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ENVIS NEWSLETTER

Acid Rain and Atmospheric Pollutant Modeling

Indian Institute of Tropical Meteorology, Pune

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

Volume 5, Issue 1 April-June 2007

Editor's Desk:

Due to some unavoidable circumstances we are unable to produce the print version of this ENVIS newsletter, however due to the tremendous interest shown by people in the area of climate related factors we could not restrain ourselves from publishing this newsletter online which provides information related to some of the factors affecting the climate change. This issue will mostly focus on the factors affecting climate change and their impact on human beings.

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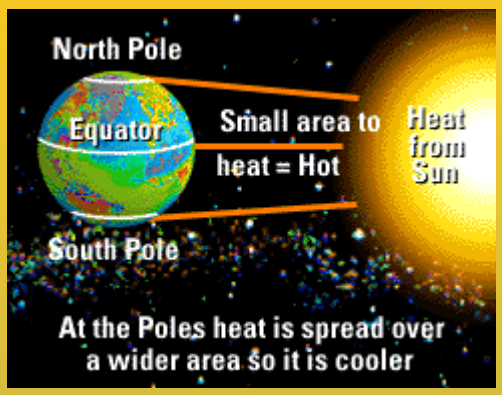
Factors Affecting Climate Change

There are many different factors that affect the climate all around the world. In the present article we would like to focus some of the major factors that play a crucial role in climate change. The major factors are as follows:

1. **Distance from the Sea**: The sea affects the climate of a place. Coastal areas are cooler and wetter than inland areas. Clouds form when warm air from inland areas meets cool air from the sea. The centre of continents is subject to a large range of temperatures. In the summer, temperatures can be very hot and dry as moisture from the sea evaporates before it reaches the centre of the continent.
2. **Ocean Currents**: Ocean currents can increase or reduce temperatures. The main ocean current that affects the UK is the Gulf Stream. The Gulf Stream is a warm ocean current in the North Atlantic flowing from the Gulf of Mexico, northeast along the U.S coast, and from there to the British Isles. The Gulf of Mexico has higher air temperatures than Britain as it is closer to the equator. This means that the air coming from the Gulf of Mexico to Britain is also warm. However, the air is also quite moist as it travels over the Atlantic ocean. This is one reason why Britain often receives wet weather. The Gulf Stream keeps the west coast of Europe free from ice in the winter and, in the summer warmer than other places of a similar latitude. The chart shown was the first chart drawn of the Gulf Stream. It was drawn by Benjamin Franklin in 1770.

3. **Direction of Prevailing Winds**: Winds that bl blow from the sea often bring rain to the coast and dry weather to inland areas. Winds that blow to Britain from warm inland areas such as Africa will be warm and dry. Winds that blow to Britain from inland areas such as the Netherlands will be cold and dry in winter. Britain's prevailing winds come from a south westerly direction over the Atlantic. The winds are cool in the summer and mild in the winter.
4. **Relief**: Climate can be affected by mountains. Mountains receive more rainfall than low lying areas because the temperature on top of mountains is lower than the temperature at sea level. That is why you often see snow on the top of mountains all year round. The higher the place is above sea level the colder it will be. This happens because as altitude increases, air becomes thinner and is less able to absorb and retain heat.
5. **Proximity to the Equator:** The proximity to the equator affects the climate of a place. The equator receives the more sunlight than anywhere else on earth. This is due to its

position in relation to the sun (see figure). The diagram shows that the equator is hotter because the sun has less area to heat. It is cooler at the north and south poles as the sun has more area to heat up. It is cooler as the heat is spread over a wider area.



6. **El Nino**: El Nino, which affects wind and rainfall patterns, has been blamed for droughts and floods in countries around the Pacific Rim. El Nino refers to the irregular warming of surface water in the Pacific. The warmer water pumps energy and moisture into the atmosphere, altering global wind and rainfall patterns. The phenomenon has caused tornadoes in Florida, smog in Indonesia, and forest fires in Brazil.
7. **Human Influence**: The factors above affect the climate naturally. However, we cannot forget the influence of humans on our climate. We have been affecting the climate since we appeared on this earth millions of years ago. In those times, the affect on the climate was small. Trees were cut down to provide wood for fires. Trees take in carbon dioxide and produce oxygen. A reduction in trees will therefore have increased the amount of carbon dioxide in the atmosphere. The Industrial Revolution, starting at the end of the 19th Century, has had a huge effect on climate. The invention of the motor engine and the increased burning of fossil fuels have increased the amount of carbon dioxide in the atmosphere. The number of trees being cut down has also increased, meaning that the extra carbon dioxide produced cannot be changed into oxygen. Thus in conclusion one can say that the earth if subjected to a change in climate. The changes may lead to:
    - a rise in global sea levels
    - a change in vegetation zones
    - an increase in disease levels
    - a change in ecosystems

Human Induced Climate Change and Rainfall

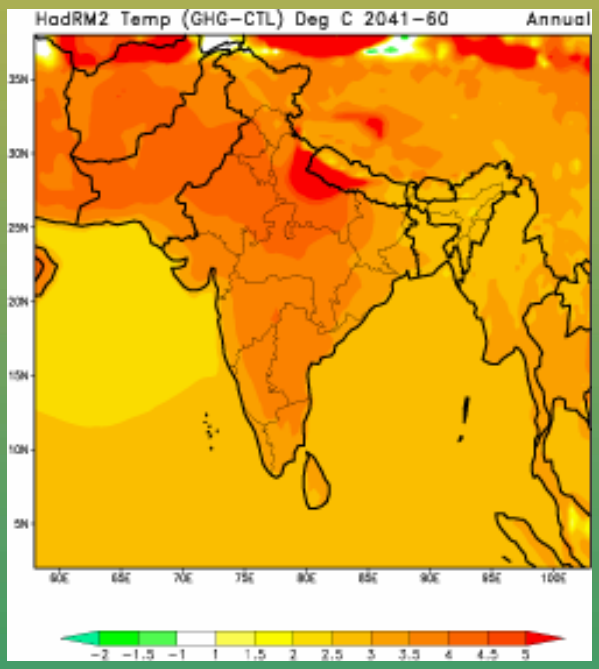
In previous article we have seen the factors that are affecting the climate change all over the world. So now we focus our attention to the Human induced climate change which started with the beginning of the industrial revolution and have resulted in dramatic changes in the chemical composition of the earth's atmosphere. It is worth while to mention here that such changes have the potential to influence

earth's climate; however, the characteristics of climate change associated with natural and anthropogenic forcings are yet to be known exactly because of the complex interactions within the earth's climate system. Although meteorological data compiled over the past century suggest that the earth is warming, there are significant variations at regional levels. There is a strong need for understanding the nature of climate change at global and regional levels to deal with, and plan action for, possible impacts. The so-called 'climate scenario', which has become a buzzword in the parlance of climate change programmes the world over, denotes a plausible representation of future climate that is constructed for explicit use in investigating the potential impacts of anthropogenic climate change.

To address several related issues on a regional scale, IITM, Pune has taken up an exciting task under the Joint Indo-UK collaborative programme on the development of climate change scenarios in India for impact assessment. This project deploys the state-of-art regional climate model (HadRM3H/PRECIS) developed by the Hadley Centre for Climate Prediction and Research of the UK Meteorological Office (UKMO), to simulate the climate over the Indian region. This programme is a coordinated effort to build scientifically sound high-resolution climate change scenarios for India and use them to assess the associated impacts in various sectors. This programme is funded by the Department of the Environment, Food and Rural Affairs (DEFRA), Government of UK, and is coordinated by the Ministry of Environment and Forests (MOEF), Government of India. Messrs. Environmental Resources Management India Ltd. has been acting as the facilitating agency. Other leading partners in this programme are: The Tata Energy and Resources Institute (TERI), Indian Institute of Management, Ahmedabad (IIMA), Indian Institute of Science (IISc), National Physical Laboratory (NPL), National Institute of Oceanography (NIO), and Indian Agricultural Research Institute (IARI). One such coordinated programme was successfully completed in the UK recently, generating a great deal of useful information for policy making. In this project so far, some of the important issues are addressed including the first glimpse of the type of climate change scenario products that are expected to be developed in future. A few climatic projections for the Indian region, based on the transient climate change experiments, and the preliminary climate change scenarios developed as part of the present project, using the Hadley Centre regional climate model HadRM2 have been developed. These scenarios are being used to assess the impact on water resources (IITM), agriculture (IARI), forests (IISc), industry, energy and transport (IIMA), sea-level variability (NIO) and human health (NPL).

In India, agriculture forms a critical component of the national economy, which is mainly dependent on the monsoon rainfall. The regional climatic variations play a dominant role even in other economic sectors like industry, services, transport, forestry, human health, etc. However, due partly to our limited understanding of the climate variability and large uncertainties in their prediction, the climatic anomalies have traditionally come to be viewed as inevitable, giving rise to a variety of adaptive practices based on experience rather than scientific insight. Indeed, very little modern climatic information has so far found direct practical applications in the socio-economic sector in the country. However, with the recent global attention on climate change issues and the particular focus on a regional approach, it is imperative that we make a synthesis of all the climatic information available, to provide a comprehensive description of the regional climate in the context of global change. Such an exercise is expected to help assessment of our vulnerability and to optimize the required adaptive and mitigatory strategies. In particular, if we are able to accurately isolate the anthropogenic impacts on climate, it would be easier to find avenues for intervention policies to avert possible adverse consequences.

Results so far out of this project indicate that, under increasing atmospheric CO_2 concentrations, the mean surface temperatures increase everywhere over India, in all the seasons. The warming is more pronounced over land areas, with the maximum increase over north India. The warming is also relatively greater in winter and post-monsoon seasons. Summer monsoon season is marked by relatively less magnitude of warming. In terms of summer monsoon precipitation response, large decreases are seen over the the western part of the region, mainly over the oceanic areas, and increases over the north-eastern parts of the country. The work here at IITM, on the application of regional climate models to develop high - resolution climate change scenarios for India, is being carried out by a team of scientists led by Dr. K. Rupa Kumar.



Climate change conclusion:

- Projections of future climate change suggest a global temperature increase of 1 to 6°C (2 to 10°F) from 1990 to 2100, with warming in most of the United States expected to be even higher.
- The current scientific research shows that climate change will have major effects on precipitation, evapotranspiration, and runoff — and will ultimately affect on the nation's water supply
- While the net impacts of a doubling of atmospheric CO_2 concentrations on agriculture as a whole are likely to be small, the impacts are likely to vary considerably from region to region.
- Climate change will lead to substantial sea-level rise along much of the U.S. coastline, due mostly to thermal expansion of the oceans.
- The very real possibility exists that warming over this century will jeopardize the integrity of many terrestrial ecosystems and will pose a threat to our nation's biodiversity.

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