Supplementary Material

Do discrepancies in seasonal CO₂ fluxes accumulate to influence the interannual CO₂ fluxes?



In the North Atlantic, we find **patterns of dominating seasonal variability** while in the Southern Ocean **observationbased output is not able to demonstrate robust conclusions on the relevance of seasonal variability.**

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Paridhi Rustogi¹, Peter Landschützer², Sebastian Brune¹, and Johanna Baehr¹

Motivation



To resolve ocean carbon sink variability on longer timescales, understanding the variability and drivers of carbon fluxes on shorter timescales is critical.

• Significant decadal variability substantially stronger than expected based on mainly model-based estimates



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SOM-FFN^[1] Observation-based dataset

(Self-organising Map with Feed-Forward Network)

Observation-based dataset Based on Surface Ocean CO₂ Atlas database

1 member

Datasets

Example Drivers of Carbon fluxes

UН

Sea Surface Temperature (SST) NOAA OISST Reanalysis ^[3]

[1] Landschützer et al., 2016

[2] Maher et al., 2019

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Seasonal Analysis of Air-Sea CO₂ Flux Variability in the North Atlantic and the Southern Ocean

Paridhi Rustogi¹, Peter Landschützer², Sebastian Brune¹, and Johanna Baehr¹

Historical simulation with RCP4.5 forcing

100 members

Mixed Layer Depth (MLD) **NOAA MIMOC**^[4]

> [3] Reynolds et al., 2007 [4] Schmidtko, et al. 2013

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General FGU21: Gather





(Max-Planck Institute Earth System Model Grand Ensemble)

Supplementary Material

MPI-ESM GE^[2]

Research Questions

- Does a particular season dominate the interannual variability of carbon fluxes?
- In which season(s) do carbon fluxes vary the most?

Do these season(s) explain the most variance in the annual time series?

• Do observation-based and model fluxes agree on the **dominant seasonal drivers?**

Study Regions



The North Atlantic Basin A region to confirm expectations of model capabilities

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The Southern Ocean



EGU21-13637 Supplementary Material

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Seasonal Scale Analysis in the North Atlantic Basin

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Supplementary Material



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Season dominating interannual variability



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Paridhi Rustogi¹, Peter Landschützer², Sebastian Brune¹, and Johanna Baehr¹

Correlation of Sea Surface Temperature and Carbon Flux



Relation between carbon flux and SST is better captured in MPI-GE for the subtropical region where carbon fluxes are driven by seasonal changes in SST.

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Seasonal Scale Analysis in the Southern Ocean



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Supplementary Material

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Significant differences in interannual variability and seasonal drivers of variability

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- •For the North Atlantic, MPI-GE is an **appropriate tool** to study carbon fluxes on a seasonal and interannual timescale.
- •For the Southern Ocean, **more observations** required for a robust conclusion on MPI-GE's ability to represent carbon fluxes on a seasonal and interannual timescale.
- •Assimilation of oceanic and atmospheric observations into MPI-ESM could offer incremental improvements in the representation of carbon fluxes, especially in the timing of the variability and in areas where observations are available and reliable.





