

Physiological constrains on Sverdrup's Critical-Depth-Hypothesis: the influences of dark respiration and sinking - DTU Orbit (09/11/2017)

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Discussions on the controls initiating the onset of the phytoplankton spring bloom in particular in the North Atlantic have since Sverdrup been dominated by the role of physical and biological drivers. Undoubtedly, these drivers play an important role in phytoplankton dynamics and thus the onset of the spring bloom. However, they neglect the cells ability to modify vital rates in response to changes in the external environment. In this study, we use a non-hydrostatic convection model coupled to an Individual-Based-Model to simulate changes phytoplankton cells during the transition from winter conditions as driven by convective mixing, and the onset of thermal stratification resulting in the spring bloom. The comparison between a simulation using a standard fixed rate approach in line with the original Sverdrup hypothesis and a simulation parameterized to include variable respiration and sinking rates showed that the latter approach was able to capture the observed phytoplankton concentration during deep convective mixing, the timing and magnitude of the spring bloom as well as simulating realistic physiological rates. In contrast, the model employing fixed rate parameterizations could only replicate field observations when employing unrealistic parameter values. These results highlight the necessity to consider not only the physical and biological external controls determining phytoplankton dynamics but also the cells ability to modify critical physiological rates in response to external constraints. Understanding these adaptive qualities will be of increasing importance in the future as species assemblages and physical controls change with changing climate

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