How can we balance the short-term carbon cycle during the 21st century?

SIGURDUR REYNIR GISLASON[1]

[1]Institute of Earth Sciences, University of Iceland, 101 Reykjavík, Iceland (*sigrg@hi.is)

All the carbon on the Earth's surface is derived from rocks. The carbon travels from one reservoir to another in the global carbon cycle. The exchange between the largest rock reservoirs is slow, but fast between the smallest reservoirs, biomass and the atmosphere. On a geological time scale (~1 My), the CO_2 concentration of the atmosphere is balanced by various negative feedbacks between the atmosphere and the rock reservoirs via the greenhouse effect. "The strength" of the greenhouse effect amounts to ~3 °C warming when preindustrial atmospheric CO_2 concentration is doubled to ~560 ppm. "The strength" of the inorganic carbon terrestrial weathering feedback, where there is abundant un-weathered Ca-Mg silicate material, has been measured to be 5–15% for every 1 °C rise in atmospheric temperature. This and other negative feedbacks cannot keep up with curent antropogenic CO_2 release rates, resulting in the rapid rise in atmospheric CO_2 concentrations.

The 2018 IPCC special report [1] suggests how humanity can balance the short-term carbon cycle during the 21st century and limit anthropogenic warming to 1.5 °C. It involves sustainability, phasing out fossil fuels, CO_2 capture from large concentrated point sources with ensuing rock storage (CCS) and direct CO_2 capture from ambient air and storing it in rock (DACS). The CCS technique has been available for three decades, yet progress is very slow. In 2018 about 40 Mt CO_2 was captured from smoke stacks world-wide [2], however the majority of it was used for enhanced oil recovery, which will eventually lead to more CO_2 released into the atmosphere. We will most likely have to implement costly large-scale direct air capture (1000 Gt CO_2) during the 21st century due to this slow growth in the CCS sector.

The CarbFix consortium has developed an unconventional method to capture CO_2 from concentrated sources and ambient air and to store this CO_2 as minerals in reactive Ca-Mg-silicate rocks. The price of direct air capture is still more than an order of magnitude higher than from concentrated sources, but with significant upscaling and development, we hope that this and other methods, will eventually balance out the short-term carbon cycle later this century.

[1] Intergovernmental Panel on Climate Change. Global warming of 1.5°C (IPCC, 2018).

[2] Global CCS Institute. The global status of CCS 2018 (Global CCS Institute, 2018).