



Seasonal to Inter-annual Variability of the Atlantic Ocean Carbon Sink

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The Atlantic Ocean is one of the most important sinks for atmospheric carbon dioxide (CO_2), but this sink is known to vary substantially from seasonal to multi-decadal time scales. Here we use observations of the surface ocean partial pressure of CO_2 ($p\text{CO}_2$) to estimate this sink and its temporal variations on a monthly basis from 1998 through 2007. We benefitted (i) from a continuous strengthening of the observational underway network and (ii) from an improved technique to interpolate the data in space and time. In particular, we combine two artificial neural network methods to reconstruct basin-wide monthly maps of the sea surface $p\text{CO}_2$ at a resolution of 1° latitude \times 1° longitude. From those, we then compute air-sea CO_2 flux maps using a standard gas exchange parameterization and high-resolution wind speeds. The evaluation of our estimates with independent time series data demonstrates that our method reconstructs the seasonal signal at these independent stations well.

We estimate a decadal mean flux of $0.45 \pm 0.16 \text{ PgC} \cdot \text{yr}^{-1}$ for the Atlantic region from 44°S to 79°N and west of 30°E , which is in good agreement with recent studies. We find the strongest seasonal variability of the sea surface $p\text{CO}_2$ and the CO_2 air-sea fluxes within the subtropics of the northern and southern hemisphere, i.e. the zones where the seasonal cycle of the sea surface $p\text{CO}_2$ is thermally driven.

Trends in sea surface $p\text{CO}_2$ suggest the strongest increase from 1998 to 2007 polewards of 40°N along the Gulf Stream, the North Atlantic Current and the Subpolar Gyre leading to a decreasing ocean carbon sink, whilst temporal trends in the South Atlantic show an increasing sink. Our results show that the air-sea flux shows only small inter-annual variability of $0.04 \text{ PgC} \cdot \text{yr}^{-1}$, with low variability both in the South Atlantic ($0.02 \text{ PgC} \cdot \text{yr}^{-1}$) and the North Atlantic ($0.02 \text{ PgC} \cdot \text{yr}^{-1}$).