

Basics of Coral Reefs and Climate Change

Section 4: Ocean Acidification

Mark Eakin

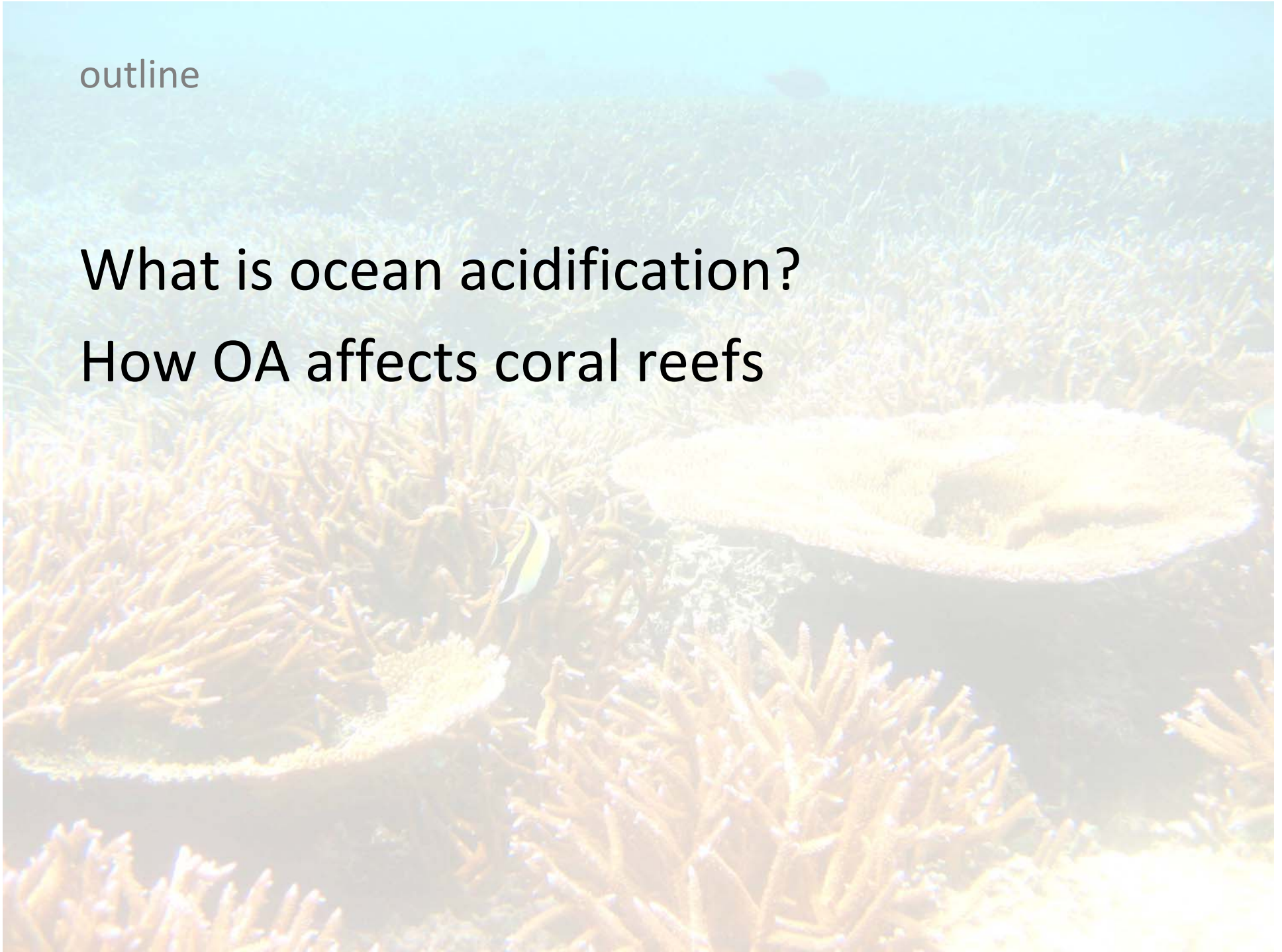
NOAA Coral Reef Watch

Guam – August 2009



outline

What is ocean acidification?
How OA affects coral reefs

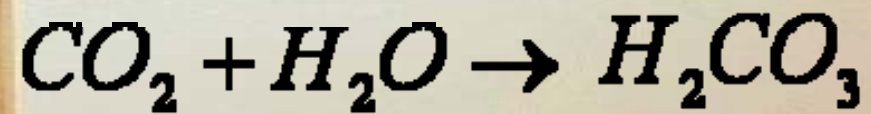
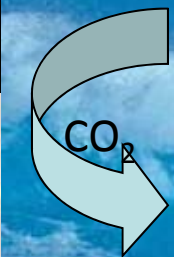


What is Ocean Acidification?



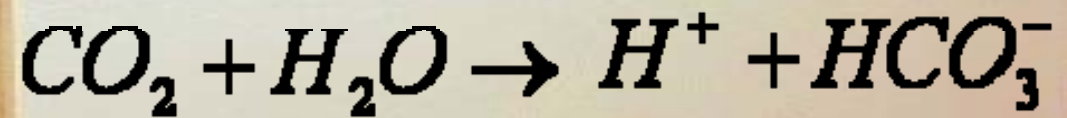
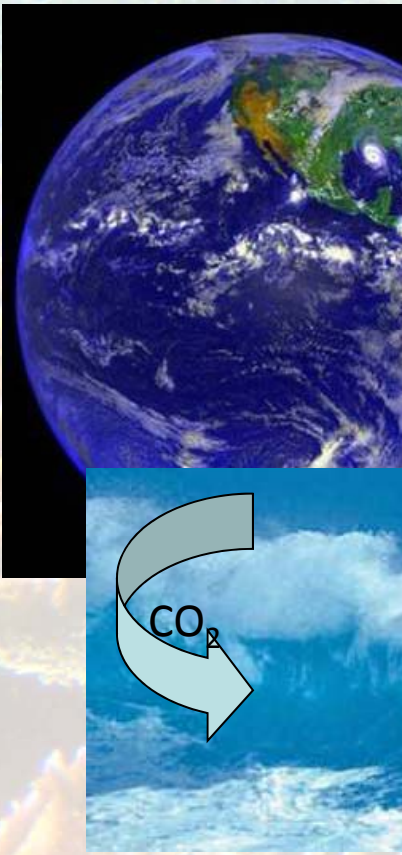
What is Ocean Acidification?

The basic chemistry...



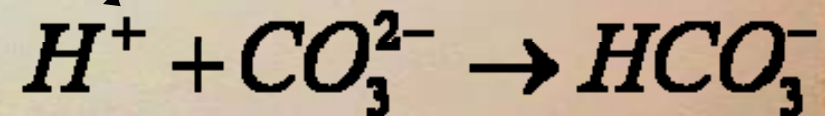
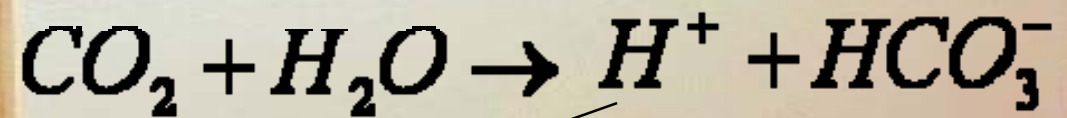
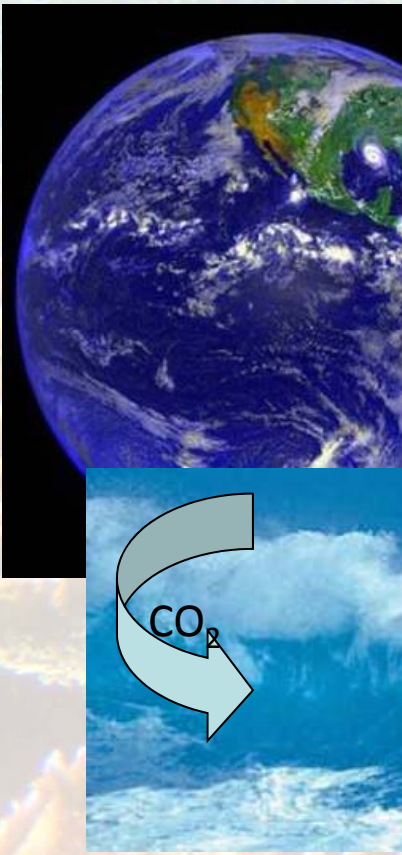
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The basic chemistry...

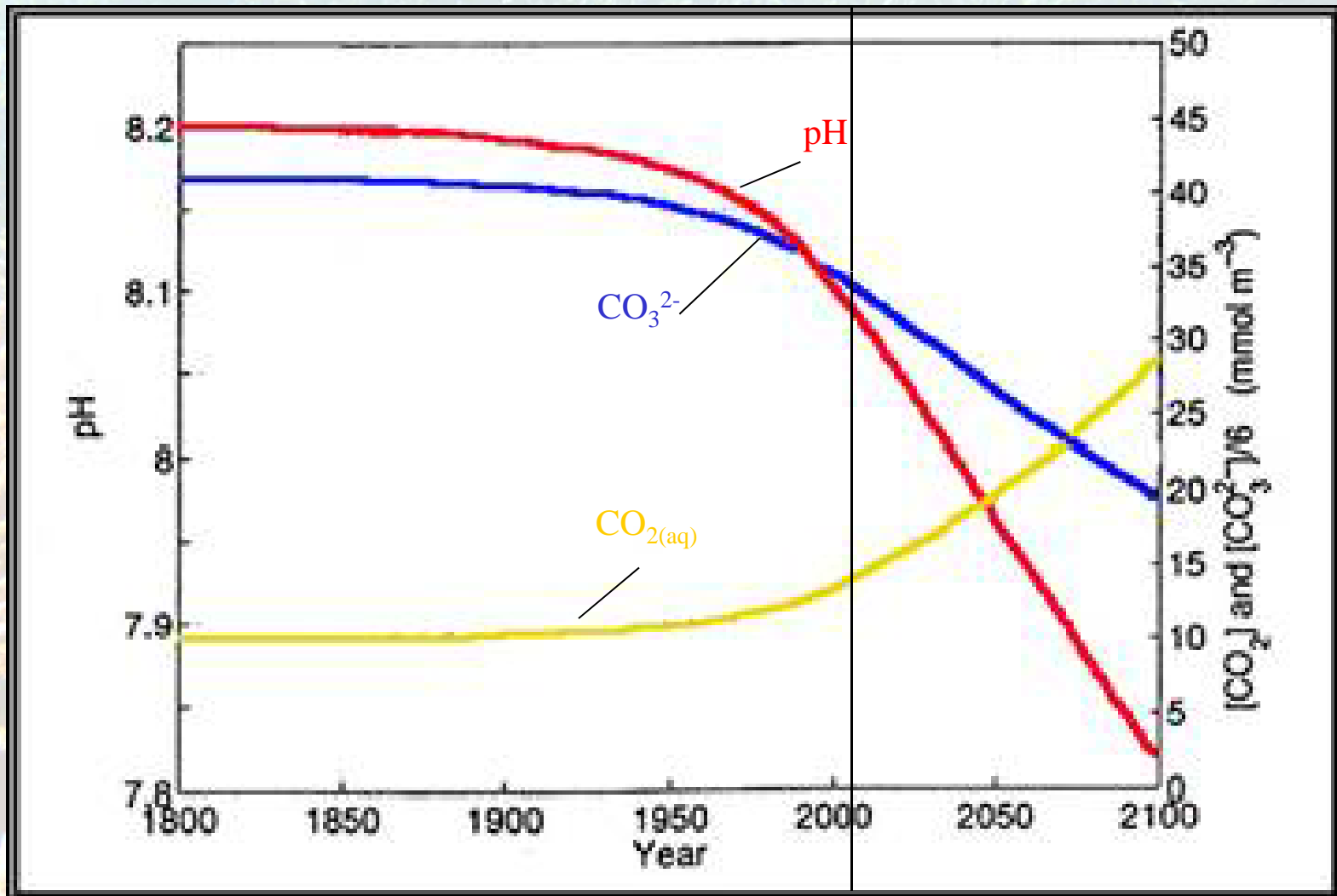


What is Ocean Acidification?

The basic chemistry...



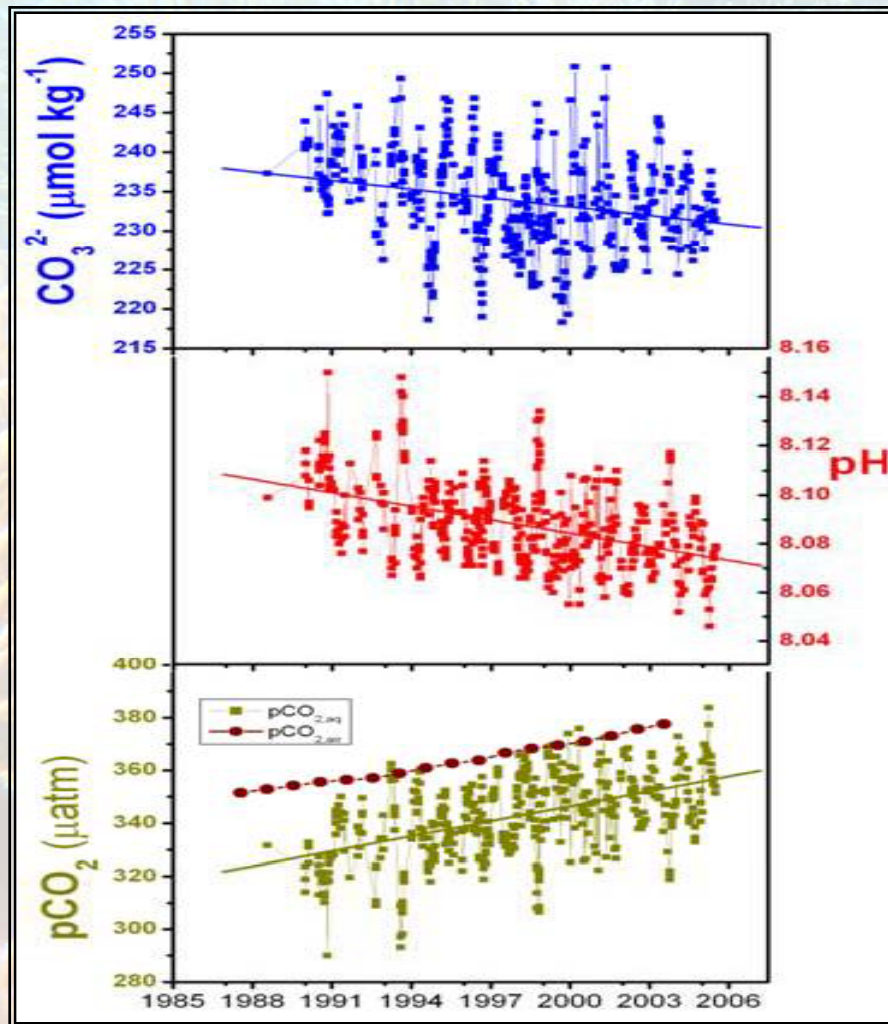
What is Ocean Acidification?



Wolf-Gladrow et al., 1999

What will the future bring?

Ocean Acidification



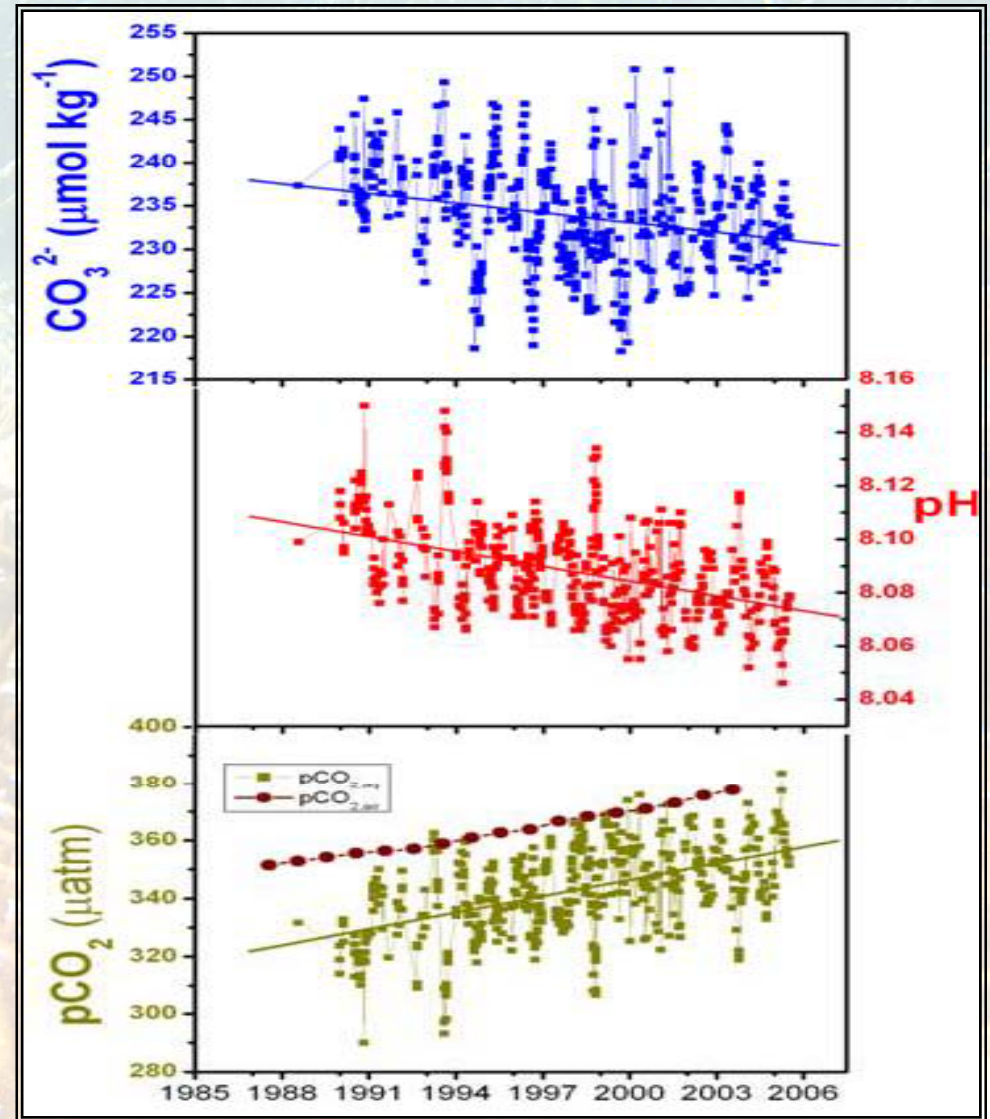
Long-term data from the Hawaii Ocean Time-series.

Trends since 1988 already show increasing CO_2 , decreasing pH and CO_3^{2-} .

What is Ocean Acidification?

Data from the Hawaii
Ocean Time-series.

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 CO_3^{2-} .



How Ocean Acidification Affects Coral Reefs

As carbonate ion decreases, it lowers the
“aragonite saturation state” (Ω)

$$\Omega_{phase} = \frac{[Ca^{2+}][CO_3^{2-}]}{K_{sp,phase}}$$

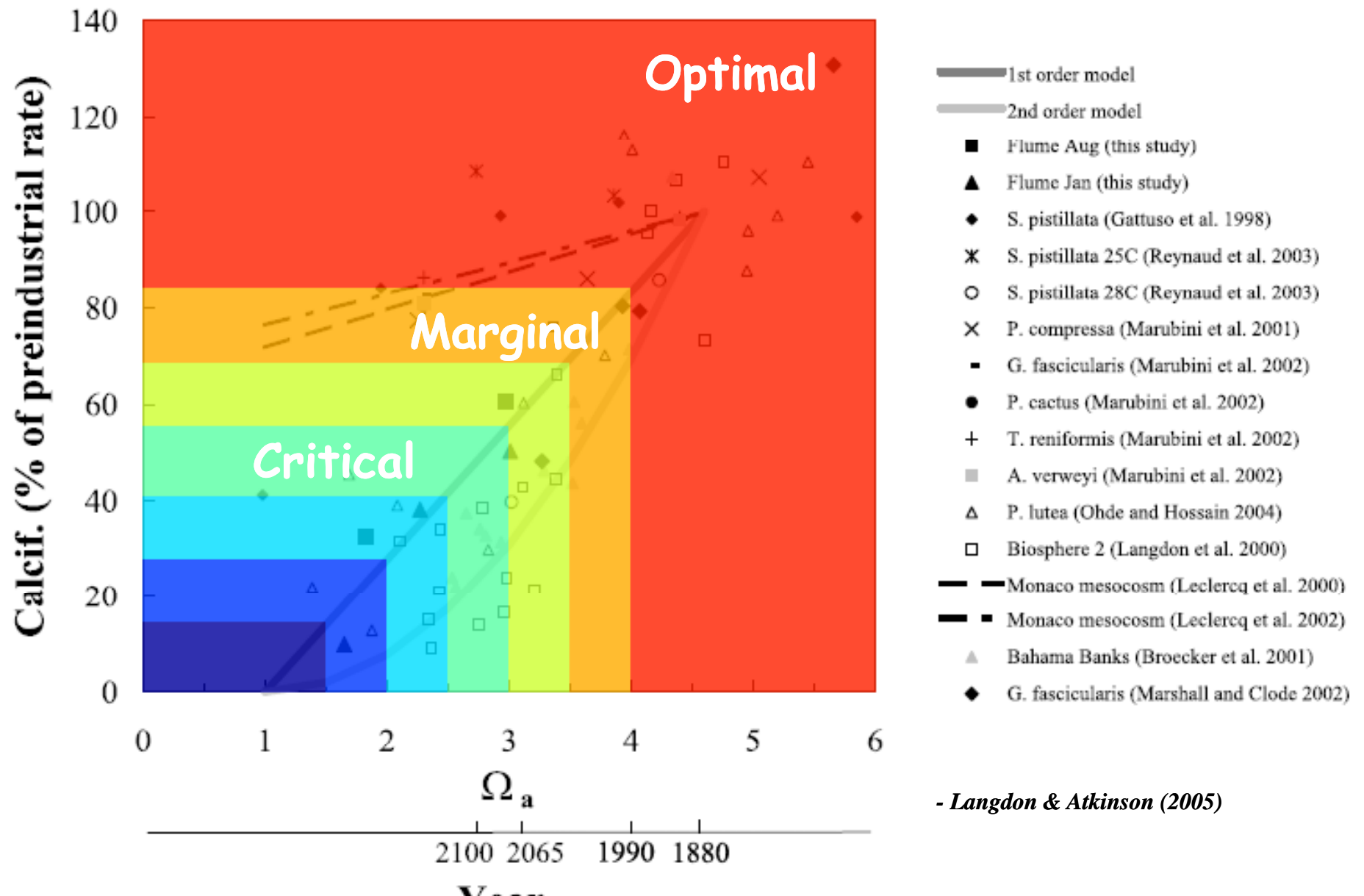
Ω measures how easy it is to precipitate
aragonite ($CaCO_3$) from the ocean water.

$\Omega > 1$: supersaturated, easy to form $CaCO_3$

$\Omega = 1$: equilibrium

$\Omega < 1$: aragonite will dissolve

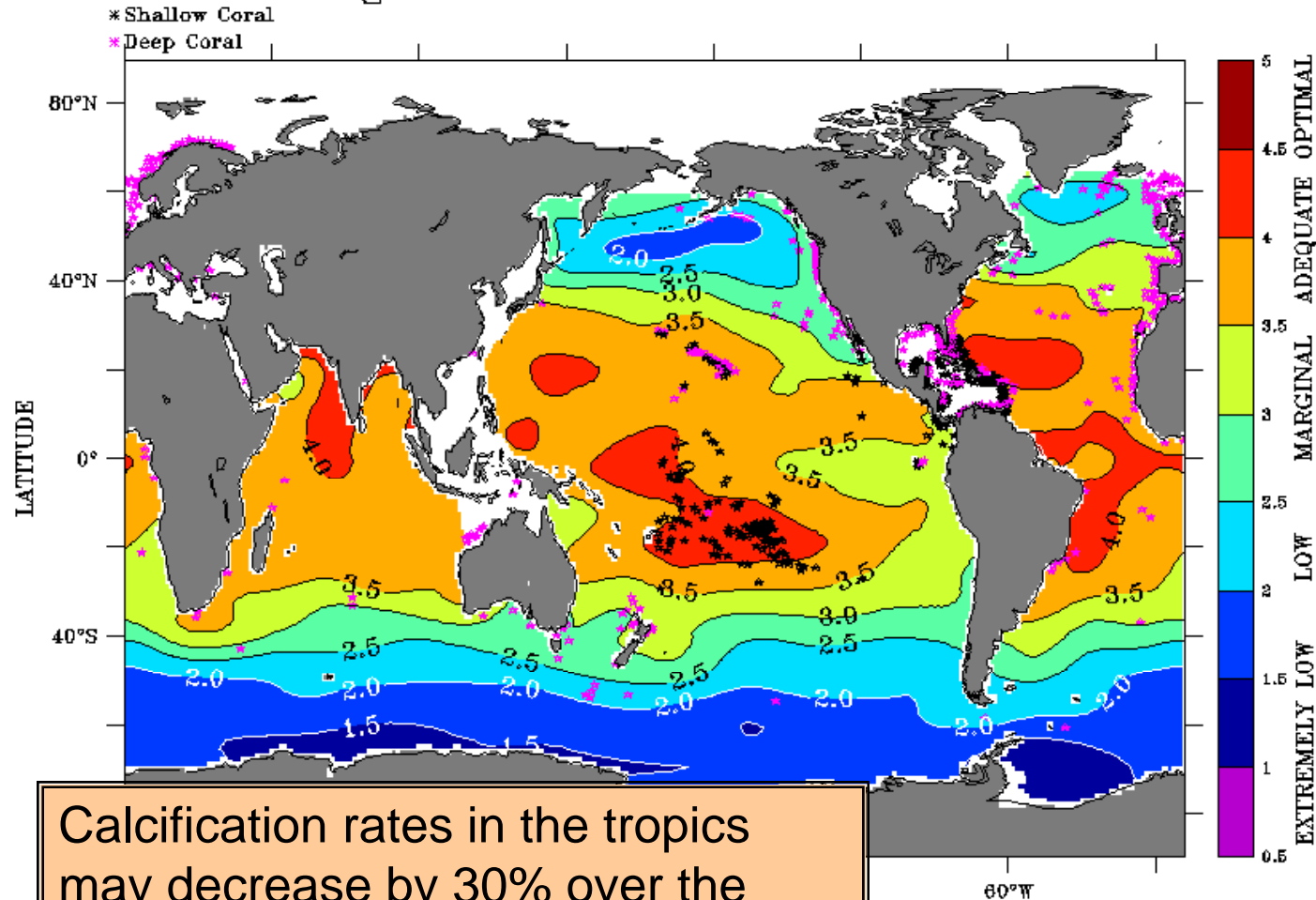
How Ocean Acidification Affects Coral Reefs



How Ocean Acidification Affects Coral Reefs

IPCC IS92a 'business-as-usual'

Aragonite Saturation Levels in 1880



Calcification rates in the tropics may decrease by 30% over the next century

After Feely et al. (in press) with Modeled Saturation Levels from Orr et al. (2005)

How Ocean Acidification Affects Coral Reefs

Slower calcification: three options

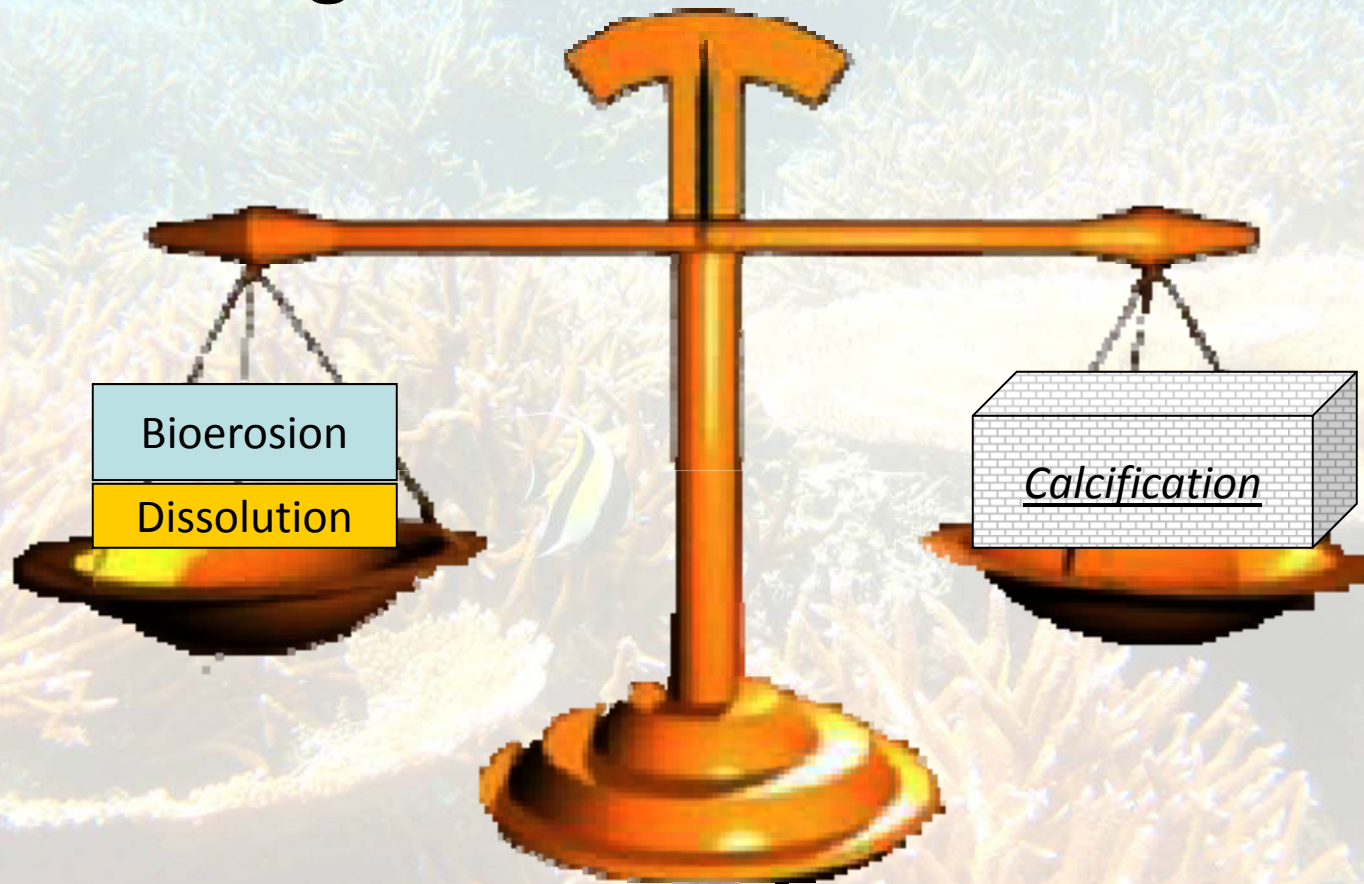
- Grow (extend) more slowly
- Build low-density skeletons
- Divert energy from other processes
 - reproduction, healing damage, etc.

Consequences

- Shifts balance between reef construction and erosion
- Reduced ability to keep up with sea level rise

How Ocean Acidification Affects Coral Reefs

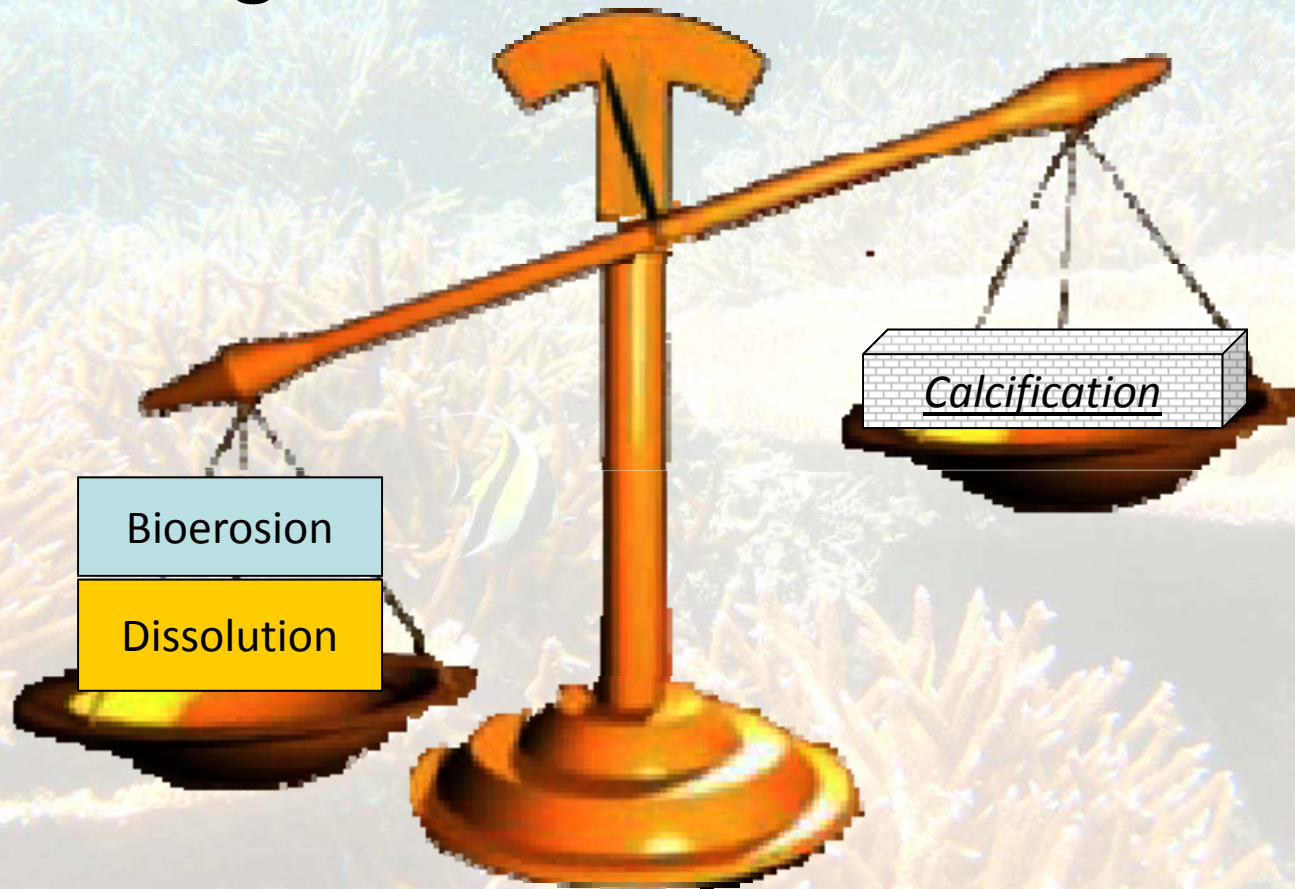
Coral reef growth in the balance



Coral reefs need to calcify at rates greater than natural degradation in order to grow (accretion).

How Ocean Acidification Affects Coral Reefs

Coral reef growth in the balance



A 20% reduction in calcification could push many reefs into net loss.