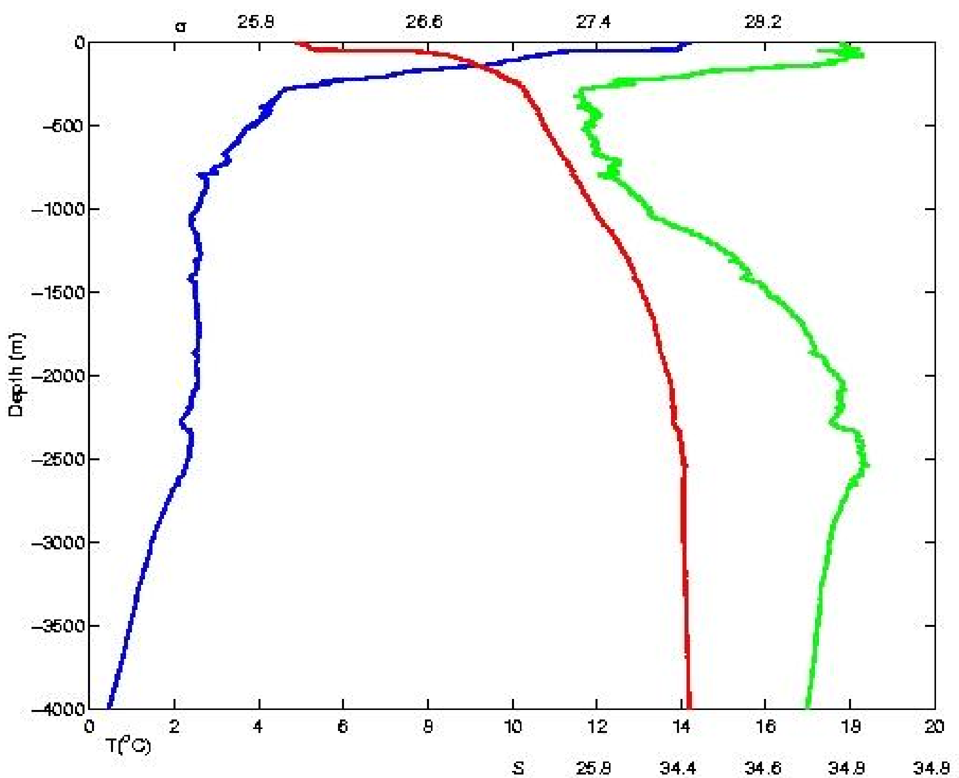
1. Geographical data relating to oceans and their importance. Physical properties of sea water, TS diagram

The distributions of temperature and salinity throughout the world oceans have been compiled from many measurements taken over a number of decades. The principal tool used is the CTD, an instrument lowered on a wire which continuously records the conductivity, temperature and pressure of the sea water. The D in CTD stands for depth which can be derived from the pressure and density. Salinity is the mass of salt per unit mass of seawater, which can be expressed in parts per thousands ($^{o}/_{oo}$).

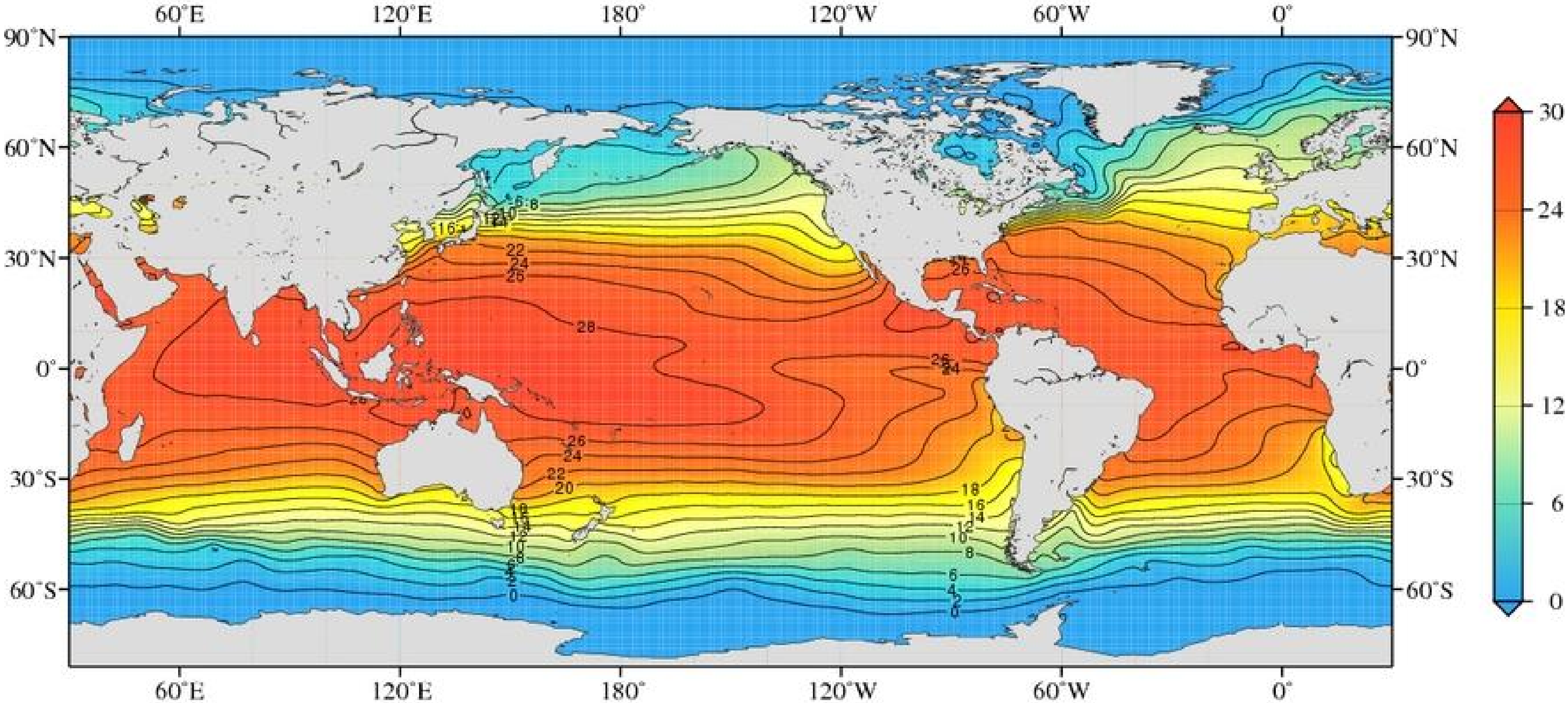
In practical terms salinity is derived from a conductivity and temperature measurement. Because sea water is made up of a mixture of salts with different conductivities the standard unit of salinity which is normally used is the p.s.u. (practical salinity unit) which for all intents and purposes is close to a part per thousand. Typical vertical profiles of temperature and salinity taken with a CTD are shown below. Also shown is the derived quantity s_t, a measure of density.



World Ocean Atlas Climatology

Decadal Average: 1955 - 2012

Contour Interval=2

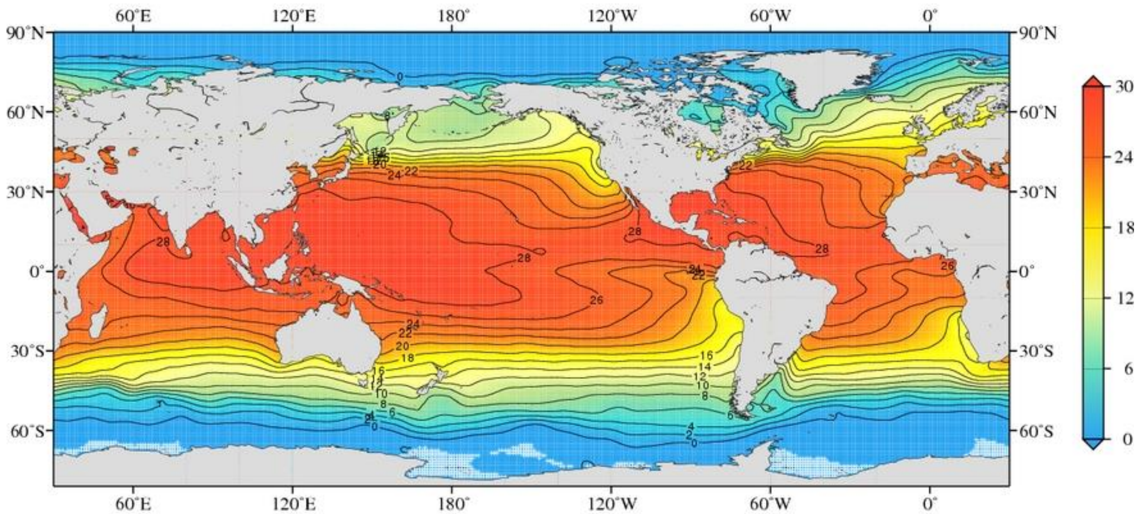


Annual temperature [°C] at the surface (one-degree grid)

World Ocean Atlas Climatology

Decadal Average: 1955 - 2012

Contour Interval=2

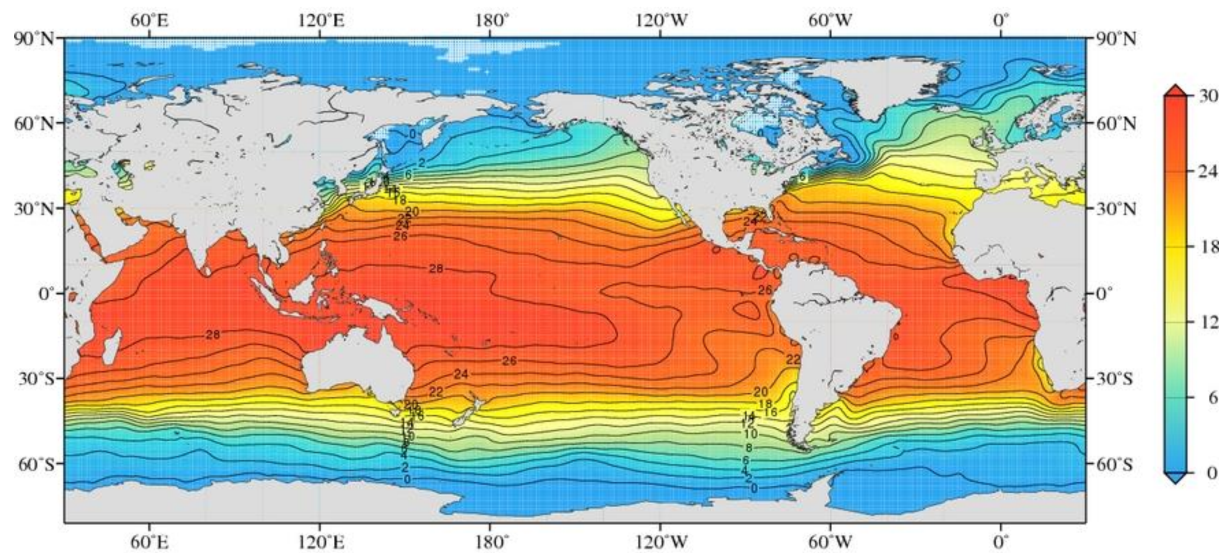


Summer (Jul.-Sep.) temperature [°C] at the surface (one-degree grid)

World Ocean Atlas Climatology

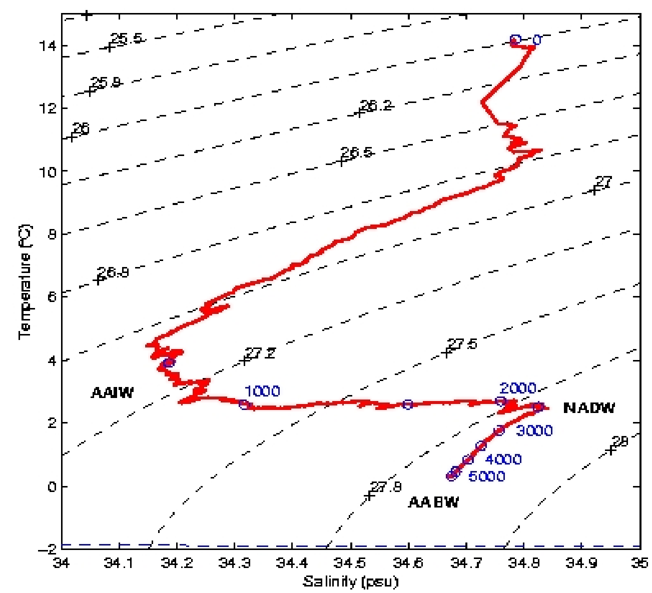
Decadal Average: 1955 - 2012

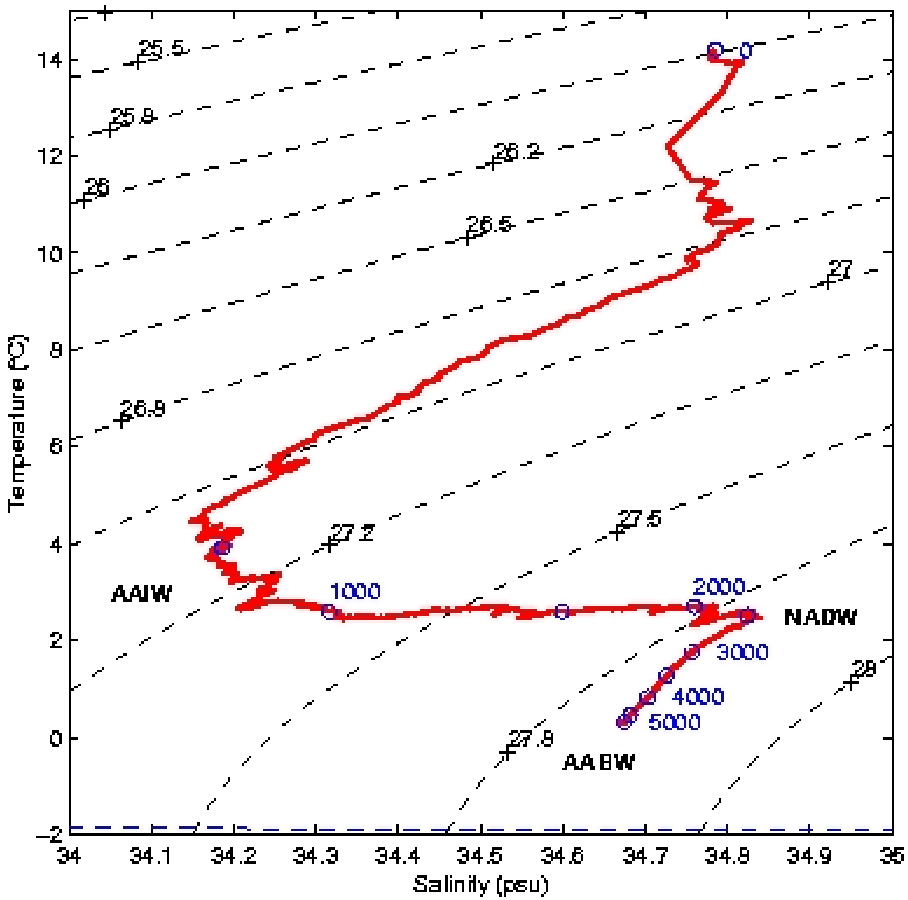
Contour Interval=2



Winter (Jan.-Mar.) temperature [°C] at the surface (one-degree grid)

A useful way of presenting hydrographic data is to plot the temperature against salinity for any given point measurement. Plotting a number of measurements from a single CTD cast produces a scatter of points which often follow a tight curve. An example of a T--S curve for a station at 9^oS in the Atlantic is shown below. The numbers on the curve correspond to depth in hundreds of metres. Also shown on the diagram are lines of constant s_t. The curve has a distinctive S--shape. Such curves can be used to identify the presence of different water masses and mixing between those water masses.





T-S diagram

T--S diagram for a CTD station at 45^{o}S in the Atlantic. The numbers on the curve correspond to depth in metres. Also shown on the diagram are lines of constant σ_t. The T--S characteristics for North Atlantic Water (NADW), Antarctic Intermediate Water (AAIW) and Antarctic Bottom Water (AABW) are shown schematically

2. Marine pollution, its sources, causes and its impact on marine environment

Marine pollution

- There are three main types of inputs of pollution into the ocean: direct discharge of waste into the oceans, runoff into the waters due to rain, and pollutants that are released from the atmosphere.
- One common path of entry by contaminants to the sea are rivers. The evaporation of water from oceans exceeds precipitation. The balance is restored by rain over the continents entering rivers and then being returned to the sea with lot of air and land pollutions.
- Pollution is often classed as point source or nonpoint source pollution. **Point source pollution** occurs when there is a single, identifiable, and localized source of the pollution. An example is directly discharging sewage and industrial waste into the ocean. Pollution such as this occurs particularly in developing nations.

  Nonpoint source pollution occurs when the pollution comes from ill-defined and diffuse sources. These can be difficult to regulate. Agricultural runoff and wind blown debris are prime examples

Å Direct discharge

Å Sewerage, Industrial wastes. Pollutants enter rivers and the sea directly from urban sewerage and industrial waste discharges, sometimes in the form of hazardous and toxic wastes.

Å Inland mining for copper, gold. etc., is another source of marine pollution. Most of the pollution is simply soil, which ends up in rivers flowing to the sea.

Å **Land runoff**

Surface runoff from farming, as well as urban runoff and runoff from the construction of roads, buildings, ports, channels, and harbours, can carry soil and particles laden with carbon, nitrogen, phosphorus, and minerals. This nutrient-rich water can cause fleshy algae and phytoplankton to thrive in coastal areas, known as algal blooms, which have the potential to create hypoxic conditions by using all available oxygen.

Polluted runoff from roads and highways can be a significant source of water pollution in coastal areas.

- Ship pollution
- A cargo ship pumps ballast water over the side.
- Ships can pollute waterways and oceans in many ways. Oil spills can have devastating effects. While being toxic to marine life, polycyclic aromatic hydrocarbons (PAHs), the components in crude oil, are very difficult to clean up, and last for years in the sediment and marine environment.
- Discharge of cargo residues from bulk carriers can pollute ports, waterways and oceans. In many instances vessels intentionally discharge illegal wastes despite foreign and domestic regulation prohibiting such actions. It has been estimated that container ships lose over 10,000 containers at sea each year (usually during storms).
- Ballast water taken up at sea and released in port is a major source of unwanted exotic marine life.
- Invasive species can take over once occupied areas, facilitate the spread of new diseases, introduce new genetic material, alter underwater seascapes and jeopardize the ability of native species to obtain food.

Å Atmospheric pollution

Atmospheric dust is responsible for various coral deaths across the world ocean.

Wind blown dust and debris, including plastic bags, are blown seaward from landfills and other areas. Climate change is raising ocean temperatures and raising levels of carbon dioxide in the atmosphere. These rising levels of carbon dioxide are acidifying the oceans. This, in turn, is altering aquatic ecosystems and modifying fish distributions, with impacts on the sustainability of fisheries and the livelihoods of the communities that depend on them. Healthy ocean ecosystems are also important for the mitigation of climate change.

- Deep sea mining
- Deep sea mining is a relatively new mineral retrieval process that takes place on the ocean floor. Ocean mining sites are usually around large areas of polymetallic nodules or active and extinct hydrothermal vents at about 1,400 - 3,700 meters below the ocean's surface. The vents create sulfide deposits, which contain precious metals such as silver, gold, copper, manganese, cobalt, and zinc. The deposits are mined using either hydraulic pumps or bucket systems that take ore to the surface to be processed. As with all mining operations, deep sea mining raises questions about environmental damages to the surrounding areas
- Because deep sea mining is a relatively new field, the complete consequences of full scale mining operations are unknown. However, experts are certain that removal of parts of the sea floor will result in disturbances to the benthic layer, increased toxicity of the water column and sediment plumes from tailings. Removing parts of the sea floor disturbs the habitat of benthic organisms, possibly, depending on the type of mining and location, causing permanent disturbances. Aside from direct impact of mining the area, leakage, spills and corrosion would alter the mining area's chemical makeup.

- Acidification

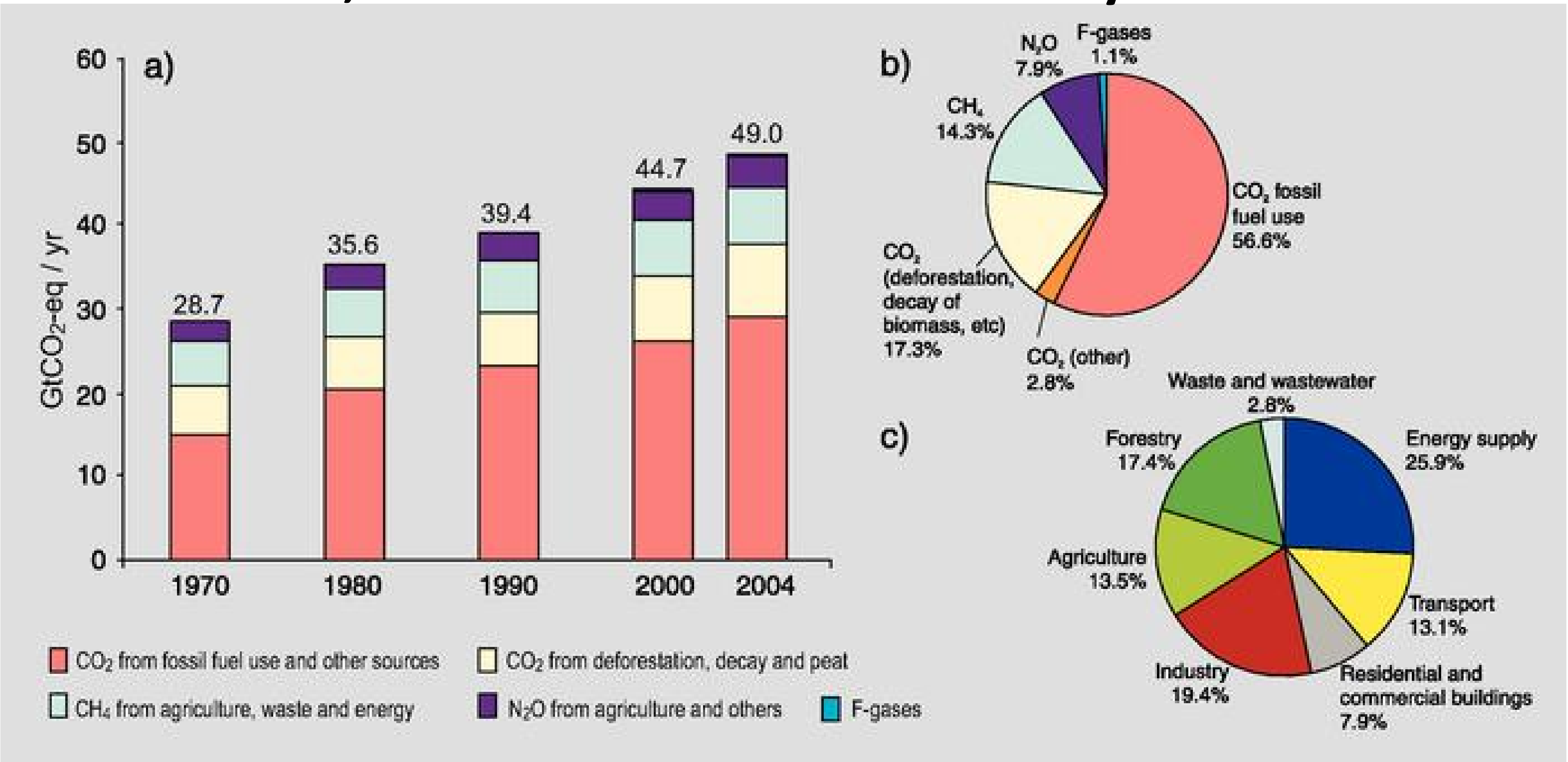
- The oceans are normally a natural carbon sink, absorbing carbon dioxide from the atmosphere. Because the levels of atmospheric carbon dioxide are increasing, the oceans are becoming more acidic. The potential consequences of ocean acidification are not fully understood, but there are concerns that structures made of calcium carbonate may become vulnerable to dissolution, affecting corals and the ability of shellfish to form shells.
- Oceans and coastal ecosystems play an important role in the global carbon cycle and have removed about 25% of the carbon dioxide emitted by human activities between 2000 and 2007 and about half the anthropogenic CO_2 released since the start of the industrial revolution.
- A report from NOAA scientists published in the journal Science in May 2008 found that large amounts of relatively acidified water are upwelling to within four miles of the Pacific continental shelf area of North America. This area is a critical zone where most local marine life lives or is born.

- Eutrophication
- Eutrophication is an increase in chemical nutrients, typically compounds containing nitrogen or phosphorus, in an ecosystem. It can result in an increase in the ecosystem's primary productivity (excessive plant growth and decay), and further effects including lack of oxygen and severe reductions in water quality, fish, and other animal populations.
- The biggest culprit are rivers that empty into the ocean, and with it the many chemicals used as fertilizers in agriculture as well as waste from livestock and humans. An excess of oxygen depleting chemicals in the water can lead to hypoxia and the creation of a dead zone.
- Estuaries tend to be naturally eutrophic because land-derived nutrients are concentrated where runoff enters the marine environment in a confined channel. In the ocean, there are frequent red tide algae blooms that kill fish and marine mammals and cause respiratory problems in humans and some domestic animals when the blooms reach close to shore.

Impact of pollution on marine environment

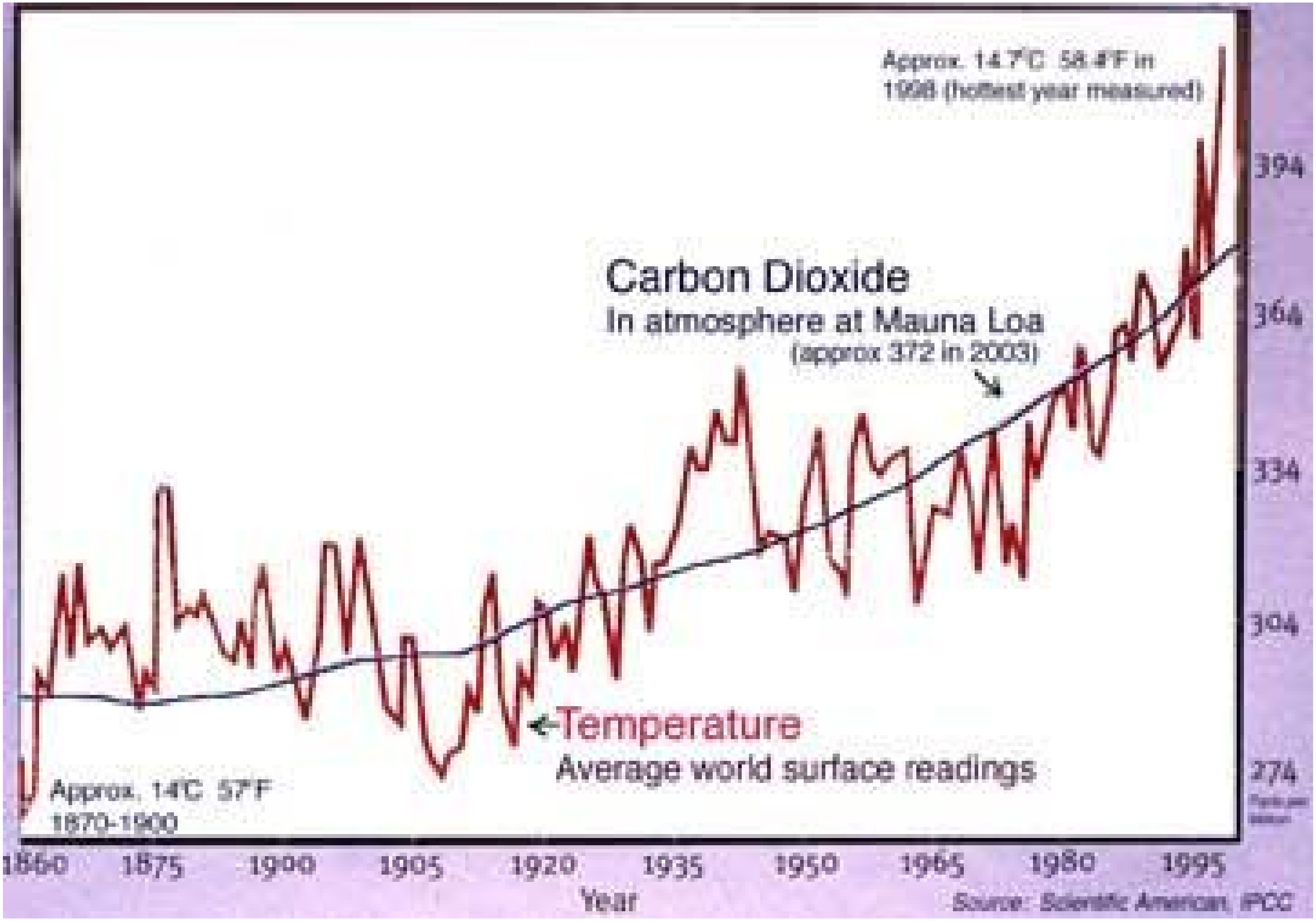
3. Global warming and sea level rise and its importance for coastal areas, small islands and marine ecosystem

Global warming and sea level rise and its importance for coastal areas, small island and marine ecosystem

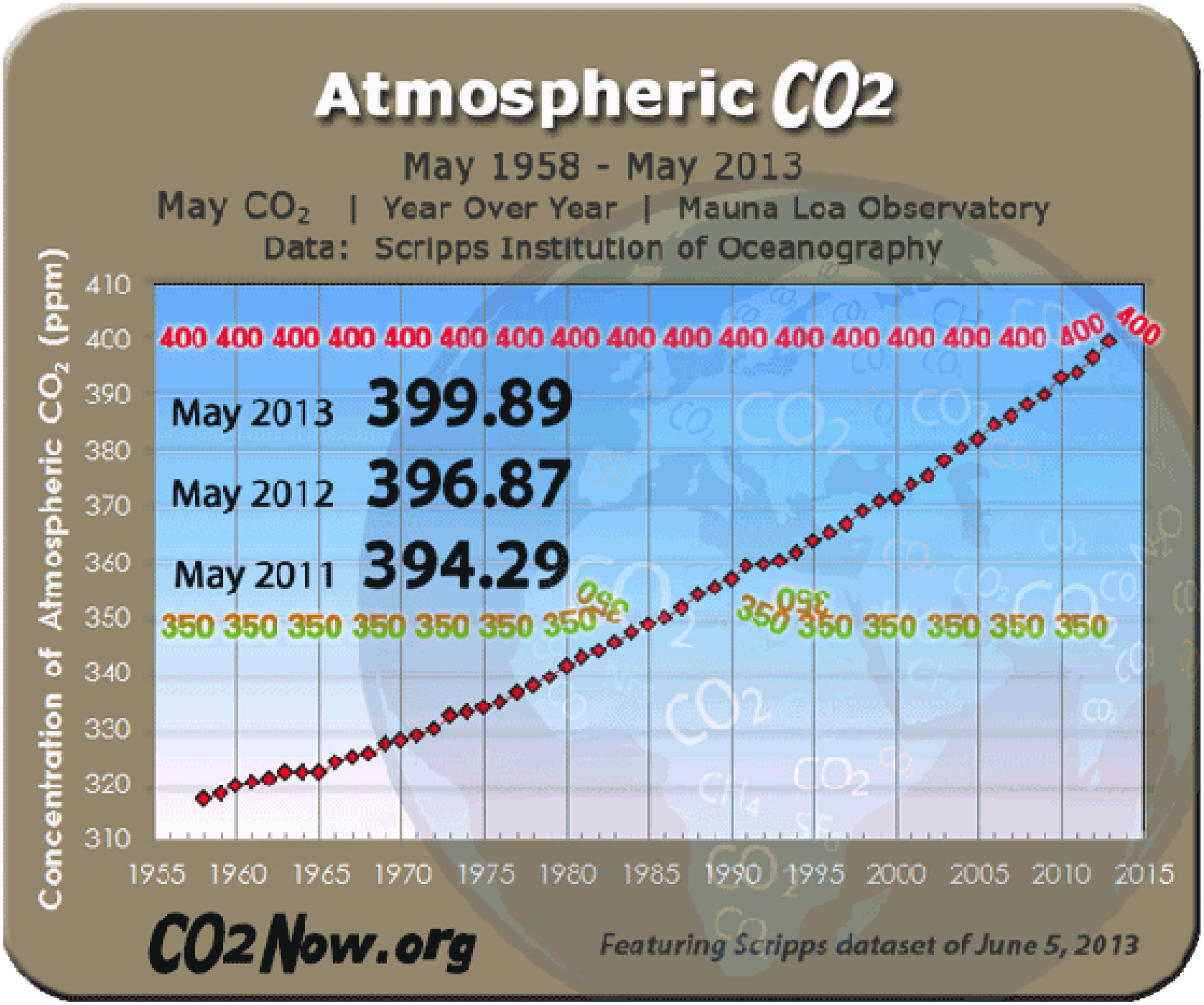


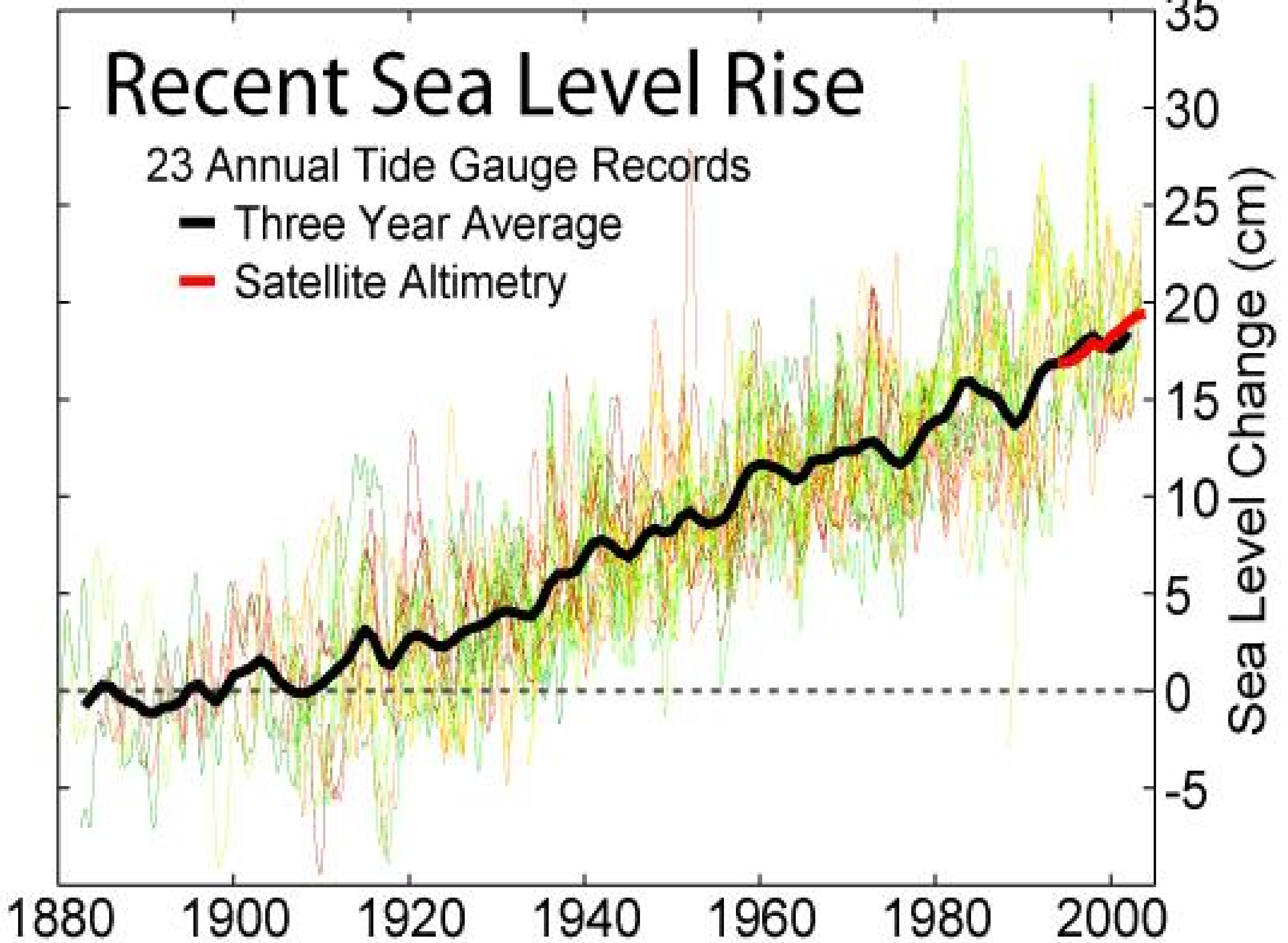
Global anthropogenic GHG emissions

The radiative forcing of the climate system is dominated by the GHGs

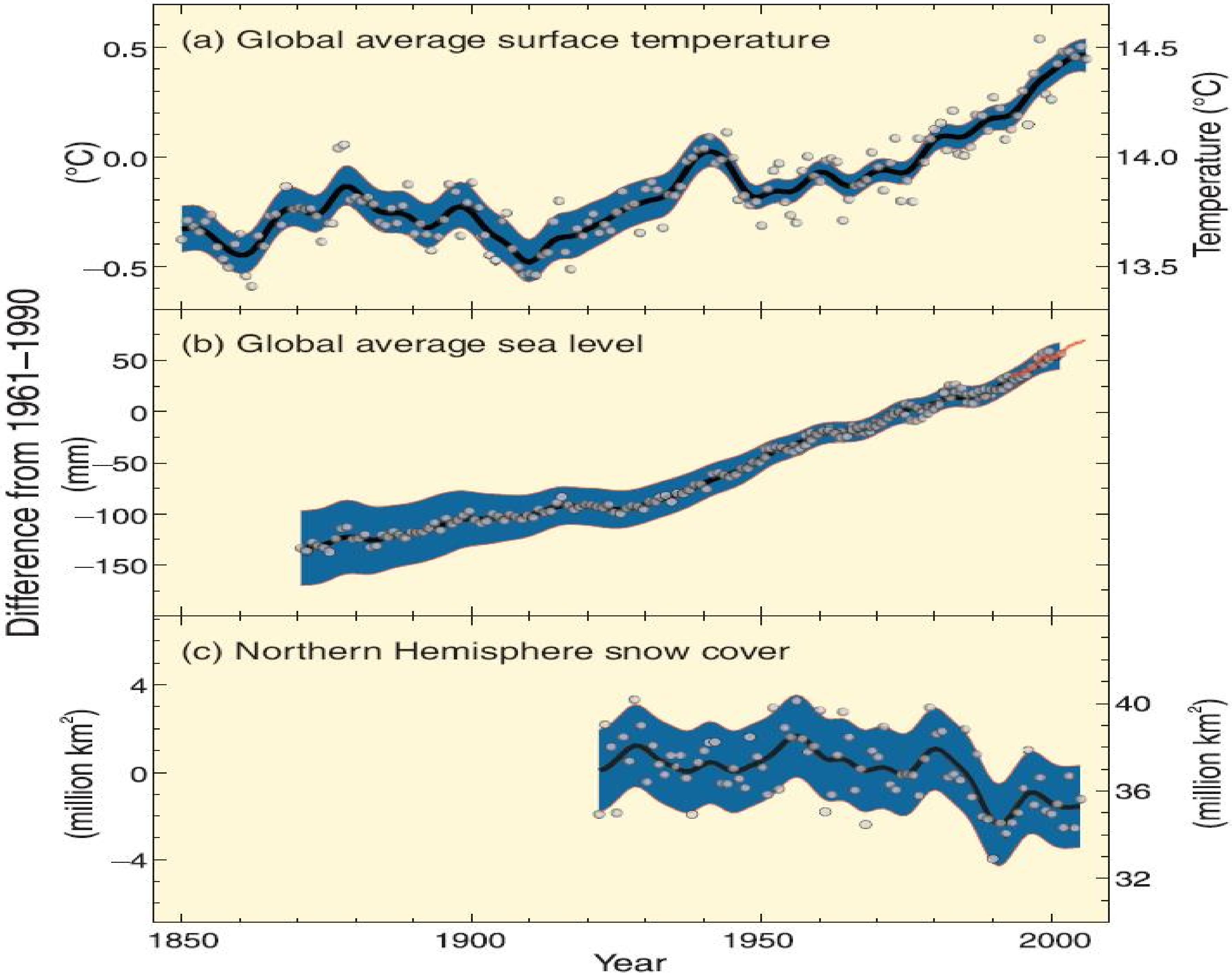


Approx. 14.7°C 58.4°F in
1998 (hottest year measured)
Carbon Dioxide
In atmosphere at Mauna Loa
(approx 372 in 2003)
Temperature
Average world surface readings
Approx. 14°C 57°F
1870-1900
394
364
334
304
274
1860
1875
1900
1905
1920
1935
1950
1965
1980
1995
Year
Source: Scientific American, IPCC


Atmospheric CO2
May 1958 - May 2013
May CO2 | Year Over Year | Mauna Loa Observatory
Data: Scripps Institution of Oceanography
Concentration of Atmospheric CO2 (ppm)
410
400
390
380
370
360
350
340
330
320
310
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
May 2013 399.89
May 2012 396.87
May 2011 394.29
CO2Now.org
Featuring Scripps dataset of June 5, 2013



Recent Sea Level Rise
23 Annual Tide Gauge Records
Three Year Average
Satellite Altimetry
Sea Level Change (cm)
35
30
25
20
15
10
5
0
-5
1880
1900
1920
1940
1960
1980
2000


(a) Global average surface temperature
0.5
0.0
−0.5
(°C)
14.5
14.0
13.5
Temperature (°C)
(b) Global average sea level
50
0
−50
−100
−150
(mm)
Difference from 1961–1990
(c) Northern Hemisphere snow cover
4
0
−4
(million km²)
40
36
32
(million km²)
1850
1900
1950
2000
Year

Climate variability and change also impacts fisheries in coastal and estuarine waters, although nonclimatic factors, such as overfishing and habitat loss and degradation, are already responsible for reducing fish stocks.

Globally an increased agricultural production potential due to climate change and CO_2 fertilisation should in principle add to food security, but the impacts on the coastal areas may differ regionally and locally.

Å **Temperature rise and the associated thermal expansion and melting of ice increases the global sea level.**

Å **Coasts will be exposed to increasing risks, including coastal erosion due to climate change and sea-level rise.**

Å **Rising sea level has negative impacts on coastal agriculture.**

Å **Global warming results in coral bleaching and eradication of different species.**

Å **Global warming induces more cyclones thereby affecting the coastal population.**

Å **Intense rain events caused by global warming will induce more river runoff and so more nutrient supply to the ocean, thereby affecting the coastal environment.**