METHANE PRODUCTION FROM SINKING PARTICULATE MATTER AT STATION ALOHA

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CONCEPT

Methane (CH₄) is a potent greenhouse gas that has 20-fold more warming potential than carbon dioxide (Saunois et al., 2016).

The oxygenated surface waters of the world’s oceans are supersaturated with CH₄ relative to the atmospheric equilibrium concentration and considered a source to the atmosphere (Holmes et al., 2000). This phenomenon has been referred to as the “marine methane paradox” since CH₄ production is thought to occur only in anaerobic environments through methanogenesis (Thauer et al., 2008).

Karl et al. (2008) hypothesized that CH₄ in the ocean was produced aerobically through the microbial degradation of methylphosphonic acid (MPN). However, del Valle et al. (2014) found that CH₄ production rates from free dissolved ¹⁴C-MPN amendments were not enough to account for its supersaturation in the ocean and hypothesized that CH₄ was produced from the degradation of particulate MPN bound to sinking particles. Recently, Repeta et al. (2016) showed that the microbial degradation of MPN and 2-hydroxyethylphosphonate bound to HWM-DOM could account for CH₄ oversaturation in oligotrophic waters, while also producing CH₄, another greenhouse gas.

EXPERIMENTAL DESIGN

Objectives: Enriching surface seawater with particles collected near station ALOHA over 52 hrs at 140 m and 250 m depth to measure CH₄ and CH₃ using GC-FID.

Particles were collected by filtering sediment trap solution (STS) using 10 μm filters and resuspended in freshly prepared STS.

Treatments were amended with glucose and nitrate to promote phosphate (P) and productivity measurements would be necessary.

Overall we show higher CH₄ and CH₃ concentrations for treatments without P addition, which is in agreement with the biological transformation of phosphonates acting as a source of CH₄ and CH₃ in the aerobic upper water column (Karl et al., 2008; del Valle et al., 2014; Repeta et al., 2016).

Studies conducted at station ALOHA (22°45′N, 158°00′W) in the Pacific Ocean north of Hawaii (Figure 1) during two expeditions:
1) HOE-Legacy 3 in March 2016
2) Hawaii Ocean Time-series (HOT) 286 in August 2016

RESULTS & DISCUSSION

All treatments show production of CH₄ and CH₃ with a decrease in production when P is added (Figs. 4 & 5). This is expected given that under P-stressed conditions, the biological transformation of phosphonates can act as a potential source of CH₄ and CH₃ in the aerobic upper water column (Karl et al., 2008; del Valle et al., 2014; Repeta et al., 2016).

Treatments with particle addition show higher CH₄ and CH₃ concentrations, with greater production in most of the cases for the treatment with higher concentration of particles. The difference is more noticeable for CH₃ production. This could indicate that sinking particles may be the source of CH₄ and CH₃ through degradation of phosphonates in the aerobic surface waters.

The removal of some HWM-DOM did not seem to affect CH₄ total production from the particle treatment but decreased the production of CH₃ (Fig. 5), which may indicate that a fraction of these gases was produced from the degradation of phosphonates bound to particles.

CONCLUSIONS

Overall we show higher CH₄ and CH₃ concentrations for treatments without P addition, which is in agreement with the biological transformation of phosphonates acting as a source of CH₄ and CH₃ in the aerobic upper water column under P-stressed conditions. We also show that there is greater production of CH₄ and CH₃ in the particle treatments, which may indicate that the degradation of particulate phosphonates may contribute to the production of these gases. However, it is difficult to discriminate whether elevated biomass in the particle treatments may enhance phosphonate degradation from DOM (Repeta et al., 2016) versus degradation of phosphonates bound to sinking particles. For this reason further experiments with additional treatments using high and low molecular weight DOM concentrations plus productivity measurements would be necessary.

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REFERENCES