

A photograph showing a house and several trees completely surrounded by floodwaters. The water is murky and turbulent, with white foam from the waves visible in the foreground. Power lines and poles are visible in the background, stretching across the sky. The scene depicts a severe flooding event.

Water Quality Analysis

Methods and Applications

Water Quality Analysis

- **Physical Factors** including suspended materials (called suspended solids) and dissolved substances (dissolved solids)
- **Chemical Factors** including concentrations of ions, pollutants, etc...
- **Biological Factors** including presence of organisms, plankton, macroinvertebrates, fish, nutrients, etc...

Physical Factors

TSS – Total Suspended Solids can be measured by taking the amount of solid separated from a water sample.

Measurement in mg/L

TDS – Total dissolved solids can be measured through evaporation and measured in mg/L

Measuring Water Clarity

- **Turbidity** is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates.
- A turbidity measurement could be used to provide an estimation of the **TSS (Total Suspended Solids)**

Causes of Turbidity

There are various parameters influencing the cloudiness of the water. Some of these are:

- **Phytoplankton**
- **Sediments from erosion**
- **Resuspended sediments from the bottom**
(frequently stir up by bottom feeders like carp)
- **Waste discharge**
- **Algae growth**
- **Urban runoff**

Ways to Measure Turbidity

Turbidity is measured in NTU: **Nephelometric Turbidity Units**. The instrument used for measuring it is called nephelometer, colorimeter or turbidimeter, which measures the intensity of light scattered at 90 degrees as a beam of light passes through a water sample.

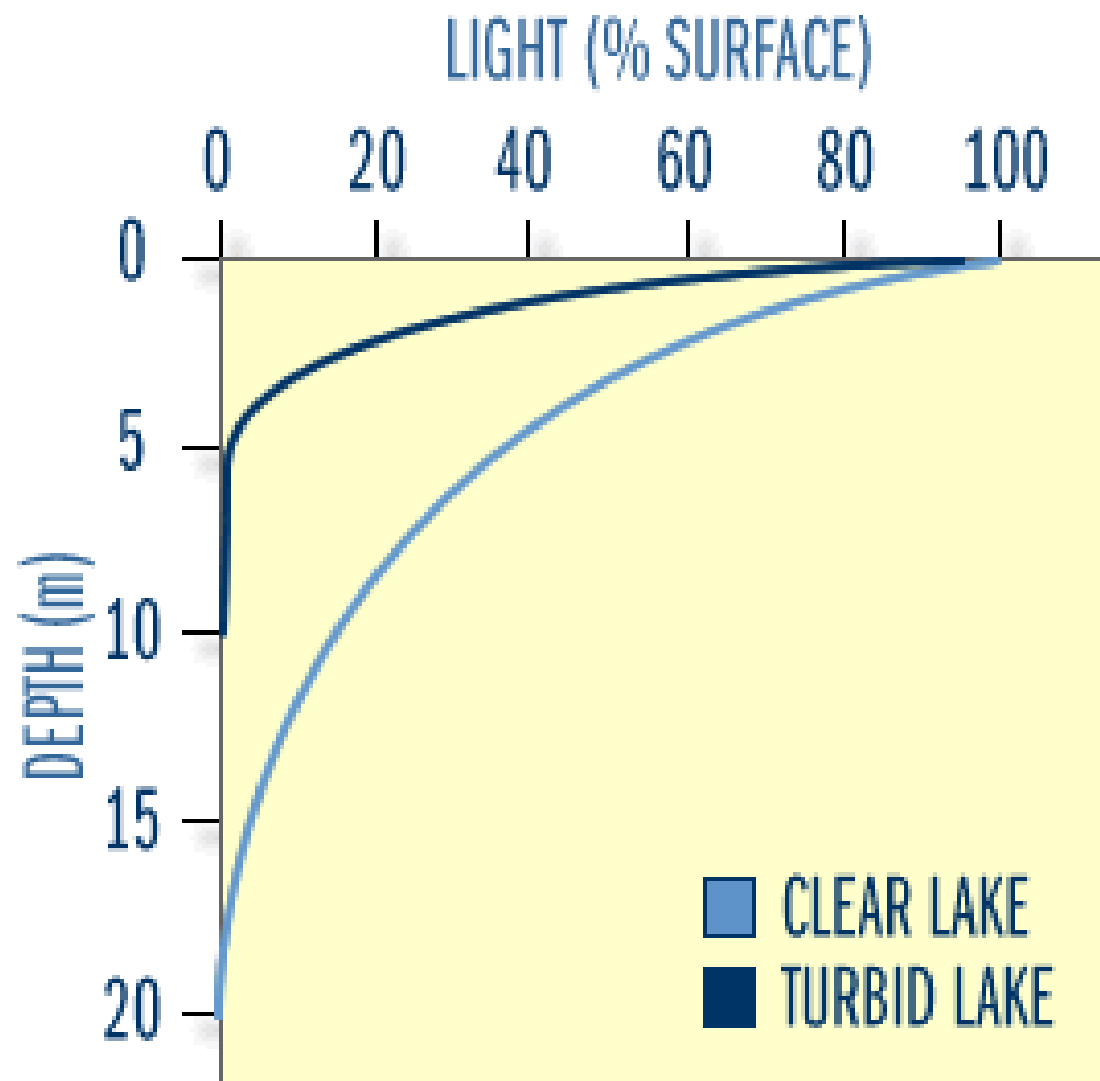
In lakes or bays, turbidity is measured with a secchi disk



Turbidity Values?

- Turbidity is measured in NTUs and sometimes FTUs (Foresl Turbidity Units)
- No suspended solids present is a value of 0 NTU, while drinking water should be no more than 5 NTU





LIGHT VERSUS DEPTH PROFILES FOR A CLEAR LAKE ($k=0.2 \text{ M}^{-1}$) AND A TURBID LAKE ($k=0.9 \text{ M}^{-1}$).

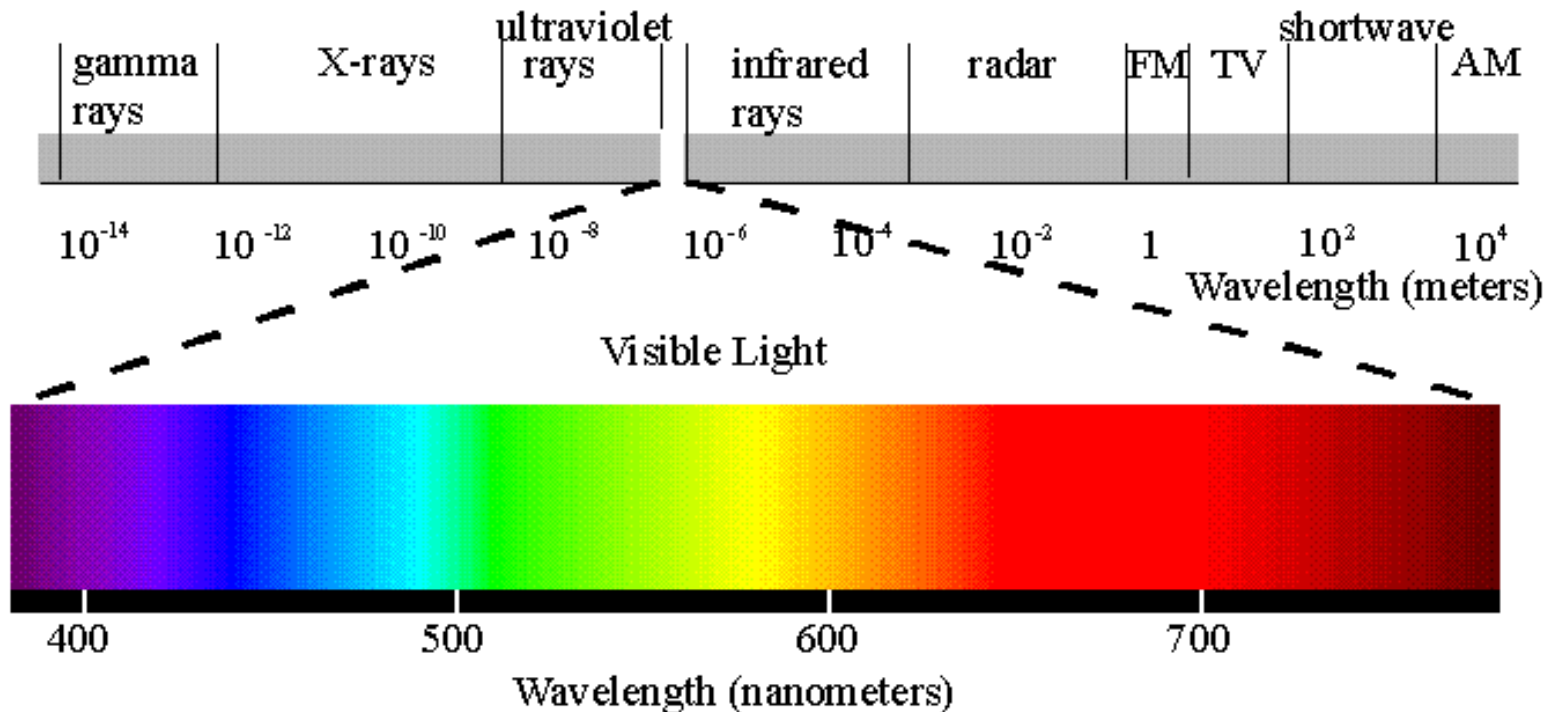
Colorimetry & Spectrophotometry

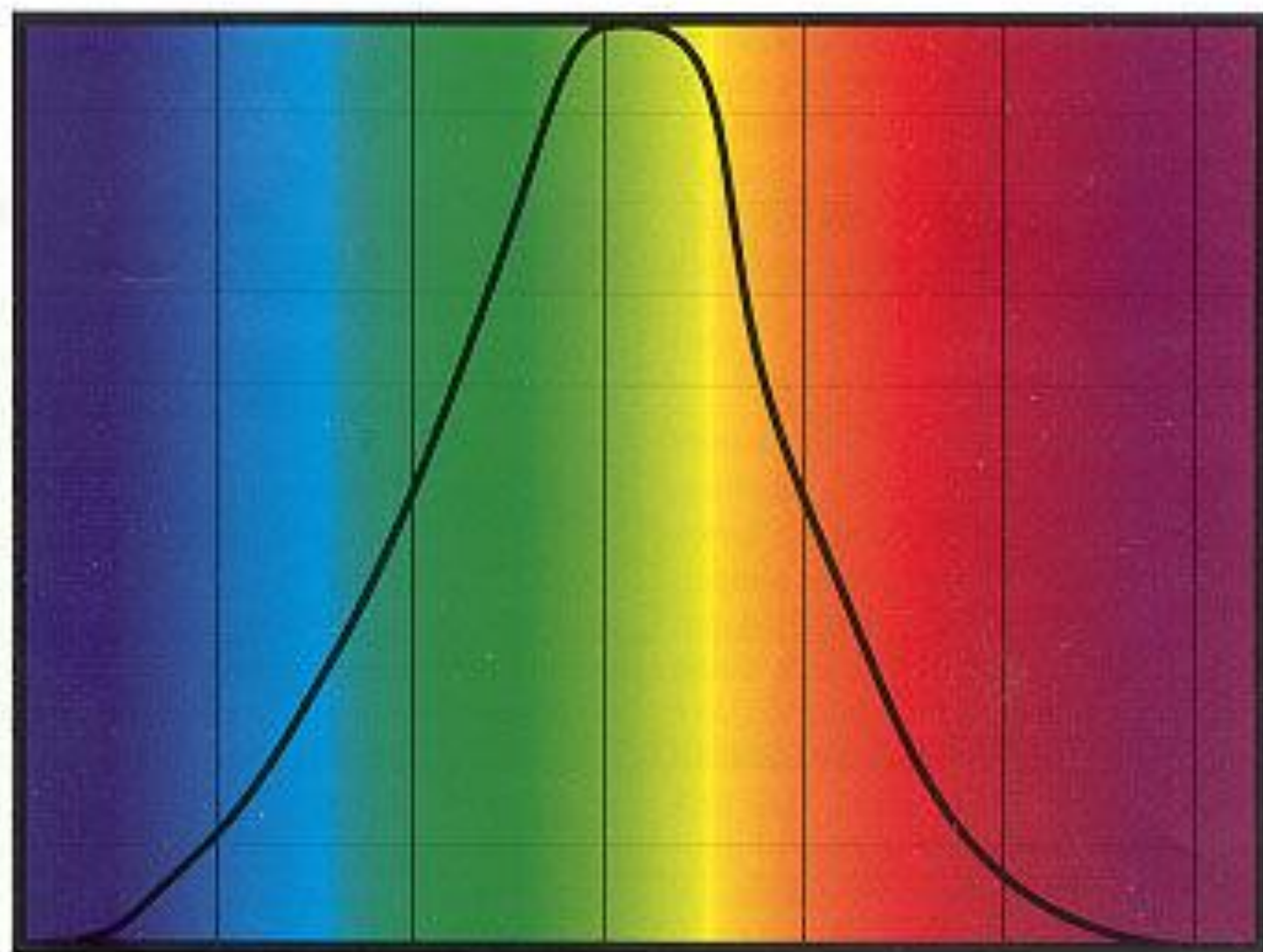
One useful and often used way of determining the concentration of a chemical in a solution, if it has a color, is to measure the intensity of the color and relate the intensity of the color to the concentration of the solution.

<http://www.chm.davidson.edu/ChemistryApplets/spectrophotometry/Spectrophotometry.html>

Principle of Light

Visible Light is a part of the electromagnetic spectrum with a range of 350 – 720 nanometers (nm)





400 450 500 550 600 650 700
Human Eye Sensitivity Chart

The LaMotte SMART 2 Colorimeter



A Computerized Way to Conduct Water Quality Analysis while using Light to Analyze the Intensity of Chemical Reactivity. The results are direct readings.

Features of the Colorimeter

- The entire multi-LED optical system is embedded in the light chamber and optimized for LaMotte test reagent systems.
- Wavelengths are set (preprogrammed for 50 tests).
- Can standardize with sample water and run multiple tests.

How it works?

It focuses on these wavelengths of light...430nm, 520nm, 570nm, 620nm

Specific chemical testing is done with kits that are colorimetric – producing a color intensive reaction

The meter measures the intensity of the color and calculates most values in parts per million (ppm)

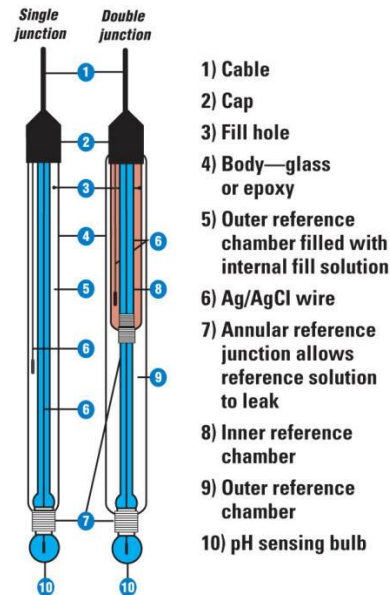
Chemical Factors: pH

- pH is a measure of the increase of Hydrogen ions in water
- Additional carbon dioxide in freshwater can decrease the pH, making the water body more acidic (dissolved gases)
- Runoff including the addition on ions in water is also important (i.e. – phosphates, chlorides, etc... that are dissolved solids)

Measuring pH

- Using a meter

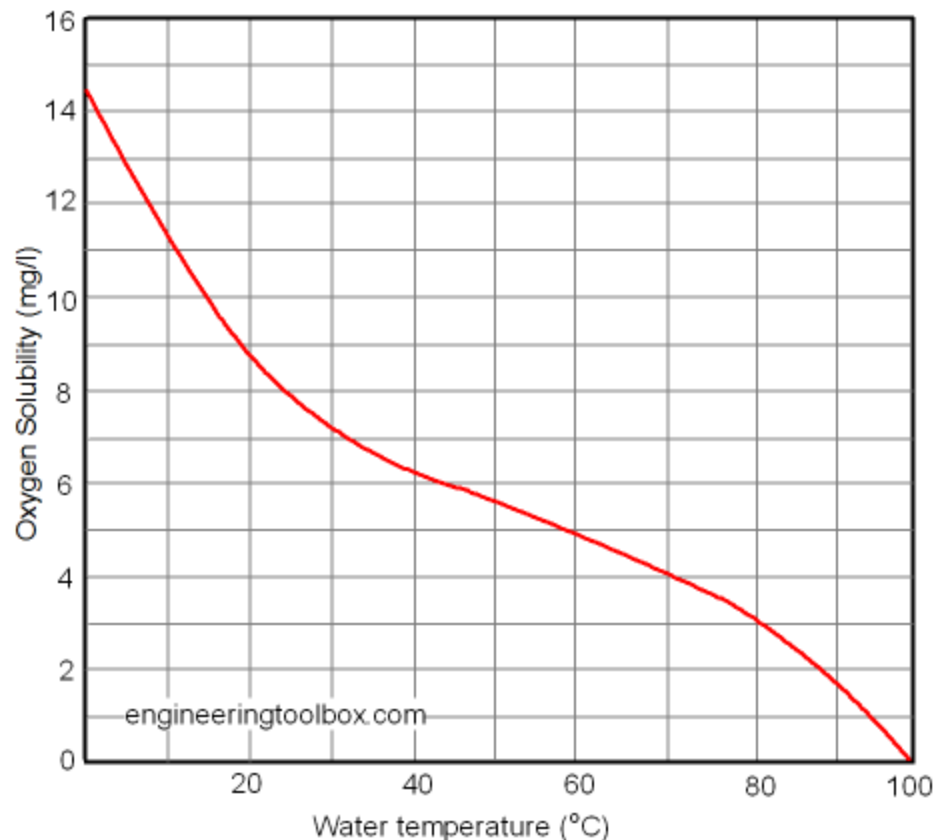
“Calibrate the probe and meter according to the manufacturer’s directions. Use of two buffers (pH 7 and 10) for calibration is recommended.”





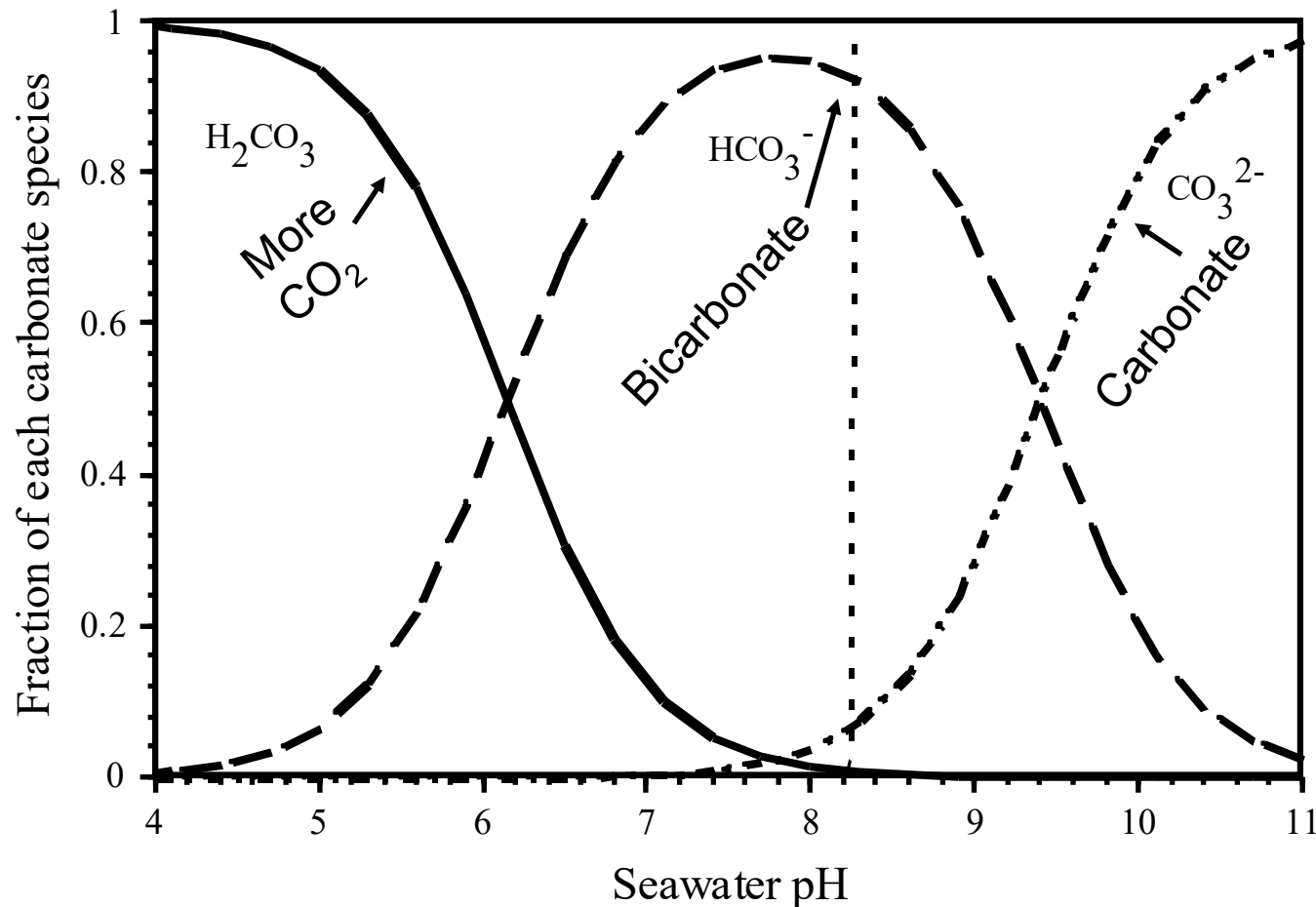
Other Factors: Gases dissolved in water

- Water can hold gases, but the amount depends on the temperature of the water.



Carbon Forms and pH of Water Bodies

- Carbonic acid (H_2CO_3), Bicarbonate (HCO_3^-), and Carbonate (CO_3^{2-}).
- $\text{H}_2\text{CO}_3 = \text{H}^+ + \text{HCO}_3^- = \text{CO}_3^{2-} + 2\text{H}^+$ (4)



Gases in Water

- Gases can be measured in mg/L as well or ppm (for both carbon dioxide and oxygen)
- Gases can be tested using meters (including the YSI series of meters)
- Gases could also be measured using test kits which include titration reactions...



Titration for O₂

- **Dissolved Oxygen** is sometimes referred to as **DO**
- The titration method to measure DO is called the **Winkler Titration**
- Once you get to the fixed stage, it could be analyzed using the colorimeter



Gases could mean...

- 1. Increased CO_2 and decreased O_2 could mean a decrease in phytoplankton or process called “eutrophication”**
- 2. How about the opposite – a plankton bloom?**
- 3. There could be seasonal variations with higher O_2 in the winter and less CO_2**

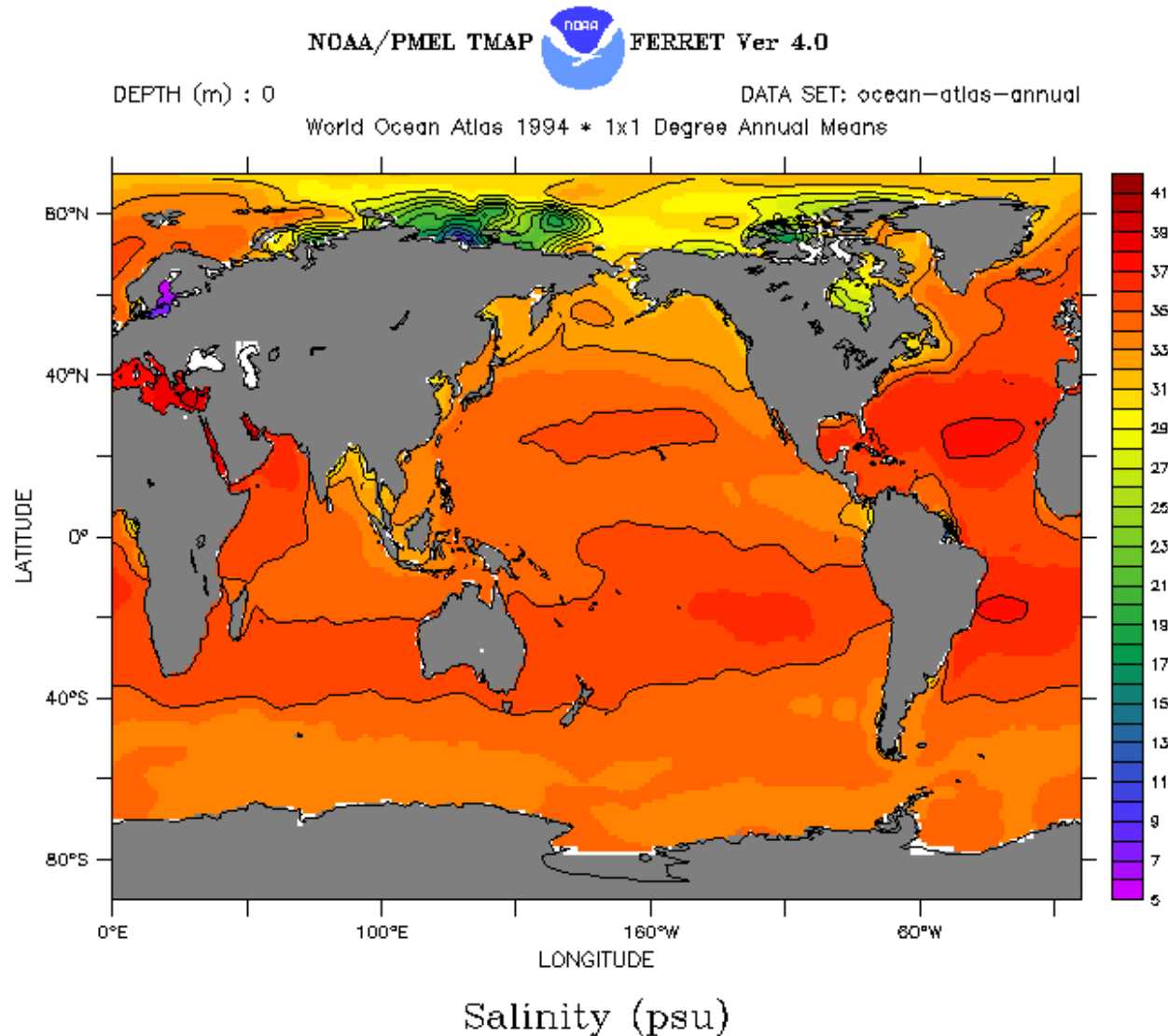
Measuring Nutrients (Kits and Colorimeter)

- Nitrogen – **Nitrates** and Total Nitrate-Nitrogen*
- Phosphorus – Usually **Phosphates***
- Sulfur – Usually in the form of Sulfates
- Iron – Sometimes considered a trace nutrient (in the oceans)

*May include some hazardous reagents

We will measure these using the colorimeter
with values in **mg/L or ppm**

Dissolved Solids: Salt ions measured in PPT or PSU



Salinity: a measure of dissolved ions

- Salinity is a measure of the dissolved cations and anions in water bodies. It can be chlorides, sodium, etc...
- Salinity is measured in parts salt per thousand parts water (PPT) or referred as PSU (practical salinity units)
- Since salt is comprised of ions, conductivity could be measured to determine salinity (most accurate method)

Measuring Salinity: Test Kit

- Using the Knudsen Titration Process. Measures the amount of chlorinity and can determine salinity

$$\text{Salinity} = 1.80655 \times \text{Chlorinity}$$

There is some subjective interpretation as to the color change when reading the direct reading titrator (to get the direct salinity reading).



Evaporation

- Take a known salt water sample and mass it using an analytical balance
- Then, heat it and capture the salt ions. Let cool in a dessicator and determine the salt content remaining (percentage) which can be converted to PPT (PSU)

Unless you use an analytical laboratory this method is not accurate.

Hydrometer



The Hydrometer is an accurate way to determine salinity if done correctly

It measures the specific gravity of water which is then converted to salinity according to temperature

It is calibrated at 60F and 60 PPT.

Refractometer



It works well with good light, but should be used in indirect sunlight.

Depending on the model, the units are hard to read accurately.

Some are calibrated at 20 C and 20 PPT.

Conductivity: Meter

Measuring the conductivity is an accurate way to determine salinity.

Conductivity of ions is measured using the following two units...

Freshwater = micro Siemens (μS)

Saltwater = milli Siemens (mS)





A **CTD**
being
set up
to
deploy



Conductivity

Temperature

Depth

Classification of Systems

- Nontidal Fresh 0 ppt, no tidal influence
- Tidal Fresh 0 - 1 ppt, tidal influence
- Oligohaline 2 - 5 ppt (slightly brackish)
- Mesohaline 8 - 15 ppt (brackish)
- Polyhaline 18 ppt and up (salt water)



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