# Study Questions—Week 8 *Diversity Gradients and Climate*

## Forests Through Time and Space
## These are due next Mon (Nov 22)

Complete the workshop questions from class. Here they are with the corrections announced in class and some clarifications prompted by questions from students. When calculating MRT remember that all fluxes have a time unit in the denominator (e.g. lb/day, kg per yr, gallons/min). MRT gives you an estimate of how long whatever you're looking at spends in the mass (or pool). The answer to question 1 below will give an estimate of how long water spends in the human body. If someone drinks more than the 40 ml/kg body weight, they will excrete more.

1. Calculate the MRT for water in humans with the following examples. **Equilibrium water intake** is about 40 ml/kg body weight **per day** for both genders. Male: 70 kg, 60% water; Female: 56.6 kg, 50% water.
2. Lifting of air masses cools them according to the adiabatic rate (dry adiabatic rate -10°C/ 1000m, wet rate is -6°C/ 1000m). Here in the PNW, orographic lifting (lifting of air due to topography forcing it up) is responsible for much of the rainfall we receive on the west side. At what elevation would clouds and rain begin to form for air that is at 16°C and 74% RH at sea level (dewpoint is 11°C). What would the air temperature be at Paradise (1676 m)? Calculate the temperature on the east side of the mountains for the same elevation where clouds formed on the west side. Assume all heating/cooling is due to elevation changes only. (1m = 3.28 ft) **Use the dry rate until the air reaches saturation, then use the wet rate.**
3. When their orchard crops are threatened by freezing temperatures at night, fruit growers will often use sprinklers to spray water in their orchards. This often results in the fruit being coated with ice, but can protect it from freezing overnight. This strategy will not work for a prolonged sub-freezing period (multiple days). Explain how this works and why it won't work for longer periods.
4. In his lecture, Bret did not get to the predictions of his theory that seeks to explain the latitudinal diversity gradient (the so-called "double-edged sword" principle). Come up with three predictions that follow from the theory. (Remember that predictions necessarily follow from a hypothesis or theory, and if a prediction turns out to be untrue, then the hypothesis/theory has been falsified.)
5. Describe two *other* theories regarding the latitudinal diversity gradient. What is the support for each of them? The evidence against?

6. How will forests respond to the climate change due to global warming? Pick a specific forest type in the temperate zone and one in the tropical zone to illustrate your answer. You may use the Internet to help gain a deeper understanding of this topic.
7. A cloudforest is located on the windward (western) side of a mountain range, starting around 915 m. The top of the mountain range is 2000 m. Dry adiabatic rate -10°C/ 1000m, wet rate is -6°C/ 1000 m. Assume all heating/cooling is due to elevation changes only for these questions.
    a. The average summer conditions on the lowland (90 m elevation, west of the mountains) are 20°C and 60% RH (dewpoint is 12°C). At what elevation would clouds begin to form? And what would the air temperature be at the summit?
    b. Due to clearing of the lowland forests, the temperature of the air in the lowland goes up to 24°C and 50% RH (dewpoint 13°C). Will this impact the cloud forest? Support your answer with calculations

# 8. Quiz Questions—Week 8

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1. Using the double-edged sword principle described by Bret to explain the latitudinal diversity gradient, explain why no organisms have evolved a stable strategy for long-term persistence in the temperate zone, and how that contributes to patterns of global diversity.
2. Forests are being used in the global warming discussion as a way of taking carbon dioxide out of the atmosphere. Different forest ecosystems hold onto the carbon in the trees for varying time periods.
    a. Which of the forest types listed below has the potential to store the most carbon Why?
    b. Which of the forest types listed below stores their carbon for the longest time? Calculate the MRT for carbon in the various forests. Is this the same forest that you chose for "a"? Explain your results.

| Ecosystem | Area ($10^{12}$ $m^2$) | Mean plant Biomass (kg $C/m^2$) | Total mass of carbon in vegetation ($10^{15}$ g) | Net primary Production ($10^{15}$ g/yr) |
|---|---|---|---|---|
| Tropical wet & Moist forest | 10.4 | 15.0 | 156.0 | 8.3 |
| Tropical dry forest | 7.7 | 6.5 | 49.7 | 4.8 |
| Temperate forest | 9.2 | 8.0 | 73.3 | 6.0 |
| Boreal forest | 15.0 | 9.5 | 143.0 | 6.4 |