

How sensitive are ocean systems to pH changes? If we permit atmospheric CO2 levels to rise to ~ 600 ppm and remain there, then surface ocean waters, and eventually all ocean waters, will experience an ~ 0.3 pH change from pre-industrial levels. Is that an acceptable limit, and why? What burden of fossil fuel CO2 is "acceptable" for climate, or geochemical, or biological, reasons? How might we view the trade-off between the direct effects of CO2 and of the induced effects of climate/temperature? The focus of the ocean science community has been on observing the evolving fossil fuel CO2 tracer signal, and the questions above have simply (and astonishingly) not yet been posed.

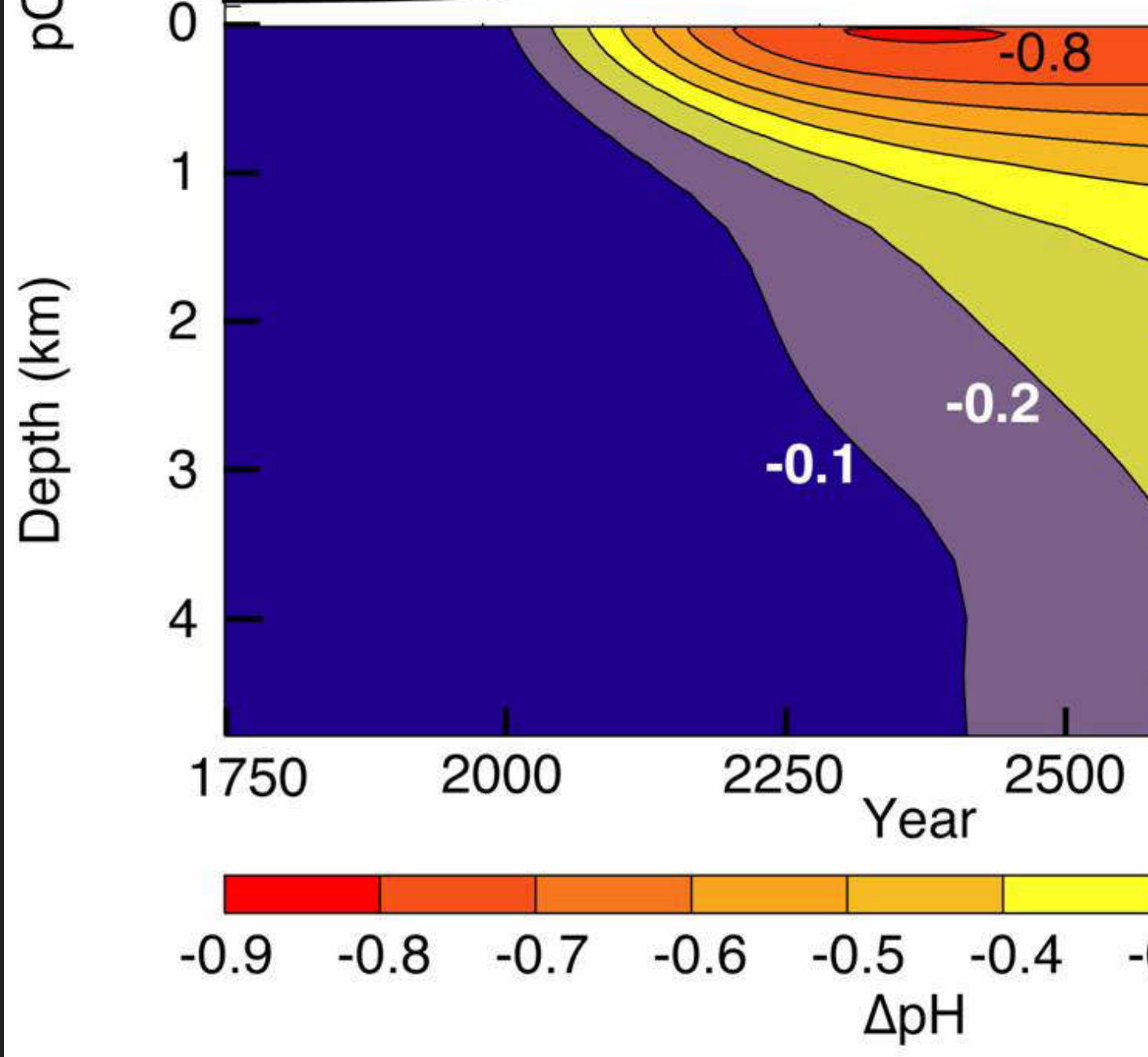
References

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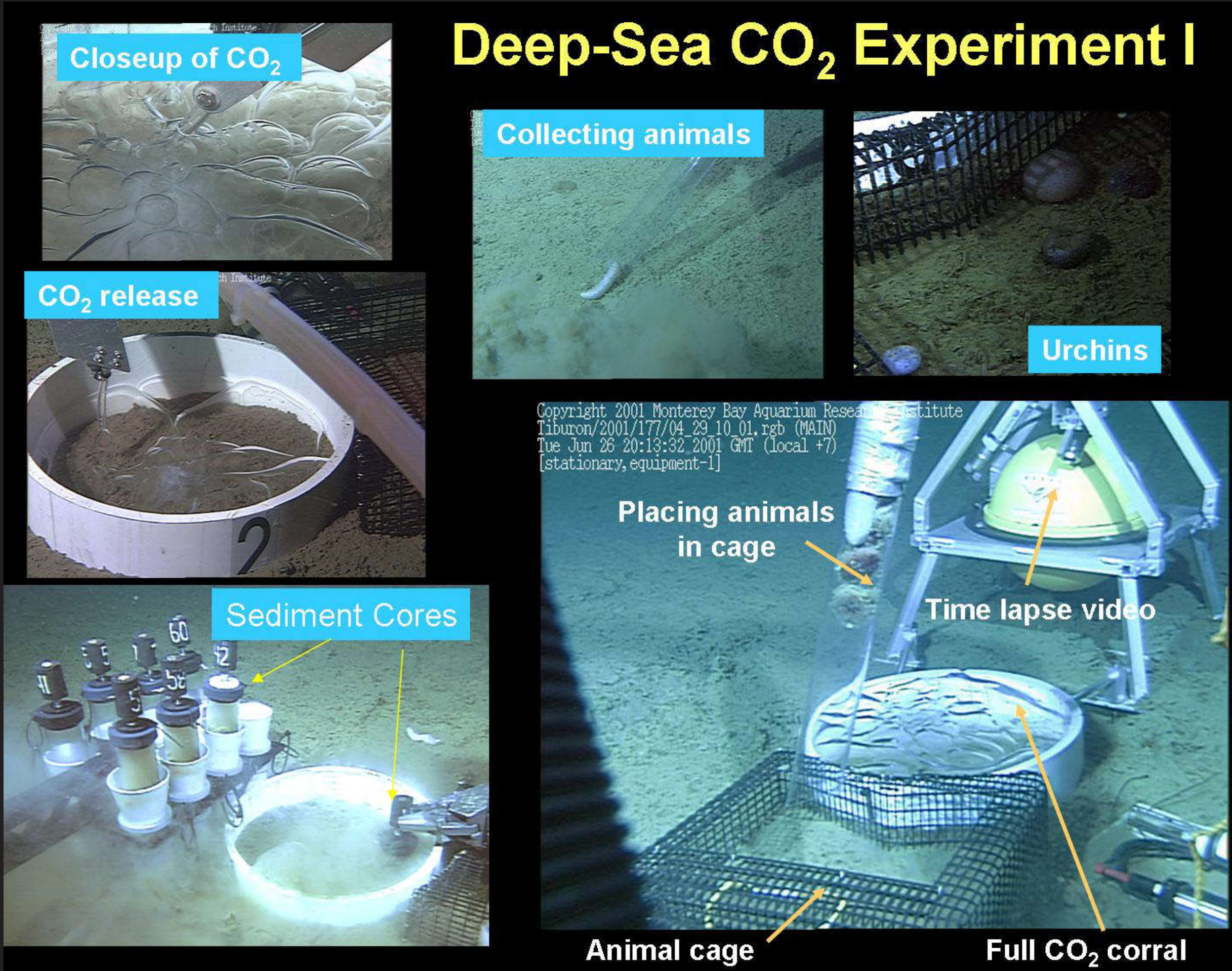
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Present Status of Ocean CO2 Perturbation Experiments

We can view the current series of deep ocean CO2 injection experiments not simply as disposal strategy tests, but also as controlled enrichment experiments that may allow us to mimic the elevated CO2 levels of a future ocean in much the same way that ecosystems are manipulated on land (Shaw et al., 2002; DeLucia et al., 1999). While these oceanic injection experiments have broken new ground, they are deficient in many ways: it is hard to control the pH perturbation achieved due to the varying tidal forcing (See Figure at far right), and very close to the source the CO2 gradients are so large that animals may either not survive, or show little response, depending upon very small changes in position. The experiments carried out so far have been short term due to limits on the amount of CO2 that can be deployed by an ROV.



How does elevated CO2 affect marine animals?

- CO2 injection causes;
- 1 – Elevated CO2 levels
 - 2 – Elevated Seawater Acidity (reduced pH)

Physiological Effects

Respiratory Stress
Increased acidity reduces the level of oxygen-binding and transport by respiratory proteins, leading to reduced aerobic capacity.

Acidosis (reduced internal pH)
Disruption of the acid/base balance of animal tissues impairs function and requires energy to restore or maintain optimal internal pH levels.

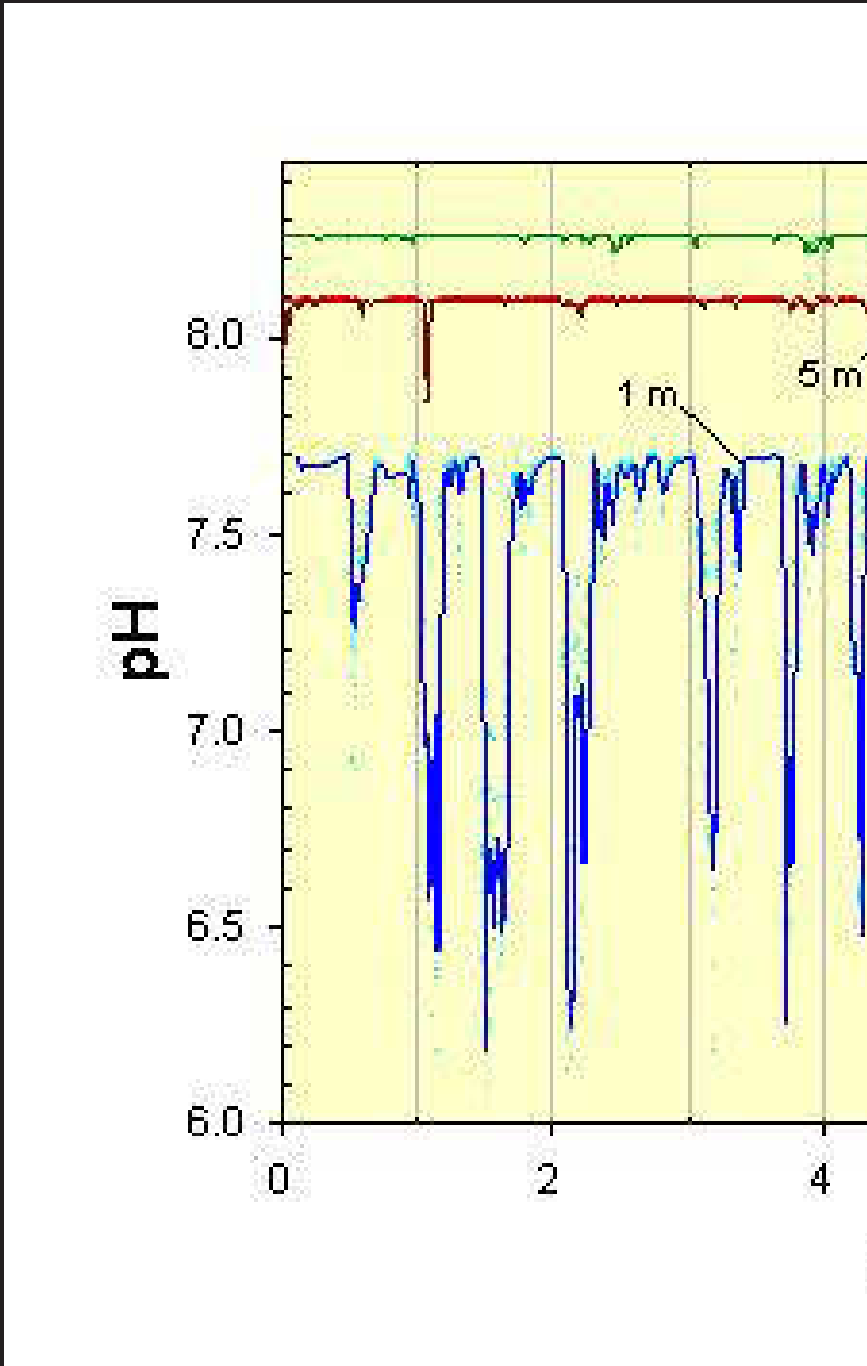
Metabolic suppression (Torpor)
Elevated CO2, reduced pH, or both can cause some animals to enter a state of reduced metabolic rate and semi-hibernation, reducing their activity, protein synthesis, growth, reproduction, etc.

Healthy

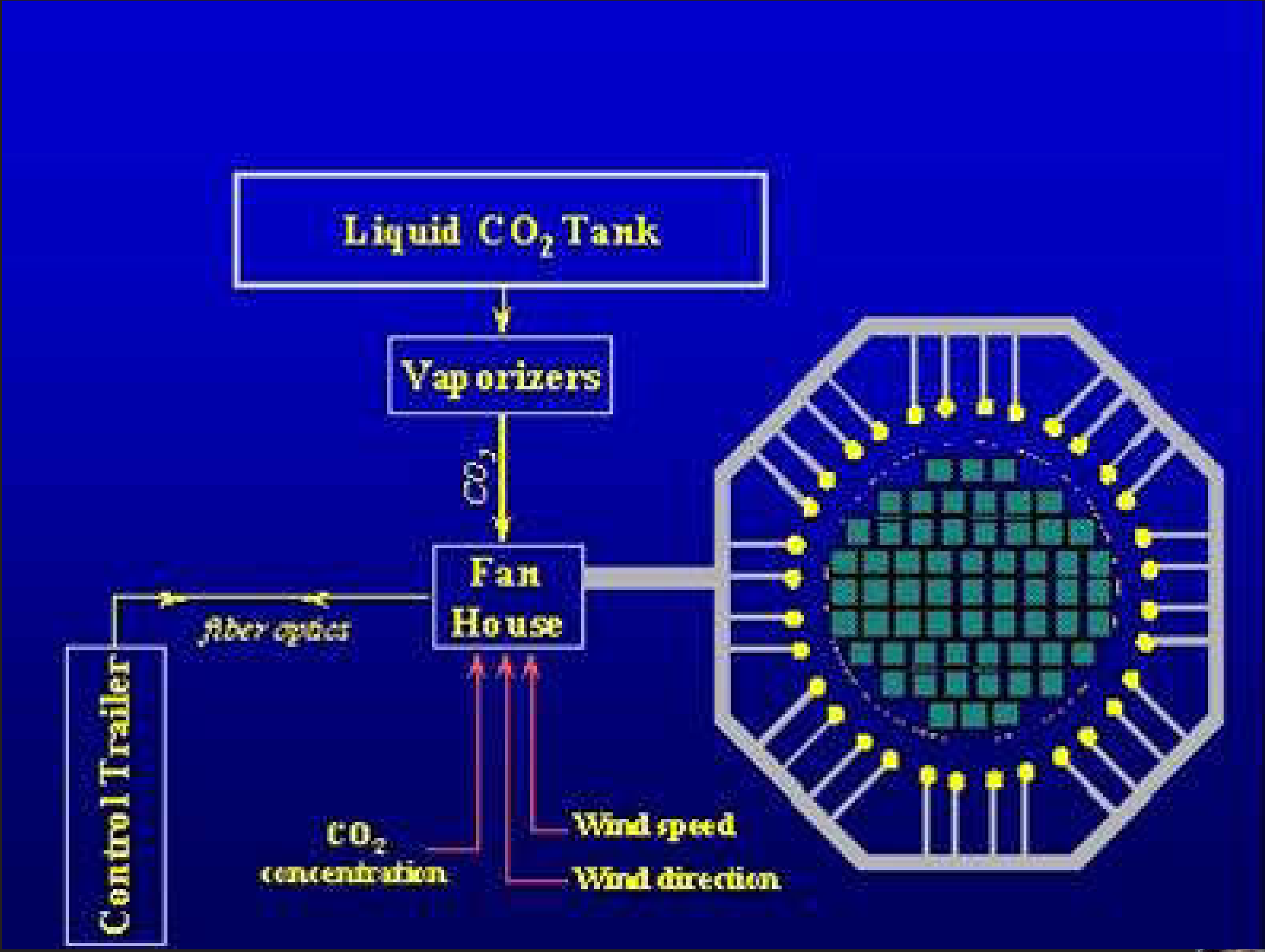


Degraded

pH Perturbations and Spiking due to currents and tidal forcing. Experimental results to be questioned. This experiment will address these inaccuracies and accurately represent a



Face Experiment Structure



Beyond Climate Cabled Experiment

