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Role of spring and summer phytoplankton to Arctic amplification

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Under greenhouse warming, it has been proved that biological-physical coupling (or bio-geophysical coupling) enhances faster Arctic warming and Arctic amplification. While role of chlorophyll in Arctic is mainly focused on mean change, role of chlorophyll year-to-year variability is not comprehended. Under present climate (fixed CO_2 concentration at the state of 1990 year), it had been suggested that Arctic chlorophyll interannual variability induces relatively cold condition in the Arctic by absorbing less solar radiation due to ice-phytoplankton coupling and shortwave extinction coefficient non-linearity. Under greenhouse warming, the CM2.1 and CMIP5 models are simulating incline of chlorophyll in spring but decline of chlorophyll in summer. In addition to mean change of chlorophyll, ice-phytoplankton coupling strength in the model is changed that spring strength is induced and summer strength is reduced by sea-ice melting due to increased long-wave radiation. It is suggesting that amplified Arctic warming by phytoplankton is not only contributed by impact of chlorophyll mean in spring but also chlorophyll interannual variability. Comparing CM2.1 Earth System Model experiments to test Arctic warming sensitivity are found: Future chlorophyll mean changes induce Arctic warming (CC1-BGC.on). Future chlorophyll interannual variation induces warm condition of Arctic (CC2-BGC.on). Ice-phytoplankton coupling induces Arctic warming (PC-BGC.on). Sub-Arctic chlorophyll induces cold condition in Arctic (PCS2-PCS1). Shortwave extinction coefficient non-linearity induces cold Arctic (PC-CC2). This study suggests that amplified Arctic amplification by bio-geophysical feedback has been responding to spring chlorophyll increase and ice-phytoplankton coupling strength decrease.