

Variability of wintertime air-sea CO₂ fluxes in the southwestern East/Japan Sea

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The East/Japan Sea is a marginal sea characterized by high oceanic uptake of anthropogenic CO₂ and significant biological production. This study examines the variability of wintertime air-sea CO₂ fluxes in the southwestern East/Japan Sea based on five years of underway CO₂ measurements. Our findings indicate that this region serves as a significant sink for atmospheric CO₂ during winter. A decrease in sea surface temperature (SST) plays a crucial role in lowering the surface fugacity of CO₂ in seawater, thereby enhancing oceanic CO₂ uptake. During the study period, the mean air-sea CO₂ flux was lowest in March 2023 and highest in February 2024, with oceanic CO₂ uptake in 2024 being 1.5 times greater than in 2023. This variation is primarily attributed to increased surface primary production, as indicated by rising surface oxygen concentrations, and stronger wind speeds. Our results suggest that interannual variability in wintertime air-sea CO₂ fluxes in this region is driven by both thermodynamic and non-thermodynamic processes, including changes in SST, vertical mixing, surface currents, and biological production.