



## **Estimates of fast methane warming possibilities for 55 million years ago**

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The end of the Paleocene (55.5/54.8 Ma) was marked by very significant periods of global climate change, the Paleocene-Eocene Thermal Maximum (PETM). This is one of the most rapid and extreme global warming events recorded in geologic history, when mean global surface temperatures rose between 5 and 9°C over a period of a few tens of thousand years.

The atmosphere currently contains about 4.6 Gt of methane with mean methane emission 0.6 Gt per annum. Atmospheric methane amount now is raising 0.02 Gt annually.

Simplest energy balance climate model used in IPCC reports shows that for 5°C global warming 250 Gt CH<sub>4</sub> is needed to be in the atmosphere with annually emission in 25 Gt, if methane live time is about 10 years as now. High methane concentration changes the atmospheric chemistry and leads to its longer live time up to few decades and annually emission could be less intensive (less than 10 Gt).

Most of the methane hydrate is now in sediments of the ocean and holds thousands of gigatons of methane. Additional hundreds of gigatons of methane are in the permafrost areas. 55 Ma ago no permafrost could be on the Earth, but even ocean methane hydrates make PETM phenomenon possible. Simple calculations show that in the case of methane warming few time smaller carbon emission into the atmosphere is needed than in the case of CO<sub>2</sub> emission.

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