(50-240329-A) **Application of Atmospheric O_2/N_2 Measurements for Determining Global Carbon Sinks**

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The Scripps O_2 program has carried out precise measurements of the trend in atmospheric O_2/N_2 ratio from 1990 to present at ~10 sites around the globe. These records can be combined with the measured global trend in CO_2 to separately resolve the global land and ocean carbon sinks. In effect, the CO_2 measurements constrain the sum of the land and ocean sinks, while the O_2 measurements provide a means to separate this sum into land and ocean components (Figure 1). The additional constraint from O_2/N_2 leverages the fact that the land sink involves net photosynthesis, which produces O_2, while the ocean sink mostly involves carbonate reactions, which do not produce O_2. The change in O_2/N_2 ratio effectively determines the change in the total atmospheric O_2 inventory because changes in N_2 are very small. The measurements since 1990 document an increasing sink for CO_2 from the ocean combined with a relatively steady global land sink for CO_2. The uncertainties are dominated by uncertainty in fossil-fuel burning and by uncertainty in a correction term for the O_2 budget, involving warming-driven outgassing of O_2 from the oceans. Despite these uncertainties, the measurements provide a precise constraint on the ocean sink on decadal time scales, while also resolving considerable additional in short-term variability in global air-sea O_2 and CO_2 exchanges via the tracer atmospheric potential oxygen (APO ~ O_2+1.1CO_2). The ocean sink estimated from O_2/N_2 measurements has recently been compared with other observational and model-based estimates of the ocean CO_2 sink by the Global Carbon Project (GCP) (Friedlingstein, Earth. Sys. Sci. Data, 2023). The O_2/N_2-based estimate is generally in good agreement with other observational methods, although the comparison is complex because the methods are not necessarily measuring exactly same quantity. This presentation will discuss these differences and discuss opportunities to provide annual updates of the global sink estimates from a range of NOAA-based observational products, including O_2/N_2 measurements.

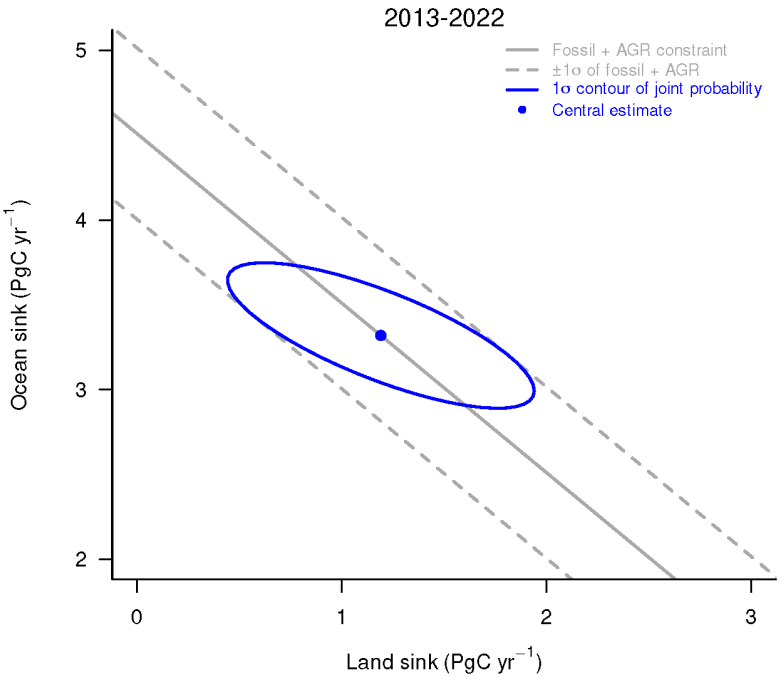

Figure 1. Global land and ocean carbon sinks over the period 2013-2022 as constrained by the measured long-term trends in atmospheric O_2/N_2 ratio and CO_2. The constraint on the combined ocean and land sink from the measured trend in CO_2 and known fossil-fuel emissions is show by the gray line, with 1 sigma bounds shown by dashed lines. The additional constraint from the measured trend in O_2/N_2 constrains the joint probability to lie within the blue circle, which is tangent to the gray dashed lines. The O_2/N_2 trend provides a tighter constraint on the ocean sink than the land sink because uncertainty in fossil-fuel emissions project more strongly onto the land than the ocean sink.