TOP TEN THINGS TO STUDY FOR TEST #3

Test #3 is on Tuesday Nov 2, 2010

(which is also Election Day!)

Like Test #1, Test #2 will consist of 10 multiple choice questions. Some questions will be slight variations of the RQ questions, but other questions will be a bit harder than those in the RQ's and they will cover the material in class presentations, in addition to the reading you've been doing for the RQ's.

FOLLOWING ARE THE TOPICS & READINGS COVERED IN TEST #3 *(also see the D2L Checklist)*

- **Test #3 will cover Topics #10 through #13.**
- The readings that accompany these topics are in **Chapters 2, (parts of 3) , 4, and 15 in the SGC-I text,** (with a few additional pages in *Dire Predictions* listed on the weekly Checklist & Textbook Reading Schedule)
- **Self Check&/ Readiness Quizzes RQ-5 & RQ-6** will help you to focus on the concepts of these readings that are most important for you to know and understand.

Following are a few more pointers on things to be sure you have read or understood:

- A review of key points from the first half of the semester related to SW & LW electromagnetic radiation can be found in the "**Class Concepts Self Test"** on p 52 in Class Notes.
  The answers are Q1-B, Q2-No, Q-3Yes, Q4-No, Q5-circle the arrows involved in part 4 of the diagram only, Q6-all the things we talked about in class in Topic #10 (see pp 123-124)]
- **The Global Energy Balance** -- focus on pp 49 -53 and 122-126 in Class Notes and -- especially -- the very important lecture on **Topic #10.**
- **Chapter 2** in SGC-I on **Topic #11 Systems & Feedbacks** -- focus on the first part of the chapter and the items emphasized in Self-Test & RQ-5.
- **Chapter 4** in SGC-I go into a bit more detail than was covered in the presentations on **Topic #12 How Climate Works** but the items in the Top Ten below will help you focus on the main points. Be sure you understand Figs 4-1, 4-2, 4-3, & have a good grasp of Earth-Sun Relationships and the seasonal climate differences, as in Fig 4-15 and 4-16. Also note that you've seen a version of Fig 4-23 in a previous lectures (tied in with thermodynamics) but here it is again, now being tied into global climate patterns. In addition, the figures discussed in class related to the **Radiation Balance & the General Circulation of the Atmosphere** that are in CLASS NOTES (pp 64-65) for Topic # 10 are very important -- **esp. those noted in the "Top 10" items below.**
- For **Ocean Circulation,** the question that will be asked will be related to how ocean circulation fits into either the figure on the bottom of p 65 or the figure on the bottom of p 67 in Class Notes. Both of these figures relate to Poleward heat transport necessary to balance out the surplus and deficit regions of energy.
  (NOTE: There will *not* be any questions on El Niño or La Niña or the Thermohaline Circulation on this test -- we didn't spend enough time in class on them to warrant a test question.)
- In **Chapter 15** in SGC focus on the first part that deals with climate changes of the past, pp 289-306
- For **Topic #13 Natural Climatic Forcing,** review astronomical forcing, solar forcing, and volcanic forcing as addressed in the Topic #13 lecture, the corresponding Class Notes pages, and in Self Test and RQ-6.

ANIMATIONS: The following **animations** *(which are also linked in your D2L Checklist)* may be useful aids for enhancing your understanding of some of the processes you've been learning about

Animations of the Global Energy Balance

Global Energy Balance

Shortwave and Longwave Energy Pathways Animation

Animations of Global Energy Balance Map Patterns *(these were shown during the Topic #12 lecture)*

Incoming Shortwave Radiation SW
Outgoing Longwave Radiation LW
Net Radiation (R net)
Air Temperature
See more at: http://geography.uoregon.edu/envchange/clim_animations/index.html#Global Energy Balance

Animation of global atmospheric circulation

Model simulation of the global atmospheric circulation for one year.

Animation showing how a convection cell forms

Formation of Convective Circulation to see how an underlying warm surface can start up a convection cell circulation

Animation of Earth-Sun Relationships that Define the Seasons

Earth-Sun Relationships

AND NOW THE TOP TEN:

On the TOPIC #10 - THE GLOBAL ENERGY BALANCE:

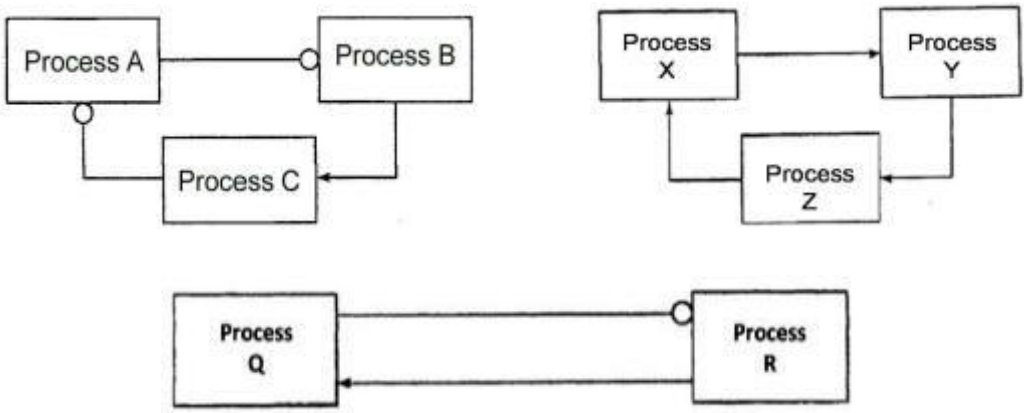
1. E**NERGY BALANCE:** Be able to write out and/or *recognize* the basic **Energy Balance Equation** *(see top of p 49 and 51 in Class Notes)* from memory using the cartoon symbols from class or fill in a missing term or + or - sign if it is blanked out.). Know what each term in the equation means, (e.g., **direct SW, diffuse SW, albedo, H, LE G,** etc. **Understand the general "pathways" of SW and LW radiation as summarized under** *"Climate Science Literacy & Global Change Concepts***" on p 51 in CLASS NOTES.** (Also see the ANIMATION noted above). *Specific Hint:* Look at the figure on p 50 in CLASS NOTES which shows **the amount of energy (in Watts per square meter)** involved in each of the different pathways. Note that MORE energy is involved in the pathways of LW related to **the Greenhouse Effect** (GHE) than just about anywhere else in the Energy Pathways diagram! A huge mount of longwave (LW) energy is transferred back and forth between the Earth's surface and the atmosphere via the GHE. Understand what the difference is between the LEFT side of the equation (the electromagnetic radiation balance part) and the RIGHT side of the equation (the thermal energy balance part, i.e. H, LE, & G). Even more specifically, do you understand the difference between these two terms??

On TOPIC # 11 - SYSTEMS & FEEDBACKS

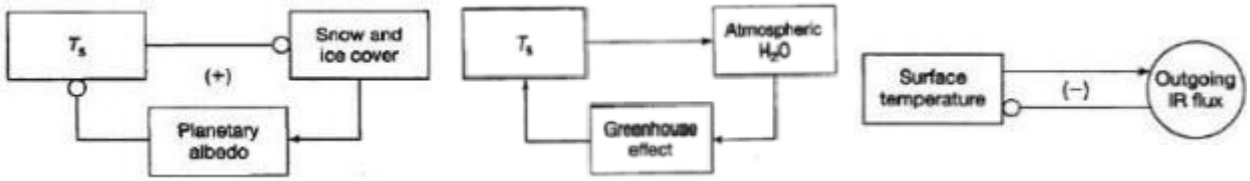
2. Understand the concept of a SYSTEM, including COUPLINGS, FEEDBACK LOOPS (both positive & negative feedback loops). Know how to recognize whether a coupling diagram is a **positive** or **negative coupling** and whether a **feedback loop** is a **positive or negative loop**. Understand that a negative feedback loop is "**self regulating"** and a positive feedback loop is **"self-amplifying."** *Specific Hint:* Know which type of loop (positive or negative) is associated with a **STABLE equilibrium state** and which type is associated with an **UNSTABLE equilibrium state** and know which of these states is of greatest concern with respect to perturbations and forcings leading to global climate change. Know the difference between a **PERTURBATION** and a **FORCING** as defined in SGC and on p 59 in CLASS NOTES.

Test your understanding (see systems diagrams on next page)

-- Coupling A-B is negative, Coupling B-C is positive, the complete A-B-C Feedback Loop is positive. Why?
-- The X-Y-Z Feedback Loop is also positive, even though it looks different than the A-B-C Loop. Why?
-- Feedback Loop Q-R is negative and is also the only system diagram shown having a stable equilibrium state. Why?



3**.** Over and above being able to identify the type of feedback or coupling by its diagram, be able to **reason your way through the actual physical processes** that are coupled together in the feedback loops shown below (and on pp 28 and 52-53 in SGC) to explain how they work.



On TOPIC # 12 - HOW CLIMATE WORKS (ATMOSPEHRIC & OCEAN CIRCULATION)
(HINT: many of the points in items below are succinctly summarized in the CHAPTER SUMMARY on SGC-I p. 81) and Topic #12 (pp 63-67) in CLASS NOTES.

4**. Variations in Energy from the Sun (due to Seasons & the Earth-Sun Relationships)** -- Understand what **causes the seasons** and know what the following terms mean: **solstice, equinox, axis tilt (obliquity), aphelion, perihelion (see # 8 below.** Understand how latitudinal differences in **solar insolation** arise due to Earth-Sun relationships and how the combination of solar **intensity** (depends on sun angle) and **duration** (depends on length of day) leads to seasonal and latitudinal differences in how much incoming shortwave solar radiation is received by the Earth (see SGC-I pp 66-68.

5 Atmospheric Circulation - Know how and why air circulates (vertically and horizontally) in **high and low pressure centers.** Know key places where **subsidence** (sinking air) occurs (i.e., the **subtropical highs)** and why it's linked to the world's largest deserts. Know where air tends **to rise** (near the equator in what's called the **intertropical convergence zone or ITCZ**) and why this is linked to the rainy tropics. Know how both these areas are linked to the process called the **Hadley circulation** (shown along with the ITCZ in Fig. 4-3 in SGC-I p 60).

6**. Global Latitudinal Energy Distribution and Net Radiation** -- Understand why more solar energy is received and absorbed by the Earth's surface in the low latitudes (near the equator) and less in the high latitudes (near the poles.) Understand **Figure 4-2** in SGC-I (p 59) and p 64 in CLASS NOTES and be able to link it to the concepts of incoming solar shortwave radiation and outgoing terrestrial longwave radiation and how this leads to energy surpluses and deficits at different latitudes. *Specific Hint:* Understand how the figure on the bottom of CLASS NOTES p 65 depicts **ways in which energy is transported poleward from surplus to deficit areas of the globe** and the **role that Hadley Cells, Rossby waves** and the transfer of energy from **H => LE => H through H_2O phase changes** plays in this transport of energy.

7. Ocean Circulation -- Understand how the *General Circulation of the Atmosphere* (Fig 4-11) drives the **circulation of the warm and cool surface ocean currents** (p. 66 in CLASS NOTES), especially via the large gyres in the oceans that are steered by winds. Know that the deep ocean "conveyor belt" circulation is driven not by winds but by differences in the temperature and salinity of the water (cold or saline = more dense; warm or fresh = less dense) *Specific Hint:* Understand the **relative roles that ocean and atmospheric circulation play in transporting heat poleward** in the Northern Hemisphere to balance areas of energy surplus with areas of energy deficit. The question that will be asked will be related to how ocean circulation fits into either the figure on the bottom of p 65 or the figure on the bottom of p 67 in CLASS NOTES.
(NOTE: There will *not* be any questions on El Niño or La Niña or the Thermohaline Circulation on this test -- we didn't spend enough time in class on them to warrant a test question.)

On TOPIC # 13 - NATURAL CLIMATIC FORCING

8. **Astronomical Forcing** -- Review the principles that govern the amount of solar energy received by the Earth due to Earth-Sun Orbital Relationships over long periods of geologic time (how much the Earth's axis tilts, how elliptical the shape of the Earth's orbit is, and the variation in the time of year when the Earth is closest to the Sun). *Specific Hint:* Know that at present, the **Earth is farthest from the Sun in July** (not January) (as in Figure X & Y below) and what implications this has for the amount of solar insolation received by the Northern Hemisphere during its summer (Jun-Aug) compared to the Southern Hemisphere during *its* summer (Dec - Feb) . How might the climate of the Northern Hemisphere have been different in the past with the opposite configuration, i.e., when the Earth was farthest from the Sun during the *Southern Hemisphere's* summer and therefore closest during the Northern Hemisphere's summer (depicted in Figure Z below)?

Figure X

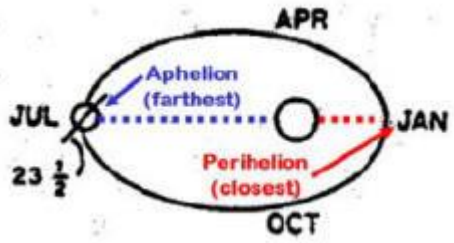


Figure Y

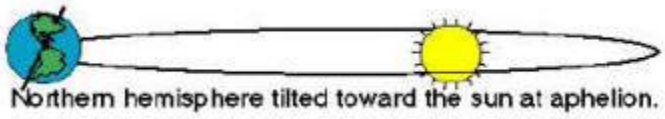
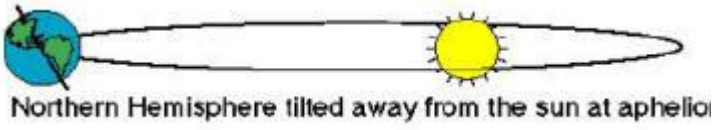


Figure Z



9. Solar Variability -- Know that periods of MORE sunspots = GREATER solar brightness and periods of FEWER sunspots = LESS solar brightness. Know where we are on the sunspot "cycle" right now (maximum or minimum). Know why the "Maunder Minimum" period is significant (answer = dearth of sunspots and a possible factor in the Little Ice Age -- although there were also a lot of volcanic eruptions then). Know also that linking solar variability to temperature trends on Earth has been inconclusive and can't account for all of recent 20th century warming.

10. Volcanism and Climate -- Know **how volcanic eruptions can affect climate**, understand the process whereby this effect takes place and what the importance of **sulfate aerosols** is. Know how temperature is affected by an eruption. *Specific Hint:* **Be able to tie all this into the ENERGY BALANCE equation (esp. incoming SW).**