AOS 103

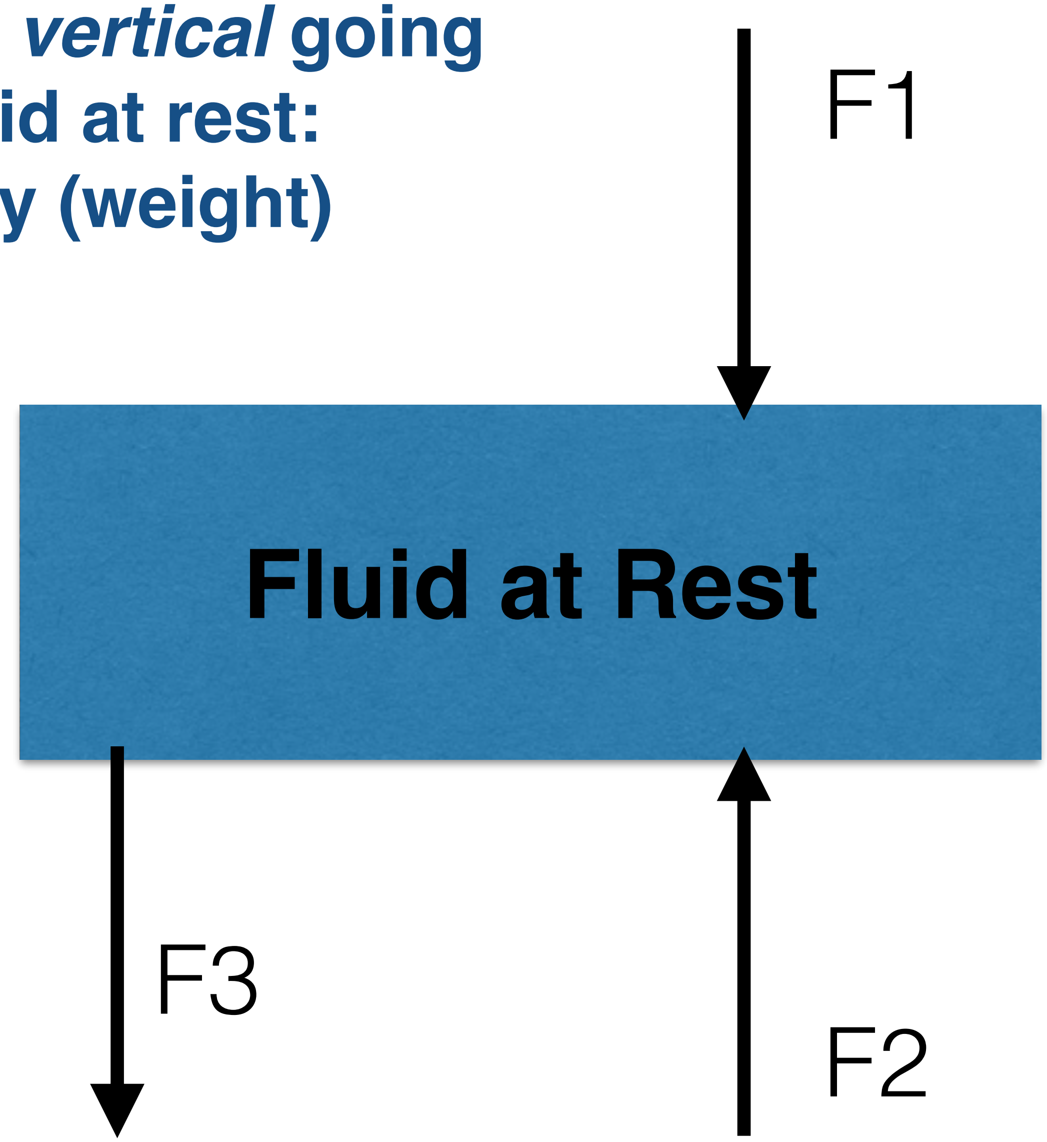
Week 3 Discussion

Pressure and Hydrostatic Balance

Explain the force balance (use a free-body diagram) that leads to hydrostatic balance

From the hydrostatic balance equation, explain the terms and what this balance implies for pressure at different depths

Only 2 things *in the vertical* going on for a block of fluid at rest: pressure and gravity (weight)

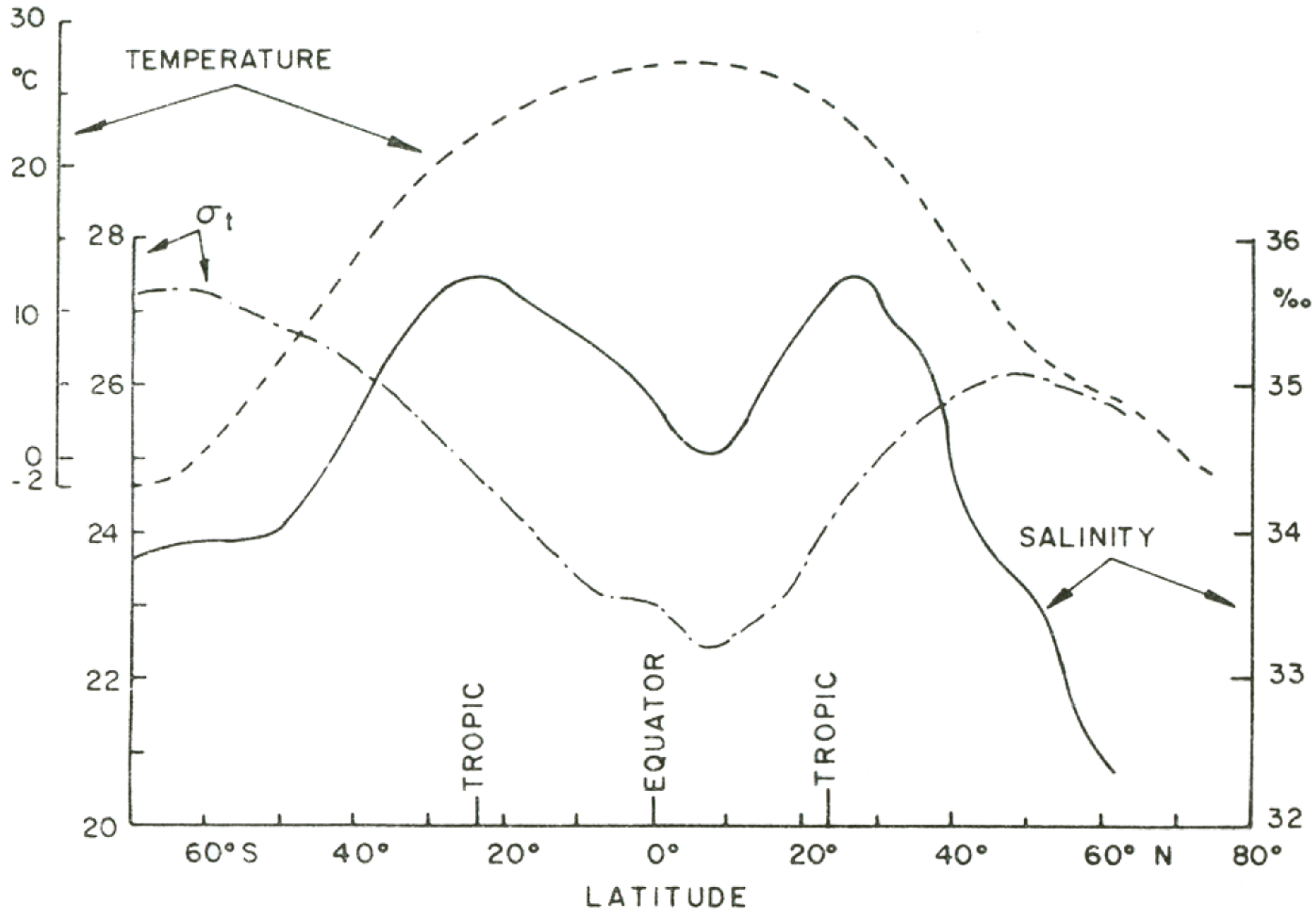


$$F_1 = -p_1 A$$
$$F_2 = p_2 A$$
$$F_3 = -\rho g V$$
$$F_1 + F_2 + F_3 = 0$$
$$-p_1 A + p_2 A - \rho g V = 0$$
$$p_1 - p_2 = -\rho g h$$
$$\Delta p = -\rho g \Delta h$$
$$\frac{\Delta p}{\Delta h} = -\rho g$$
$$\frac{\partial p}{\partial z} = -\rho g$$

Hydrostatic balance just says that at any point in the water column, the pressure is proportional the weight of the fluid above it. So at larger depth, the pressure is larger

Global Salinity Variation

Explain why the solid curve on this plot looks the way it does



Variation with latitude of surface temperature, salinity and density (σ_t)–average for all oceans.

The solid curve indicates global salinity variation as a function of latitude (pole to pole). The general story here (as told by the curve) is high salinity at mid-latitudes, low salinity at the equator and a notable asymmetry at the poles (NP vs SP).

These signals can be interpreted through the sign of P-E where (P)receiptiaton and E(vaporation) are controlled by large scale atmospheric patterns or sources of fresh water such as river and sea ice (melt/freezing).

At the equator, the large solar heat flux causes ascension of hot air and large amounts of precipitation ($P-E>0$), therefore there is a large freshwater input at the equator and low salinity

Conversely, at the mid-latitudes evaporation dominates b/c dry air is descending (i.e., the Hadley Cell circulation) and thus $P-E <0$, so there is high salinity

At the North Pole (NP), there are many sources of freshwater input form river runoff and sea ice melt, and thus it is relatively fresher than the South Pole (SP), which has more sea ice frozen (and thus saltier water b/c salt does not freeze with the ice).

Density - Equation of State

Why do we care about density (in the context of wanting to know useful things about the ocean)?

Write the linear form of the equation of state, explaining each term

Describe how density is a function of temperature, salinity, and pressure (how it changes given changes in each of those variables)

Equation of state is in lecture slides

We care about density b/c it tells us 1) about stratification and vertical stability of the water column (e.g. light over heavy water and vice versa) and 2) density gradients can drive flows (e.g. geostrophic flows via pressure gradients…density relates to pressure via hydrostatic balance, so changes in density can cause changes in pressure)

The equation of state (EOS) tells us that with higher temperature, the density is generally lower (and vice versa) and with higher salinity, the density is higher (and vice versa).

Water Masses

What types of processes can lead to water mass formation?

How are water masses defined (give examples)?

Why are T/S plots useful relative to water masses?

Draw a T/S plot for a vertical profile that is characterized by high temperature (15C), low salinity(31PSU) at the surface, slightly lower temperature (12C) and equal salinity(31PSU) at mid-depth and low temperature (8C), high salinity at the deepest point (34PSU)
(draw 3 plots, T(z), S(z), T/S plot)

Localized, surface processes (wind, evap, sea ice melt/ freezing) can lead to water mass formation

Water masses can be defined by any property that is materially conserved (potential temperature, potential density)

T/S plots allow us to track water masses from limited measurements and see where water masses are mixing with each other.