

# Introduction

## “Great Rivers and Changing Oceans” with Ajit Subramaniam



Dr. Mike Passow  
Earth2Class Workshops

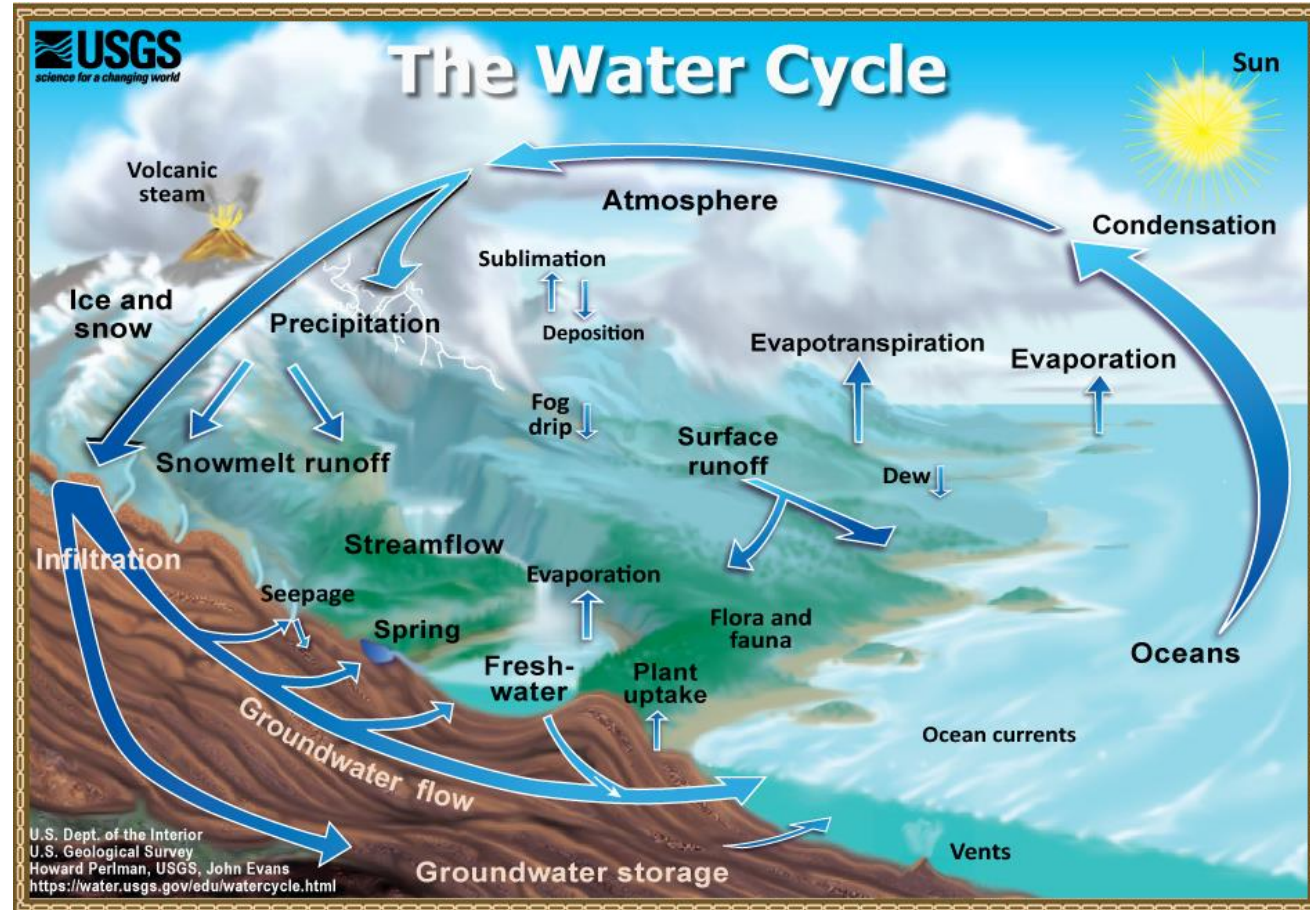
Revised 13 Apr 2019



Ajit is a Lamont Research Professor.  
<https://www.ideo.columbia.edu/~ajit/>



Rivers transport solids, liquids, and gases to the sea as part of the “Water Cycle”



<https://water.usgs.gov/edu/watercycle.html>

# Rivers entering the ocean bring:

- Fresh water (different physical/chemical properties than salt water)
- Solid particles (silt, sand, floating leaves, twigs, etc.)
- Dissolved ions ( $\text{Na}^+$ ,  $\text{Cl}^-$ ,  $\text{NO}_x$ ,  $\text{PO}_x$ , etc.)
- Runoff, including agricultural (fertilizers) and storm overflow
- Dissolved gases ( $\text{CO}_2$ )
- Bacteria, Planktonic, and larger organisms
- Discharge rates vary cyclically and non-cyclically

# River **plumes** in the ocean

When rivers enter the sea, because they have different physical properties from the surrounding seawater, they often remain separate as **plumes** for  $10^1 - 10^2$  km

Mixing rates vary greatly, and can have significant impacts on ecosystems

“Great rivers” can be very different



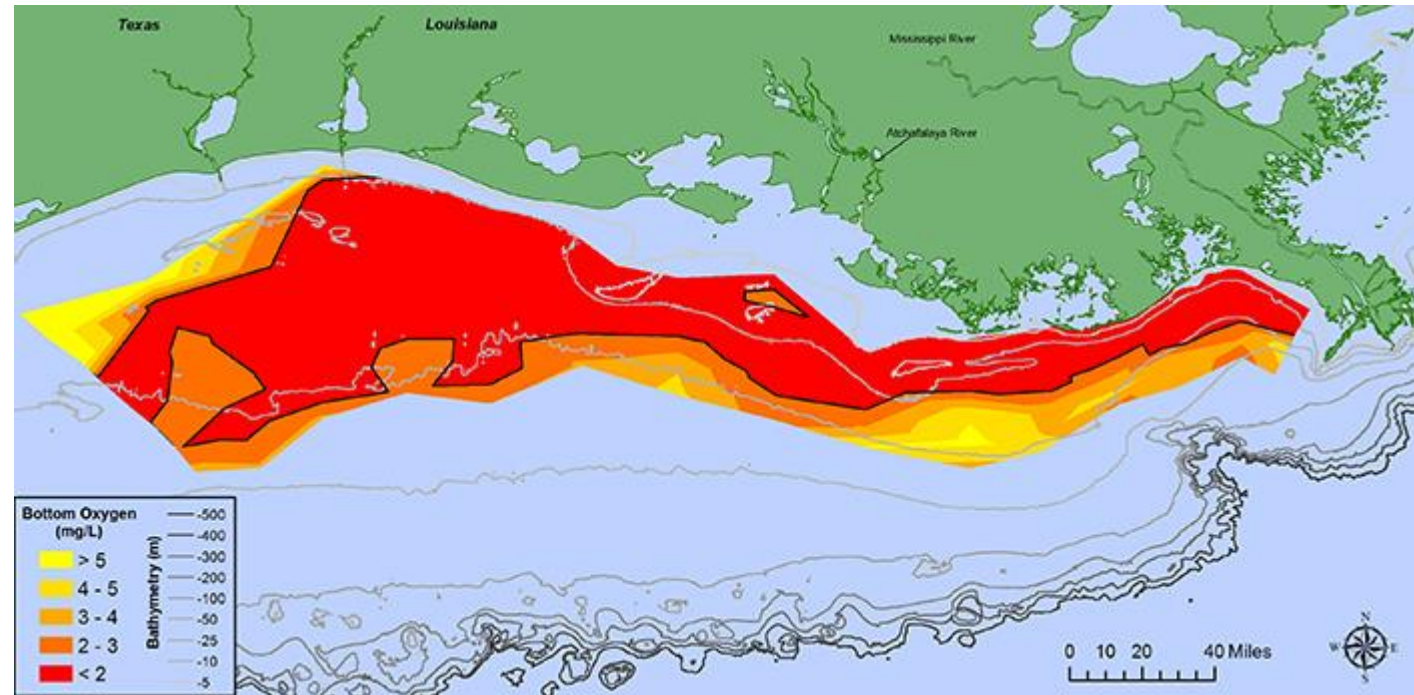
# Solid sediments

- Clay to boulders, depending on force (flow)
- Builds deltas as sediments settle
- Smaller particles can be carried far out to sea
- Silicates and other insoluble matter



# Dissolves nutrients

- Nitrates ( $\text{NO}_x$ )
- Phosphates ( $\text{PO}_x$ )
- Other elements
- Can 'overfertilize' ocean and create "Dead Zones"
- Major Dead Zone in the Gulf of Mexico



<http://www.noaa.gov/media-release/gulf-of-mexico-dead-zone-is-largest-ever-measured>

# Dissolved gases

- Carbon Dioxide (CO<sub>2</sub>)

May come directly from groundwater or C-rich soils, or from aquatic organisms through respiration or natural decay processes

Vary considerably depending on flow—larger rivers have greater percentage of photosynthesizers compared with small streams surrounded by plants

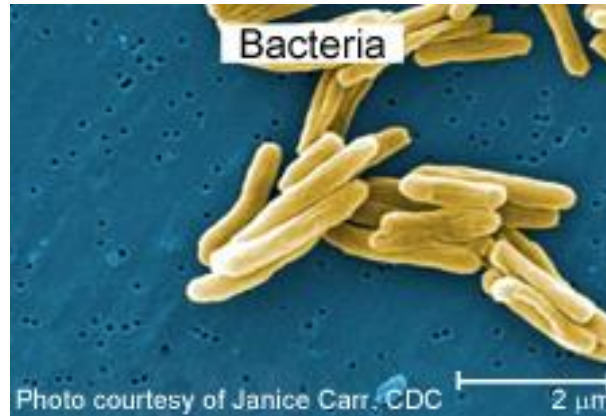
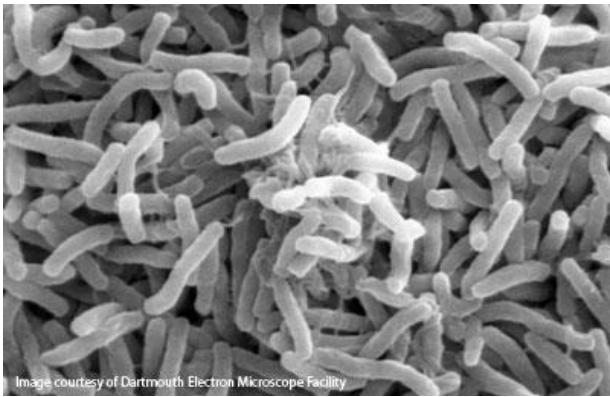
<http://www.washington.edu/news/2015/08/12/co2-emissions-change-with-size-of-streams-and-rivers/>



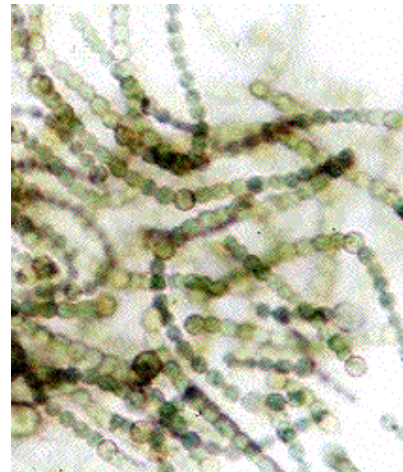


# Marine and aquatic bacteria

- Base of food chains, decomposers



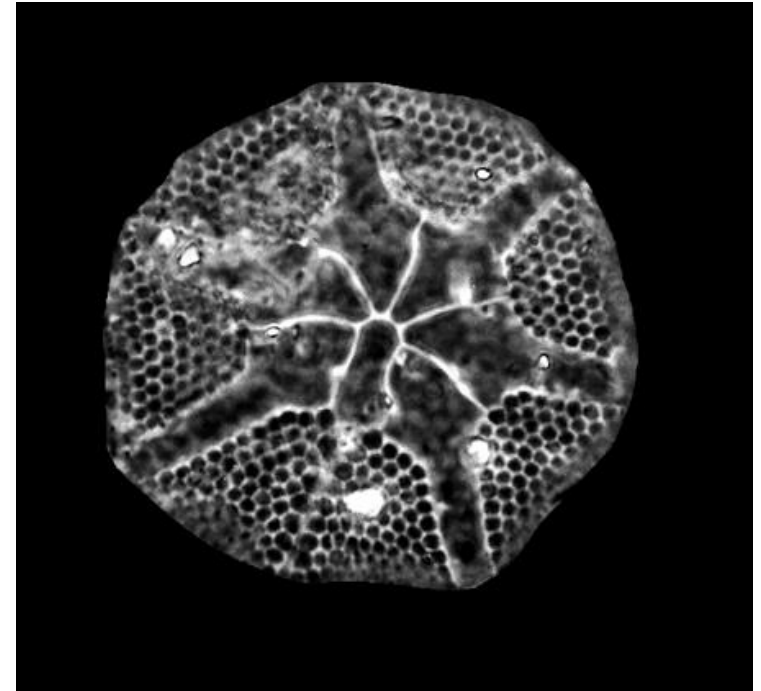
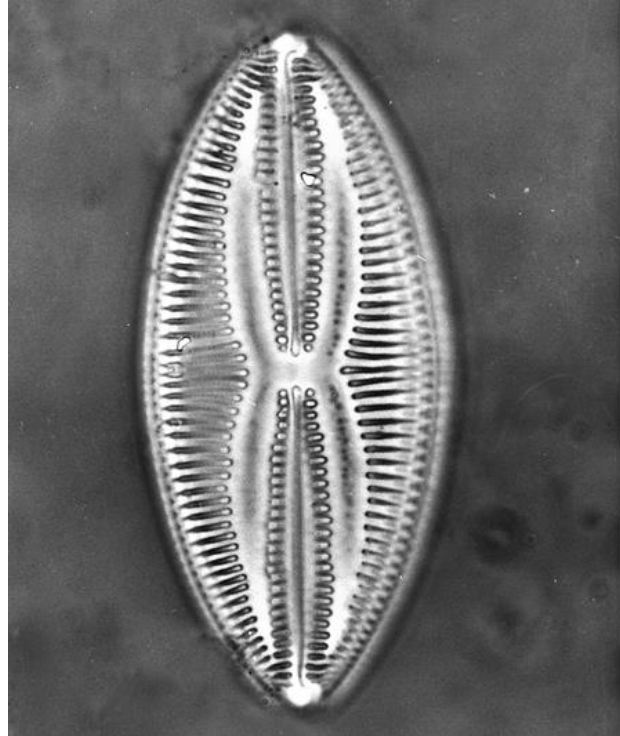
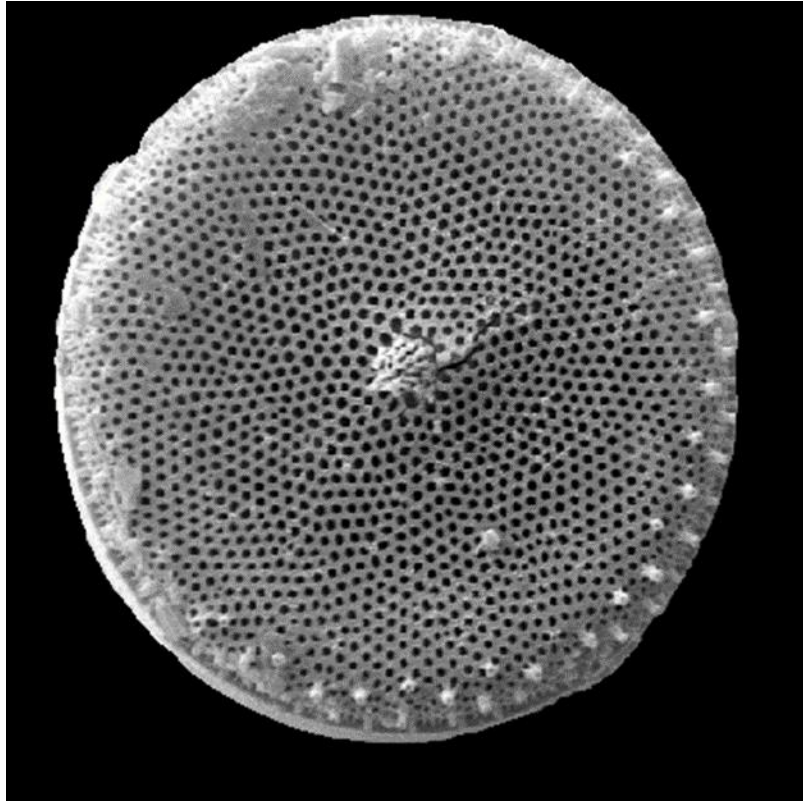
[http://www.teachoceanscience.net/teaching\\_resources/education\\_modules/marine\\_bacteria/get\\_started/](http://www.teachoceanscience.net/teaching_resources/education_modules/marine_bacteria/get_started/)



<http://cmore.soest.hawaii.edu/cruises/biolincs/microbes.htm>

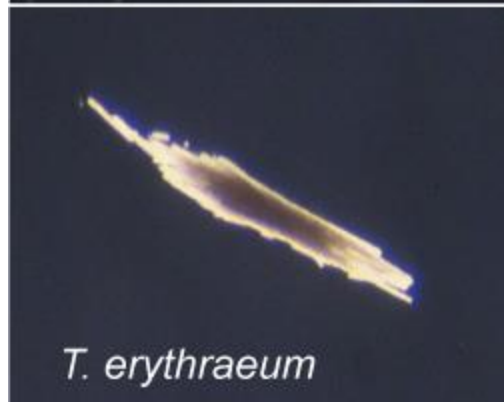
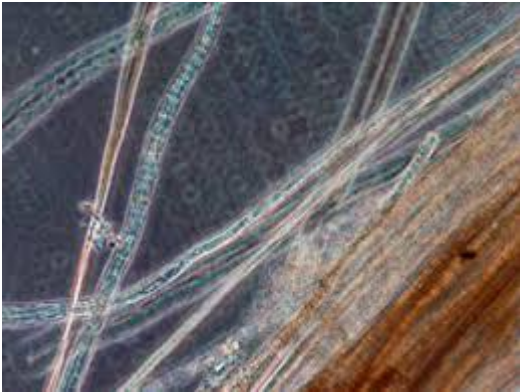
<http://www.ucmp.berkeley.edu/bacteria/cyanointro.html>

# Phytoplankton

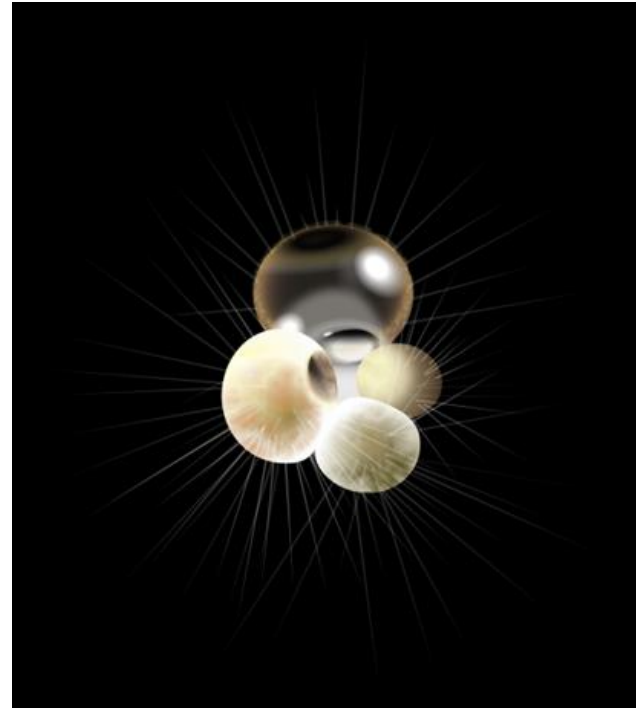
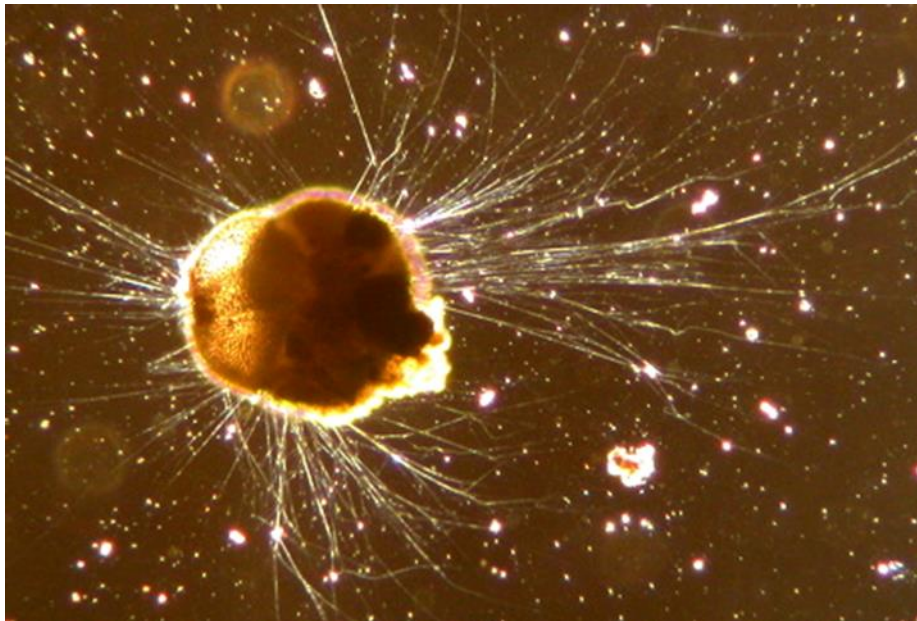


<http://www.ucl.ac.uk/GeolSci/micropal/diatom.html>

# Trichodesmium – N<sub>2</sub>-fixing (diazotroph) cyanobacteria



# Zooplankton

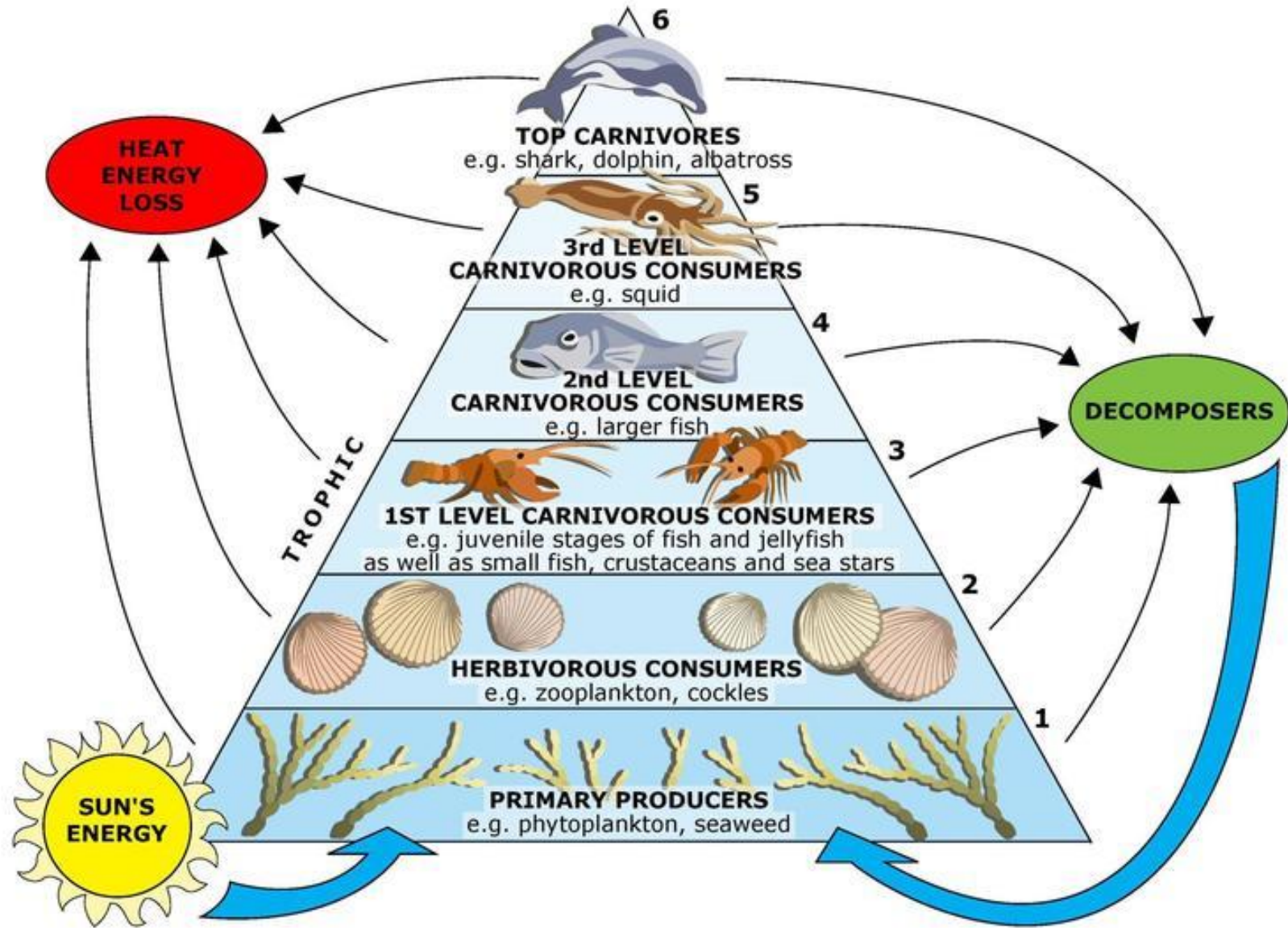


<https://en.wikipedia.org/wiki/Foraminifera>

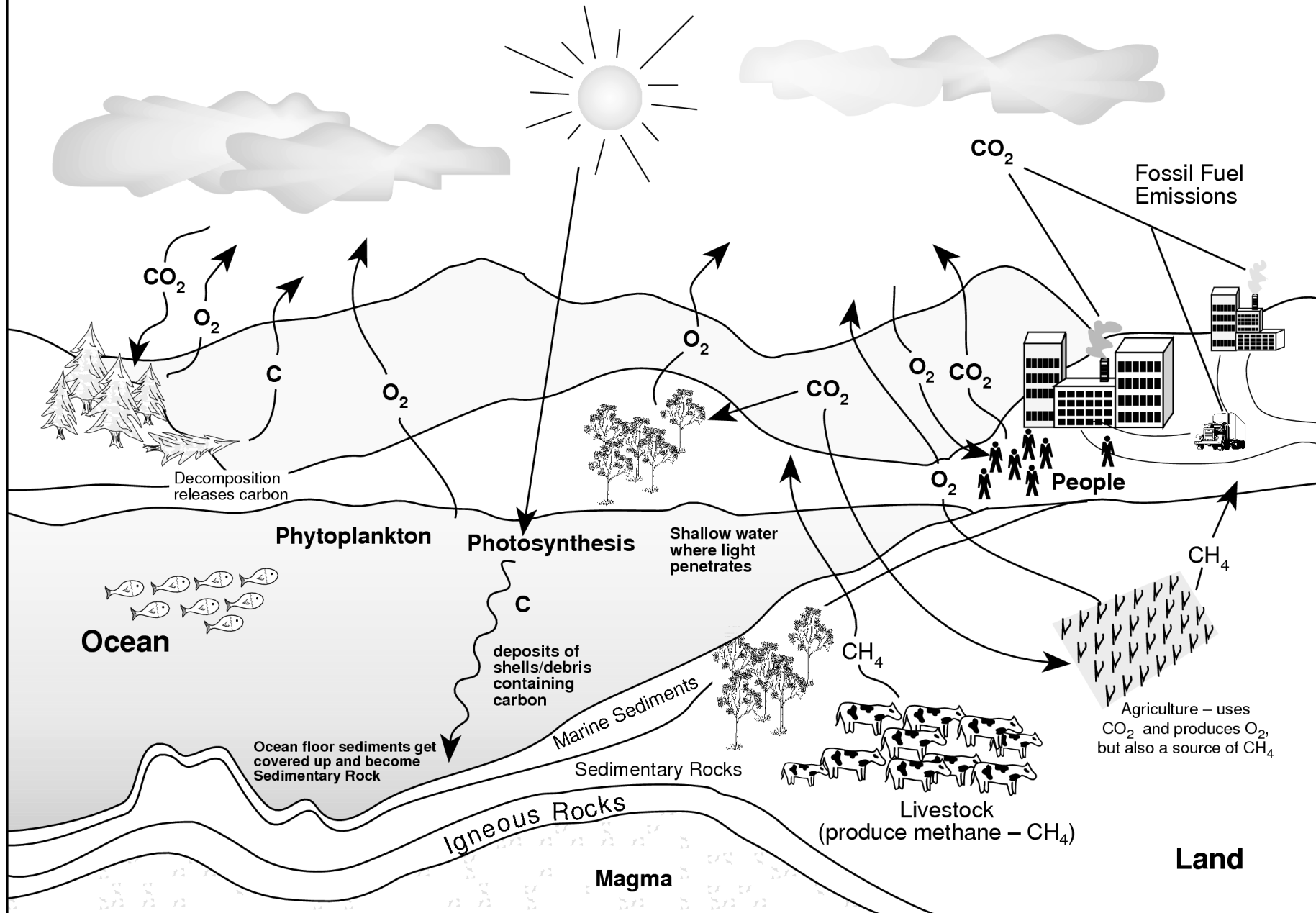
[http://www.teachoceanscience.net/teaching\\_resources/education\\_modules/plankton\\_-\\_aquatic\\_drifters/learn/](http://www.teachoceanscience.net/teaching_resources/education_modules/plankton_-_aquatic_drifters/learn/)

# The Marine Food Web

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# Carbon Cycle



# The World's Greatest Rivers—The Amazon (#1)



- Brazil, Colombia, Peru
- Average discharge about 209,000 m<sup>3</sup> per second (7,400,000 cu ft/s; 209,000,000 L/s; 55,000,000 US gal/s)
- Greater than next 7 largest combined
- 20% of river discharge to ocean
- Watershed 7,050,000 km<sup>2</sup>

# The Congo (Zaire) River (#2)

- 2<sup>nd</sup> longest in Africa (Nile)
- 41,000 m<sup>3</sup> per second (1,450,000 cu ft/sec)
- Watershed 4,014,500 km<sup>2</sup>
- Discharges into Atlantic





# The Orinoco River (#3)



- 4<sup>th</sup> by discharge (after Ganges-Brahmaputra-Meghna)
- 37,000 m<sup>3</sup>/sec
- Watershed 880,000 km<sup>2</sup>
- Enters Caribbean (Atlantic)

# The Mississippi River System (“Ole Man River”)

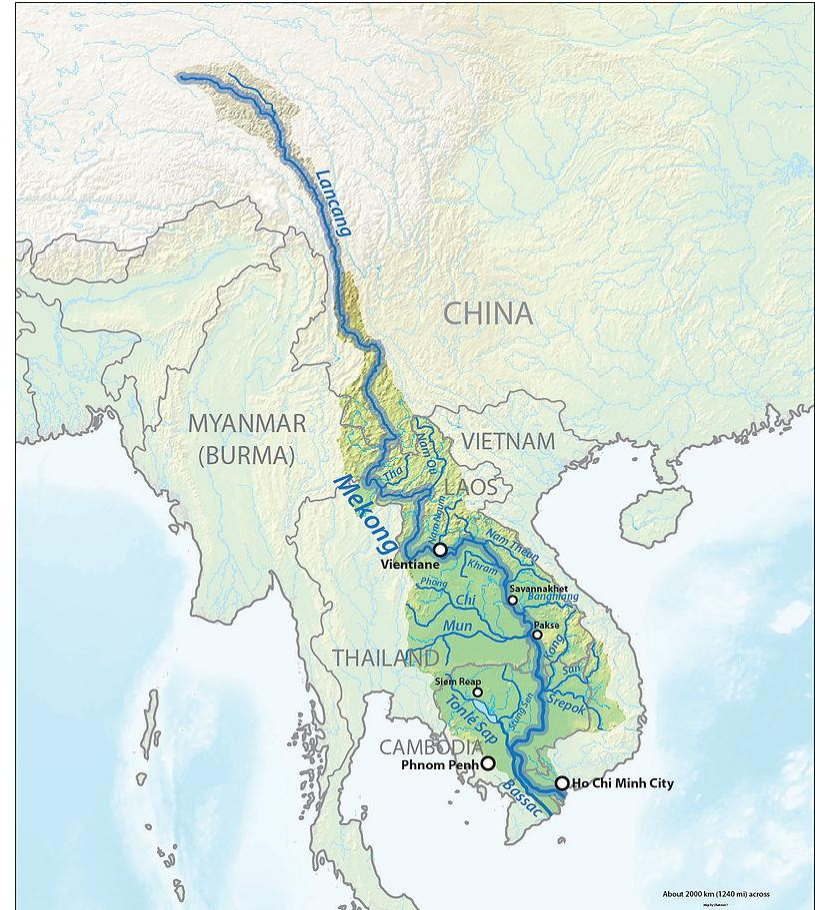


- 15<sup>th</sup> largest in discharge
- 16,796 m<sup>3</sup>/sec average flow
- Watershed 3,202,230 km<sup>2</sup>
- 2nd largest drainage in North America after Hudson Bay system
- Enters Gulf of Mexico

[https://en.wikipedia.org/wiki/Mississippi\\_River](https://en.wikipedia.org/wiki/Mississippi_River)

# The Mekong River

- 12<sup>th</sup> longest in world, 7<sup>th</sup> in Asia
- Watershed 759,000 km<sup>2</sup>
- 16,000 m<sup>3</sup>/sec
- Enters South China Sea



# Hudson River



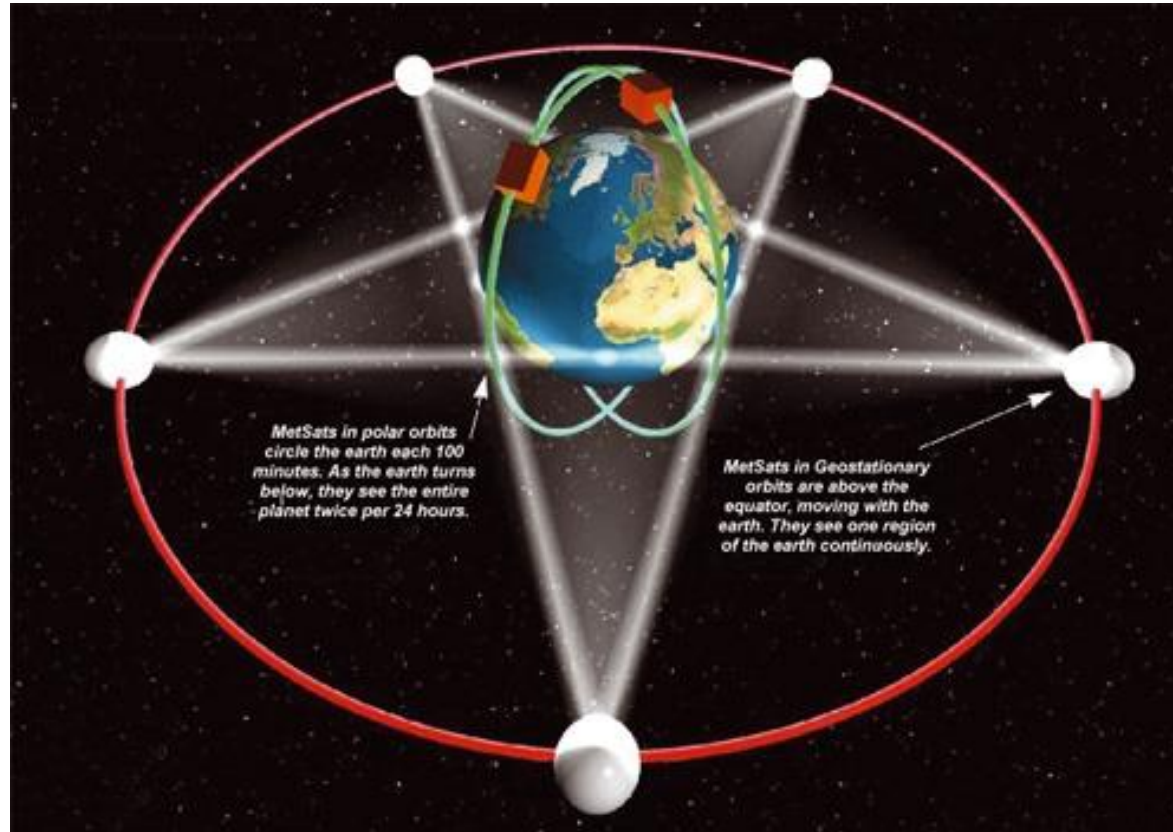
- Watershed 36,260 km<sup>2</sup>
- 620 m<sup>3</sup>/sec

But it's our river!



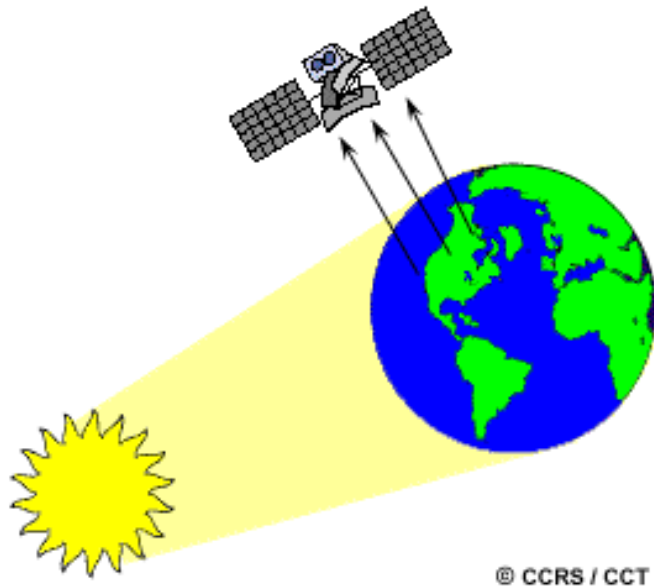
# Remote Sensing

- GOES (Geostationary Operational Environmental Satellite – weather)
- POES (Polar Operational Environmental Satellite – detailed monitoring)

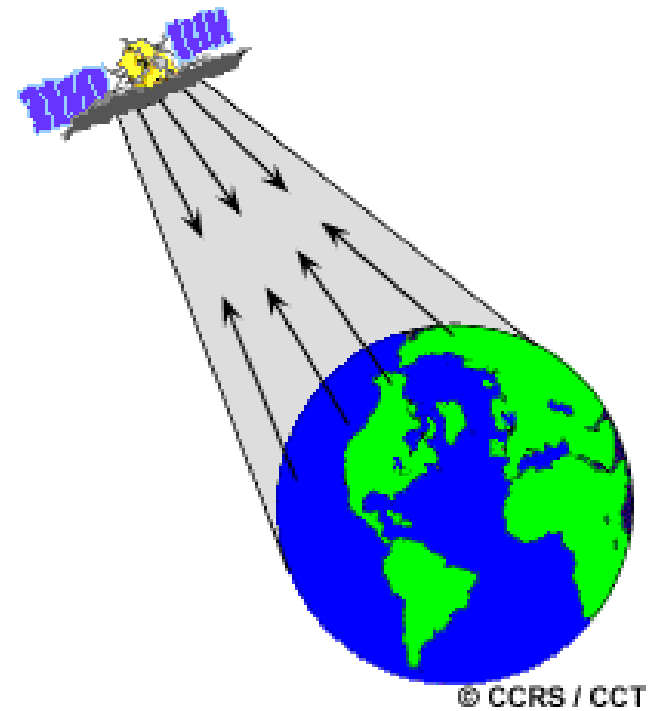


# Remote Sensing

- Passive Sensing



- Active Sensing

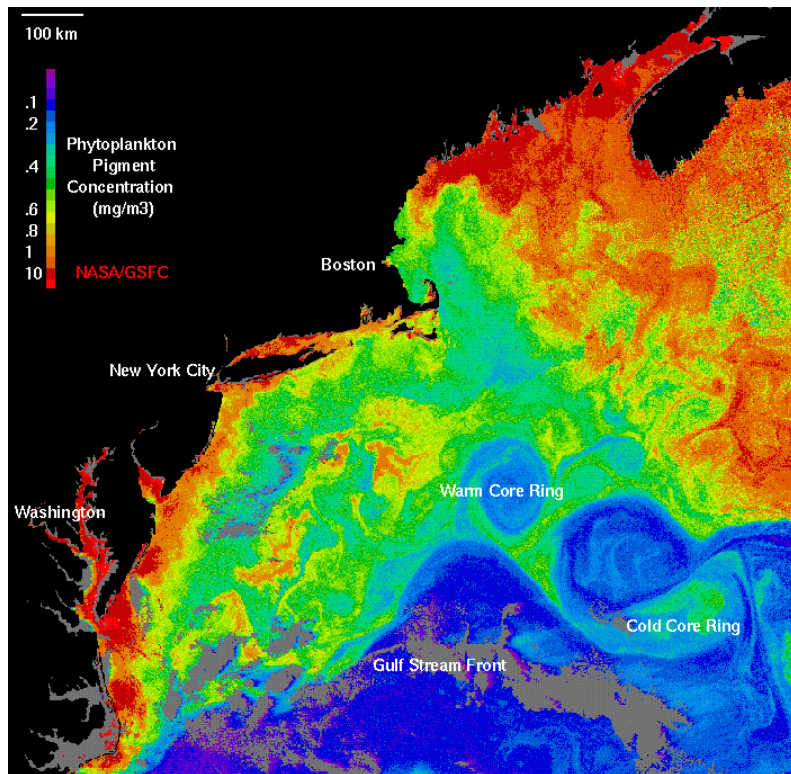


# Remote Sensing – SeaWiFS

## Sea-viewing Wide Field-of-view Sensor

- 1997 – 2010

<https://oceancolor.gsfc.nasa.gov/data/seawifs/>

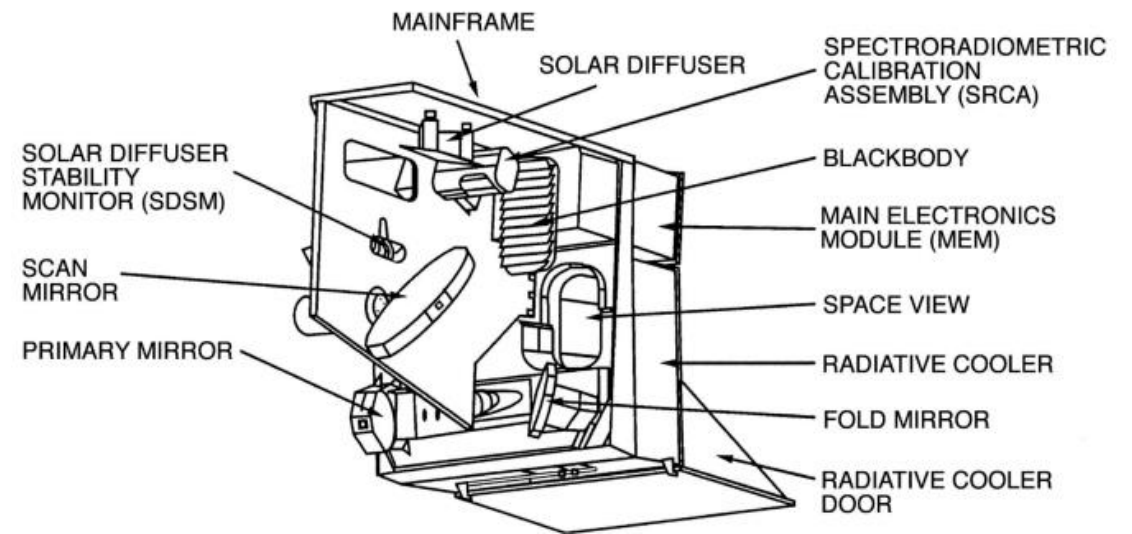
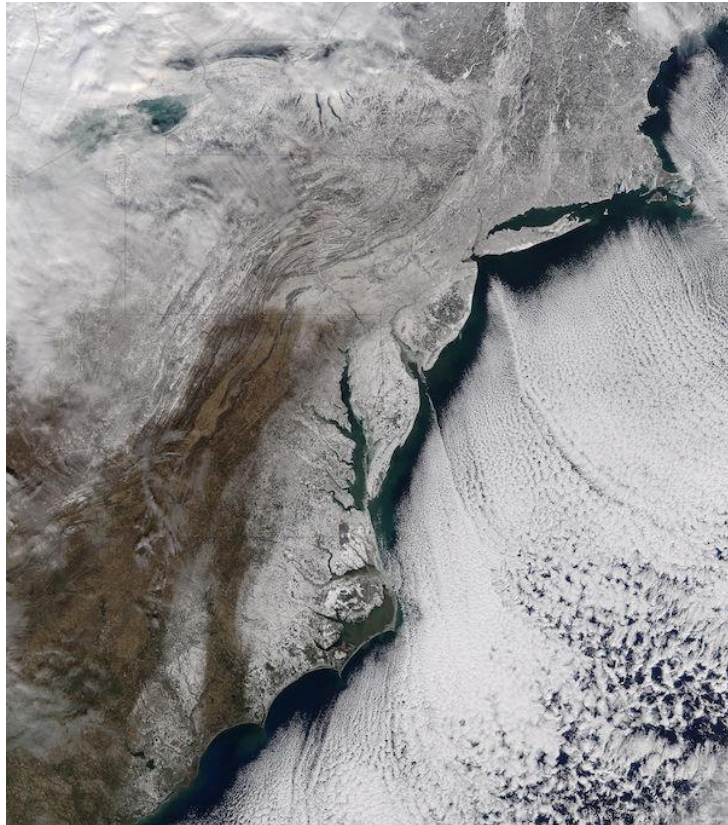


[https://oceancolor.gsfc.nasa.gov/SeaWiFS/BACKGROUND/SEAWIFS\\_BACKGROUND.html](https://oceancolor.gsfc.nasa.gov/SeaWiFS/BACKGROUND/SEAWIFS_BACKGROUND.html)

# Remote Sensing – MODIS

## Moderate Resolution Imaging Spectroradiometer

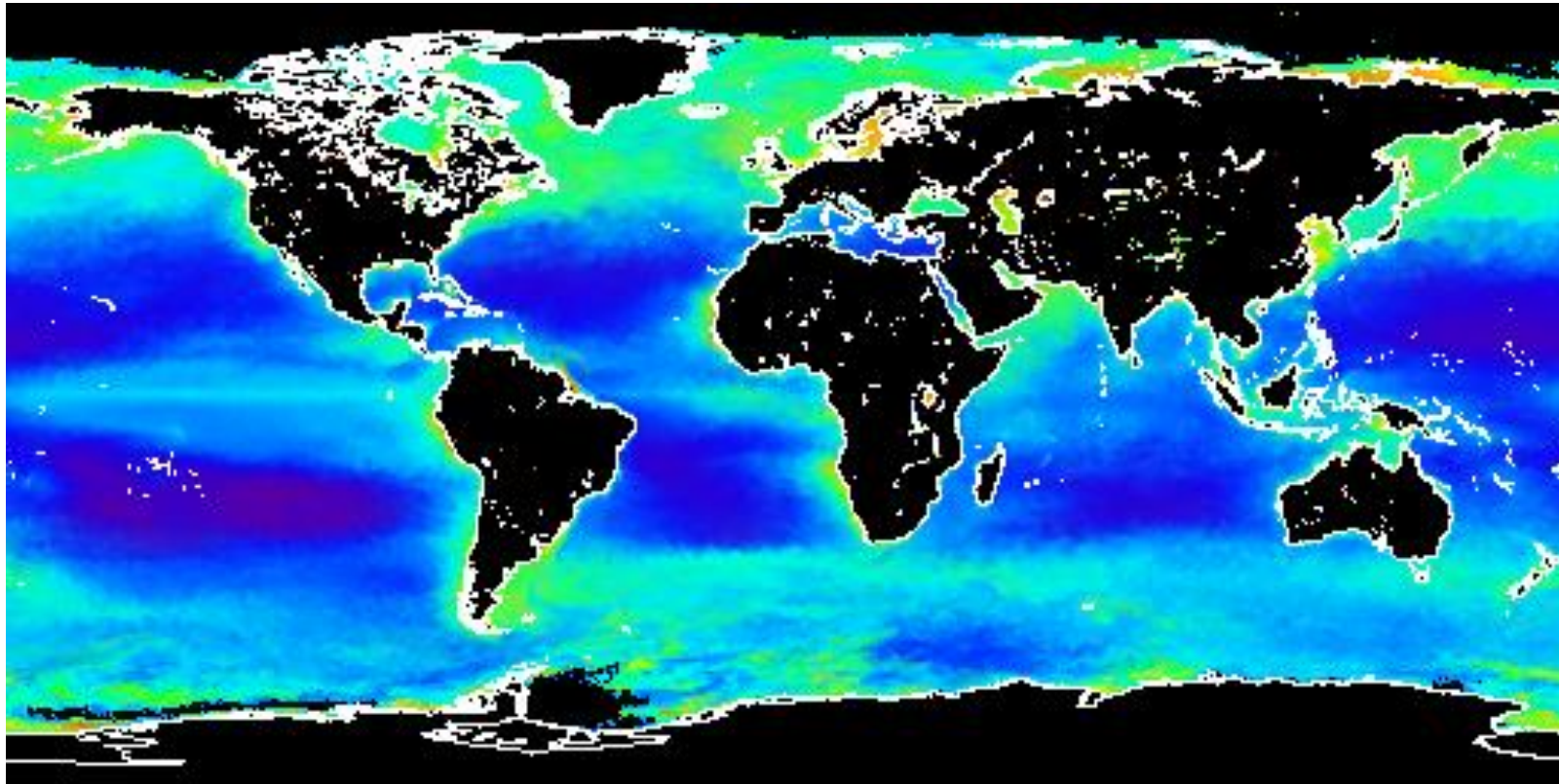
- <https://modis.gsfc.nasa.gov/about/components.php>



[https://modis.gsfc.nasa.gov/gallery/individual.php?db\\_date=2018-01-09](https://modis.gsfc.nasa.gov/gallery/individual.php?db_date=2018-01-09)



# Remote Sensing – Ocean Color and Plankton Distribution



<https://oceancolor.gsfc.nasa.gov/cgi/browse.pl?sen=am>