EVST201a/G&G140a

Problem Set #6 (Due Friday, Oct 21)

1. Compute the volume and mass of water in the world ocean, assuming that the ocean covers 2/3 of the globe and has an average depth of 5km. If the average salinity is 35ppt by mass, compute the total mass of salt in the sea.

2. Compute the temperature rise of the ocean surface if the full solar irradiance ($1380 W/m^2$) is absorbed in the first 10 meters of the ocean for a duration of 12 hours. The heat capacity of water is 4218 J/degree/kg.

3. Compute the temperature drop of the ocean surface overnight (12 hours) due to infrared emission to space. Ignore the greenhouse effect. Assume the ocean radiates like a Black Body with T=15C. Assume the first 10 meters of the ocean is well mixed.

4. If the water in the Arctic Ocean started at the freezing point in the evening, how much ice could be formed overnight (12 hours) by losing IR radiation to space? Assume the ice temperature is zero Celsius. The latent heat of freezing is $3.34*10^5$ J/kg. Neglect heat gain or loss to the atmosphere above or the ocean below. Give the ice thickness in meters.

5. Compute the direction and speed of Ekman Layer drift under the following conditions. a) no sea surface slope or horizontal pressure gradient, b) Ekman Layer depth =100m, c) windspeed =15m/s, d) wind direction = easterly, e) wind stress $\tau=C\rho_{air}U^2$ where C=0.003, f) latitude=15N. Explain the direction of Ekman drift using a vector diagram. Show that the units in your calculation are consistent.

6. The wind-driven gyre in the North Atlantic is thought to transport heat northward, keeping Europe and Scandinavia warm. Compute the net rate of heat transported northward under the following assumptions: a) the Gulf Stream is 200km wide and 1km deep with a temperature of 20C, b) it's average velocity is 50cm/sec, c) an equal amount of water returns southward in the eastern Atlantic but with a cooler temperature (T=10C). [Hint: The flux of mass in an ocean current is the product of the water density, the current speed and cross-sectional area. The heat carried per unit mass is the product of its heat capacity and temperature. The heat capacity of water is approximately 4218 J/degree/kg]. Express your answer in Watts.

7. Explain why the salinity and temperature may increase or decrease with depth in the ocean, but the water density must always increase.