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Quantifying the added value of underway pCO data from sailboats

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The ocean regulates the climate by annually absorbing roughly 25 % of anthropogenic CO_2 emissions from the atmosphere. In order to quantify the capacity of the ocean carbon sink from observations, measurements of the sea surface partial pressure of CO_2 (pCO_2) are essential. Building on the existing observational networks, we can utilize neural networks and other statistical methods, to interpolate data gaps in time and space creating homogeneous pCO_2 maps to estimate the exchange of CO_2 through the air-sea interface. However, uncertainties in these neural network interpolations are still substantial, particularly in less frequently monitored ocean regions such as the Southern Ocean. Trying to close existing data gaps, MPI is working with a novel, cost efficient and environmentally friendly fleet: sailboats. Sailboat pCO_2 has been regularly collected since 2018, however, their added value has not yet been quantified.
Here, we quantify the added value and rate of improvement of underway pCO_2 data from such racing events by creating a twin of all available SOCAT observations, excluding data from sailboat races. We apply the SOM-FFN technique on all pCO_2 observations in SOCAT as well as the twin dataset and calculated the sea surface pCO_2 and subsequently the air-sea CO_2 exchange. By comparing the reconstructive air-sea CO_2 fluxes, we were able to quantify the difference, representing the added value of sailboat racing events.
Our results show that the reconstructions on SOCAT and the twin dataset significantly differ in the air-sea CO_2 flux density on regional scales by up to 1.26 mol m^{-2} yr^{-1}. 99 % of the significant differences fall below 0.40 mol m□² yr□¹. While differences are within the noise in many regions, significant differences can be detected in the less frequently monitored Southern Ocean, where pCO_2 data from single events, such as the Vendée Globe are added, as well as in the North Atlantic, where the majority of racing events took place. While the results after 5 years of data collection do not show a significant effect when globally integrating the air-sea CO_2 exchange, our results highlight the potential of sailing yachts as an observational platform, particularly in less frequently navigated ocean regions. We conclude that sailboat races provide a complementary observing platform to research vessels and robotic floats. Considering the recurrence of sailboat races, they have the potential to improve reconstructive air-sea CO_2 flux estimates on a larger scale in the future.