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Towards the quantification of the role of terrestrial surface water degassing on the short-term carbon cycle

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The release of CO_2 from Earth's terrestrial surface waters to the atmosphere is a major contributor to the short-term carbon cycle. This flux from surface waters is much larger than degassing from the Earth's crust and mantle, and the combined CO_2 drawdown from the atmosphere by weathering of silicates and carbonates on the continents. Hence majority of the CO_2 degassed from surface waters originates from organic matter decomposition.

Here we report, 1) the *in-situ* CO_2 partial pressure (p_{CO2w}), and the CO_2 concentration of more than one hundred springs, rivers, lakes, man-made reservoirs and wetlands soils in Iceland, and 2) CO_2-fluxes between each of these waters with the atmosphere. The *in-situ* CO_2 concentrations and partial pressures were calculated with the PHREEQC code.

The highest partial pressure of CO_2 (P_{CO2}) was 100.000 µatm in wetland soil waters before their exposure to the atmosphere. The lowest P_{CO2} was 0.32 µatm in spring water emerging from glassy basaltic rocks. During the 1970 to 2021 sampling period, the atmospheric P_{CO2} ranged from 360 to 415 µatm. The flux of CO_2 across the air−water interface (F_{CO2}) is proportional to the concentration differences been to the aqueous fluid and gas such that:

$F_{CO2} = k\,(C_w - C_0)$,

where k is the gas transfer velocity at the *in-situ* temperature, wind- and water-velocity, C_w is the CO_2 gas concentration in the well−mixed bulk aqueous fluid underlying the surface film at the air/water interface, and C_0 is the CO_2 gas concentration at the water surface film in exchange with the atmosphere (e.g., Alin et al., 2011).

We find that the degassing flux from wetland soils is far faster than the influx of CO_2 into the basaltic spring waters due to the high P_{CO2} of these waters. Hence the CO_2 degassing fluxes from terrestrial waters is dominated by rivers, lakes and reservoirs draining organic rich wetlands. One consequence of this results is that reservoirs, erected in sparsely vegetated and carbon poor soils, tend to have P_{CO2} below or close to the P_{CO2} of the atmosphere limiting their CO_2 fluxes to the atmosphere.

Alin et al., 2011. JGR. 116, G01009, doi:10.1029/2010JG001398.