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Effect of sea ice extent on atmosphere–ocean CO_2 exchange

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One of the components of the CO_2 balance on Earth is the gas exchange between atmosphere and ocean. The dynamical equilibrium between the atmosphere's and the ocean's CO_2 contents corresponds to a certain relationships between the gas' partial pressure and a temperature/salinity of water. Reported observational data show high correlation between seasonal variability of the atmospheric CO_2 content and the sea ice extent. However, the relation between an oceanic surface temperature and the atmospheric CO_2 content is not those directly following from the physical laws: The maximal CO_2 content in the atmosphere at the hemispheric scale is reported for Winter seasons, when the solubility of the colder oceanic water has its maximum. The CO_2 content decrease in the atmosphere and its increase in the sea water take place during the period of the ice sea melt up to the minimal sea ice extent (May–September in Northern Hemisphere). The increase of the CO_2 content in the atmosphere of the Northern Hemisphere corresponds to the period of maximal development of the sea ice cover (April–October). The moments of change in the tendencies are strongly related to the near-surface monthly-mean air temperatures reaching the temperature of water freeze (ice melt). The amplitudes of the cycles increase with latitude: From 0–5 ppm at 10°S to 20 ppm at 60–80°N. The Arctic seas dissolve at least 3×10^{14} moles of CO_2 in Spring–Summer seasons. This corresponds to additional flux at the interface of about 15 moles per m^2 per season and indicates formation of CO_2 deficit in sea waters during winter seasons. Thus, one more parameter responsible for the CO_2 balance, is seasonally varying surface area available for the gas exchange. Results of quantitative estimation of this effect are provided. The work is supported by RFBR grant 06-05-65152-a.