Air-sea CO2 flux variability in frontal regions of the Southern Ocean from CARbon Interface OCean Atmosphere drifters

Boutin, J., L. Merlivat, C. Hénocq, N. Martin, J. B. Sallée

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ABSTRACT: Nine CARbon Interface OCean Atmosphere (CARIOCA) drifters were deployed in the Southern Ocean (south of the subtropical front, STF) between 2001 and 2006. They recorded 65 months of measurements in all seasons between 57°S and 40°S. Hydrological fronts detected by altimetry indicate that one buoy explored the polar zone (PZ) of the Atlantic Ocean and the western Indian Ocean; the remaining buoys explored the northern and southern parts of the subantarctic zone (SAZ) from the mid-Indian Ocean (73°E) to the eastern Pacific Ocean (112°W). The air-sea CO_2 fluxes along the buoy trajectories are primarily driven by the spatial variability of the fugacity of CO_2 in seawater, fCO_2: in the SAZ, they vary between 21.1 and 24.2 mol m^{-2} yr^{-1}, and the largest sinks occur close to the STF; in the PZ they vary between 21.6 and 0.6 mol m^{-2} yr^{-1}. When spatially extrapolated over each region, the yearly fluxes amount to 20.8 Pg C yr^{-1} in the SAZ and to 20.1 Pg C yr^{-1} in the PZ, with very small seasonal variation. In winter-spring, the sea-surface salinity and sea-surface temperature indicate mixing with deep water close to the subantarctic front and an episodic signature of north Atlantic deep water close to the polar front (PF). These events are associated with fCO2 close to equilibrium. On a small scale (of a few km), close to the STF, fCO_2 variations of 1-2 Pa (10-20 µatm) are associated with the presence of compensated mixed layers.