ID: W1957766056

TITLE: Toward quantifying the response of the oceans' biological pump to climate change

AUTHOR: ['Philip W. Boyd']

ABSTRACT:

The biological pump makes a major global contribution to the sequestration of carbon-rich particles in the oceans? interior. This pump has many component parts from physics to ecology that together control its efficiency in exporting particles. Hence, the influence of climate change on the functioning and magnitude of the pump is likely to be complex and non-linear. Here, I employ a published 1-D coupled surface-subsurface Particulate Organic Carbon (POC) export flux model to systematically explore the potential influence of changing oceanic conditions on each of the pump?s ?moving parts?, in both surface and subsurface waters. These simulations were run for typical high (High Nutrient Low Chlorophyll, HNLC) and low (Low Nutrient Low Chlorophyll, LNLC) latitude sites. Next, I couple pump components that have common drivers, such as temperature, to investigate more complex scenarios involving concurrent climate-change mediated alteration of multiple ?moving parts? of the pump. Model simulations reveal that in the surface ocean, changes to algal community structure (i.e., a shift towards small cells) has the greatest individual influence (decreased flux) on downward POC flux in the coming decades. In subsurface waters, a shift in zooplankton community structure has the greatest single effect on POC flux (decreased) in a future ocean. More complex treatments, in which up to ten individual factors (across both surface and subsurface processes) were concurrently altered, ~ halved the POC flux at both high and low latitudes. In general climate-mediated changes to surface ocean processes had a greater effect on the magnitude of POC flux than alteration of subsurface processes, some of which negated one another. This relatively simple 1-D model provides initial insights into the most influential processes that may alter the future performance of this pump, and more importantly reveals many knowledge gaps that require urgent attention before we can accurately quantify future changes to the biological pump.

SOURCE: Frontiers in marine science

PDF URL: https://www.frontiersin.org/articles/10.3389/fmars.2015.00077/pdf

CITED BY COUNT: 43

PUBLICATION YEAR: 2015

TYPE: article

CONCEPTS: ['Biological pump', 'Environmental science', 'Flux (metallurgy)', 'Climate change', 'Oceanography', 'Global warming', 'Atmospheric sciences', 'Climate model', 'Nutrient', 'Phytoplankton', 'Ecology', 'Geology', 'Chemistry', 'Biology', 'Organic chemistry']