

A rapid decrease of the carbon sink in the North Atlantic subpolar gyre: results from the SURATLANT Program (1993-2006)

A. Corbière¹, N. Metzl¹, G. Reverdin¹, A. Lenton¹, C. Brunet¹, D. Thuillier¹, M. Ramonet², T. Takahashi³ and R. Wanninkhof⁴

¹LOCEAN - IPSL, Université Pierre et Marie Curie, Paris, France

²LSCE - IPSL, Gif sur Yvette, France

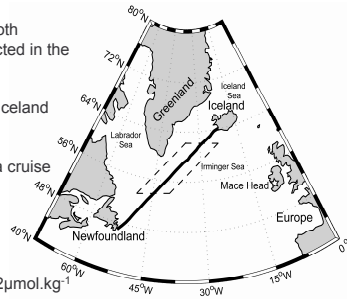
³LDEO, Columbia University, Palisades, New York, USA

⁴NOAA/Atlantic Oceanographic and Meteorological Laboratory, Miami, Florida, USA

Since 1993, regular sea surface water sampling for both hydrological and carbon parameters has been conducted in the North Atlantic subpolar gyre:

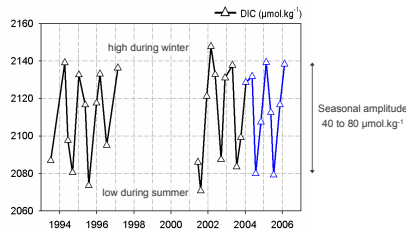
- ✓ 3 to 4 times a year along the same track, between Iceland and the Newfoundland
- ✓ About 30 samples of DIC, TA are collected during a cruise
- ✓ The carbon samples were measured back at LDEO between 1993-1997 and at LOCEAN (since 2001)
- ✓ The accuracy of DIC and TA are estimated to be $\pm 2 \mu\text{mol.kg}^{-1}$

The analysis is focused on the open ocean region
53°N-62°N/45°W-20°W

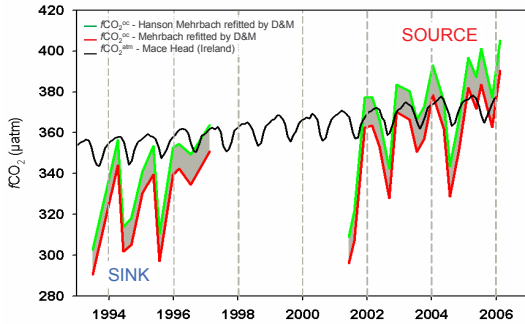
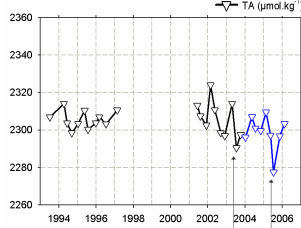


Analysis over the period 1993-2006 Extended results of Corbière et al., 2006

The DIC concentrations appeared relatively stable over 13 years



The TA concentrations decreased since 2001
Rapid decrease observed in Summer 2003 and 2005 maybe related to coccolithophore blooms [Raitsois et al., 2006]

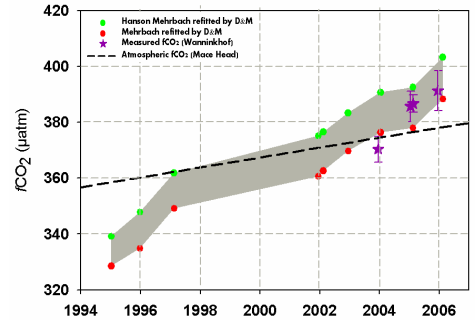


The $f\text{CO}_2^{\text{oc}}$ evolution is mainly controlled by sea surface warming, up to 2°C since 1993 and results in a large changes for the air-sea CO₂ fluxes

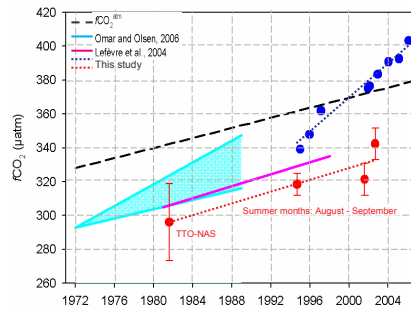
The increase of oceanic $f\text{CO}_2$ appears faster than in the atmosphere

Trend analysis

Based on Winter data we estimate an increasing rate of
 $f\text{CO}_2^{\text{oc}}: +5 \mu\text{atm.yr}^{-1} - r^2=0.96$
 $f\text{CO}_2^{\text{atm}}: +1.8 \mu\text{atm.yr}^{-1} - r^2=0.99$



Synthesis view of the decadal variations of $f\text{CO}_2^{\text{oc}}$



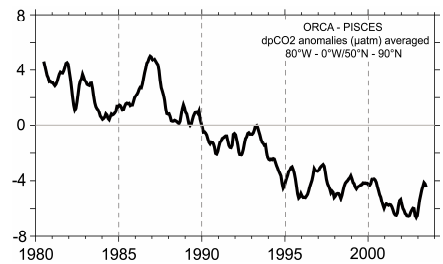
The winter trend results is faster in recent years compared to estimates between 1972-1989 based on winter $f\text{CO}_2$ reconstruction [$+1.5 - +3.2 \mu\text{atm.yr}^{-1}$, Omar and Olsen, 2006]

The summer trend is in very good agreement with the value derived by Lefèvre et al [2004] for the same months and suggests that the $f\text{CO}_2^{\text{oc}}$ growth rate in the NASG is lower in summer than in winter

A modelling view

As opposed to the trends deduced from observations, global biogeochemical ocean models estimate an increase of the carbon sink for the recent years.

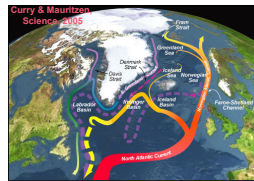
CARBOOCEAN simulations need to be seriously validated against ocean carbon systems measurements (not only $f\text{CO}_2$ but DIC and TA as well).



CONCLUSION

Since three decades, observations show that the carbon sink decreased significantly in the high latitude of the North Atlantic. The $f\text{CO}_2^{\text{oc}}$ decadal rate is faster in recent years compared to estimates between 1972-1989. The origin of this change is likely related to an advection of water masses from temperate latitudes into the Irminger Sea.

Estimating this dramatic carbon sink change represents an important challenge for both atmospheric and oceanic models. This also highlights the need for continuing long-term sea surface ocean observations of carbon properties (DIC, TA and $f\text{CO}_2$) and through syntheses as proposed in CARBOOCEAN investigate both interannual and decadal variability of the oceanic carbon pumps in the entire North Atlantic.



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- SURATLANT DIC, TA and calculated $f\text{CO}_2$ data are available at <http://www.carboocean.org>
- The measured $f\text{CO}_2$ data from AOML are available at <http://www.aoml.noaa.gov/co2/gcc/>

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