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TITLE: Leads in Arctic pack ice enable early phytoplankton blooms below snow-covered sea ice

AUTHOR: ['Philipp Assmy', 'Mar Fernández Méndez', 'Pedro Duarte', 'Amélie Meyer', 'Achim Randelhoff', 'C. J. Mundy', 'Lasse Mork Olsen', 'Hanna M. Kauko', 'Allison Bailey', 'Melissa Chierici', 'Lior Cohen', 'Anthony P. Doulgeris', 'Jens K. Ehn', 'Agneta Fransson', 'Sebastian Gerland', 'Haakon Hop', 'Stephen R. Hudson', 'Nick Hughes', 'Polona Itkin', 'Geir Johnsen', 'Jennifer King', 'Boris P. Koch', 'Zoé Koenig', 'Sławomir Kwaśniewski', 'Samuel R. Laney', 'Marcel Nicolaus', 'Alexey K. Pavlov', 'C. Polashenski', 'Christine Provost', 'Anja Rösel', 'Marthe Sandbu', 'Gunnar Spreen', 'Lars H. Smedsrud', 'Arild Sundfjord', 'Torbjørn Taskjelle', 'Agnieszka Tatarek', 'Józef Wiktor', 'P. Wagner', 'Anette Wold', 'Harald B. Steen', 'Mats A. Granskog']

ABSTRACT:

Abstract The Arctic icescape is rapidly transforming from a thicker multiyear ice cover to a thinner and largely seasonal first-year ice cover with significant consequences for Arctic primary production. One critical challenge is to understand how productivity will change within the next decades. Recent studies have reported extensive phytoplankton blooms beneath ponded sea ice during summer, indicating that satellite-based Arctic annual primary production estimates may be significantly underestimated. Here we present a unique time-series of a phytoplankton spring bloom observed beneath snow-covered Arctic pack ice. The bloom, dominated by the haptophyte algae *Phaeocystis pouchetii*, caused near depletion of the surface nitrate inventory and a decline in dissolved inorganic carbon by $16 \pm 6 \text{ g C m}^{-2}$. Ocean circulation characteristics in the area indicated that the bloom developed in situ despite the snow-covered sea ice. Leads in the dynamic ice cover provided added sunlight necessary to initiate and sustain the bloom. Phytoplankton blooms beneath snow-covered ice might become more common and widespread in the future Arctic Ocean with frequent lead formation due to thinner and more dynamic sea ice despite projected increases in high-Arctic snowfall. This could alter productivity, marine food webs and carbon sequestration in the Arctic Ocean.

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