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Global Warming and Methane Emissions: Some Recent Case Reports

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Verkhoyansk (North East Siberia), located north of the Arctic Circle and about 3,000 miles east of Moscow, is regarded as the coldest region in the Northern Hemisphere. During winter, Verkhoyansk is one of the coldest spots in the world, with temperatures frequently dropping well below -50°C. However, in recent times, during June 2020, this region has stood out for its above-extreme temperature, showing a record increment in temperature to around 38°C. The environmentalists and meteorologists of Europe have reported that the average temperature in Siberia during January to June, 2020 was much higher than the usual June temperature of only 20°C, so that a thermal wave essentially prevailed in these regions [1]. This unusual rise in temperature has accelerated considerable melting of permafrost and polar ice caps in the Northern Hemisphere, leading to major oil spill of at least 20,000 tons of diesel fuel in Norilsk, located above the Arctic Circle in north-central Russia. Earlier, in July 2019, there has been occurrence of extensive wildfire, encompassing almost two million hectares of land in Siberia and Far East of Russia. It is believed that the forests caught fire due to the heat generated by temperature of around 30°C, strong wind and heat lightning. It included 846 hectares in the Krasnoyarsk region, more than 557 hectares in Yakutia, and 519 hectares in the Khanty-Mansi Autonomous Okrug [2]. Russia during 2018 also witnessed 9,900 wildfires, occupying a total of 3.2 million hectares, while in 2017, 9,200 wildfires spread to 1.4 million hectares in total. Wildfires are ravaging parts of the Arctic, with areas of Siberia, Alaska, Greenland and Canada being engulfed in flames and smoke. Satellite images clearly show the plumes of smoke from the fires, caused by dry storms in hot weather. Greenpeace Russia has reported burning of as much as 3.3 million hectares - an area even bigger than Belgium [3]. Harmful pollutants and toxic gases were found to be released into the atmosphere. The fire contributed to climate crisis by an estimated release of 100 megatons of CO_2 in the atmosphere just between the time period of June and July in 2019. The black carbon (soot), upon falling on snow reduced the reflectivity, trapping up more heat, thereby accelerating the melting process. A recent survey conducted by the Russian P.P.Shirshov Institute of Oceanology, Russian Academy of Science and other scientists from Europe has shown that such rise in temperature in the specified regions of Siberia is likely to occur once in 80,000 years. However, it is surprising as well as highly alarming that such a critical situation has crept in within a time frame of just 130 years. The reckless anthropogenic activities and rampant release of greenhouse gases like chlorofluorocarbons, CO_2, nitrous oxide and methane in the environment have been considered as the major factors for such warming effect, which if not regulated, may bring about temperature increase in even shorter span of time. This incident also indicates that probably the global climatic condition is facing a rapid change with time. In the absence of proper pollution control management, many other regions of the world will succumb similarly to such an environmental disaster. It has been proved multiple times that man-made pollution is the prime cause for this global climate change which can only be prevented if adoptive measures are implemented to control global warming emerging from greenhouse gas emissions.

In this regard, another recent trend of major concern is the gradually increasing level of atmospheric methane with the advent of this century. For several decades, our attention with regard to greenhouse gases was more focused on CO_2, attempting several measures to cut down carbon emissions. Under 'Carbon Trading' as specified in the Kyoto Protocol, a country responsible for causing more carbon emissions is able to purchase the right to emit more, whereas the country with lesser emissions sells the right to emit carbon to other countries or entities. The countries or polluting entities emitting more carbon thereby satisfy their carbon emission requirements, and the trading market results in the most cost-effective carbon reduction methods being exploited first. Methane is a colorless, odorless and combustible gas and is also a potent greenhouse gas that traps thermal infrared radiation much more efficiently and, in consequence, has a Global Warming

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Potential (GWP) ~86 times stronger per unit mass than CO_2 on a 20-year time scale and 28-times more powerful on a 100-year time scale [4]. The 2020 Global Methane Budget shows that methane emission is heading in a wrong direction, rising faster than at any time in the past two decades, thereby making methane the second most important human-influenced greenhouse gas in terms of climate change after CO_2. Although the SARS-CoV2 global pandemic has led to a drastic temporary drop in CO_2 emission due to halting of transportation and several industrial sectors, methane emissions continue to prevail. At one point of time, 'will-o'-the-wisp', a luminescent light flashing over bogs, swamps or marshes, resembling a flickering lamp, was considered as a ghostly phenomenon. However, the main scientific basis of such bioluminescence is the oxidative breakdown of phosphine and methane produced by organic decay in the marshy and swampy areas. The common sources of methane include water-logged rice farmlands and wastes, dairy and cattle farms, decaying organic matter, methanogenic microbes in low-oxygen environments, and combustion of fossil fuels formed by anaerobic decomposition of dead organisms. Wetlands contribute almost 30% of global methane emission, oil and natural gas 20%, enteric fermentation and manures up to 24%, and landfills up to 11%. Human activity, including raising of livestock like cattle and sheep is responsible for 60% emissions, along with coal mining, which releases methane from deep within the rock [5]. A team of researcher headed by Robert B. Jackson of Stanford University, in their recent observations has shown that 596 million metric tons of methane emission occurred in 2017, and the level reached a record of 1,875 parts per billion in 2019, with 50 million ton annual increase. This is projected to cause at least 4.3°C rise in temperature by the end of this century [6,7]. According to a recent update by the Global Carbon Project of global methane sources and sinks, there has been an upsurge in global methane emissions by 9% in 2017, compared to 2000-2006, which has virtually made it impossible to fulfill the objective of Paris Agreement to keep the level of warming well below 2°C. In contrast to Europe where methane emissions from landfills and manures have been reduced over past decades due to implementation of sound policies and management practices, countries like Africa and Middle East, China, and South Asia including Oceania are collectively held responsible for such massive increase [8]. This is an alarming signal which if continued can usher in natural disasters like drought, flooding and forest fires, which can devastate agricultural crops, causing food scarcity and mass migration. The recent discovery of a novel methane seep in the High Antarctica will also lead to our newer understanding of methane cycle and role of methane in global warming. Antarctica is estimated to contain as much as a quarter of earth's marine methane, almost ranging between 80 and 400 Gt C methane. An expansive microbial mat, constituted by the symbiotic associations of bacteria and methane consumers, capable of forming a methane 'sediment filter', was found to form in 2011 at a site known as Cinder Cones in McMurdo Sound on the sea floor of Ross Sea, about 10 m below the frozen ocean surface. The microbial community has not yet formed a sufficient filter to mitigate the release of methane from the sediment, so that the methane flux from the sediment is still significant at 3.1 mmol methane m^{-2} d^{-1} [9]. Methane has a lifetime of about 10 years in the atmosphere, much shorter than CO_2, meaning that measures to mitigate methane emissions can rapidly reduce the rate of global warming. Feed supplements like algae may help to reduce methane burps from cattle. Several new techniques are being developed to monitor methane level and measure methane emissions from space using 'cubesats' satellites. Priorities for improving the methane budget include (i) a global, high-resolution map of water-saturated soils and inundated areas emitting methane, based on a robust classification of different types of emitting habitats; (ii) further development of process-based models for inland-water emissions; (iii) intensification of methane observations at local scales (e.g., FLUXNET-methane measurements) and urban-scale monitoring to constrain bottom-up land surface models, and at regional scales (surface networks and satellites) to constrain atmospheric inversions; (iv) improvements of transport models and representation of photochemical sinks in top-down inversions; and (v) development of a 3D variational inversion system using isotopic and/or co-emitted species such as ethane to improve source partitioning [7]. Time has come when we should shift towards the use of biogas, biofuel (bioethanol, bioacetone or bioisopropanol) or biodiesel (fatty acid methyl/ethyl esters) produced from renewable bioresources, as environment-friendly energy source, or else sooner or later, we would have no alternative than to introduce a new program of 'Methane Emission Trading' just as we presently have 'Carbon Trading' to check bulk CO_2 emissions.

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