ID: W2079830288

TITLE: Evaluating primary and secondary production in an Arctic Ocean void of summer sea ice: An experimental simulation approach

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ABSTRACT:

The gross primary (GPP) and secondary production in the Arctic Basin, Eurasian shelves and the Barents Sea were investigated through the physically?biologically coupled, 3D SINMOD model with 20 km grid size. The model was applied in an experimental setting where a control run had atmospheric forcing from the European Centre for Medium-Range Weather Forecasts (ECMWF) reanalysis data. In order to test the effect of how retreating ice cover in the forthcoming century may affect the productivity through physical processes in the Arctic Ocean we added a latitude dependent air temperature starting at 1 °C at 40°N increasing to +2,+4,+6 and +8 °C at 90°N to the temperature forcing taken from ECMWF data. The model indicates that gross primary production (GPP) increases along the temperature gradient both in the Arctic Basin and along the Eurasian shelves from approximately 10 to 40 and 30 to 60 g C m?2 y?1, respectively. In contrast, GPP in the Barents Sea was more or less constant (ca. 100 g C m?2 y?1). For secondary production (key mesozooplankton species Calanus finmarchicus and Calanus glacialis) the results of the experimental runs are more complex. With an air temperature increase towards +8 °C secondary production of C. glacialis in the Barents Sea dropped from about 3.9 to 0.3 g C m?2 y?1, while that of the Arctic Basin and Eurasian shelf increased from approximately ?0.1 to 1.5 and 1.4 to 2.4 g C m?2 y?1, respectively. Secondary production changes are unevenly distributed spatially during future warming with the most significant increases occurring along the Eurasian shelves and the Chukchi Sea. Reductions are predicted for the Kara Sea and northern Baffin Bay. During warming and among the key mesozooplankton species the distribution of C. finmarchicus is constrained to the Barents Sea and eastern Fram Strait while C. glacialis almost disappears from the northern Barents Sea, the western Fram Strait and northern Baffin Bay. In contrast, this typical Arctic species expands to the Arctic Basin and on and off the Eurasian shelf, in particular the Chukchi and East Siberian Seas.

SOURCE: Progress in oceanography/Progress in Oceanography

PDF URL: None

CITED BY COUNT: 188

PUBLICATION YEAR: 2011

TYPE: article

CONCEPTS: ['Arctic', 'Sea ice', 'Oceanography', 'Environmental science', 'Arctic ice pack', 'Climatology', 'Canada Basin', 'Arctic sea ice decline', 'Primary production', 'Atmospheric sciences', 'Geology', 'Sea ice thickness', 'Ecosystem', 'Ecology', 'Biology']