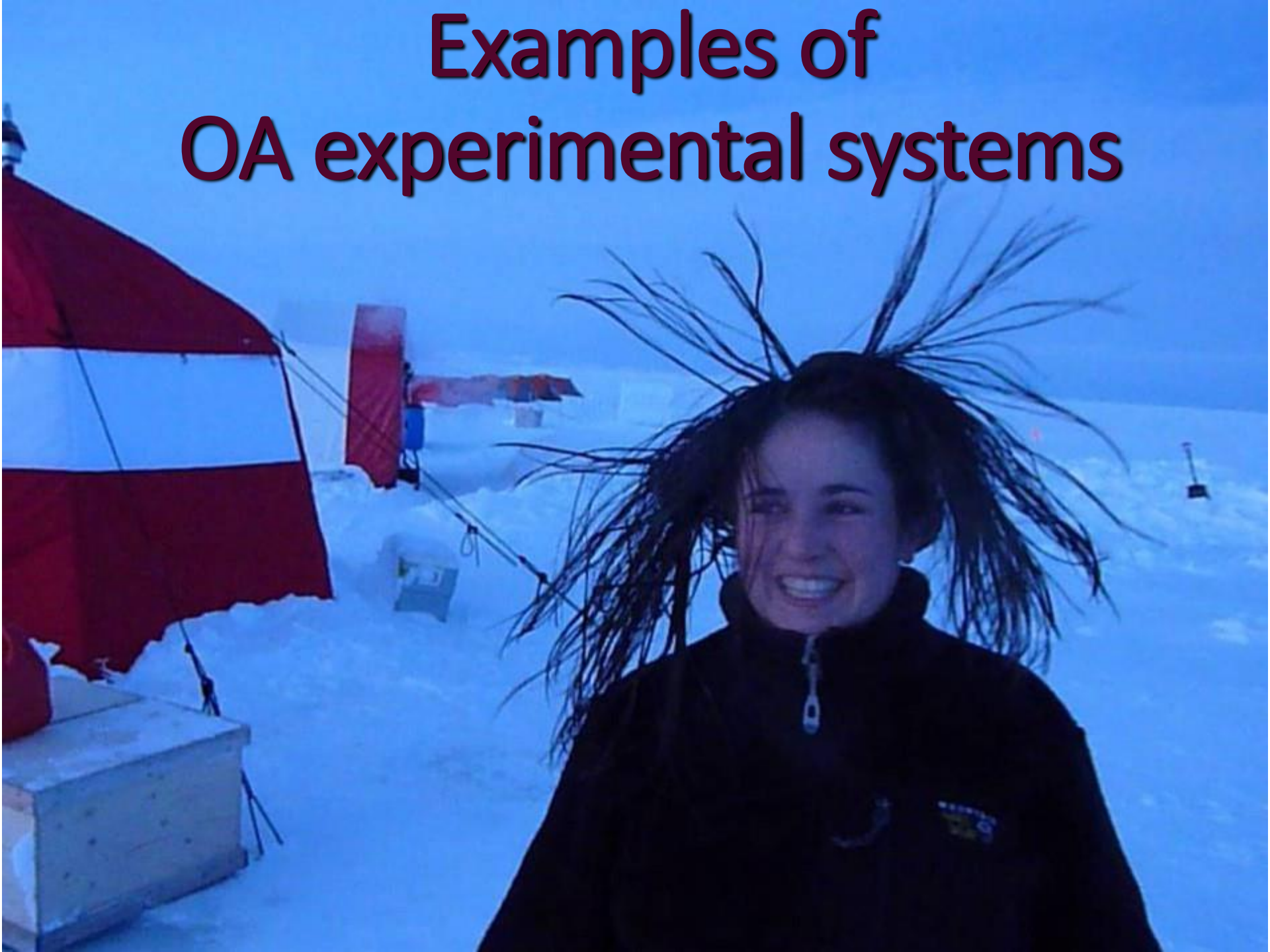
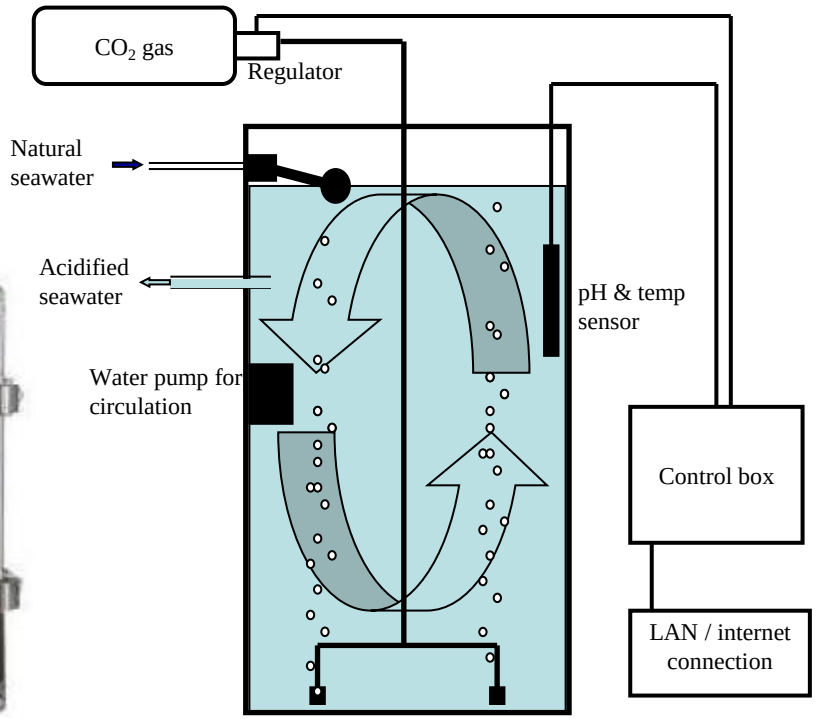
Examples of OA experimental systems



"Bubbling" with CO_2 :

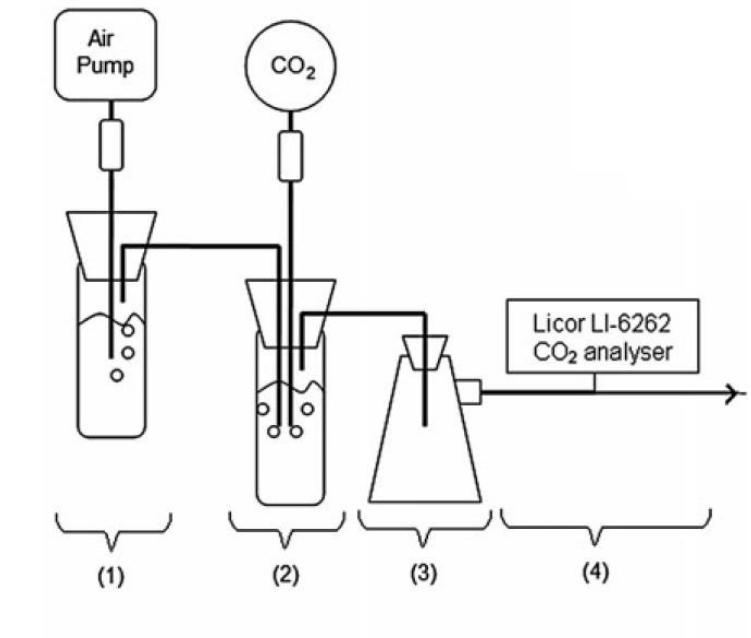
pH-stat bubble with pure (or very high CO_2), monitor pH

- pH controllers range of prices
- Pure CO_2 gas is cheap
- Easy to set up
- Replicable
- Many different biological applications
- Flow through vs recycled

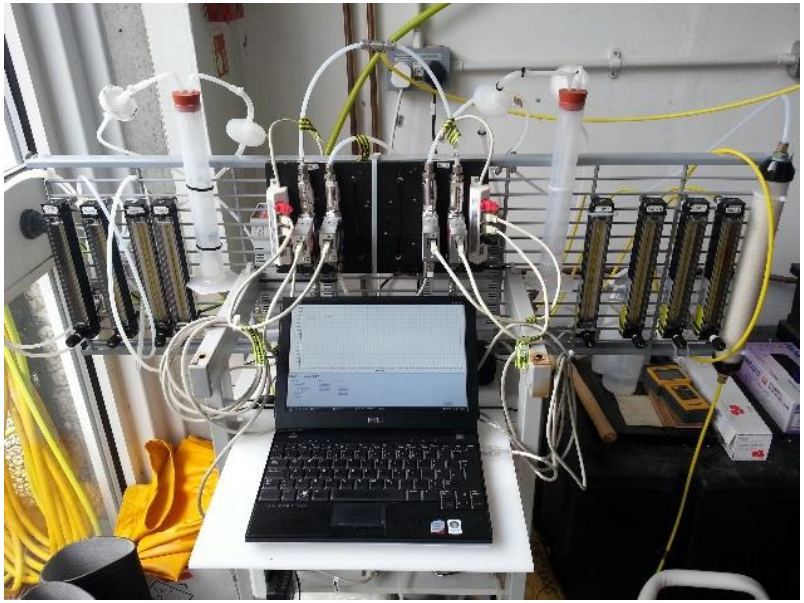


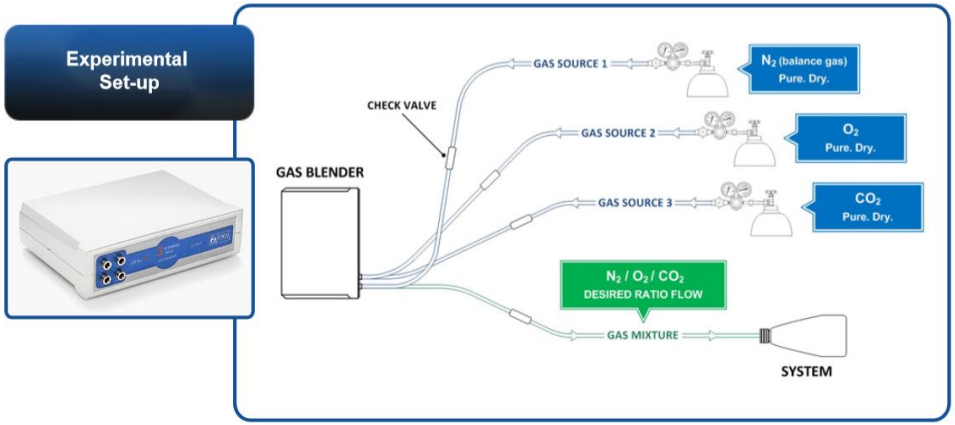
“Bubbling” with CO_2 :

Gas-mixing – pre-mixed to a particular CO_2 concentration



- “simple” gas mixing system - cheap
- Precise mass flow controllers - expensive
- Replicable – gas can be bubbled into individual containers
- Many different biological applications
- Be aware CO_2 concentration is atmospheric (ppm), not seawater pCO_2





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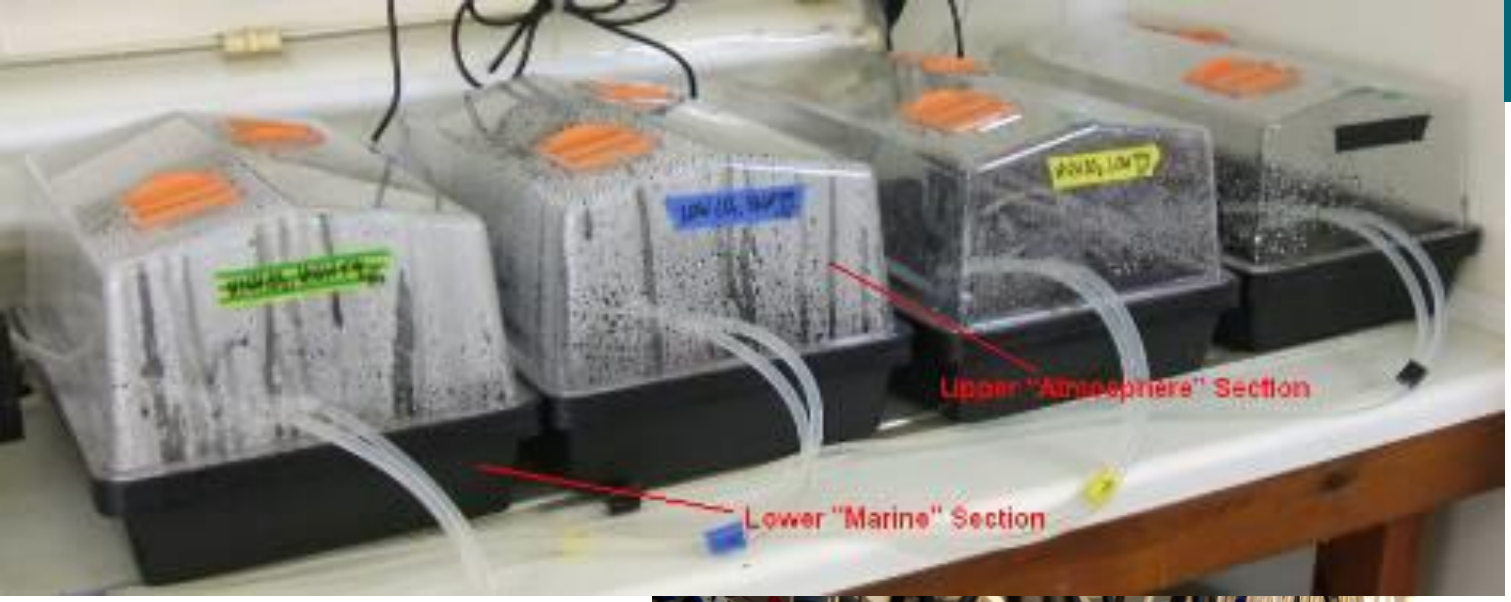
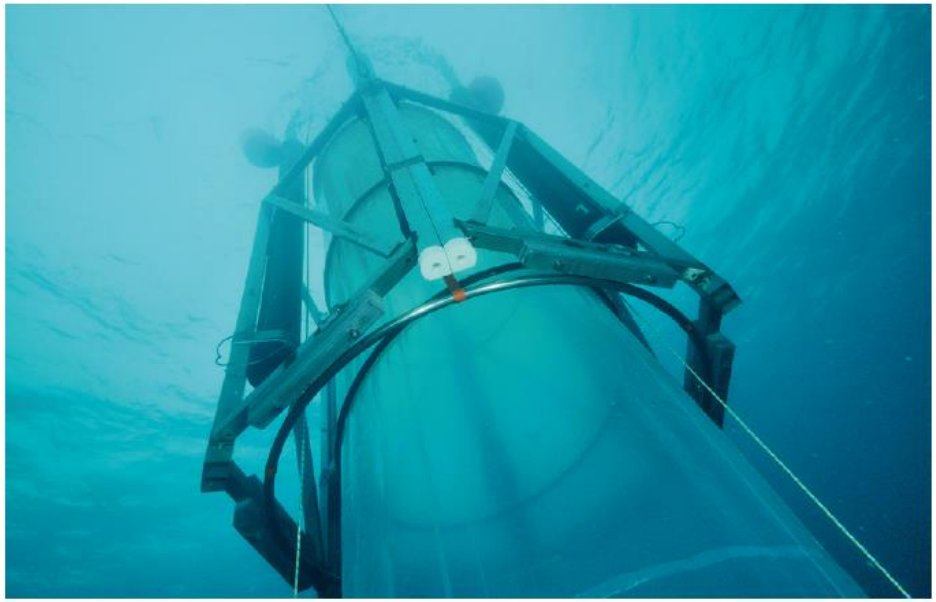


Mixing high CO_2 water

- Still need to create the high CO_2 water – can use pure CO_2 (cheaper)
- Useful for organisms that don't "like" bubbles
- Good for large volumes



Acid/base + HCO_3^-/CO_3^{2-} additions

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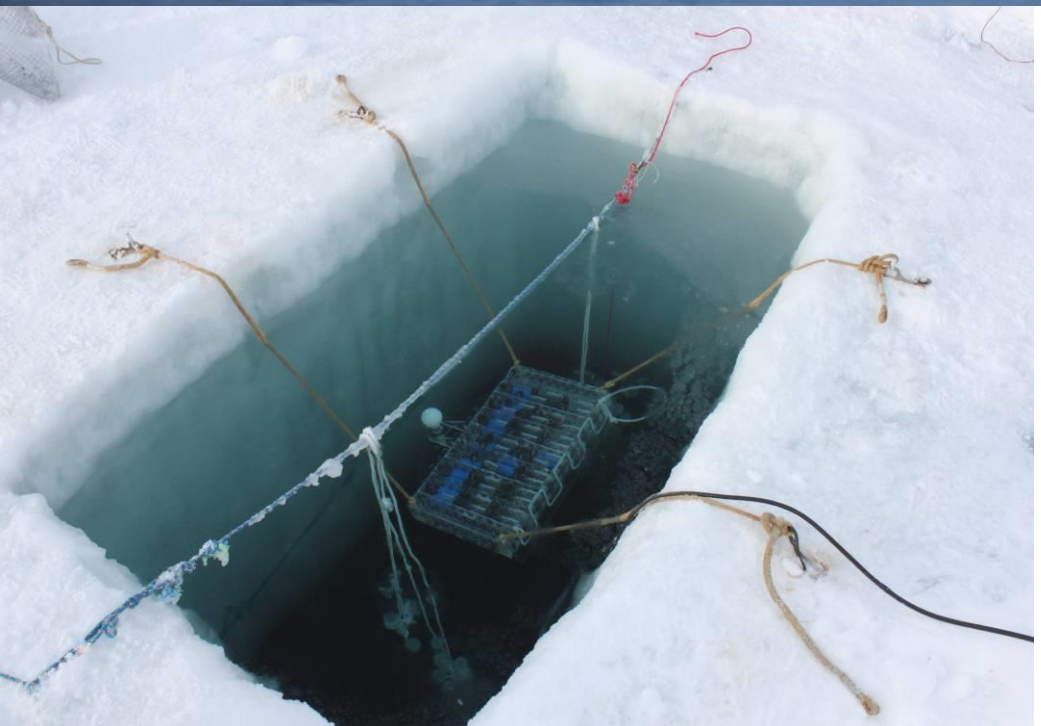

- Useful for small volumes
- Remote/challenging situations
- Biologically useful in determining certain processes
- Inexpensive
- Challenge getting the chemistry right!

FOCE – Free Ocean CO_2 Enrichment systems

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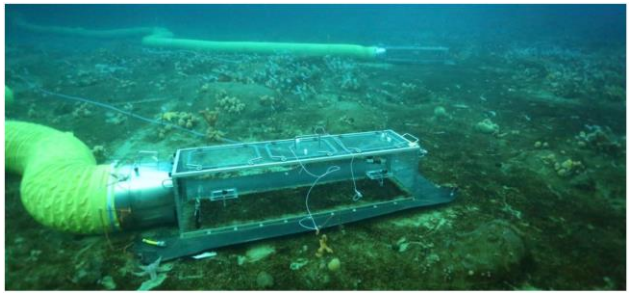
- *In situ* carbon dioxide manipulations
- Expensive to build
- Good for ecosystem studies (rather than single species)



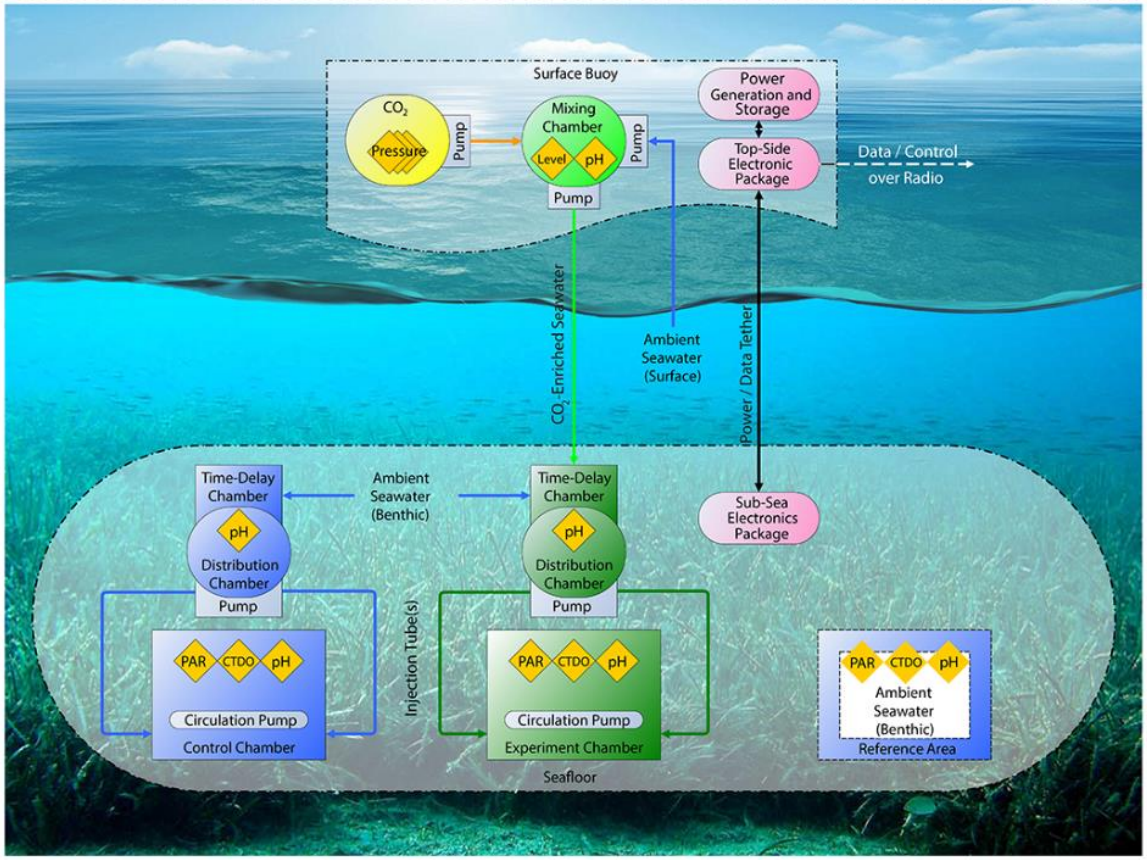


Figure 1. Conceptual diagram of a FOCE system. The number of control, experiment, and reference areas vary depending on the experimental design and budget. Additional sensors are also optional. PAR: photosynthetically active radiation; CTDO: conductivity, temperature, salinity, and oxygen sensors. See the main text for definitions of the subcomponents.

Summary

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- Which system you choose depends on:
  - Scientific **question**
  - Knowledge about the **organism**
  - Available **resources**
  - Logistics

- There is no wrong manipulation system, as long as its done right!

- Give yourself time to set up and learn how to use the system prior to experiments

Questions?