Effect Of Feedback Mechanisms On The Earth’s Climate System

Question 1. Examine the feedback mechanisms affect the earth’s climate system (100%)

The earth consists of five different components. They are; lithospheres, hydrosphere, biosphere, cryosphere and atmosphere. The interaction between these components is very critical to life on earth. Consequently, the planet is considered as an interconnected system. This different sphere or compartments of the earth’s system is interconnected to each sphere in some way or another. Wherefore, any interruption in the one sphere will impact the other spheres. Each system has a different structure which will determine its purpose and impact on lives on the earth’s surface(biosphere). To study the feedback mechanism of the climate system, the climate system and it operation must be understood clearly.

The term Climate refers to the average changes in weather pattern over a short period of a given location, this may be even day or hours. Even though climatic conditions change it is stable over a short period of time such as years. The planet has undergone different climate conditions, one that is knows is the ice ages period coming from warmer or hot conditions. On the other hand, weather is the day to day changes in atmospheric condition over a place. Weather is referring to condition such as precipitation, temperature, humidity, and air pressure. (Garreaud 2009). The climate system is due to the interaction between the spheres, more specifically in this case of the ocean and the atmosphere. The way the earth responds the different condition can be characterized as a feedback. A feedback can be either negative or a positive the feedback. If the earth system faces an extreme condition it will naturally react whether to continue the condition or counterattack to reduce the effects. The energy on the earth is solar driven which mean the energy comes from the sun. The energy leaves the sun in the form of infrared waves through the atmosphere onto the surface either on the lithospheres, hydrosphere, biosphere, or the cryosphere. The feedback may be good which counterattacks or worsens a condition. Therefore, if the earth is heating a negative feedback would cause the system to cool down and the positive feedback would allow the continue to heat.

In negative feedback it causes a stability by offsetting a variable in the system which is changing. A negative feedback does not cause a negative outcome in most cases it is to cause a stabilization in the climate system when the has being an interruption in the equilibrium. An example of this is global warming. When this increases there will be an increased in the rate at which water is evaporated from water bodies or transpiration from the plants to cause a build up of clouds which will produce some amount of albedo effect to cause cooling. Global warming is the increase in the atmospheric temperature due to increases in the gases concentration in the atmosphere known as greenhouse gases. These gases include carbon dioxide, water vapour, nitrous oxide, and methane. These gases help to trap heat onto the earth’s surface and causing reflection of some of these short wavelengths and letting the long wavelength to a pass through. (Cess, 2005).

The wavelength is reflected due to its length the shorter wavelength are bombarded on theses

greenhouse gases causing a reflection causing a small percentage of the radiation to pass through the atmosphere and while there is less interaction with the long wavelength radiation sources passes through more easily. The energy trap in the earth's surface will cause an increase in the atmospheric temperature causing more the evaporation and transpiration. The increase in water vapour in the atmosphere form cloud with the dust particles after condensation. This will continue until there is a huge cloud cover.

http://www.webshade.com.au/ShadeInfo/ShadeFacts/directindirectUVR.html

Figure 1. Cloud causing an albedo effect in reflecting radiation

The cloud cover will cause an increase in the albedo effect. The albedo effect is the reflection of the radiation from a white surface, this is usually ice or cloud cover. The increase in albedo effect will cause a global cooling. This negative feedback was to change the counterattack the heat increase in the atmosphere.

Another example of the negative feedback mechanism is global warming, which in turn will cause a increase in the serge of hurricanes. Global warming cause by the trapping of heat onto the earth's surface causes a instability in the natural environs. When the surface gets warmer, more water will be vaporized into water vapor causing it to be more moister environment with high sea levels and the altered atmospheric conditions, this will cause a changes in the hurricanes structure which may cause more or less damage to property. The increase in these conditions is due to global warming giving this natural phenomenon more favourability of forming into stronger hurricanes. The increase in temperature will be the drive for increase in low pressure system such as hurricane, storm and cyclone across the world and also this will increase the chance and number of hurricane will be form and strength of these low pressure system. After the hurricane, a low-pressure system surge there is a stabilization in the equilibrium of the earth natural process and condition. Hence, why this condition could be considered as a negative feedback.

A positive feedback causes an instability by increasing the magnitude of the variable that is changing in the earth's system. In positive feedback the climates system basically amplifies causing further instability in the earth climate system. A feedback mechanism is the water vapour feedback, while water is one the earth atmosphere dominant greenhouse, therefore a change in the concentration will be producing a significant feedback on the climate. According to Belyea, (2009) In 1967 it was proposed that the atmosphere might conserve its relative humidity, and if so, this would lead to a positive feedback because a warmer atmosphere would contain more water vapor, thus amplifying the warming. Indeed, GCMs do tend to conserve global mean atmospheric relative humidity. An example of a positive feedback mechanism is the cooling of the atmosphere, where a perfect event was in the early years where the global ice-age occurs. In the early centuries, The Mid-Pleistocene Transition where a major shift in the planets climate system to response due to orbital forcing. During this period of the glacial-interglacial period the climate cycles normally lasted for up to 40000y per obliquity cycles whereas the glacial interglacial period after the Mid-Pleistocene Transition gradually intensified over multiple obliquity cycles. The changes in the cycles allows the earth temperature to become colder and dustier and this lasted for a very long period. The decrease in temperature cause the sea level to decrease and ice sheet to increase while increasing the albedo effect causing more the opportunities for more reflection of the radiation on the earth's surface causing a continuation of the decreasing the global atmospheric temperature over this period.

(Chalk, Hain, Foster, Rohling, Sexton, Badger, & Martínez-García, 2017).

Another example of the positive feedback mechanism in the earth climatic system because of human's activity in taking down trees for use of building or other purposes. This can be referred to as deforestation. It can be described as the clearing of an areas of land either by natural or deliberate circumstances. According to Houghton, Jenkins, & Ephraums, (1990). there about 19% of carbon in the earth's biosphere across the planet and 81% in the lithosphere. In all forests, tropical, temperate, and boreal together, approximately 31% of the carbon is stored in the biomass and 69% in the soil. In tropical forests, approximately 50% of the carbon is stored in the biomass and 50% in the soil. The forest plays a significant role in storage and the transpiration takes place to allow water in the to increase the humidity and temperature of the surrounding. As these trees are removed from their habitat, the rate of transpiration or the amount has reduces and cause a drying in the atmosphere. The drying will cause an expansion of the of the grasslands and savanna causing further reduction the percentage cover for forest trees. (Belyea, 2009). The tress which are such a vital carbon storage will lose all these storage carbon to the soil or to the atmosphere will cause an increase in atmosphere temperature overtime.

In conclusion, the earth consists of different components and these interact with each other in some instances may cause in stability in the climatic condition, the way planet treats or stabilize itself is known as a feedback mechanism. It affects the earth's climatic system in significant ways wither in a positive way or negative. The term negative and positive feedback is not a rating but how the system responds to an instability situation. In a negative feedback the earth responds by trying to stabilize that condition by counter act and try to supress it. In positive feedback the system continues to destabilize in a continued direction. Question 4. Examine the influence of sea-level change on mangrove ecosystems. (100%)

The impact of sea-level change on the coastal ecosystem is very important it. It is a determining factor of the survival of these species for example mangrove ecosystem. Sea-level change is either rising or declining and this is due to natural phenomenon due to tectonic activities or man driving causes. There are two types of sea level change. They are, relative sea level change and eustatic sea level change. Sea-level changes across the world are due to several factors which include; thermal expansion and contraction of water, changes in the atmospheric pressure, ocean-atmosphere interactions, ocean circulation and coastal upwelling, water and ice-mass exchange and human activity.(Burns, 2020). Sea level change is range on a broad scale and it does rise at the same rate across the world. However, due to the tectonic activity, this may not show in the actual measuring at the space and time. The mangrove ecosystem plays a very important role in protecting inward living organisms again strong surge in wind and protect the coastline from coastal erosion. The mangrove thrives well around the coastal region, these organisms can survive fresh or very saline conditions. The changes in the sea-levels cause regression or transgression of these mangroves species as they species are vulnerable to changes in the sea levels.

The evidence of sea level change is manifested through knowing the past events of the height of the sea level by studying the paleo sea level records. The evidence of sea level rise has been recorded for over three million years using different proxies. According to IPCC (2013) it was recorded were the sea level was approximately ten (10) meters above the present sea level. Therefore, after the ice age the when the planet began to get warmer, they had an increase in atmospheric temperature causing an expansion of the sea water. Therefore, this would be seen

in the rise in the sea level. An example of this sea level rise based on evidence is an experiment done in Barbados coastline. According to Fairbanks (1989), coral reefs were drilled to locate evidence of this sea level rise. During the last deglaciation, the sea level was about 121 meters below present with a low uncertainty. While this rise of the sea was not incremental it had a rapid and slow rise throughout the years.

The Sea level rise in the last ice age was due to the pressure of the ice on the land. Due to the complexity of the ice pressure on the land, causing a very high pressure causing the crust to force itself towards the mantle causing the land to sink. The area will now replace that area where the land sunk and this will be deemed as the sea rising in that area. If the sea level appears to be falling, it is because the ice glaciers has melted and the land is no longer under pressure and will cause a low pressure movement on the soil and causing it to take it original position and the sea level to fall.

The sea level according to current proxies and record is that the world sea level is rising is due to the melting of the ice caps. According to Straneo, and Heimbach, (2013) the Greenland ice sheet is losing most of its capacity over the pass two decades, this mis contributing to quarter of the global sea-level rise. The increase in the melting of the nearby sea ice causes a retreat in the glaciers. In recent records, it shows that the there is an inflow of water in to the North Atlantic Ocean, and thus the ice melts. Incidentally, global warming has also contributed to the creation of unstable circumstances for the glaciers.

Mangroves are autotrophic organisms whose habitat is along water body bodies. Most mangroves are mainly distributed along the tropics which in the equatorial or tropical zone between 30°N and 30°S. There three types of mangroves, Red Mangrove, white mangrove, and the black mangrove. Each of these mangroves survive better along the coast in a zonation basis where the red is further into the water and the white in furthest onto the land. These organisms thrive very well in these hot or warm condition as they are unable to withstand very cold temperature in the temperate and polar zones. Therefore, temperature plays a very critical role in the distribution of these organism. The richest mangrove communities occur in areas where the water temperature is greater than 24ºC in the warmest month. The most recent estimates suggest that mangroves presently occupy about 14,653,000 ha of tropical and subtropical coastline (McLeod & Salm, 2006). However, due to sea level rise across the world and the human activity by removing these mangroves for personal uses or converting the mangrove forest into the aquaculture causing a decline the mangrove populations.

Mangroves are very important, not only a habitat to aquamarine organisms, but also a very good source of carbon storage. As these plants are located in the tropical region, this allows mangroves to be a highly productive ecosystem. According to Alongi, (2014) “mangroves occupy only 0.5% of the global coastal area, they contribute 10–15% (24 Tg C y?1) to coastal sediment carbon storage and export 10–11% of the particulate terrestrial carbon to the ocean. Their disproportionate contribution to carbon sequestration is now perceived as a means for conservation and restoration and a way to help ameliorate greenhouse gas emissions. Of immediate concern are potential carbon losses to deforestation (90–970 Tg C y?1) that are greater than these ecosystems' rates of carbon storage. Large reservoirs of dissolved inorganic carbon in deep soils, pumped via subsurface pathways to adjacent waterways, are a large loss of carbon, at a potential rate up to 40% of annual primary production.” (Alongi, 2014).

The mangrove habitat is dependent on the level of the sea, if the sea rise it will cause a retreat

of the mangroves landward and if the sea level declines the species will move seaward. Due to climate change across the world the mangrove has to the sea level change as one of the great impacts on it. (McLeod & Salm, 2006). Mangroves are not able to response fast enough but will be able to do so if the sea level rise occurs very slowly and if the space on the land is adequate for expansion of the species.

Examples of mangrove responses to changes in relative sea level.

The mangrove accretion takes place very slowly especially on the lagoon areas causing the lagoon and embayment mangroves to become more vulnerable to sea level changes. This is due to the rate at which accretion occurs in this region. Peat accumulation is the decompose material built up overtime in the mangrove ecosystem. According to Deverel, Drexler, Ingrum, and Hart (2008) peat accretes when decomposition is faster. Peat accumulates slower in the lagoon because of the low sediment supply in that region compared to deltaic and estuarine mangrove forests. The sediment in the lagoon is from autochthonous process which means that the sediments form is already from there and has not come from anywhere except the close area. This however causes the very slow rate at which the mangrove forest in the peat in accumulated over time. Unlike the mangrove on the deltaic and estuarine mangrove forests, which has a higher rate can withstand the sea level rise better than the lagoon and embayment. Therefore, it is evident that you would find more mangrove surviving sea level rise on deltaic and estuarine mangrove forests than lagoon and embayment. For example, according to Parkinson, DeLaune, and White, (1994), there’s an estimation where the peat accumulation was building up thousands of years according to test done with the carbon 14 isotope, this study was conducted in South Florida. The sample was collected where several meters of the peat was tested and deem to have different environmental conditions. Also, the evidence shows that the accumulation took place very slowly.

The sea level change is very important. The stable sea level will not cause a significant effect on the mangrove habitat this is referred to as stable relative sea level. If the mangrove is being affected it is due to the salinity, surface area, depth of inundation and other factors which will determine the mangrove forest to stay in the same habitat. If the sea level falls this can be considered as regression. In this phase the plant will move towards the sea and expand its vegetation. Relative sea level rising as its name suggest that the sea is rising can be referred to as transgression. When the sea moves towards the land or rises it reduces the surface areas for the mangroves to thrive in. This event will cause the mangrove to move inland while depending on other environmental conditions that is suitable for the plant species.

In conclusion, the sea level change can have diverse effects on the mangrove forest. The sea level change is due to natural phenomena which is cause my global warming. The water property causes the water to expand when warm and contracts when its cooler, this then in turn affect the outlook of the sea level rise. The rise may be due tectonic reason when the land may sink due to pressure from the glacier and cause the ocean to cover, the land being pressurize by the ice to seem as water is rising. However, when the ice has melted away the ice no longer put pressure on the land and cause the land to rise in its former state and this will all the records to show that water is decline. The most current evidence is the melting of the ice sheet across the world causing the volume of the ocean to be increasing which is causing a global sea level rise. This sea level rise is putting a strain on the coastal shoreline and the mangroves species. The increase and decrease in the level cause the forest to move inland or seaward. However,

depending on the location of the mangrove the rate at which it accumulates peat is very critical as this is a determining factor in the survival of these organisms.