EOSC 112 - CHAPTER 4 SOLUTIONS

REVIEW QUESTIONS:

1.) What are the functions of the global circulatory system?

The driving force for the atmospheric circulation is the global distribution of energy. The angle at which the Sun's rays strike the Earth changes from the equator toward the poles. The result is that incoming solar radiation decreases with latitude. More solar radiation is received in the tropics than at the poles, resulting in an equator-to-pole temperature gradient. This temperature gradient drives the atmospheric circulation because of the inverse relationship between the temperature and the density of a gas: higher temperatures correspond to lower densities. Differences in the distribution of global temperatures cause differences in air density and, therefore, pressure. Air tends to move from areas of high pressure to areas of low pressure. These large-scale movements of air produce the global windbelts. These windbelts are significantly modified by the Coriolis Effect, which is caused by the Earth's rotation.

2.) Explain why the distribution of solar energy varies with latitude.

Due to the curvature of Earth, the radiation reaching Earth at high latitudes is spread over larger areas than is the radiation reaching Earth at low latitudes. Each square meter of the surface receives proportionately less energy as we move to the higher latitude, and incoming solar flux thus decreases from the equator toward the poles.

3.)

a. Draw a graph showing the variation of incoming solar energy and outgoing infrared radiation with latitude.

This is figure 4-2 in textbook (Kump et al.).

b. Indicate the regions of energy surplus and energy deficit.

There is a surplus of energy in the tropics, where incoming radiation is greater than outgoing radiation, and a deficit at high latitudes, where more radiation is emitted than is received.

c. Explain why this distribution is important for the atmospheric circulation.

The latitudinal energy gradient produces atmospheric temperature and density differences that force the atmosphere to circulate, carrying warmer air toward the poles and colder air toward the equator. These circulations move energy from regions where there is a surplus to regions where there is a deficit.

4.) Explain why heating an air mass causes it to rise.

When an air mass is heated, its density becomes lower than that of its surroundings, and buoyancy causes lower-density air to rise.

5.) Use a diagram to describe Hadley cells. Why does the Hadley circulation change seasonally?

This is figure 4-3 in textbook (Kump et al.).

Because the distribution of solar energy varies with the season and the locations of high-pressure systems, Hadley circulation changes seasonally. For example, low-pressure systems from the mid-latitudes often migrate into the Polar Regions in summer, breaking down the surface high-pressure systems and disrupting the easterly flow.

6.) What is the Coriolis Effect? How does the Coriolis Effect help determine the global pattern of winds?

The Coriolis Effect is the apparent tendency for a fluid (air or water) moving across Earth's surface to be deflected from its straight-line path. The Coriolis Effect applies to any object moving on a rotating body. East-west movements of surface winds are the result of the Coriolis Effect.

12.) Describe three processes that produce uplift in the atmosphere and are important in causing precipitation.

i. An air mass moving across a mountain range can cause uplift (topographic uplifting) from the increasing elevation of the land surface.

ii. Uplift due to frontal wedging causes heavy precipitation along frontal zones in the middle latitudes.

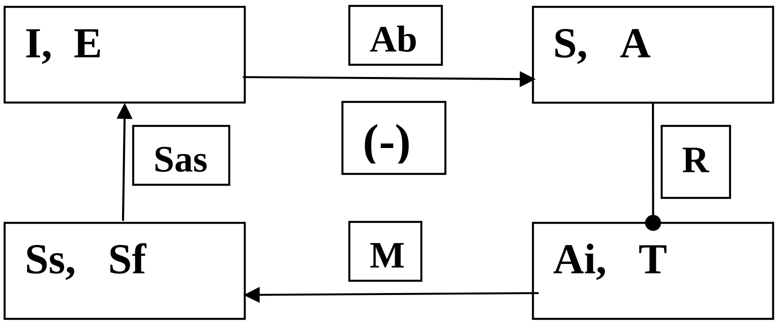
iii. Convergence of warm surface air around the equatorial belt creates the convection responsible for the Inter-Tropical Convergence Zone (ITCZ). Convection occurs not only in the tropics, but wherever there is intense surface heating. Therefore, although convection does not always produce rain, it is the dominant rainfall-producing process over warm land masses in summer (localized convection).

PROBLEM:

2. a) The statement of question 2a) mixes <u>components</u> and <u>physical attributes</u>. Here, I present the solution clearly separating <u>components</u>, <u>attributes</u> and <u>couplings</u>.

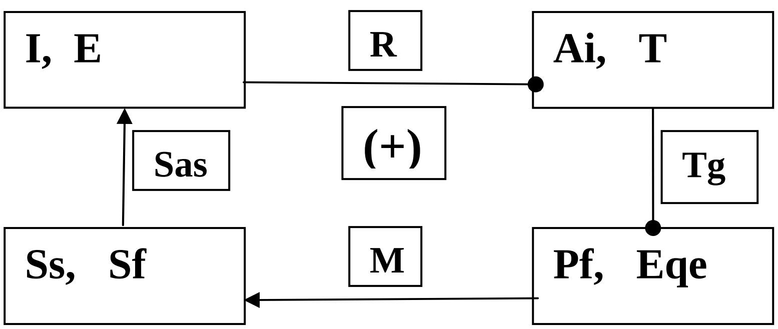
First feedback loop

Components	Physical attributes	Physical couplings
Ice (I)	Extent (E)	Absorption of sunlight (Ab)
Surface (S)	Albedo (A)	Reflection of sunlight (R)
Air (Ai)	Temperature (T)	Changes in moisture content (M)
Storms (Ss)	Snowfall (Sf)	Surface accumulation of snow (Sas)



Second feedback loop

Components	Physical attributes	Physical couplings
Ice (I)	Extent (E)	Reflection of sunlight (R)
Air (Ai)	Temperature (T)	Changes latitudinal T gradient (Tg)
Polar front (Pf)	Equatorward extent (Eqe)	Changes in moisture content (M)
Storms (Ss)	Snowfall (Sf)	Surface accumulation of snow (Sas)



b) The first feedback loop is negative and the second is positive. See systems diagrams.

c) The feedback loop between ice extent, surface albedo, air temperature, and storms snowfall is a negative feedback loop that tends to prevent ice sheet growth. The feedback loop between ice extent, air temperature, the location of the polar front zone, and storms snowfall is a positive feedback loop that tends to promote ice sheet growth. Whether the ice sheet grows or not depends on which of these feedbacks is stronger. This can only be determined with a mathematical model.