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The Impact of a Lower Sea Ice Extent on Arctic Greenhouse Gas Exchange

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Arctic sea ice extent hit a new record low in September 2012, when it fell to a level about two times lower than the 1979-2000 average. Record low sea ice extents such as these are often hailed as an obvious example of the impact of climate change on the Arctic. Less obvious, however, are the further implications of a lower sea ice extent on Arctic greenhouse gas exchange. For example, a reduction in sea ice, in consort with a lower snow cover, has been connected to higher surface temperatures in the terrestrial part of the Arctic (Screen et al., 2012). These higher temperatures and longer growing seasons have the potential to alter the CO_2 balance of Arctic tundra through enhanced photosynthesis and respiration, as well as the magnitude of methane emissions. In fact, large changes are already observed in terrestrial ecosystems (Post et al., 2009), and concerns have been raised of large releases of carbon through permafrost thaw (Schuur et al., 2011). While these changes in the greenhouse gas balance of the terrestrial Arctic are described in numerous studies, a connection with a decline in sea ice extent is nonetheless seldom made.

In addition to these changes on land, a lower sea ice extent also has a direct effect on the exchange of greenhouse gases between the ocean and the atmosphere. For example, due to sea ice retreat, more ocean surface remains in contact with the atmosphere, and this has been suggested to increase the oceanic uptake of CO_2 (Bates et al., 2006). However, the sustainability of this increased uptake is uncertain (Cai et al., 2010), and carbon fluxes related directly to the sea ice itself add much uncertainty to the oceanic uptake of CO_2 (Nomura et al., 2006; Rysgaard et al., 2007). Furthermore, significant emissions of methane from the Arctic Ocean have been observed (Kort et al., 2012; Shakhova et al., 2010), but the consequence of a lower sea ice extent thereon is still unclear.

Overall, the decline in sea ice that has been seen in recent years has the potential to influence greenhouse gas exchange across terrestrial ecosystems and the Arctic Ocean, but the overall impact remains unclear. In this study, we therefore try to reduce this uncertainty by addressing the influence of the decline in sea ice extent on all affected greenhouse gas fluxes in the high latitudes. Also, we will address the need for more research, on the ocean and on the land, to understand the impact of a lower sea ice extent on Arctic greenhouse gas exchange.

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