

TOP TEN THINGS TO STUDY FOR TEST #4

Test #4 is on TUESDAY Nov 25th A Test #4 Study Session will be held on Monday Nov 24th @ 4 :30 - 5:30 pm in the [Bannister Tree-Ring Building, Room 110](#)

Like the other tests, Test #4 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 will cover the material in class presentations and reading you've been doing. NOTE: There WILL be an INDIVIDUAL test this time!

FOLLOWING ARE THE TOPICS & READINGS COVERED IN TEST #4 (also see the D2L Checklist)

- **Topic #11 Wrap-Up on Volcanism & the G-5 Group Activity** (Review Class Notes p 75-77)
- **Topic #12 - Ozone Depletion in the Stratosphere** (Class Notes pp 79-81)
- **Topic #13 Global Warming & Anthropogenic Forcing** (Class Notes pp 83-89)
- **Additional Key Concepts related to Topic #13:**
 - **Radiative Forcing** figure on Class Notes p 86-87
 - **Global Dimming figures shown in presentation on Nov 21**
 - **Assignment I-3 and I-4 The Climate Science Basics Tutorials: Lessons 3 and 4**

READINGS:

- **SGC E-Text:** SGC Chapter 1 (review) & SGC Chapter 15 (pp 301-313)
also review SGC- Chapter 15 (on Holocene climate change and volcanism pp 296 -300 & Figures 15-1, 15-5, 15-6, and 15-11)
- **Dire Predictions:** (pp 26-27 and 94-97) on the **Carbon Cycle** & (pp 64 -75) on various aspects of **Climate Models**
- **IPCC 2007:** (PDF's) [IPCC: FREQUENTLY ASKED QUESTION 2.1 How do Human Activities Contribute to Climate Change and How do they Compare with Natural Influences?](#) & [Synthesis Report for Policymakers \(SPM\)](#)

NOTE: These readings are also linked to **SELF TEST 8 on Global Warming** and in the D2L Checklist for **Week 13**.

Self Check&/ Readiness Quizzes:

SELF TESTS & RQ-7 & RQ-8 will help you to focus on the concepts of these readings that are most important for you to know and understand, in fact **SELF TESTS 7 & 8** are probably your BEST RESOURCES to prepare for Test #4 -- in addition to Class Notes!

The test will also cover a few concepts from earlier in the semester (specified in the "Top 10" below) that are necessary background for the concepts of **Ozone Depletion & Global Warming**. Note that some questions on the test may come directly from Dr H's class presentations (along with the accompanying pages in Class Notes). So if you have missed any classes, be sure you review these presentations online using the CLASS FOLLOW UP link. Also the **I-3 and I-4 Climate Basics Tutorials** should be reviewed as their information is especially relevant for this section of the course!

AND NOW THE TOP TEN

ON TOPIC #11 WRAP-UP: G-5 VOLCANISM & CLIMATE ACTIVITY

1. Volcanism and Climate G-5 Activity (see pp 76-77 in Class Notes) What is the difference between how the **tropospheric and stratospheric temperature** responds to an eruption and why? **Specific Hint:** Be able to tie all this into the **ENERGY BALANCE** as in question #5 on page 77 in Class Notes (see also # 10 below for info about the Energy Balance and volcanism) .

ON TOPIC #12 - OZONE DEPLETION IN THE STRATOSPHERE

[NOTE: Start out by going through the 6-bullet summary on p. 81 of Class Notes -(Ozone Depletion: What, Why & Where)- These are the key concepts to know and understand.]

2. Ozone vertical distribution & the Chapman Mechanism - Know where most of the Earth's ozone is located (what level in the atmosphere). Know how to interpret the absorption curve for Ozone/Oxygen which you've seen before but is repeated on p 79 in Class Note. Can you answer questions about O₃'s ability to absorb both UV and IR wavelengths? Understand the difference between how ozone forms in the troposphere vs. the stratosphere and whether the O₃ at these two levels is "good" or "bad." Know what a Dobson unit is (i.e., "Dobson units" are used to describe ozone column depth; low Dobson units = greater ozone depletion.)

Specific Hint: Know what the **Chapman mechanism** is, where it operates in the atmosphere, and how it both produces and destroys ozone. -- Know how photons are involved in the production and destruction of ozone through the Chapman mechanism. Know what the process photodissociation (by UV) is and how it operates in the natural Chapman mechanism and in the anthropogenic destruction of ozone.

3. Anthropogenic-Related Depletion of Ozone -- Know what a catalyst is and why chlorine is considered a catalyst for ozone destruction. Know what role CFCs play with respect to the depletion of ozone.

Specific Hint: Know how the link between chlorine and ozone depletion was discovered (see SGC Fig 1-7) Mechanisms for halting ozone depletion -- Know how international agreements and CFC substitutes are both playing a role in the halting of stratospheric ozone depletion and why the ozone hole is taking such a long time to "heal."

4. Antarctic Ozone Hole -- Know what the Antarctic Ozone Hole is, when and where it occurs, and how the processes that are involved in it are unique when compared to the processes that affect the distribution of ozone over the rest of the globe.

Specific Hint: Understand the importance of the **Spring season**, the **polar vortex** and **polar stratospheric clouds (PSCs)** for the development of the Antarctic ozone hole. Know the story of how the ozone hole was discovered .

TOPIC #13 GLOBAL WARMING & ANTHROPOGENIC FORCING

5. Carbon Reservoirs & Fluxes, -- Know what the major **carbon reservoirs** are and what processes lead to **fluxes** of carbon into (**sinks**) and out of (**sources**) these reservoirs, especially **respiration/decomposition and photosynthesis** (p 83 in Class Notes).

Specific Hint: Understand what causes the annual oscillations in the **Keeling Curve**. Know the chief causes of the currently observed rise in CO₂ concentrations and how the atmospheric carbon *steady state* is being "perturbed" and disrupted. Know that **carbon emissions into the atmosphere** have increased at an increasing rate since the Industrial Revolution due to both GHG emissions and land use change (i.e., deforestation). I

Specific Hint: Know also that *re-forested* lands in the U.S. and Europe have recently become carbon sinks, while *tropical deforestation* has been accelerating dramatically (see graphs on p 84 in Class Notes & pp 174-175 in Dire Predictions.)

6. Radiative Forcing - Read [IPCC: FREQUENTLY ASKED QUESTION 2.1 How do Human Activities Contribute to Climate Change and How do they Compare with Natural Influences?](#) Know what radiative forcing is and how to read the **important Radiative Forcing figure shown on pp 86 and 87 in Class Notes**. Could you use the figure on p 90 to answer a question about which forcings are best understood? Which are the most effective in forcing a radiative change? Which lead to warming and which lead to cooling?

Specific Hint: What is the difference in the forcing related to **ozone in the stratosphere vs. the troposphere?**

7. "Observable Changes" -- **Climate Science Basics Tutorial I-3** (Lesson 3) and the **"Too Hot Not to Handle"** film described many global climate changes that are already occurring. The figure on p 91 in Class Notes summarizes these: **"Indicators of a Warming World"**. Can you recognize which changes have been observed in response to warming temperatures and which haven't? (e.g., See Q 17 in Self Test 8, based on the IPCC 2007 Synthesis Report "Summary for Policymakers")

Specific Hint: Many of the "Indicators" (on Class Notes p 91) were covered in the movie **"Too Hot Not to Handle."** Could you **answer a question about one of these items** addressed in the movie and/or covered in the Lessons of the Climate Science Basics Tutorials: Heat Waves, Weather Extremes, Snowpack, Forest Fires, Coral Reefs, Extinctions, Tropical Diseases, Pollen, Melting Alaska, Rising Sea Level, Storm Surges, Hurricanes?

Specific Hint: See also the section in **Dire Predictions** on how *"fingerprints distinguish human and natural impacts on climate."* (pp 72-75). Know how tropospheric and stratospheric temperatures change after the natural forcing of an volcanic eruption, vs. the anthropogenic forcing of the enhanced greenhouse effect.

8. Evidence from Natural Archives - Know what the importance is of the time series plots of reconstructed temperature anomalies called **"The Hockey Stick"** and **"The Spaghetti Plate"** on p 88 in the Class Notes and in **Questions #8 and #10 in Self Test #8 on Global Warming**. (see the Hockey Stick figure in color [HERE](#). The Spaghetti Plate figure can be seen in color on **p 47 in Dire Predictions**.)

Specific Hint: What do the Hockey Stick and Spaghetti Plate figures suggest about whether the most recent warming is simply natural climate variability or anthropogenically influenced? Also be sure you understand how the modified "Hockey stick" figure in **Question #9 in Self-Test #8 on Global Warming** ties together 3 different types of information: (1) the paleorecord, (2) the modern observed record, and (3) future model projections of the earth's average temperature. Click [HERE](#) to see this same figure.

9. Evidence from Natural vs. Anthropogenic Model Comparisons -- See the **I-4 Tutorial on Climate Modeling** and Section 2. on "Causes of Change" in the [IPCC Synthesis Report Summary for Policy makers \(SPM\)](#) and pp 64-71 in **Dire Predictions** on Climate Models. Also review p 89 in Class Notes and **Question #11 in Self Test #8 on Global Warming** (including the HINT).

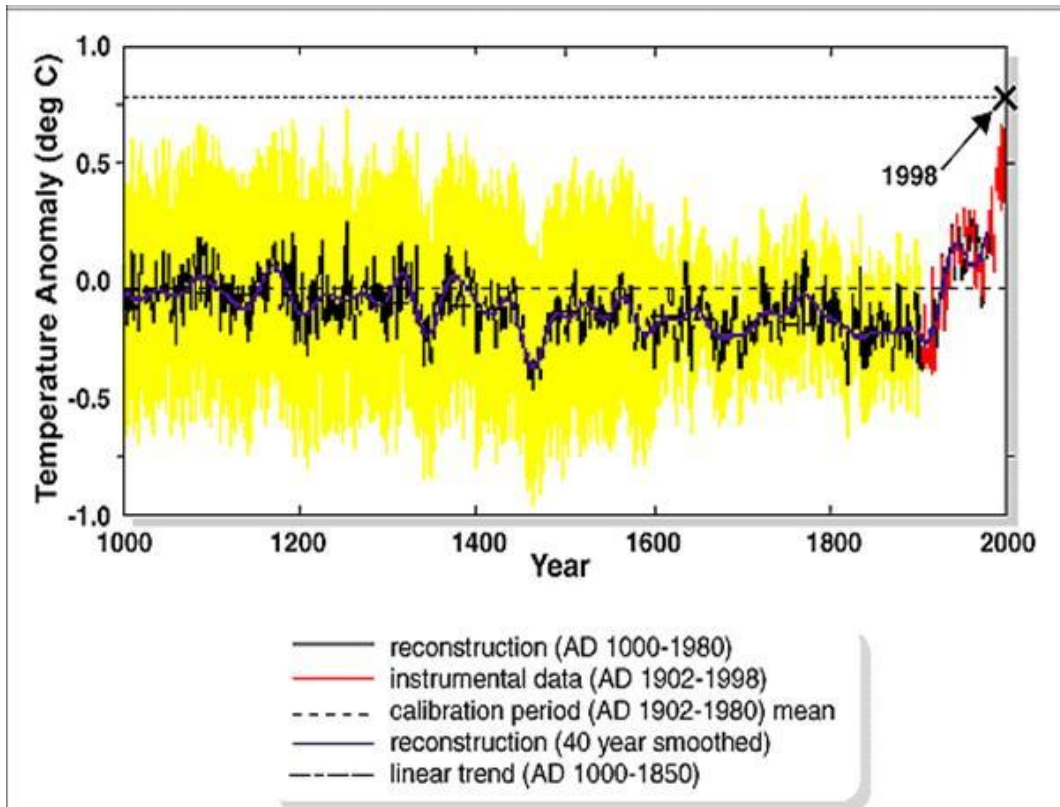
Specific Hint: Understand how the natural and anthropogenic- forced computer projections of temperature provide evidence about the role that anthropogenic forcing plays in explaining the observed temperature variations since 1900.

10. Be sure you understand how energy surplus and deficit changes can take place from different kinds of radiative forcings as displayed on the **RADIATION / ENERGY BALANCE DIAGRAM** (Fig 4-2 in SGC p 61 and also on p 65 in Class Notes). **A brief review of the Radiation Balance Diagram and surplus and deficit changes** was given on Monday Nov 7th. The relevant part of the presentation refers to Question # 5 on p 77 in Class Notes and the shift of curve A and B after a major volcanic eruption. The **presentation given on Nov 6th as background to the G-5 Assignment on Volcanism spells out how to reason this out** (see Class Follow-Up). The answer to Question #5 on p 77 of Class Notes is given in the presentation on Nov 20th (see Class Follow Up).

Specific Hint: **How might Curves A and/or B shift if -- instead of volcanic forcing -- the forcing was an anthropogenically enhanced GH Effect?? How might forcing from Global (Solar) Dimming shift Curves A or B?** (see examples below)

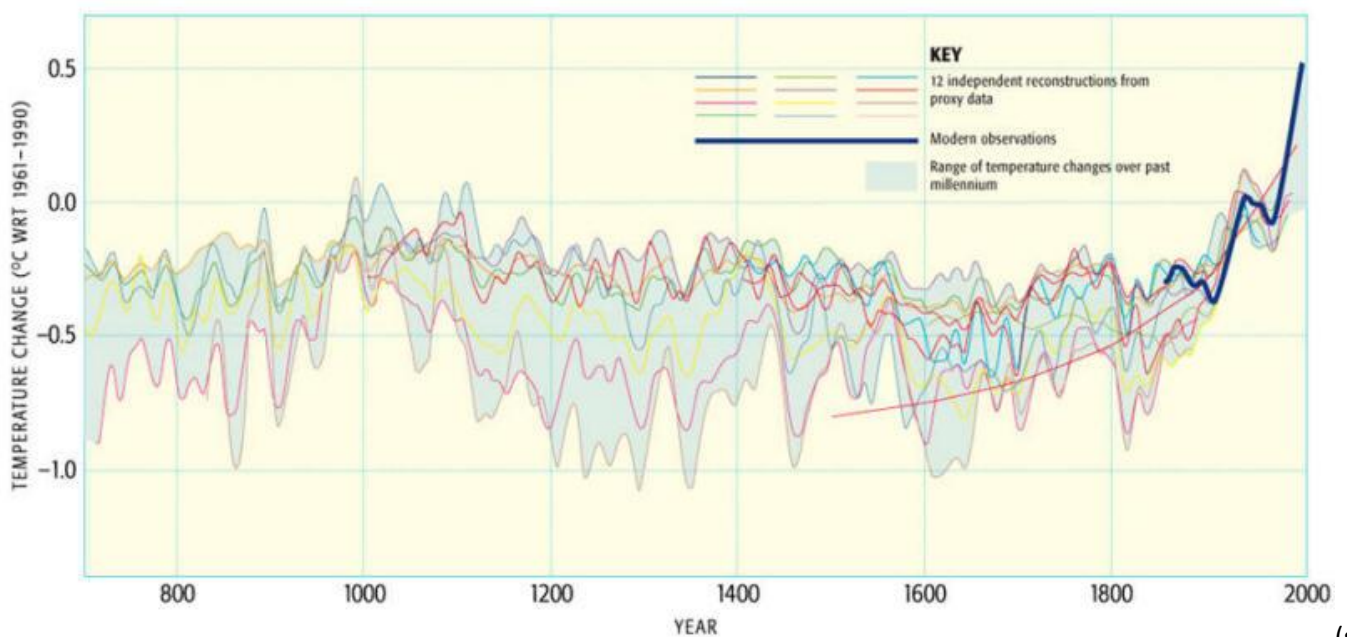
The "Hockey Stick" Figure

(yellow area indicates the range of uncertainty in the values of the reconstructed temperatures)



The "Spaghetti Plate" Figure

NORTHERN HEMISPHERE TEMPERATURE CHANGES OVER THE PAST MILLENNIUM



see p 46-47 in *Dire Predictions*)

(s

