**Supplementary online material**

**Background: Basis of NCP measurements**

Within the ocean mixed layer, net community productivity (NCP) is a function of photosynthesis and community respiration according to the following approximate stoichiometry (Redfield et al., 1963),

$$\text{Photosynthesis} \quad 106\text{CO}_2 + 16\text{HNO}_3 + \text{H}_3\text{PO}_4 + 122\text{H}_2\text{O} \rightarrow \text{Respiration} \quad (\text{CH}_2\text{O})_{106}(\text{NH}_3)_{16}\text{H}_3\text{PO}_4 + 138\text{O}_2$$

NCP can therefore be estimated from net changes in the inventories of several upper ocean properties; notably oxygen, organic and inorganic carbon, nitrogen and phosphorus. In equation (1), if the forward reaction (photosynthesis) exceeds the reverse reaction (respiration), the system is net autotrophic, which leads to an increase in $[\text{O}_2]$ and a decrease in dissolved inorganic carbon (DIC) within the mixed layer. This net autotrophy is characterized by a net accumulation and sinking of organic carbon, in the form of particulate and dissolved organic carbon (POC and DOC). In contrast, if heterotrophy exceeds autotrophy within the mixed layer, oxygen decreases and dissolved inorganic carbon increases. Given that oxygen and inorganic carbon have a gaseous component, a gas exchange flux component must be included in their mass budgets.

**The implications of variable fluorescence measurements**

Because NCP is proportional to the net primary productivity (NPP) minus heterotrophic respiration integrated over the mixed layer, where NPP is a function of the autotrophic biomass and specific growth rate ($d^{-1}$), a comparison of $F_v/F_m$ may also shed light into the influence of growth rate on NCP. A linear relationship, albeit variable, between $^{14}$C NPP (Nielsen, 1951) and $F_v/F_m$ has been reported in numerous studies (Kolber and Falkowski, 1993; Boyd et al., 1997; Suggett et al., 2001; Melrose et al., 2006). The relationship should be stronger with oxygen derived productivity because oxygen evolution
occurs at PSII sites, and not all electrons generated at PSII are utilized for carbon fixation. Comparison of $F_v/F_m$ to NCP therefore gives insight into the dependence of NCP on PSII dynamics, oxygen evolution and autotrophic growth rate, and physiological stress due to iron limitation.
Supplementary Material Figure 1. SAZ-Sense North-bound transect NCP (from in situ O$_2$/Ar), uncalibrated pCO$_2$ (from EIMS mass 44 measurements), total (optode) and biological (EIMS) oxygen supersaturation, and sea surface temperature (SST) and salinity (SSS). Approximate position of fronts is also represented.
Supplementary Material Figure 2. SAZ-Sense NCP (mmol O$_2$ m$^{-2}$ d$^{-1}$) as a function of geographical position and time. Only positive NCP measurements are illustrated.
Supplementary Material Figure 3. GPP estimates based on triple isotopic composition of dissolved oxygen. Oxygen in the surface ocean has two main sources: air and photosynthetic splitting of water. These sources have distinct isotopic signatures. Atmospheric O2 has a characteristic isotopic signature derived from a stratospheric reaction with a mass independent fractionation between O2 and CO2 (Luz et al., 1999; Boering et al., 2000; Thiemens, 2001; Lammerzahl et al., 2002; Luz and Barkan, 2005). Mass-independent fractionation is manifested in a non-zero value of $^{17}\Delta$, where

$$^{17}\Delta = \ln\left(0.001*\delta^{17}O + 1\right) - 0.516*\ln\left(0.001*\delta^{18}O + 1\right) - \delta^{17}O - 0.516*\delta^{18}O.$$ 

The overall isotopic signature of O2 in the surface ocean thus depends on the relative abundance of atmospheric and photosynthetic O2. The sinks for dissolved O2 in the surface ocean are respiration and gas exchange. These processes fractionate O2 mass dependently and therefore do not change $^{17}\Delta$. GPP is the rate of photosynthetic O2 production required to maintain the observed departure of $^{17}\Delta$ from atmospheric equilibrium against the equilibrating effect of gas exchange (Luz and Barkan, 2000).
Supplementary Material Figure 4. $^{17}\Delta$ of O$_2$ (per meg) vs. biological O$_2$ supersaturation (%). Solid lines represent isopleths of constant NCP/GPP. The relation between the two properties defines NCP/GPP, which, when multiplied by a factor of ~2 to account for stoichiometry (Bender, 1999) is comparable to the “f” export ratio.
Supplementary Material Figure 5. Mixed-Layer NCP vs. (A) Chl a (green) (B) depth integrated $^{14}$C primary production (red). The diameter of the filled red and green circles indicates the magnitude of the $^{14}$C production and Chl a values. Legend shows the largest corresponding values. Positive and negative NCPs are represented by black and grey symbols, respectively, such that the thickness of the band in each figure is proportional to the continuous NCP measurement. Negative NCP values could result from vertical mixing of O$_2$ undersaturated waters. The black, red, and blue dashed lines represent the climatological positions (Orsi et al., 1995) of the Subtropical, Subantarctic, and Polar fronts, respectively.
Supplementary Material Figure 6. Spatial extent of aeolian soluble Fe deposition fluxes. Each color represents a filter measurement integrated over a section of the cruise track. Full details are contained in Bowie et al. (Bowie et al., 2009).
Supplementary Material References


