

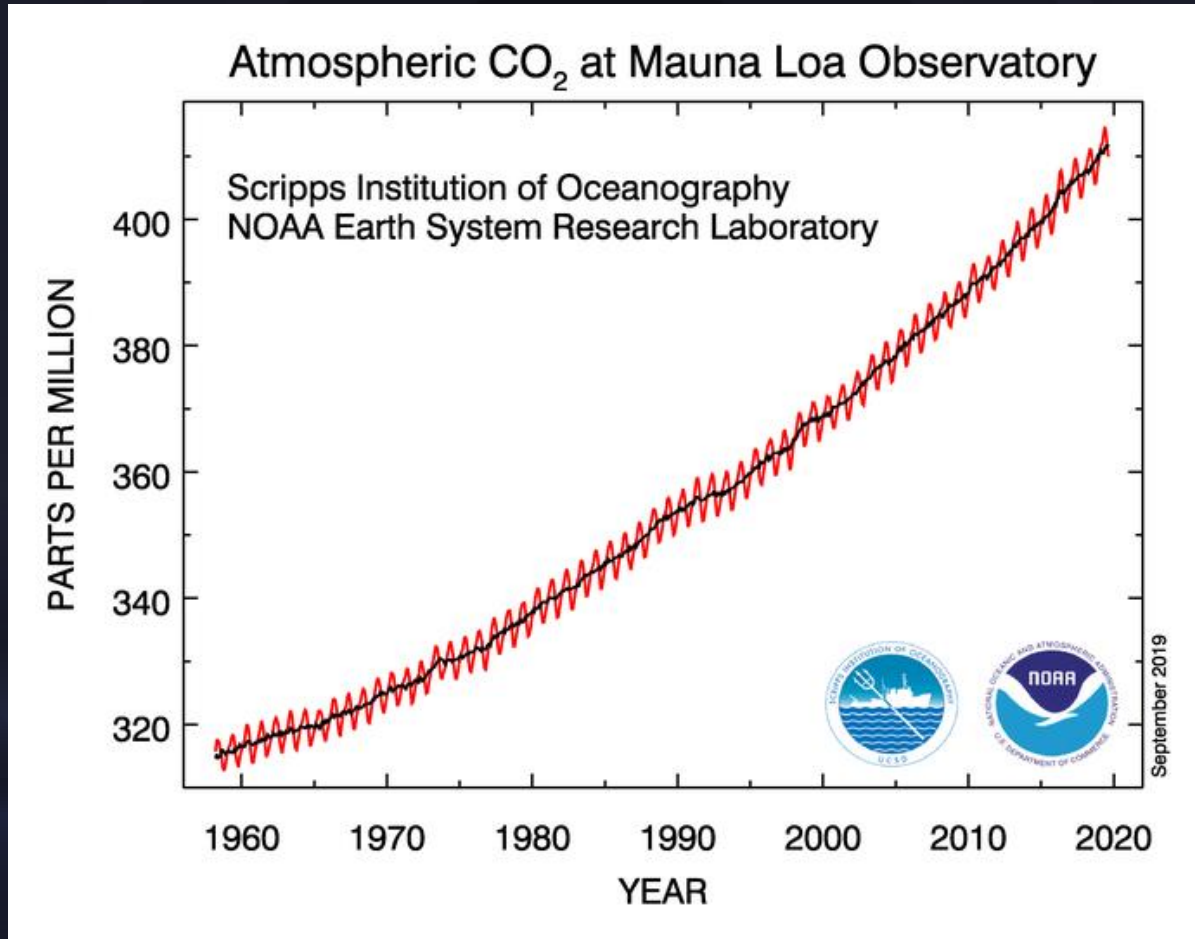
An underwater photograph of a coral reef. The water is clear and blue, with sunlight filtering through the surface, creating a dappled light effect on the coral below. The coral appears to be a mix of hard and soft corals, with various textures and colors ranging from light green to brown.

OCEAN ACIDIFICATION: PERSPECTIVE WITH MOHID

Marta López Mozos- MARETEC (IST)

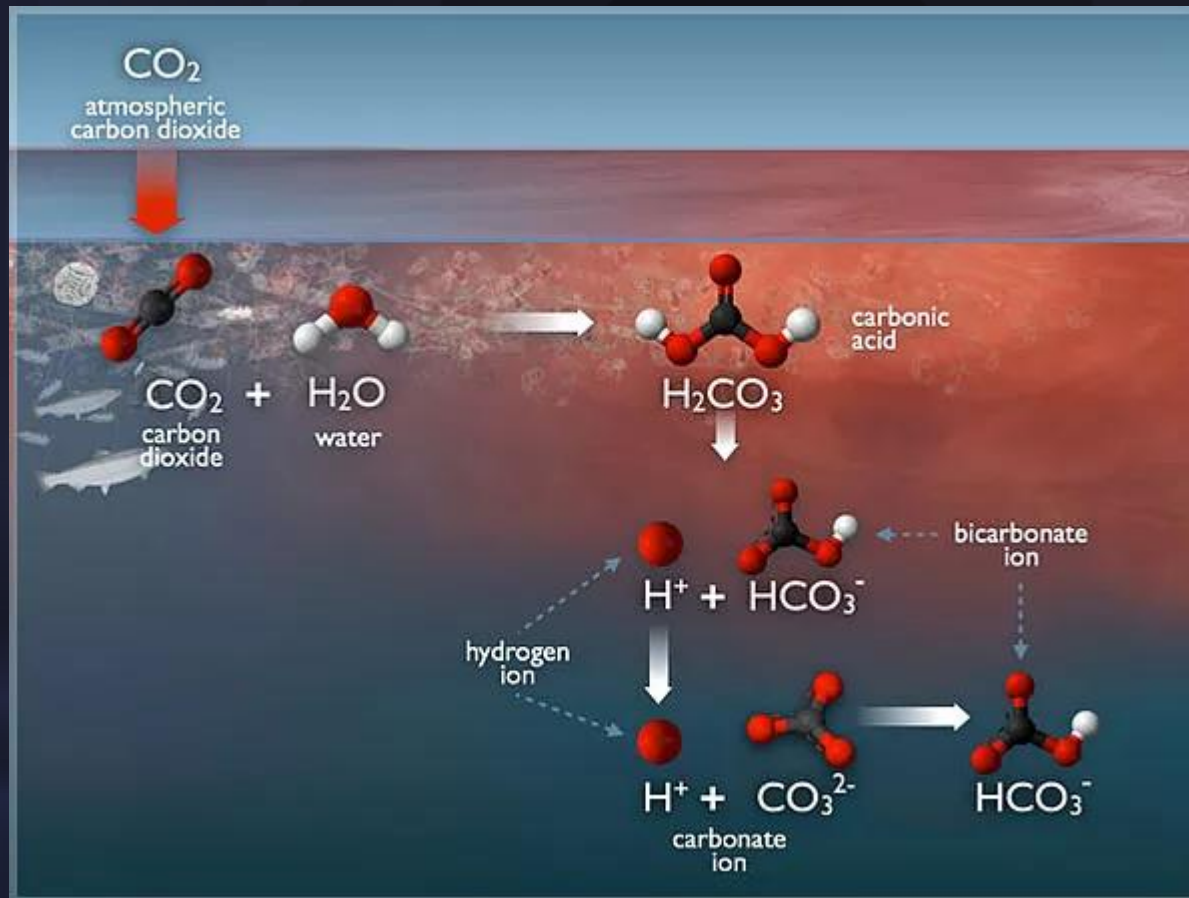
MOHIDing
11th and 12th December 2019, Lisbon

Atmospheric carbon dioxide

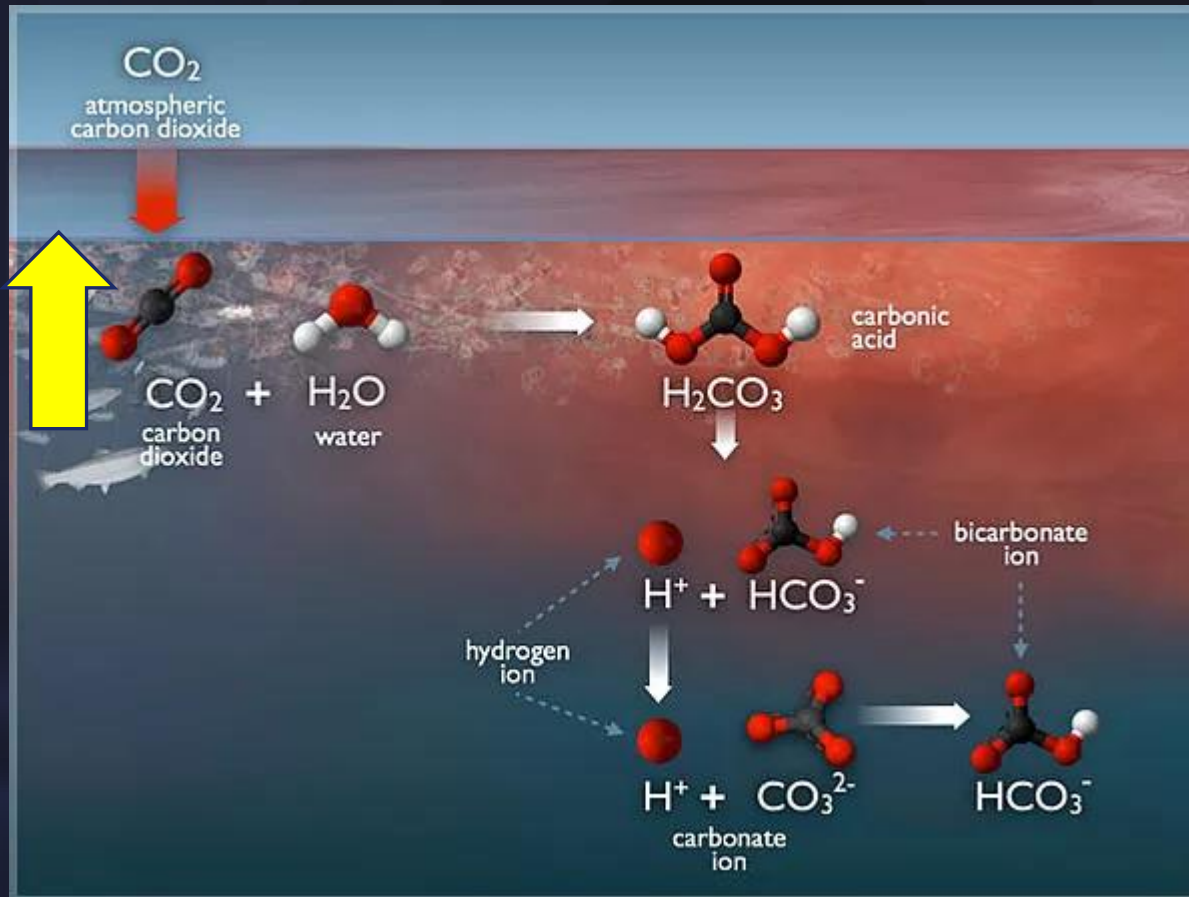


NOAA, 2019

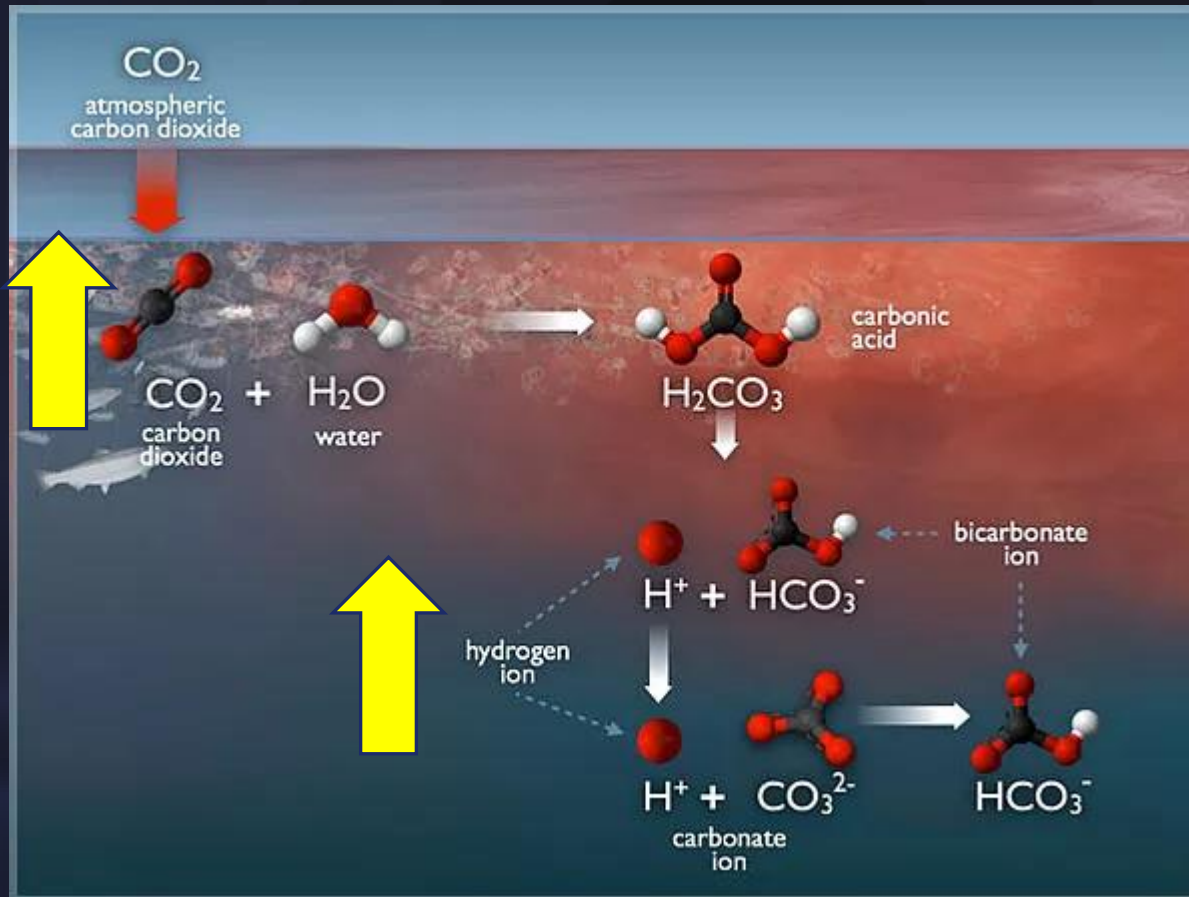
CO₂ in seawater



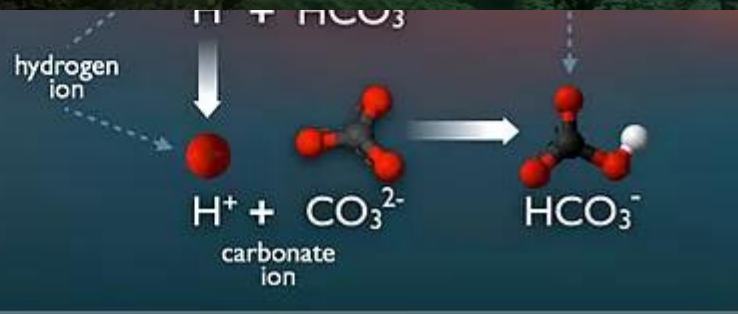
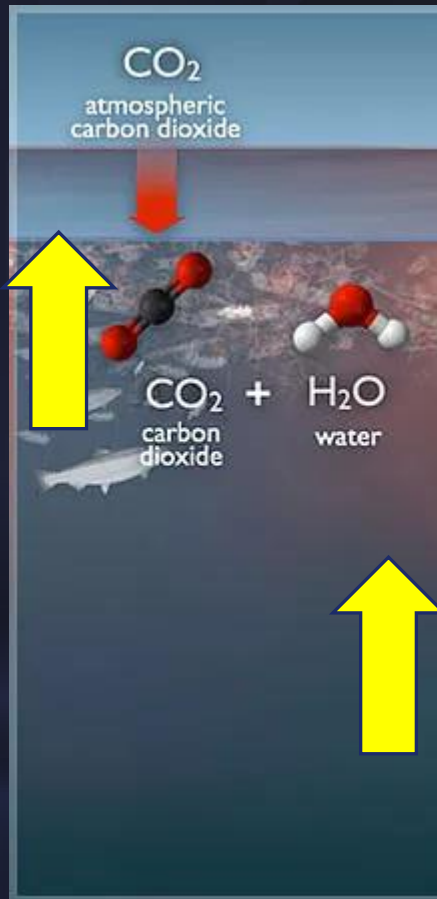
CO₂ in seawater



CO₂ in seawater

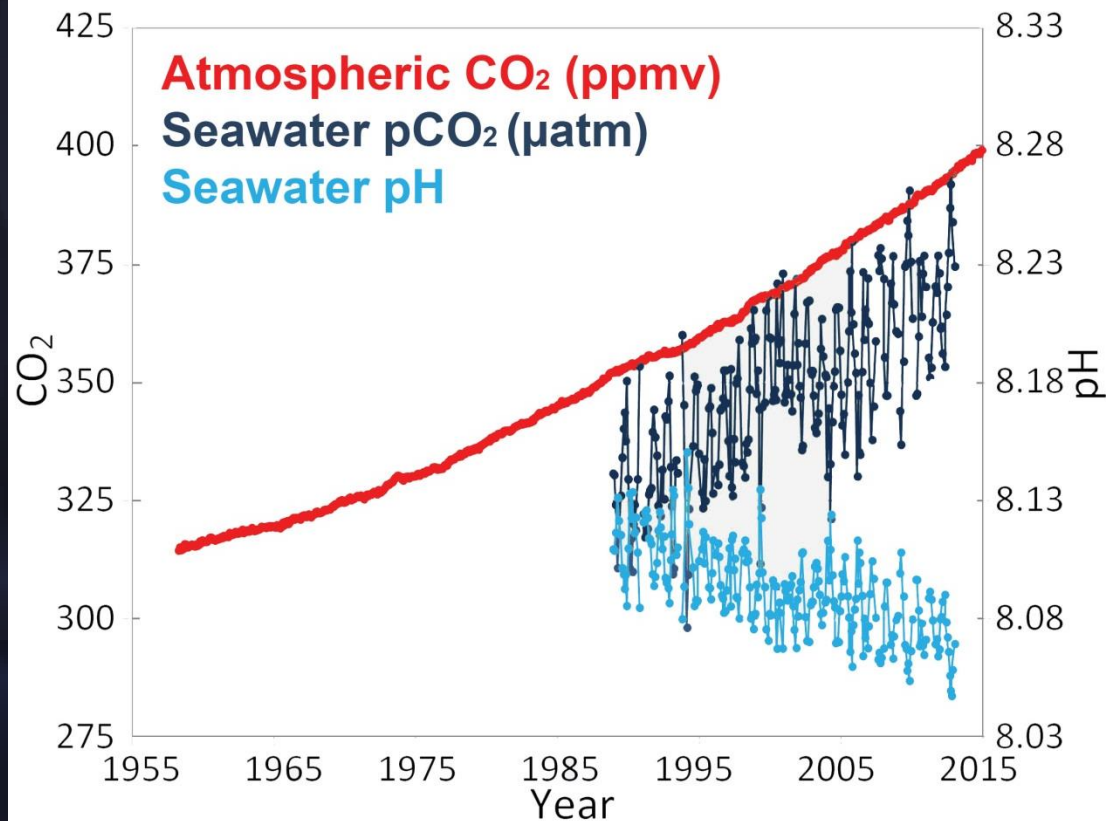


CO₂ in seawater

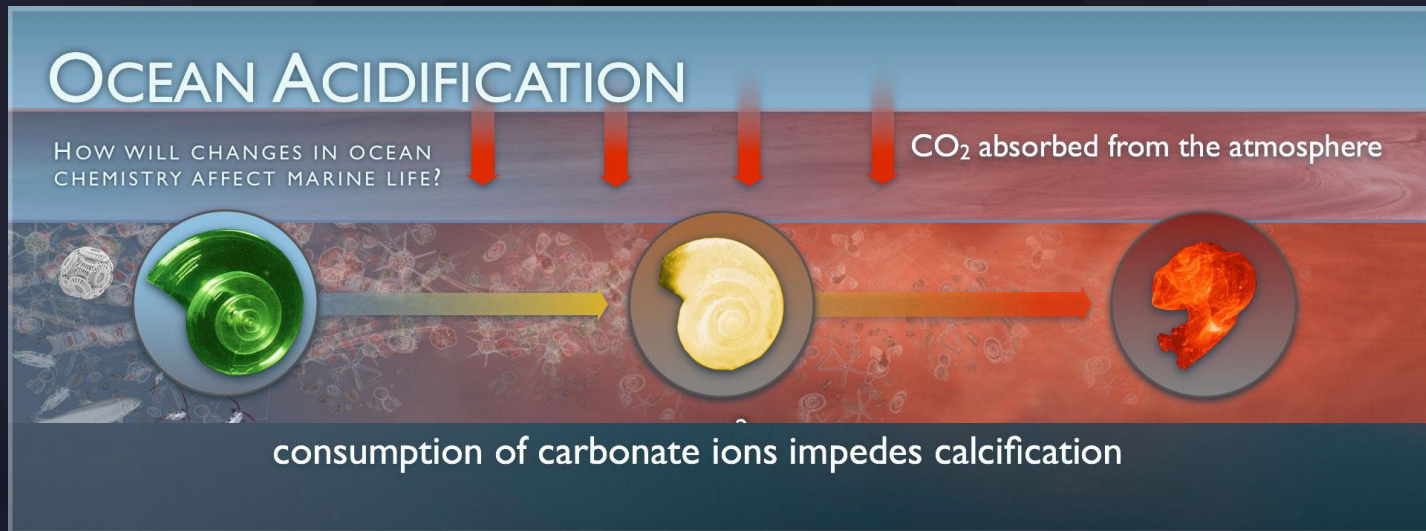


Ocean acidification

Time series of carbon dioxide and ocean pH at Mauna Loa, Hawaii



Ocean acidification and calcification



Modified from Ocean Acidification
program, NOAA, 2019

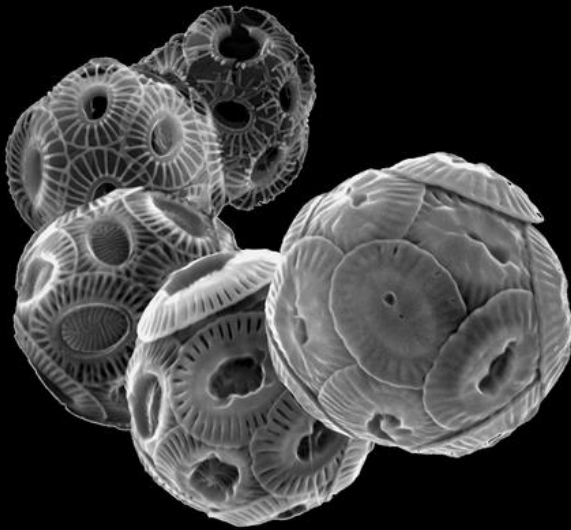
Ocean acidification and calcification

OCEAN ACIDIFICATION

HOW WILL CHANGES IN OCEAN
CHEMISTRY AFFECT MARINE LIFE?

CO₂ absorbed from the atmosphere

Acidification impedes calcification

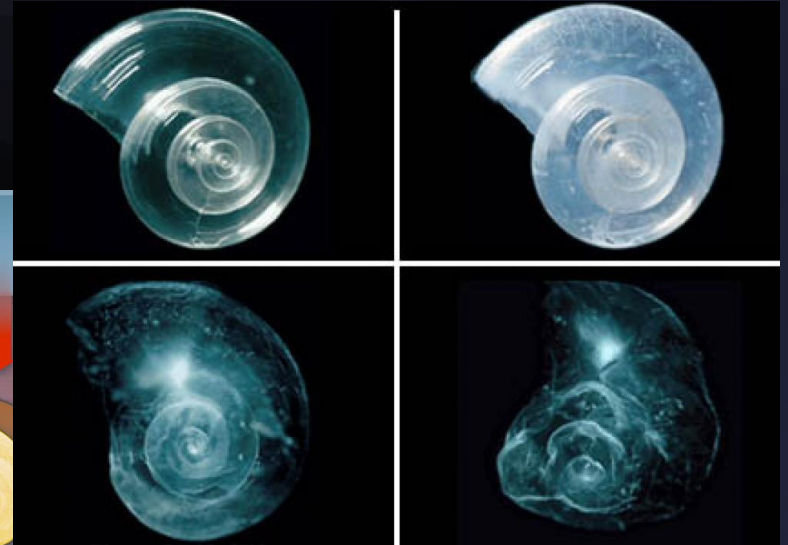


Modified from Ocean Acidification
program, NOAA, 2019

Ocean acidification and calcification

OCEAN ACIDIFICATION

HOW WILL CHANGES IN OCEAN
CHEMISTRY AFFECT MARINE LIFE?



tion

How we model this process?



CO₂ in seawater

- CO₂ seawater system = four parameters
 - Alkalinity
 - DIC (Dissolved Inorganic Carbon)
 - pCO₂/fCO₂ (Partial pressure of CO₂/fugacity)
 - pH

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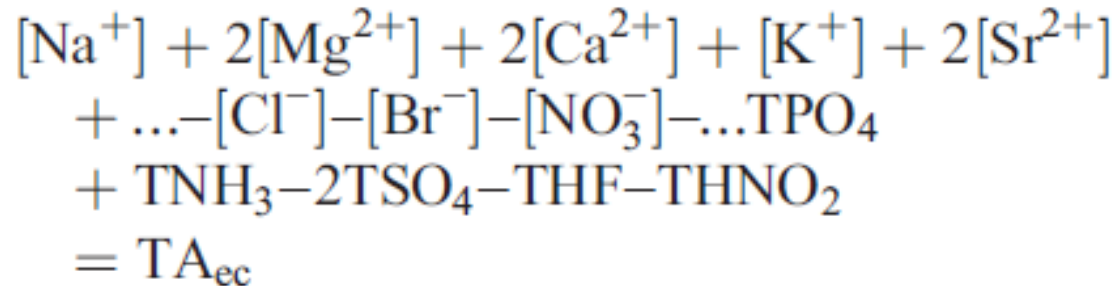
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$$\text{DIC} \equiv \Sigma\text{CO}_2 = [\text{CO}_2] + [\text{HCO}_3^-] + [\text{CO}_3^{2-}]$$

CO₂ in seawater

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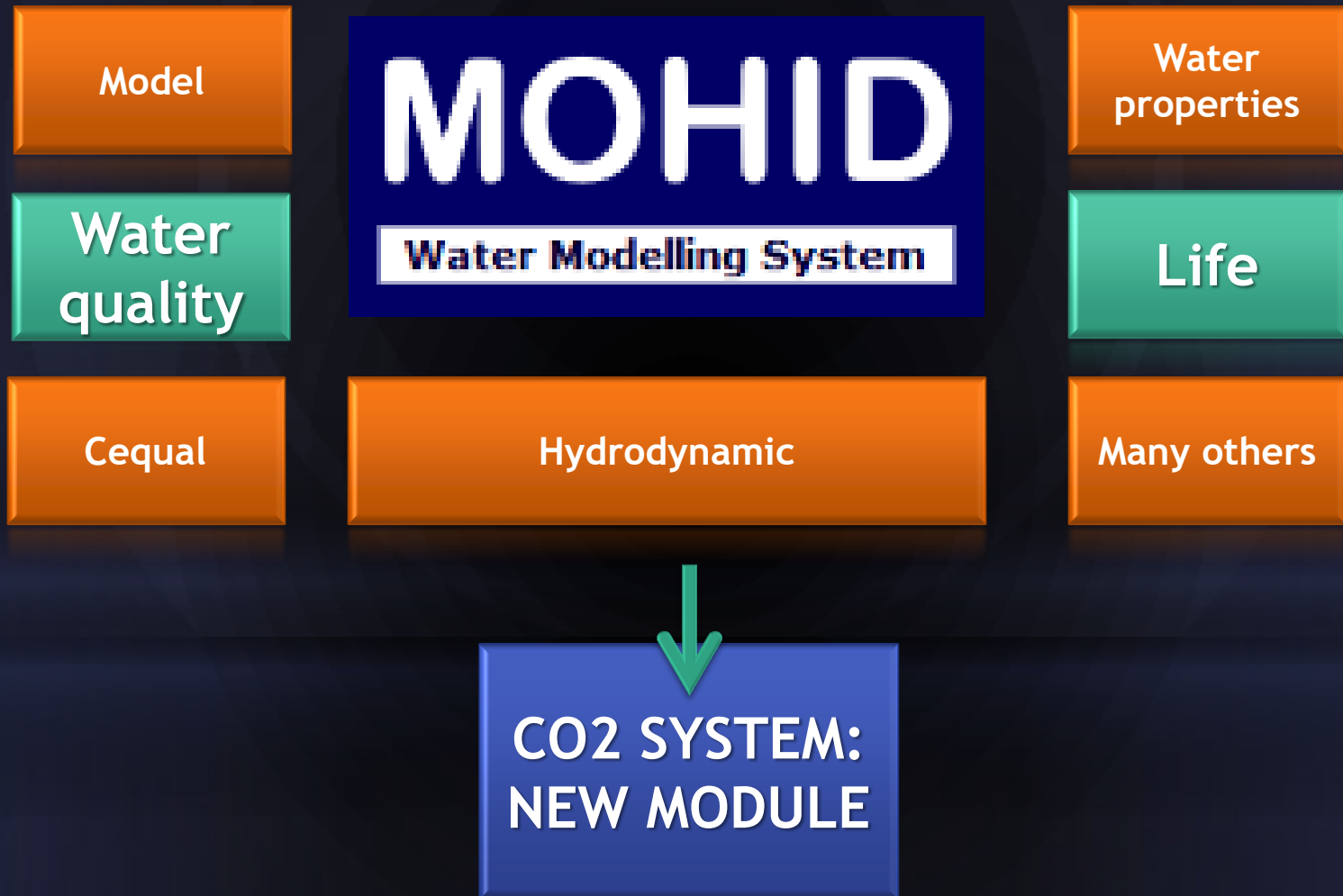
MOHID Water



MOHID water

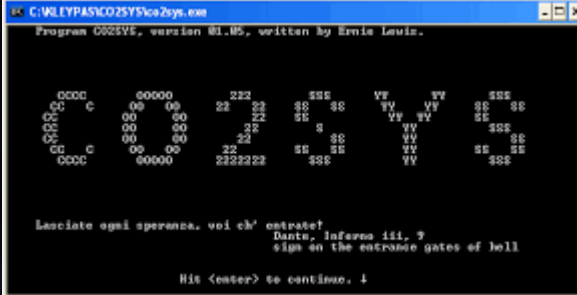


MOHID water



CO2 system: new module

- Two master variables
 - Alkalinity
 - DIC
- Calcium carbonate dissolution and precipitation
- Support of CO2Sys program (Lewis et al., 1998)



```
C:\WLEYPAS\CO2SYS\co2sys.exe
Program CO2SYS, version 01.05, written by Ernie Lewis.

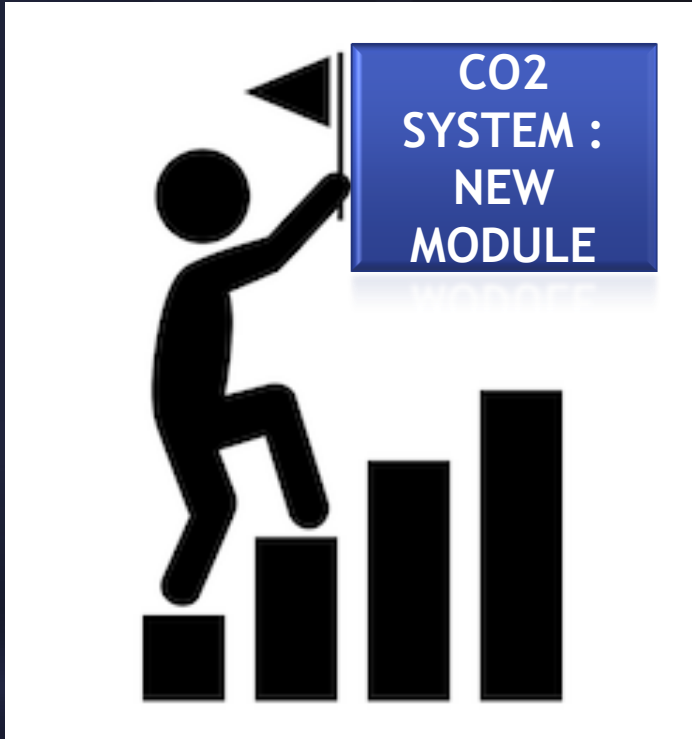
      CCCC      00000      222      $$$      VV      VV      $$$
    CC  C      00  00      22  22  $S  $S  VV  VV  $S  $S
    CC      00  00      22  22  $S  $S  VV  VV  $S  $S
    CC      00  00      22  22  $S  $S  VV  VV  $S  $S
    CC  C      00  00      22  22  $S  $S  VV  VV  $S  $S
    CCCC      00000      2222222  $$$      VV      VV      $$$

Lasciate ogni speranza, voi ch' entrate!
Dante, Inferno iii, 7
sign on the entrance gates of hell

Hit <enter> to continue, 4
```

- Expected outputs: alkalinity, DIC, pH, pCO2, between many others

CO2 system module: accurate and challenges



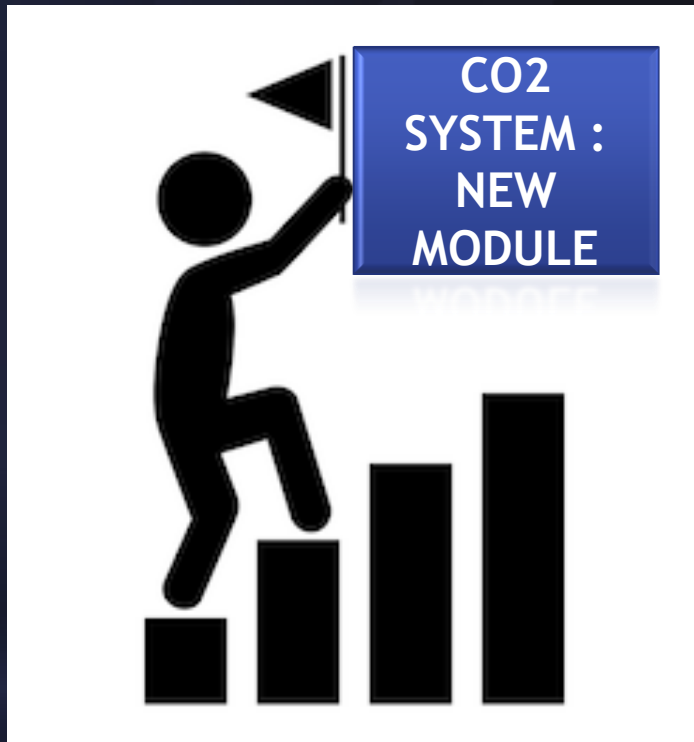
INPUTS FOR THE MODULE:

- Chemical constants depend on temperature and pressure and are high sensitives.
- WATER QUALITY module doesn't model CO2.

PROGRAMMING DIFFICULTIES:

- New cycles: calcium carbonate precipitation and dissolution. Sulphure cycle ? Improvement of Water Quality?
- Construction of a new module, dependent on other modules
- To add CO2Sys program
- New module = low computational cost

CO2 system module: accurate and challenges



CO2 system module: forcings and initial conditions



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Providing PRODUCTS and SERVICES for all marine applications

Ocean Monitoring Indicators (OMI)

Track the changes in the ocean associated with climate change



Ocean Acidification
(Seawater pH)



Ocean Heat



Sea Level
including
Thermosteric Rise

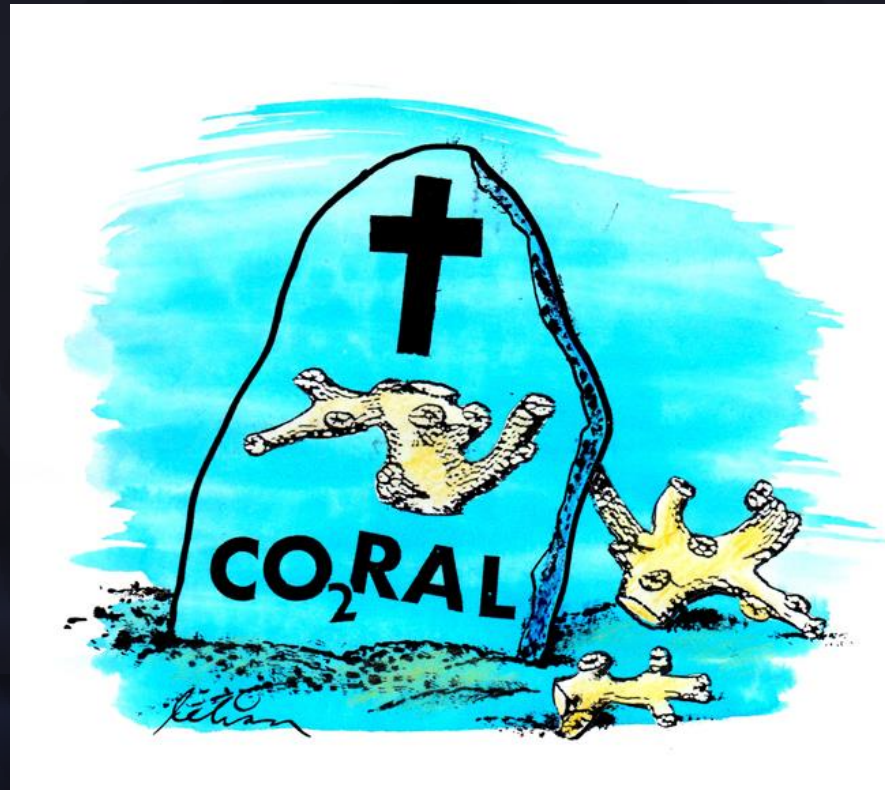


Sea Ice Extent



Arctic
Freshwater

THANK YOU FOR YOUR ATTENTION



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