Ocean Acidification

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Dear Friends,

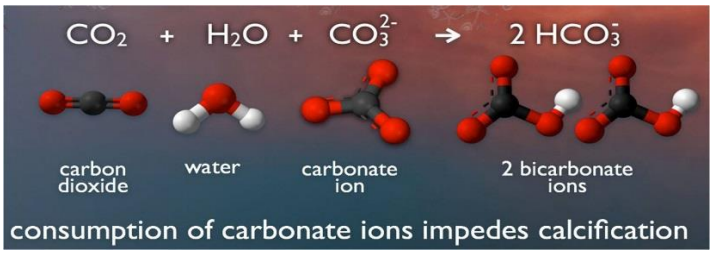
This month, we shall talk about Ocean Acidification. This is a case for which, we have a very clear boundary definition, thanks to the chemistry of saturation. Mankind has not yet crossed this boundary yet, but the effects are visible, and we must take note of our impact. The root cause is once again the carbon dioxide gas that we emit as a result of our dependence on fossil fuels for our energy requirements and for many other industrial activities, like cement production. Roughly one fourth of this gets absorbed by the ocean water leading to the formation of Carbonic Acid (H_2CO_3) that leads to this effect. Another one-fourth gets absorbed by the plants, and the remaining one-half stays in the atmosphere being the primary cause for global warming and climate change.

Ocean water is basically alkaline with an average pH value of little over 8.2 in the pre-industrial period. The formation of Carbonic Acid (H_2CO_3) causes this value to reduce progressively. The chemical equations are shown below:

$$CO_2 + H_2O = H_2CO_3$$

$$H_2CO_3 > H^{+1} + HCO_3^{-1}$$

$$HCO_3^{-1} > H^{+1} + CO_3^{-2}$$

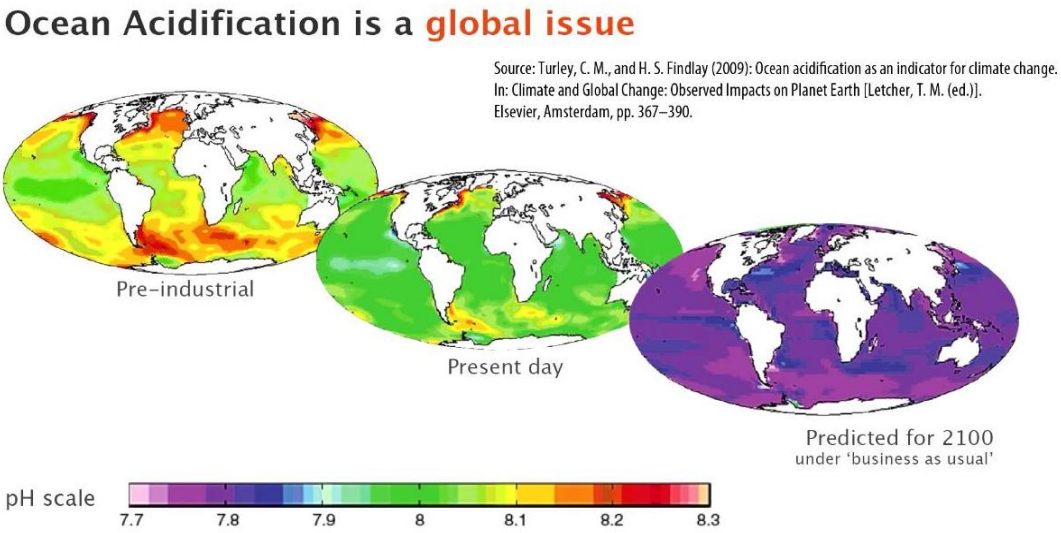


The two H^{+1} ions released by the above processes lead to acidification.

So what, we may ask? Well, it has to do with the ability of ocean water to dissolve aragonite, a form of Calcium Carbonate ($CaCO_3$). We all know that calcium plays an important role in our bone formation. It is the same for all fish and other water based life forms, and for them, it is in the form of aragonite. Now imagine a situation where the bone matter tends to get dissolved in the water that surrounds the life under water. This is roughly what happens when the basicity level of ocean water goes down. Ocean water which is normally a saturated solution of aragonite tends to get un-saturated with a possibility of dissolving additional quantities of aragonite. This phenomenon poses a great threat to all marine life. The true impact of this process may be gauged from the fact that a 0.1% increase in pH value leads to 26% increase in acidity.

The boundary for this trend is simple: the point at which ocean water becomes unsaturated in aragonite. We still have a margin, but if we continue to emit more and more Carbon Dioxide into

the atmosphere, we are moving closer to this danger. The following picture offers an overall perspective, with some projections, under ‘Business as Usual’ scenario.



The next picture shows the possible impact on corals under water due to acidification. On the left we have a completely bleached scenario as opposed to the natural colorful presence on the right.

Ocean acidification, along with Climate Change and Chemical Pollution have an adverse effect of marine food production and marine bio-fuel production, both of which are important components of our modern lifestyle.

This is a summary of a PB-MOOC lecture by Prof. Kevin Noone at the Department of Applied Environmental Science at Stockholm University.