

## Production mechanism of organic aerosols in a CH<sub>4</sub>/CO<sub>2</sub> atmosphere by far-UV light

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Organic aerosols are produced in CH<sub>4</sub>-rich reducing atmospheres, such as Titan, early Earth and exoplanets, but their production mechanisms are not well constrained. We conducted laboratory experiments to form organic aerosol analogues using a far UV (FUV) hydrogen/helium lamp ( $\lambda > 110$  nm) and measured the aerosol production rate as a function of CH<sub>4</sub>/CO<sub>2</sub> ratio in the reactant gas. The aerosol production exhibits a steep decrease when the CH<sub>4</sub>/CO<sub>2</sub> ratio becomes less than unity. In order to interpret the experimental data, we also performed one-box photochemical calculations, including 791 reactions and 134 species up to C<sub>8</sub> hydrocarbons. We found that the observed production rate is in a good agreement with polymerization reaction rates involving aromatic hydrocarbons (i.e., benzene), suggesting benzene is the key parent molecule controlling the aerosol production. On the other hand, polymerization reactions involving polyynes do not account for the experimental data, suggesting that they are not the limiting molecules. This implies that aerosol production rate in an early Earth atmosphere due to solar FUV would become significantly lower than a previous estimate which includes polymerizations of polyynes as the formation reactions of aerosols [1], resulting in an optically thinner aerosol layer.

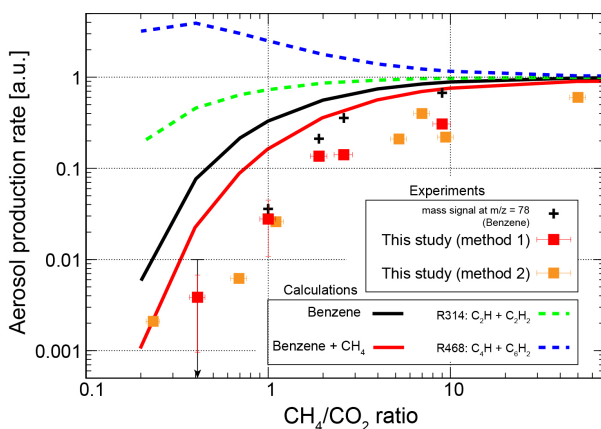


Figure 1. Observed aerosol production rate and calculated reaction rates as a function of CH<sub>4</sub>/CO<sub>2</sub> ratio.

[1] Pavlov, Brown & Kasting (2001), *JGR* **106**, 32267-23287