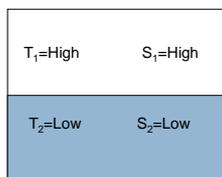


LESSON 2: Properties of Fluids

PART 2

Double Diffusion (DD)

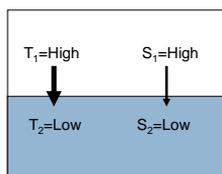
- Consider a stable column of seawater where two water masses are vertically stacked



ρ same in both, or top is slightly less;
(i.e. it's a stable system)

Double Diffusion (DD)

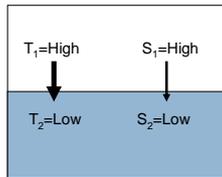
- On small scales – molecular to several meters – there is a tendency for the temperature and salinity gradients to equalize



The heat diffusion rate is much faster (**100 x greater**) than the salt diffusion rate

Double Diffusion (DD)

- This transfer of properties induces movement across the interface, resulting in fine-scale (meters) structures that could develop into larger scale instabilities

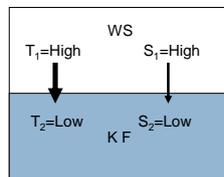


Must start with $E > O$

If there is already turbulent motion than these small scale processes will be irrelevant!

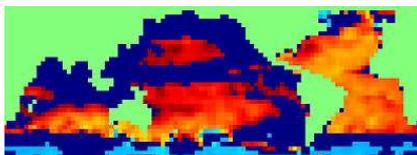
Double Diffusion (DD)

- Warm/salty (W/S) over cold/fresh (K/F)
 - Heat transfers downward
 - Salt water layer on top becomes heavier and/or freshwater below becomes lighter
 - Manifests as “salt fingers”
 - A variant of DD



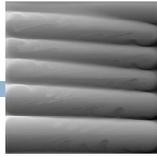
Where Does Salt Fingering Occur?

- In temperate latitudes
 - Evaporation exceeds precipitation
- Evaporation 'leaves behind' salt, surface waters are saltier than waters beneath.
- Surface waters are warmer than waters beneath, so conditions favoring salt fingering are realized throughout much of the upper temperate ocean.



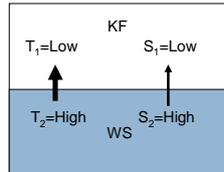
Layering

aka: Diffusive Convection



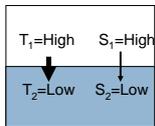
□ Cold/Fresh over Warm/Salty

- ▣ Water at the interface becomes lighter and rises, water just below interface sinks
- ▣ Spreads out laterally forming layers



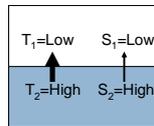
Double Diffusion (DD)

- The temperature and salinity gradients across the interface must be the same sign:



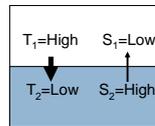
$$\frac{\partial T}{\partial z} > 0, \frac{\partial S}{\partial z} > 0$$

Salt Fingering



$$\frac{\partial T}{\partial z} < 0, \frac{\partial S}{\partial z} < 0$$

Layering



$$\frac{\partial T}{\partial z} > 0, \frac{\partial S}{\partial z} < 0$$

No double diffusion
