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FeeP – An in-situ PO_4^{3-} and Fe^{2+} addition experiment to waters of the sub-tropical north-east Atlantic

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Between the 24th April and 26th May 2004, Plymouth Marine Laboratory in collaboration with scientists from NIWA, New Zealand, Laboratoire Arago, France and Universities of East Anglia and Plymouth conducted a two-ship exercise using RRS Charles Darwin and RV Poseidon to test the hypothesis that: The supply of, and the interaction between iron and phosphorous control biological activity and fluxes in the subtropical North Atlantic. An experimental area in international waters to the west of the Canary Islands was selected following an intense period of vertical and horizontal mapping by the Charles Darwin. Using SF6 as a tracer for amended waters, two separate experiments were performed: The first involved the addition of 20 tonnes of anhydrous monosodium phosphate at 10 m depth over an area of approximately 25 km^2, centered at 27.8˚N 23.3˚; The second experiment was conducted at 27.5˚N 22.5˚W. 5 tonnes of acidified iron sulphate were added over the first 12 hours, then after 24 hours, 20 tonnes of phosphate were added over the top of the iron. Measurements of nutrient chemistry, gas exchange and biological activity were monitored prior to and after deployment of the fertilised patches relative to several control stations. Hydrodynamically the experiments were performed in two distinct patches of water; the first displayed relatively constant conditions of surface temperature and salinity (20.68 – 20.81˚C; 37.135 – 37.165 respectively) and was characterized by a mean mixed layer depth of 40m which following night-time convection deepened up to 90m. During the second experiment, the surface mixed layer was restricted to 25m and following a period of settled weather, surface temperatures increased from 20.66 to 21.24 ˚C over 7 days. Prior to and during the cruise airflow was predominantly from

the north so that atmospheric deposition was relatively low (Fe $<$65 nmolm^{-2}d^{-1}, P $<$11 nmolm^{-2}d^{-1}). Dissolved phosphate concentrations were elevated to $>$200 nmol l^{-1} relative to mean background phosphate concentrations of 8.3 and 13.3 nmol l^{-1} for experiments 1 and 2 respectively, whilst during experiment 2, dissolved iron was elevated to 3 nmol l^{-1} from background concentrations of 0.2 – 0.4 nmol l^{-1}. Some changes were observed which included increases in picoeukaryote abundance during both experiments, and significant increases in microzooplankton grazing and chlorophyll fluorescence and DMS decrease during experiment 1. The diazotrophic community was dominated by unicellular cyanobacteria, and although *Trichodesmium* numbers were seen to increase during experiment 2 at both IN and OUT stations, there was no overall shift in the population make-up. Rate experiments indicated that the microbial community was likely to be limited or co-limited by one or more nutrients in addition to Fe and P, and that this varied between the component fractions. Bacterial productivity (^{3}H-Leucine) and primary productivity (^{14}C) showed only small deviations from background whilst microbial phosphate uptake (^{33}P) and nitrogen fixation (^{15}N) increased by up to 6 times and 4.5 times during both addition experiments.