Response of Coral Reef to Ocean Acidification

Sola Cho

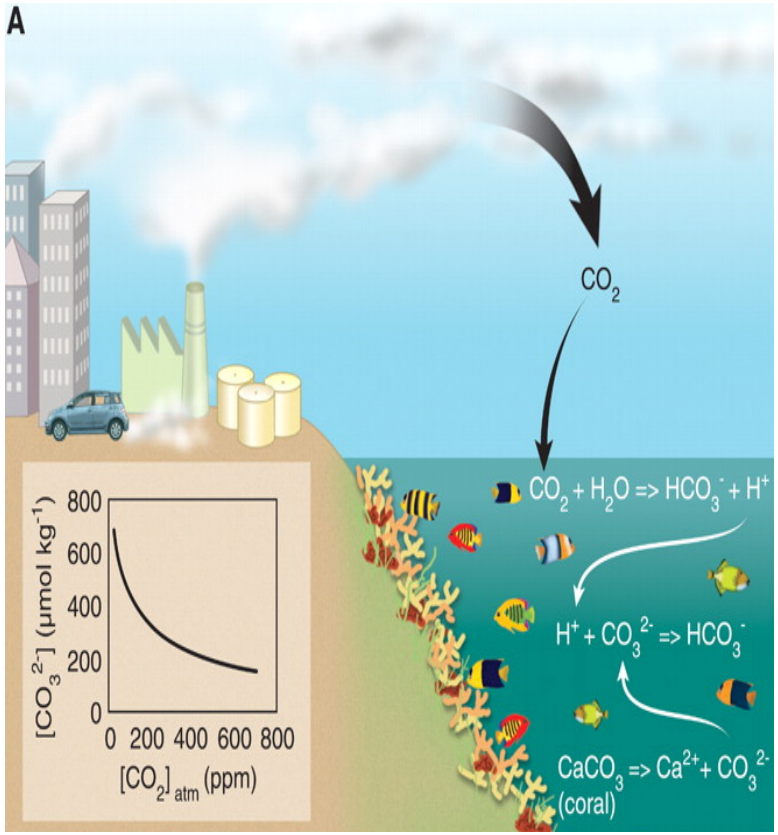
NDSU Geochemistry 428

Contents

Back Ground

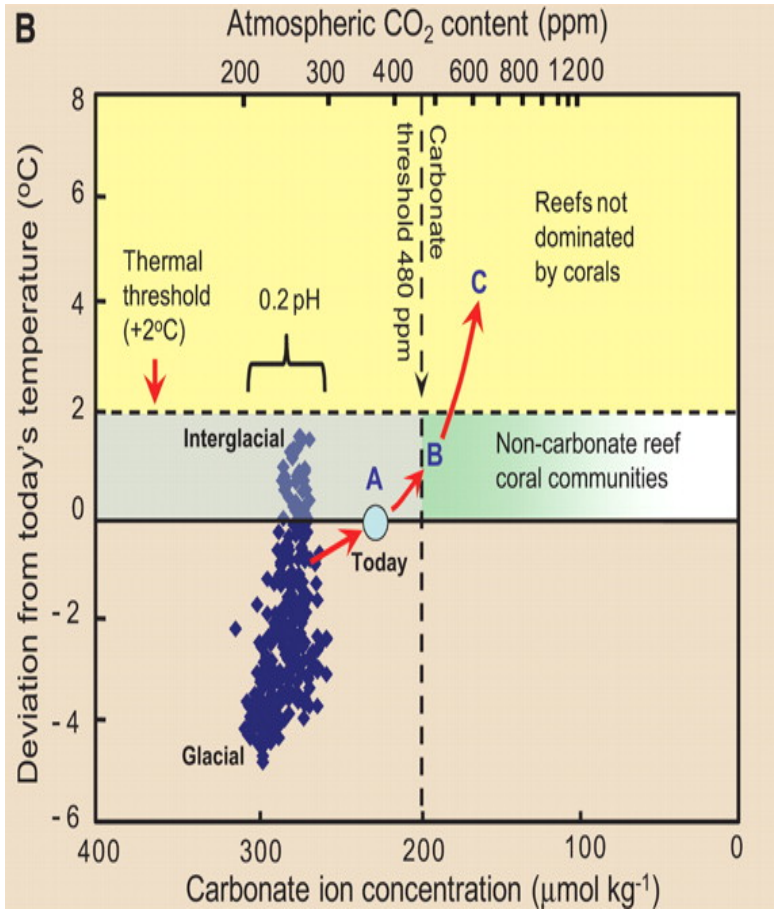
- Atmospheric carbon dioxide concentration is expected to exceed 500ppm and global temperature is expected to rise by at least 2°C by 2050 to 2100.
- Under conditions expected in the 21st century, global warming and ocean acidification will compromise carbonate accretion, with corals becoming increasingly rare on reef systems.

Warming and Acidifying Seas



- Linkage between buildup of atmospheric carbon dioxide and the slowing of coral calcification due to ocean acidification
- Increasing atmos carbon dioxide concentration, and hydrogen concentration also increase(ocean acidification), and decrease of concentration of carbonate
- Making it unavailable to marine corals

Warming and Acidifying Seas



- Relation between temperature, [CO_2]atm, and carbonate-ion concentrations
- The thresholds for major changes to coral communities are indicated for thermal stress(+2°C) and carbonate-ion concentrations.
- The arrows pointing progressively toward the right hand top square

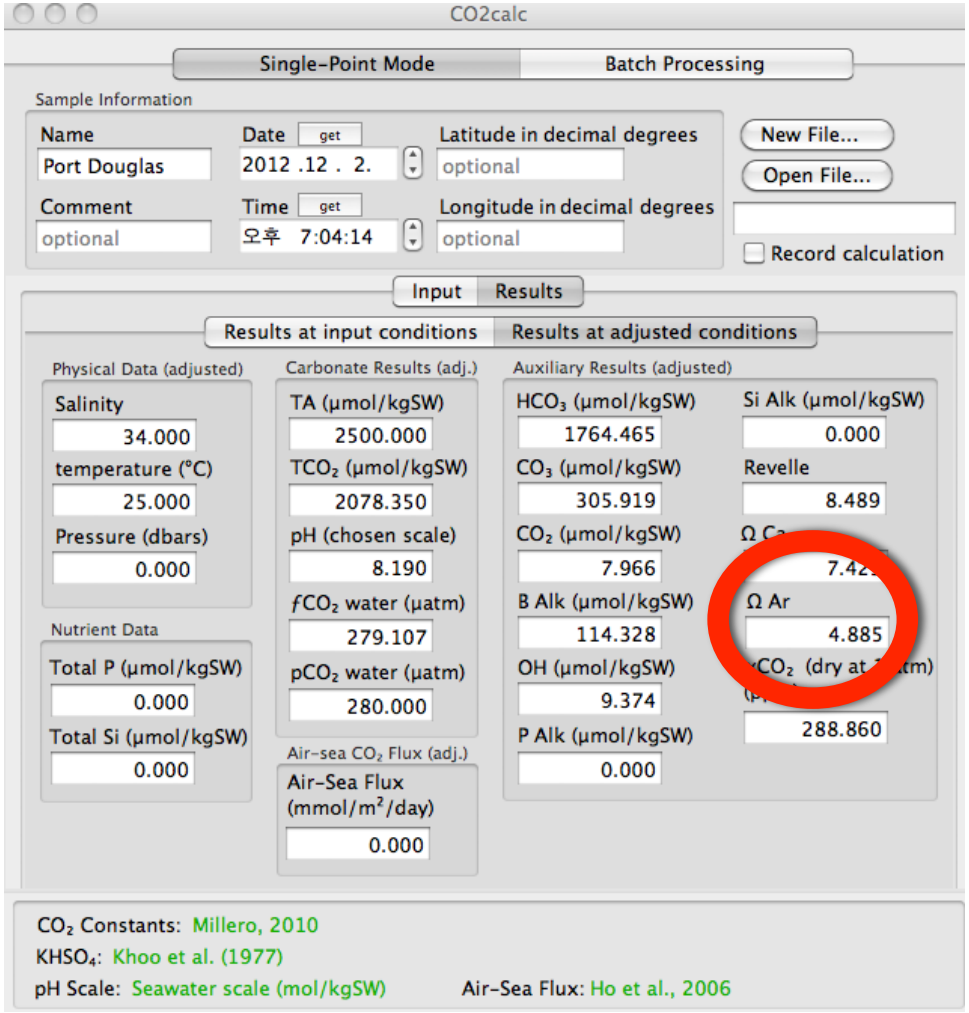
Example of Response to Ocean Acidification

- Great Barrier Reef
- A : reef slope at Heron Island
- B : coral communities associated with inshore reefs around St. Bees Island
- C : reef slope around Port Douglas
- Not in same place, but

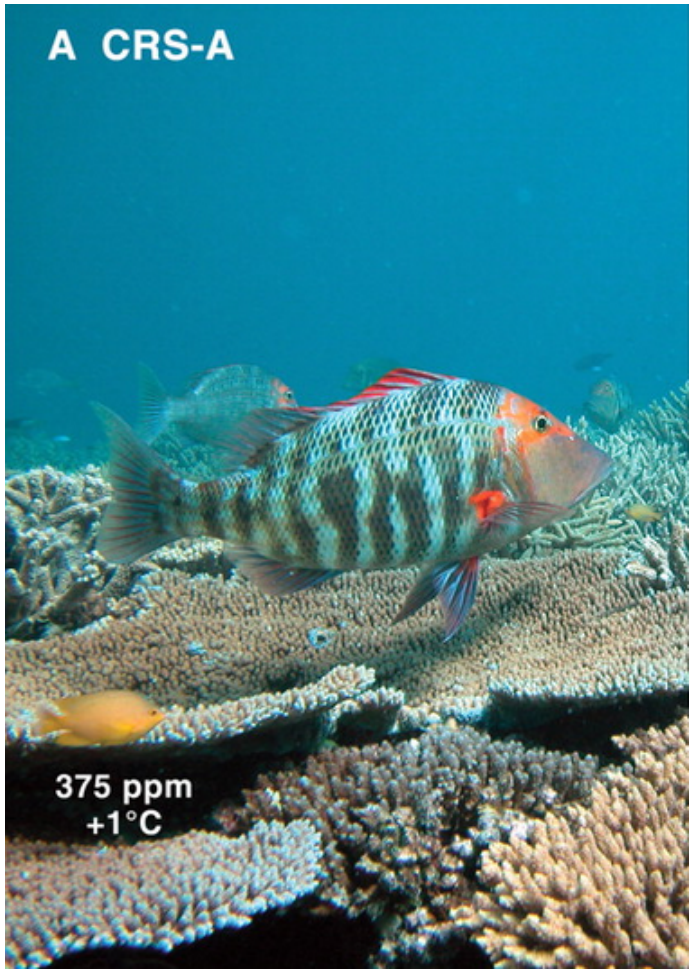
How to use 'CO_2Calc'

- 'CO_2Calc'
  - Application for the calculation of carbonate system
  - developed by finding Ecosystems Response to Climate Change Project in response to its Ocean Acidification Task
  - Fill out required data and then get the value that we want

How to use 'CO_2Calc'



Result



Sample Information

Name: Heron Island
Date: get 2012 .12 . 2.
Time: get 오후 5:31:35
Latitude in decimal degrees: optional
Longitude in decimal degrees: optional
Comment: optional
New File...
Open File...
Record calculation

Input | Results

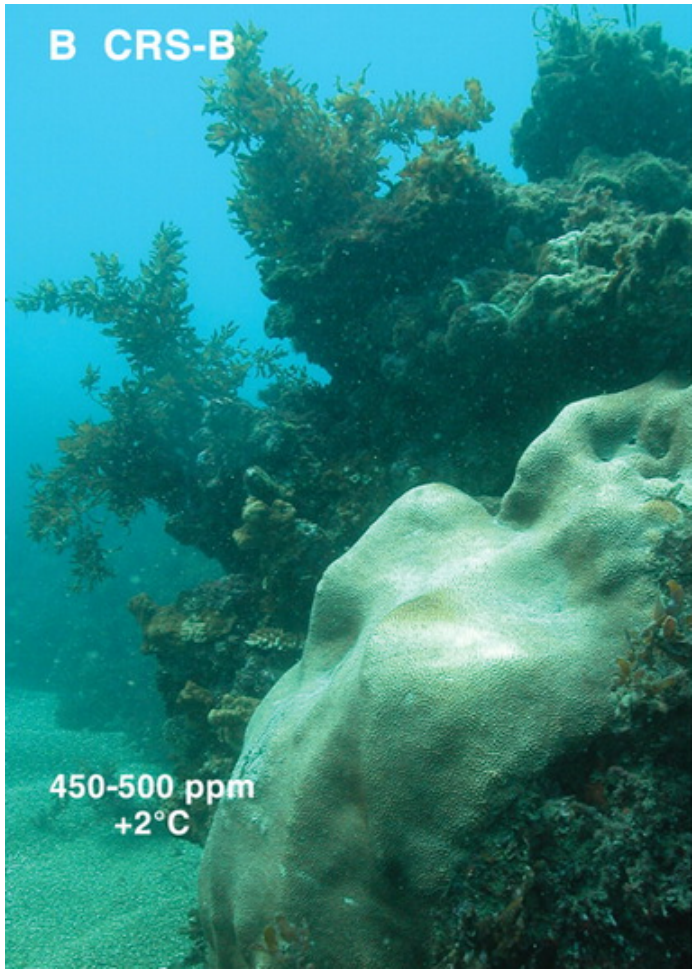
Results at input conditions | Results at adjusted conditions

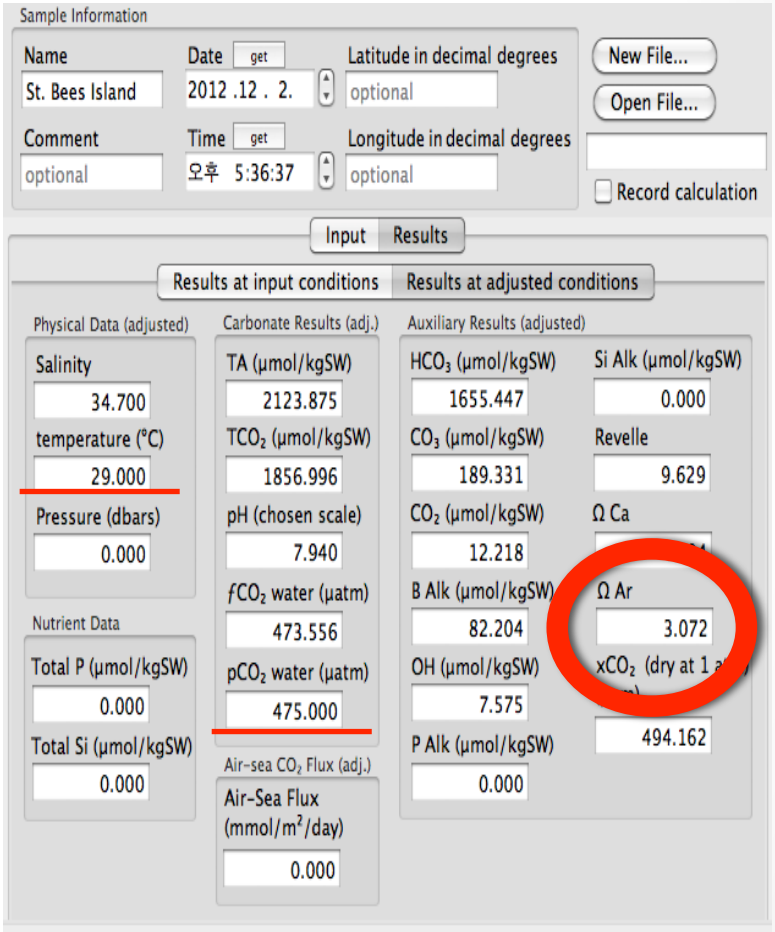
Physical Data (adjusted)		Carbonate Results (adj.)		Auxiliary Results (adjusted)	
Salinity	34.700	TA (µmol/kgSW)	2408.726	HCO_3 (µmol/kgSW)	1770.617
temperature (°C)	28.000	TCO_2 (µmol/kgSW)	2044.049	CO_3 (µmol/kgSW)	263.556
Pressure (dbars)	0.000	pH (chosen scale)	8.070	CO_2 (µmol/kgSW)	9.876
Nutrient Data		fCO_2 water (µatm)	373.847	B Alk (µmol/kgSW)	101.636
Total P (µmol/kgSW)	0.000	pCO_2 water (µatm)	375.000	OH (µmol/kgSW)	9.371
Total Si (µmol/kgSW)	0.000	Air-sea CO_2 Flux (adj.)		P Alk (µmol/kgSW)	0.000
		Air-Sea Flux ($mmol/m^2/day$)	0.000		

Si Alk (µmol/kgSW)	0.000
Revelle	8.872
Ω Ca	
Ω Ar	4.253
xCO_2 (dry at 1 a	
	389.243

A little bit changed but remain coral dominated and carbonate accreting

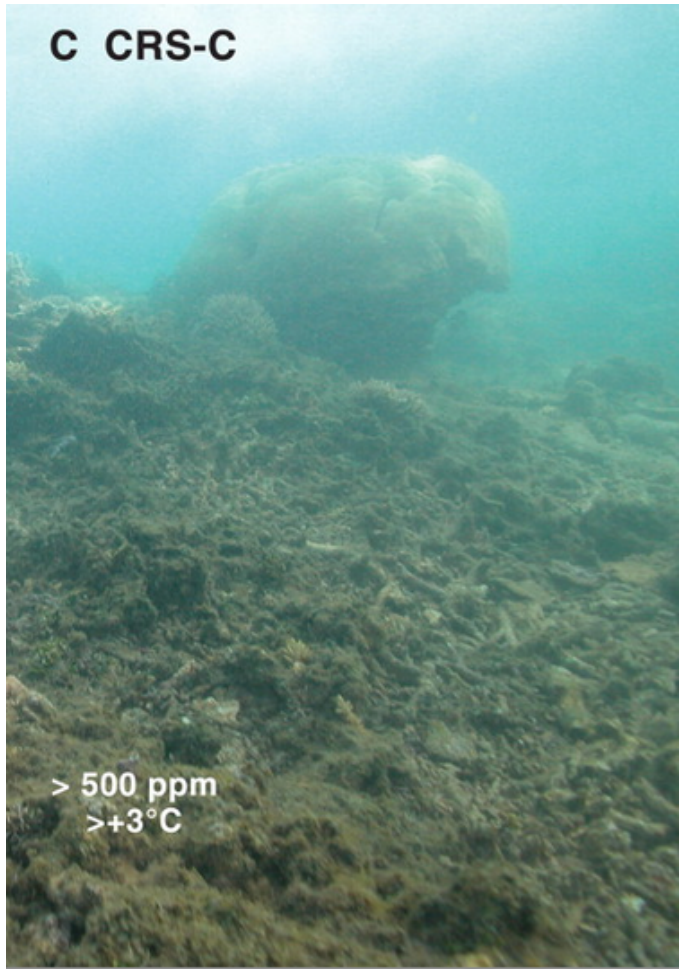
Result

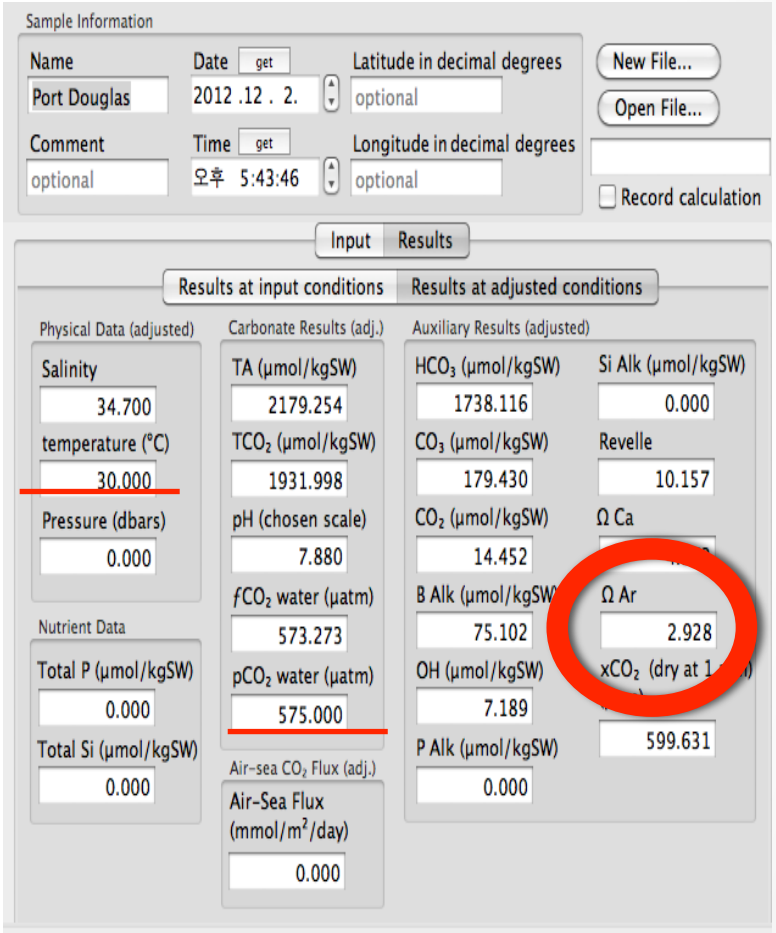




Higher CO2, some areas becoming dominated by more thermally tolerant corals

Result





Density and diversity of corals on reefs decline, including losses of coral associated fish

Result

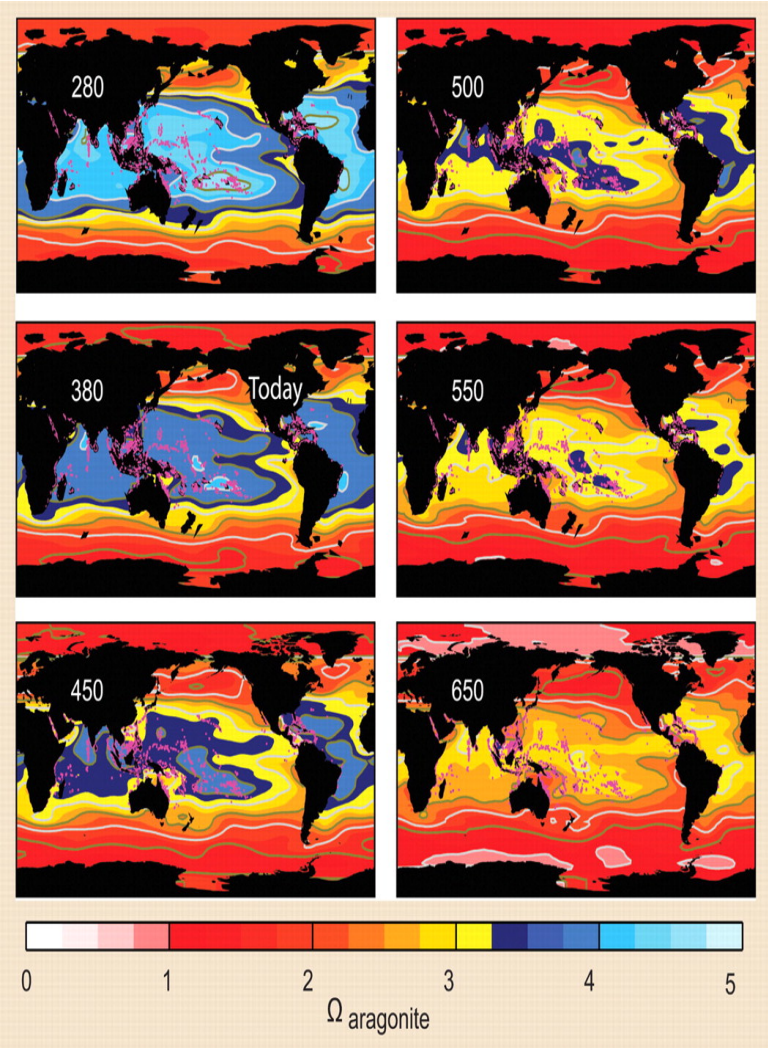
	A		B		C	
Condition	28°C	375ppm	29°C	475ppm	30°C	575ppm
Ω Aragonite	4.253		3.072		2.928	

- Change in aragonite saturation
  - Changes in aragonite saturation occur as atmospheric CO_2 concentrations increase
  - Changes in aragonite saturation occur as temperature increase

Result

- Formula of aragonite saturation
  - Ω aragonite = $[Ca^{2+}]*[CO_3^{2-}]/K_{sp}$ aragonite
- Meaning of Change in aragonite saturation
  - Under acidified conditions, the oceans become less saturated in respect to aragonite, meaning that aragonite does not precipitate from seawater as readily. So it means the density and diversity of corals on reefs are likely to decline.

Conclusion



- Before the industrial revolution, nearly all shallow-water coral reefs had Ω aragonite > 3.25(when [co2] lower than 280ppm), there is a lot of corals on reefs.
- The number of existing coral reefs with aragonite saturation decreases rapidly as [CO_2] increase

Conclusion

- Decreased linear extension rate and skeletal density of coral colonies
- Reducing habitat quality and diversity
- Corals may maintain both growth and density under reduced carbonate saturation, so side effect is the diversion of resources from other essential processes(reproduction)

Reference

- http://www.sciencemag.org/content/318/5857/1737.full

Thank you