ENVIS NEWSLETTER

Acid Rain and Atmospheric Pollution

(A project of the Ministry of Environment and Forests, Govt. Of India)

Indian Institute of Tropical Meteorology, Pune

Visit us at: http://envis.tropmet.res.in

Volume 5, Issue 2 July - December 2007

Contents

ENVIS Support TEAM:
Programme Officer:
Aparna Deshpande
Technical Support:
Abhishek Solanki,
Ashish Sharma

Editor's Desk:

We are happy to bring out this second issue of ENVIS Newsletter of IITM in the year 2007. This year can be considered to be special year as the Nobel Peace Award for the first time is given to the work carried out in environmental science. The attention given to the most important issues of today's world-wide problem, would definitely help in opening the eyes of people and force them to help for fighting against the global warming which the world is facing today. A brief summary of the Nobel peace prize 2007 and highlights of IPCC Fourth assessment report are therefore included in this issue. The inauguration of the first Tsunami early warning centre in Hyderabad in this year adds up to the glory of success achieved by mankind in fighting against natural calamities.

In addition, this issue also focuses on some new aspects related to air pollution: Greenhouse gases and pollution filled brown clouds. We have also tried to cover important issues related to acid rains in India along with a discussion on Indian Monsoon 2007. To make the Bulletin a truly effective forum for all atmospheric pollution related issues of the country, feedback and contributions from scientific communities and research groups are highly appreciated.

G. Beig **B. N. Goswami**

Editors

Noble Peace Prize 2007 to Climaate change

The Geneva based Intergovernmental Panel for Climate Change (IPCC) and the former United States Vice President Al-Gore were awarded the Nobel Peace Prize for their work on environment.

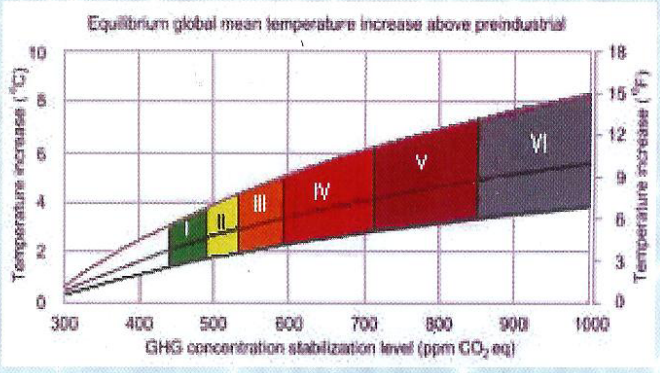
The IPCC and former vice-president of United State Al-Gore received this year Nobel Prize for peace. The prize reflected their efforts to build up and disseminate knowledge about man made climate change and to lay the foundations for fighting it. This is the first time that such a prize was given for fight carried out in saving the environment. As head of a body set up by the United Nations Environment Programme and the UN's World Meteorological Organisation to evaluate the available science on climate change, IPCC Chairman, R. Pachauri has overseen the publication of a long-awaited report on global warming this year. From the report it is clear that the earth's recent warming was more than 90 % likely to be man-made.

After the announcement of Nobel Prize, at a media conference, he pointed towards the clear evidence of the pace of global warming which showed that "11 of the warmest years since instrumental records have been kept occurred during the last 12 years, which accelerates the climate change". However his approach towards the industrialised countries is quite optimistic. These countries should and can handle their responsibilities in cutting greenhouse gases. The cost of reducing emissions is really not high and amounts to three per cent of gross domestic product in the year 2030. Therefore if one looks at the expenditure on relief and rehabilitation after natural disasters, it is much cheaper and far more enlightens to prevent some such problems in the first place.

The individual choices about transport, heating and consumptions are extremely important. Development of a country adds to the changes in lifestyle, behavioural patterns, and consumption patterns and so on. So every society should carry out a detailed analysis on the kind of lifestyle changes that needs to be brought about for saving the environment. This is an absolutely critical part of mitigation measures. For this there is a need of public that consists of "green dictators". If all the individuals think about moving in particular direction the change observed would be much better and faster too. So now its time for all of us to act as said by Mahatma Gandhi "Be the change you want to see in the world".

IPCC Fourth Assessment Report

In the latest IPCC report issued at the beginning of February, scientists said it was "very likely" - or more than 90% probable - that global warming was man-made. The report predicts a "best estimate" that temperatures would rise by between 1.8-4°C in the 21st century, within a likely range from 1.1-6.4°C. The study projects a rise in sea levels in the range of 28 - 43cm in the 21st century.



The projected temperature increase for a range of stabilization scenarios (the coloured bands). The black line in middle of the shaded area indicates 'best estimates'; the red and the blue lines the likely limits. From the work of Working Group III.

Tsunami Early Warning Centre

A state-of-the-art National Tsunami Early Warning Centre, which has the capability to detect earthquakes of more than 6 magnitude in the Indian Ocean was inaugurated in Hyderabad by Union Minister for Science & Technology Kapil Sibal.

According to an INCOIS release, the warning system comprises a real-time network of seismic stations, BPRs and 30 tide gauges to detect tsunamigenic earthquakes and monitor tsunamis. The tsumanigenic zones that threaten the Indian Ocean were identified by considering past tsunamis, earthquakes, their magnitudes, and the location of the area relative to a fault and also by tsunami modelling.

Photograph of the tsunami early warning centre in Hyderabad (PTI)

Greenhouse Gases' Continued Rise

The steady rise in atmospheric levels of the greenhouse gases blamed for climate change shows no signs of abating, as per the latest World Meteorological Organization report.

The three major gases namely. CO_2, N_2O, and CH_4 alone contribute about 88% of the increase in radiative forcing of the atmosphere by changes in long-lived greenhouse gases occurring since the beginning of the industrial age (~ 1750). The Global Atmosphere Watch (GAW) programme of the World Meteorological Organization (WMO) promotes systematic and reliable observations of the global atmospheric environment, including measurements of CO_2, CH_4, N_2O, and other atmospheric gases. The measurement data are reported by participating countries and archived and distributed by the World Data Centre for Greenhouse Gases (WDCGG) at the Japan Meteorological Agency (JMA). Statistics on the present global atmospheric abundances are given in Table 1. They have been increasing in the atmosphere since the beginning of the industrial age. Water vapour is a natural component of the climate and weather system that is indirectly affected by human activities through changes in temperature, land surface characteristics and aerosol effects on clouds. The latest analysis of data from the WMO-GAW Global Greenhouse Gas Monitoring Network shows that the globally averaged mixing ratios of carbon dioxide (CO_2) and nitrous oxide (N_2O) have reached new highs in 2005 with CO_2 at 379.1 ppm and N_2O at 319.2 ppb. The CO_2 is up by 0.53% and N_2O is up by 0.2% from 2004.The mixing ratio of methane (CH_4) remains unchanged at 1783 ppb. These values are higher than those in pre-industrial times by 35.4%, 18.2% and 154.7%, respectively. Atmospheric growth rates in 2005 of these gases are consistent with recent years. Methane growth has slowed during the past decade. The recently introduced NOAA Annual Greenhouse Gas Index (AGGI) shows that from 1990 to 2005 the atmospheric radiative forcing by all long-lived greenhouse gases has increased by 21.5%.

WMO report said levels were likely to keep rising unless emissions of CO_2, methane and nitrogen oxides were slashed. The announcement comes on the eve of UN climate negotiations in Nairobi. There is no sign that N_2O (nitrous oxide) and CO_2 are starting to level off. "It looks like it will just continue like this for the foreseeable future. The accumulation of such gases- generated by burning fossil fuels such as coal, oil and gas - traps energy coming originally from the Sun, causing global temperatures to rise. This is expected to lead to melting of polar ice caps and glaciers, rising sea levels and more extreme weather events such as storms and floods. The trend of growing emissions from industry, transport and power generation is set to continue despite international agreements on regulating them, the UN agency warned. "To really make CO_2 level off we will need more drastic measures than are in the Kyoto Protocol today," Geir Braathen of WMO explained. "Every human being on this globe should think about how much CO_2 he or she emits and try to do something about that."

Compulsory caps: The Kyoto Protocol sets limits for emissions of six greenhouse gases for the richer countries of the world which have ratified it. The period for which targets exist runs until 2012. The US and Australia have rejected the compulsory cap. China has ratified the Protocol, but as a developing nation, it is not required to reduce its emissions - despite its booming economy. A report by former World Bank economist Sir Nicholas Stern warned of severe problems if global warming was ignored. The latest data were gathered from monitoring stations, ships and aircraft around the world under the umbrella of WMO.

Other Greenhouse Gases: The ozone depleting chlorofluorocarbons (CFCs) also contribute to the radiative forcing of the atmosphere. Their overall contribution to the global radiative forcing is significant (12% of the total). While atmospheric CFCs are now decreasing slowly, some of the CFCs still have a serious impact on the atmospheric greenhouse effect. Some species such as hydrochlorofluoro- carbons (HCFCs), which are strong infrared absorbers, are increasing at rapid rates, although low in abundance. Ozone in the troposphere does not have a long lifetime, but it has an atmospheric greenhouse effect that is comparable to those of the CFCs. Although tropospheric ozone is important for the atmospheric greenhouse effect, it is difficult to estimate the global distribution and trend due to its very uneven geographic distribution. All the gases mentioned here are also monitored as part of the WMO-GAW network.

Table 1. Global abundances of key greenhouse gases as averaged over the twelve months of 2005 as well as trends from the WMO-GAW global greenhouse gas monitoring network.

	CO_2 (ppm)	CH_4 (ppb)	N_2O (ppb)
Global abundance in 2005	379.1	1783	319.2
2005 abundance relative to year 1750	135.4%	254.7%	118.2%
2004-05 absolute increase	2.0	0	0.6
2004-05 relative increase	0.53%	0.0%	0.19%
Mean annual absolute increase during last 10 years	1.9	2.8	0.74

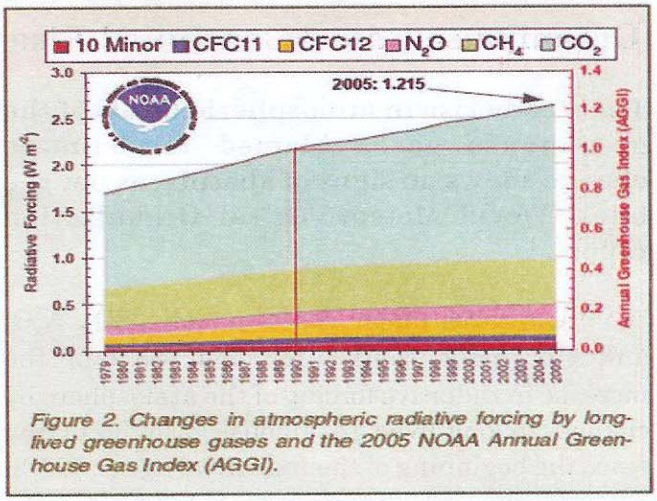


Figure 2. Changes in atmospheric radiative forcing by long-lived greenhouse gases and the 2005 NOAA Annual Greenhouse Gas Index (AGGI).

Brown Clouds Coupled With GHG Emission Endanger Asian Water Supplies

A new analysis of pollution-filled "brown clouds" over south Asia, carried out at Scripps Institution of Oceanography at UC, San Diego, US, finds that atmospheric brown clouds containing soot and trace metals from a variety of urban, industrial and agricultural sources have enhanced solar heating of the lower atmosphere by about 50 percent. The Scripps paper, published in the 2 August 2007 edition of the journal Nature, concludes that the combined heating effect of greenhouse gases and the brown clouds is enough to explain the withdrawal of Himalayan glaciers observed in the past half century. The glaciers supply water to major Asian rivers, which comprise the principal water supply for billions of people in China and India.

National Air Quality Monitoring Programme (NAMP)

The Central Pollution Control Board is executing a nation wide program of ambient air quality monitoring known as National Air Quality Monitoring Programme (NAMP). The network consists of three hundred and thirty two (332) operating stations covering one hundred and twenty one (121) cities/towns in twenty five (25) states and four (4) Union Territories of the country. Under NAMP, four air pollutants viz. sulphur dioxide (So_2), oxides of nitrogen as NO_2, suspended particulate matter (SPM) and respirable suspended particulate matter (RSPM / PM_{10}) have been identified for regular monitoring at all the locations. The monitoring of meteorological parameters such as wind speed and wind direction, relative humidity (RH) and temperature were also integrated with the monitoring of air quality.

Parameter wise findings are as follows:

Sulphur dioxide: Low levels of SO_2 were observed in all the seventeen cities. A decreasing trend was observed in residential areas of Delhi, Hyderabad, Kanpur, Lucknow, Mumbai and Pune. The decreasing trend may be ascribed to various interventions that have taken place in recent years such as reduction of sulphur in diesel, use of cleaner fuel such as CNG in Delhi and Mumbai etc. Other measures include implementation of Bharat Stage-III emission norms for new vehicles and commensurate fuel quality. Also there has been a change in domestic fuel used from coal to LPG which may have contributed to reduction in ambient levels of SO_2.

Nitrogen dioxide: NO_2 levels were within the prescribed NAAQS in the cities except Agra during most of the years. Agra being a sensitive city, the standards are stricter. A decreasing trend has been observed in residential areas of Faridabad, Kolkata, Solapur and Pune. Fluctuating trends in NO_2 were observed in residential areas of Bangalore, Hyderabad etc. Vehicles are one of the major sources of NO_2 and their number is increasing exponentially. The reasons for low levels of NO_2 may be various measures taken such as banning of old vehicles, better traffic management etc. The reasons behind reduction in No_2 may be introduction of improved vehicular technology in the form of Bharat Stage - III vehicles.

RSPM: RSPM levels exceed the prescribed NAAQS in most of the cities but a decreasing trend has been observed in residential areas of Ahmedabad, Solapur and Kanpur. The reason of decrease in RSPM levels might be due to the implementation of stricter vehicle emission norms and commensurate fuel quality, use of cleaner fuels, banning of diesel driven vehicles in some cities etc. Fluctuating trends have been observed in residential areas of Chennai, Kolkata etc. The reason for high particulate matter levels may be vehicles, engine gensets, small scale industries, biomass incineration, resuspension of

traffic dust, commercial and domestic use of fuels, etc.

Carbon monoxide: High levels of CO might be attributed to increase in vehicular population especially passenger cars in Delhi. Despite an increase in number of vehicles, CO levels have reduced during last few years. The decrease may be attributed to measures such as conversion of three wheelers of CNG in Delhi.

Acid Rain Status in India - An update

Growth of economy of a country mainly depends on the amount of use of energy resources. As India is among the fastest growing countries with regard to economy, the natural consequence one can draw of it is that there has been massive increase in the current use of energy resources in different public/private sectors. This reflects in the fact that emission of air pollutants in India has drastically increased with the passage of time mainly on account of the anthropogenic activity. Use of resources is a time-honoured necessity for the growth and development of civilization, but the other side of it is that it has led to several adverse consequences of it, as one in the form of acid rain which may have many-fold detrimental impact on the society.

Acid rain is caused mainly by the presence of sulphuric and nitric acids in the rain water which are results of oxidation of sulphur and nitrogen contents emitted in the atmosphere mainly through bio-fuel, fossil fuel and bio-mass burning in the vehicles, industries, thermal power plants etc. Transports of oxides of nitrogen and sulphur from a source region to a region of less availability of potential acid neutralizer (e.g., CaCO3, $MgCO_3$, $Ca(OH)_2$, NH_3 etc.) may also lead to acidification of precipitation particles there.

From the chemistry point of view, a water sample showing pH value equal to 7 is said to be neutral. However, while dealing with the acidity/alkalinity of rain water in the atmospheric sciences, a pH value range of 5.6-5.65 is taken as the reference value (i.e., neutral pH-value range) to decide whether the rain water is acidic, neutral or alkaline. This is because of the partial dissolution of atmospheric CO_2 in the rain water causing presence of weak carbonic acid (H_2CO_3) in the rain water which lowers its pH-value. Thus, while dealing with rain water acidity, a pH-value range 5.6-5.65 is taken as pure water neutrality in equilibrium with atmospheric Co_2

There have been megre reports of acid rain in India in the past and that too have been only the episodic. Reported acid precipitations in India includes the acid rain in Chembur and Colaba industrial areas of Mumbai, in the vicinity of Singrauli Super thermal Power Plant (average pH value 5.3), at a rural site of Bhubaneswar (median pH value 5.0) and the Silent valley (pH=5.3). Latest reports on acid rain are at Kalyan (pH= 5.28), Chembur (pH=4.8), Sinhagad (pH= 5.2), Delhi (pH<5.6) and very recently at Panipat (pH<5.6) of National Capital Region of Delhi. Although the pH value of rain water at Pune has been reported to lie in the alkaline range, its value has shown decreasing trend from a value of~ 7.5 in 1986 to ~6.2 in 1998. The main reason is attributed to the decrease in the level of calcium ion and increase in sulphate and nitrate ions. Rain fall in Agra and Delhi regions have also shown decrease in pH value with the passage of time. Thus, it is a situation which alarms to have control over the emission not only in these regions but in other regions also.

It has been found that potential neutralizer of the acidic components of rain water in Indian region is Calcium which is mainly naturally derived from the soil. As the soil of the most part of Indian land is Calcareous, it contains abundance of Calcium. So, the Indian soil has as yet put a check on the acidification of rain water, but how long? So, it is advised to every individual of the society, particularly in benevolence to the living beings, to be aware of alarming levels of various unwanted anthropogenic emissions and neutralization potential of the naturally derived metallic components, abstain from the activity causing dangerous emissions and dissuade the others and try to search for alternatives causing diminished or nil emission. Otherwise, it would lead to potential chemical hazardous phenomena like acid rain.

(Contributed by- Kaushar Ali, IITM, Pune)

Indian Monsoon 2007: Possible impacts of ENSO and IODM

India receives nearly 80 % of the annual rainfall over major parts of the country during the summer monsoon period (June-September). The Long Period Average (LPA) seasonal rainfall is about 892 mm with a standard deviation of about 88 mm and coefficient of variation of 9 % (www.imd.gov.in). The inter-annual variability of the Indian summer monsoon rainfall is influenced by several factors such as the El Nino Southern Oscillation (ENSO) phenomenon, Indian Ocean Dipole Mode (IODM), Eurasian snow cover etc. During the summer monsoon period of 2007, India received 105 % of LPA rainfall. In this article illustrations are presented to show that ENSO and IODM could have been dominant factors leading to enhanced monsoon activity during Monsoon 2007.

Fig. 1 displays the sub-division wise rainfall distribution over India during the southwest monsoon 2007 (downloaded from website of India Meteorological Department www.imd.gov.in). Figure clearly depicts rainfall to be normal or in excess over major parts of the country. Details can be inferred from the figure. Month wise distribution of rainfall departures for the month of June, July, August and September were 19 % above LPA, 3 % below LPA, 1 % below LPA and 18 % above LPA respectively. Thus rainfall during the months of June and September were major contributors.

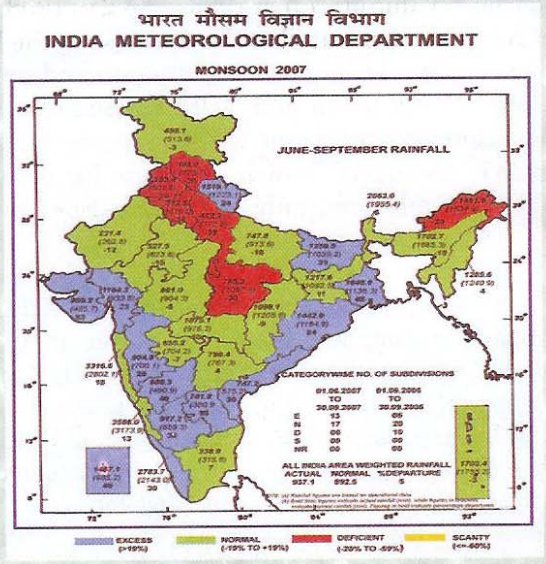


Figure 1: Sub-division wise rainfall distribution over India during southwest monsoon season (June to September) - 2007

The normal sea surface temperatures (SSTs) are higher over the equatorial west Pacific and lower over the equatorial east Pacific. Anomalous warming (cooling) over the east (west) Pacific leads to the El Nino phenomenon, while reverse situation leads to the La Nina phenomenon. Numerous studies have shown that the El Nino (La Nina) phase of ENSO over the Pacific Ocean is unfavourable (favourable) for summer monsoon activity over India.

On the other hand the SSTs are higher over the eastern equatorial Indian Ocean and lower over the western equatorial Indian Ocean. Anomalous warming (cooling) over the western (eastern) Indian Ocean leads to a phenomenon now designated as the positive phase of the Indian Ocean Dipole Mode, while the reverse situation is designated as the negative phase of this mode. Recent studies have shown that the positive (negative) phase of this mode over the Indian Ocean is favourable (unfavourable) for monsoon activity over India.

The anomalous SST distribution for the months of June, July, August and September 2007 over the Indian Ocean and the Pacific Ocean convey similar inferences, hence here we present the maps for the month of September 2007 only. Furthermore the rainfall contribution during September 2007 was substantial. Fig. 2 displays the anomalous SST distribution for September 2007 (downloaded from www.cpc.noaa.gov/products/BCD).

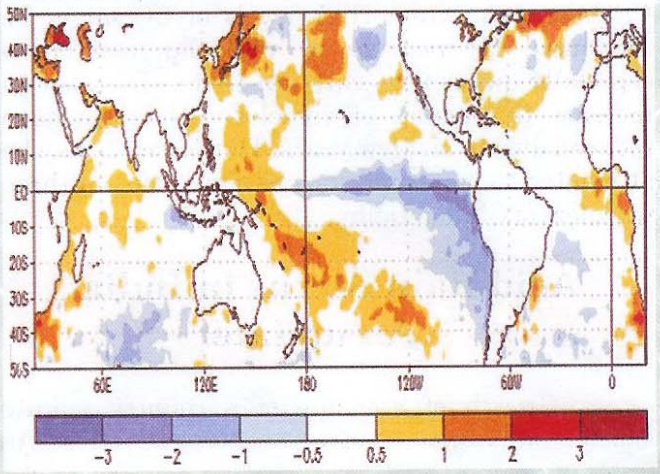


Figure 2: Anomalous sea surface temperature (SST) for September 2007

Negative SST anomalies prevail over the eastern equatorial Pacific from 180E up to the coast of South America. On the other hand positive SST anomalies prevail over the western equatorial Pacific Ocean between 130E till 180E. This anomalous SST distribution over the Pacific depicts the La Nina phase of the ENSO phenomenon. Over the Indian Ocean positive SST anomalies prevail over the western region lying between 50E till 70E and negative SST anomalies just south of Sumatra (100E to 120E). This depicts the positive phase of the IODM. Thus during the summer 2007 both the Pacific with the La Nina phase and the Indian Ocean with the positive IODM phase were favourable for the monsoon activity.

Normally the positive phase of the dipole mode over the Indian Ocean is associated with the El Nino phase over the Pacific. However, during the summer of 2007 the positive dipole phase is associated with the La Nina phase. The reasons for this type of anomalous SST distribution over the Indian and the Pacific Ocean leading to a combined positive dipole-La Nina event need to be investigated separately.

Fig. 3 and Fig.4 depict the pressure-longitude section for the anomalous divergence and divergent circulation averaged between 5°N-5°S (downloaded from www.cpc.noaa.gov/products/CDB). Fig. 3 is for the sector 80W-100E and Fig.4 for the sector 100E-80W.

The anomalous ascending motion over the equatorial Indian sector (60°E-80°E: Fig. 3) indicates strong convective activity over this region associated with enhanced rainfall activity. The monsoon rainfall during September 2007 was 18% above LPA over India. The above normal rainfall could be due to the convective activity & the associated ascending motion over India. Hence, it is presumed that the ascending motion depicted over the equatorial region (Fig. 3) also prevailed over the Indian land region. At 150 hPa this ascending motion appears to flow towards the east and also towards the west. The

westward flow descends over the sector 60°W-20°W (Fig.3). Thus this vertical cell of ascending motion over the Indian longitudes and descending motion over the west around 60-20W could be due to the IODM phenomenon. Fig. 4 shows anomalous ascending motion over the western Pacific (120°E-160°E) associated with the convective activity over that region and anomalous descending motion over the eastern Pacific (160°W-120°W: Nino 3.4 region). Thus this vertical cell of descending motion over the eastern Pacific and ascending over the Indian-west Pacific region (Fig 3 and 4) could be due to the La Nina phenomenon. Thus the anomalous SST distribution over the Indian and the Pacific Oceans and the two vertical cells associated with ENSO and IODM clearly illustrate the impact of ENSO and IODM on monsoon activity over the Indian region during 2007.

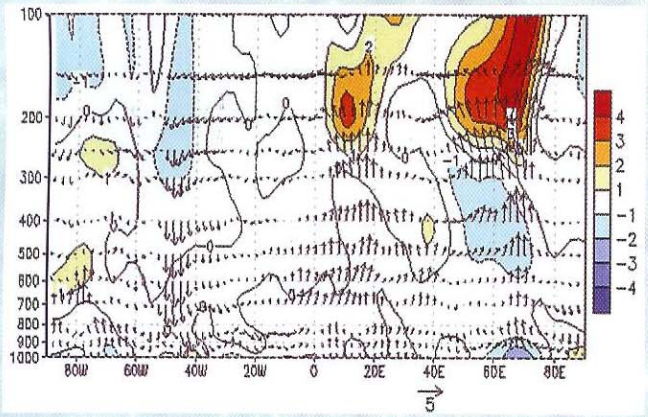


Figure 3: Pressure-longitude section (80°W-100°E) of anomalous divergence (contour interval is 1 x 10^{-6} s^{-1}) and W – E divergent circulation averaged between 5°N-5°S for September 2007. The divergent circulation is represented by vectors of combined pressure vertical velocity and the divergent component of the zonal wind. Red shading and solid contours denote anomalous divergence. Blue shading and dashed contours denote anomalous convergence.

Summary : From the above illustrations it is speculated that the positive phase of the dipole mode over the Indian Ocean and the La Nina phase of ENSO over the Pacific could have contributed to the enhanced monsoon activity over the Indian region. A detailed analysis is required.

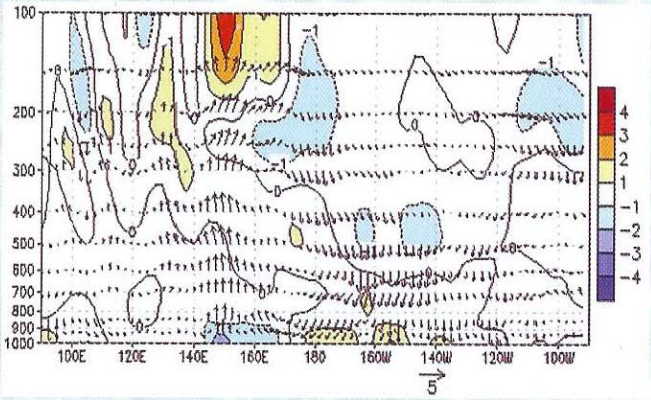


Figure 4: Pressure-longitude section (100°E-80°W) of anomalous divergence (contour interval is 1 x 10^{-6} s^{-1}) and E – W divergent circulation averaged between 5°N-5°S for September 2007. The divergent circulation is represented by vectors of combined pressure vertical velocity and the divergent component of the zonal wind. Red shading and solid contours denote anomalous divergence. Blue shading and dashed contours denote anomalous convergence.

(Contributed by - Sudhir Sabade, Ashwini Kulkarni and Ramesh Kripalani, IITM, Pune)

Did You Know ?

- Information on temperatures from around the world is available starting in the 1860s. This temperature information gives us a pretty accurate picture of what has been happening for the last 140 years. For example, over the last 100 years, temperature data show clearly that temperatures around the world have increased an average of 0.6° Celsius.
- The twentieth century was the warmest century of the last 1000 years, and the 1990s was the warmest decade of that century.
- 200 years ago the climate was colder than today. During this period, called the 'Little Ice Age', northern waters were ice choked and European explorers could not navigate the Northwest Passage.
- If the Greenland Ice Sheet melts, it contains enough ice to raise the global sea level by 6-7m.
- Greenhouse gases accumulate in the atmosphere because their molecules have life spans of decades or even centuries.
- The average car produces its own weight in CO_2 emissions each year.
- Every litre of gas you use in your vehicle produces almost 2.5 kg of CO_2, as well as many other pollutants.
- One-third of the carbon dioxide emissions generated by human activities comes from transportation. Furthermore, in urban areas, vehicles produce up to three-quarters of the pollutants that combine to form ground level ozone, the main ingredient of smog.
- 92% of the energy used in washing machines is used by the hot water heater to heat water, and only 8% of the energy is actually used to run the machine. Using cold water to wash and rinse our clothes save up to 225 kg of CO_2 per year.
- Replacing one frequently used regular light bulb with an energy efficient compact fluorescent bulb will save 225 kg of CO_2 per year.
- Methane is a very powerful greenhouse gas because it can retain 21 times more heat than CO_2.

CONCLUSION: 'There is substantial economic potential for the improvement of global greenhouse gas emissions over the coming decades, that could offset the projected growth of global emissions or reduce emissions below current levels', taking into account financial and social costs and benefits.

Fight against Global Warming and save your money....

There are five ways in which you can now save your money as well as help in solving the climate crisis at the same time. The five things are as follows:

1. Compact fluorescent lightbulbs
These energy-efficient bulbs cost less than $4 and are produced by major corporations like GE. If every household switched five regular light bulbs for five fluorescent bulbs, it would be the equivalent of taking 1 million cars off the highways for a full year.

2. Outdoor solar lighting
These yard or patio lights cost less than $20, and they don't burn any electricity or produce any CO_2.

3. Programmable thermostats
Though these thermostats cost from $50 to $100, they can actually cut your heating and cooling costs. Set the setting so it's a little bit cooler in the winter and warmer in the summer when you're not in the house. A difference of 2 degrees can reduce a home's CO_2 emissions by up to 9 percent over the course of a year.

4. Air filters
Changing the air filters in your heating and cooling systems regularly can knock 2 percent off of your CO_2 output each year.

5. Electric heater
Heaters use a lot of energy and generate a lot of CO_2. A blanket costs less than that and can cut your home's CO_2 emissions by almost 4½ percent.

Recent Development
ENVIS site at IITM in Regional Marathi language

All queries and feedback regarding this newsletter should be addressed to:

Dr. Gufran Beig
ENVIS-Coordinator
Indian Institute of Tropical Meterology,
Dr. Homi Bhabha Road,
Pashan, Pune - 411 008, India
Telephone: + 91-20-25893600
Fax: +91-20-25893825
Email: pollution@tropmet.res.in
URL: http://envis.tropmet.res.in