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Seasonal controls of the short term variability of pCO_2 at the Scotian Shelf

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Much of the surface ocean carbon cycle variability can be attributed to the availability of sunlight, through processes such as heat fluxes or photosynthesis, which regulate the ocean carbon cycle 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 those have been limited to a time span of several days to months, or exceptionally, for longer periods. Optical methods have helped to infer short-term biological variability, however lacking corresponding investigations of oceanic CO_2 system. Here, we employ high-frequency CO_2 system and optical observations covering the full seasonal cycle on the Scotian Shelf, Northwestern Atlantic Ocean, in order to unravel daily periodicity of the surface ocean carbon cycle and its effects on annual budgets. We show that significant daily periodicity 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), is delayed for several hours relative to the daylight cycle due the daily build-up of essential Chlorophyll a, to cell physiology and to grazing effects, all restricting or hindering photosynthesis in the early morning hours. NCP collapses in summer by more than 90%, when the mixed layer depth reaches the seasonal minimum, which eventually makes the observed daily periodicity of the CO_2 system vanish.