Field Observations of acidification-driven carbonate mineral dissolution

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Global calcium carbonate dissolution

Impact of Anthropogenic CO_2 on the $CaCO_3$ System in the Oceans

Richard A. Feely,[1,*] Christopher L. Sabine,[1] Kitack Lee,[2] Will Berelson,[3] Joanie Kleypas,[4] Victoria J. Fabry,[5] Frank J. Millero[6]

50 – 70% OF CARBONATE PRODUCED IS DISSOLVED IN THE UPPER OCEAN.

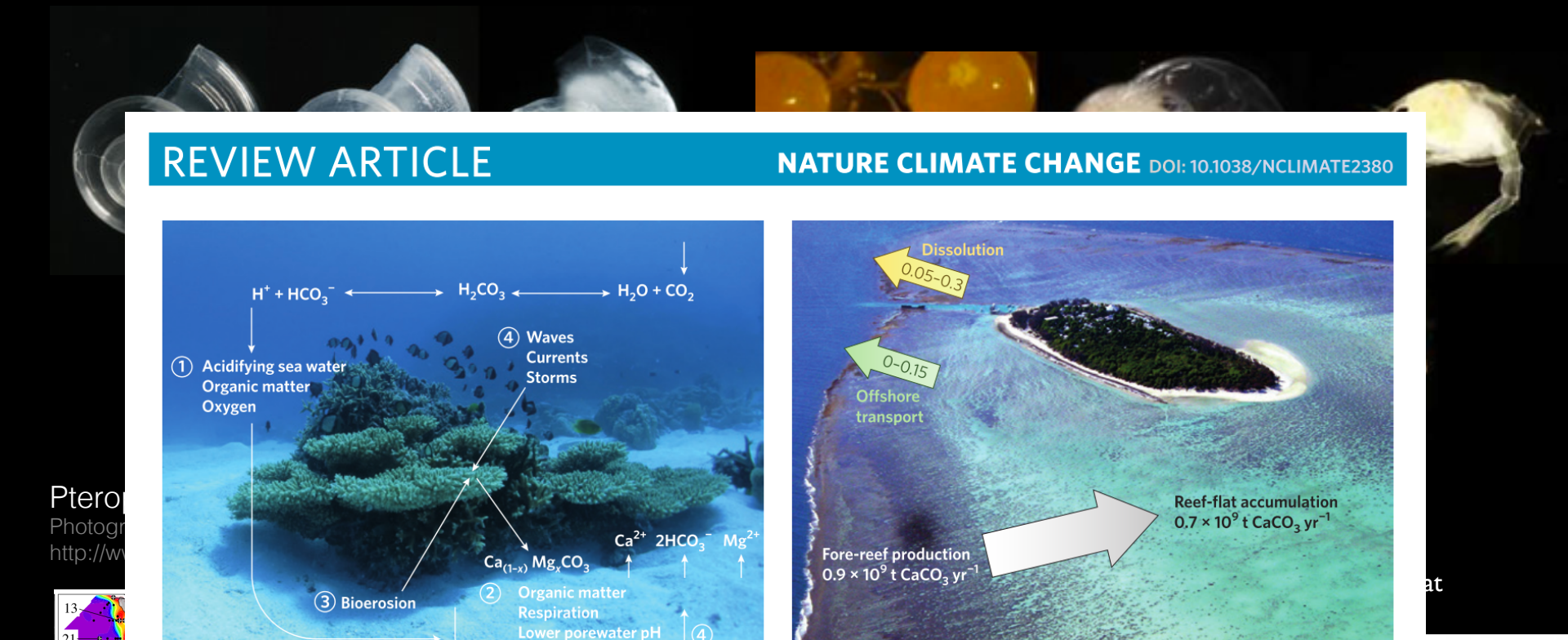
Direct observations of basin-wide acidification of the North Pacific Ocean

Robert H. Byrne,[1] Sabine Mecking,[2] Richard A. Feely,[3] and Xuewu Liu[1]

High-Mg Calcite – Aragonite – Calcite

Understanding Environmental Impacts

Duration ◆ Intensity ◆ Extent



REVIEW ARTICLE **NATURE CLIMATE CHANGE** DOI: 10.1038/NCLIMATE2380

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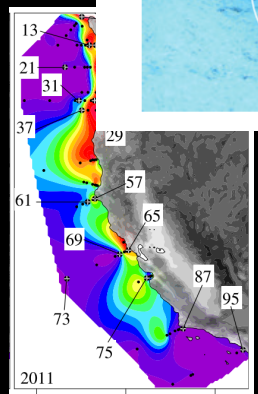
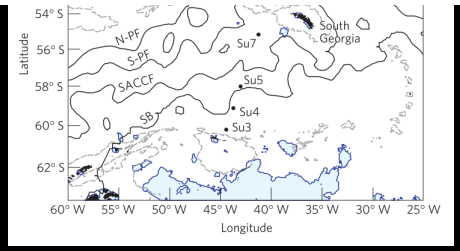
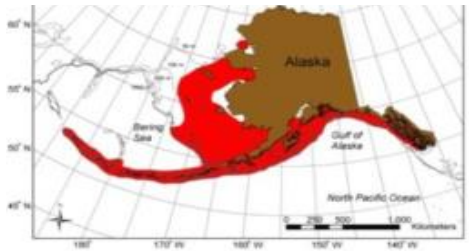
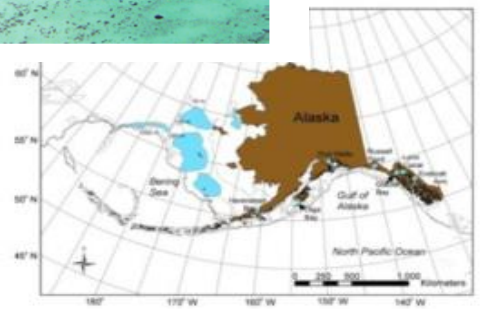
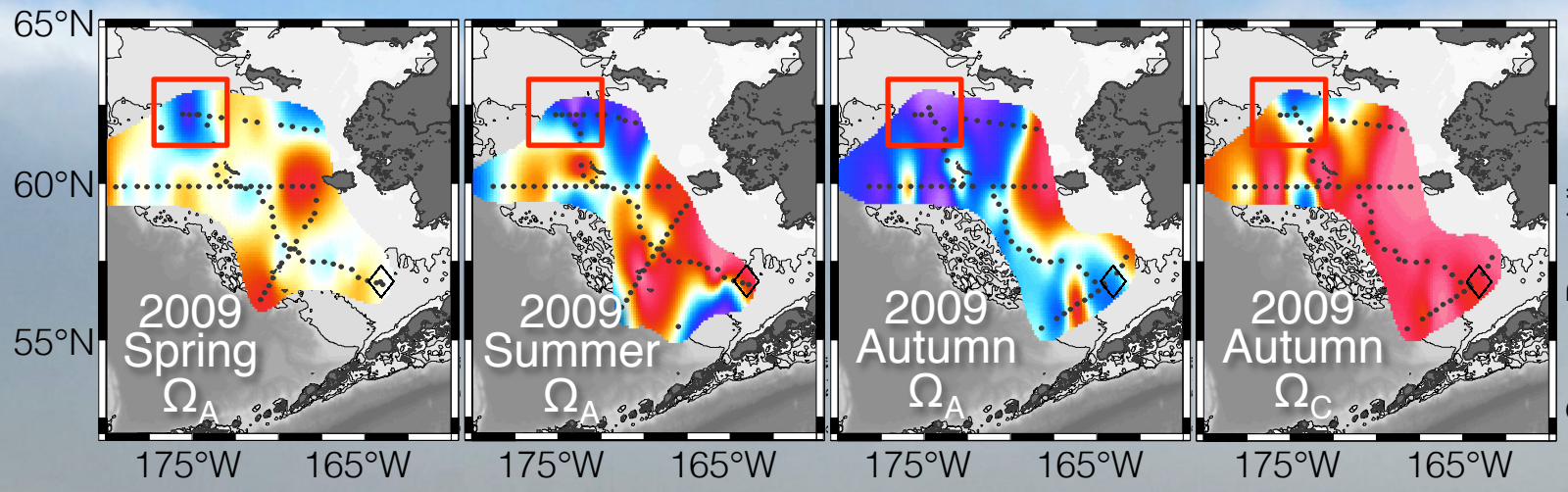
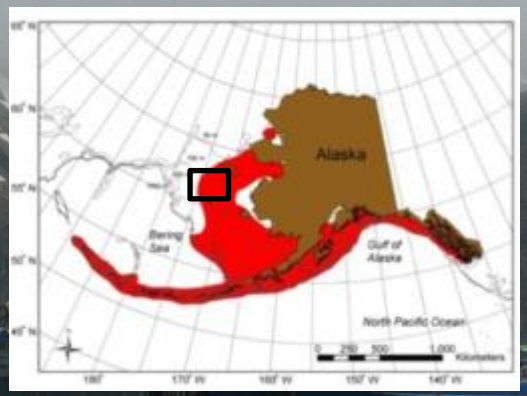












Observations show that undersaturations are already present in the Bering Sea.

GRL

The role of ocean acidification in systemic carbonate mineral suppression in the Bering Sea

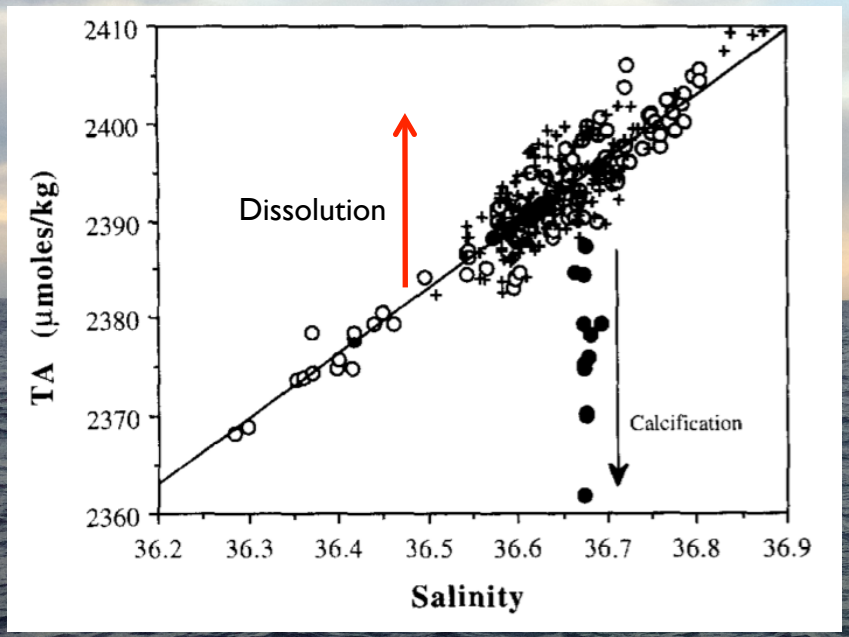
Jeremy T. Mathis,[1] Jessica N. Cross,[1] and Nicholas R. Bates[2]

Coupling primary production and terrestrial runoff to ocean acidification and carbonate mineral suppression in the eastern Bering Sea

Jeremy T. Mathis,[1] Jessica N. Cross,[1] and Nicholas R. Bates[2]

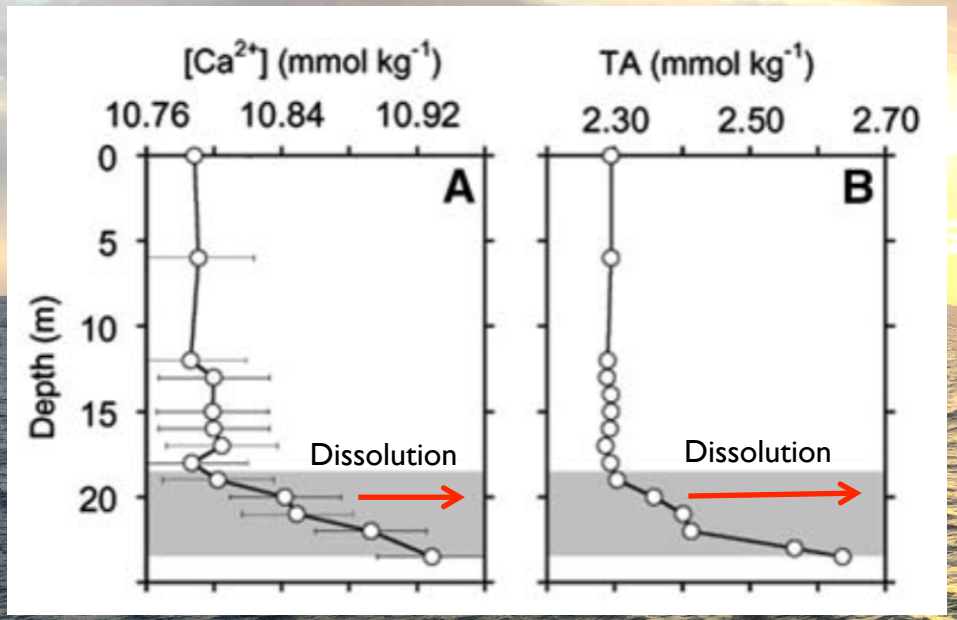
JGR

Direct observations of geochemical dissolution



Alkalinity changes in the Sargasso Sea: geochemical evidence of calcification?

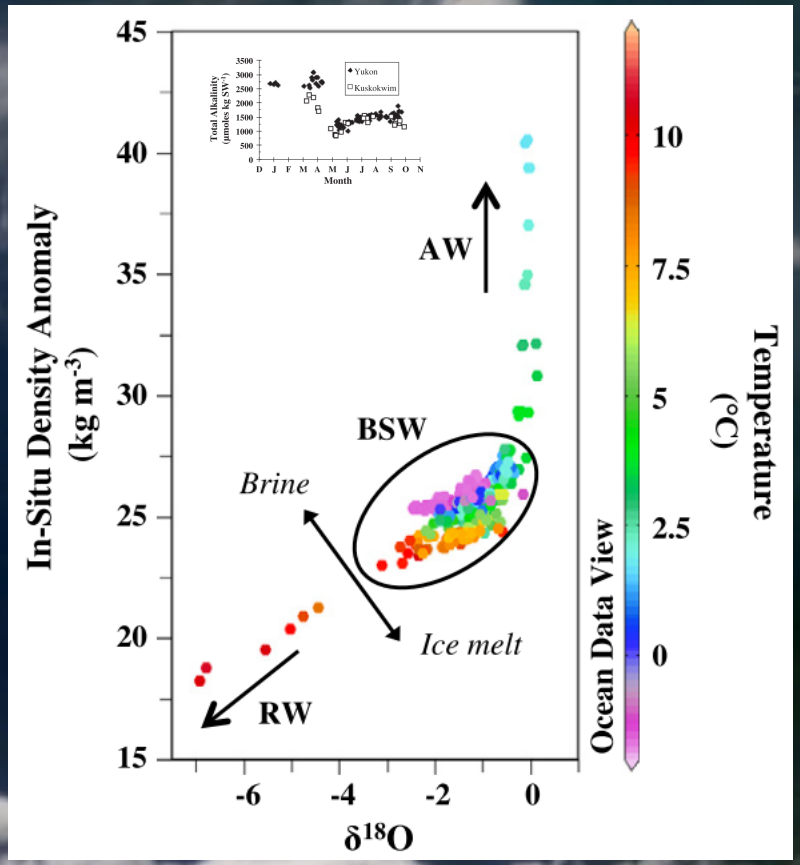
Nicholas R. Bates, Anthony F. Michaels, Anthony H. Knap

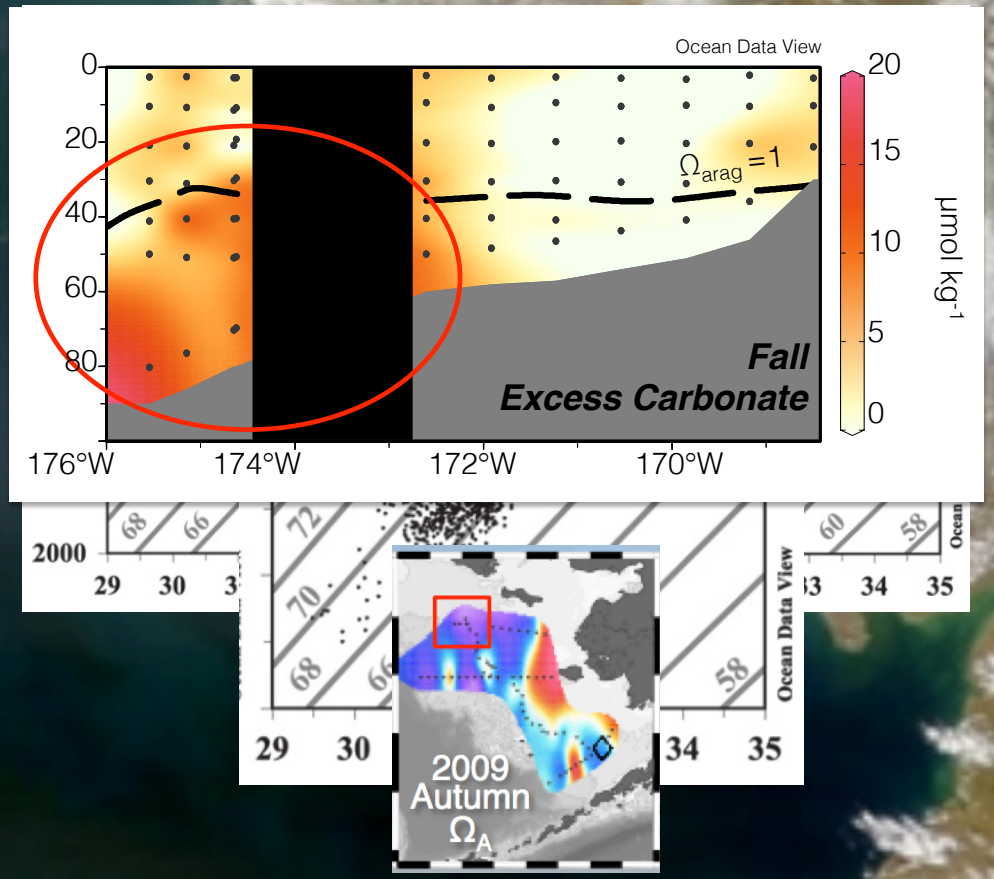


Dissolution of Carbonate Sediments Under Rising pCO_2 and Ocean Acidification: Observations from Devil's Hole, Bermuda

Andreas J. Andersson · Nicholas R. Bates · Fred T. Mackenzie

Direct observations of geochemical dissolution



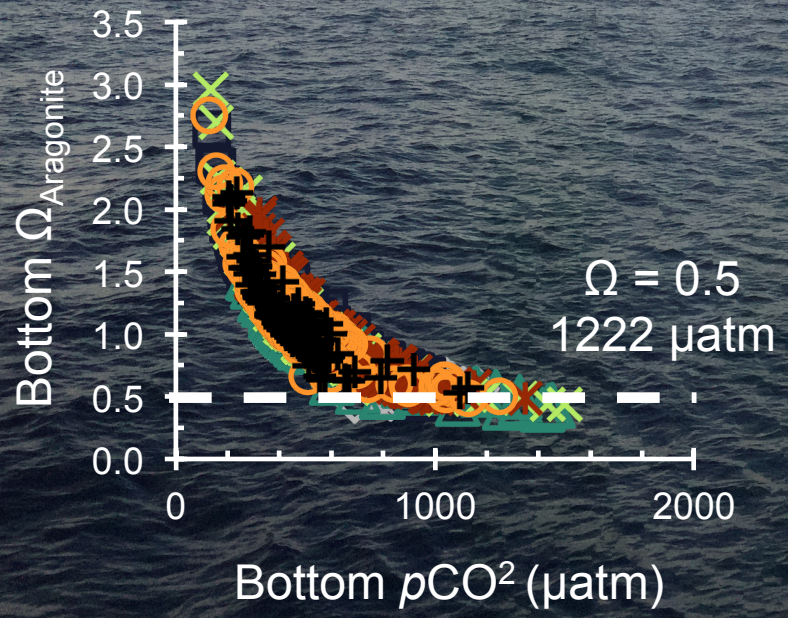


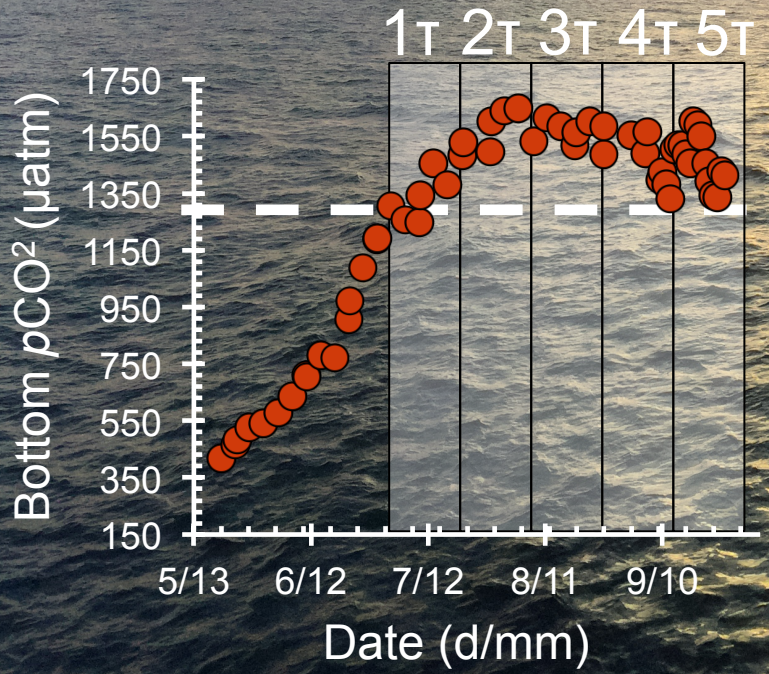
Conservative and non-conservative variations of total alkalinity on the southeastern Bering Sea shelf

Jessica N. Cross [a,*], Jeremy T. Mathis [b,1], Nicholas R. Bates [c,2], Robert H. Byrne [d,3]

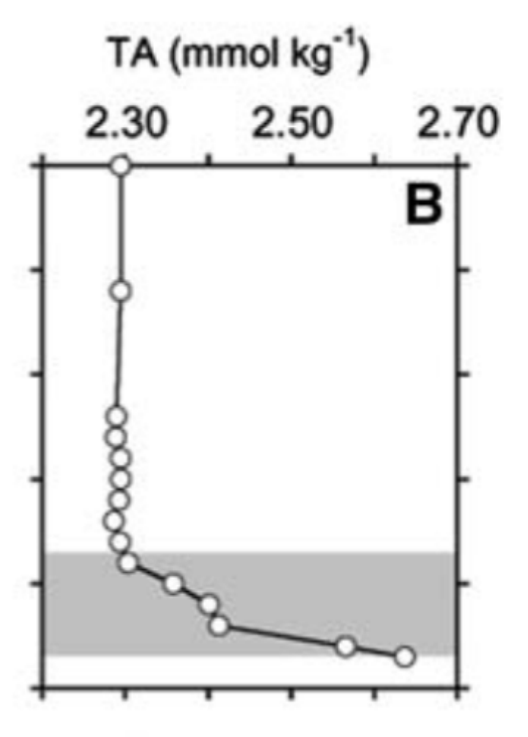
Indirect observations of geochemical dissolution

TIME SERIES RECORDS OF THE DURATION AND INTENSITY OF CORROSIVE CONDITIONS CAN SHOW IF DISSOLUTION IS POSSIBLE.





Mechanisms driving geochemical dissolution



ANTHROPOGENIC ACIDIFICATION IS NOT THE ROOT CAUSE OF ALL CARBONATE MINERAL DISSOLUTION.

- Biological pump
- Natural volcanic laboratories
- Upwelling systems

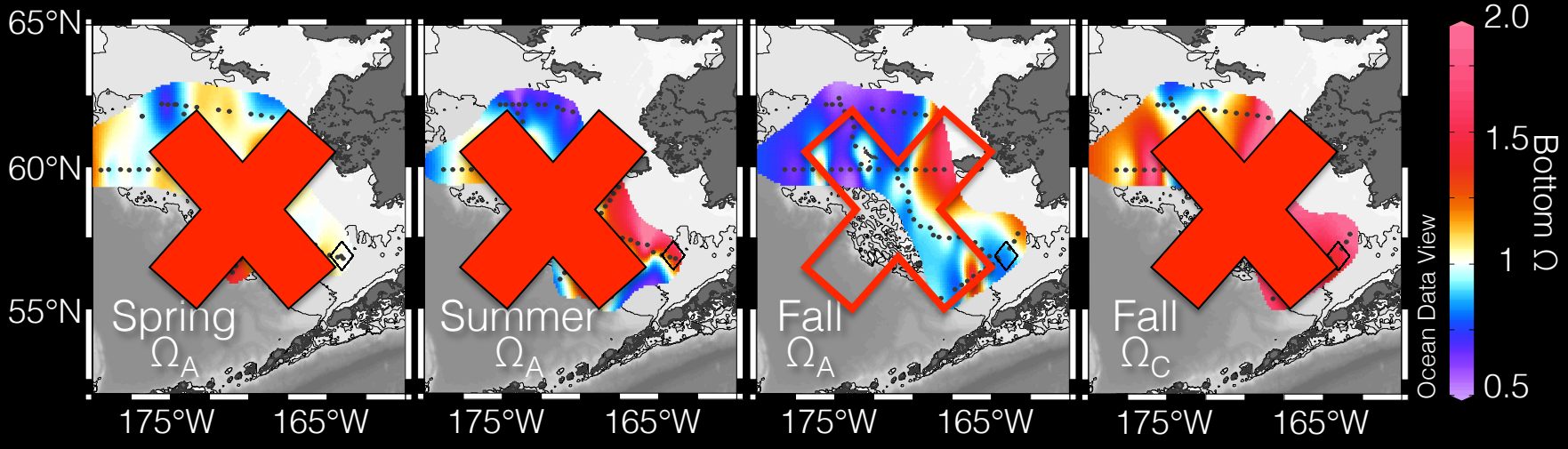
- Reduction of calcification
- Biodegradation
- Mechanical breakdown

Dissolution of Carbonate Sediments Under Rising pCO_2 and Ocean Acidification: Observations from Devil's Hole, Bermuda

Andreas J. Andersson · Nicholas R. Bates · Fred T. Mackenzie

The Anthropogenic Contribution

We estimate approximately **66.5 µmol kg^{-1}** of anthropogenic CO_2 is dissolved in the Pacific Arctic.

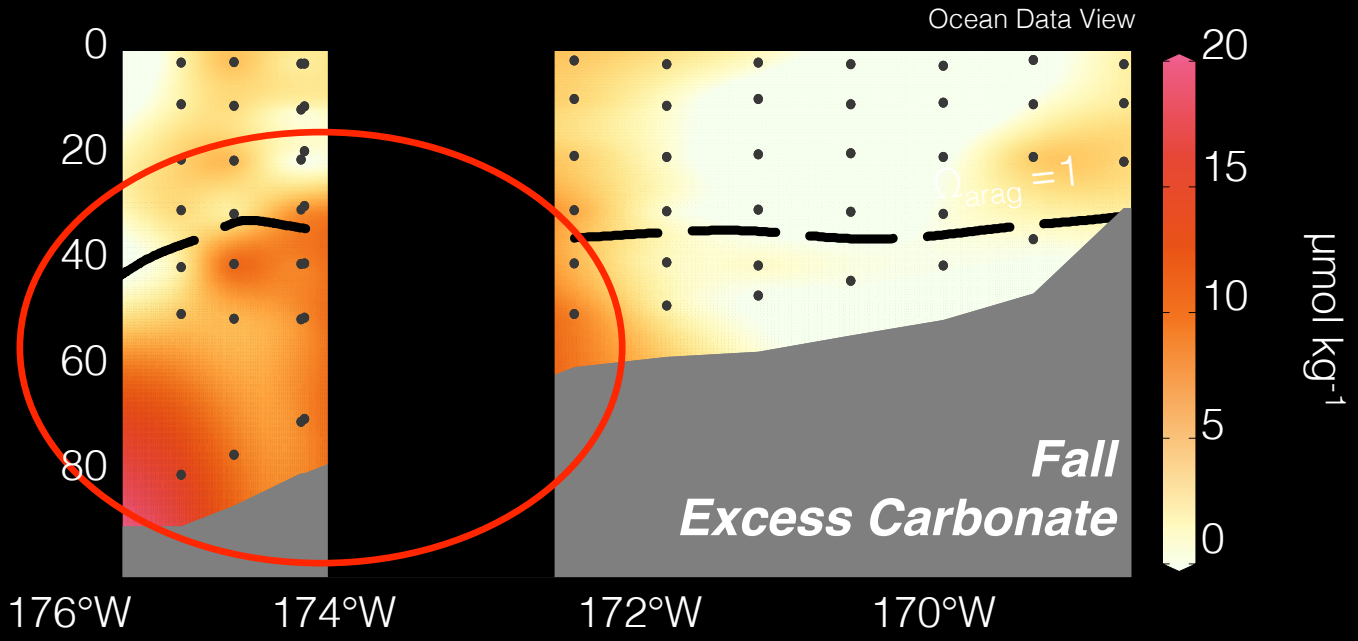


Cross, J.N., Mathis, J.T., Bates, N.R., and Byrne, R.H., 2013. Marine Chemistry, 154, 100-112.

The Anthropogenic Contribution

THESE PERSISTENT UNDERSATURATIONS RESULT IN CARBONATE MINERAL DISSOLUTION.

*Without anthropogenic CO_2, these undersaturations are **too weak** and **too short** to cause dissolution.*



Cross, J.N., Mathis, J.T., Bates, N.R., and Byrne, R.H., 2013. Marine Chemistry, 154, 100-112.

Charting the Way Forward

In-situ observations of geochemical dissolution

Volcanic carbon dioxide vents show ecosystem effects of ocean acidification

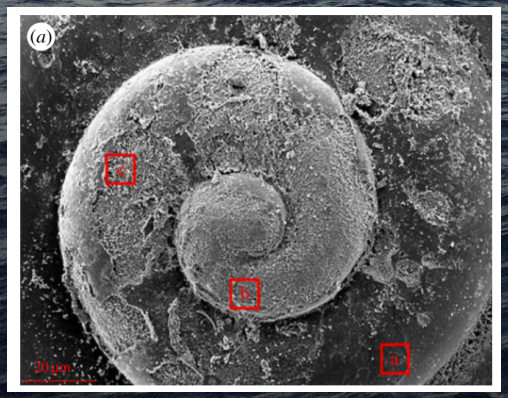
Jason M. Hall-Spencer[1], Riccardo Rodolfo-Metalpa[1], Sophie Martin[2], Emma Ransome[1], Maoz Fine[3,4], Suzanne M. Turner[5], Sonia J. Rowley[1], Dario Tedesco[6,7] & Maria-Cristina Buia[8]

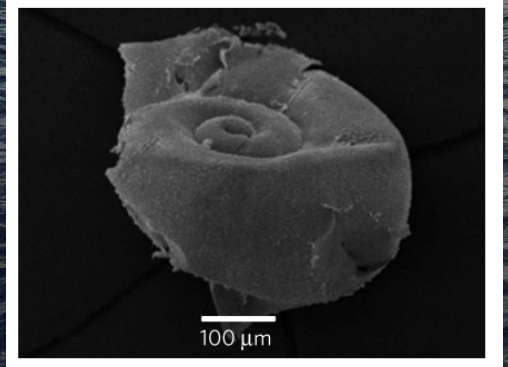
Changes in pteropod distributions and shell dissolution across a frontal system in the California Current System

N. Bednaršek[1,3,*], M. D. Ohman[2]

Extensive dissolution of live pteropods in the Southern Ocean

N. Bednaršek[1,2,3], G. A. Tarling[1]*, D. C. E. Bakker[2], S. Fielding[1], E. M. Jones[4], H. J. Venables[1], P. Ward[1], A. Kuzirian[5], B. Lézé[2], R. A. Feely[6] and E. J. Murphy[1]

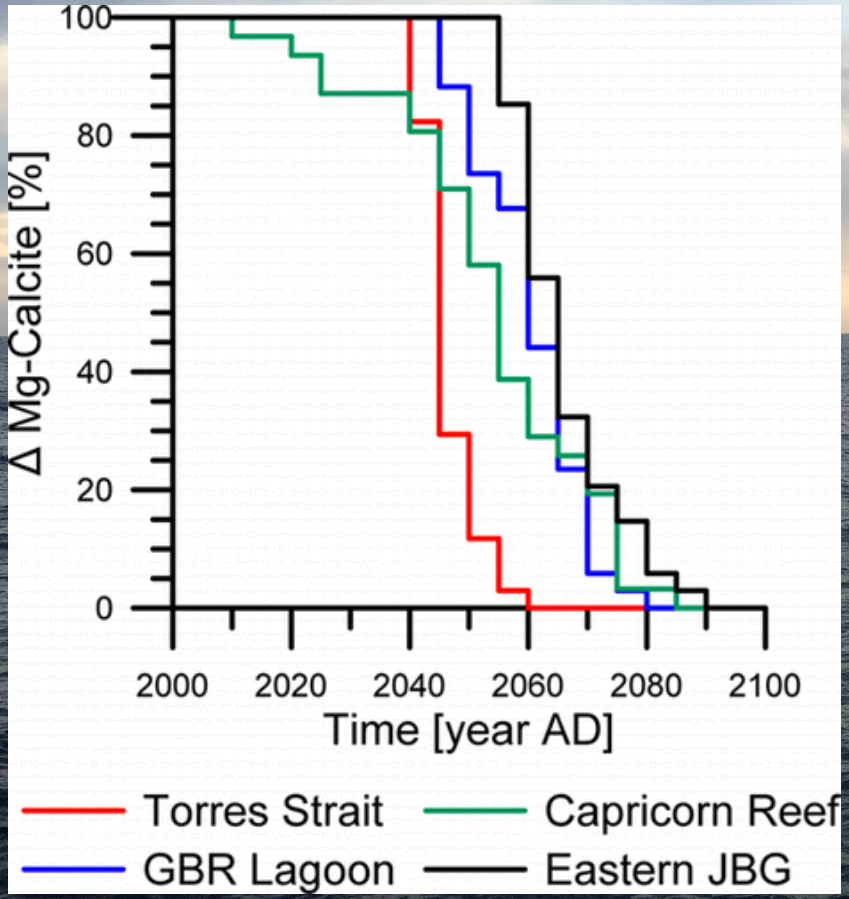




Limacina helicina shell dissolution as an indicator of declining habitat suitability owing to ocean acidification in the California Current Ecosystem

N. Bednaršek[1], R. A. Feely[1], J. C. P. Reum[2], B. Peterson[3], J. Menkel[4], S. R. Alin[1] and B. Hales[5]

Broad scale sedimentary response over continental shelves



High-Magnesium Calcite Dissolution in Tropical Continental Shelf Sediments Controlled by Ocean Acidification

R. R. Haese,*,† J. Smith,‡ R. Weber,‡ and J. Trafford‡

‘A geological marker for the Anthropocene Epoch’

Summary

- Ecosystem level concerns are driving observations of acidification-driven dissolution.
- Geochemical and SEM evidence shows shallow water dissolution
- Broad sedimentary response of high-Mg calcites expected by 2100


Questions?