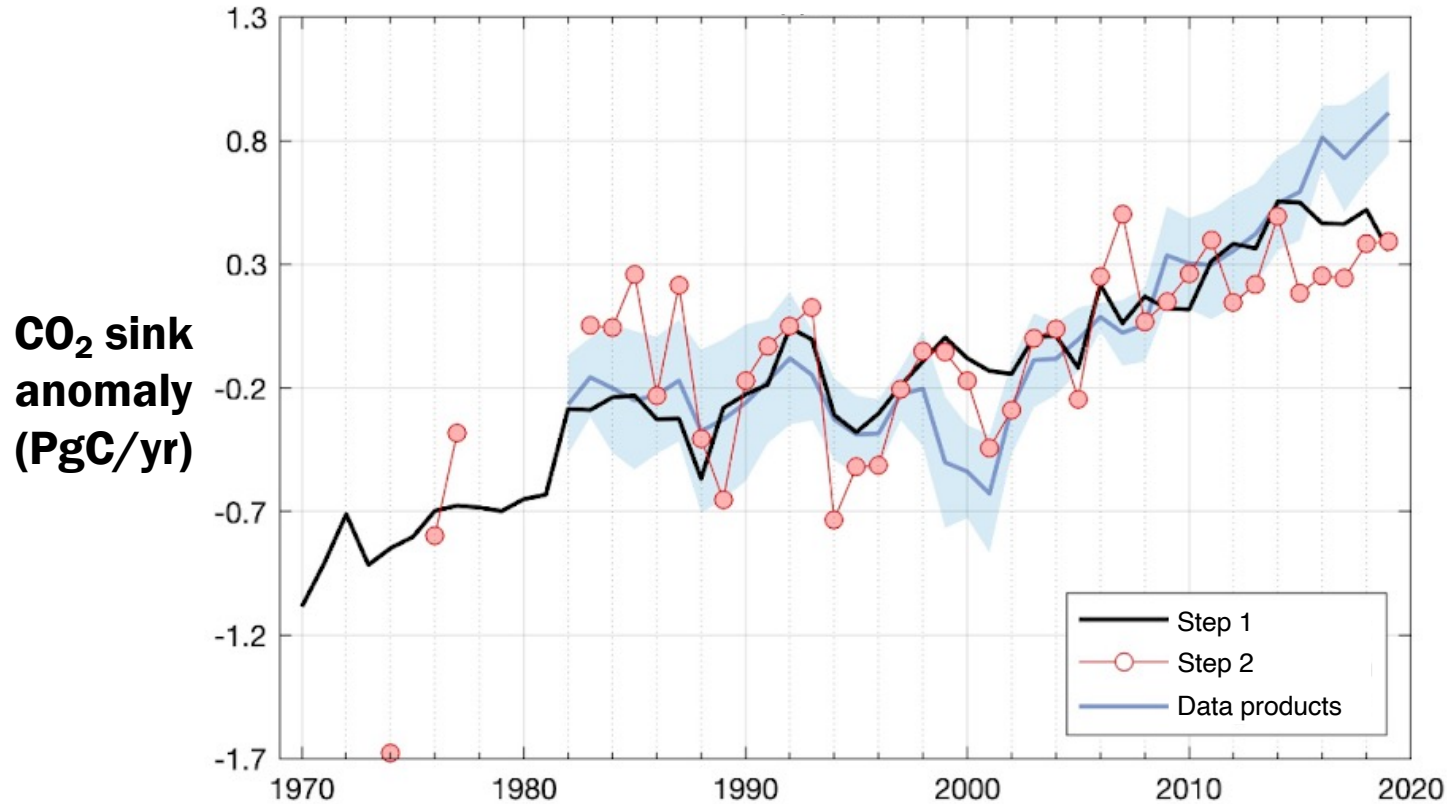
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# Variability of the global ocean CO<sub>2</sub> sink

- The hybrid approach suggests that the model underestimates the amplitude of the interannual variability
  - Does not support a strong increase of the oceanic CO<sub>2</sub> sink in 2010s

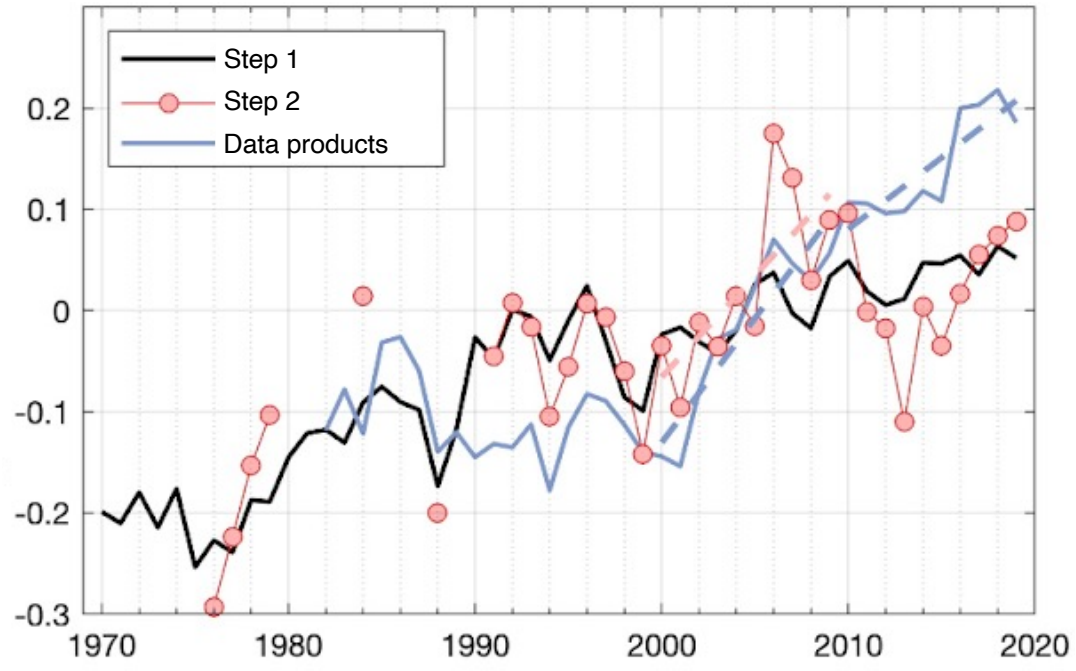
Global ocean



	Amplitude of interannual variability between 1990-2019 (PgC/yr)	Trend in 2010s (PgC/yr/decade)
Step 1	0.13	0.26
Data products	0.25 ± 0.08	0.77 ± 0.38
Step 2	0.23	0.08

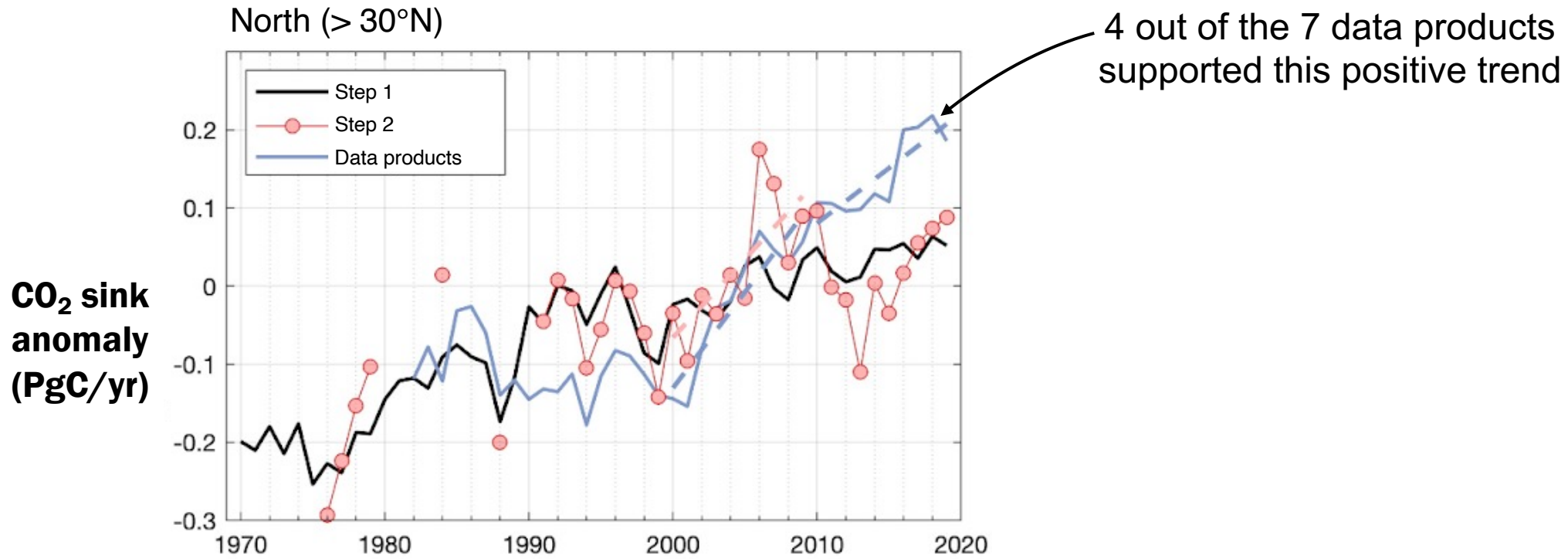
# Variability of the global ocean CO<sub>2</sub> sink

North (> 30°N)

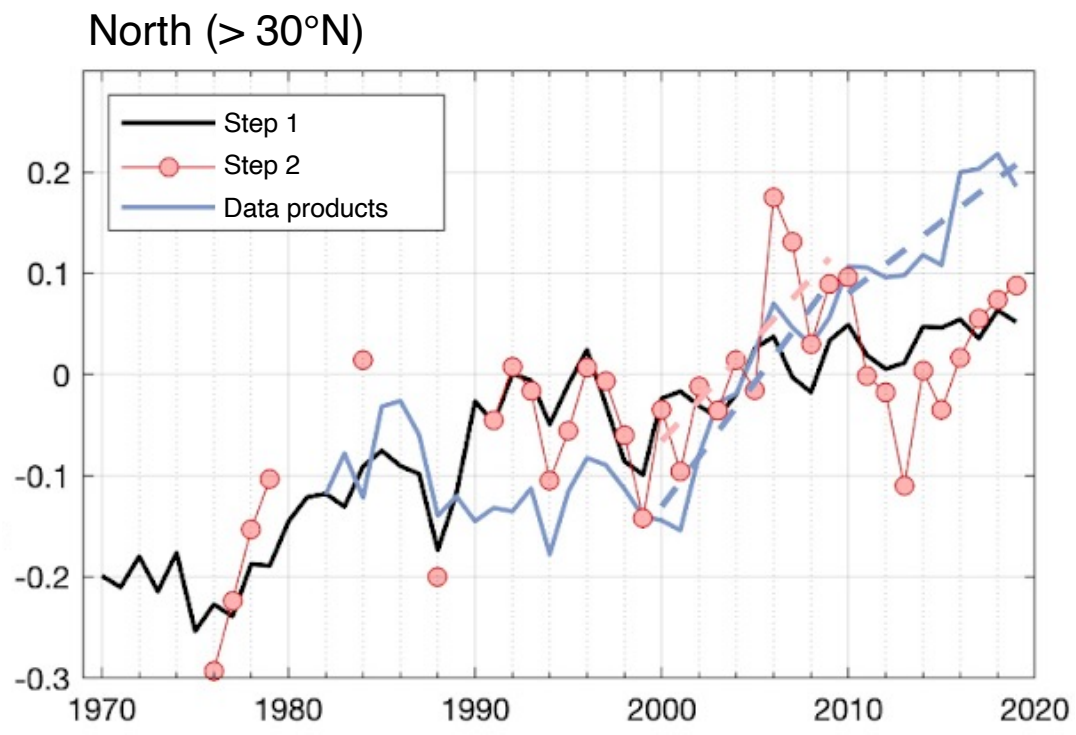


**CO<sub>2</sub> sink anomaly (PgC/yr)**

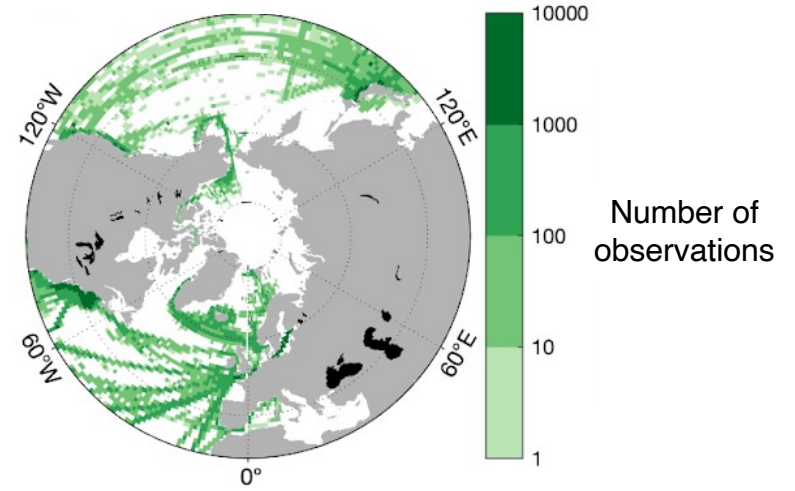
- Some data products suggest a strong positive trend in 2010s in the North



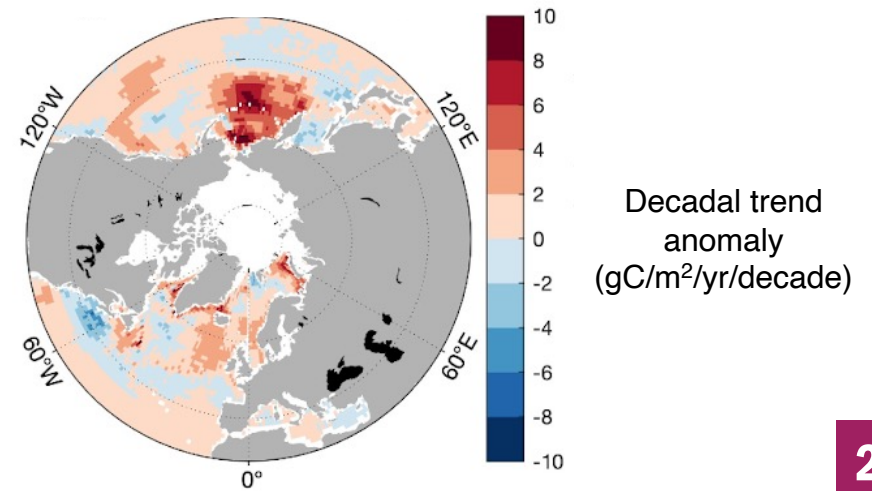
- Some data products suggest a strong positive trend in 2010s in the North
- Mostly associated with the subpolar North Pacific region which was under sampled in the 2010s



SOCAT observations in 2010s



Decadal trend in 2010s from data products with highest trend



- **Global Ocean Biogeochemical Models underestimate interannual variability (-39%)**
  - **Refutes a strong decadal trend in the 2010s**
- **Data products might be sensitive to a lack of data and overly amplify the 2010s trend**

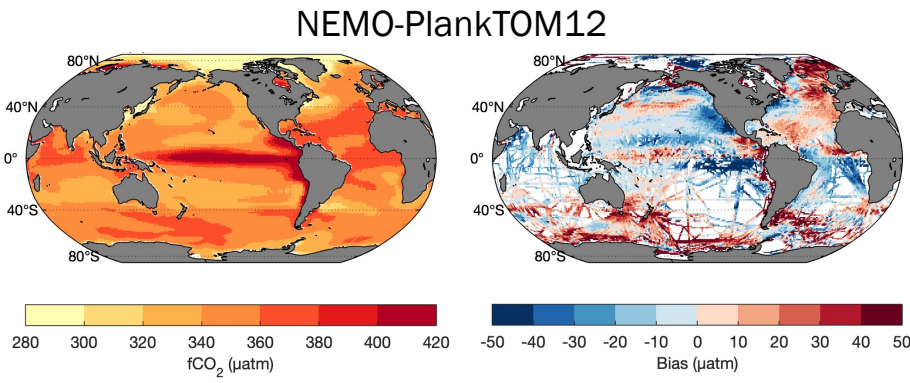
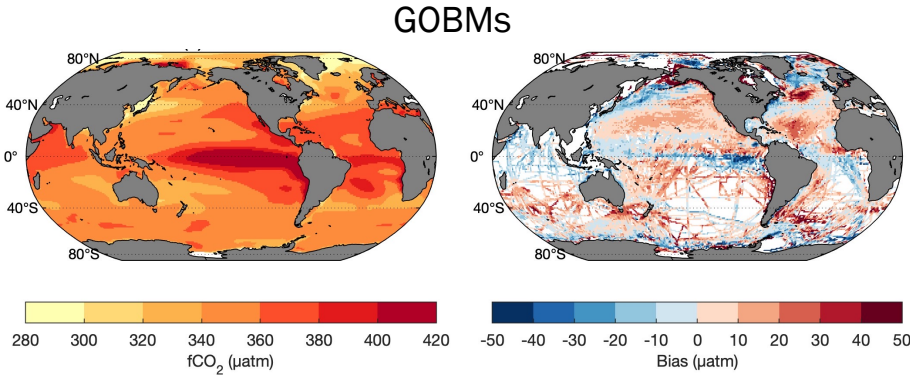
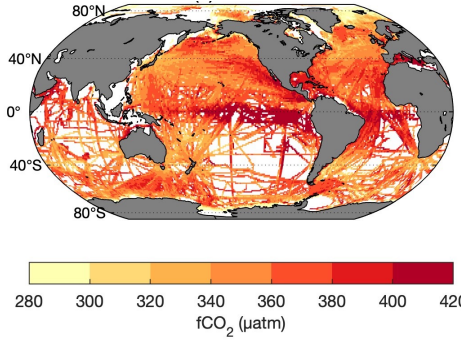
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## Thank you

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AIAV in PgC/yr  
(Amplitude of interannual variability)

