

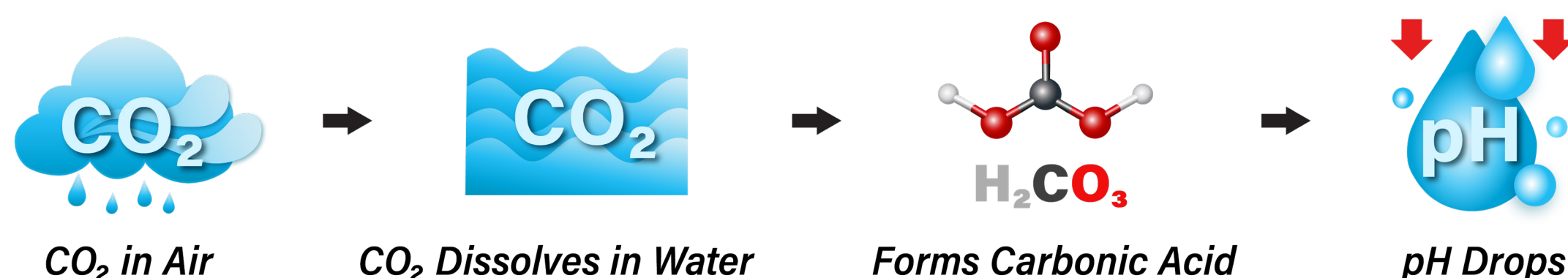
Influence of Atmospheric Carbon Dioxide on the Acidification of the Ocean



UNDERSTANDING THE INFLUENCE OF CARBON DIOXIDE ON WATER PH

Introduction

Carbon dioxide plays a critical role in the chemistry of water. As CO₂ levels in the atmosphere rise, more of the gas dissolves into oceans and other water systems – changing their chemistry and lowering pH. Understanding this process is essential for environmental monitoring, aquaculture, water treatment, and laboratory analysis, where even small changes in pH can have significant consequences.



Carbon dioxide is a naturally occurring gas that is produced through respiration in animals and from the decay of organic matter. Plants use this carbon dioxide in the process of photosynthesis, which results in the production of oxygen. Carbon dioxide as a gas dissolves in water to form carbonic acid, which can lower the pH of water as seen in **figure 1**.



Figure 1. The chemical reaction of carbon dioxide and water to form carbonic acid, which dissociates into hydrogen and bicarbonate ions. The increase in carbon dioxide forces the reaction to the right, resulting in an increase in hydrogen ion concentration, which causes a decrease in pH.

WHY THIS MATTERS?

As atmospheric carbon dioxide increases, the oceans absorb more of this gas, acting as a long-term carbon reservoir. This process has measurable effects on water chemistry.

Henry's Law states that the solubility of a dissolved gas in a liquid is directly proportional to its partial pressure. In the case of carbon dioxide, as atmospheric concentration increases, more gas dissolves into the ocean.

This increased dissolution drives the formation of carbonic acid, leading to higher hydrogen ion concentration and lower pH levels over time.

Influence of Atmospheric Carbon Dioxide on the Acidification of the Ocean



Figure 2 shows the correlation between increasing atmospheric carbon dioxide and rising levels in seawater, along with a corresponding decrease in pH.

This shift in pH can have significant consequences for marine ecosystems.

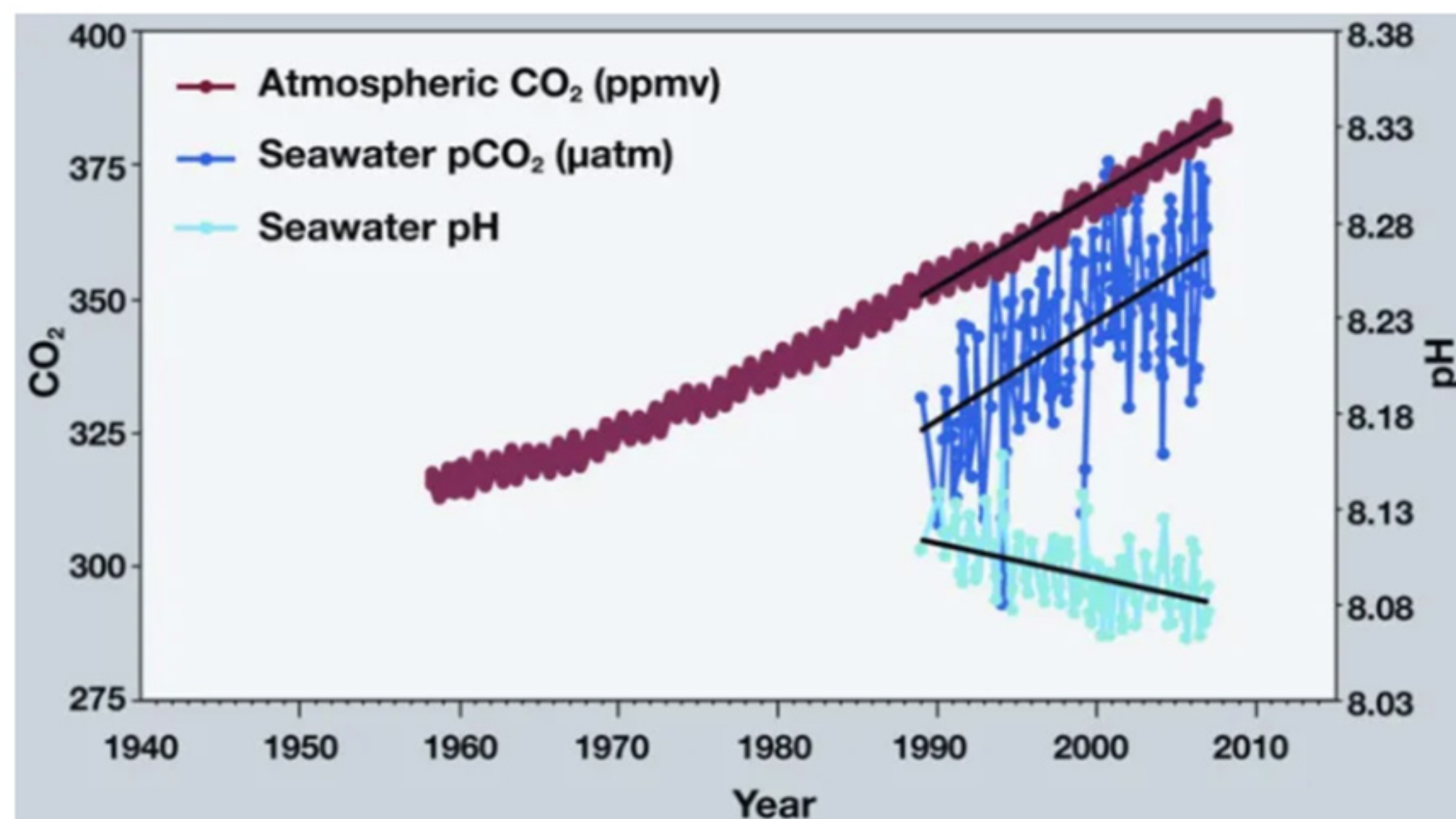


Figure 2. Graph showing rising levels of carbon dioxide in the atmosphere leads to an increase in carbon dioxide in the ocean, which causes a decrease in seawater pH. Source: [Smithsonian](#) and [NOAA](#).

IMPACT ON MARINE LIFE

Marine animals that rely on carbonate are known as calcifiers. These organisms – including coral, sea urchins, starfish, and mollusks – require calcium carbonate to build shells and skeletal structures.

As ocean pH decreases, carbonate availability is reduced, making it more difficult for these organisms to grow and maintain their structures.

EVERYDAY EXAMPLES OF CO₂ AND PH

There are practical examples that demonstrate the influence of dissolved gases and pH changes.

Carbonated beverages contain dissolved carbon dioxide at higher concentrations due to pressure. When a can is opened, the pressure decreases and carbon dioxide escapes from the solution, visible as bubbles.

The effect of acidic conditions can also be demonstrated using shell materials. When a shell is placed in vinegar (acetic acid), it gradually dissolves as the acid reacts with carbonate.

These simple observations mirror the same chemical principles affecting natural water systems.

Influence of Atmospheric Carbon Dioxide on the Acidification of the Ocean



PRACTICAL EXPERIMENT: MEASURING THE EFFECT OF CO₂ ON PH

This experiment demonstrates how dissolved carbon dioxide influences pH – and how these changes can be measured in real time using a pH meter. A simple experiment can be conducted using carbonated beverages and a calibrated pH meter.

Measure the pH of samples immediately after opening, and again after degassing. Degassing can be achieved through heating, stirring, or agitation, as solutions hold less gas at higher temperatures. Once the gas is removed, measure the pH again and compare the results.

Cola contains additional acids such as phosphoric acid, while seltzer water contains only dissolved carbon dioxide. This difference allows for comparison between CO₂-driven acidity and other acid sources.

Consider:

What differences would you expect between pre- and post-degassing measurements?

Accurate pH measurement is essential for understanding these changes in both controlled experiments and real-world applications.

APPLICATIONS

Understanding the relationship between carbon dioxide and pH is critical in:

- Environmental monitoring and ocean research
- Aquaculture and marine systems
- Water treatment and quality control
- Food and beverage production
- Laboratory and educational settings

Reliable pH measurement enables better control, analysis, and decision-making across these fields.

PROPER CARE & MEASUREMENT TIPS

To ensure accurate and reliable pH measurements:

- Always calibrate your pH meter before use
- Rinse the electrode between samples to avoid contamination
- Store the electrode properly in storage solution
- Avoid measuring at extreme temperatures without compensation
- Regularly check electrode condition for consistent performance

Consistent measurement practices are key to obtaining meaningful and repeatable results.