

Arctic Methane Eruptions



Three large craters (up to 30m dia.) recently discovered in Siberia help provide more evidence that we might be approaching a tipping point in the Earth's climate. They were probably formed by eruptions of methane (also known as natural gas) from the thawing permafrost.[1] Permafrost holds large amounts of methane in the form of solid hydrates, which are only stable in a specific range of pressures and temperatures.[4] Outside of this range, the methane turns to gas and builds up pressure until the permafrost bursts.[3] Methane is a greenhouse gas, so it contributes to a vicious cycle (called "positive feedback") where more methane causes more warming which releases yet more methane.[2]

Why is This Important?

There is a large pool of carbon locked in the Arctic permafrost; at least twice as much carbon, and possibly five times as much methane, than what is presently in the global atmosphere.[4] Climate scientists previously envisioned that melting could allow a large enough fraction of these gases to seep out to impact our climate in the future. "Under sustained Arctic warming, modelling studies and expert judgments indicate with medium agreement that a potential combined release totalling up to 350 PgC as CO₂ equivalent could occur by the year 2100." [4] To put this in perspective, that amount is roughly equal to the remaining global carbon budget that humans could emit while still keeping global warming within 2°C of pre-industrial temperatures.[5] Those spontaneous methane releases do not count as human emissions, and would not reduce our budget as long as they continue to behave as modelled. This seepage, as imagined before the crater discoveries, would form a moderate positive feedback over centuries, with a magnitude similar to other climate–terrestrial ecosystem feedbacks.[4] Sudden methane eruptions and permafrost craters were not predicted by the IPCC reports.

Scientific Progress

The latest IPCC report had found no clear evidence so far that thawing contributed significantly to the current global carbon budgets; in other words, it hadn't really started yet.[4] It is much too early to know if the recently discovered craters will change this conclusion, or how well they fit with previous models of Arctic methane seepage. These craters were first brought to the attention of scientists in July 2014, even though two of them are at least a year old. Only one of them has been studied at the time of this writing. It will probably take months before scientific expeditions finish collecting data, a year or more before peer-reviewed articles are published, and at least five years before an IPCC report expresses consensus views about them.

Other Ideas

Dr. Marina Leibman, Chief Scientist for the Earth Cryosphere Institute, suggests that similar methane eruptions may have occurred as recently as 10,000 years ago, during the Holocene thermal maximum, when Arctic temperatures were warmer than they are now.[7] She suggests this would explain the “pothole lakes” that are found nearby the craters.

A variety of alternate explanations were offered before scientists even had a chance to see the craters themselves. Some of these speculations continue to circulate in the internet echo chamber, even though they have been ruled out by more recent observations. A popular idea is that the holes were left by pingos, which are giant blocks of ice. A melting pingo would cause the ground to subside, creating an ordinary sinkhole, but it would not explain the ring of ejecta. Soil was thrown out of the hole during the eruption, forming a 1m tall mound around the edge.[6] It is possible for pingos to burst when the ground is cooling, but there is no question that the region has been warming.[7] The air at the bottom of the largest crater is rich in methane, even though methane is lighter than air and has had at least a year to dissipate since the hole formation.[1]

1st hole: 30km from Bovanenkovo, Yamal Peninsula, 30m diameter, 70m deep

2nd hole: 90km from Antipayuta village, Taz District, 15 m diameter, formed Sep. 27th, 2013

3rd hole: Near Nosok village, Taymyr Peninsula, Kransoyark region, 4m diameter, 80m deep



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Note that 350 PgC = 350 GtC = 1285 GtCO₂
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