GEOS 204 1. Hour Exam

March 10th, 2009 Name: Answer Key

Please answer five of the following six questions. You can also answer the extra credit question.

Please note that answers without an explanation will not receive full credit.

Sketches and drawings should be done carefully. I don't think that any of the questions are trivial - they all require some thought (I hope).

1. Systems

a) What is an equilibrium state? Which different equilibrium states do exist in systems? How would you test for them?

b) Describe the two equilibrium states of Daisy World. Make sure to explain how you arrived at your answer.

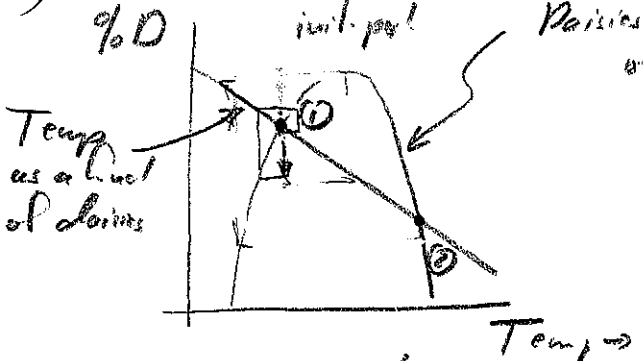
a) equilibrium state describes a state at which the system does not change unless driven to do so

stable eq. - small perturbation causes system to return to initial conditions

unstable - small perturbation causes system to completely move away

perturb system and see what happens

b) Daisy world can be represented graphically



2 equilibria where hill curves intersect.

perturb equilibria

(1) - return to equilibrium → stable

(2) - all daisies die → unstable as real eq. (1)

→ unstable

2. Feedback Loops

a) Why are feedback loops so important when studying the Earth's climate?

b) Describe one positive and one negative feedback loop that affects the earth's climate.

c) How can clouds affect planetary climates ?

a) Magnitude of changes in solar luminosity to small to explain obs. climate change → need amplifier

or —

over history of earth solar luminosity has changed by 20% but climate has been v. stable → need neg. feedback to stabilise climate.

either are valid.

b) any reasonable are valid for example.

positive · various albedo feedbacks

negative · radiative Ts feedback

c) can cool climate by increasing albedo

or

can warm climate because by conc of H_2O, a greenhouse gas

which would miss out in the end depends on cloud type.

3. Greenhouse Effect

Alright, in this day and age it has to be asked:

a) How much has the average global temperature of the earth risen since 1850?

b) So, how does the greenhouse effect work?

c) And why are we so concerned about CO_2, even though it occurs in only minimal concentrations in the earths atmosphere?

a) about one degree Celsius

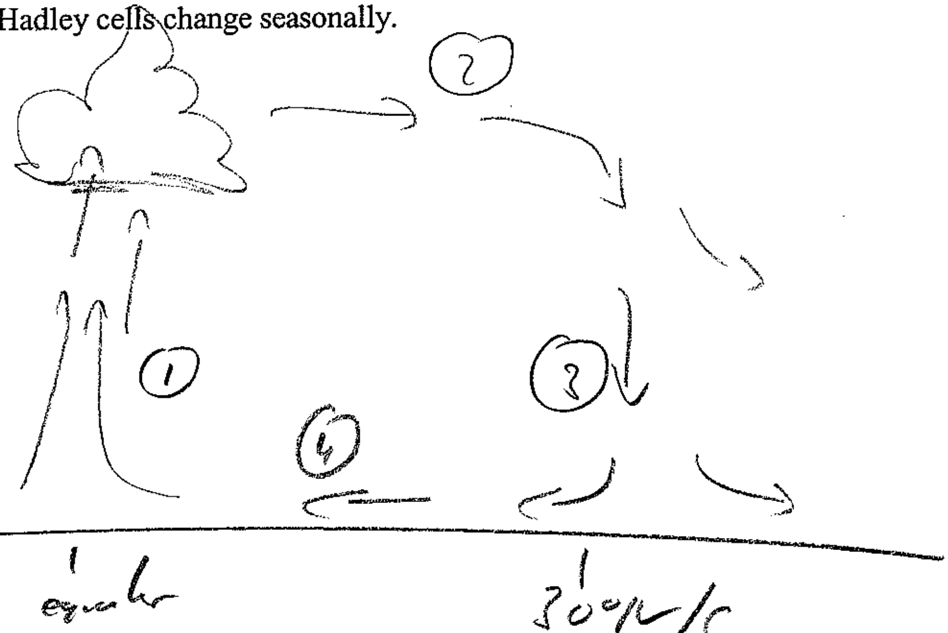
b) sunlight reaches atmosphere and heats earth's surface
→ surface warms and emits infrared radiation (IR)
→ IR is trapped by atmosphere → atm is heated
→ part of IR is radiated back to surface and contributes to heating → increase in T.

c) because it has IR values to the earth's radiation peak in an area that is almost not trapped by IR (10 µm).

4. The Hadley Circulation

a) Draw a diagram to describe Hadley cells and to explain the processes that contribute to their formation.

b) Why do Hadley cells change seasonally.



(1) differential heating near equator evaporates water and heats air → warm moist air rises, helped by release of latent heat as air cools adiabatically
→ lots of rain @ ITCZ

(2) cools in upper atmosphere

(3) sinks near 30°N/S → heats adiabatically
→ warm, dry air → horse latitudes / deserts

(4) return flow to ITCZ → trade winds.

b) because zone of highest insolation shifts seasonally

5. Geostrophic Flow

a) Give a general explanation of geostrophic flow. What is it, how and when does it form, why is it important?

b) Give a specific example of geostrophic flow to illustrate your general explanation from above.

a) geostrophic flow forms when a gas or liquid is affected by two forces which cancel out, causing air/fluid to flow perpendicular to these two forces.

b) hurricane
gyre
eb. anything rescannable will add.

6. Wind-driven Ocean Currents

a) What is the Ekman spiral? Explain why Ekman transport occurs.

b) Why do ocean currents not move in exactly the same direction as the wind?

Extra Credit Question (5 points)

We haven't talked about deep ocean circulation yet, but you might figure this out on your own. **SO, THINK!**

The lower atmosphere (troposphere) convects readily because it is... -- well you tell me.

Now consider how the atmosphere is heated, then think about the heating of the oceans. Can you explain why deep ocean thermal convection does NOT occur?