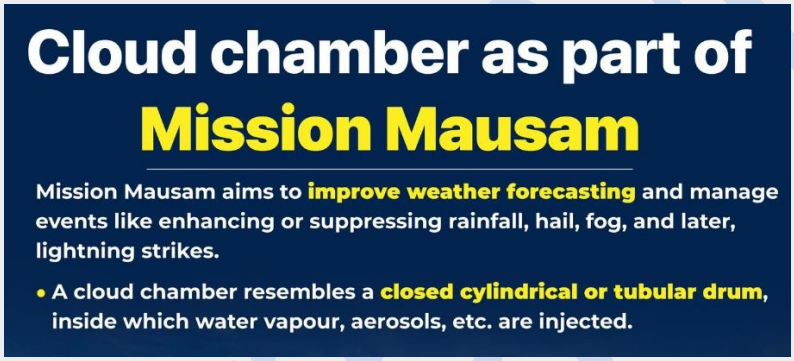
1. Why India is building a cloud chamber as part of Mission Mausam

Introduction

Mission Mausam, launched by the government last month, aims to not just improve weather forecasting in the country but also 'manage' certain weather events, and on demand, enhance or suppress rainfall, hail, fog and, later, lightning strikes.

For effective weather modification, one of the most important areas is cloud physics, in which India will have to strengthen research. Towards this end, India is establishing a first-of-its-kind cloud chamber at the Indian Institute of Tropical Meteorology (IITM), Pune.



What is a cloud chamber?

A cloud chamber resembles a closed cylindrical or tubular drum, inside which water vapour, aerosols, etc. are injected. Under the desired humidity and temperature inside this chamber, a cloud can develop.

The Pune facility will allow scientists to study the seed particles that form cloud droplets or ice particles in a sustained manner.

Many countries have basic cloud chambers, which have limited functionalities and scope to perform specific studies.

With Mission Mausam, however, India is building a cloud chamber with convection properties, as required to study Indian monsoon clouds. Globally, there are only a handful of convective cloud chambers.

Why is India building a convective cloud chamber?

Cloud physics basically involves the study of cloud behaviour during normal and extreme conditions; intra-particle interactions inside a cloud; the formation of rain droplets and ice particles; the influence of moisture added into the atmosphere due to cyclones or low pressure systems; and interactions between different cloud layers, among others.

The objective of establishing a convective cloud chamber is to gain a better understanding of cloud physics under conditions commonly affecting Indian weather systems. Thereafter, this knowledge can be used for strategic planning of weather modification.

How are scientists planning to use the cloud chamber?
With the establishment of a convective cloud chamber, scientists will have the flexibility to tailor physical and atmospheric parameters to suit environmental requirements that influence the Indian weather and climate.

"We have certain new ideas and we wish to test them. Within a controlled-environment, wherein we can apply various temperature, humidity, convective conditions and other parameters, we plan to monitor and understand clouds to arrive at high-level scientific findings on how monsoon clouds behave," said Thara Prabhakaran, senior IITM scientist and expert in the physics of clouds.

Over the next 18-24 months, the Indian team will mainly focus on developing complex and highly advanced instrumentation and probes that will be deployed when the chamber is ready. The civil construction of the chamber will take place in the coming months.

"We will need highly advanced instrumentation backup, capable of monitoring the minute properties of the conditions under investigation. We will also have to perform seed particle injection into the chamber, which will offer us a scenario to look at different environmental conditions," Prabhakaran added.

How has India's experience with cloud seeding been?
One such dedicated experiment was the Cloud Aerosol Interaction and Precipitation Enhancement Experiment (CAIPEEX) programme, which was conducted in four phases lasting more than a decade.

In the last phase, experiments were performed over a limited geographical area along the rain-shadow regions of Maharashtra's Solapur district from 2016-2018. Analysis of the experiments reaffirmed that under suitable conditions, cloud seeding was an effective strategy for enhancing rainfall over a region. Rainfall could be enhanced by up to 46 per cent (±13 percent at some locations and on average) , and about 18 per cent (±2.6 percent) in a 100 square kilometre area in the downwind of seeding location over this rain shadow region.

However, it has been widely recognised that cloud seeding is not a silver bullet to address rainfall problems.

Relevance: GS Prelims & Mains Paper II; Governance
Source: The Hindu

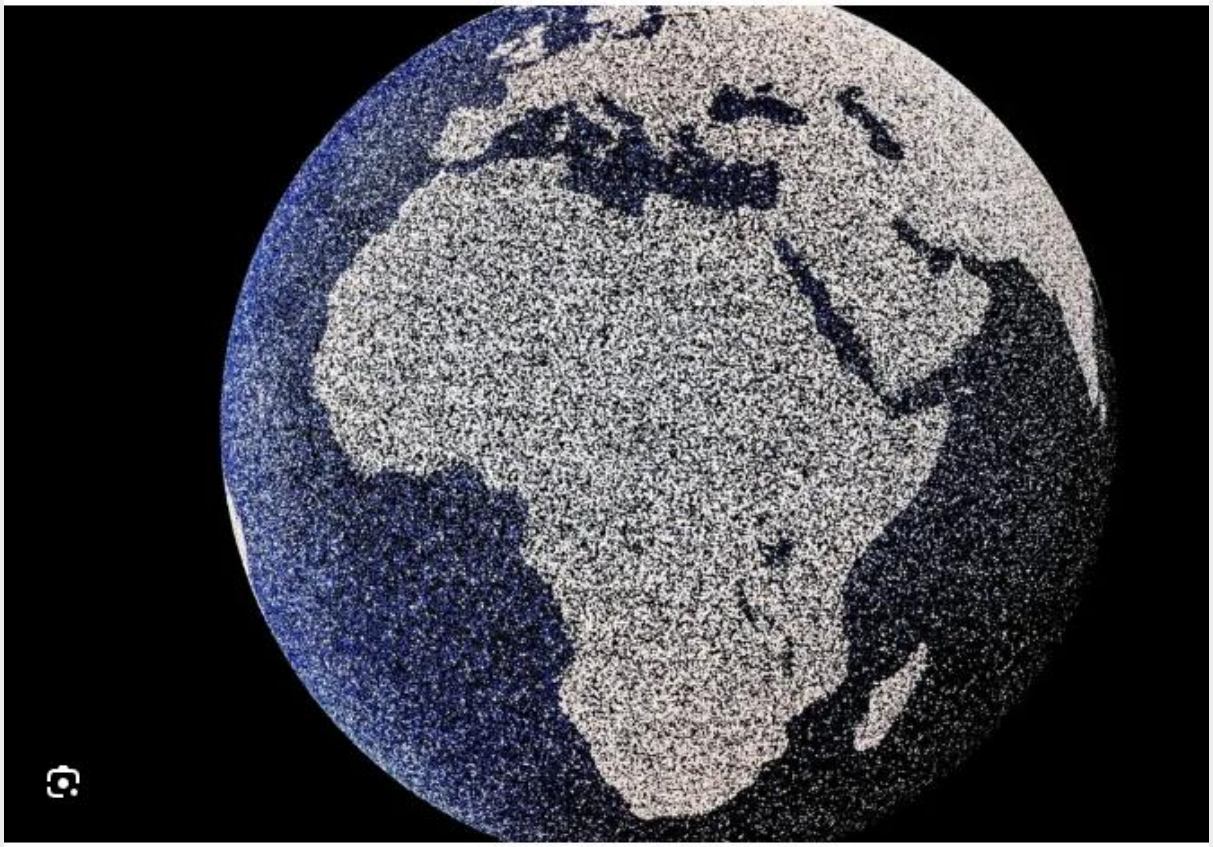
2. Spraying diamond dust to cool Earth: What a new study proposes, despite 'geoengineering' concerns

Introduction

A new study has argued that spraying millions of tonnes of diamond dust in the Earth's upper atmosphere every year could help cool down the Earth and combat global warming. It might appear to be a rather outlandish claim, but this is not the first time such a solution has been proposed.

Several other compounds, such as sulphur, calcium, aluminium, and silicon, have been suggested previously for doing the same job. The central idea here is to scatter material that can reflect solar radiation into Space and prevent it from reaching Earth, thereby cooling down the planet. The installation of space-based mirrors has also been proposed.

Such solutions, called geo-engineering (more specifically solar radiation management), have been under study for quite some time, though they have never been tried. The new study published in Geophysical Research Letters found that diamonds would be more effective in doing the job than any other material previously considered.



Scientists want to shower Earth with diamond dust to cool it down - Earth .com

Context for geoengineering: The problem of rising temperatures

The measures employed so far to halt global warming have proved inadequate. Global temperatures have continued to rise and emissions of greenhouse gases, the main reason for the warming, have not been curbed, maintaining an upward trend in 2022.

Scientists estimate that even if global emissions magically dropped to zero now, it would be decades before temperatures stabilise and come down.

Global temperatures are already about 1.2 degrees Celsius higher than pre-industrial times (between 1850-1900), with 2023 being around 1.45 degrees Celsius warmer. The world cannot restrict this rise below 1.5 degrees Celsius, one of the targets mentioned in the 2015 Paris Agreement, though some theoretical scenarios still allow for the possibility.

The bare minimum for achieving the target requires the world to cut its emissions by at least 43 per cent from the 2019 levels, by 2030. Ongoing and promised actions, however, will likely result in a reduction of just two per cent by 2030. As a result, scientists have been looking for radical technology solutions that achieve dramatic results within a short period, even if only temporarily. Geoengineering offers such options.

What is Geoengineering?

Geoengineering refers to any large-scale attempt to alter the Earth's natural climate system to counter the adverse impacts of global warming. Solar Radiation Management (SRM), in which materials are proposed to be deployed in Space to reflect incoming solar rays and prevent them from reaching Earth, is one of the two broad geoengineering options being explored.

Then there are Carbon Dioxide Removal (CDR) technologies, which include Carbon Capture and Sequestration (CCS). While they offer quick-fix solutions for reducing emissions or temperatures, they are not particularly viable.

The only method being tried out in practice is CCS. Carbon dioxide emitted, from industry or power plants, is "captured" at source and deposited deep below the Earth's surface in suitable geological formations for long-term storage. Since carbon dioxide is not released into the atmosphere, overall emissions are reduced.

Another option involves the captured carbon being used as an input for other industrial processes (known as Carbon Capture and Utilisation or CCU). In Carbon Capture, Utilisation and Storage (CCUS), some carbon dioxide is utilised and the rest is stored underground.

Under Direct Air Capture (DAC) methods, carbon dioxide is sucked out through large "artificial trees" from ambient air and directed towards storage sites or utilisation. Since these methods can potentially eliminate carbon dioxide accumulated over the years, the benefits are larger compared to CCS. But the challenges are bigger too. Some experimental projects are currently trying out these technologies.

Potential for Solar Radiation Management

The most ambitious and potentially rewarding form of geoengineering is SRM, which is still at the conceptual stage. It draws inspiration from the natural process of volcanic eruptions, in which large amounts of sulphur dioxide are released. These combine with water vapour to form sulphate particles that reflect sunlight into space, reducing the amount reaching Earth.

The Mount Pinatubo eruptions in the Philippines in 1991, one of the largest in the 20th century, are believed to have reduced the Earth's temperature by 0.5 degrees Celsius that year. Scientists are trying to artificially emulate the process and have explored the capabilities of

several materials, including sulphur dioxide, calcium carbonate, and sodium chloride or common salt.

Diamonds have been discussed, too. The new study compared seven compounds and found diamonds the most effective in producing the desired results. But to achieve a temperature reduction of 1.6 degrees Celsius, about five million tonnes of diamonds would need to be sprayed into the upper atmosphere every year.

Challenges and concerns

Though theoretically possible, SRM options face huge technology and cost challenges in implementation. Besides, manipulating natural processes on a large scale can have unintended and unforeseen consequences. It can affect global and regional weather patterns and rainfall distribution. There are ethical concerns as well. Altering natural sunlight can affect agriculture, vegetation, and biodiversity, and might be detrimental to some life forms.

Even CCS technologies have flaws, as one study by researchers from Oxford University and Imperial College in London showed last year. Though it might be technically possible or desirable to deploy these technologies in some cases, heavy reliance on them to achieve climate objectives might not be feasible or practical, it said.

It further pointed out that mainly employing CCS to meet climate goals by 2050 would cost the world at least US$ 30 trillion more than a route primarily focused on renewable energy and maintaining energy efficiency. Besides, an adequate number of safe underground sites for storing huge amounts of carbon dioxide might not be available.

Still, CCS options are considered almost inevitable now, given the already visible effects of global warming. There are no scenarios for the world to achieve the 1.5 degree or 2 degree Celsius targets that do not require contribution from CCS and CDR technologies.

Relevance: GS Prelims & Mains Paper III; Environment
Source: Indian Express

3. PM Modi attends BRICS Summit in Russia: What is the group, its significance for India

Introduction

BRICS Summit 2024: Prime Minister Narendra Modi left for Kazan in Russia recently to attend the 16th BRICS Summit. The summit is the first after the grouping's expansion last year. For India, it is especially significant as Prime Minister Narendra Modi could meet China's President Xi Jinping here, soon after the two countries agreed on a disengagement along the LAC.

What is BRICS?

List of Countries attending BRICS Summit: BRICS stands for Brazil, Russia, India, China and South Africa, the original five members who were large, non-Western economies. On January 1 this year, BRICS admitted four new members: Egypt, Ethiopia, Iran and the United Arab Emirates. The organisation now represents almost half the world's population and almost one quarter of the world's economy.

Essentially, BRICS has been envisaged as a grouping of non-Western countries, which can act as a counterweight to institutions like the World Bank and the International Monetary Fund, dominated by the Global North.

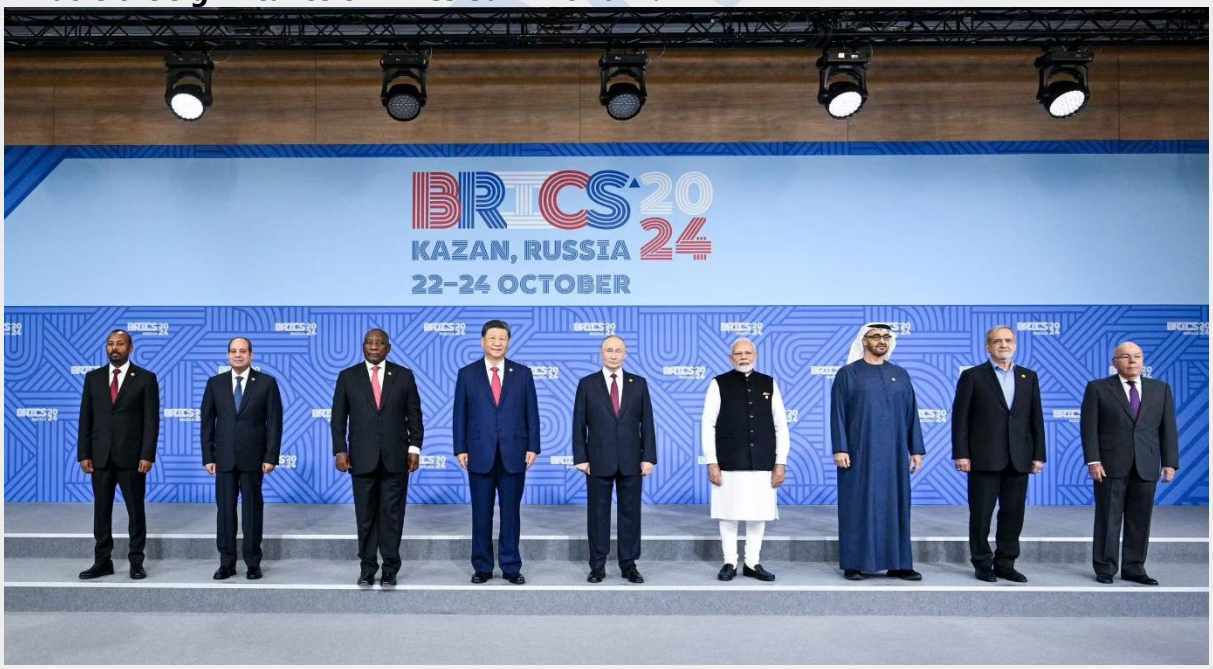
The acronym BRIC was first used in 2001 by Goldman Sachs in their Global Economics Paper, 'The World Needs Better Economic BRICs'. The paper projected that Brazil, Russia, India, and China would be among the world's largest economies in the next 50 years or so.

As a formal grouping, BRIC started after the meeting of the leaders of Russia, India and China in St. Petersburg on the margins of the G8 Outreach Summit in 2006. The grouping was formalised during the first meeting of BRIC Foreign Ministers on the margins of the UNGA in New York in 2006.

The first BRIC Summit was held in Yekaterinburg, Russia, in 2009. It was decided to include South Africa at the BRIC Foreign Ministers' meeting in New York in 2010, and accordingly, South Africa attended the 3rd BRICS Summit in Sanya, China, in 2011.

The next wave of expansion came after the summit in South Africa last year. Invitations were extended to Argentina, Egypt, Ethiopia, Iran, Saudi Arabia and the United Arab Emirates (UAE). While four of the above joined in January this year, Saudi Arabia has accepted the invitation but delayed formal joining. Argentina, whose new President Javier Milei is more pro-West, declined.

What is the significance of BRICS Summit 2024?



PM Modi is meeting Russian President Vladimir Putin again, after the two leaders met in July. As Russia faces increased pressure from the West, the meetings underline the importance New Delhi gives to traditionally strong India-Russia ties. For Putin, the gathering of so many world leaders in Russia is a message to the West that its attempts to isolate Moscow amid the Ukraine war have not succeeded.

Modi could possibly also meet Xi. While the Ministry of External Affairs (MEA) has not confirmed the meeting yet, Foreign Secretary Vikram Misri on Monday said Modi is expected to have "a few bilaterals during his visit, which are presently being worked out". The last Modi-Xi meeting had also come about on the sidelines of a BRICS Summit, in South Africa in August last year.

President Masoud Pezeshkian of Iran, the major player in the other war raging at present — the devastating conflict in West Asia — will also attend the summit.

The BRICS membership is in line with India's policy of multilateralism and seeking to give a stronger voice to the Global South.

"India values the close cooperation within BRICS which has emerged as an important platform for dialogue and discussion on issues concerning the global developmental agenda, reformed multilateralism, climate change, economic cooperation, building resilient supply chains, promoting cultural and people to people connect, among others. The expansion of BRICS with the addition of new members last year has added to its inclusivity and agenda for the global good," PM Modi said in a statement ahead of his departure for Russia.

India will also seek to boost trade, security, economic and climate cooperation at the summit. Many analysts believe that BRICS has so far not lived up to its potential, because of the internal differences amid members — the India-China border dispute, for example — and because not all members share Russia's and China's antipathy to the West.

Relevance: GS Prelims & Mains Paper II; International Organisations
Source: Indian Express