Cosmic connection

What's the science behind climate change? It appears that "something" from outer space is also triggering it. So, human beings are not the only ones to be blamed, explain Alkendra Pratap Singh and C Sivaram

The cloud experiment

In 1998, Jasper Kirkby proposed a novel experiment called CLOUD (Cosmics Leaving Outdoor Droplets) to understand the formation of clouds due to cosmic rays in controlled laboratory conditions. Cosmic rays are energetic charged particles, originating in outer space, that continuously bombard the Earth's atmosphere. An interdisciplinary consortium of scientists, from 18 institutes and 9 countries, is working in the world's largest particle-physics laboratory, European Organization for Nuclear Research or CERN in Geneva. Recently, CERN caught global attention for its Large Hadron Collider (LHC) experiment designed to understand behaviour of subatomic particles at very high energies. In the CLOUD experiment, scientists use Proton Synchrotron to emit particle-beam, to understand the formation in a cloud chamber. In a fully developed CLOUD experiment, possible by 2010, the temperature and pressure conditions anywhere in the atmosphere can be re-created and all experimental conditions can be measured.

The cloud chamber was invented by a Scottish physicist, C T R Wilson. He was fascinated by the cloud formation and discovered that the water droplets formed, in a transparent glass chamber of supersaturated water vapour, is due to the presence of ions. Due to this fact, it became possible to see the paths of electrically charged particles, so the cloud chamber served as detector of charged particles. Later on, it was used for the discovery of cosmic rays. Similar type of experiment is now used, by CERN, to study the connection between the cosmic rays and cloud formation. Wilson received the Nobel Prize in physics in 1927 for his work on the cloud chamber. Perhaps he was the first cloud maker.

There has been a continuous increase in the average temperature of the near-Earth surface, due to global warming. This is just one aspect of a broader picture called climate change. As per the Intergovernmental Panel on Climate Change (IPCC), a premier scientific body, climate change occurs because of internal changes within the climate system or in the interaction between its components, or because of changes in external forces either for natural reasons or because of human activity.

More than the human touch

Can one imagine that apart from human activities, "something" from outer space is also playing some role in triggering the changes? At least scientists at the world's prestigious particle-physics laboratory CERN feel that may indeed be the case.

The story begins from the comparison of data on clouds and cosmic rays. Henrik Svensmark, published his finding in 1998 in *Physical Review Letters* where it was confirmed that there is a clear link between cloud formation and cosmic rays. The more the cosmic rays, the more will be the cloud formation.

A major breakthrough came, two years later, when it was found that the low-altitude clouds (below three km) respond more closely to the variations in cosmic rays. In order to understand the underlying mechanism behind the cloud formation due to cosmic rays, the world's largest particle-physics laboratory CERN is getting into an experiment called CLOUD (see box). The basic idea is to form clouds in the laboratory using a particle-beam and study the formation in controlled conditions.

Another slightly different experiment called SKY (means cloud in Danish), done in Copenhagen, successfully established a close relationship between low-altitude cloud formation and variations in cosmic rays.

The presence of clouds causes a cooling effect on the Earth, so if there are variations in the cloud formation due to variations in cosmic rays, certainly it will contribute to climate change.

There is well known anti-correlation between solar activity and cosmic ray flux, leading to less cloud formation.

There are evidences of climate change due to cosmic rays over a millennial timescale. The Phanerozoic eon, which was some 545 million years ago, evidenced to and fro swings between hot (i.e. ice-free) and cold (i.e. glaciated) climates.

Cosmic rays

Astrophysicists like Nir Shaviv believe that the Sun's motion relative to the spiral arm of our galaxy, Milky Way, cause dramatic changes in the cosmic rays and this can be attributed to the rhythmic climate change during Phanerozoic eon.

Similarly there could many more astrophysical events like supernova explosions and solar activity which can also contribute to the variations in cosmic rays and hence the climate change.

CO2 concentrations were high before too

The greenhouse theory of climate change mainly relies on the gases that absorb the radiation and thereby warm the atmosphere. A major component of the green house gases, after water vapour, is carbon dioxide or CO2.

It is not for the first time that CO2 concentrations in the atmosphere have become high. Even in the Mesozoic era, which was some 251 million years ago, the CO2 concentration was much higher in the atmosphere due to intense volcanic activity. This is quite puzzling to those who solely believe in the greenhouse theory of climate change.

In this context one can only think of 'runaway' greenhouse effect on Venus, our sister planet! (without life and surface temperature of 700 0C).

Henrik Svensmark, Director of Center for Sun-Climate Research in Danish National Space Center, Denmark, believes to such an extent, on the theory that it can be used to improve the annual forecasts of the Asian monsoon. The experiments like CLOUD and SKY will surely help IPCC in outlining a further roadmap on climate change.

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