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New wintertime observations allow re-examination of Southern Ocean carbon sink variability

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The Southern Ocean accounts for 40% of the uptake of anthropogenic CO_2 by the global ocean, which in turn absorbs a quarter of all anthropogenic CO_2 emissions, mitigating climate change. Despite its importance, sampling of the Southern Ocean is sparse and biased towards the summer months, and consequentially uncertainties in the carbon sink and its variability are largest there. Recently, autonomous platforms have begun to provide year-round coverage of the parameters needed to estimate the Southern Ocean carbon sink; however, these new observations cannot address the historical sparsity. We present a new estimate of the sink to address historically sparse wintertime sampling through interpretation of subsurface summertime observations to produce new 'pseudo' wintertime observations of surface fCO_2, boosting the wintertime spatiotemporal coverage by 22% and improving the spatial distribution. We show through a commonly used machine learning technique mapping method, that enhanced wintertime coverage does not significantly alter estimates of the flux or its variability at the sub-basin scale. After adjusting for surface boundary layer temperature effects, we find a strong mean sink south of 35°S of 1.29 ± 0.29 PgC yr^{-1} for 2004-2018, consistent with recent independent estimates from atmospheric data.