Improving CO₂ Air-sea Fluxes by Combining O₂ and CO₂ Data

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The evolution of CO₂ and O₂ in the atmosphere is strongly coupled by the processes controlling their exchange with the land and the ocean. Combining O₂ and CO₂ data thus provide additional constraints on CO₂ fluxes and key insights into the processes at play. In particular, estimates of CO₂ fluxes based on atmospheric data assimilation such as Carbon Tracker are heavily tied to the ocean “prior” they use (i.e. the first guess of air-sea CO₂ fluxes obtained independently from atmospheric CO₂ data).

In this study, we exploit the strong link between O₂ and CO₂ data in the ocean and the atmosphere to constrain the estimate of air-sea CO₂ fluxes. This also provides insight into the process controlling the strong variability of oceanic origin that depends on the rate of ocean uptake of CO₂, ocean production/respiration, warming/cooling and mixing, all processes which impact both air-sea CO₂ and O₂ fluxes. Ultimately, this estimate will improve our estimate of ocean “priors”.

Figure 1. Estimates of regional CO₂ and O₂ fluxes obtained by an oceanic inversion in this study and in previous estimates. This illustrates the links between CO₂ and O₂. For example, in the Southern Ocean, deep convection brings carbon-rich/oxygen-poor waters to the surface, leading to strongly coupled CO₂ out-gas and O₂ in-gas. Positive fluxes towards the atmosphere and symbols indicate estimates based on different ocean model parametrization.