Over the last 20 years, climate models have evolved from atmospheric-only general circulation models to more complex earth system models that do include explicit representations of all key components of the Earth System. Among the new components, marine biogeochemical schemes are now widely used in the latest generation of Earth System Models. Among the ~40 climate models used in the last IPCC assessment report, ~15 do include an explicit representation of marine biogeochemistry, from very simple biogeochemical scheme to more complex marine ecosystem models. The integration of marine biogeochemical components have enabled 2 key new developments: (1) climate models explicitly simulate the coupling between the carbon cycle and climate – e.g. climate models can be used to derive compatible fossil-fuels emissions from a given atmospheric trajectory, taking into account climate-carbon interactions (see Jones et al. 2013, Journal of Climate), and (2) climate models simulate some of the key stressors of marine ecosystems – e.g. climate models are used to project the evolution of not only ocean temperature, but also ocean acidification, de-oxygenation and productivity changes (see Bopp et al. 2013, Biogeosciences).

The work carried out within the framework of GREENCYCLESII – Work Package 2 (WP2) is clearly positioned into the evolution of climate modelling tools. Because the marine biogeochemical components of earth system models are more and more complex, they require (1) more data to parameterize some of the key processes embedded in these models, (2) more data to evaluate, at the global scale, these models, and (3) new techniques / analysis to use these simulations.

In WP2, we have derived new parameters, based on new lab experiments, to characterize the physiological response of a key phytoplankton functional group, the picophytoplankton, to changes in light, temperature and nutrient. These new parameters have been used in a global biogeochemical model to perform sensitivity experiments for the response of phytoplankton productivity to climate change.

In WP2, we have built a new plankton functional type database (as project leaders for the MAREDAT project) to be able to evaluate some of the more complex marine ecosystem models at the global scale. Work carried out in WP2 specifically focuses on the distribution of coccolithophores and Phaeocystis, key phytoplankton groups because of their contribution to oceanic carbon fluxes through calcification and dimethylsulphide production, and phytoplankton pigments that will allow the derivation of the relative contribution of several plankton functional groups to total chlorophyll-a.

In WP2, we have developed and used new parameterizations to be able to represent **the evolution of marine N2O emissions**, N2-fixation andf nitrification in response to ocean acidification and climate change. Using one biogeochemical model in which these new developments have been embedded, we have shown for the first time that N2O emissions may be decreasing in response to climate change, thus exerting a weak negative feedback onto anthropogenic global warming.

In WP2, we have evaluated and used the new CMIP5 models to explore **the response of phytoplankton productivity to climate change**. Our analysis shows a strong decrease in primary production in response to climate change (fro -2% to -18%, depending on models and scenarios, Bopp et al. 2013), with implications for carbon uptake and for marine ecosystems. The drivers of this change have been analysed. The differences between models also have been explored, and point towards the representation of nutrient cycles and limitations as a major mechanism explaining model divergence. These results are used in IPCC AR5 WG1 (Carbon cycle and other biogeochemical cycles chapter) as well as in WG2 (Ocean Systems Chapter).

This briefing statement is intended for use by Policy Makers and Journalists – if you have any questions or would like further information on the points raised above then please use contact the GCII Project Co-ordinator.

Email: gc2@geog.cam.ac.uk
Website: www.greencycles.org