

Geochemical and Isotopic Characterization from the Polygonal to Landscape Scale in an Arctic Ecosystem

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NGEE Arctic

Next-Generation Ecosystem Experiments

Advancing predictive understanding
of Arctic ecosystems
in response to climate change...

“How does thawing of permafrost—and the associated changes in landscape evolution, hydrology, soil biogeochemical processes, and plant community succession—affect feedbacks to the climate system?”

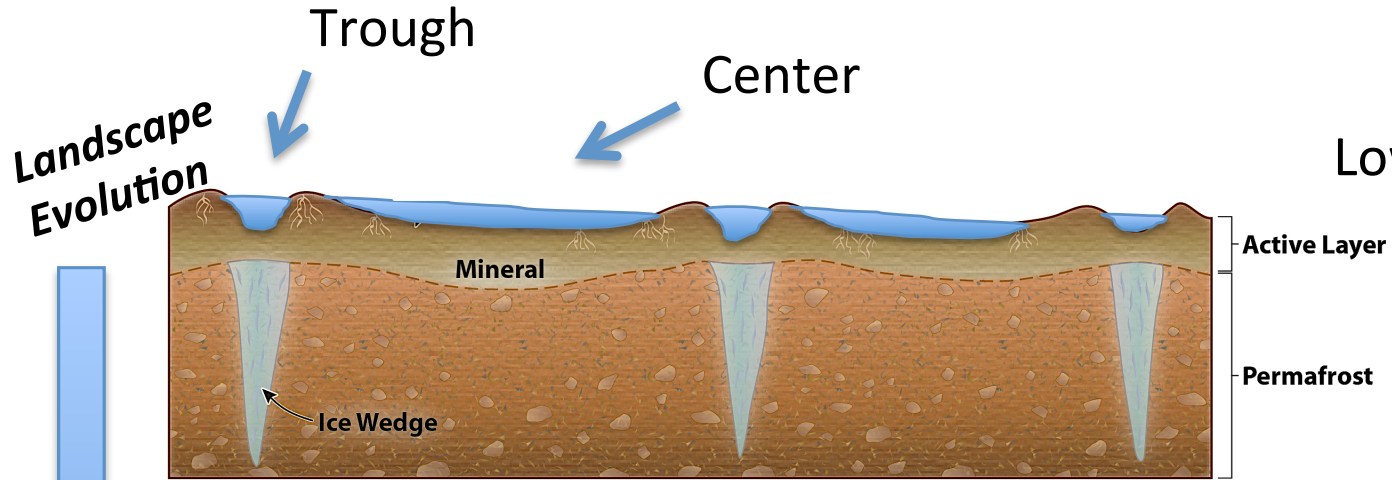


Outline and significance of main topics

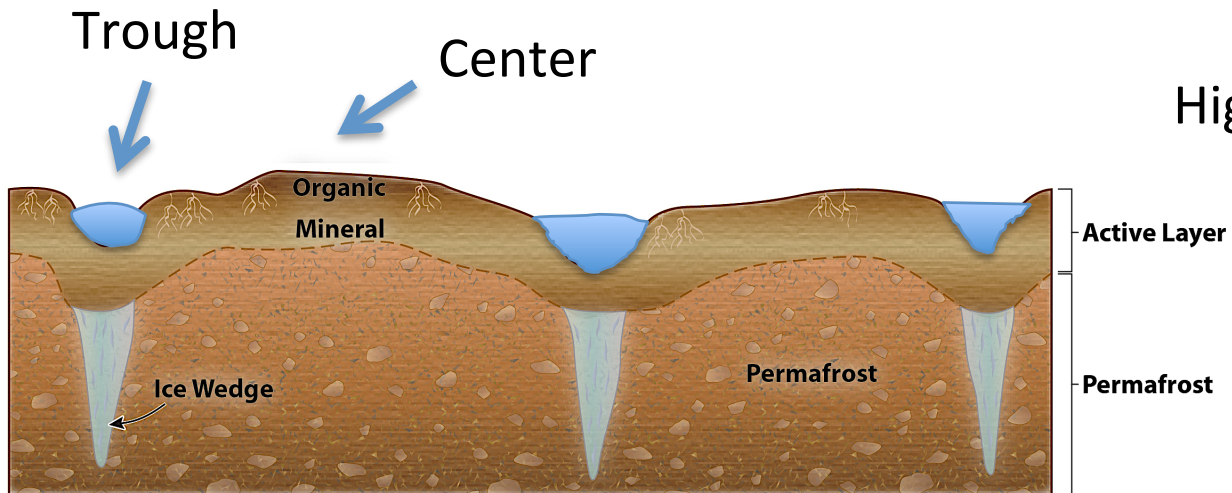
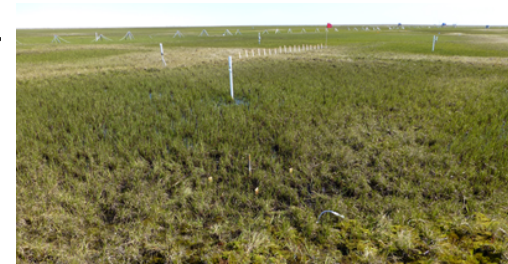
- Active layer geochemistry
- Nitrogen cycling
- CH₄ and CO₂: mechanisms and pathways



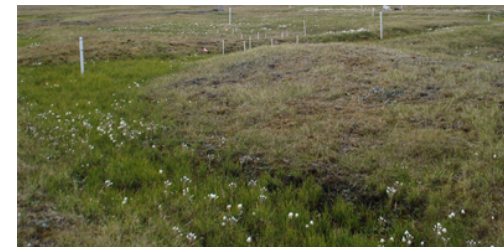
Ice Wedge Polygons



Low-Centered Polygon

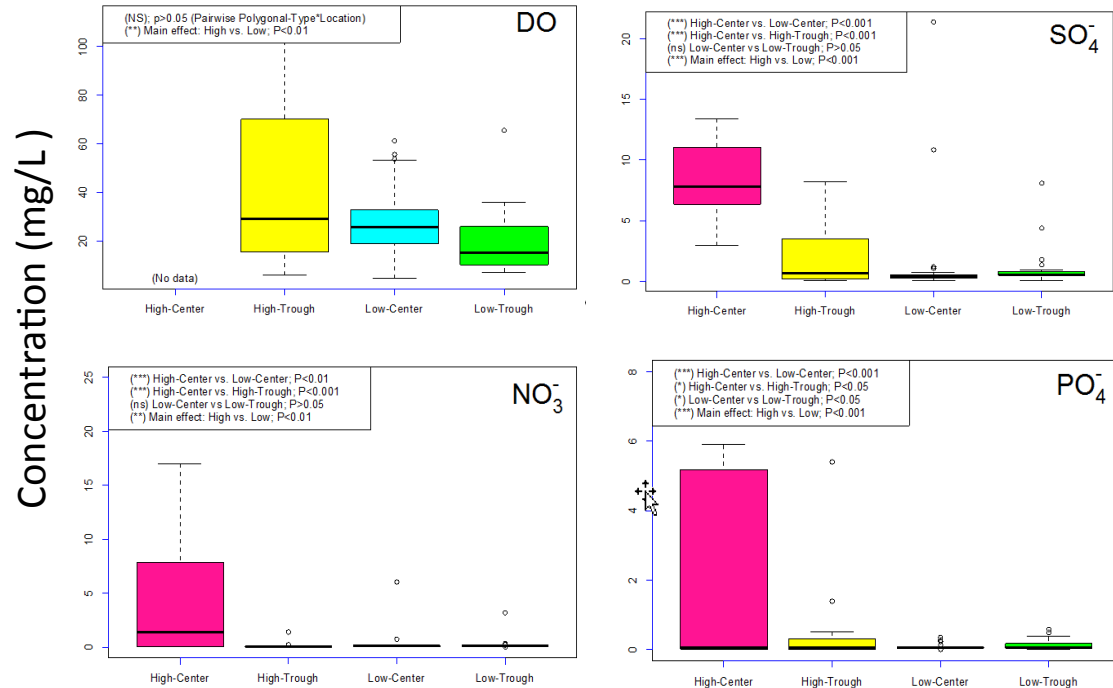


High-Centered Polygon



Intensive Geochemistry Survey

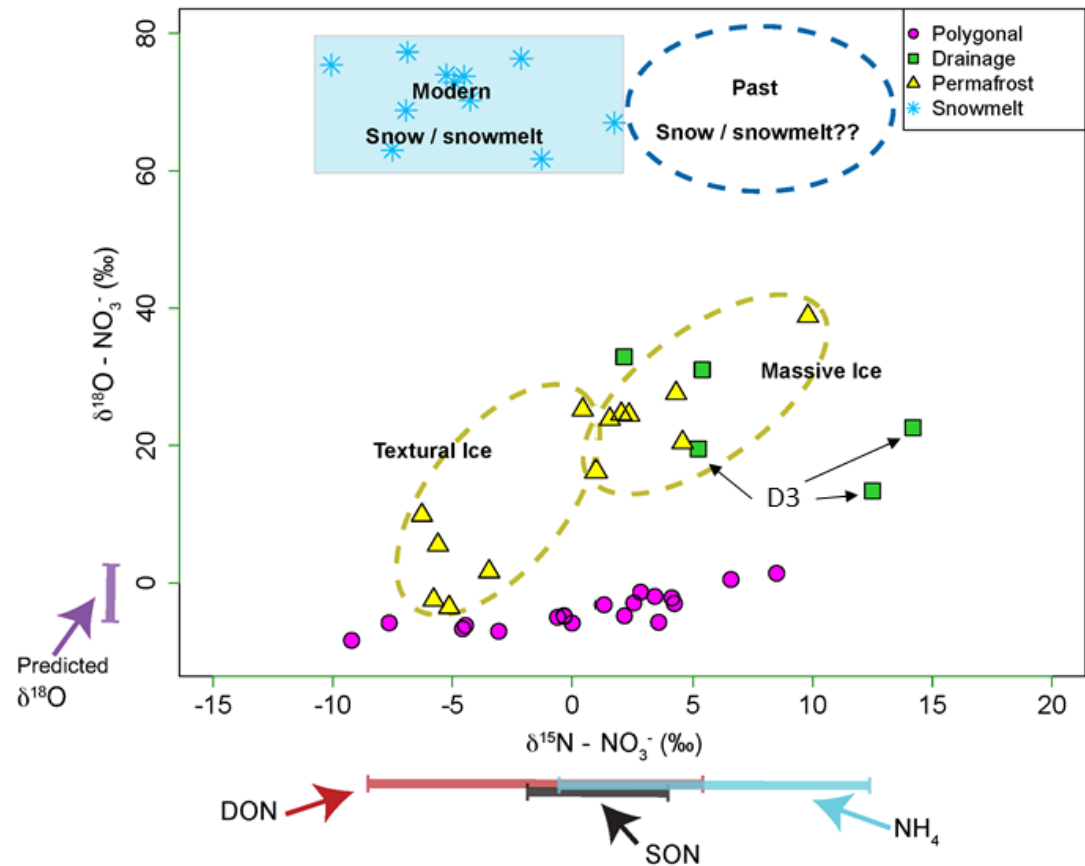
- First comprehensive examination of biogeochemical variability in polygonal ground active layer waters (54 analytes)
- Polygon types matter. Low center areas are distinct from high centers
- Polygon features (troughs vs. centers) also matter but for different biogeochemical constituents than polygon types
- Can use types & features to represent variations in polygon chemistries over large scales
- Nutrient availability will likely change with increased permafrost degradation



Newman et al. (2015). Microtopographic and depth controls on active layer chemistry in Arctic polygonal ground. *Geophysical Research Letters*.

Nitrogen sources and cycling

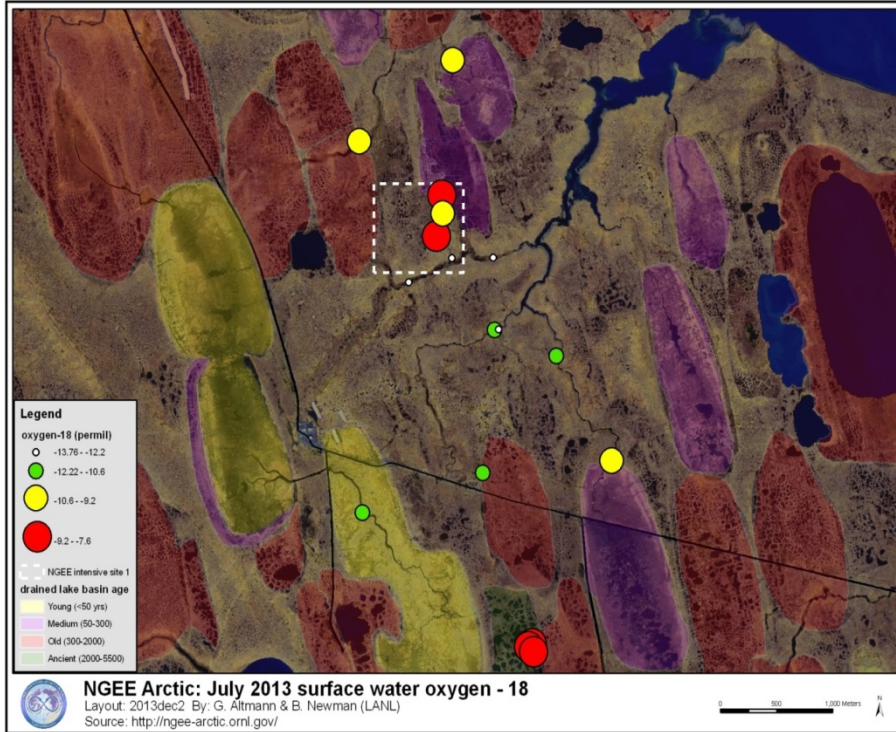
- Different sources of nitrate have distinct isotopic compositions
- Nitrate in the unsaturated zone of high-centered polygons was from microbial nitrification
- Permafrost nitrate contained a mix of atmospheric N and microbial N. Potential tracer for permafrost degradation?



Heikoop et al. (2015). Isotopic identification of soil and permafrost nitrate sources in an Arctic tundra ecosystem. JGR Biogeosciences.

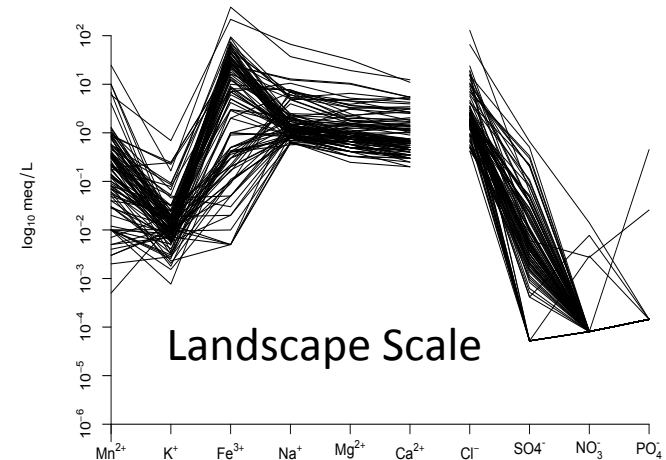
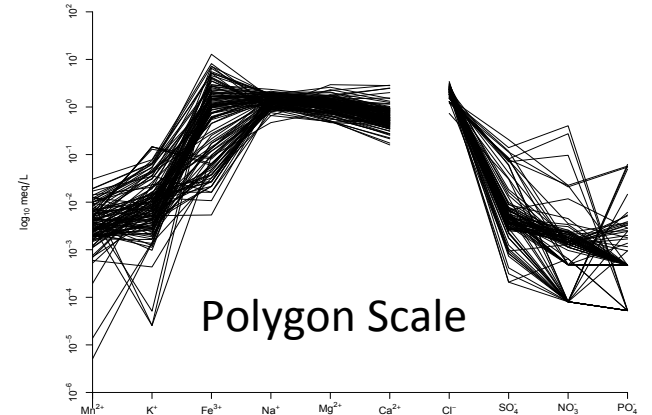
Landscape Scale Geochemistry

Landscape Scale Oxygen-18 in Water



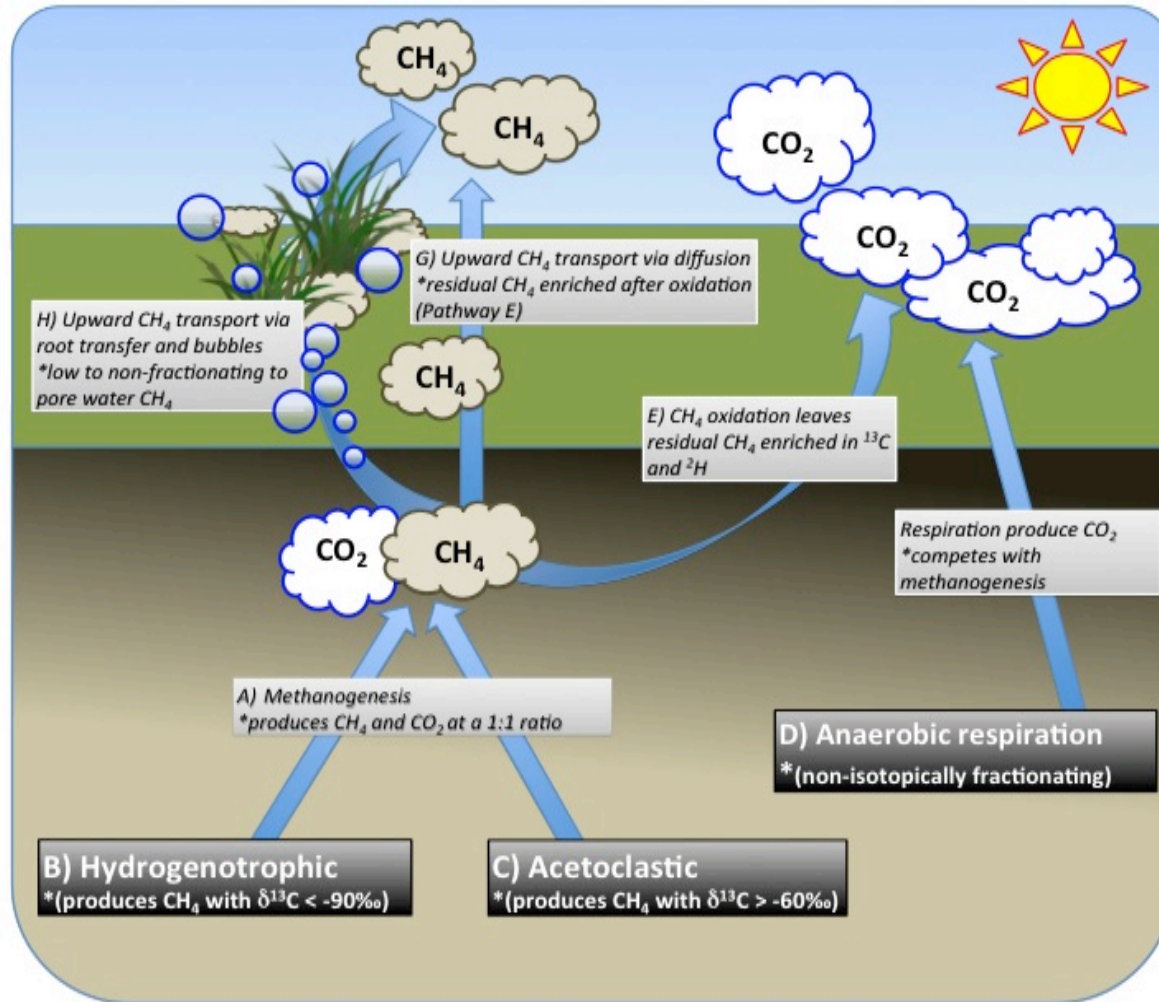
Over 7‰ variation in $\delta^{18}\text{O}$

- Indicates important differences in water sources & evaporation losses across the landscape



Landscape scale variability in chemistry is even larger than at the polygon scale

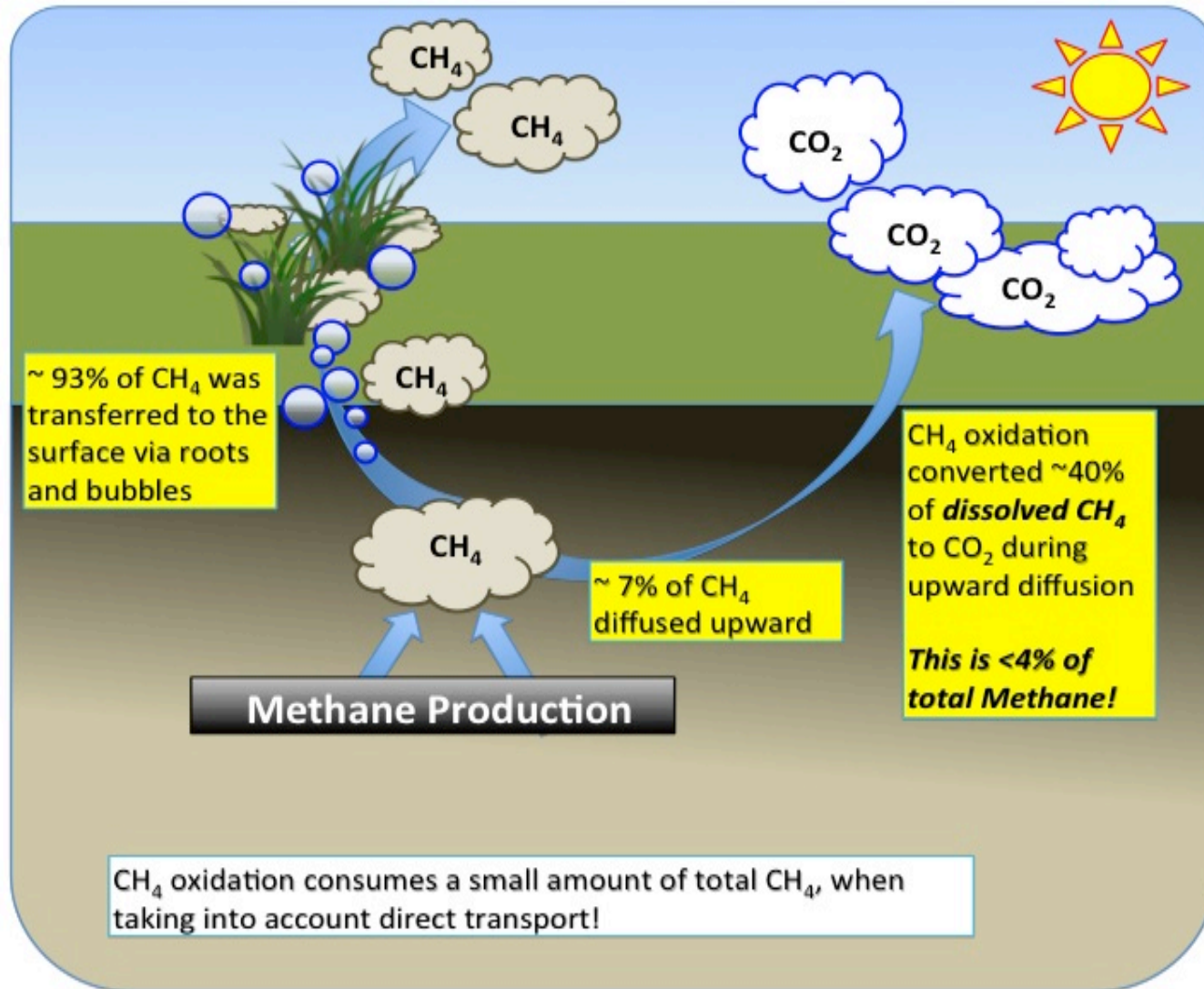
CH₄ and CO₂: Novel isotope mass balance model

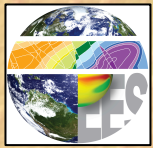


What are the relative contributions of CH₄ and CO₂ production and transport pathways?

- CH₄ and CO₂ production mechanisms
- Vertical transport pathways
- Methane oxidation

Our estimates suggest direct upward transport is dominant, and CH₄ oxidation not as substantial as expected





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Thank you!