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# Simulated and observed trends in key variables of the Arctic marine carbon cycle

Nadine Goris (1,2), Christoph Heinze (1,2), Siv Lauvset (1,2), Dmitry Petrenko (3), Dmitry Pozdnyakov (3), Jörg Schwinger (1,2)

(1) University of Bergen, Geophysical Institute, Bergen, Norway, (2) Bjerknes Centre for Climate Research, Bergen, Norway, (3) Nansen International Environmental and Remote Sensing Center, St. Petersburg, Russia

For the Arctic region, a thorough monitoring of the marine carbon cycle is important, as the general "polar amplification" of climate change also translates into the biogeochemical realm. As compared to the global ocean, the sink for human-produced $CO_2$ is fairly small in the Arctic Ocean itself. Nevertheless, it is important to follow up this Arctic sink as a further control of the regional carbon budget and to record changes in the marine carbon cycle on the way towards a "blue Arctic". Since observations on the Arctic are rare, the EU FP7 MONARCH-A project tries to enable adequate descriptions of the status and evolution of the Arctic region Earth system components by generating time series of observation datasets and model hindcasts. In terms of the marine carbon cycle, this analysis focuses mainly on the key variables $pCO_2$ and primary productivity. For oceanic $pCO_2$, the comprehensive data-sets SOCAT and LDEO were combined, while measurements of atmospheric $CO_2$ were collected from the GLOBALVIEW-$CO_2$ data integration project. Monthly Primary Production fields were retrieved from the sensors MODIS and SeaWiFs. In order to get an overall picture of the behavior and trends of those key variables, in addition the physical-biogeochemical model MICOM-HAMOCC-M was employed.
The investigation showed that both oceanic and atmospheric $pCO_2$ are consistent variables which have a regular annual cycle and a similar behaviour all over the Arctic for both model and data. In contrast, primary production shows an irregular annual cycle in both range and form, varying over the Arctic. While a few well distributed measurement stations with continuous observations are sufficient to get a comprehensive picture for consistent variables like $pCO_2$, it is relatively difficult and costly to get a comprehensive record of non-consistent variables. Since the provided data-set for primary production covers a relatively short time-scale, it was neither possible to confidently validate the model nor to determine significant trends. Widespread measurements for at least 40 years are needed to capture both different regional behavior and associated trends stressing the value of the existing spatially comprehensive Arctic datasets of primary production and the importance of continuing the sensor-retrievals in the following years. The measurement stations of atmospheric $CO_2$ provide a good characterization of $CO_2$ with continuous measurement on a few, well distributed locations and allow for a confident data-model comparison all over the Arctic, while the coverage of the LDEO/SOCAT database allows for confident statements about the trends of oceanic $pCO_2$ in the region between $60^oW$ and $30^oE$. Here, the validated model MICOM-HAMOCC-M simulates a fast rising oceanic $CO_2$ partial pressure leading to an accelerated decrease in ocean $CO_2$ uptake in the Arctic.