Chemical Oceanography I: The Properties of Water

Summary. In this lecture, we will discuss the molecular properties of pure water and how these properties influence a huge range of physical, chemical and biological processes in the ocean (from biological productivity to currents, weather and climate). Much of the focus will be on density and the thermal properties of water. We will finish up by discussing the effects of adding solutes to water on these properties. These will lead us into our discussion in the next lecture on the physical and biological processes that determine the solutes that are present in sea water.

Learning objectives. These are the major organizing points of the lecture. You should understand how all of the materials presented in lecture and readings related to these learning objectives.

1) Water has many properties that are unique among any liquids known. The majority of these properties are due to the properties of the water molecule. Water is a polar molecule – even though it has a net charge of zero, the distribution of protons and electrons are such that some parts of the molecule are more negative and others more positive. The interaction between these partial + and – charges, called hydrogen bonds (or H-bonds) accounts for most of water’s unique properties.

2) The thermal properties of water make it a terrific thermal buffer (you can add or remove a lot of heat from water without the temperature changing very much). These properties are critically important in climate and weather.

3) The density (weight per unit volume) of water is a critically important property that determines many physical and biological processes in the ocean. Stratification (layering by increasing density with depth) of the water column in any body of water (lakes or oceans) affects circulation, productivity, and interactions with the atmosphere (weather and climate).

4) Water is a blue liquid that is largely transparent in the visible spectrum but strongly absorbs both ultraviolet and infrared light.

5) The addition of solutes to water alters many important properties of water, in particular the density, freezing point, and temperature of maximum density.
**A Simple Experiment**

Finish: 1 gram of water vapor at 100°C

- **Latent Heat of Evaporation:** 540 cal/gram, converts water at 100°C to vapor at 100°C

1 gram of liquid water at 100°C

- **Heat Capacity:** 1 cal/gram°C, converts water at 0°C to water at 100°C

Heat Added (cal/gram) → 0°C

- 1 gram of liquid water at 0°C
- **Latent Heat of Fusion:** 80 cal/gram, converts ice at 0°C to water at 0°C

Start: 1 gram of ice at 0°C