

Improved winter data coverage of the Southern Ocean CO₂ sink from extrapolation of summertime observations

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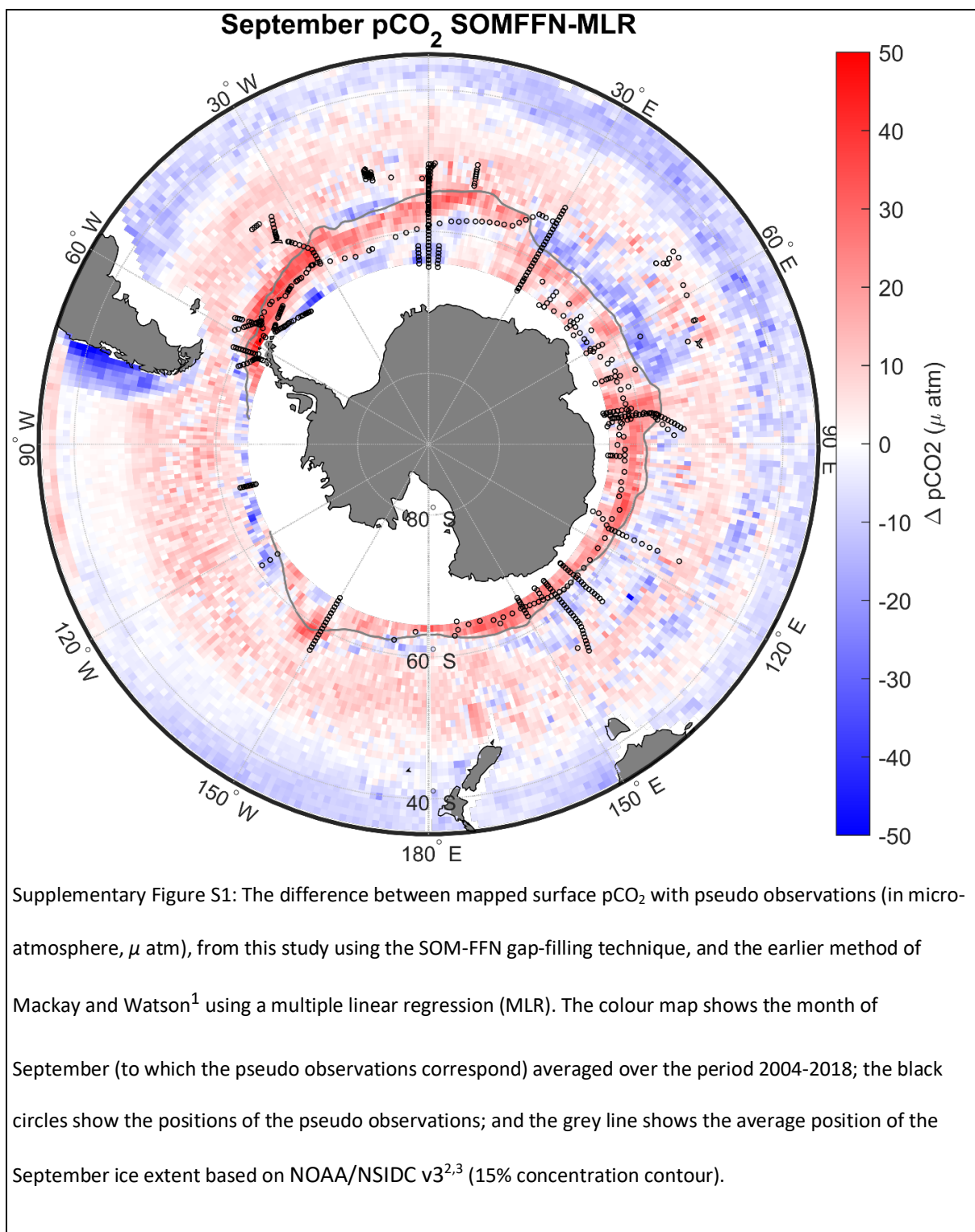
1. Faculty of Environment, Science and Economy, University of Exeter, Exeter, UK.

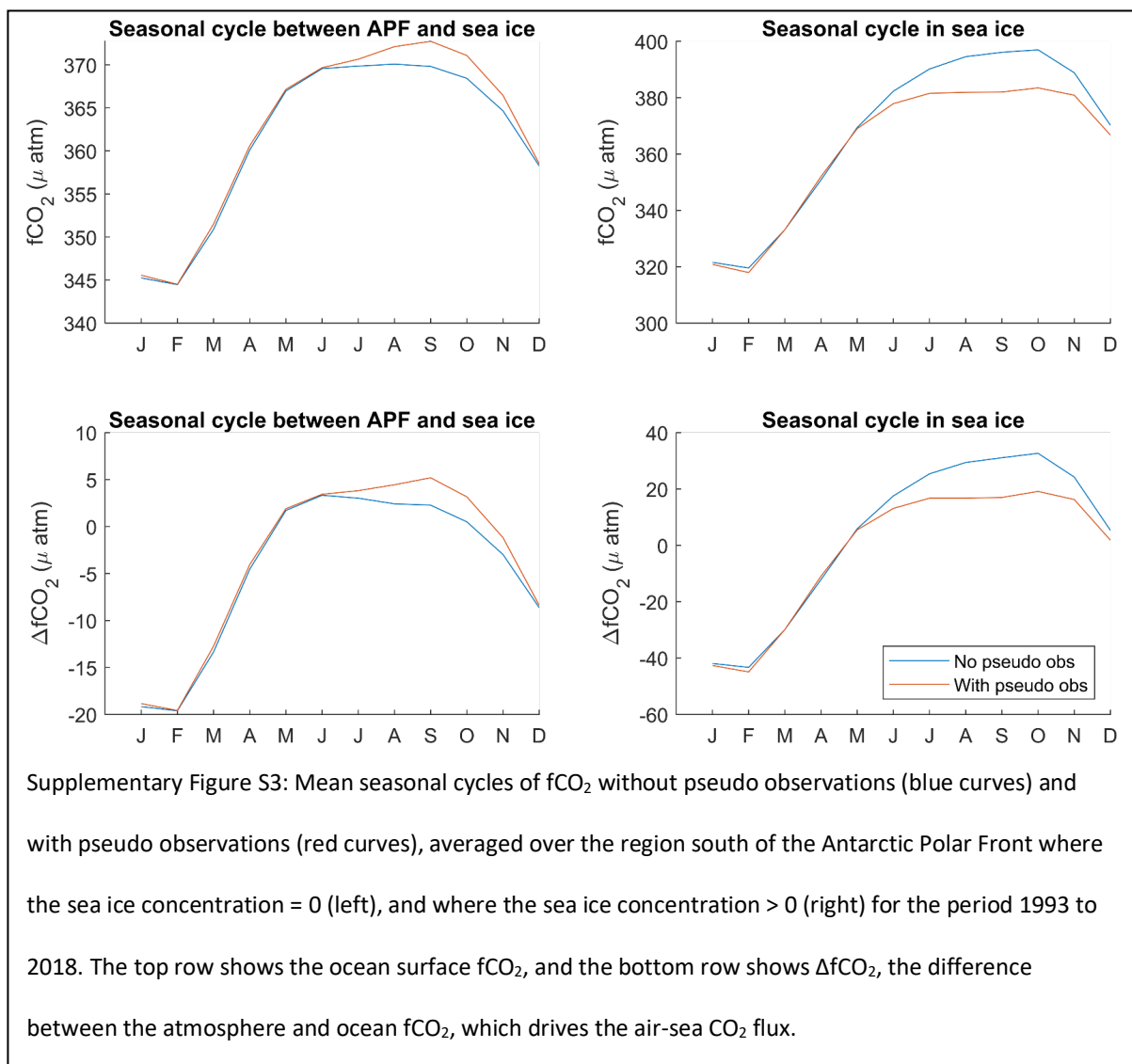
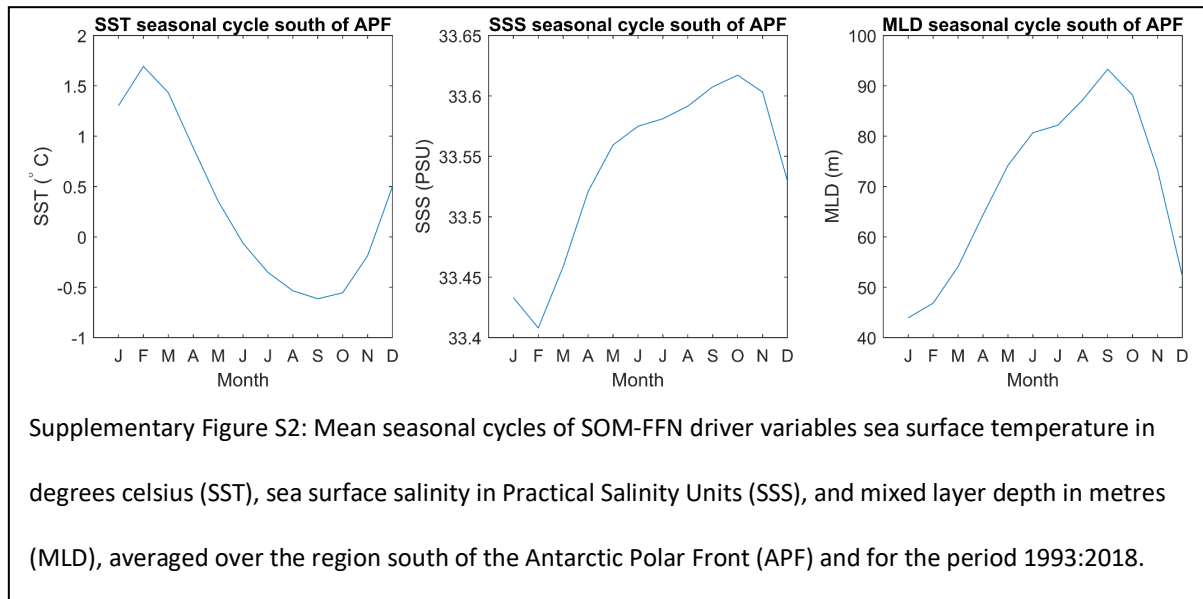
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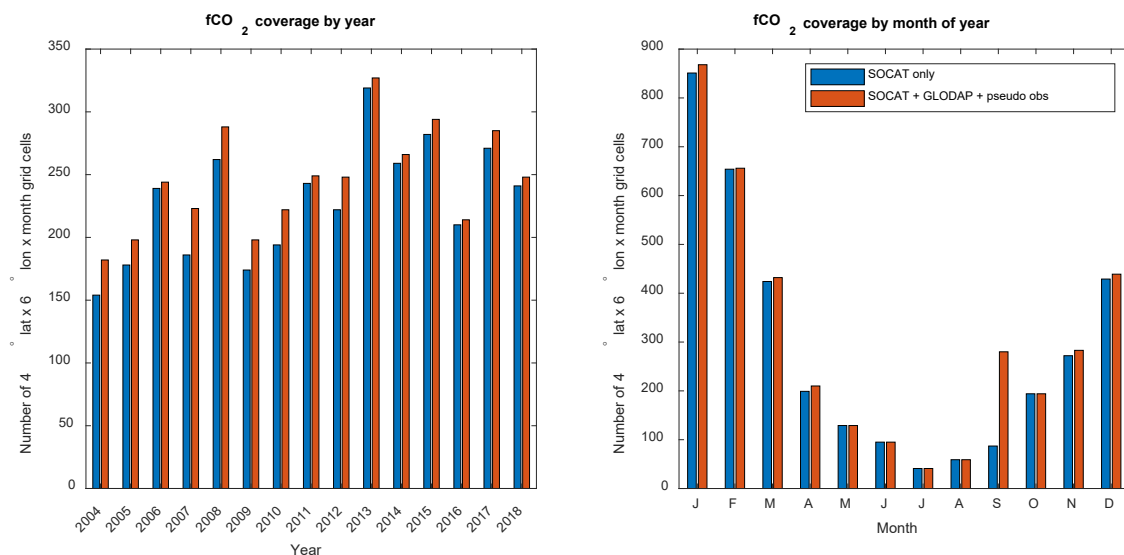
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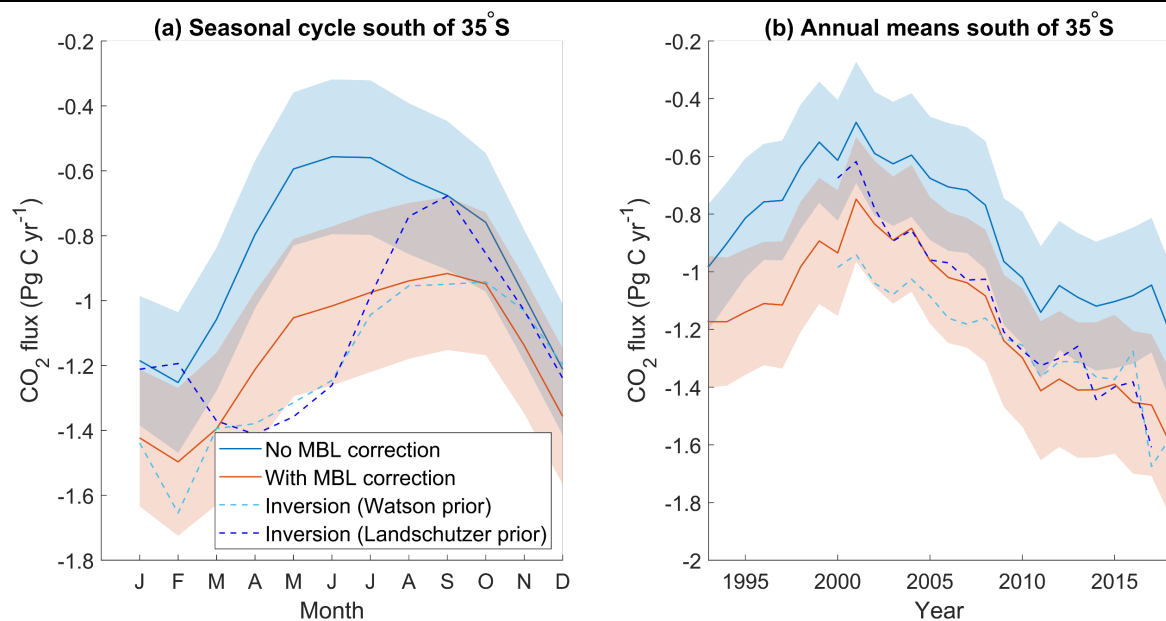
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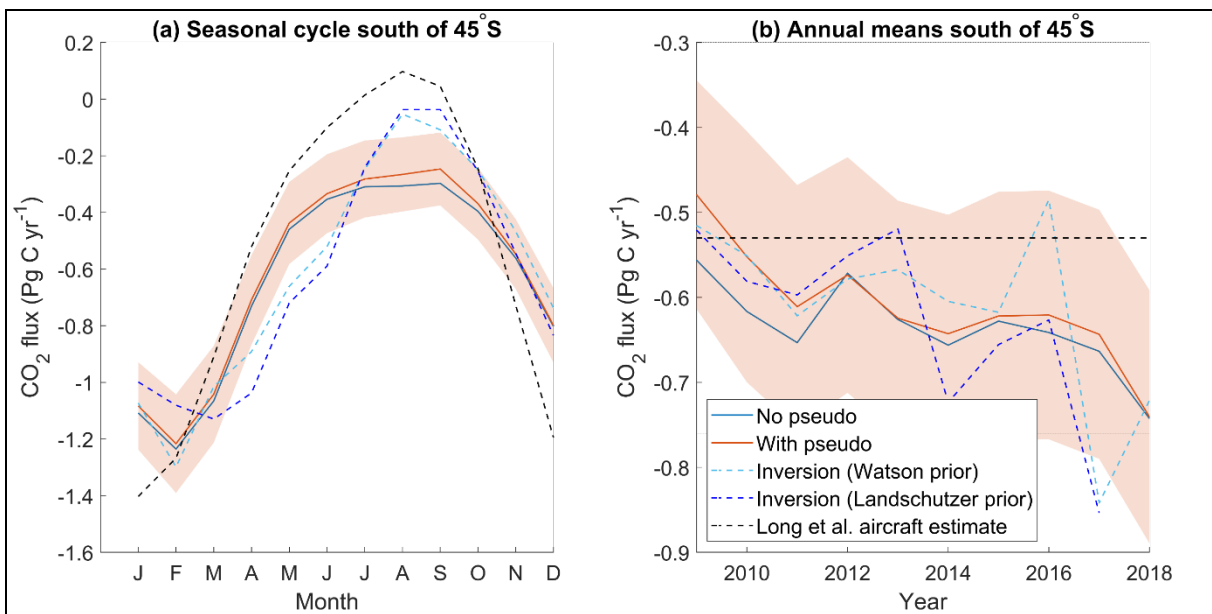




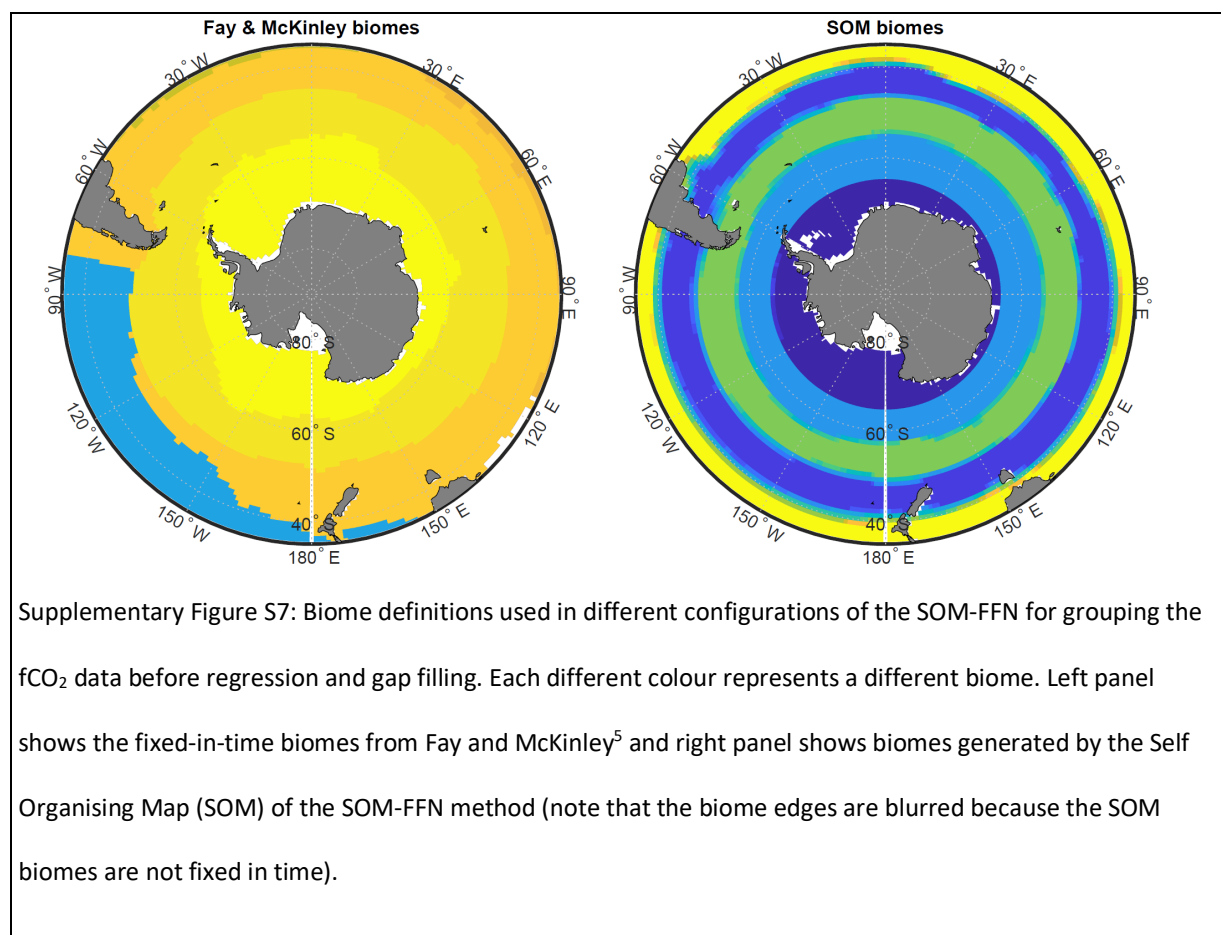
Supplementary Figure S4: Distribution of fCO₂ data coverage south of the Antarctic Polar Front by year (left) and by month (right). The data are monthly averages further binned onto a 4° latitude by 6° longitude grid, as on Figure 1. The blue bars show the number of monthly bins containing SOCAT fCO₂ data, and the red bars show the number with fCO₂ data either from SOCAT, a pseudo observation, or calculated from surface GLODAP observations. Note that the September data coverage is high due to the choice of that month as corresponding to the pseudo observations, which are constructed using profiles from all non-winter months.



Supplementary Figure S5: (a) 2000-2017 mean seasonal cycle and (b) annual mean air-sea CO₂ fluxes (negative into the ocean) for the Southern Ocean south of 35°S based on sea surface fCO₂ from the SOM-FFN with and without a Mass Boundary Layer (MBL) correction. Values are Petagrams of carbon per year (Pg C yr⁻¹). Each line represents an ensemble mean (see Methods), and the shaded areas are the 1-σ uncertainties. Also plotted are the same quantities derived from an atmospheric inversion using two different priors (coloured dashed lines; see Methods).



Supplementary Figure S6: (a) 2009–2018 mean seasonal cycle and (b) annual mean air-sea CO₂ fluxes (negative into the ocean) for the Southern Ocean south of 45°S based on sea surface fCO₂ from the SOM-FFN with and without pseudo observations. Values are Petagrams of carbon per year (Pg C yr⁻¹). Each line represents an ensemble mean (see Methods), and the shaded area is the 1- σ uncertainty on the SOM-FFN result with pseudo observations. Also plotted are the same quantities derived from an atmospheric inversion using two different priors (coloured dashed lines; see Methods), and a further inversion constrained by aircraft data from Long et al⁴ (black dashed line with uncertainty bounds given by black dotted lines).



1. Mackay, N. & Watson, A. Winter Air-Sea CO₂ Fluxes Constructed From Summer Observations of the Polar Southern Ocean Suggest Weak Outgassing. *J. Geophys. Res. Ocean.* **126**, 1–25 (2021).
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doi:<https://doi.org/10.7265/N59P2ZTG>
3. Peng, G., Meier, W. N., Scott, D. J. & Savoie, M. H. A long-term and reproducible passive microwave sea ice concentration data record for climate studies and monitoring. *Earth Syst. Sci. Data* **5**, 311–318 (2013).
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