Separating the effects of ocean acidification from ocean carbonation in the coccolithophore *Emiliania huxleyi*

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The coccolithophore *Emiliania huxleyi* was cultured in a set of experiments under a broad range of carbonate chemistry conditions to separate the effects of individual carbonate chemistry parameters such as carbon dioxide (CO_2) and pH. In the first experiment, alkalinity was kept constant (~2320 µmol/kg) and fCO_2 was varied in 18 steps from ~20 to ~6300 µatm. In the second experiment, pH was kept constant (pH_{free} = 8) with fCO_2 varying between ~40 to ~3700 µatm. Results from the constant alkalinity approach show for the first time a physiological optimum for growth and productivity. The optimum fCO_2 levels for growth, particulate inorganic and organic carbon production were located at ~250 µatm, ~400 µatm and ~700 µatm, respectively. The comparison of the two experiments reveals that growth and productivity are increasing similarly from low to intermediate CO_2 levels but start to diverge in the high CO_2 range. Here, growth and productivity decrease linearly at constant alkalinity whereas they stay consistently high at constant pH. These findings suggest that growth and productivity are directly related to CO_2 at sub-saturating concentrations in the low CO_2 range whereas towards higher levels negative trends, which have also been reported in previous studies, are induced by increasing proton concentrations (decreasing pH).
This study enhances our understanding of the physiological response of *E. huxleyi* to ongoing ocean acidification, in clear contrast to ocean carbonation.