These presentation files have been put together to complement the ocean acidification resource:

The Ocean of Tomorrow

prepared by the NZ Marine Studies Centre.

Please do not print or re-use this presentation for any other purpose.

Unless otherwise stated, graphs are taken from the Intergovernmental Panel on Climate Change (IPCC) reports, 2008 – 2014.

NEW ZEALAND
MARINE STUDIES CENTRE
University of Otago

www.marine.ac.nz

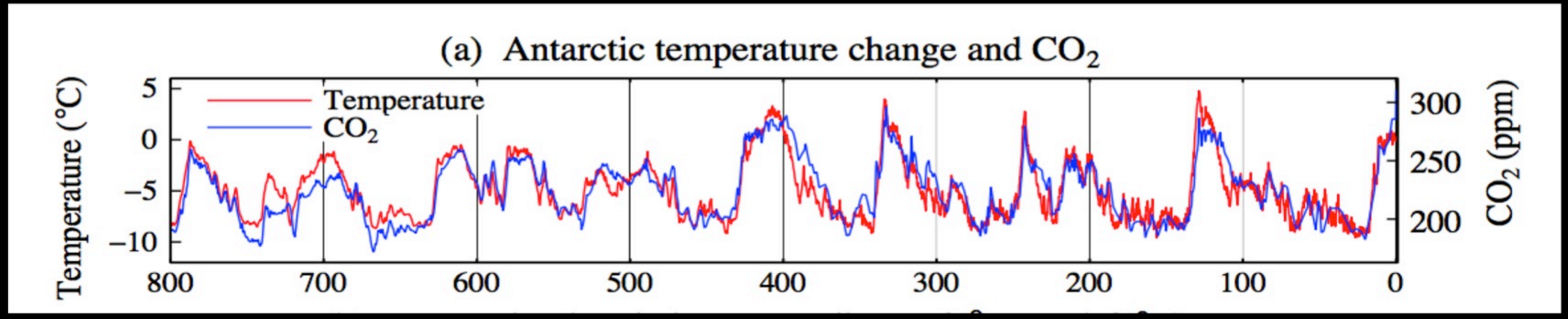
Part 2

Recent pH changes and the marine contexts of pH change.

Leading into activity 2A and 2B.

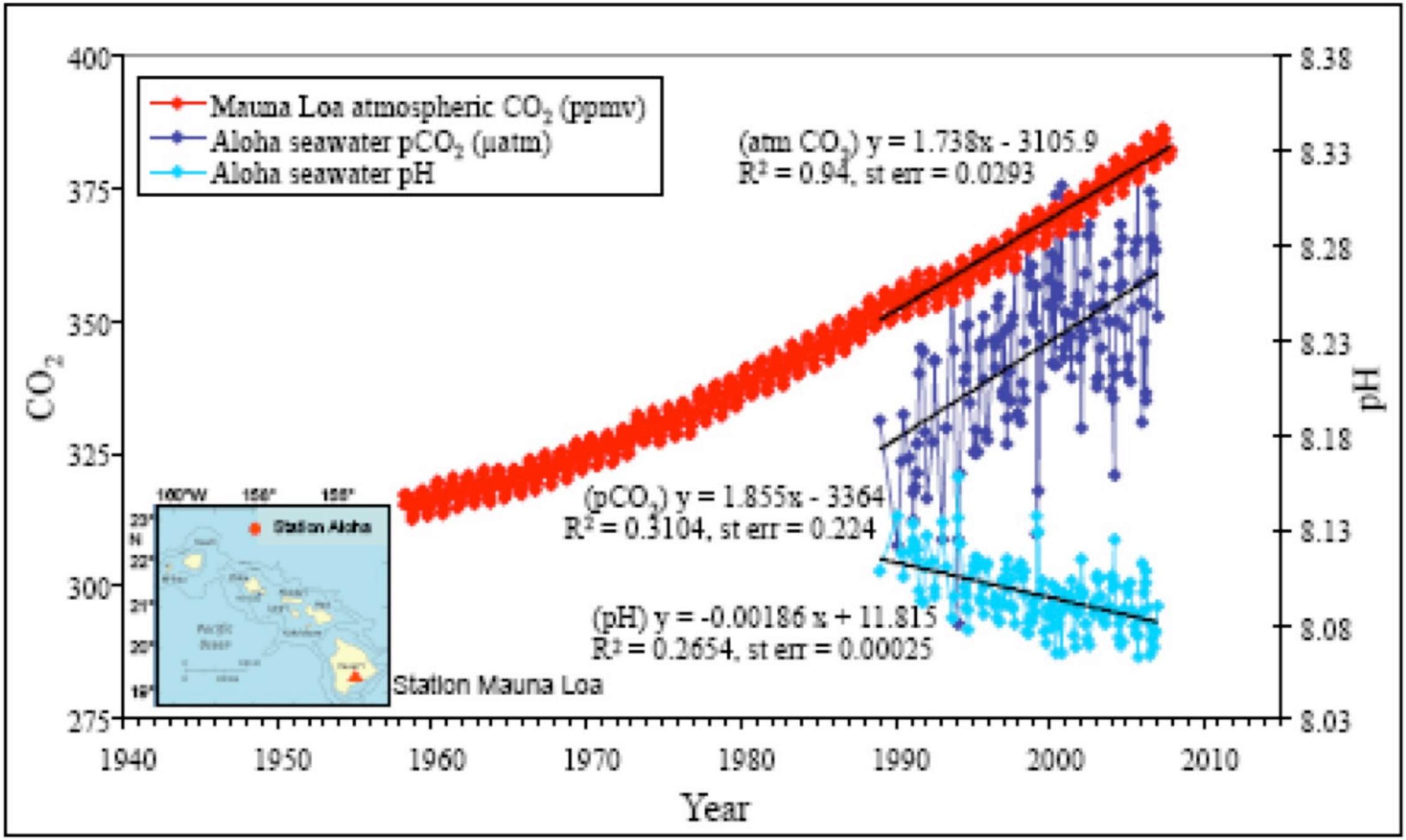
CO_2 is the principal determinant of Earth's climate state, the radiative "control knob" that sets global mean temperature (Lacis et al., 2010, 2013).

Degree of control is shown by comparison of CO_2 amount with Antarctic temperature for the past 800,000 years.



Hansen et al . (2016) Ice melt , sea level rise and superstorms.
Atmos. Chem. Phys., 16, 3761–3812, 2016

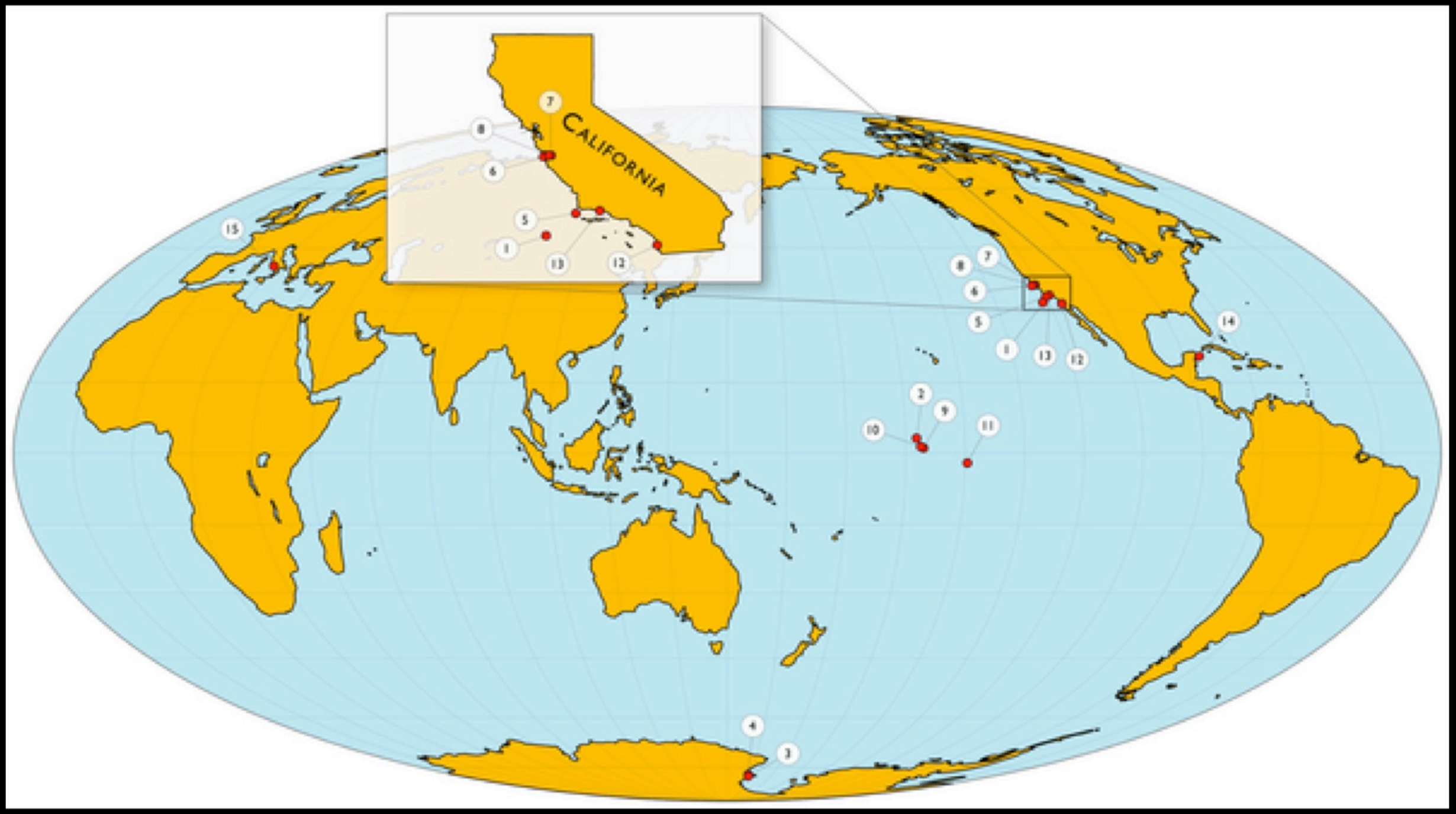
CO_2 Time Series in the North Pacific Ocean



Recent pH change

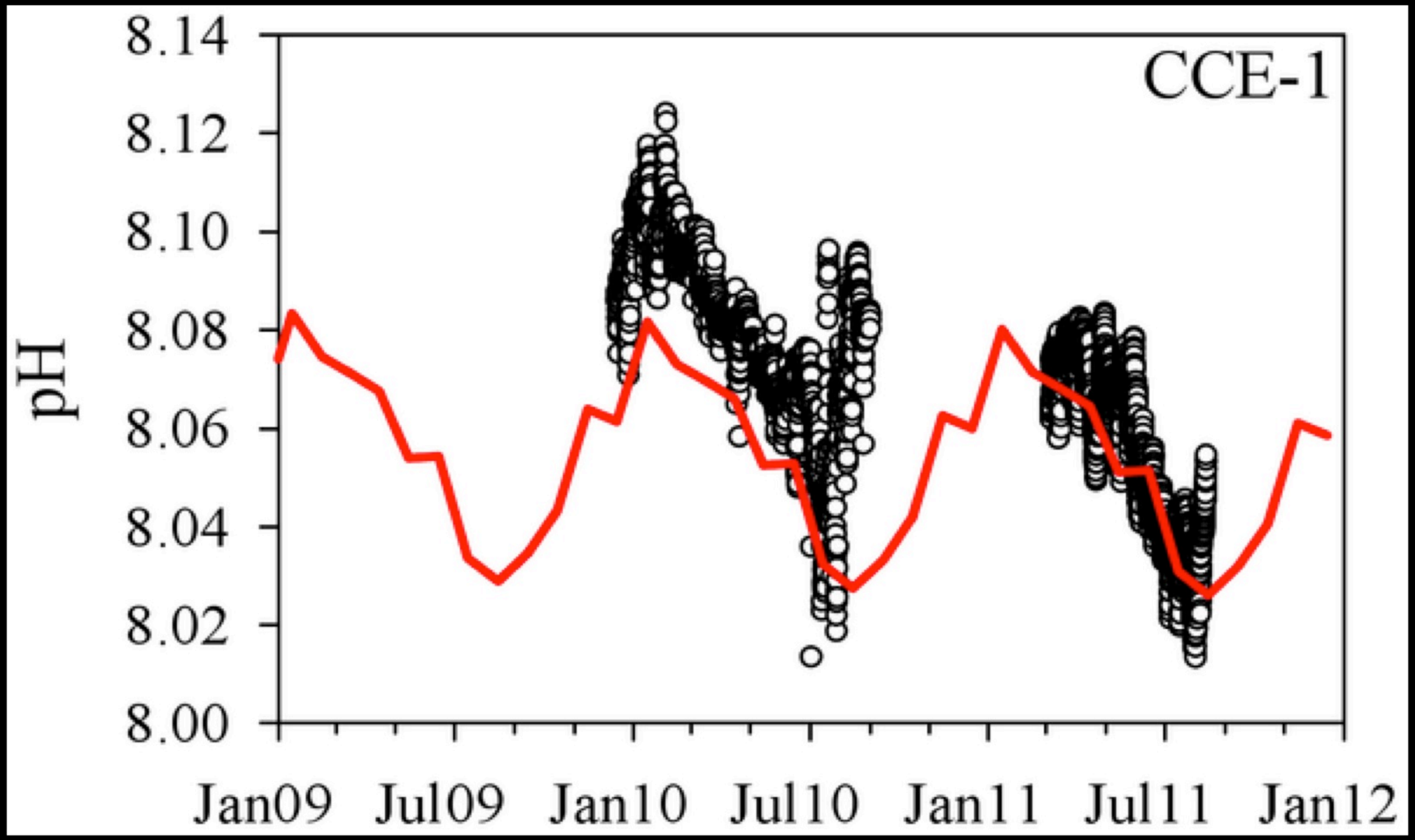
- In the last 200 years, oceans have absorbed over 500 Gigatonnes of CO_2
- Equivalent to about 48% of the total produced by human industrial activity
- There are approx 30% more H+ ions in the sea
- Reduction of overall pH by 0.1 units in only 200 years (would have taken more than 6,000 years naturally)

Figure 1. Map of pH sensor (SeaFET) deployment locations.



Hofmann GE, Smith JE, Johnson KS, Send U, Levin LA, et al. (2011) High-Frequency Dynamics of Ocean pH: A Multi-Ecosystem Comparison. PLoS ONE 6(12): e28983. doi:10.1371/journal.pone.0028983
http://journals.plos.org/plosone/article?id=info:doi/10.1371/journal.pone.0028983

Figure 4. Comparison between sensor data (symbols) and the pH climatology (line) near CCE-1.



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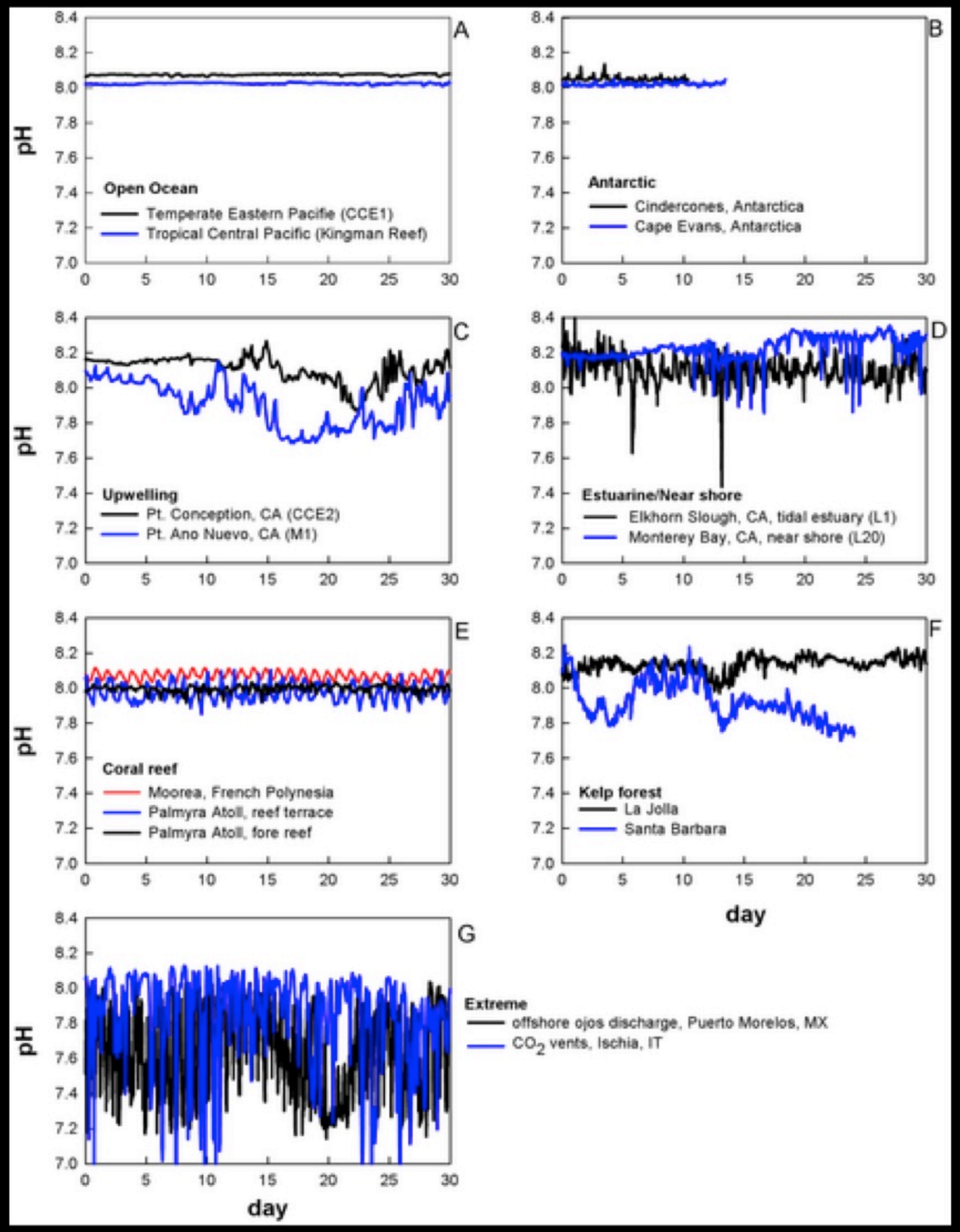
http://journals.plos.org/plosone/article?id=info:doi/10.1371/journal.pone.0028983

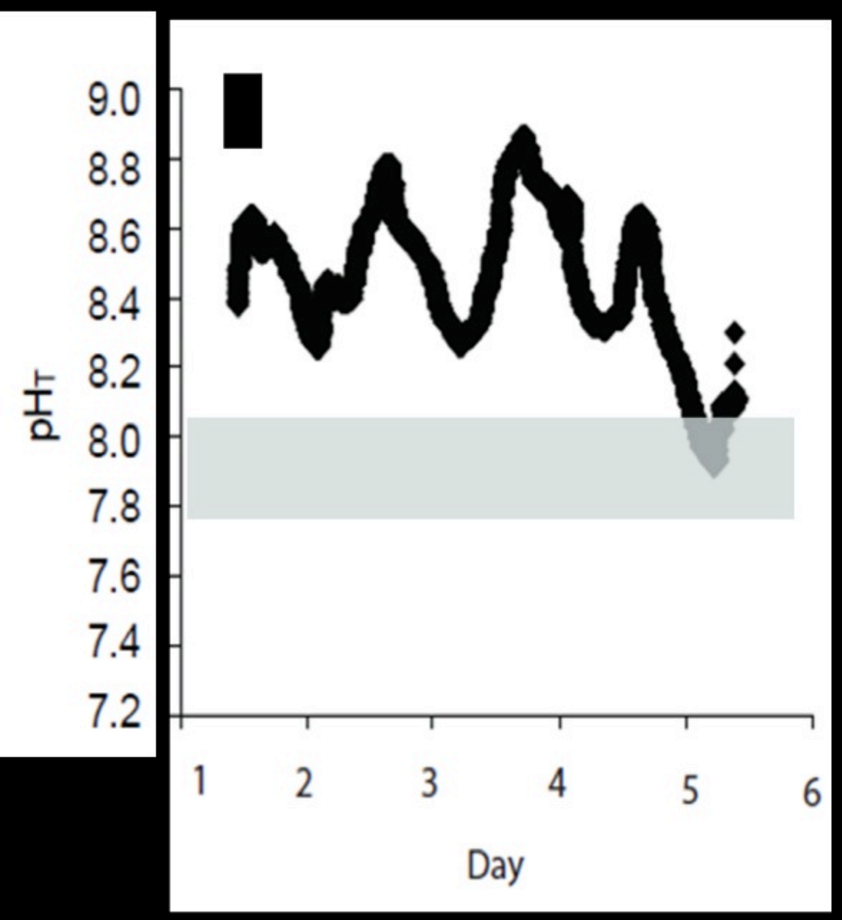
Figure 2. pH dynamics at 15 locations worldwide in 0–15 m water depth.

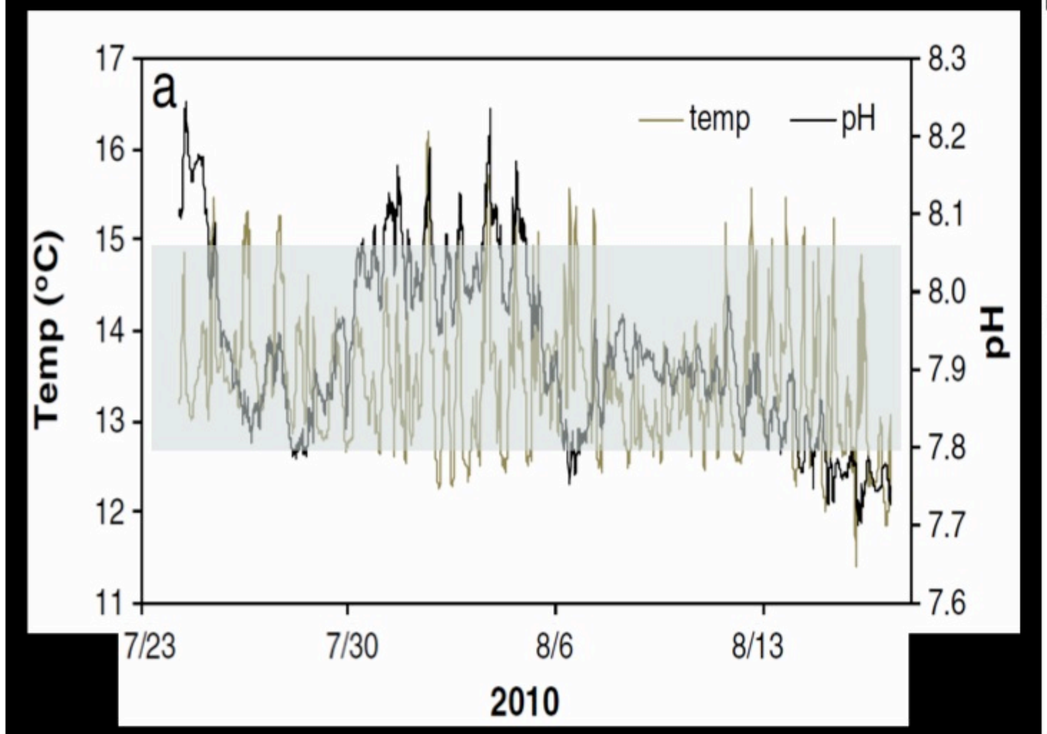


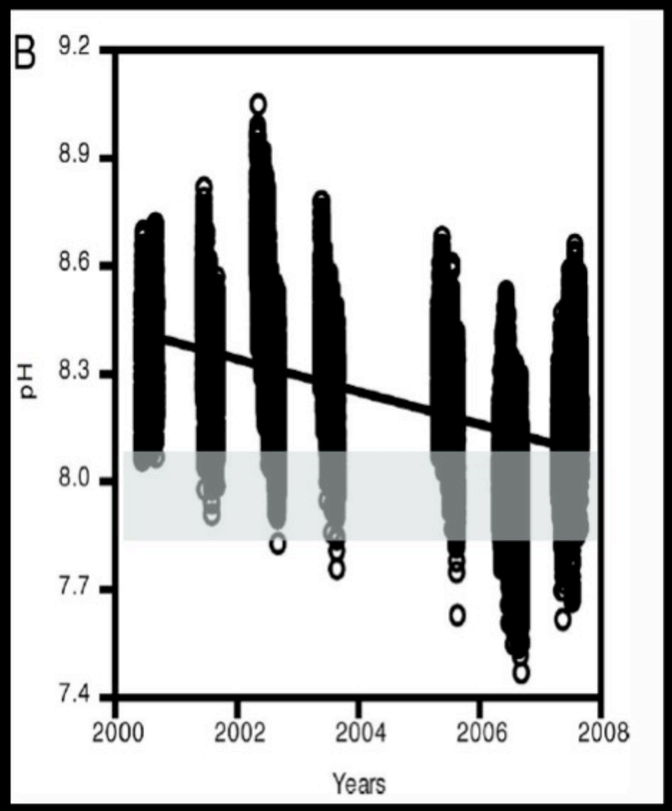
Hofmann GE, Smith JE, Johnson KS, Send U, Levin LA, et al. (2011) High-Frequency Dynamics of Ocean pH: A Multi-Ecosystem Comparison. PLoS ONE 6(12): e28983. doi:10.1371/journal.pone.0028983

http://journals.plos.org/plosone/article?id=info:doi/10.1371/journal.pone.0028983

Short-term variability can be large at several time scales







Days

Otago, New Zealand

C. Cornwall et al, Proc. Royal Society B, 280, 1772 (2013)

Months

California, USA

P.C. Yu, et al, J Exp Mar Biol and Ecol, 400, 288–295, (2011)

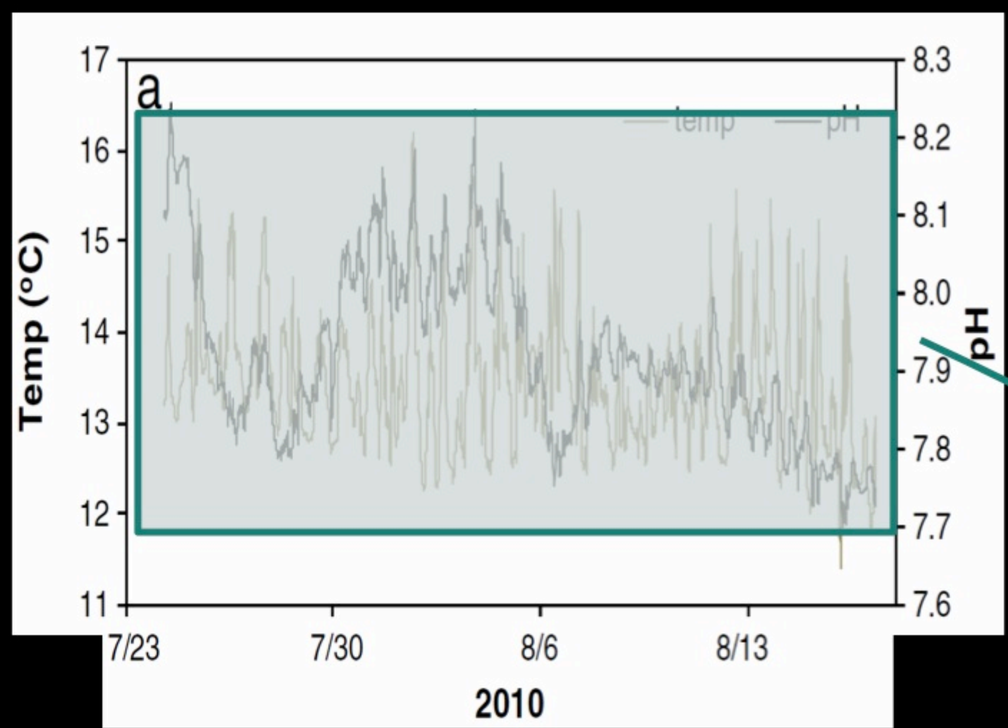
Doug Mackie OAX 2017

Years

Washington State, USA

Wootton et al, PNAS, 105, 48 18848–18853 (2008)

Short-term variability can be large



Months

California, USA

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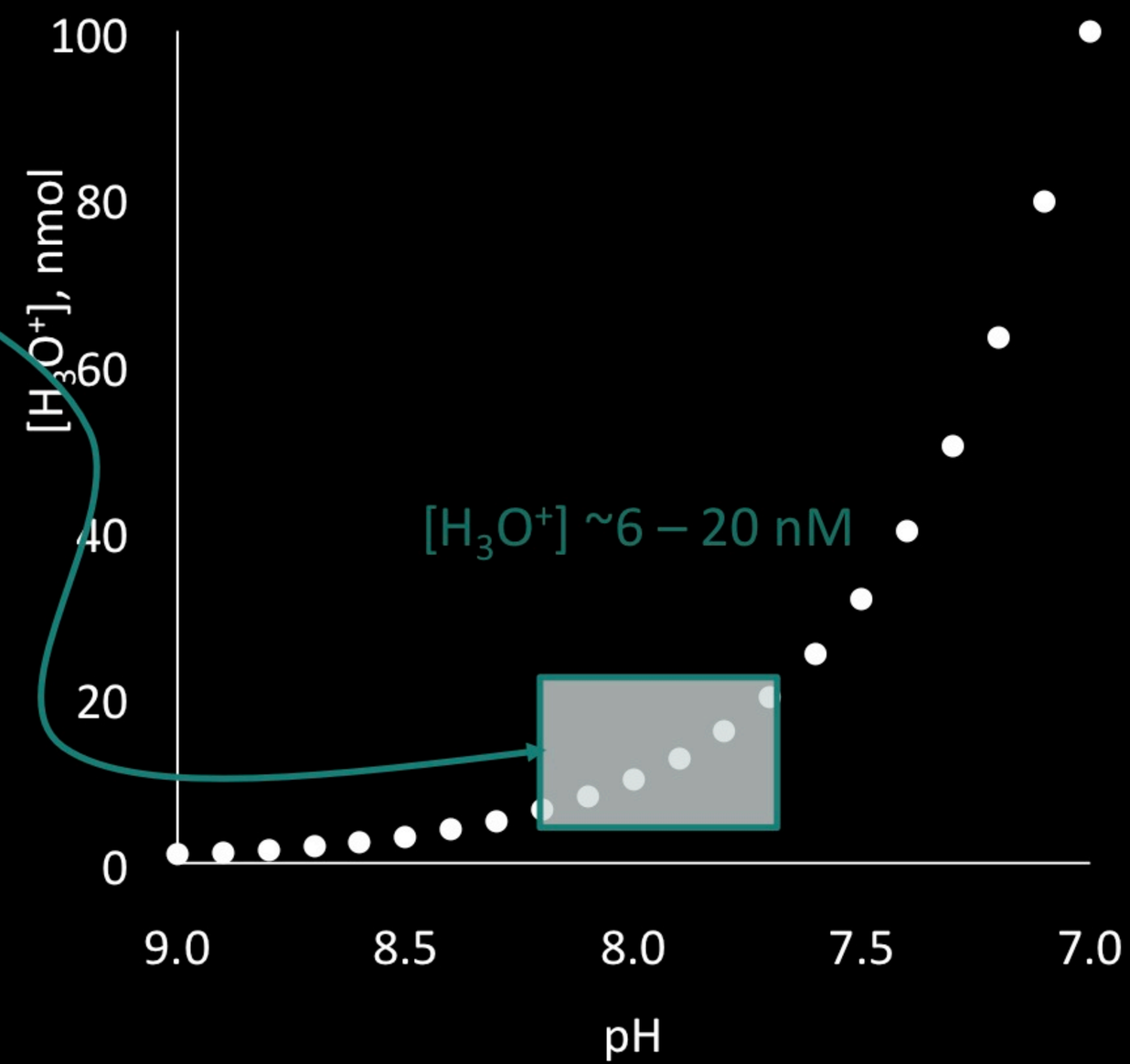
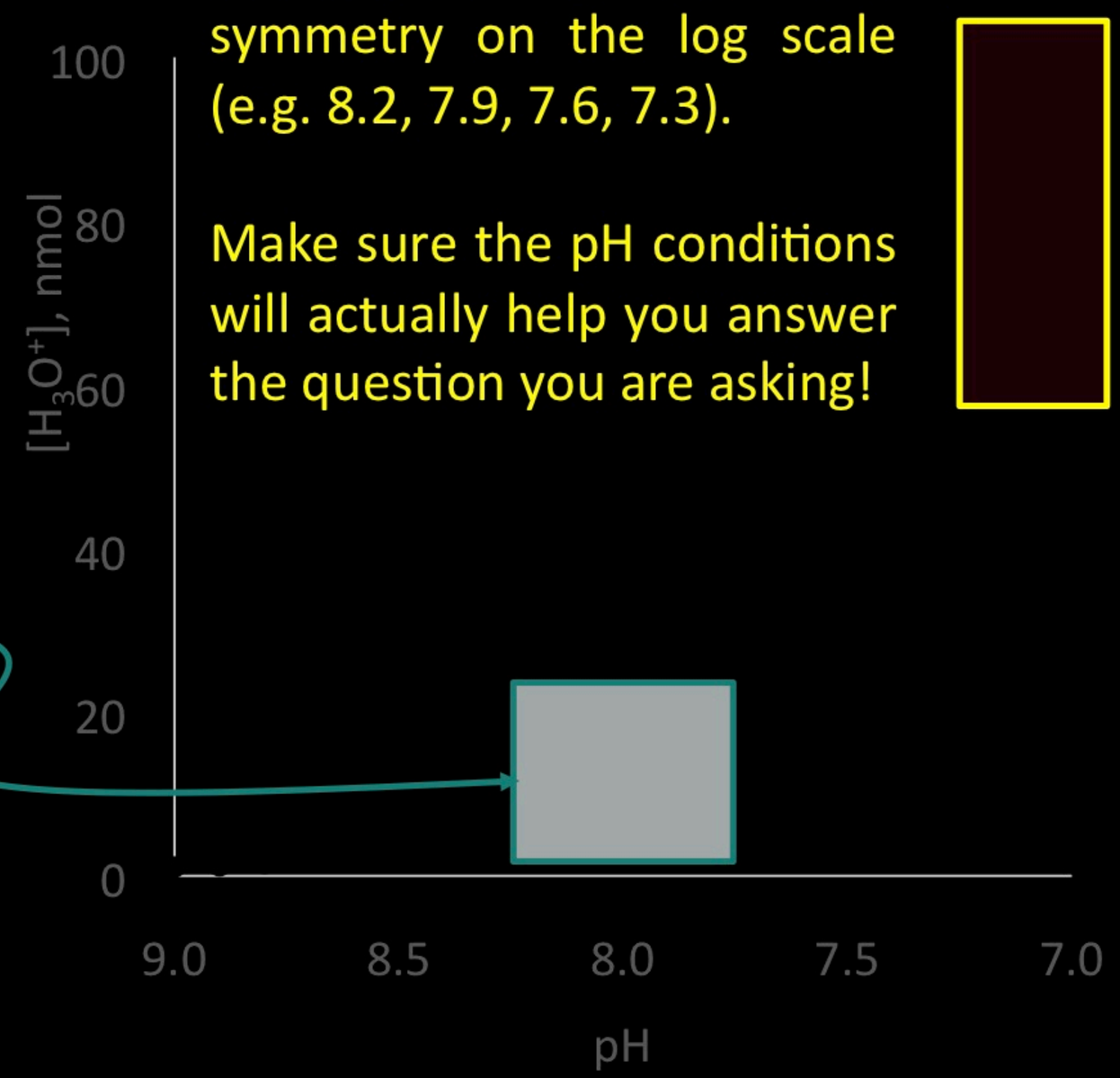


Important for experiments to not confuse the position of baseline with magnitude of natural variations

Most OA experiments happen in a range of ~8.2 – 7.6 or 7.7, which represents realistic conditions for most organisms.

Don't choose very low values just because you like the symmetry on the log scale (e.g. 8.2, 7.9, 7.6, 7.3).

Make sure the pH conditions will actually help you answer the question you are asking!



- Natural short-term variability in pH can be large
- This can make end of expected end-of-the-century changes seem small
- But OA is a permanent shift in baseline.
- Important not to confuse position of baseline with magnitude of natural variations
- pH log scale (non-linear) so need to take care in experiments to use relevant target pH

Activity 2A and 2B: Investigation into natural pH changes in a simulated rockpool

- What causes natural cycles of pH change?
- How does pH vary in different ecosystem simulations?
- Where might pH naturally vary and where might it normally remain fairly stable?
- What organisms might be tolerant of pH change?
- What organisms might be vulnerable to pH change?
- Could any organisms benefit from increased CO_2 in the ocean?