There Is No Planet B! Impacts Of Ocean Acidification On Planet A

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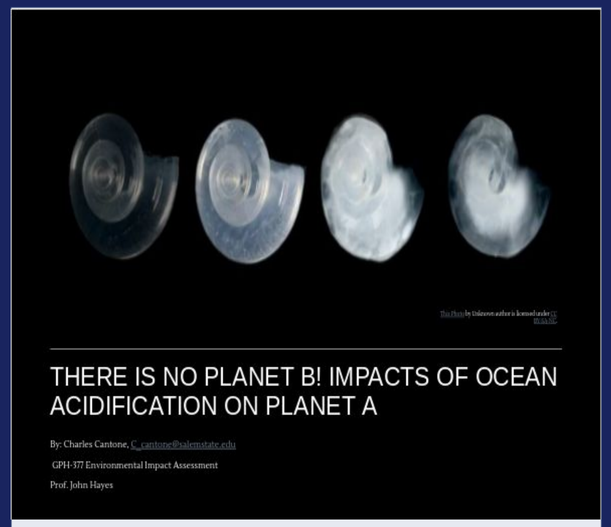
GPH377-Environmental Impact Assessment, Prof. John Hayes



ABSTRACT

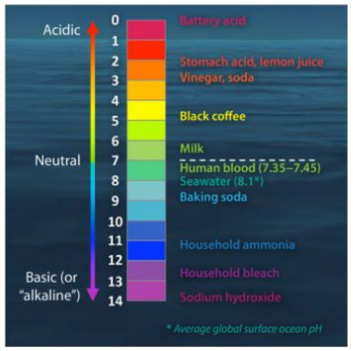
Pollution is changing the chemistry of our oceans. Even though the ocean is the world's largest carbon sink, it has its limits before negative consequences begin to reveal themselves. Since the end of the preindustrial era in 1850, the Earth's oceans have absorbed about 29% of carbon dioxide emissions globally. In the short decade from 2008 to 2018 we have dumped roughly 40 gigatons of harmful emissions into the atmosphere which has had visible negative impacts on the environment, with a large portion of those emissions being CO_2. Due to the increased CO_2 in the atmosphere, the ocean water is now 30% more acidic when compared to the PH levels at the start of the industrial era. Marine life is suffering due to this increased acidity, but more importantly marine life is suffering at the hands of humans and we must turn our current situation around.

UNDERSTANDIN DATA

- In order to properly read the next two tables, we must first understand what's going on.
- CO_2 at seas surface & PH at sea surface, these tables use two different forms of analysis called the *Community Climate System Model* (CCSM) and the *Global Ocean Data Analysis Project* (GLODAP).
- **CCSM**- Portrays CO_2 at sea surface level. This was developed by the University Corporation for Atmospheric Research (UCAR) and this includes models of atmospheric, ocean, land, and sea-ice.
- **GLODAP**- Chemical analysis of water samples which ultimately helps us collect biogeochemical data. And the data is collected on the basis of 12 core varibales: oxygen, salinity, phosphate, silicate, nitrate, dissolved inorganic carbon, total alkalinity, PH, CFC-11, CFC-12, CFC-113, CCL_4

WHAT IS PH?

The image to the right picures a pH scale ranging from 0-14. PH is a measurement that tells us how acidic a liquid is or how basic. The lower you move on the scale the less harmful however, the numbers are increasing. The higher you move on the scale where the numbers are decreasing would mean a lower pH level, and this would tell you that the liquid is of a higher acidity level. Any liquid that has a pH level between 7-0 automatically tells us that it is acidic. From 7-14 tells us that it is less acidic and closer to a base with 14 being completely alkaline. A pH level of 7 is neutral, neither acidic or alkaline.



https://www.pmel.noaa.gov/co2/file/The+pH+scale+by+numbers

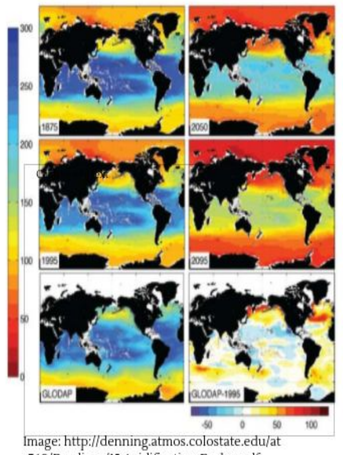
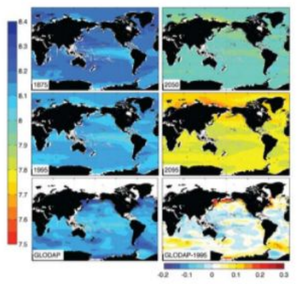


Image: http://denning.atmos.colostate.edu/ats760/Readings/15.Acidification.Feeley.pdf

CO^2 AT SEA SURFACE

In the image to the left which depicts CO_2 concentrations at the sea surface level contains 6 individual images. The first 4 from the top are using the CCSM model, and the bottom 2 using the GLODAP model. The verticle bar displaying numbers from 0-300 represents CO_2 concentrations in the units of umol kg^{-1} and the darker the shade of blue indicates a higher concentratio of CO_2. The horizontal bar represent the waters aragonite saturation and the values range from −50 – 100 umol kg^{-1}. Aragonite saturation measures carbonate ion concentrations in the water. Below 3 and we will begin to see organisms increasingly stressed with less ability to form hardened shells or $CaCO_3$ (clams, oysters, coral, ect.) when we reach below 1 calcium carbonate begins to dissolve.

PH AT SEA SURFACE



The image shows us another grouping of models. The top 4 are using the CCSM model, bottom left is using the GLODAP model, while the bottom right dipicts the difference between the both models. Here we're looking at surface pH concentrations. The verticle bar to the left represents pH levels. Comparing the images from 1875 and 2095 gives a great contrast of ocean acidicty from the pre-industrial era and the long-term aftereffects of an intense industrial era polluting the environment. The horizontal bar that ranges from −0.2 - 0.3 represents the pH change in the surface water along with the difference between both models, CCSM and GLODAP. The white areas at the top of the GLODAP images is due to no recorded data.

Image: http://denning.atmos.colostate.edu/ats760/Readings/15.Acidification.Feeley.pdf

Ocean acidification is an extremely important issue to focus on. This problem is rapidly progressing and it's proving to be deadly to many different species that call the ocean home. The ocean absorbs about a quarter of the CO_2 released by human activities annually. However, as the atmospheric CO_2 levels increase so do the ocean CO_2 levels which is causing massive damage within our waters.

Our oceans contain massive reservoirs of carbon that is exchangeable with the atmosphere. This is only possible due to the CO_2 reacting with ocean water to form carbonic acid. As the CO_2 in the atmosphere increases, the interaction between the ocean's surface water and the CO_2 end up changing the chemistry of the water, which ultimately leads to ocean acidification.

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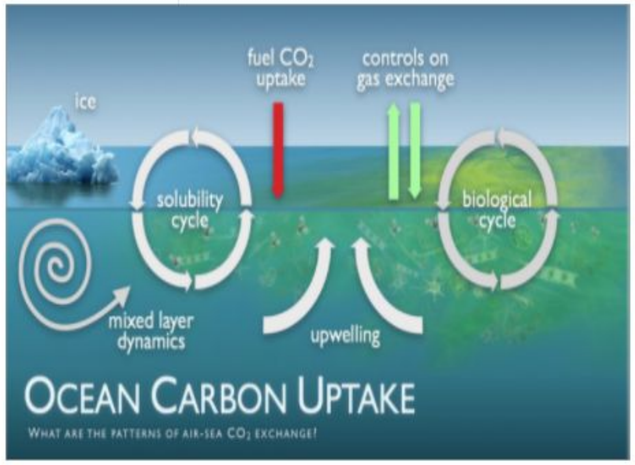
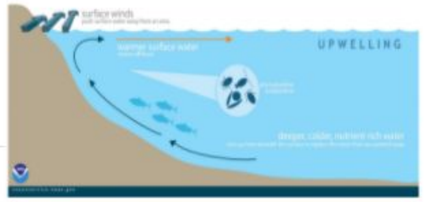
CO_2 UPTAKE



• https://www.pmel.noaa.gov/co2/story/Ocean+Carbon+Uptake

Changes in CO_2 within the coean will closely mirror the changes within the CO_2 in the atmosphere.

Air- sea gas exchange is a physio-chemical process; however, it takes about 1-year to fully equilibrate CO_2 into the ocean's surface water.
Oceans hold massive reseviours of CO_2, the CO_2 can be exchnaged between the atmoosphere and the surface water. This is possible due to the CO_2 reacting with the surface water which in turn creates Carbonic Acid or H_2CO_3. This is where our problem arises, as atmospheric CO_2 increases (and it's increasing rapidly) the reaction between the carbon and the surface of the ocean ultimately changes the very chemistry of the water. This is ocean acidification.
As we can see from the previous slide, ocean uptake moves the CO_2 around along with the oher natural circulations within the water. Specifically upwelling, upwelling is the natural process of very cold nutrient rich and usualy very CO_2 rich water rising from deep waters. This colder water takes the place of the warmer surface water and the process continues.

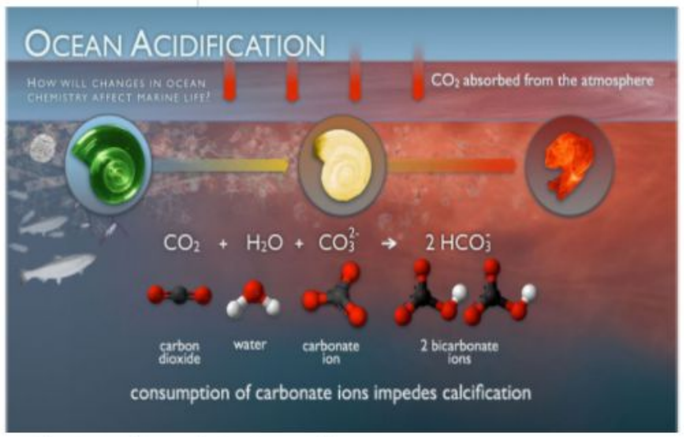


https://oceanservice.noaa.gov/facts/upwelling.html

WHAT IS THE SOLUTION? IS THERE A SOLUTION?

- With OA impacting all live in the ocean a solution can't come fast enough. OA of course has a negative impact on human lives as well.
- We also see global warming excelaerated due to OA impacting the ocean's ability to intake CO_2. Communities that rely on the ocean as their livelihood are at serious risk and this is the very reason this issue must be turned around.
- Dramatically cutting your use of fossil furels is a step in the righ direction. Trying to be concoius about what's damaging to the environment (I.e. Earth friendly)
- Holding fossil fuel producer accountable for the damage they have caused within the environment. They shoud also be held especially accountable for continully misinforming the public about what was truly going on as well as the risks to the enviornment.

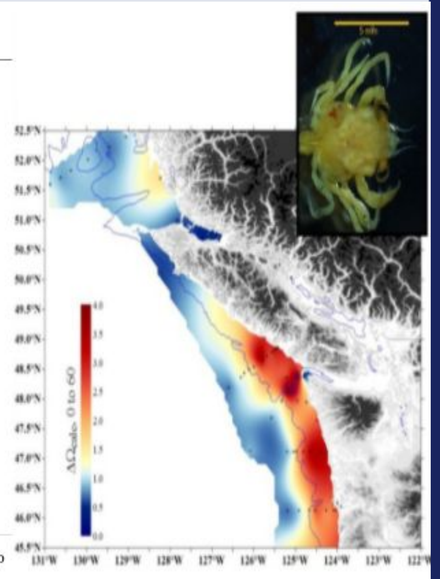
IMPACTS ON OCEAN LIFE



• https://www.pmel.noaa.gov/co2/story/Ocean+Acidification

Ocean Acidification (OA) is causing very negative imacts within ocean life populations. For a direct example we'll look at the Dungeness crab native to the Northeastern Pacific. NOAA studies show that internal and external dissolution[1] has begun to take place within their exoskeleton. The dissolution is making it more difficult for them to grow and reach full size, populations are smaller and have less structue in their shells. This is a trend not only witnessed in Dungeness crabs, but in many species that have calcified exoskeletons as well as oysters and clams.

Dissolution[1] – dissipation or in this context, weak areas of the crabs shell



https://www.pmel.noaa.gov/co2/file/Exoskeleton+Dissolution+figure

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