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ASPECT STUDY ON CARBON DIOXIDE (CO_2) FLUX IN THE GLOBAL OCEAN USING SATELLITE

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ABSTRAK

Latar Belakang: Peningkatan dari CO_2 di atmosfer dan berpotensi menghasilkan pemanasan global telah menjadi suatu perhatian besar pada umat manusia. Sepertinya sangat sulit untuk melaksanakan pengamatan atas CO_2 perubahan terus menerus antara udara-laut. Samudra berisi lebih dari lima puluh kali karbon di atmosfer dan dapat sebagai penyangga yang membatasi konsentrasi CO_2 di dalam atmosfer. Perubahan terus menerus Gas CO_2 antara udara dan samudra adalah konsentrasi CO_2 di dalam samudra dikendalikan oleh proses fisika, kimia dan biologi. Dengan perbedaan konsentrasi CO_2 udara-laut terjadi pertukaran konsentrasi gas CO_2 antara udara-laut, yang kaya nutrien. **Metode:** Data dari WOCE ship dianalisis dengan linier regresi, Y = ax – b , sehingga R2 dapat ditentukan koefisiennya, dihitung menggunakan program math lab, Net sea-air CO2 Flux sehingga perubahan Gas CO2 terus menerus dapat dihitung dengan Rumus : F = K ΔPCO2. **Tujuan:** Mendeteksi hubungan perubahan terus menerus gas CO_2 dengan pemanasan global dan mendeteksi perubahan tekanan CO_2 (pCO_2) yang berhubungan dengan perubahan iklim. **Hasil:** PCO_2 di dalam perairan permukaan samudra yang global bervariasi secara musiman, di atas suatu cakupan yang luas dan di bawah kontrol pCO_2 di atmosfer sampai sekarang. Efek pemanfaatan biologi CO_2 adalah membedakan perubahan temperatur musiman. Amplitudo air permukaan yang musiman pCO_2 di dalam perairan di garis lintang tinggi pada daerah kutub pada garis lintang 40^o dan katulistiwa efek biologi mempengaruhi, daerah yang hangat/ dingin dipengaruhi oleh temperatur. Efek ini adalah sekitar 6 bulan pergeseran fase. Maka, sepanjang batasan-batasan antara dua rejim ini, cenderung untuk batal satu sama lain, membentuk suatu zone pCO_2 amplitudo kecil. Dengan data satelit pCO_2 yang tinggi penyebab pengurangan koefisien pertukaran gas CO_2 antara udara-laut dan menghasilkan TCO_2, suhu permukaan laut penyebab utama berkurangnya TCO_2 tetapi di zone equtorial TCO_2 yang tinggi disebabkan oleh pencampuran vertikal dan mengalir atas. **Kesimpulan:** Disamping proses biologi seperti pernapasan dan fotosintesis untuk mengurangi CO_2 secara alami untuk mengurangi pemanasan global sebagai sumber bencana karenanya kita harus melaksanakan, berhenti melakukan penebangan hutan, pembakaran hutan, pemakaian bahan bakar fosil sehingga tidak mengganggu biodiversitas sebagai penunjang ketahanan pangan dan kestabilan alam.

Kata Kunci: Kecepatan Angin, PCO_2, TCO_2, Suhu Permukaan Laut, bencana alam, pemanasan Global, biodiversitas.

ABSTRACT

Background: The increase of atmospheric CO_2 and the potentially resulting global warming has been a great concern for human society. As it extremly dificult to perform observations of CO_2 flux between air-sea. Ocean contains more than fifty times carbon in the atmosphere and can be taken as buffer limiting the concentration of CO_2 in atmosphere. Carbon dioxide flux between air and ocean is CO_2 concentration in ocean is controlled by physical, chemical and biological processes. It can be determined from air-sea CO_2 concentration differences and carbon dioxide (CO_2) exchange between air-sea, in these rich in nutrients. **Method:** Data from WOCE ship is analysis with linier regresion, Y = ax – b, get R2 determint coeffisien, calculated with math lab, Net sea-air CO2 Flux Calculated with Flux = K ΔPCO2. **Objective:** The objective of the present study is as the followings: to detect carbon dioxide flux relations with global warming and to detect partial pressure CO_2 (pCO_2) relations with climate change. **Result:** The pCO_2 in surface waters of the global oceans varies seasonally over a wide range above and below the current atmospheric pCO_2. The effect of biological utilization of CO_2 is diferentiate from that of seasonal temperature changes using seasonal temperature data. The seasonal amplitude of surface water pCO_2 in high latitude waters locate pole ward of about 40^o latitude and in the equaturiol zone is dominate by the biology effect, whereas that in the temperate gyre regions is dominated by the temperature effect. These effects are about 6 months out of phase. Accordingly, along the boundaries between these two regimes, they tend to cancel each other, forming a zone of small pCO_2 amplitude. Within satellite data the high pCO_2 cause of decrease of coefficient air-sea of gas exchange and resulting the increasing of TCO_2, SST high cause to decrease TCO_2 but in the equtorial zone TCO_2 high that cause by vertical mixing and up welling. **Conclusion:** Beside the biological process as respiration and photosynthesis to lessen CO_2 in nature so that do not as source of disaster hence we have to execute, lessening the source of disaster for example; deforestation, combustion of forest, usage of fossil fuel so that do not bother biodiversity as food resilience supporter and balanced of nature.

Keywords: Wind speeds, pCO_2, TCO_2, SST, disaster, Global Warming

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INTRODUCTION

In recent years, the industrialization and urbanization tent to cause more problems in our living environment. The human and societal dimensions of environmental changes are the most important for environmental protection and conservation.[1] Specially, ocean waters are major resources for fish and biodiversity life for human life as the contribute ninety percent of world ocean Resources.[2] Human population and activities in the world are generally concentrated near the coast, over sixty percent of the human population lies in the coastal zone.[1] Human recreational activities, commercial and sport fishing and tourism are concentrated in coastal waters. For coastal waters, assessment of environmental component will be based on a number of receiving ecological characteristics, nature of the food chain, level of productivity and water temperature. They are potential for the increase of atmospheric CO_2 and the magnitude of the net CO_2 flux across the sea surface are important understanding the global carbon cycle. Base on approximately 2.5 million measurement s made for the pCO_2 in surface waters of the global ocean since 1960, the climatologically distributions of monthly sea-air pCO_2 difference, ΔpCO_2 and the net air-sea have been estimated for a reference year 1995.

The increase of atmospheric CO_2 and the potentially resulting global warming has been a great concern for human society. As it the extremely difficult to perform accepted in a form as below.[3,4,5] Global Warming is:

1. It is growing for an international consensus scientist that the warming of the earth's climate is realizing and has been caused by an increase in emissions of Carbon Dioxide (CO_2) and the other greenhouse gases.
2. Ocean contains more than fifty times carbone in the atmosphere and can be taken as a buffer limiting the concentration of CO_2 in atmosphere.

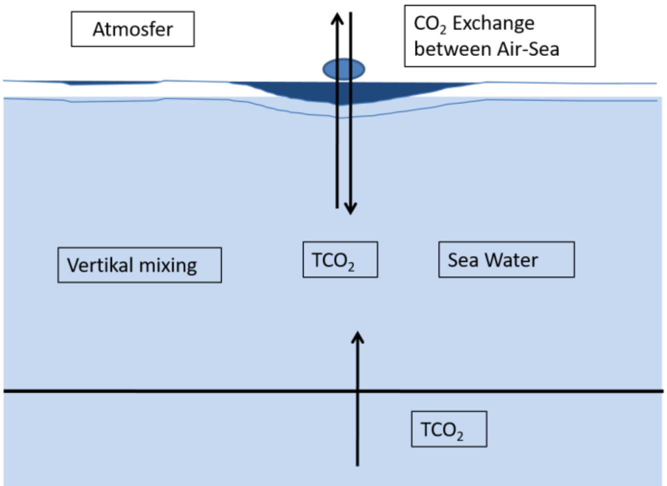

Figure 1. Carbon Dioxide (CO_2) Exchange between Air-Sea

Since the late 18 the century, the CO_2 concentration in the atmosphere has been increased by emission from fossil, fuel combustion, deforestation and cement production.[6,7] Carbone Dioxide (CO_2) flux between air and ocean:

1). CO_2 concentration in ocean is controlled by physical, chemical and biological processes and all these processes have been not well understood until now.

2). Much effort has gone into determining the relationship between gas transfer and wind speed.

3). CO_2 gas flux between ocean and air can be determined from air-sea CO_2 concentration differences and CO_2 gas exchange air-sea shows in figure 1.

Table 1. Global Warming and Ocean CO_2 Budget
IPCC (Intergovernmental Panel on Climate Change)

Sumber	**Total Carbon Gt/yr**
Fosil fuel	5.4 ± 0.5
Deforestation	1.6 ± 1.0
Total	**7.0 ± 1.2**
(Sink)	
Remaining in atmosphere	3.4 ± 0.2
Absorption of ocean	2.0 ± 0.8
Total	**5.4 ± 0.8**
Missing sink	**1.6 ± 1.4**

We can see major resources problem in our living environment as; fossil fuel, deforestation, sink is remaining in atmosphere and absorption of ocean (Table 1).

The research problems are formulated as the followings:

1. Within satellite data, why Carbon dioxide (CO_2) flux relationship with global warming?
2. Within parameterize partial pressure CO_2 (pCO_2), Why CO_2 flux relations with climate change?

The objectives of this study are application of study on carbone dioxide flux relations with climate change in the Indonesia using satellite data. The more detailed objectives of the present study are as the followings:

1. To detect carbon dioxide flux relations with global warming.
2. To detect partial pressure CO_2 (pCO_2) relations with climate change.

The research result would give information's regarding to the following aspects:

1. The carbon dioxide (CO_2) flux based on climatologically surface ocean pCO_2, and seasonal biological and temperature effect.
2. The increase of atmospheric CO_2 and its potential for the global warming effect.

Net Sea Carbon Dioxide (CO_2) Flux Over The Global Ocean

The ΔpCO_2 show the oceanic source for atmospheric CO_2 indicated by red and yellow are located in the areas of deep water upwelling (Figure 2). The effect of winter up welling is seen in the sub-arctic western pacific and that of up welling induced by the southwest monsoon during July-august is seen in the Persian Gulf. The strong source zone located along the Pacific equatorial is supported by the coastal up welling along south the America as well as by the upward entrainment of the equatorial under current water. The source intensity is toward the western Pacific due mainly to CO_2 losses to photosynthesis and to the atmosphere. Strong CO_2 sink (blue and purple areas) are seen along the pole-ward edges of sub-tropical gyres, where major warm current is located. The Gulf stream in the North Atlantic and the Kuroshio Pacific are both major CO_2 sink due to primarily to cooling as the flow from warm tropical oceans to sub polar zones.

Along the northern border of the south ocean, CO_2 sink areas caused by cooling of pole ward flowing current such as the Brazil current located along eastern south America, the current located of south Africa the east Australian current located along south-eastern Australia. These warm water currents meet with cold current flowing equator-ward from the Antartic zone along the northern border of the southern Ocean.

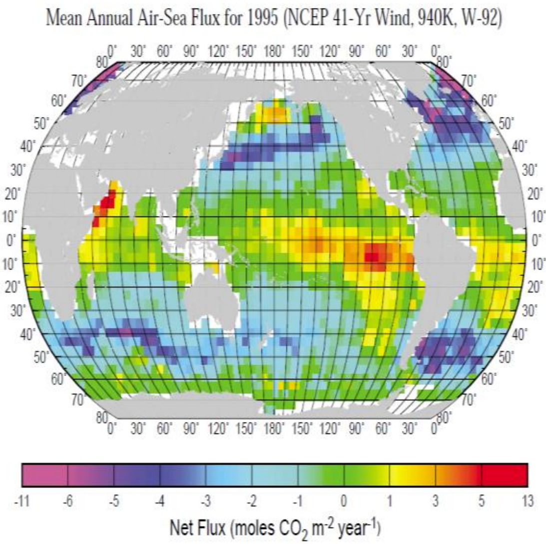

Figure 2. Global Distribution of the Net sea-air CO_2

As the sub Antarctica waters rich in nutrients flow northward to more sunlight regions, CO_2 is drawn down by photosynthesis thus creating strong CO_2 sink conditions. Confluence of sub-tropical waters with polar waters forms broad and strong CO_2 sink zones as result of juxtaposition of the lowering effects on pCO_2 of the cooling of warm waters and photosynthetic draw down of CO_2 in sub polar waters rich in nutrients.

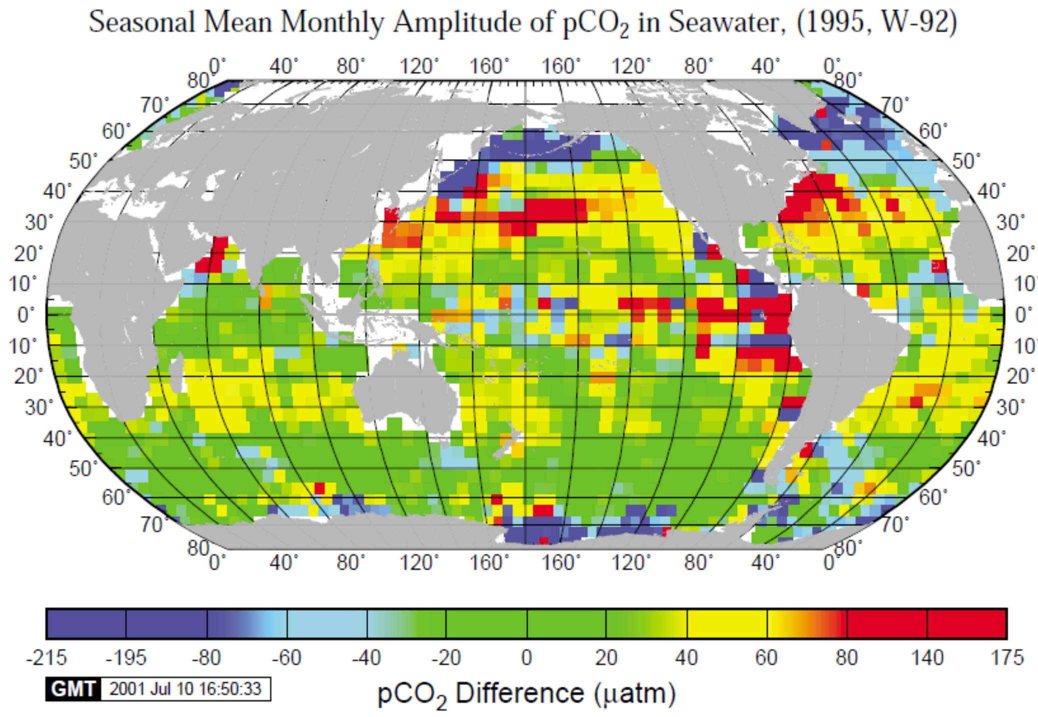

Figure 3. Seasonal Mean Monthly Amplitudo of pCO_2 in Seawater

Seasonal Mean Amplitude of pCO_2 Seawater

The difference between the pCO_2 in the surface ocean water and that in the overlying air represents the thermodynamic driving potential for the CO_2 gas transfer across the sea surface. The direction of the net transfer of CO_2 is governed by the pCO_2 difference and the sea –air CO_2 gas transfer velocity, which has been improved using an expanded data set consisting of about 940.000 pCO_2 measurement. Figure 3 shows the distribution peak to peak seasonal amplitude of surface-water pCO_2. The positive value indicates areas where the surface water pCO_2 maximum occurs during warm-water seasons. Within each hemisphere, seasonal changes for the temperate oceans (positive values) are approximately 6-month sout of phase from those (negative values) for the sub polar oceans. The seasonal variation in the northern hemisphere, in several pixels the sub artic Atlantic, eastern equatorial Pacific, Arabian sea, Chilean coast and Antarctic coast, abrupt change in the sign and colors (form red to dark blue) are observed. Because of the course spatial resolution of our analysis, the pCO_2-SST relations become reversed in area with fine scale oceanographic features such as the East greenland current in the sub artic Atlantic, the Brazil current in the south Atlantic and coastal up welling areas (Takahashi, 2000).

In Figure 2, seasonal amplitudes as negative as blue–purple are observed in subpolar and polar regions. This is a result of the biological drawdown of pCO_2 during summer and the increase in pCO_2 during winter due to the vertical mixing of high-CO_2 subsurface waters. The positive values (yellow and red) are founding the mid-latitude oceans where the warm period pCO2 values are greater than the cold period values. Seasonal amplitudes as large as 120 matm (282 matm in March and403 matm in August) are observed in the mid-latitude areas. These are the areas where seasonal temperature changes account for more than 50% of the seasonal pCO_2 changes. The Arabian Sea is an exception to the midlatitude seasonality, and seasonal amplitudes as large as 174 matm are observed. Here, the minimum monthly pCO_2 value of 355 matm is observed during

March; and the maximum monthly pCO_2 of 529 matm occurs in July, during which a maximum daily value as high as 640 matm is observed. The extremely high values are due primarily to the monsoon-induced upwelling of deep waters. Large seasonal amplitudes are also observed near the Chilean coast, where strong upwelling is known to occur. The green areas where seasonal changes are small are foundalon g the boundary between the warm subtropical waters and the colder subpolar waters of the Southern Ocean. This is due to the near cancellation of the temperature effect by the biology effect.

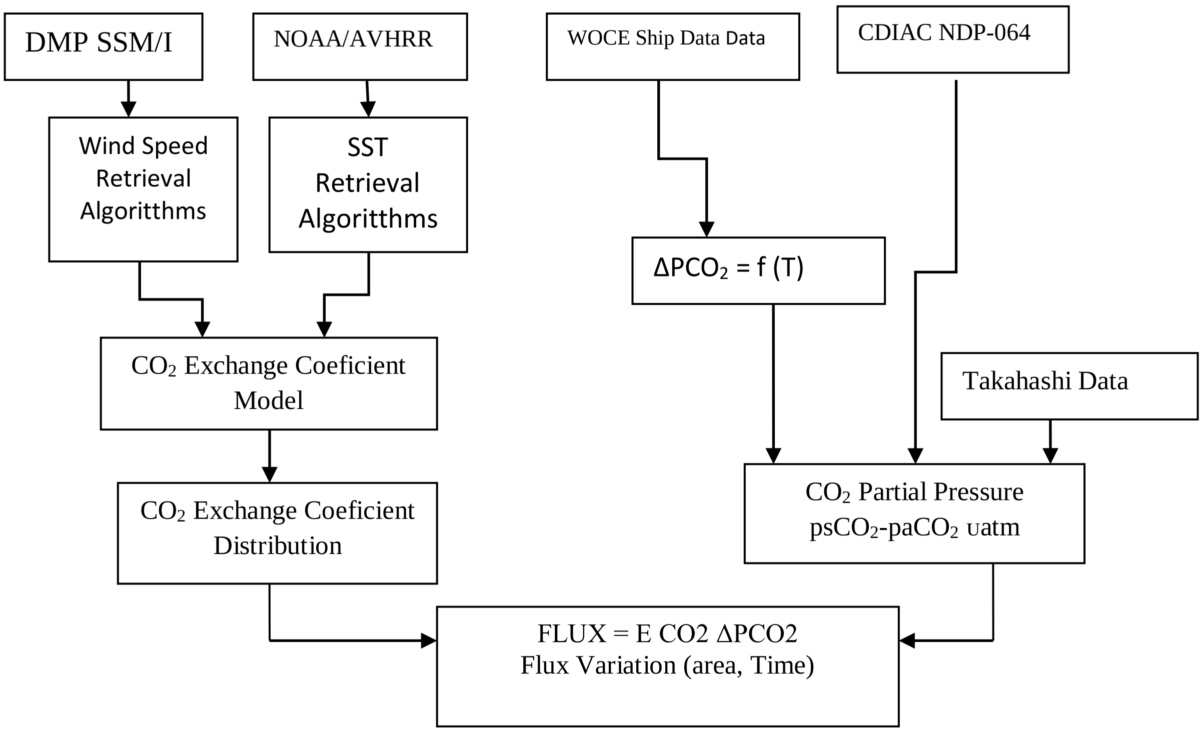

Figure 4. Framework of Research Concept

METHOD

Location of Research

This research was conducted in the Global Ocean.

Framework of Research Concept

Research conception divide into three frameworks, namely preparation, operation and validation, which can be seen in Figure 4.

Material and Method

The material and method from CO_2 flux can be seen at Figure 5.

Data Analysis Method

Data from WOCE ship is analyzed with linier regresion, $Y = ax - b$, get R^2 determint coeffisien, calculated with math lab, Net sea-air CO_2 Flux, F can calculate using following eguation:

$$F = K\, \alpha\, (\Delta pCO_2)_{sea\text{-}air}.$$

where:

K = CO2 gas Coefisien gas exchange (transfer velocity)

A = Solubility of CO2 in Seawater

$(\Delta pCO2)$sea-air = Sea-Air pCO2

The result would be the monthly $\Delta pCO2$.

AVHRR SST (Atmospheric Very High Resolution Radiometric Sea Surface Temperature) dan SSM/I (S) satellite data with radiometric calibrate geologicate radiance. Satellite data is process to level-2 product (Geophysical parameters on Earth Surface) by SeaDas Software and its results synchronous with ENVI.

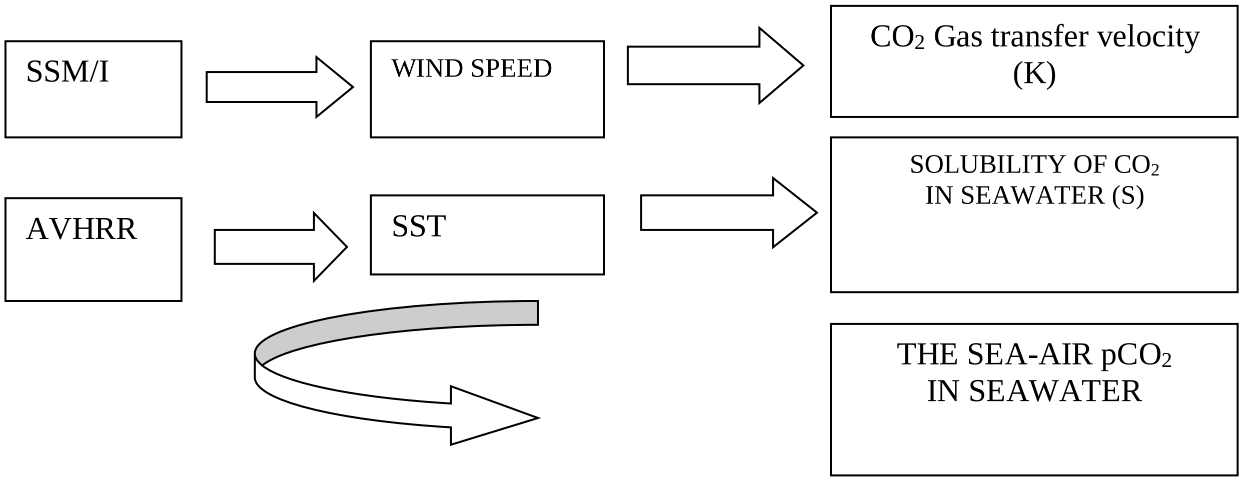

Figure 5. Material and Method

RESULT AND DISCUSSION

How and Why Is This Field Relevant?

As the world enters the 21st century there will increased focus on cycling of carbon. We are all aware that CO_2 and other greenhouse gases are increasing in the atmosphere. There is no better example to show than the classic data from C.D. Keeling[6] showing the seasonal oscillations and the steady annual increase of CO_2 at the Mauna Loa Observatory Most experts conclude we are already witnessing the impact of this increase as global warming and the signal is expected to become increasingly more pronounced between now and the year 2050. This is within the lifetime of students reading this book. Thus, an important focus of education in chemical oceanography should be on the concentrations of carbon species and their controlling mechanisms.

The ocean carbon cycle influences atmospheric CO_2 via changes in the net air-sea CO_2 flux that are driven by differences in the partial pressure of CO_2, P_{CO2}, between the surface ocean and atmosphere. The inventory of dissolved CO_2 in the oceans is 50-60 times greater than that in the atmosphere, so a small perturbation of the ocean carbon cycle can result in a substantial change in the concentration of CO_2 in the atmosphere. The regional and vertical partitioning of carbon in the ocean is dominated by two interdependent carbon pumps that deplete the surface ocean of total CO_2 relative to deep water. Because the solubility of CO_2 increases with decreasing temperature, the Solubility Pump transfers CO_2 to the deep sea during formation of cold deep water at high latitudes. This is a link of the ocean carbon cycle to physical processes. At the same time the biological pump removes carbon from surface waters by settling of organic and inorganic carbon derived from biological production. The biological pump transports organic carbon and $CaCO_3$ to deeper water where much if it is dissolved or remineralized increasing the total CO_2 reservoir in the deep sea that is isolated from the atmosphere. If there was no biological pump, atmospheric CO_2 would be about three 4 times higher than it is today. This is a link of the ocean carbon cycle to biological processes. Figure. 5.2 Relationship between CO_2 Flux and Latitude at Longitude 72.5 on July. The Maximum – minimum values CO_2 flux are 0.3 to -0.5 mole CO_2 m^{-2} at latitude -52^o to 40^o respectively, decreasing. Trend relationship CO^2 flux and latitude at longitude 72.5 on January with value are -0.3 to -0.07 moles CO_2 m^{-2} at latitude -52^o to 55^o, respectively decreasing.

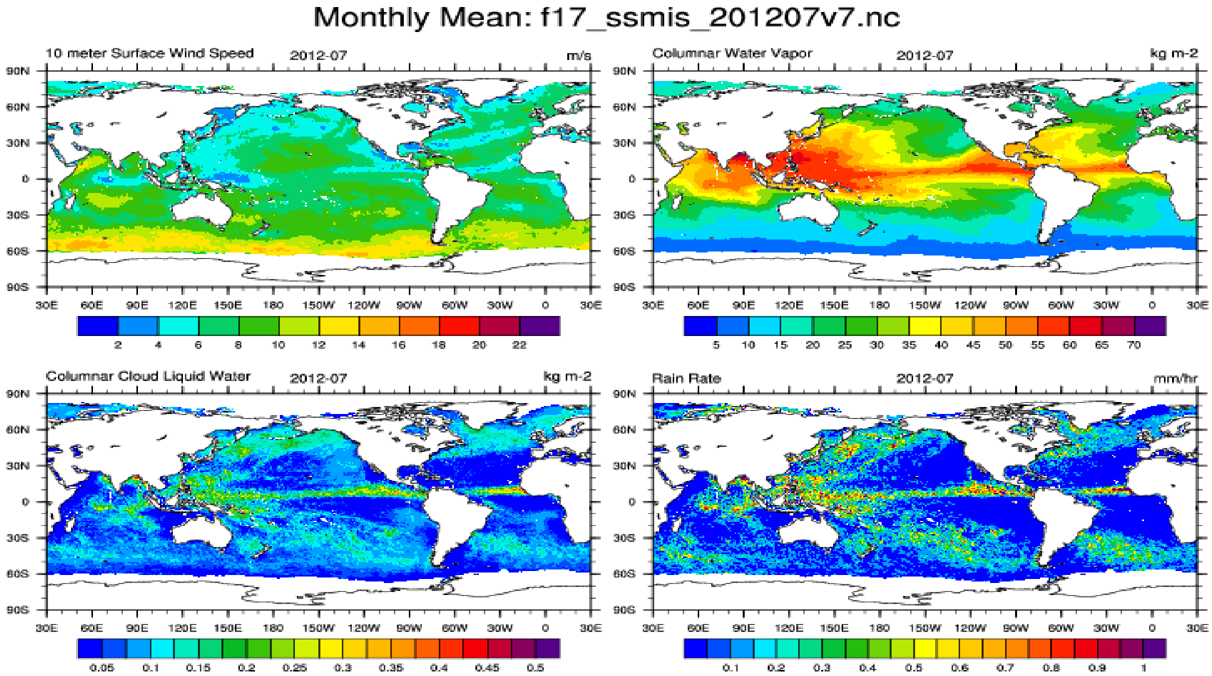

Figure 6. SSMI (v7) *monthly* means of 10 wind speed, columnar cloud liquid water, columnar water vapor and rain rate for July 2014.

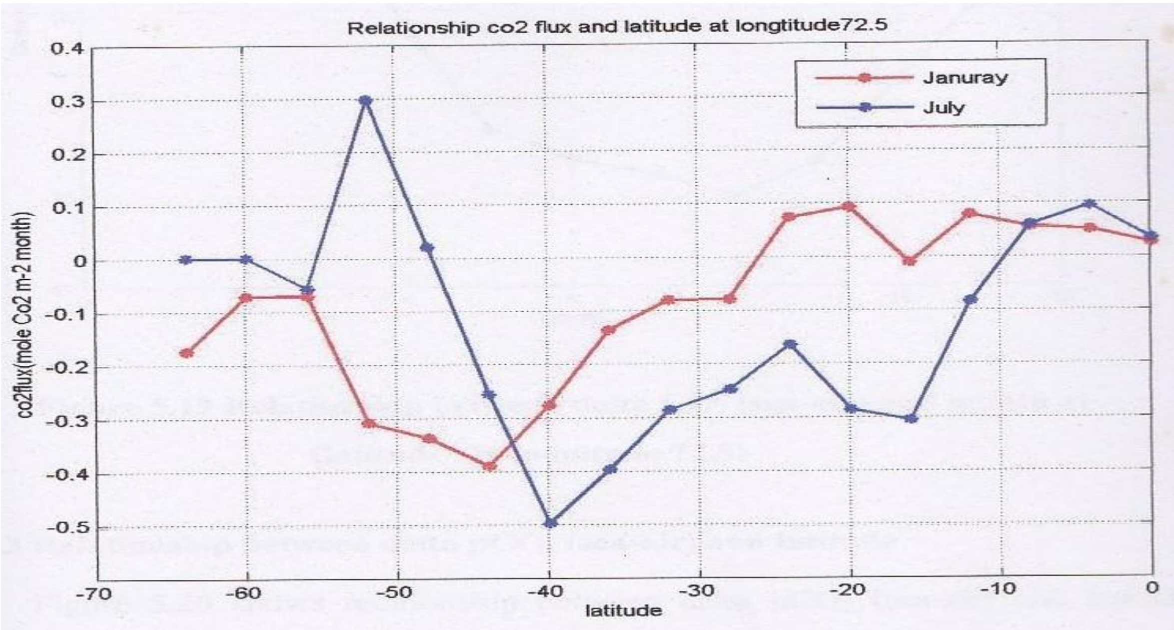

Figure 7. Relationship of delta CO2 sea-air and month at latitude -20 longitude 72.5

Figure 7 shows relationship delta CO_2 sea-air and month at latitude -20 longitude 72.5 is get trend from January to June from 18 to -22 delta pCO_2 occurs decrease, on low pCO_2 from February to august are found in the heigh latitude are at austral summer on February and northern summer on August. These areas intense sink for atmosphere CO2 and at Ocean occurs to the photosynthesis utilization of CO_2. In these areas low CO_2 flux is 0.3 mole m^{-2}v month at sub polar water areas 40^oS-60^oS. In these areas low pCO_2 water are formed by cooling of warm water with the biological dropdown of pCO_2 in the nutrient –rich sub polar water.

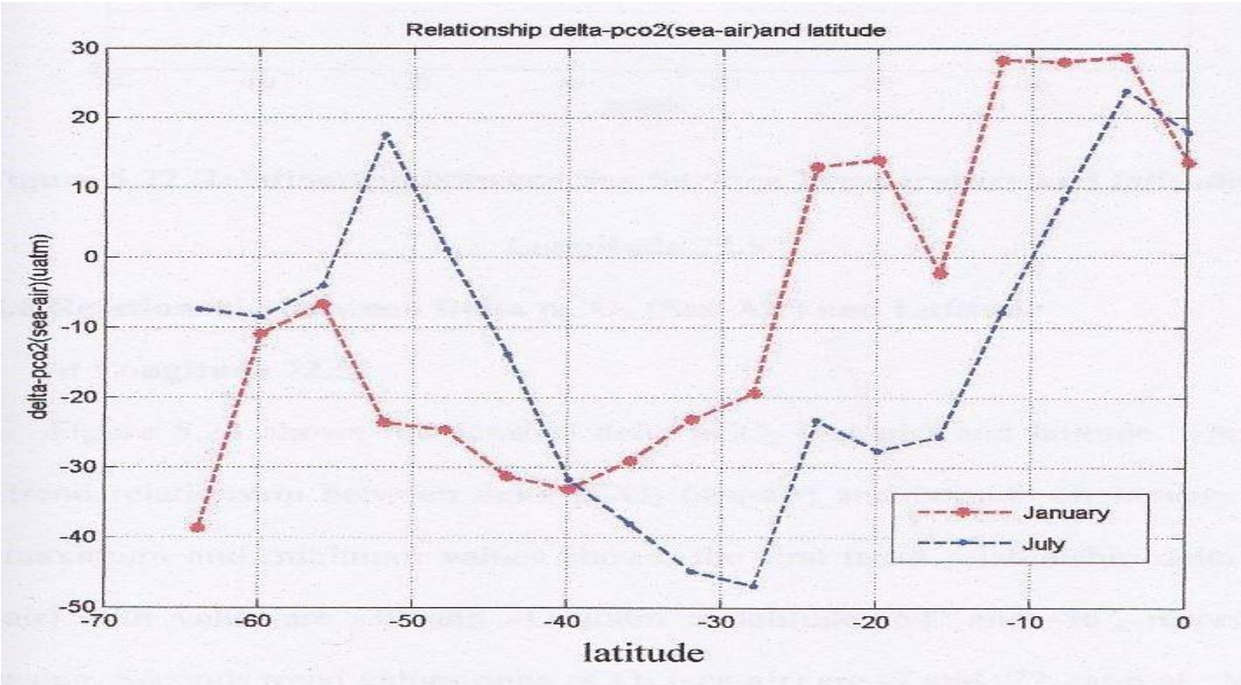

Figure 8. Relationship of delta CO2 sea-air and moth at latitude -20 longitude 72.5

Figure 8 shows relationship of delta CO_2 sea-air and moth at latitude -20 longitude 72.5 low ΔpCO_2 areas found in the high latitude areas in the South Ocean, Indian Ocean during the austral summer (February) and the Sub artic and Atlantic Ocean during the Northern summer (August). These Areas represent an intense sink for atmospheric CO_2, which attributed primarily to the photosynthetic utilization of CO_2. The broad low ΔpCO_2 areas dark and light blue which are found.

CONCLUSIONS

Conclusions beside biological process like respiration and photosynthesis to lessen CO_2 in nature so that do not as source of disaster hence we have to execute, lessening the source of disaster for example; deforestation, combustion of forest, usage of fossil fuel.

SUGGESTION

Suggestion for the future study it is recommended to do the deeper study using different method on the CO_2 flux.

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