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New ventilation and gas saturation constraints for the Arctic Ocean from dissolved gas tracer data

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Timescales of ventilation and the extent of CO_2 uptake of the Arctic Ocean are still only poorly known. This contribution presents results of multiple tracers analyzed in the project Ventilation and Anthropogenic Carbon in the Arctic Ocean (VACAO), which is part of the Synoptic Arctic Survey carried out in summer 2021 on the Swedish icebreaker Oden. The combination of CFC-12, SF_6, ^{39}Ar, and ^{14}C measurements yields ventilation timescales and constraints for transit time distributions of the complete water column. The results allow assessing the evolution of the carbon storage and ventilation of the past 40 years thanks to the available historical data [1] [2].

CFCs and SF_6 are limited to young water masses and show very low concentrations in the deep basins of the Arctic Ocean. The radioisotope ^{39}Ar with its half-life of 268yrs is perfectly suitable to investigate ventilation timescales of deep and intermediate water masses within the Arctic Ocean. The quantum optical measurement technique Argon Trap Trace Analysis (ArTTA) drastically reduces the sample size requirements compared to low-level counting used in the 1980s, thus enabling a better resolution of the water column in great depths. More than 60 samples of ocean water were taken for ArTTA and first results agree well with previous data from the Eurasian Basin. ^{14}C age measurements are also in good agreement with historical data in the deep basins and show the decline of ^{14}C input from the Nordic Seas within the uppermost water column.

The saturation of all gaseous transient tracers is influenced by surface conditions as well as interior mixing processes. Measurements of stable noble gas isotopes (He, Ne, Ar, Kr, Xe) are used to determine small saturation anomalies that arise during air bubble dissolution, rapid cooling, or ice formation and subsequent interior mixing of water masses. These saturation distortions for different boundary conditions are of key importance to correct the input function for gas tracers in the Arctic Ocean and hence to constrain the ventilation timescales and the uncertainty of the age distributions.

[1] Schlosser et al. (1994), *Radiocarbon* 36, 327-343.

[2] Schlosser et al. (1995), *Progress in Oceanography* 35, 1-28.