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Acceleration of the sea surface fCO2 growth rate in the North Atlantic subpolar gyre (1993-2008)

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We describe the evolution of the surface ocean CO2 fugacity (fCO2) over the period 1993-2008 in the North Atlantic subpolar gyre (NASPG). During winters 1993-2003 the growth rate of fCO2 (2.1 to 3.7 µatm.yr-1) between 53-62°N and 45-25°W was higher than in the atmosphere (1.8 µatm.yr-1), leading to a reduction of the ocean carbon uptake. This is mainly explained by the sea surface warming, up to 0.24°C.yr-1, which occurred when the North Atlantic Oscillation (NAO) index moved into a negative phase in winter 1995/96 causing northward advection of warm and saline water derived from the North Atlantic Current into the Irminger basin. The winter data from 2001-2008 indicate that fCO2 has increased much faster (5.5 to 7.1 µatm.yr-1) than in the atmosphere (2.1 µatm.yr-1) in these years. This result derived from DIC and TA data (SURATLANTE program) is confirmed by in-situ fCO2 measurements from the same region obtained in winters of 2003-2007. The fCO2 increase in recent years is fast enough to create ocean CO2 source in winter 2007-2008. The change over 2001-2008 appears to be almost entirely due to changes in seawater chemistry (increase of DIC and nutrients concentrations and a decrease of TA) explaining 95% of the fCO2 trend observed. This suggests that the rapid fCO2 increase is not driven by regional uptake of anthropogenic CO2. Instead, these variations are likely controlled by recent increase of convective processes-vertical mixing in the NASPG identified since 2007. There is also the possibility that the observed fCO2 increase could be caused by variations of remineralization in response to changes in marine species composition (e.g. ecosystems more based on recycling than export).