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Understanding controls of diel patterns of biological CO_2 fixation in the North Atlantic Ocean

Helmuth Thomas (1), Susanne E. Craig (1), Blair W. Greenan (2), William Burt (1), Gerhard J. Herndl (3), Simon Higginson (1), Lesley Salt (4), Elizabeth H. Shadwick (5), and Jorge Urrego-Blanco (1)

(1) Dalhousie University, Department of Oceanography, Halifax, NS, Canada (helmuth.thomas@dal.ca, +1 902 494-3877), (2) Bedford Institute of Oceanography, Fisheries & Oceans Canada, Dartmouth, NS, Canada, (3) University of Vienna, Department of Marine Biology, Vienna, Austria, (4) Royal Netherlands Institute for Sea Research, Department of Biological Oceanography, Texel, The Netherlands, (5) Antarctic Climate & Ecosystems Cooperative Research Centre, University of Tasmania, Hobart, Tasmania, Australia

Much of the variability in the surface ocean's carbon cycle can be attributed to the availability of sunlight, through processes such as surface heat flux and photosynthesis, which regulate carbon flux over a wide range of time scales. The critical processes occurring on timescales of a day or less, however, have undergone few investigations, and most of these have been limited time spans of several days to months. Optical methods have helped to infer short-term biological variability, but corresponding investigations of the oceanic CO_2 system are lacking. We employ high-frequency CO_2 and optical observations covering the full seasonal cycle on the Scotian Shelf, Northwestern Atlantic Ocean, in order to unravel diel periodicity of the surface ocean carbon cycle and its effects on annual budgets. Significant diel periodicity ion the surface CO_2 system occurs only if the water column is sufficiently stable as observed during seasonal warming. During that time biological CO_2 drawdown, or net community production (NCP), are delayed for several hours relative to the onset of photosynthetically available radiation (PAR), due to diel cycles in Chlorophyll a concentration and to grazing. In summer, NCP decreases by more than 90%, coinciding with the seasonal minimum of the mixed layer depth and resulting in the disappearance of the diel CO_2 periodicity in the surface waters. Ongoing work focuses on the transfer of these patterns to the individual -ideally remotely detectable- biological species, responsible for the CO_2 fixation at the seasonal scale in order to predict vulnerability of the system due to climate change.