Maninderpal Singh
Homework METR 112

1. **If a hypothetical large amount of greenhouse gases are ingested into the atmosphere, does the climate of Earth respond and warm instantaneously? Why or why not? Please explain this and briefly the concept of committed warming. (6 pts)**

Ans: Greenhouses gases affect a lot on earth's climate. To prove this point let's say if there is no atmosphere (n = 0) and earth's temperature would be 255.0k. Now if greenhouse gasses are added to atmosphere an n increased to 0.01. Now new temperature would be 255.6 K which is warming of 0.6 K. Other thing change with this warming. For example, this rise in temperature would start melting the ice, if ice starts melting then the planet would be less reflective which would absorb more radiation which leads to decreases in albedo therefore further warming. The Increase in greenhouse gases has imposed a radiative forcing and Carbon Dioxide is only responsible for 55%. If a lot of greenhouses gases are injected into the atmosphere, earth's temperature would also increase dramatically.

2. **What is a radiative forcing? What is a positive radiative forcing? What is a negative radiative forcing? (6 pts)**

Ans:

Radiative forcing is defined to be the response to an instantaneous change in the temperature of the planet has adjusted to the change. For some technical reason, radiative forcing is a change in the energy balance at the tropopause.

Radiative forcing (RF) = $\Delta Ein - \Delta Eout$

Positive radiative forcings correspond to changes that warm the climate, whereas negative radiative correspond to changes that cool the climate. In negative radiative forcing Earth's loses more energy to space compared to gain from Sun. In positive radiative forcing incoming energy increase than outgoing energy.

3. **What is the difference between a greenhouse gas and an aerosol? How can each affect the Earth's atmospheric radiative balance? (8 pts)**

Greenhouse gases are responsible for the greenhouse effect. These gases are present in the atmosphere as well as started produced during industrial revolution such as CO2. Greenhouse Gases absorb infrared radiation. In other hand, aerosols are particles present in the atmosphere in

the form of dust or smoke and do not fall under the force of gravity. Aerosols offset approximately 40% of the radiative forcing from increasing greenhouse gases.

The greenhouse gases intercept some of the energy escaping to space and redirect it to earth surface back. Greenhouse gases increase energy in for the surface which warms the planet. The sulfate aerosols produced when sulfur released to the atmosphere during the burning of fossil fuel, biomass, from the natural process in the ocean and react with other atmospheric constituents. Sulfacet aerosols are highly reflective and reflect incoming solar radiation back to space, therefore, the net effect of the aerosol is to cool the climate.

4. **What is the difference between a radiative forcing versus a feedback loop? (3 pts)**

Radiative forcing is a response to an instantaneous change in the temperature of the planet has adjusted to the change.In other words, radiative forcing is a change in the energy balance at the tropopause. Where feedback loop, if atmosphere warming up then it leads to more warming. For example, if Earth's temperature warming due to ice melt and decrease the average planetary albedo make planet less reflective which leads to absorb more radiation from the sun. In the result earth's temperature would more increase.

5. **List 2 fast feedbacks and 2 slow feedbacks described in Chapter 6. Identify whether each is positive or negative. (8 pts)**

Ans :

Fast feedback occur very fast in response to change in surface temperature. It includes

- Water vapor
- Lapse-rate
- cloud

Water vapor feedback arises because warmer can hold more water vapor. It can increase humidity in the atmosphere, and due to greenhouses gases, water vapor can lead to more warming, therefore, it is positive feedback.

The lapse rate is a negative feedback in the climate system. In lapse rate, warmer atmosphere radiate more power to space because of power radiated by the black body is equal to $\sigma T4$.

Slow Feedback includes processes that respond slowly to increasing surface temperature such as

- Melting ice sheet
- Permafrost

Ice sheet melt so slowly. It takes centuries or longer to respond to a change in temperature. This is an example of positive feedback because they amplify an initial warming.

Permafrost is a carbon reservoir where a large amount of carbon stored in the ground. If permafrost melt due to warming, carbon can go to atmosphere back in the form of methane or carbon dioxide. This process leads to climate change, therefore, it is the example of positive feedback.

6. **Explain why water-vapor changes are considered a feedback and not a forcing. (4 pts)**

   Ans : Feedbacks are processes that respond to changes in the surface temperature, whereas forcings are unrelated to the surface temperature. The feedback arises because the atmosphere can hold more water vapor which can increase atmospheric humidity. Water vapor is itself greenhouse gases which can lead to additional warming, therefore, water vapor considers as a feedback. Forcing is unrelated to the surface temperature but water vapor does therefor water vapor is not forcing.

7. **Please use the following journal article, Liu et al. (2014), as an additional resource to answer the following questions. The title of the journal article is Wildland fire emissions, carbon, and climate: Wildfire–climate interactions written by scientists from the USDA Forest Service. (10 pts)**

   a) What are 3 major greenhouse gas emissions from wildfires?
   Ans :
   1. Carbon dioxide (CO_2)
   2. Methane (CH_4),
   3. Nitrous oxide (N_2O))

b) What are 2 major aerosol particles emitted from wildfires?

Ans:

1. Black Carbon
2. Organic Carbon

c) What are some of the major radiative forcing examples from wildfire emissions? List 3 mentioned in the paper.

Ans:

- Changes in radiative forcing lead to subsequent changes in air temperature, humidity, and wind.
- A reduction in surface temperature.
- Enhance climate anomalies such as droughts