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Supporting Information for

Oxygen in the Southern Ocean from Argo floats: determination of processes driving air-sea fluxes

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Introduction

This supporting information contains: a comparison of mean sea surface temperature (SST) calculated from the NOAA optimal interpolation SST data product and mean SST calculated from the Argo oxygen floats used in this study (Figure S1), a comparison of CM2.6 model output of oxygen fluxes subsampled at float locations to the regional means (Figure S2, Table S1), and a comparison of float derived supersaturation to World Ocean Atlas climatology (Figure S3).

Text S1.

In order to determine whether the Argo oxygen dataset used in this study was spatially biased within each Southern Ocean province, we compared the mean Argo SST for each region to the NOAA optimal interpolation SST data product mean for the comparable region (Figure S1). For months where the mean ± standard deviation for each dataset did not overlap with the mean of the other dataset, we removed that month's data from the air-sea gas flux analysis.

An additional test of spatial bias was made using a subsampling of CM2.6 model output. CM2.6 is a 1/10 degree climate model with a simplified ocean biogeochemical model embedded [*Delworth* et al., 2012; *Galbraith et al*., 2010, 2015]. Subsampling of the model output at float locations indicate a close match to the 1:1 line, but with the largest differences at the highest fluxes into the ocean (Figure S2). This results in a potentially significant difference between subsampled float averages and model averages in the SAZ and SIZ (Table S1).

Text S2.

The float measurements in this study are compared to World Ocean Atlas (WOA) climatology in Figure S3. The largest disagreement between WOA and float averages is in the SIZ during winter months, with the float measurements indicating almost twice as large a degree of undersaturation as the WOA climatology. This is the period of time and location with the fewest cruise data used for climatological means.

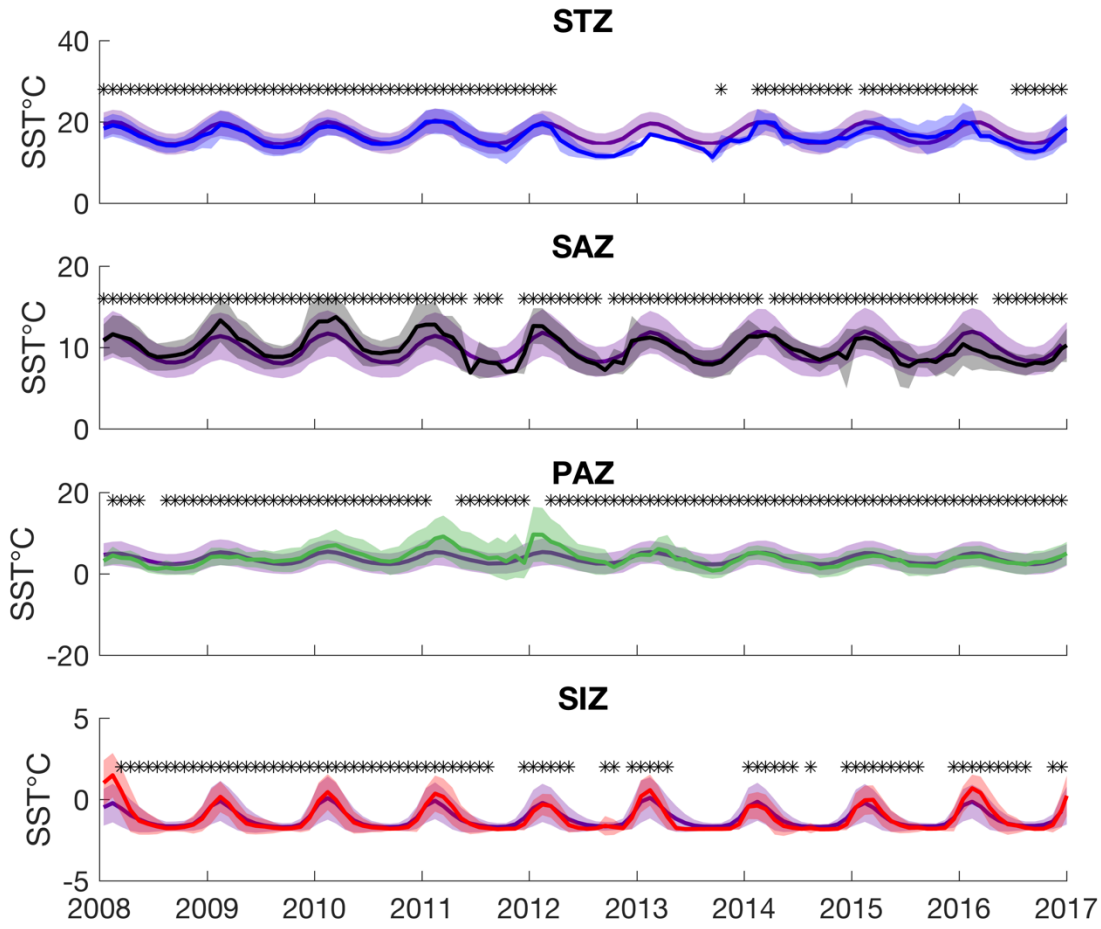

Figure S1. Comparison between monthly mean SST from the combined Argo dataset used for this study and the NOAA Optimal Interpolation SST dataset for each region. Months where the mean ± 1 standard deviation of both datasets did not overlap the mean of the other dataset were excluded from this analysis. Asterisks mark months that passed this filter and were used for this study.

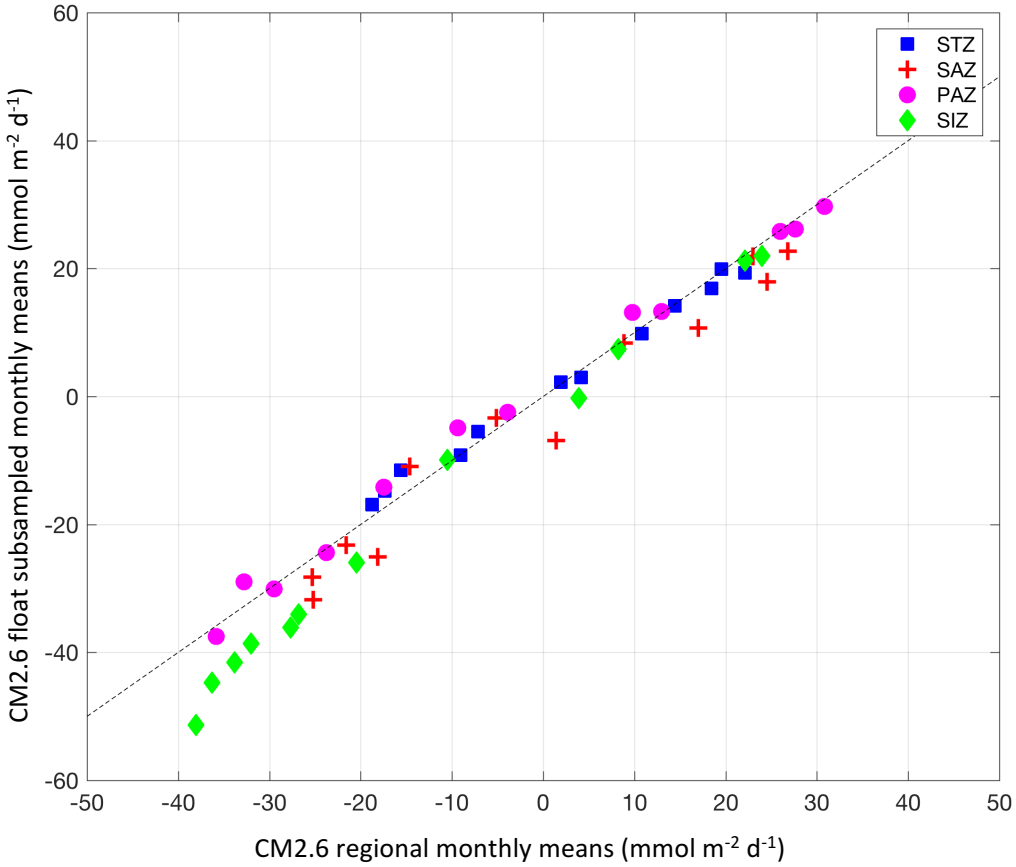

Figure S2. Comparison of mean monthly oxygen fluxes for CM2.6 subsampled points against model regional means. High resolution (1/10 degree) model control output was subsampled at daily interpolated float locations for each of the four regions from model years 188-196. Dashed line shows 1-to-1 line. The SIZ shows the largest disagreement in winter months, when a large polynya opened in the Weddell Sea that coincided with several float locations. However, repeat subsampling when the polynya was not present (years 181-183) yielded similar results. This analysis attempts to quantify potential undersampling of spatial variability by the Argo oxygen floats used in this study. Comparison of the subsampled and total regional fluxes is presented in Table S1.

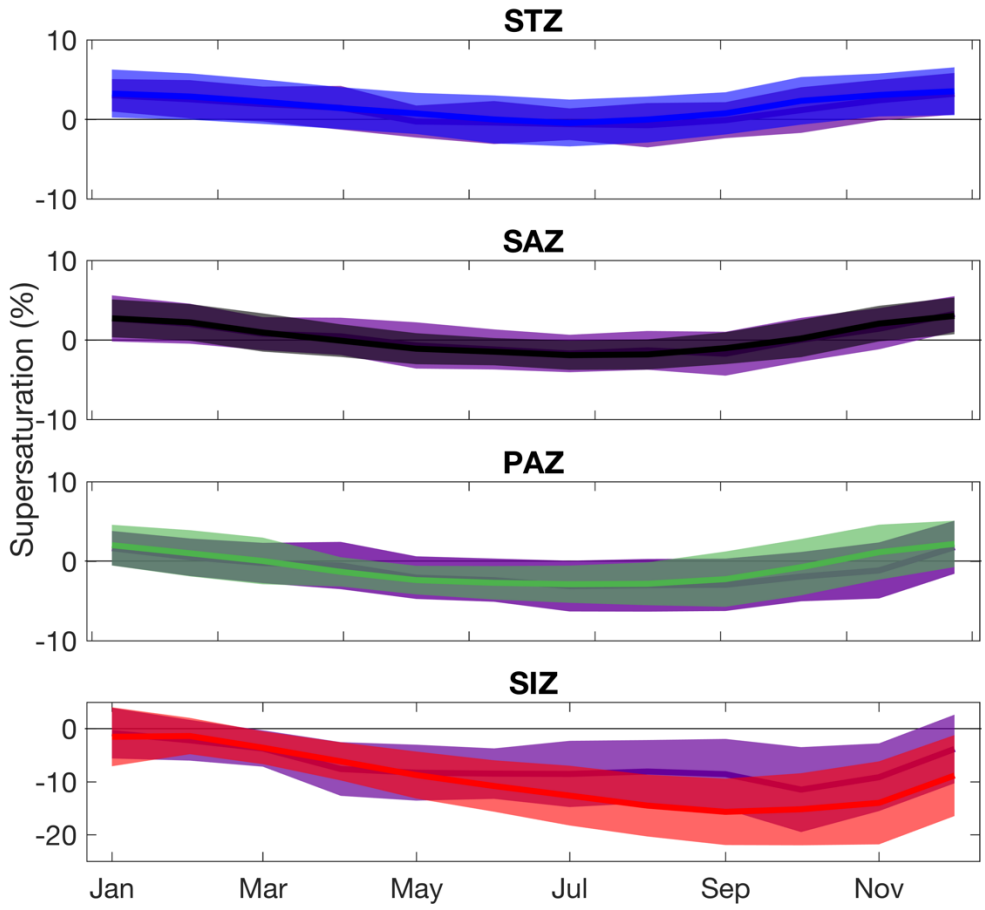

Figure S3. Regional supersaturation calculated from an average 9 years of Argo float data and World Ocean Atlas (WOA). Monthly means (solid lines) and standard deviations (shaded areas) from float data (colored by region) and World Ocean Atlas (purple). The largest difference between climatological means and float measurements are in the SIZ. Note the different y-axis scale for the SIZ.

	Total Model		Subsampled points		Difference	
	mol m^{-2} yr^{-1}	**Tmol yr^{-1}**	**mol m^{-2} yr^{-1}**	**Tmol yr^{-1}**	**mol m^{-2} yr^{-1}**	**Tmol yr^{-1}**
STZ	0.7	**28.0**	0.8	**33.0**	-0.1	**5.0**
SAZ	-0.3	**-5.0**	-1.5	**-28.5**	1.2	**-23.5**
PAZ	-1.4	**-37.2**	-1.0	**-28.2**	-0.3	**9.0**
SIZ	-5.1	**-88.3**	-7.1	**-122.3**	2.0	**-34.0**
Total		**-102.5**		**-146.0**		**-43.5**

Table S1. Comparing CM2.6 output subsampled at float locations to the total output. Fluxes were significantly larger into the ocean in the SAZ and SIZ in the subsampled points than in the total region. This points toward the possible magnitude of uncertainty in regional flux estimates due to undersampling of spatial variability.