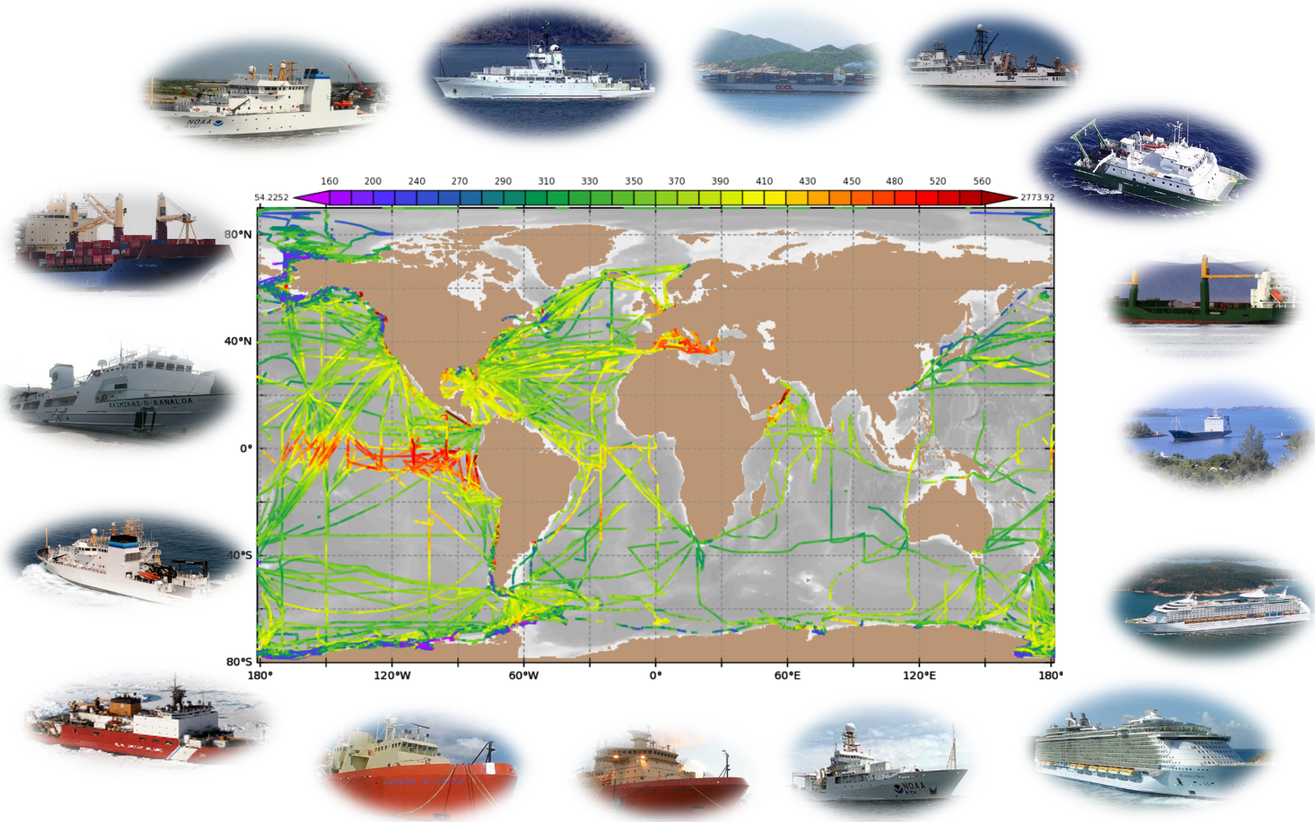
Data gathering:
Ocean Carbon Cycle – Sea-air CO_2 fluxes

$$\text{Sea-air } CO_2 \text{ flux} = k\,K_o\,\Delta pCO_2$$

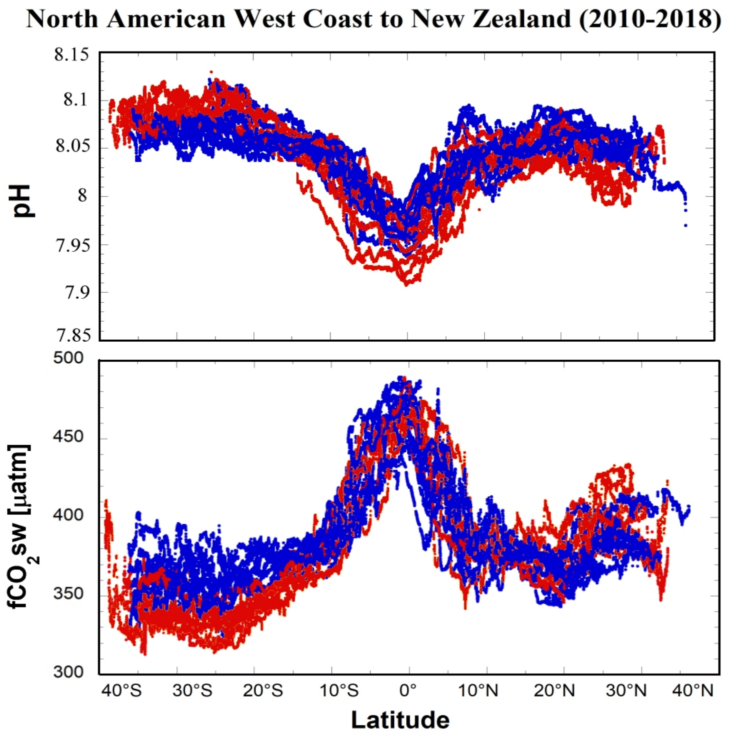
- NOAA OOMD supports the largest ship of opportunity pCO_2 measurement campaign in the world comprised of 15 ships of opportunity with automated CO_2 systems in FY20



Ship tracks and ships with autonomous pCO_2 systems sponsored by the NOAA/GOMO program

Monitoring the Carbonate System in the Northeast Pacific Ocean

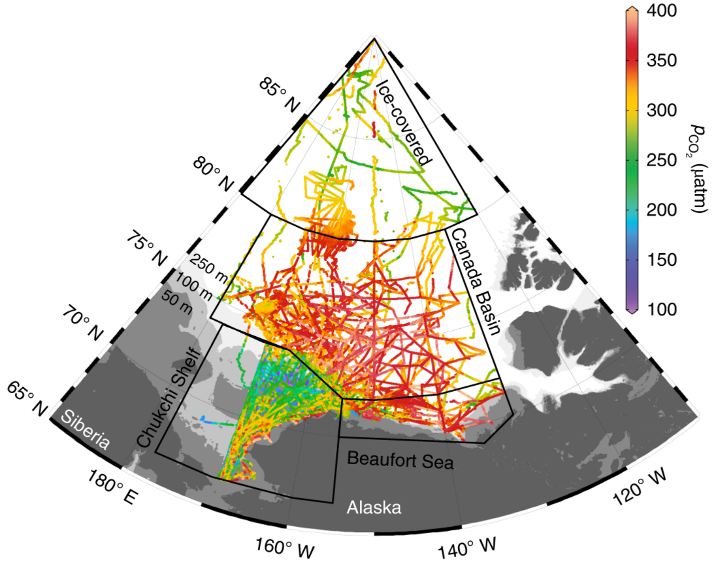
- The tropical Pacific is the major natural source of CO_2 from the ocean to the atmosphere, contributing nearly 70% of the global flux to the atmosphere. Interannual variability of the sea-air CO_2 flux in the tropical Pacific is also the major source of CO_2 flux variability in the global oceans. Underway fCO_2 data collected in the equatorial Pacific play a significant role in many publications, highlighting the importance of this dynamic region to the global CO_2 cycle.

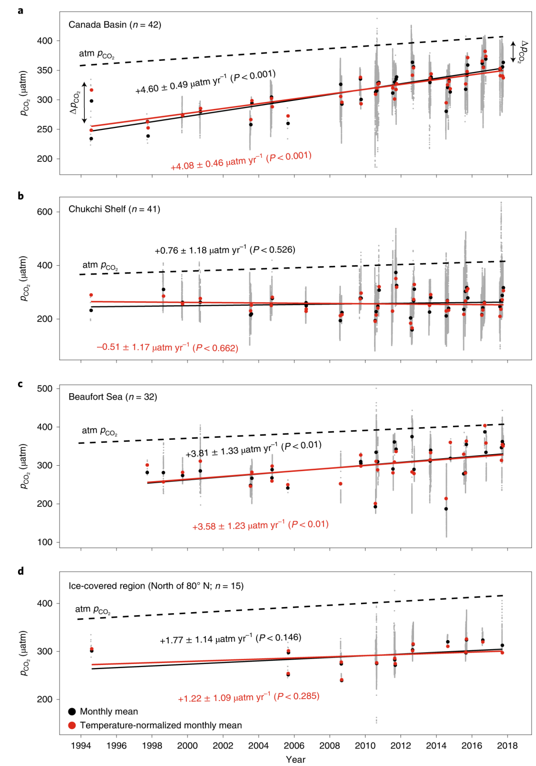


pH and fCO_2 data from trans-Pacific container ship crossings from the North American Pacific Coast to New Zealand during 2010–2018. Crossings shown in red occurred during months of April through September, while those in blue happened during October through March. These data will be included in an Earth Systems Science Data paper we are preparing (Cosca et al., in preparation).

Dramatic trends in summer ΔpCO_2 over the past two decades in the Canada Basin related to declines in sea ice

Summer pCO_2 has increased dramatically over the past two decades in the Canada Basin which is in sharp contrast to trends in the Chukchi Sea. An analysis of the drivers of pCO_2 trends in these regions indicates that summer sea ice loss in the Canada Basin has led to changes in the upper ocean that have caused this dramatic trend in pCO_2





(left) Summer pCO_2 observations in the western Arctic Ocean from 1994-2017 from Fig. 1 of Ouyang et al. (2020). (right) Long-term trends in summer pCO_2 in different regions of the Arctic Ocean from Fig. 2 of Ouyang et al. (2020). Most observations in the later years were contributed by NOAA pCO_2 systems installed on the USCGC Healy (since 2011) and the R/V Sikuliaq (since 2015).

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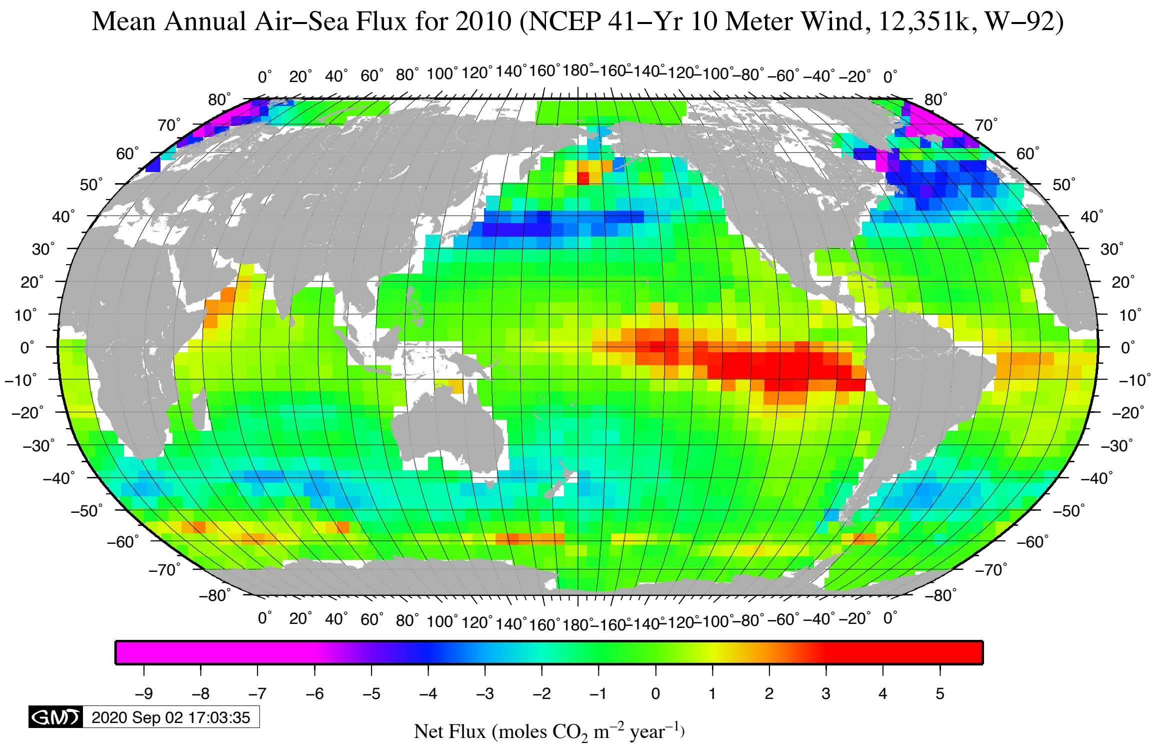
A final update of the canonical Takahashi climatology of surface ocean pCO_2

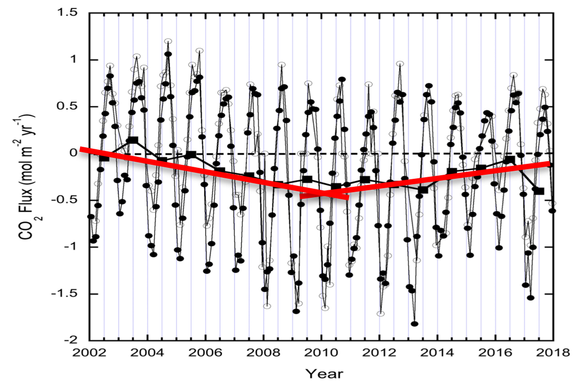
We have recreated the climatology with a dataset of more than 12 million observations for the reference year 2010. The new version of the climatology revises the contemporary global ocean sink by nearly 25% from -1.42 to -1.76 Pg C in comparison to the Takahashi et al. (2009) product. The subtropics and the high latitude Northern Hemisphere accounts for most of this increase in ocean uptake which more than offsets a nearly 25% increase in outgassing from the tropics.



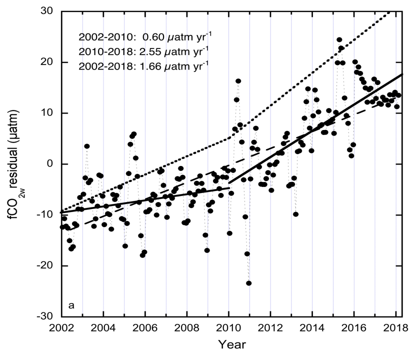
Mean annual air-sea CO_2 flux from the updated climatology for reference year 2010 in mol C m-2 yr-1 defined such that negative (positive) values represent regions of ocean uptake (outgassing).

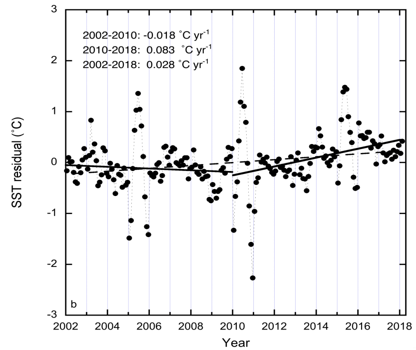
Large Decadal Changes in Air-Sea CO_2 Fluxes in the Caribbean Sea

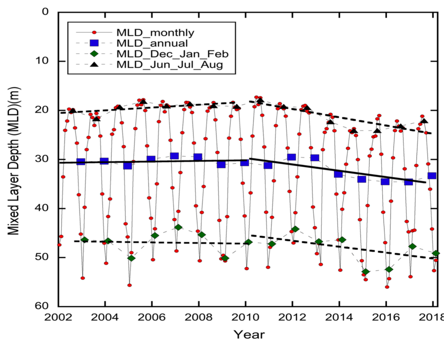
Taking advantage of a 17-year dataset from ships of the Royal Caribbean Cruise Lines in the Northern Caribbean we created monthly maps at 1° by 1° using a multi-linear regression analysis with robust error analysis. The results showed surprisingly large decadal changes in surface water CO_2 and air-sea CO_2 fluxes. From 2002 to 2017, the Caribbean Sea became an increasing CO_2 sink until 2009-2010. The trend then reversed itself and the CO_2 flux became slowly less negative, while still remaining a sink



The reversal of the trend is mostly attributed to changes in sea surface temperature (SST) and mixed layer depth (MLD) which showed similar trends through the decade







The reversal seems to be synchronous with large climate re-organizations such as the North Atlantic Oscillation (NAO) or the Atlantic Multidecadal Oscillation (AMO)