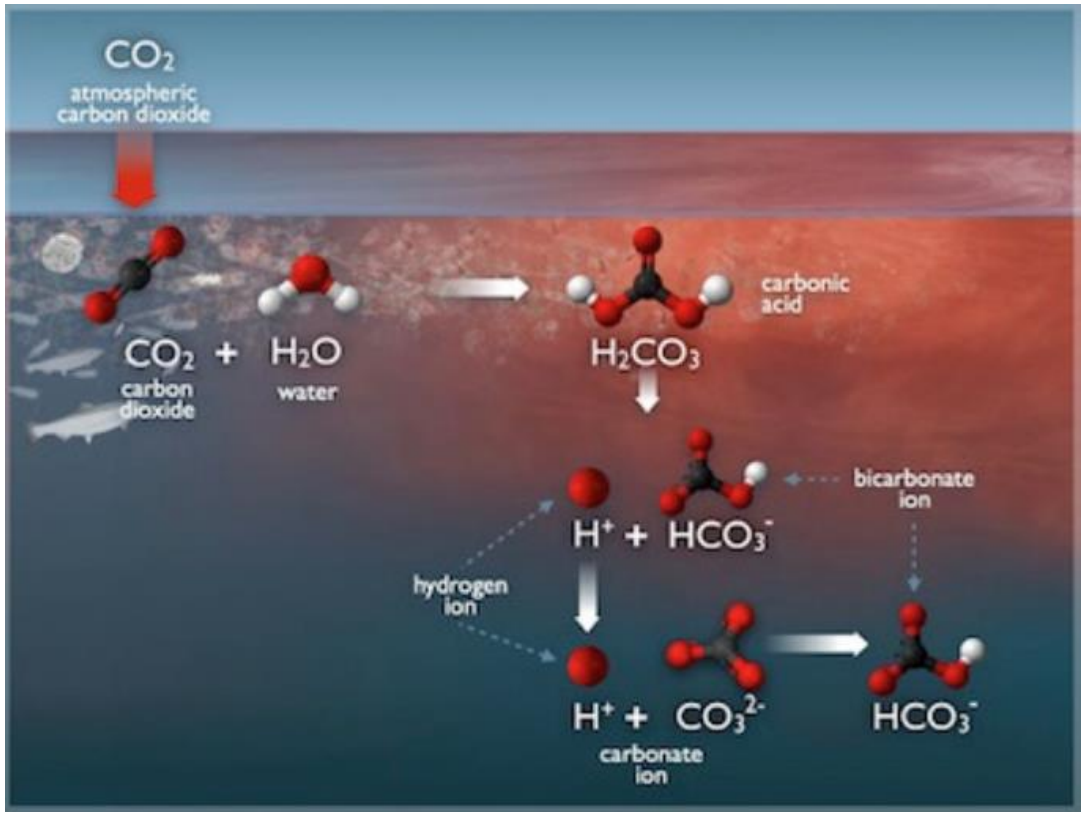
Miðalsúrleik í sjógvi

SDG14.3.1 - Average marine acidity (pH) measured at agreed suite of representative sampling stations

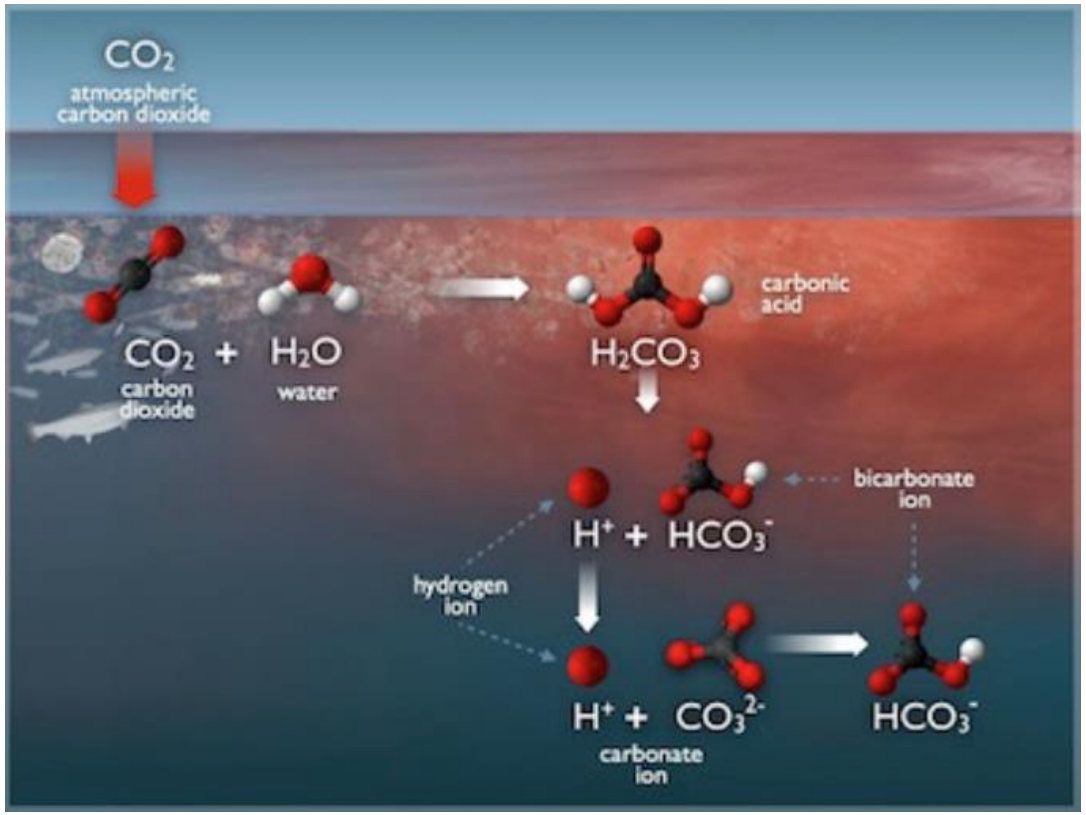


Ian Salter, Havstovan

14 LIFE BELOW WATER

Miðalsúrleik í sjógvi

SDG14.3.1 - Average marine acidity (pH) measured at agreed suite of representative sampling stations



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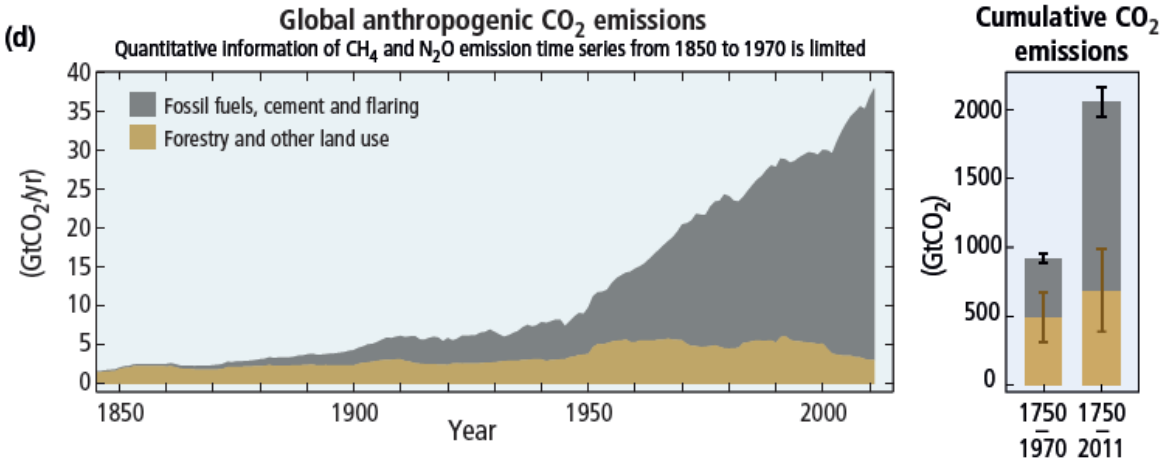
The other CO_2 problem

The evil twin of global warming

Atmospheric CO_2 – rates of change

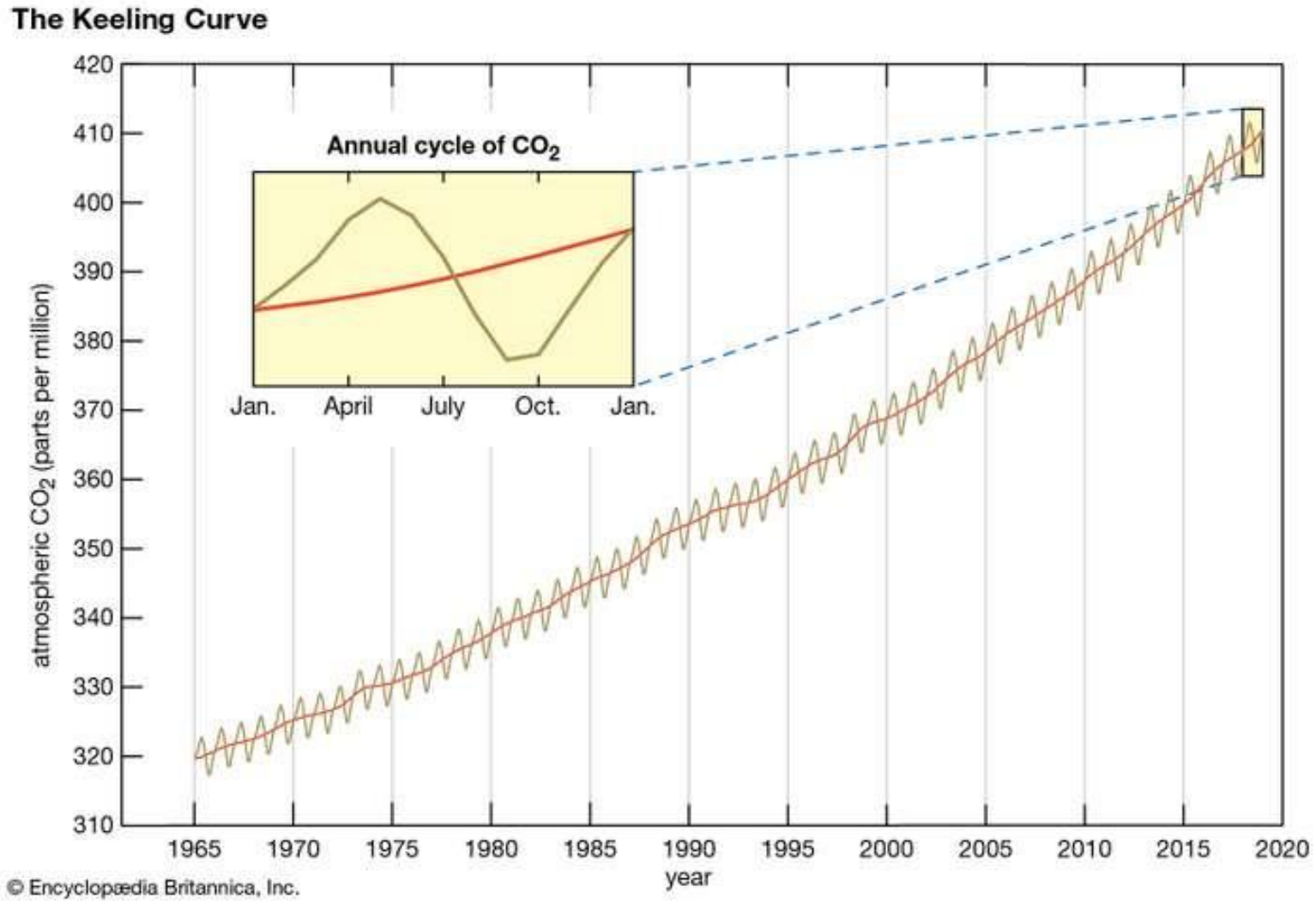
Humans >>>> Lots of extra CO_2 in atmosphere

2,000 trillion (1,000,000,000,000) kg



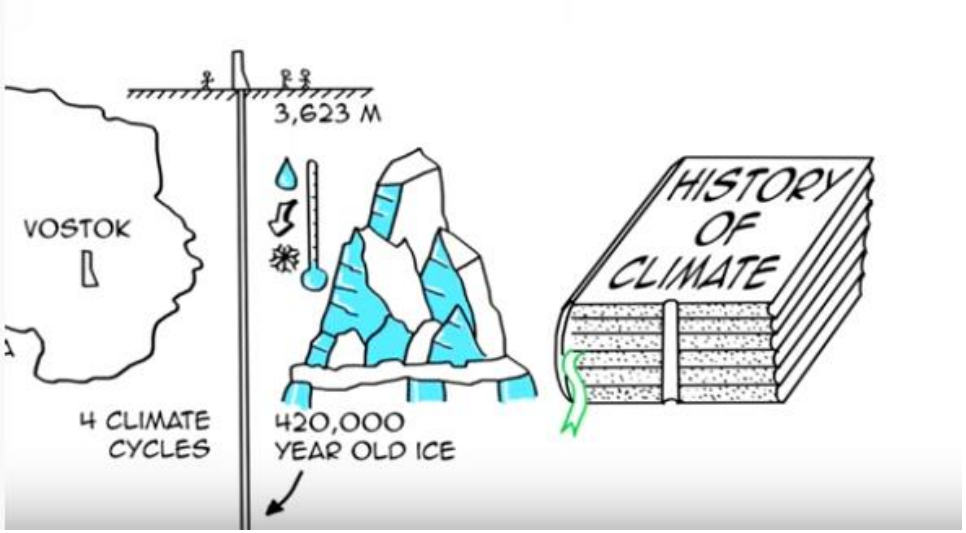
IPCC AR5

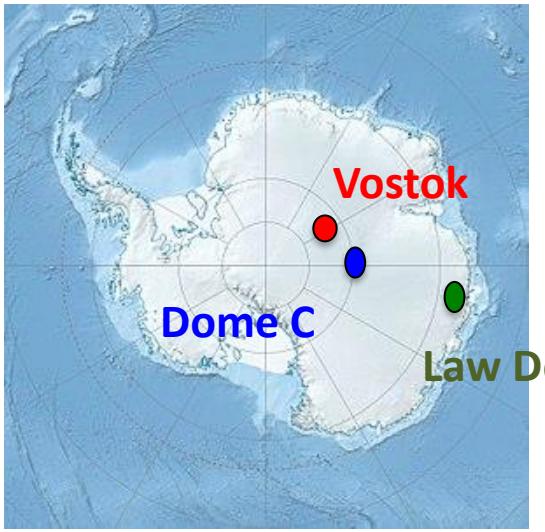
The Keeling curve

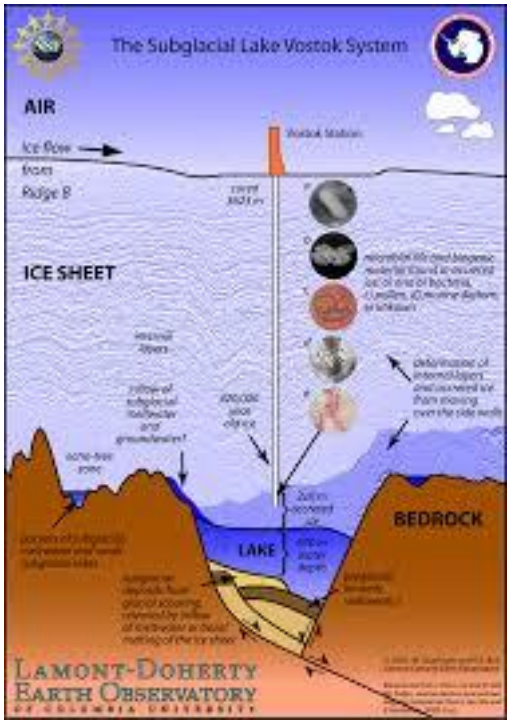


Atmospheric CO_2 – rates of change

Paleoclimate – climate time machines – the Vostok record and the Dome C

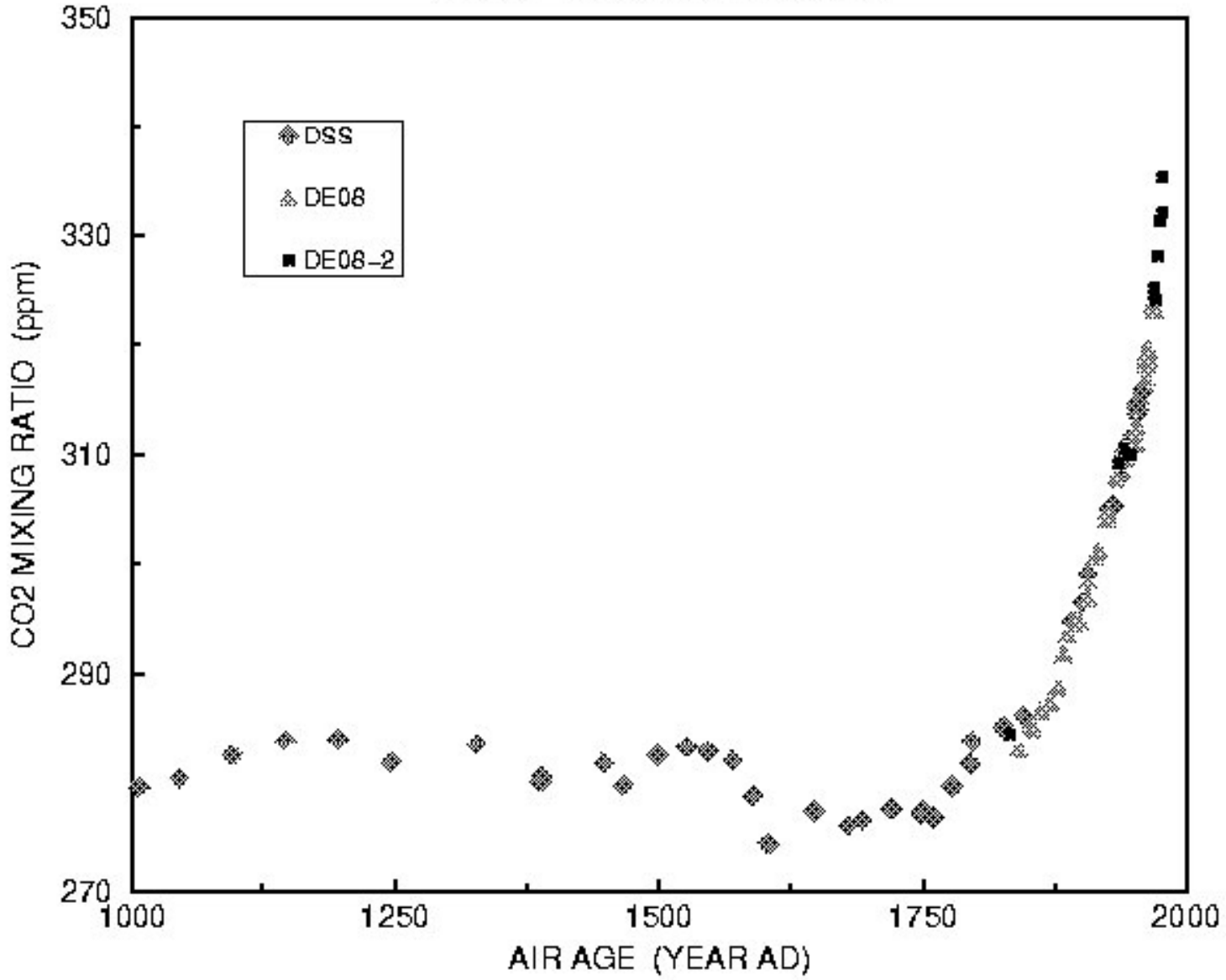






LAW DOME, ANTARCTICA ICE CORES

Source: Etheridge et al. (CSIRO)



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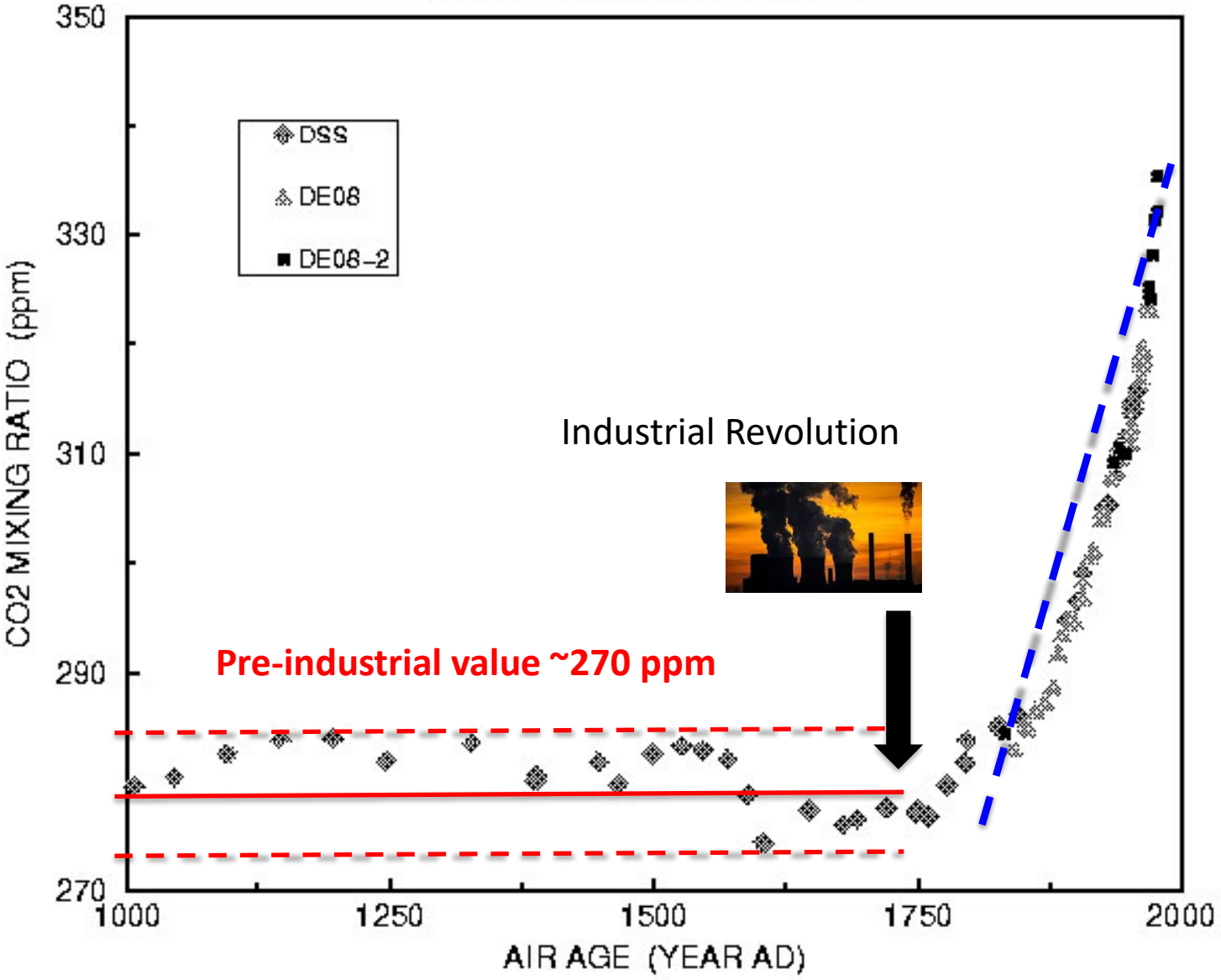
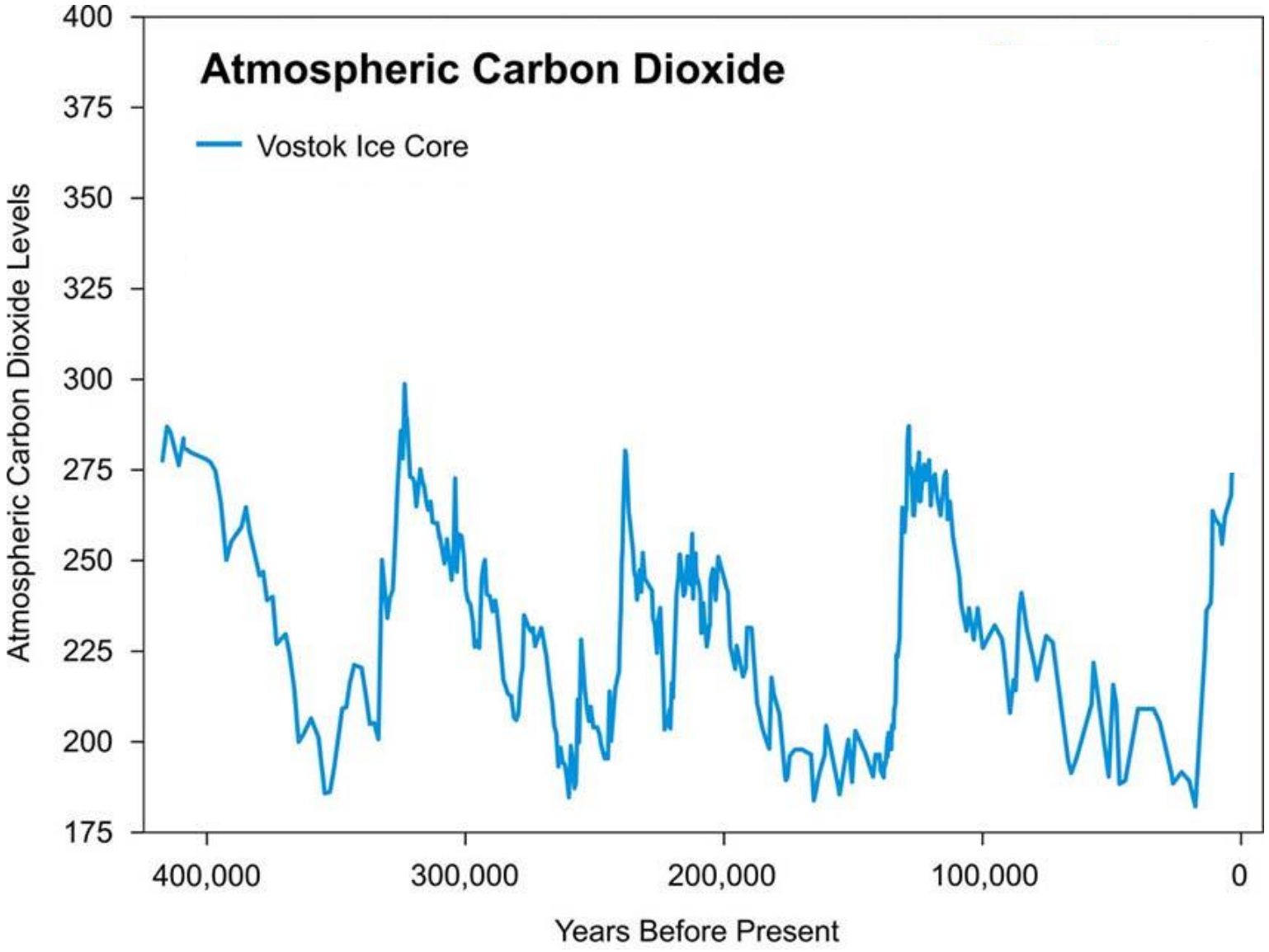


Atmospheric CO_2 – rates of change



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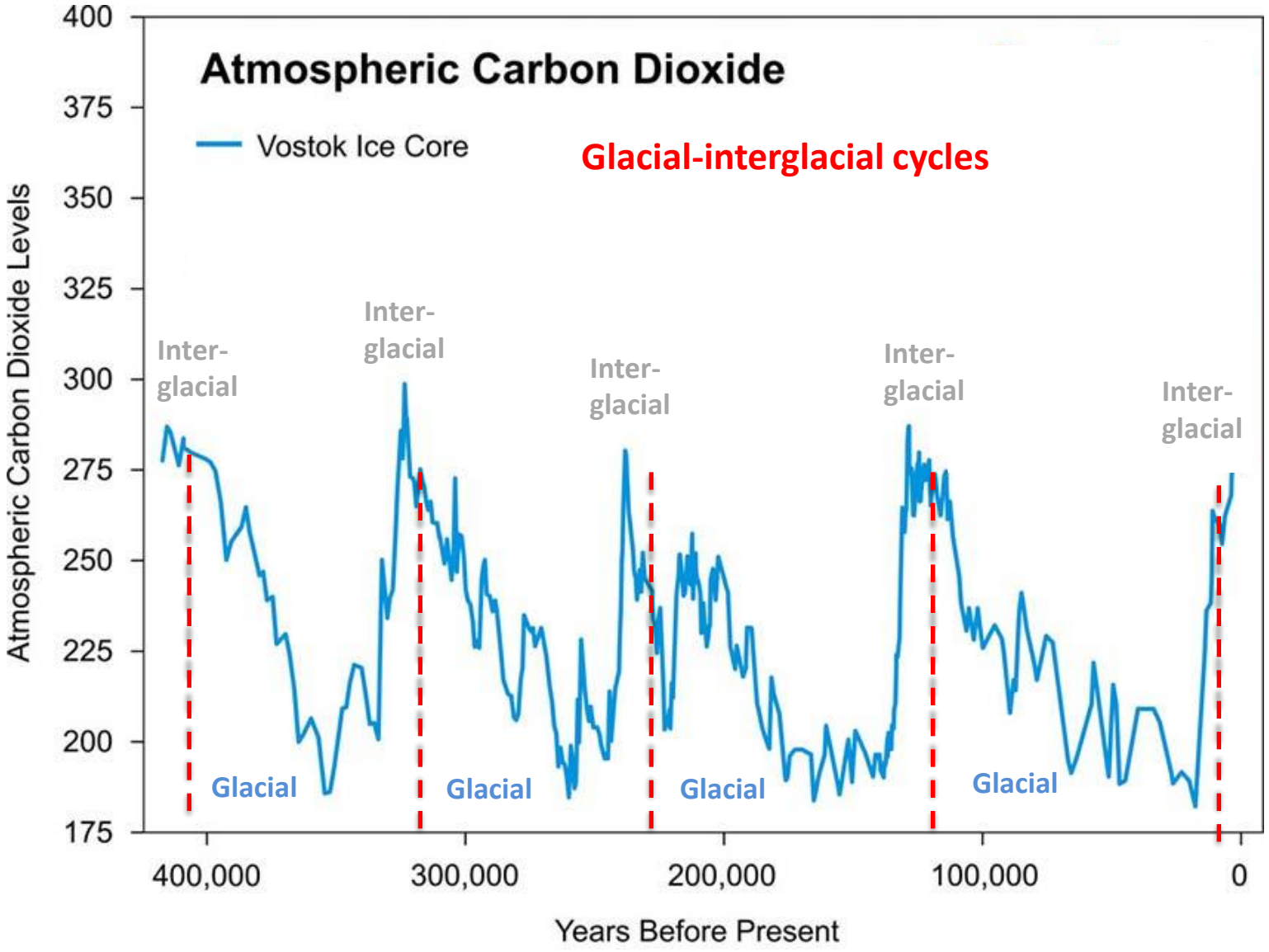
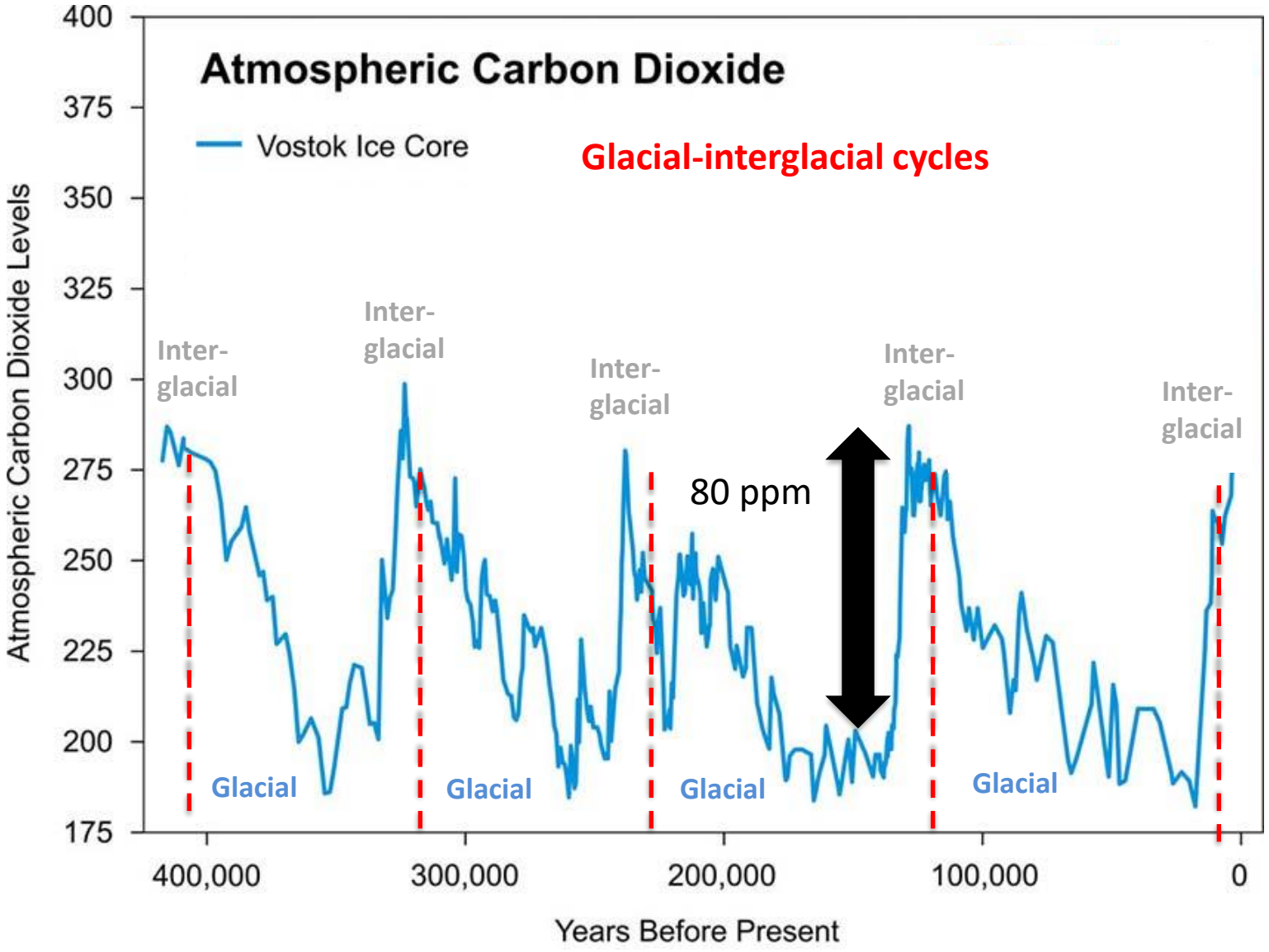
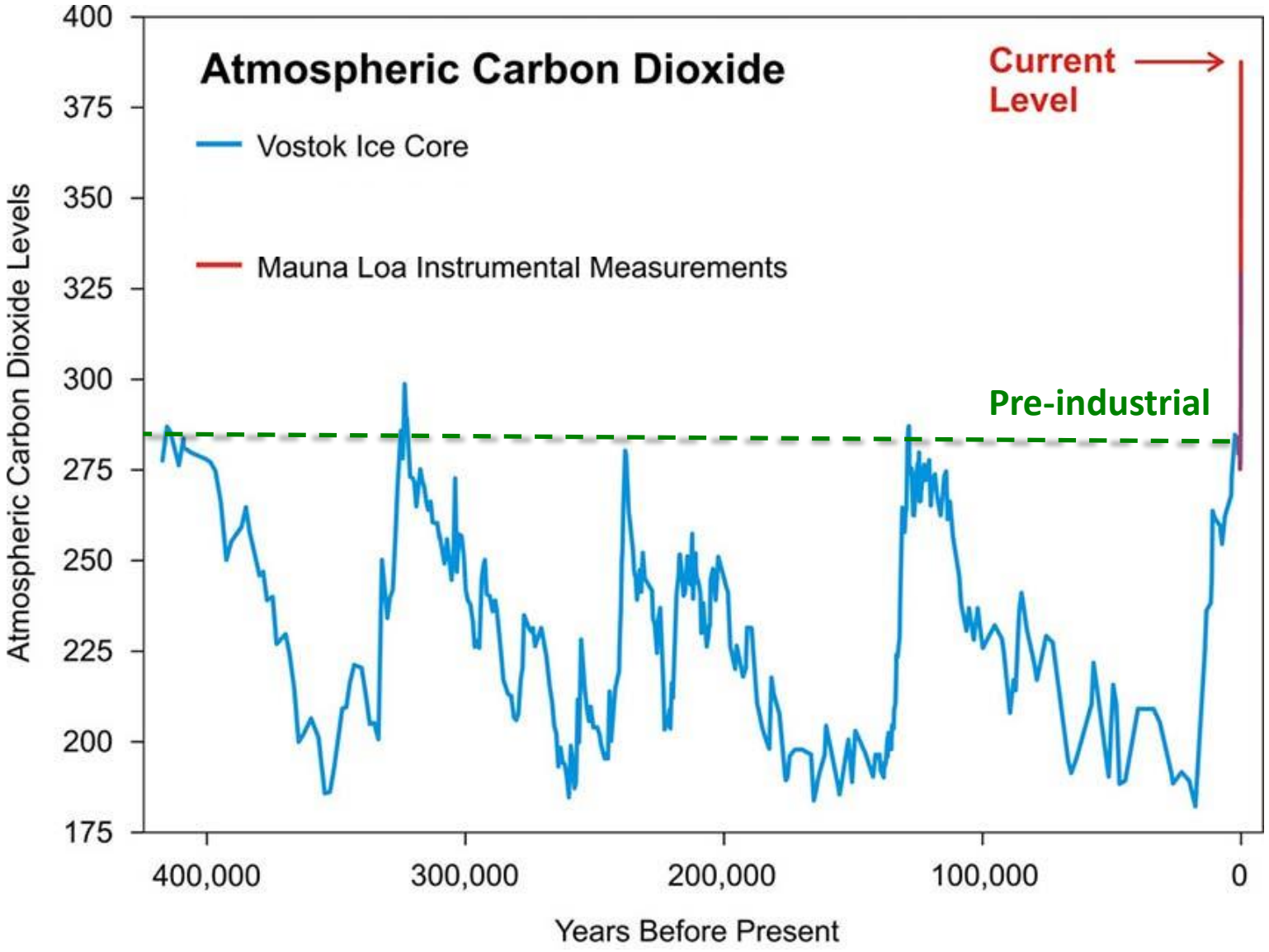


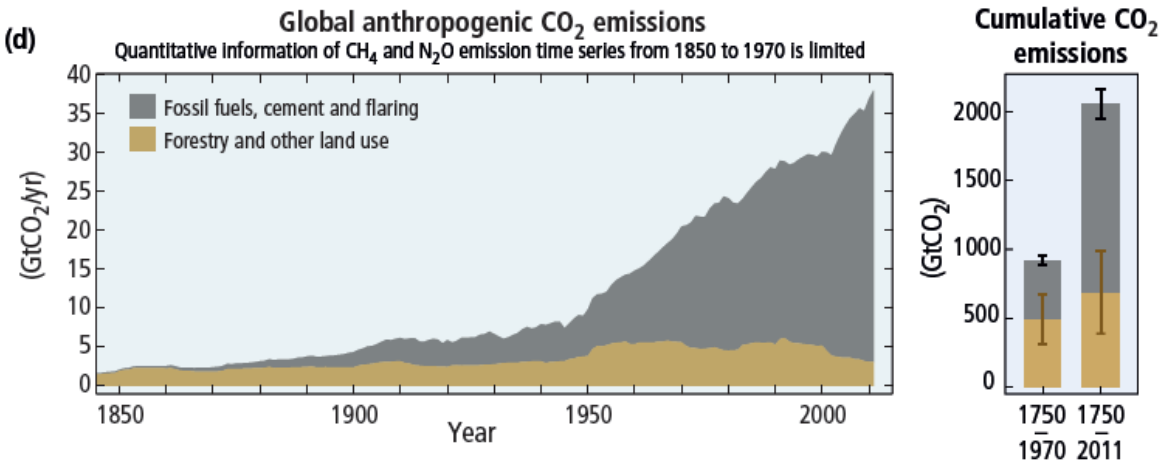
Atmospheric CO_2 – rates of change



Atmospheric CO_2 – rates of change



Where have all our CO_2 emissions ended up?



Atmosphere

1/3

Land plants

1/3

Ocean

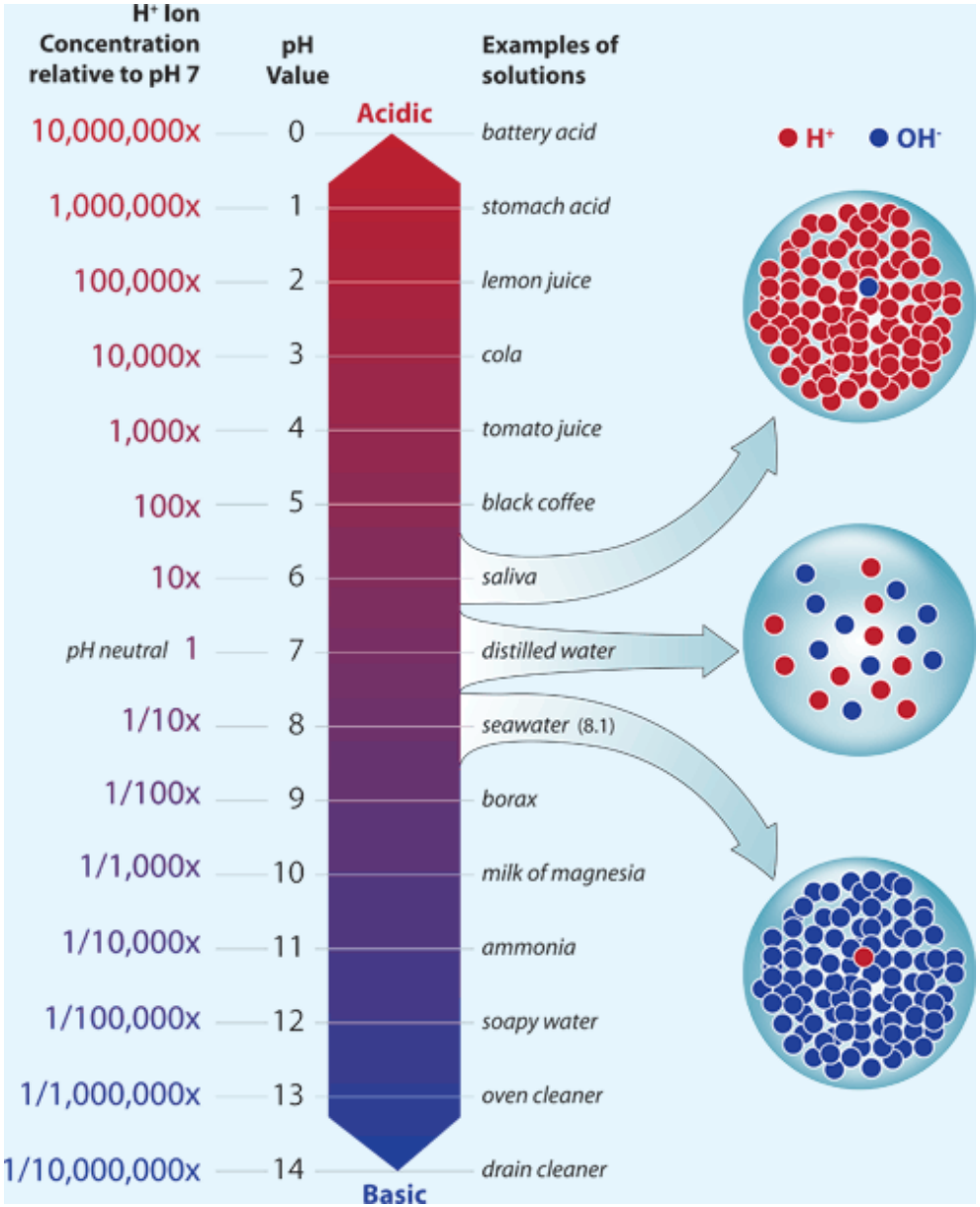
1/3

What happens when CO_2 enters seawater?

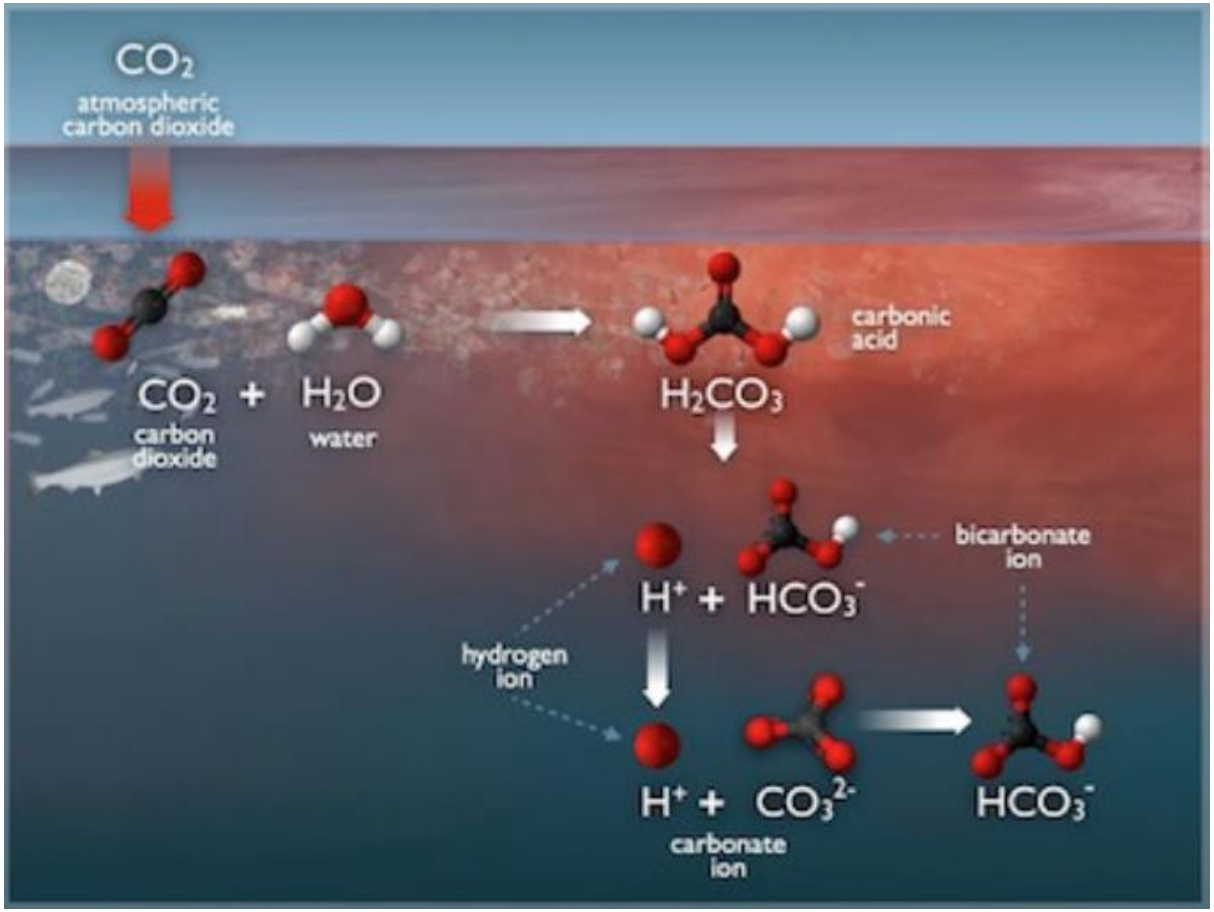
pH decreases
(Ocean acidification)

Acids and pH

$$pH = -\log_{10}[H+]$$



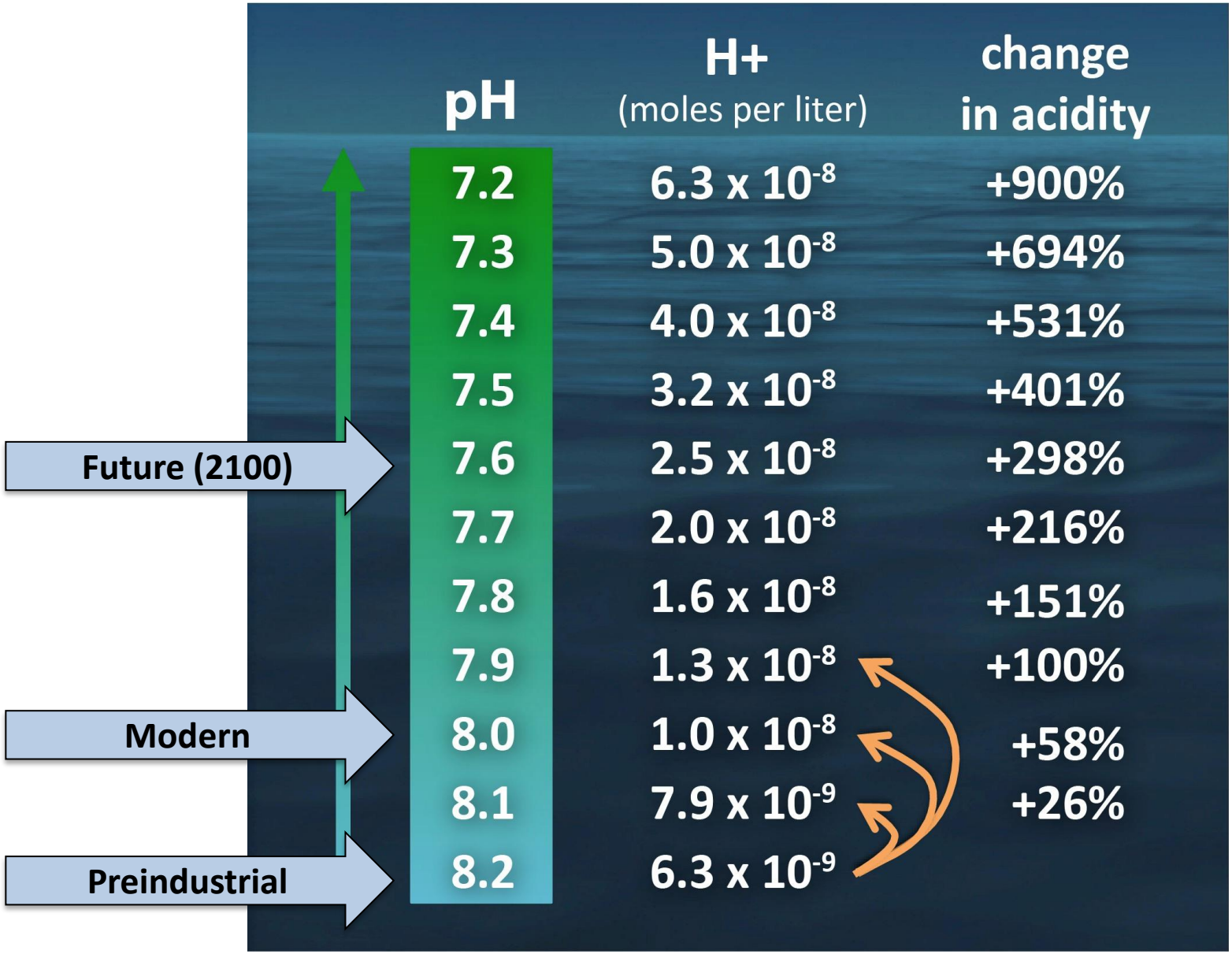
Seawater Carbonate Chemistry



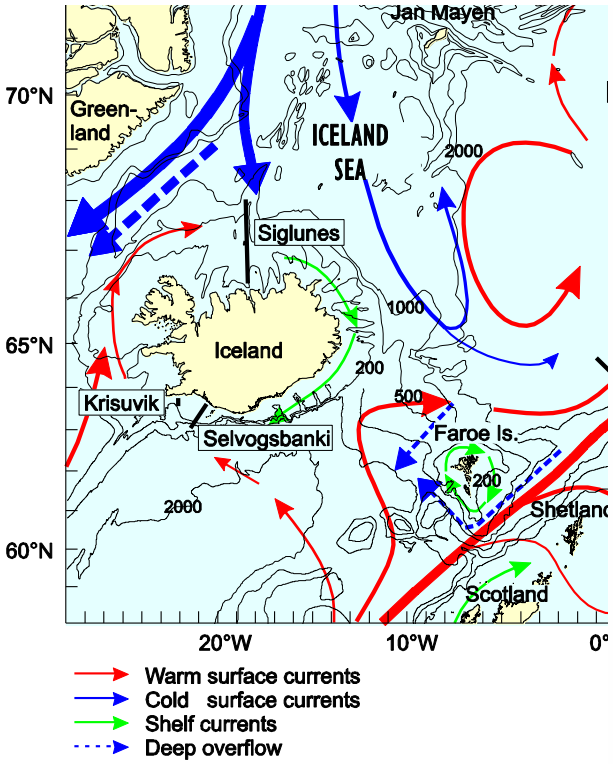
Dissolved Inorganic Carbon (DIC) = CO_2 + HCO_3^- + CO_3^{-2}

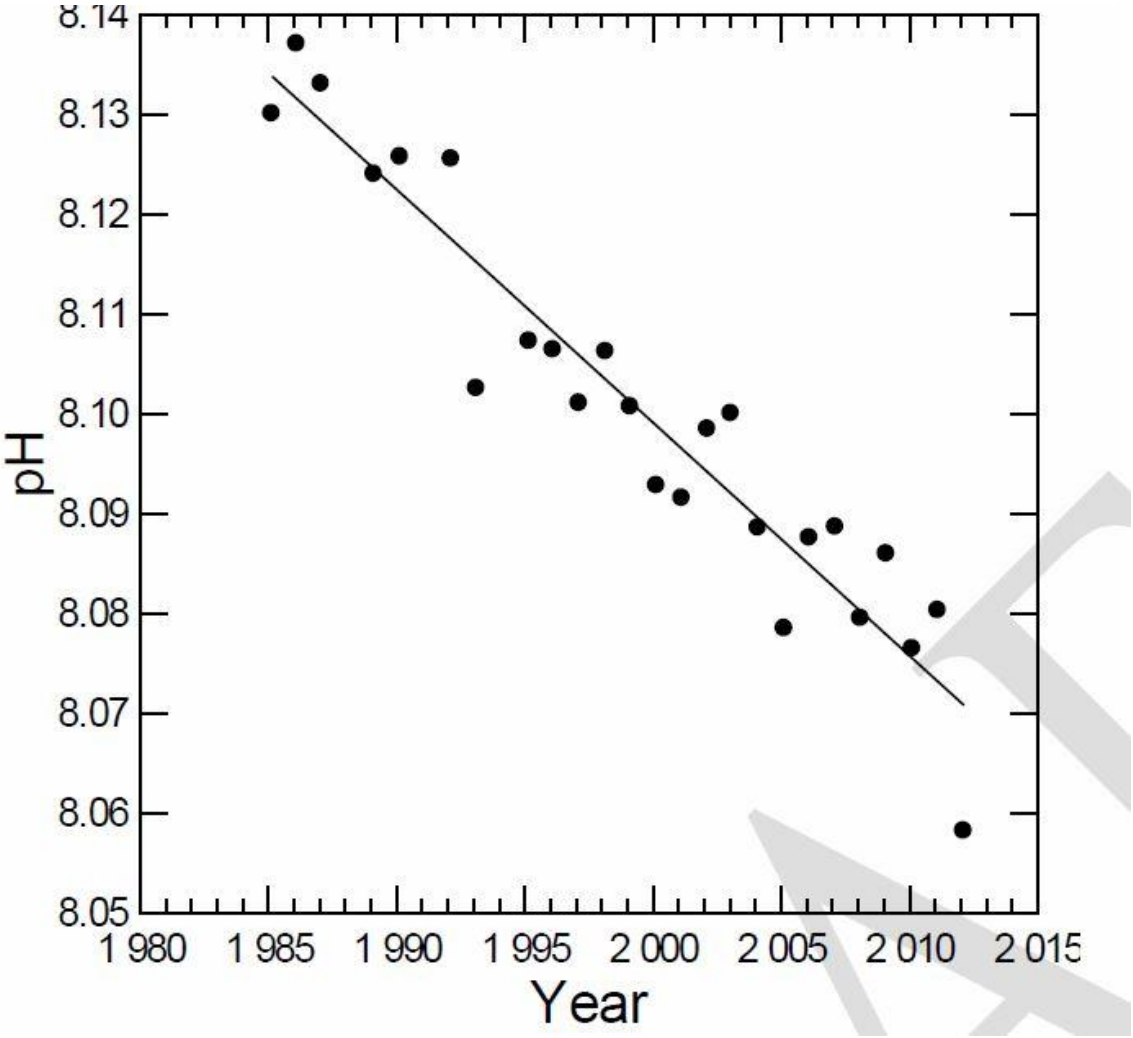
Carbon dioxide + bicarbonate + carbonate

pH and relative changes in acidity

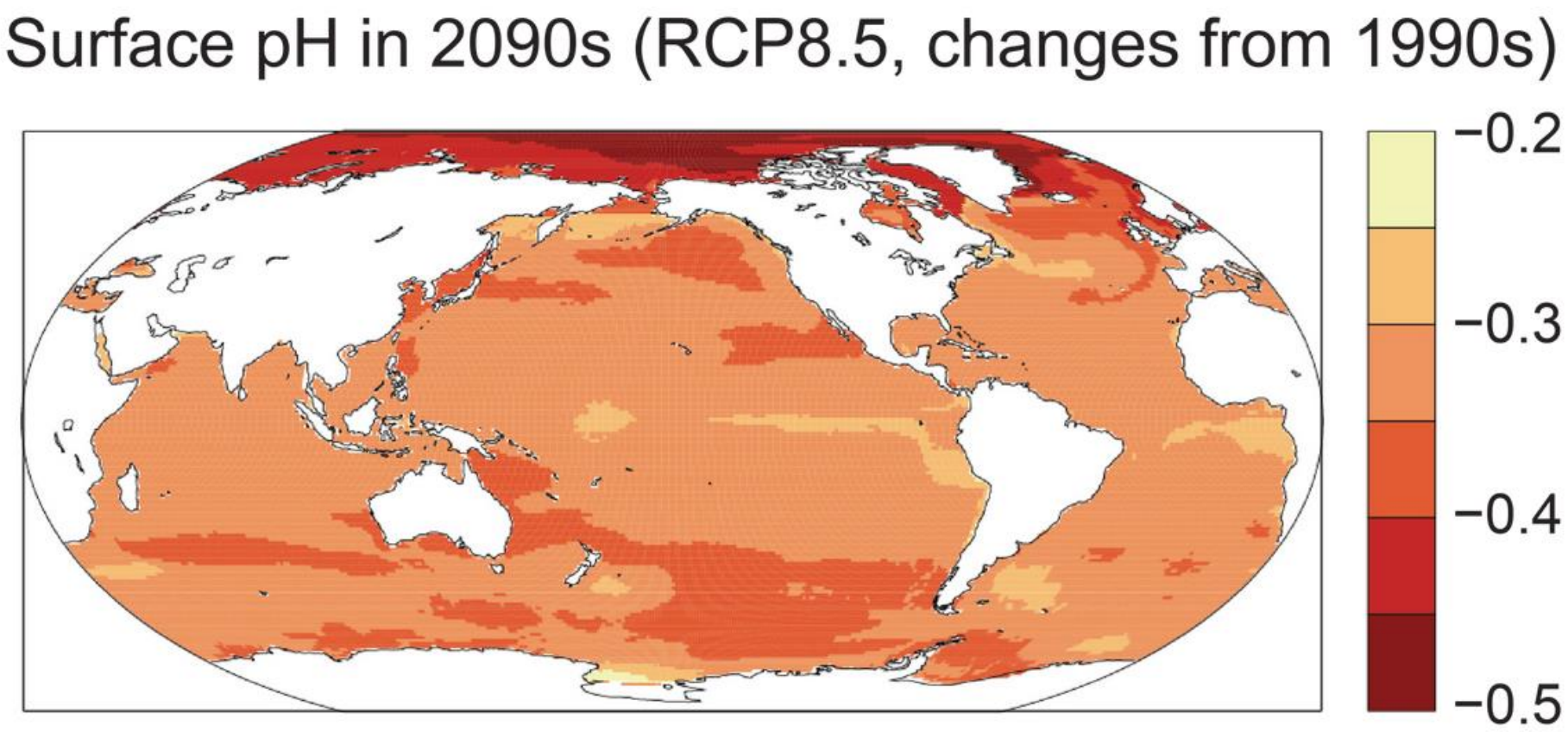


pH í Íslandshavinum





Spatial variability in pH changes



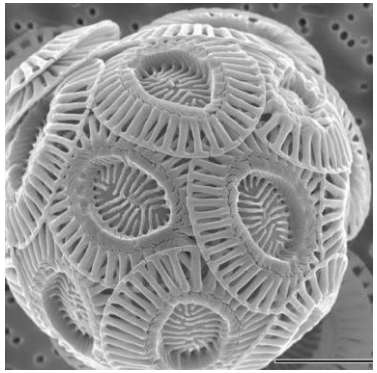
Colder temperatures

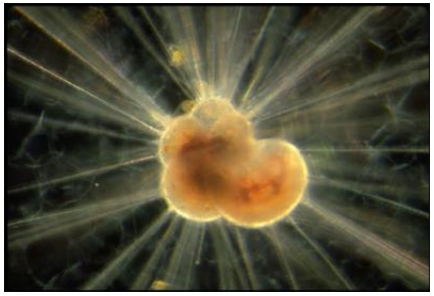
Freshwater input

Impact on Biology ($CaCO_3$)

Impact on Biology ($CaCO_3$)

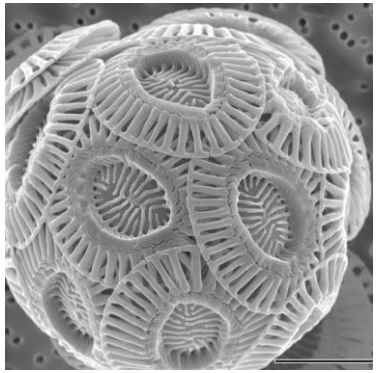
Marine plankton – base of marine ecosystem on which all life depends

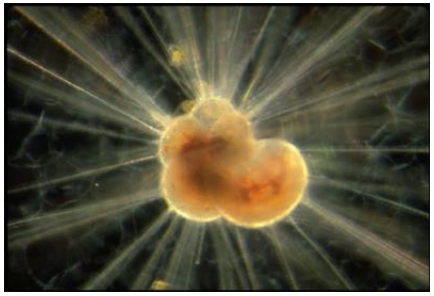




Impact on Biology ($CaCO_3$)

Marine plankton – base of marine ecosystem on which all life depends

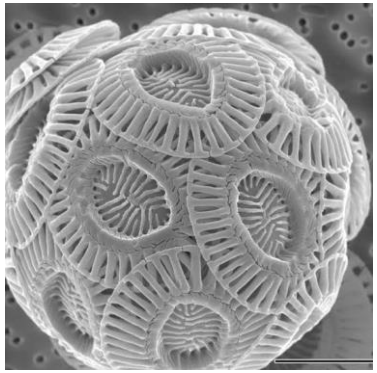


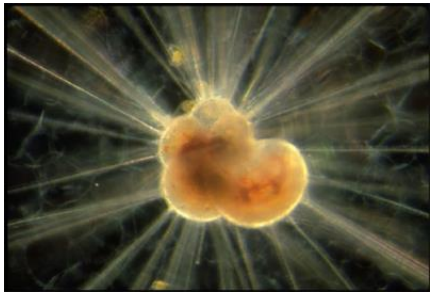


Corals – habitats and nursery grounds

Impact on Biology ($CaCO_3$)

Marine plankton – base of marine ecosystem on which all life depends

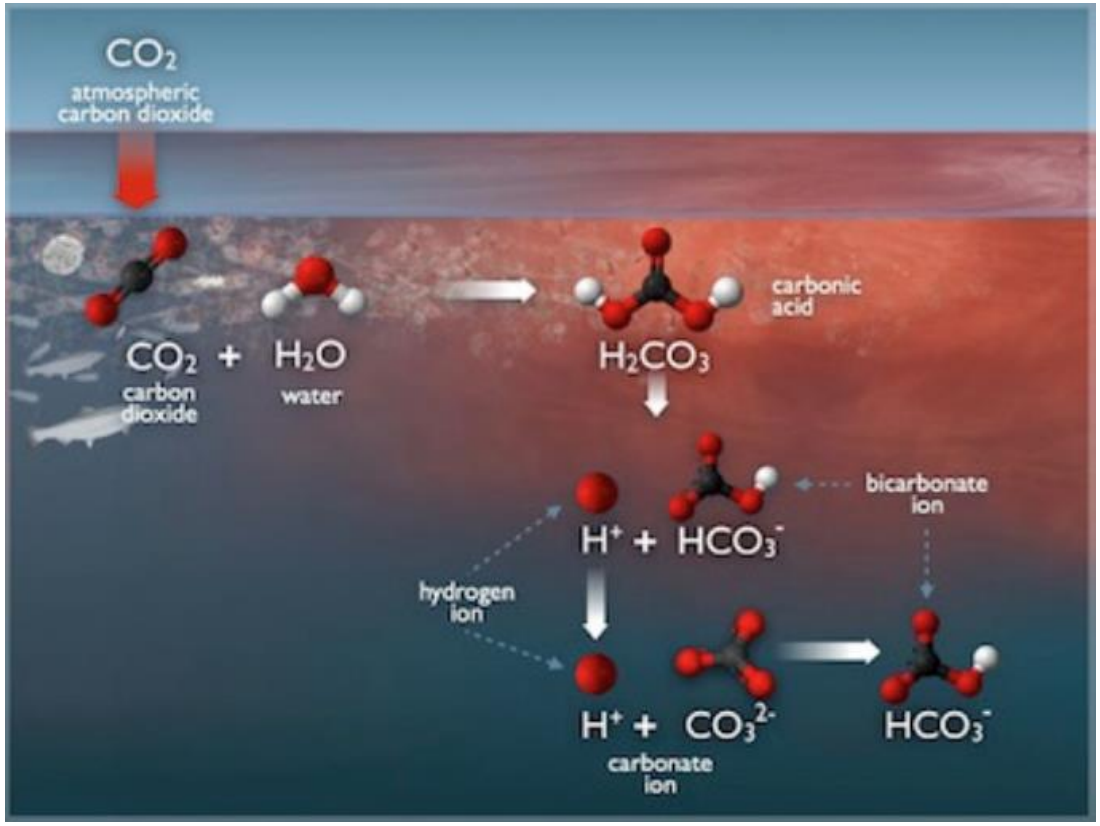




Corals – habitats and nursery grounds

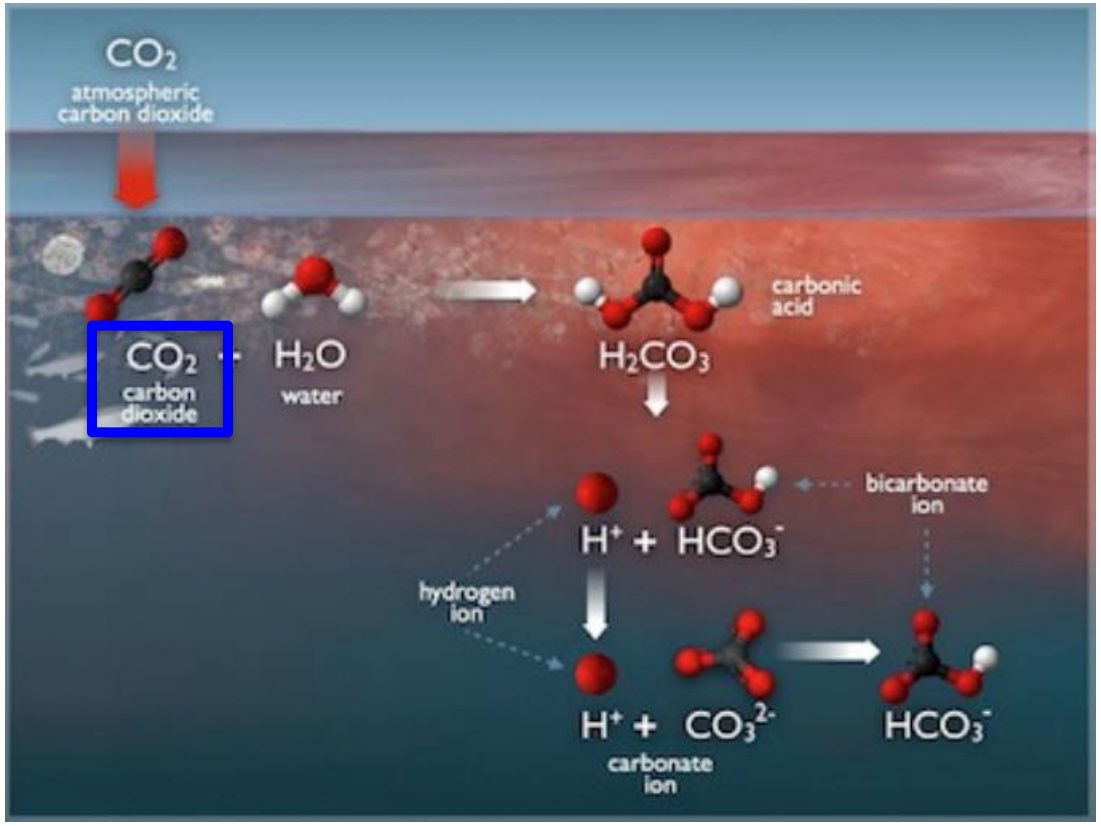
Juvenile fish – prior to gill development

Measuring carbonate system parameters



Measuring carbonate system parameters

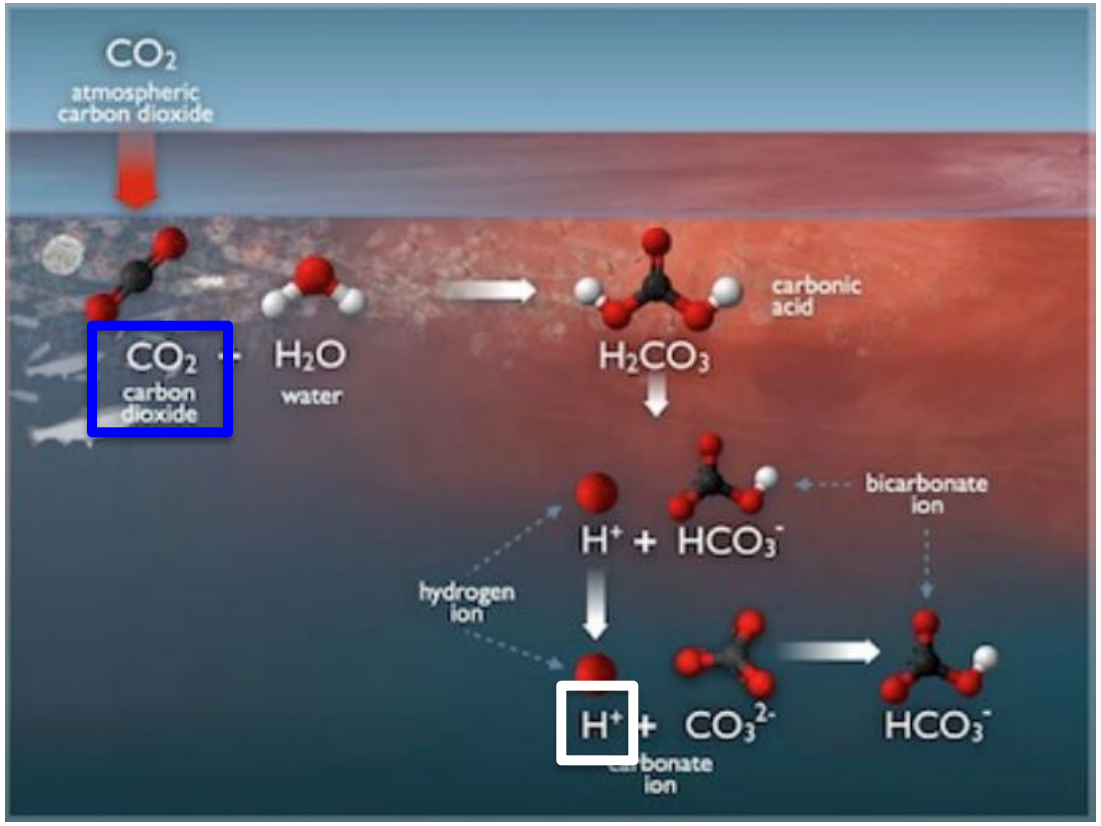
pCO_2



Measuring carbonate system parameters

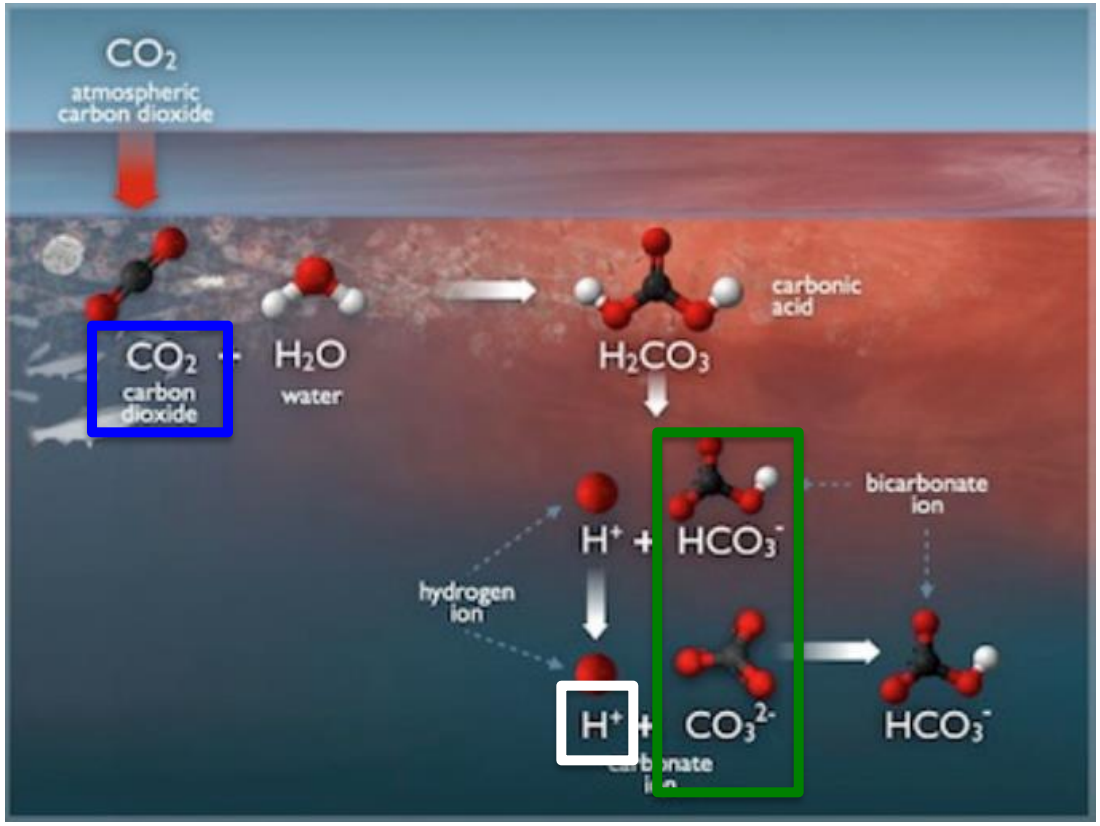
pCO_2

pH



Measuring carbonate system parameters

pCO_2



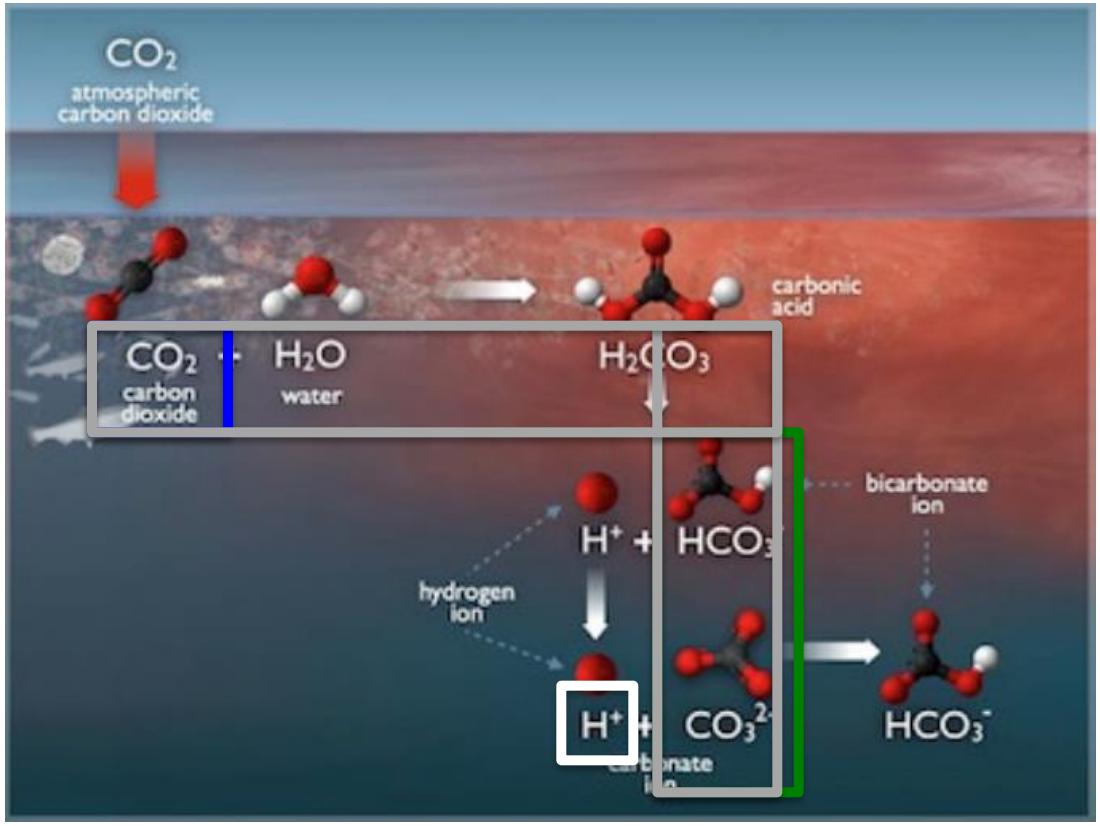
pH

Total Alkalinity

Measuring carbonate system parameters

pCO_2

pH



Total Dissolved Inorganic Carbon

Total Alkalinity

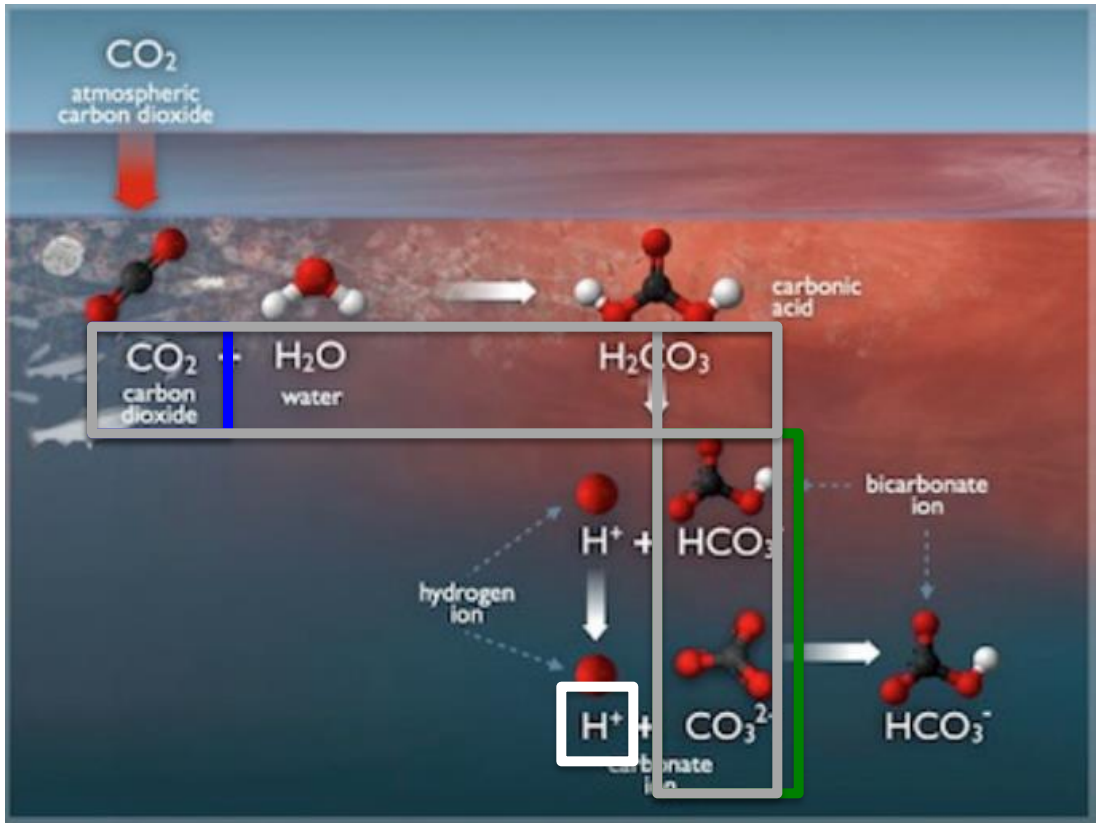
Measuring carbonate system parameters

Determining any two parameters, entire carbonate system can be constrained

(i) Important for analytical uncertainty and data classification by UN (CRM)

(ii) I have changed the measurement strategy at Havstovan

pCO_2



Total Dissolved Inorganic Carbon

Total Alkalinity

pH

Measuring carbonate system parameters

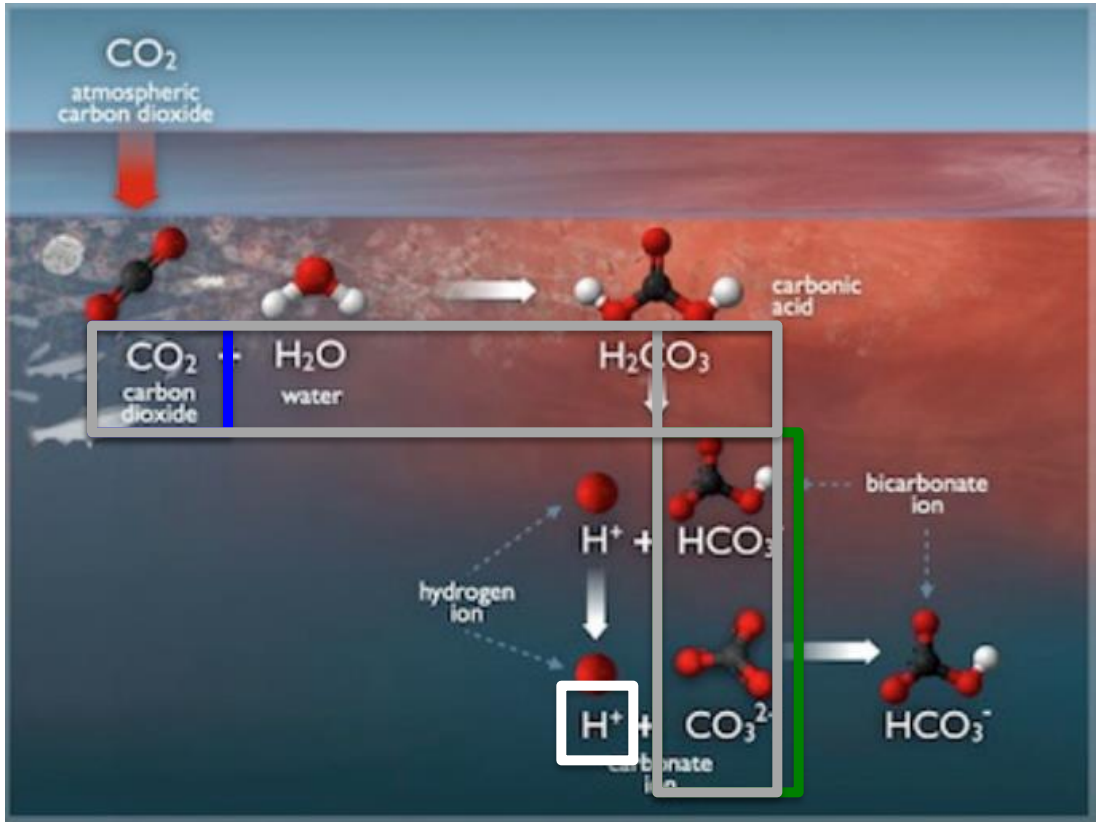
Old measurement strategy abandoned

(i) Complex instrumentation, prone to problems, not time-efficient

(ii) Data quality was sub-standard

pCO_2

pH



Total Dissolved Inorganic Carbon

Total Alkalinity

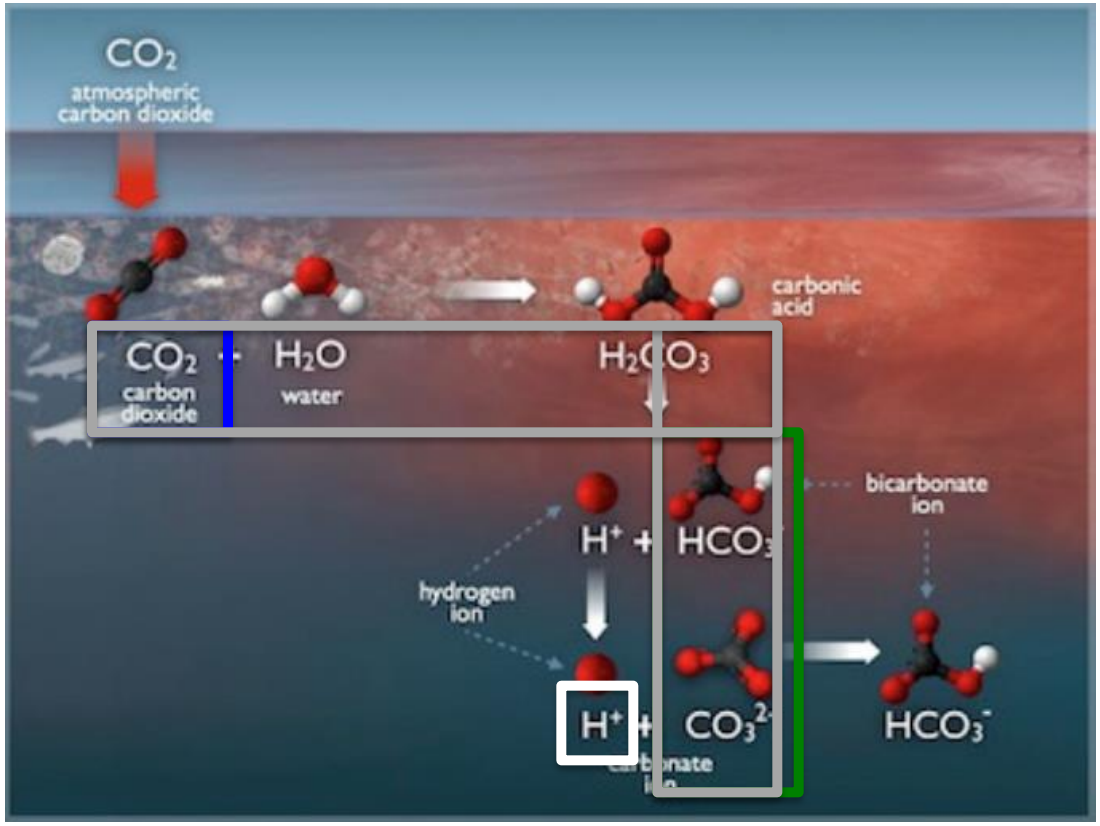
Measuring carbonate system parameters

Old measurement strategy abandoned

(i) Switched to manual determination of Alkalinity and pH

(ii) Sustainable and better data quality.

pCO_2



Total Dissolved Inorganic Carbon

pH

Total Alkalinity

Sustainable Development Goals Indicator SDG14.3.1

Category:	**1. Climate**	**2. Weather**	**3. Undefined**
	Specalist labs	Competent labs	Capacity-building

Sustainable Development Goals Indicator SDG14.3.1

Category:	**1. Climate**	**2. Weather**	**3. Undefined**
	Specalist labs	Competent labs	Capacity-building
Alkalinity	2 µmol kg^{-1} (0.1%)	10 µmol kg^{-1} (0.4%)	>10 µmol kg^{-1}
DIC	2 µmol kg^{-1} (0.1%)	10 µmol kg^{-1} (0.5%)	>10 µmol kg^{-1}
pH	<0.003 (0.04%)	<0.02 (0.25%)	>0.002

Sustainable Development Goals Indicator SDG14.3.1

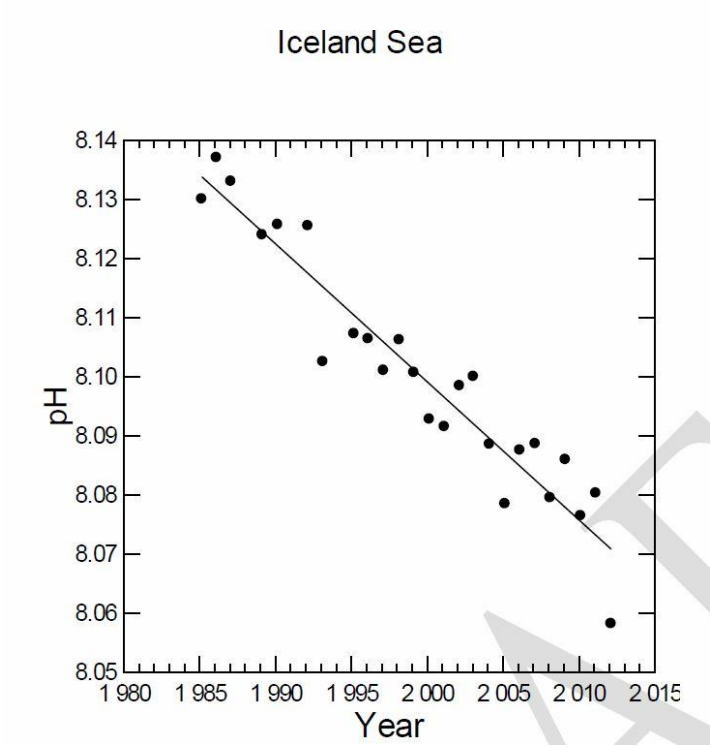
Category:	**1. Climate**	**2. Weather**	**3. Undefined**
	Specalist labs	Competent labs	Capacity-building
Alkalinity	2 µmol kg^{-1} (0.1%)	10 µmol kg^{-1} (0.4%)	>10 µmol kg^{-1}
DIC	2 µmol kg^{-1} (0.1%)	10 µmol kg^{-1} (0.5%)	>10 µmol kg^{-1}
pH	<0.003 (0.04%)	<0.02 (0.25%)	>0.002
Old Alkalinity			**25 µmol kg^{-1} (1.1%)**
Old DIC			**11 µmol kg^{-1} (0.11%)**

Sustainable Development Goals Indicator SDG14.3.1

Category:	**1. Climate**	**2. Weather**	**3. Undefined**
	Specalist labs	Competent labs	Capacity-building
Alkalinity	2 µmol kg^{-1} (0.1%)	10 µmol kg^{-1} (0.4%)	>10 µmol kg^{-1}
DIC	2 µmol kg^{-1} (0.1%)	10 µmol kg^{-1} (0.5%)	>10 µmol kg^{-1}
pH	<0.003 (0.04%)	<0.02 (0.25%)	>0.002
Old Alkalinity			**25 µmol kg^{-1} (1.1%)**
New Alkalinity		**2.5 µmol kg^{-1} (0.11%)**	
Old DIC			**11 µmol kg^{-1} (0.11%)**
New pH	**0.0026 (0.03%)**		

Sustainable Development Goals Indicator SDG14.3.1

Long-term monitoring required – multi-decadal required to accurately report trends in ocean acidification

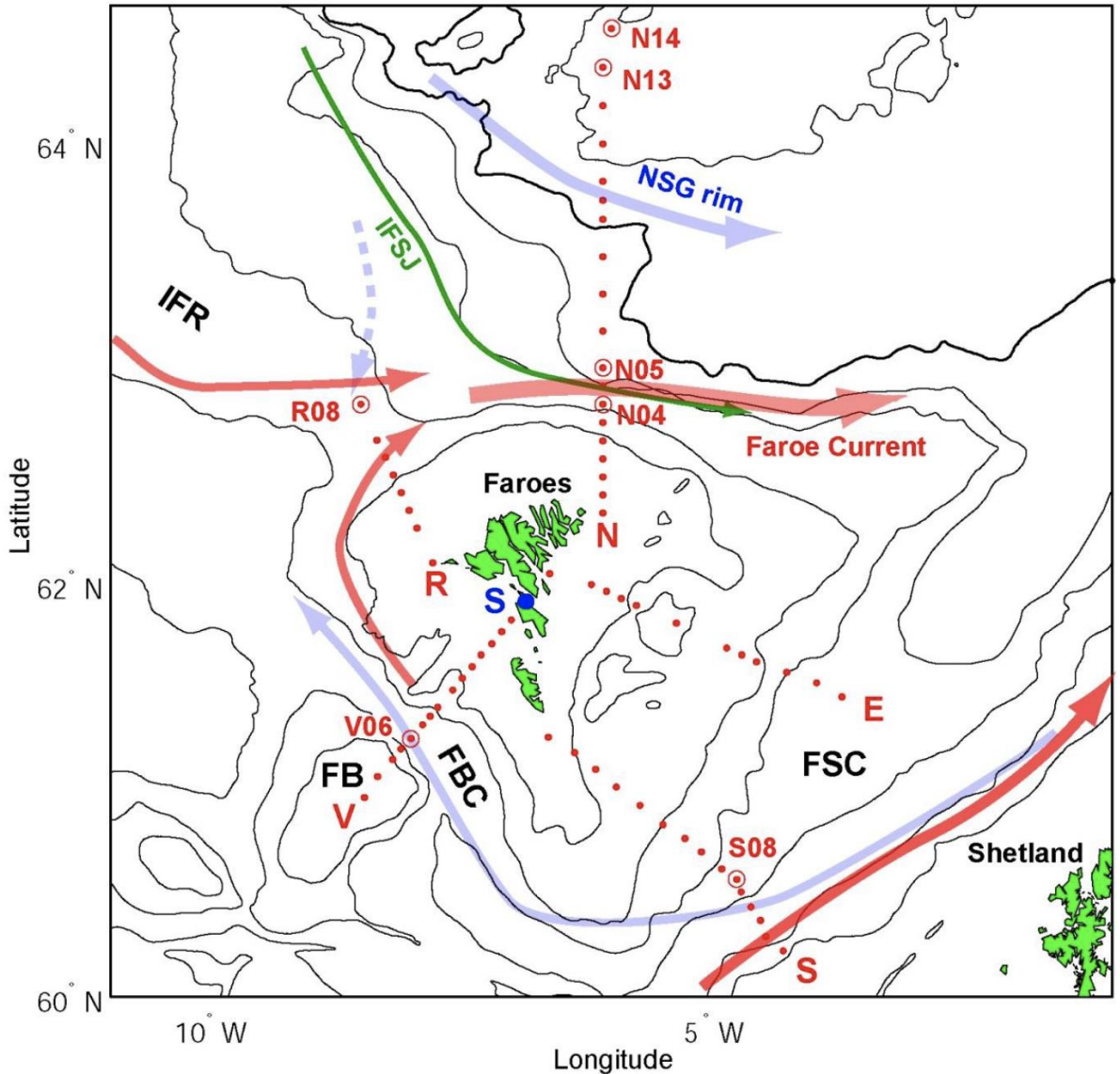


0.0017 – 0.0027 pH units per year

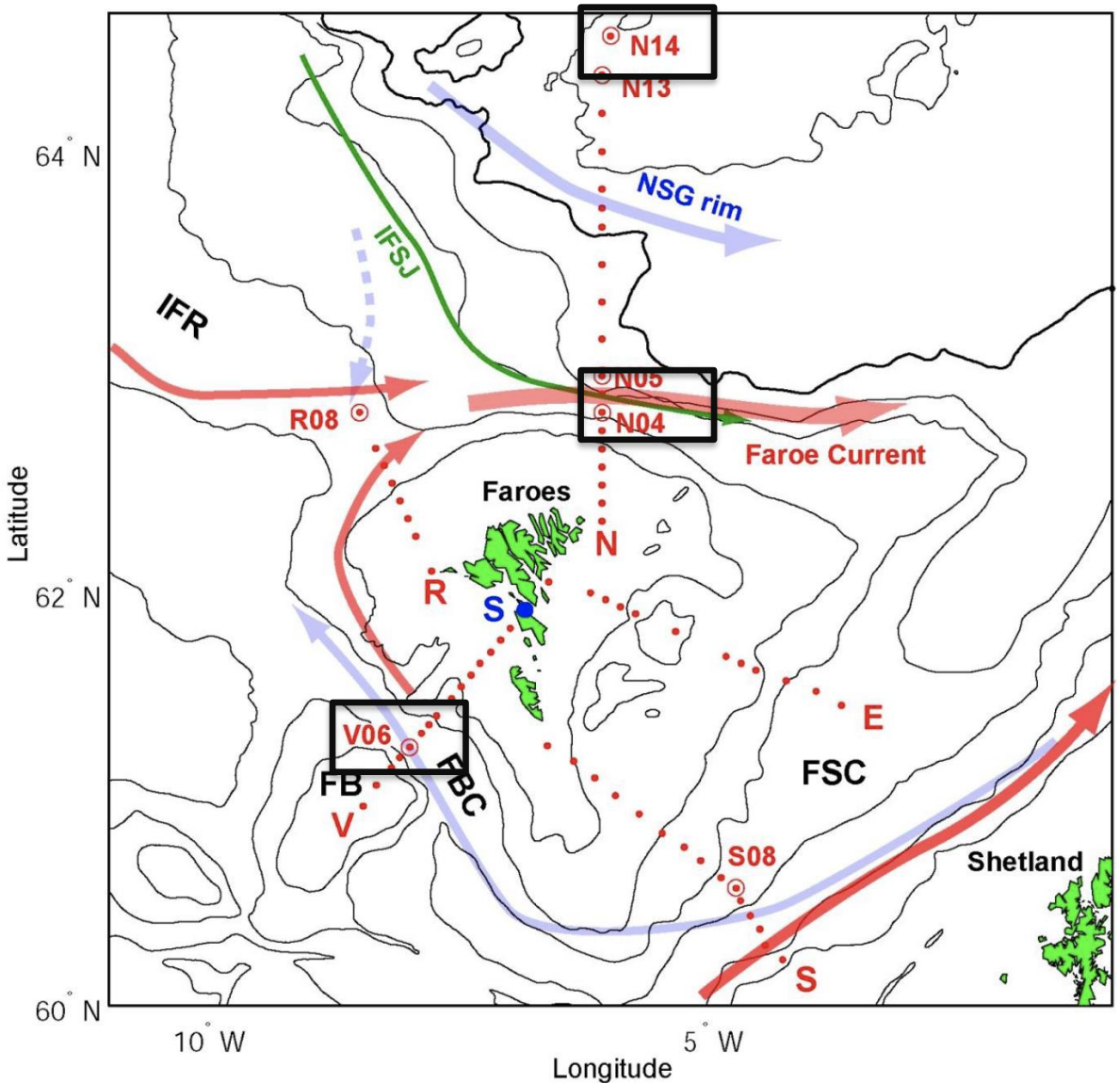
Change of 0.04% per year

Uncertainty estimates 0.03% per year

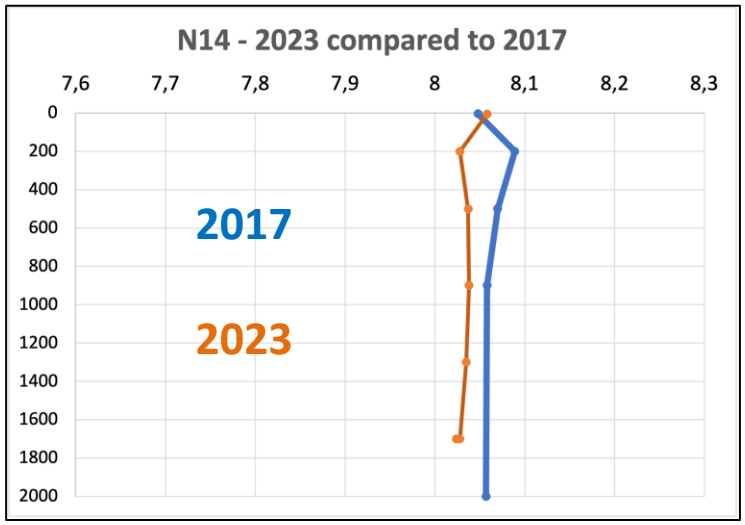
Faroese Sampling strategy

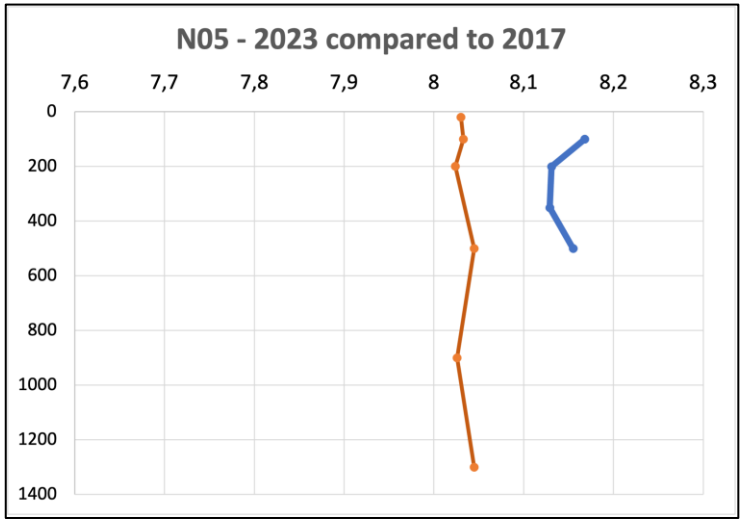


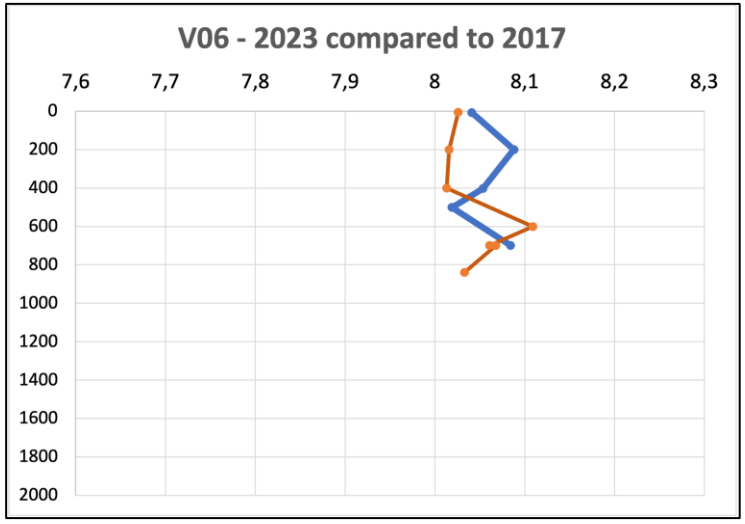
Faroese Sampling strategy



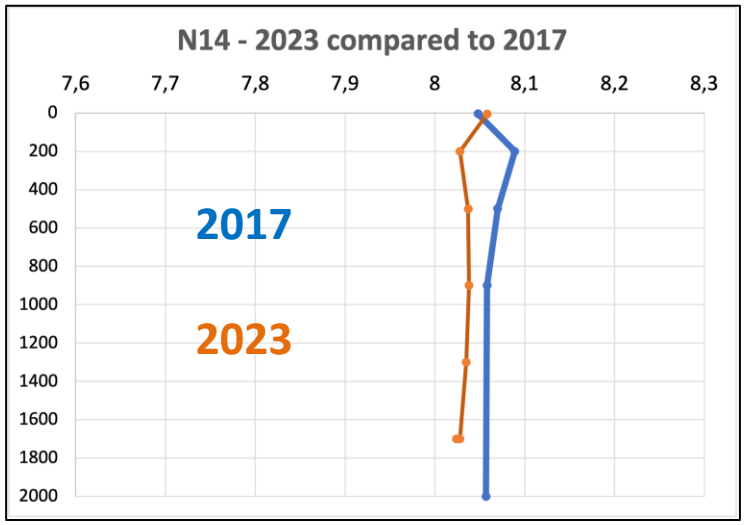
Detectable changes in Faroese waters - winter

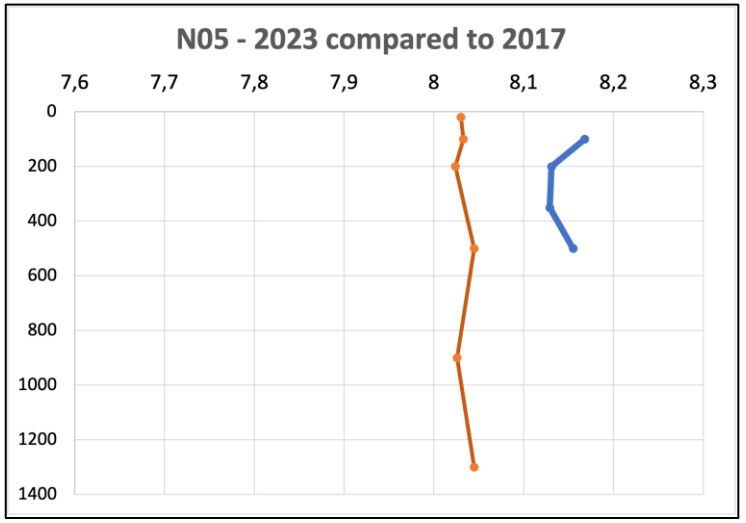


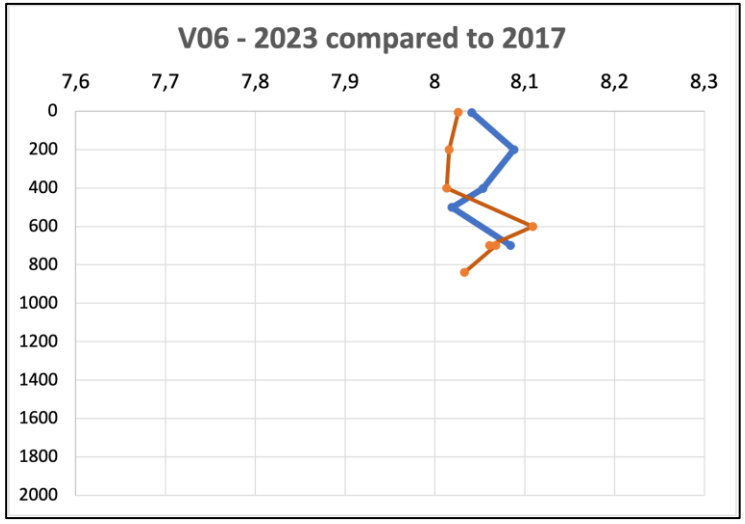




Detectable changes in Faroese waters - winter







Station	Year	pH	Change
N05.	2017	8.146	
	2023	8:034	0.11% / yr
N14	2017	8.064	
	2023	8:037	0.05% / yr
V06	2017	8.062	
	2023	8.046	0.03% / yr

Indicator SDG14.3.1 marine pH

Summary

Ocean acidfication resulting from climate change is a pressure on marine systems

Developmed methods that meet SDG14.3.1 data requirements

Preliminary analyses show acidification progressing in Faroese waters at expected rate

Recommendations

Measurements in shelf waters required – many more measurements needed

Investment in newer technologies required