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Processes controlling the seasonal variations of inorganic carbon in the North Sea

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Data on dissolved inorganic carbon (DIC), partial pressure of CO2 (pCO2) and nutrients have been collected during four cruises carried out in the whole North Sea, each cruise covering one month of each season between 2001 and 2002. The impact of biological activity, air-sea exchange and physical mixing processes on the monthly variations of DIC have been determined for each regions of the North Sea using the International Commission for the Exploration of the Seas (ICES) boxes separation. For the February-July period, the biological activity was the main factor controlling the DIC variations in the upper layer of the whole North Sea and was responsible for a loss of 20 to 50 mmol m-3 month-1. The concomitant atmospheric input increased DIC by 8 to 12 mmol m-3, whereas the mixing term was low, except in the north-western North Sea, where it increased DIC concentrations by approximately 10 mmol m-3. We computed the Net Community Production based on Carbon (DIC) data (NCPC) for the North Sea. For the productive period, the NCPC was higher in the upper layer of the northern and central North Sea than in the coastal and southern areas. Maximum values of 1.0 to 1.5 mol C m-2 month-1 were observed in May in the northern and central North Sea, whereas maximum of 0.5-0.7 mol C m-2 month-1 were observed in April in the southern and coastal areas of the North Sea. We compared the NCPC to the NCP calculated from nitrogen data from the same cruises and converted into moles of carbon using the Redfield ratios (NCPN). Results showed that in areas where nitrate was depleted by April, i.e. mainly in the central and northern North Sea, DIC consumption continues until July, leading to a large difference between NCPC

and NCPN. On the other hand, in coastal areas where nitrate were available during the complete productive period, NCPC and NCPN were very similar. For the whole year in the upper layer of the North Sea, the NCPC of 2.3 mol C m-2 yr-1 was a factor two higher than NCPN and higher than previous calculation of the net carbon production in the North Sea based on nutrient data. We argue that NCP based on nutrient data converted to moles of carbon using the Redfield ratios, leads to underestimation of the net carbon production for the North Sea because of the preferential recycling of nutrients.