VERTICAL AND SURFACE CARBONDIOXIDE OBSERVATION IN EQUATORIAL INDONESIA

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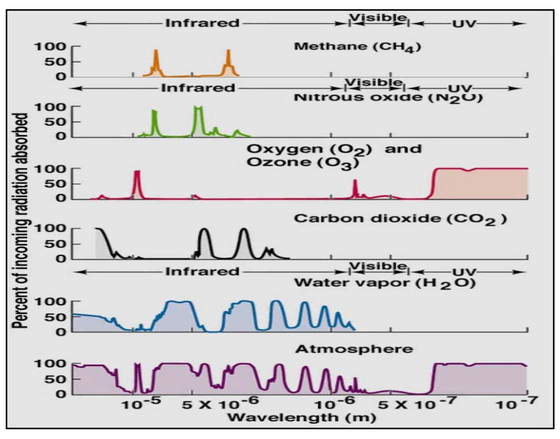
Introduction



Infrared spectrum absorption from earth surface
(Source: http://www.geology.iastate.edu)

Green House Gases (GHG): CO_2, N_2O, CH_4, SF_6, PFCs, HFCs (as black body), are the main driver for the greenhouse effect and GHG are essential to maintaining the earth temperature. Ideally, the earth surface's temperature will always be in steady state because of the balance of heat radiation through absorption of infrared in the atmosphere, causing the earth not get cold or hot quickly.

As a GHG (Green House Gases), CO_2 absorb emission energy radiation from earth in wavelength 2 - 20 micrometers. CO_2 absorb infra red energy for vibration and stretching, causing lower atmosphere becomes warmer. Some scientist had a notion that CO_2 is also posses a black body characteristic, thus the raise of CO_2 concentration will follow the absorption heat cycle of atmosphere. The higher CO_2 concentration become shorter infrared path distance, before total atmospheric absorption happen, however occurred in the lower atmosphere. In the same time, more infrared will be released out to the space (Heinz Hug, 2008)[2].

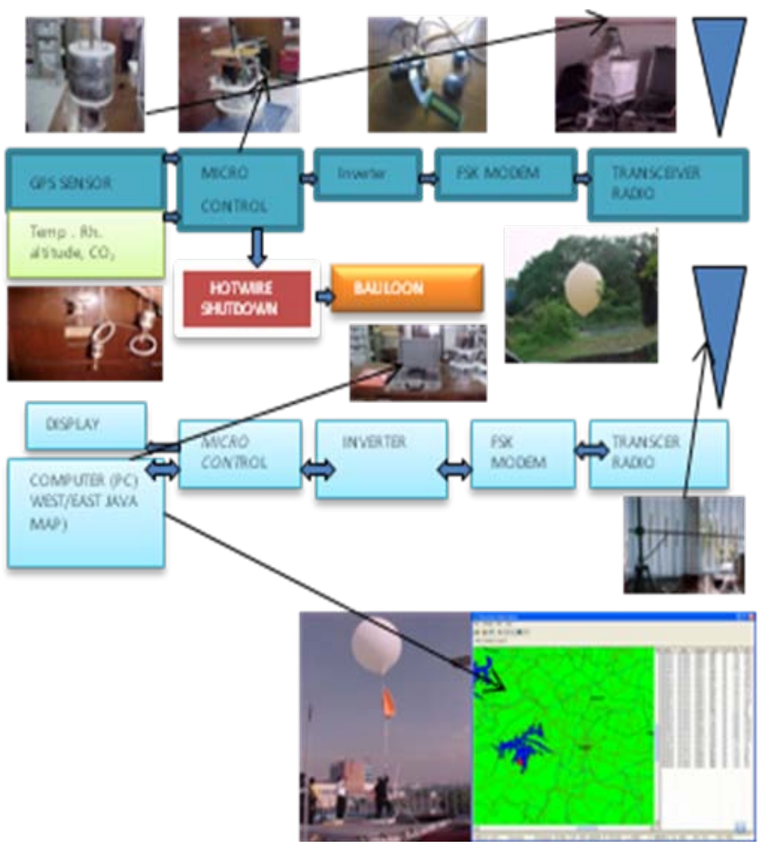
The aim of this research is to study the vertical concentration of CO_2 in Indonesia. The goal is to identify the concentration pattern in tropopause area, to discover the CO_2 convection movement pattern and its surroundings stream, to find a characteristic of carbon dioxide in the surface,, and to compare carbon dioxide concentration in certain location in Indonesia due to human activity

Data and Research Method

This research is basically to observe vertical and surface carbondioxide concentration. The vertical observation utilized by launching a measuring balloon, the CO_2 concentration can be measured, and the change of CO_2 concentration and the probability of CO_2 convection can be identified. The payload consist of CO2 NDIR sensor that transmit its result to the receiver , after reaching troposphere layer the payload disconnect automatically with the balloon and drop freely into the earth surface.

While the surface observation is to monitor diurnal variations of surface atmospheric carbon dioxide. To accomplish that, we build 5 CO_2 ground station in 3 different island in Indonesia. Two of this station located in the equatorial region. Using the NDIR CO_2 sensor, result data than collected, analyze and displayed by CO_2 software. Adding to the data observation, are the data satellite from AIRS (Atmospheric Infrared Sounder) in NASA Aqua Satellite. The data consist of mole fraction value of carbon dioxide in free troposphere. In daily or monthly observation.

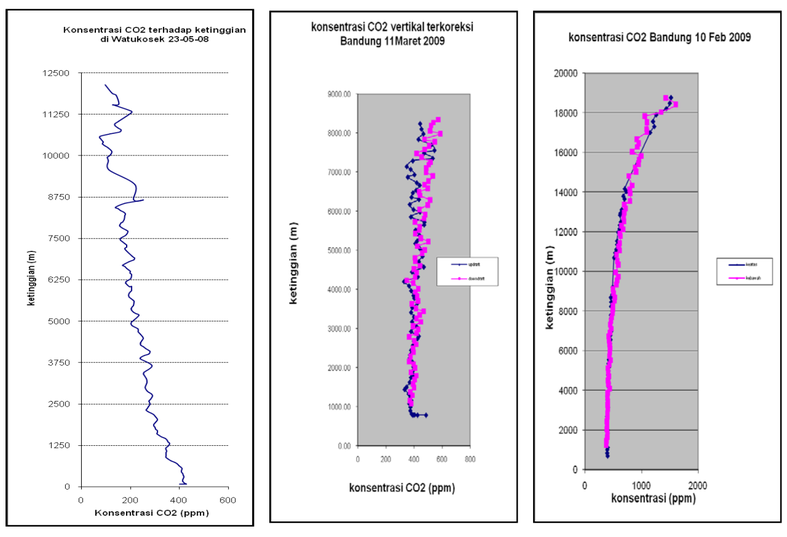
Vertical Observation



Instrument systems to measure CO_2 vertical and balloon launched
(Source : Chunaeni Latief,2008)

Balloon carrying payload fill with sensor was conducted with height arrangement from 18 to18.5 km with velocity between 2.5 m/s until 6 m/s, and time sampling 30 seconds per data. It was expected that there would be a layer sample between 75 - 180 m. So there would be a representative sample at atmosphere layer and the ability in sending data and also saving power battery.
After the result of measurement compilation by sorting elevation, CO_2 data concentration sequenced and correction using ideal gas, then the data can be plotted.

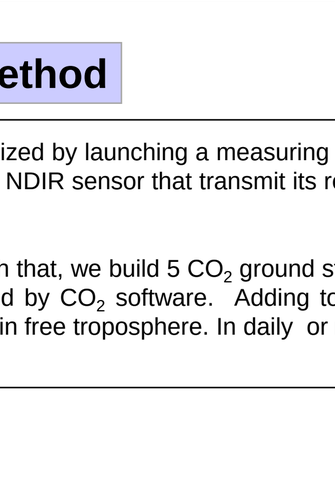
The pattern of CO_2 profile measurement was similar to different location. At certain elevation (example at 2.279 km ion Bandung Oct'08) shows the CO_2 concentration went down (decrease) to 298.1 ppm, and then went up (increase), with temperature still went down (decrease) about 17.43 ^oC, this because seasons transition from dray to rainy season respectively.
This phenomenon called mixing height, it occurred from the concentration changes due to balloon move up because of the convection from seasons variation bellow.



Watukosek Bandung Bandung

CO_2 Vertical Profile in Bandung and watukosek Indonesia
(Source : Chunaeni Latief et.al,2008)

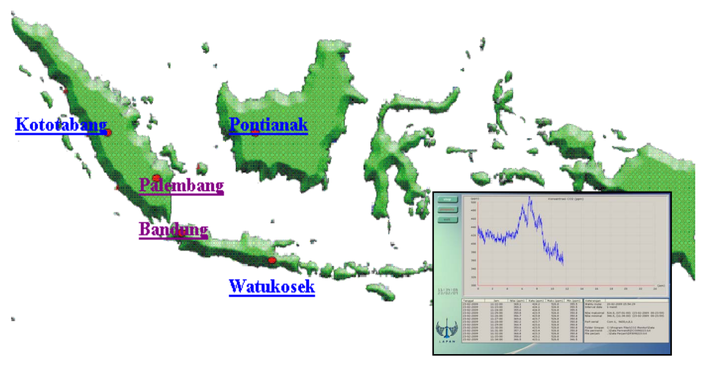
Surface Observation



CO_2 ground station placed in 5 different location Bandung, Watukosek, Palembang, Kototabang and Pontianak. The last two location was located in the equatorial region.

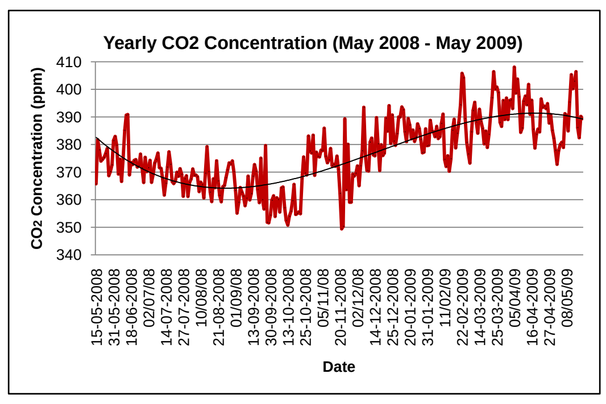
Every CO_2 gound stations composed of NSDIR CO_2 sensor with measurement range 0 - 2000 ppm, attached at a 12.5 meter tower and join with self design data logger. The sensor have response time of 30 seconds with accuracy ±(20ppm + 2% of reading).

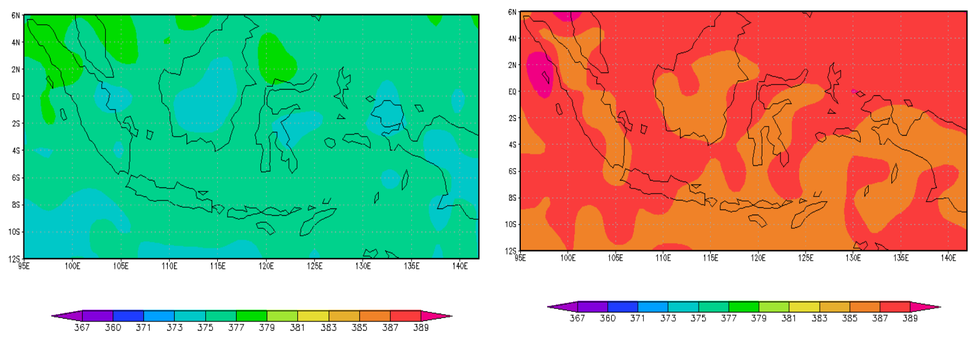
The sensor was placed inside sensor house to protect from heat and water. The result data can be monitored in the CO_2 display in daily observation. Added to the observation were the wind observation (wind speed and wind direction) from two different sources, from NCAR models analysis and AWS (Automatic Weather Station) placed in each station



CO_2 Ground Station, Location and CO_2 data monitor
(Source : Asif Awaludin,2008)

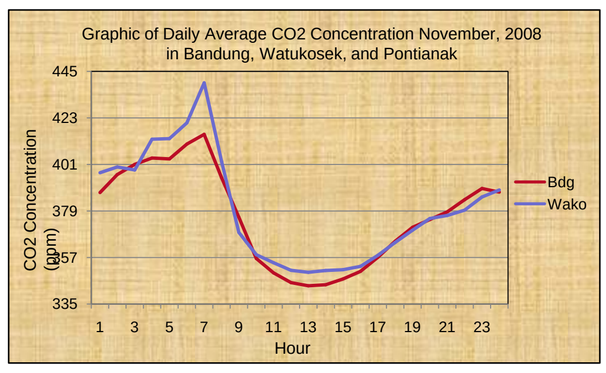
We also monitor the CO_2 surface concentration from the satellite data. The AIRS data from Aquos satellite was collected and analyze to add some perspective for the surface carbondioxide research.
In here shows the increase of the carbondioxide concentration in the Indonesia territory. From 2002 until 2009 there have been an increase about 12 ppm (376 ppm on 2003 and 388 ppm on 2009) based on the average mass fraction measurement from the satellite.



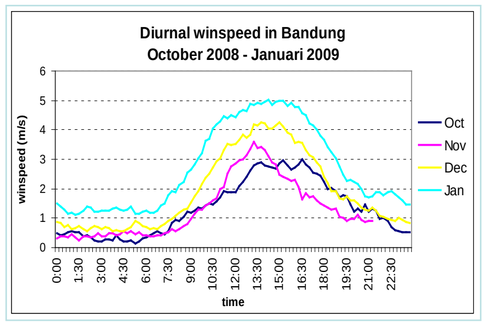


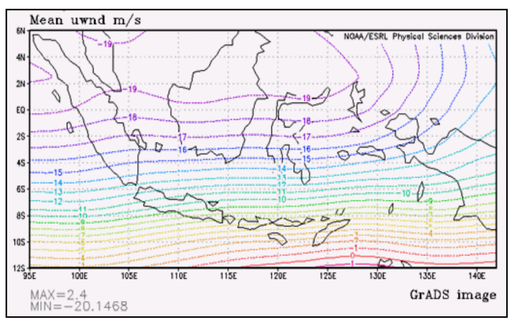
August 2003 August 2009

CO_2 observation using AIRS data satellite in August (2003 and 2009)
(Source : http://mirador.gsfc.nasa.gov)



CO_2 Yearly and Diurnal Variation in Different Location in Indonesia
(Source : Asif Awaludin,2008)





Wind Direction and Wind Speed from NCAR and AWS
Source :www.cdc.noaa.gov/data/gridded/data.ncep.reanalysis.pressure.html)

CONCLUSION

A self design CO_2 measurement system had been made by team from LAPAN for measuring both vertical and surface CO_2 concentration to provide a more comprehensive research on atmospheric science especially in greenhouse gases research. Added to this research are the AIRS data satellite from NASA .

CO_2 vertical concentration pattern in different location (Bandung and Watukosek) showed that by increased altitude the CO_2 concentration becomes lower. The vertical profile nearly had the same pattern (increasing altitude will cause a decrease of CO_2 concentration) in every location but there was also a changing pattern in certain altitude (CO_2 concentration becomes lower although the altitude increases) which presumed because of mixing height.

In surface observation there is a same pattern in every location which resulting a sinusoidal pattern of CO_2 concentration. Maximum concentration value occurred at about 5.00 – 8.00 in the morning, while the minimum concentration value occurred at about 12.00 – 16.00 in the afternoon. The yearly observation data showed an oscillation curve similar to the keeling curve. From satellite data showed an increase average of 12 ppm from 2003 until August 2009.

There is also an influence occur from wind speed and wind direction to the CO_2 pattern. Photosyntheyic rate and respiration are considered as the reason of the sinusoidal curve of CO_2 concentration in the surface observation.

In surface observation there is a same pattern in every location which result a sinusoidal pattern of CO_2 concentration. The yearly observation data shows part of the continuous keeling curve of the CO_2 pattern where the lowest concentration occur in august - october while the maximum in march – april (although it still in research progress). Maximum concentration value occurred at about 5.00 – 8.00 in the morning, while the minimum concentration value occurred at about 12.00 – 16.00 in the afternoon.

The wind observation also related to the surface CO_2 pattern where the maximum average of wind speed (3 m/s – 5 m/s, depending on the location) from 10.30-16.30 will reduce the CO_2 concentration.

Reference

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