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The seasonal cycles of pCO_2 and CO_2 fluxes in the North Atlantic north of 40˚N

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Surface seawater pCO_2 and related parameters were measured at high frequency in the North Atlantic ocean between 36 and 52˚N onboard the volunteer observing ship MS Falstaff. Over 90,000 datapoints are used to produce the seasonal cycles of seawater pCO_2 and CO_2 fluxes for 2002/2003. The surface ocean carbon cycle is largely controlled by three factors: thermodynamics, biology and air-sea gas exchange. The first two factors have a significant and opposing effect on pCO_2 whereas the gas exchange has a smaller influence on pCO_2 levels. Generally, the CO_2 flux shows a seasonal cycle with close to zero fluxes or outgassing in the summer and CO_2 uptake during fall and winter in this region. The CO_2 air-sea fluxes are compared using two averaging schemes. In the first, the fluxes are calculated for each location from the measured ΔpCO_2 and gas transfer velocity determined from a relationship with windspeed retrieved at the location of the ship. In the second method the ΔpCO_2 is averaged over each 4˚ by 5˚ pixel and multiplied by an averaged gas transfer velocity for this pixel. The fluxes determined by the first method are 1 % lower than the averaged fluxes and this bias is mainly caused by the variability in wind speed. The Falstaff fluxes are compared to the climatology by Takahashi et al. (2002) and the difference is between 8 and 11 % depending on the time-correction scheme. Furthermore we use two wind speed sources to analyze the effect on the CO_2 flux: co-located satellite data (QuikSCAT) and 6-hourly reanalysis data (NCEP/NCAR). The annual CO_2 sink is 22 % greater when using 6-hourly NCEP/NCAR wind speeds compared to the QuikSCAT wind speed data. Since the ship transits the 4˚ by 5˚ pixel quite rapidly wind speed variability only has a small effect and the gas transfer velocities derived for steady winds appear appropriate.