Global Biogeochemical Cycles

Supporting Information for

Dynamics of diurnal methane emission from seagrass meadow and mangrove creek at estuaries of northwest Gulf of Mexico

Hao Yu[1], Richard Coffin[1], Hannah Organ[1], Derry Xu[1]

[1]Department of Physical and Environmental Sciences, Texas A&M University-Corpus Christi, Texas, USA

Contents of this file

Introduction

This supporting information provides detailed information about data used in Figure 6 and Figure 7, and supplementary figures used in this paper.

The first part (Text S1 and Text S2) explains data used in two figures that described the CH_4 cycling in seagrass and mangrove creek. It includes calculation methods and related assumptions.

The second part is supporting figures. Figure S1 is the nonlinear increase of CH_4 in floating chambers in a long-term observation (Section 3.2). Due to the disadvantage of the floating chambers, long-term data were not perfect. Problems such as overturning and relocating of chambers were notated in the dataset. Figure S2 is CH_4 and sulfide profile in sediment porewater (Section 3.3). Figure S3 is the variation of CH_4 in the water incubation experiment (Section 3.4). Figure S4 shows the salinity and CH_4 along the mangrove creek from inside to outside (Section 4.3.1). Figure S5 is the wind speed comparison in section 4.3.2.

Text S1. Detail information about CH_4 cycling in the seagrass meadow (Figure 6)

(1) Average hourly variation of CH_4 concentration in the daytime and nighttime and daily variation:

- *In-situ* daytime variation from 9:45 am to 19:05 pm (9.35 hours) was used to calculate the average hourly variation in dissolved CH_4 concentration.

$\Delta[CH_4]_{remain\text{-}daytime}$ = -37.58nM/9.35hr = -4.02 nmol/L·hr

- *In-situ* nighttime variation from 22:00 pm to 5:00 am (7 hours) was used to calculate the average hourly variation in dissolved CH_4 concentration.

$\Delta[CH_4]_{remain\text{-}night}$ = +36.08nM/7hr = +5.15 nmol/L·hr

- The summer day includes13 hours of daytime and 11 hours of nighttime.

$[CH_4]_{remain\text{-}whole\text{-}day}$ = -4.02 nmol/L·hr *13hrs + 5.15 nmol/L·hr *11hrs = + 4.5 nmol/L

Hence, 4.5 nmol/L of dissolved CH_4 was left in the water column during whole-day cycling.

(2) Plant mediation of CH_4 by seagrass

- Daytime: No or few CH_4 was transported by seagrass due to photosynthesis. A decline of dissolved CH_4 in the water column could support this point.
- Nighttime:

An increase of CH_4 in overlying water was used to calculate seagrass transport of CH_4 overnight. Assuming oxygen in sediment chambers was enough to support seagrass survival during the incubation experiment, CH_4 in overlying water increased after sunset like the in-situ conditions.

If seagrass kept normal photosynthesis after sunrise:

$[CH_4]_{plant\text{-}mediation}$ = 81.9/11 = 7.4 nmol/L·hr

If seagrass did not take photosynthesis after sunrise:

$[CH_4]_{plant\text{-}mediation}$ = 81.9/14 = 5.8 nmol/L·hr

(3) Sediment-water diffusive flux was calculated using Fick's First Law (Table 1)

(4) Water-air CH_4 fluxes in daytime and night were average diffusive fluxes during observation in the day and overnight, respectively.

Text S2. Detail information about CH_4 cycling at the mangrove creek (Figure 7)

(1) Average hourly variation of CH_4 concentration during different stages of the tidal procession:

- High tide (8 hours): $\Delta[CH_4]_{high\text{-}tide}$ = (92.6-56.9)/8 = 4.5 nmol/L·hr
- Ebb 1 (4 hours): $\Delta[CH_4]_{ebb1}$ = (106.9-92.6)/4 = 3.6 nmol/L·hr
- Ebb 2 (4 hours): $\Delta[CH_4]_{ebb2}$ = (78.2-106.9)/4 = -7.2 nmol/L·hr
- Flood (7 hours): $\Delta[CH_4]_{flood}$ = (53.5-78.2)/7 = -3.5 nmol/L·hr

(2) Whole tidal process:

Duration: high tide: 9 hours; ebb1: 4 hours; ebb2: 4 hours; flood: 7 hours

$\Delta[CH_4]_{all}$ = 4.5*9+3.6*4+(-7.2)*4+(-3.5)*7 = +1.6 nmol/L·day

(3) Export of CH_4 from mangrove to bay:
The increase of CH_4 in high tide came from CH_4 produced in sediment and transported to the water column. The increase of CH_4 in the beginning 4 hours of ebb was transported from inside the mangrove creek. We assume the same amount of CH_4 was exported outside the bay. As a result, about 70% of CH_4 produced in high tide was transported to the outside bay.
3.6*8/4.5*9 *100% = 71%

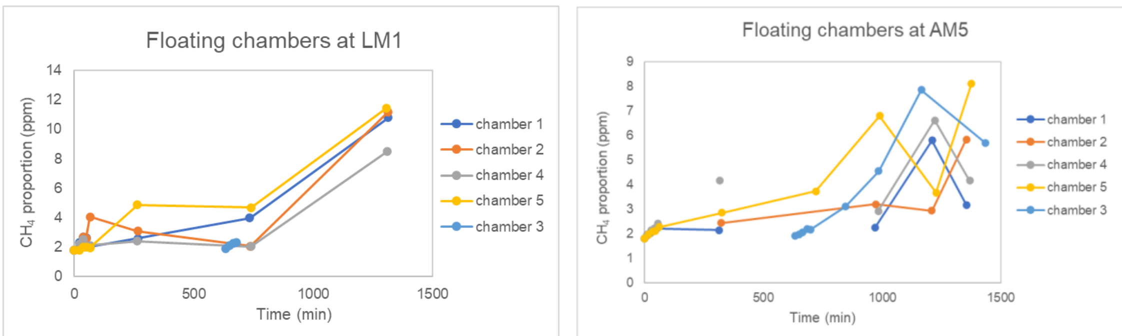

Figure S1. CH_4 proportion in floating chambers during diurnal variation. (a) LM1; (b) AM5.

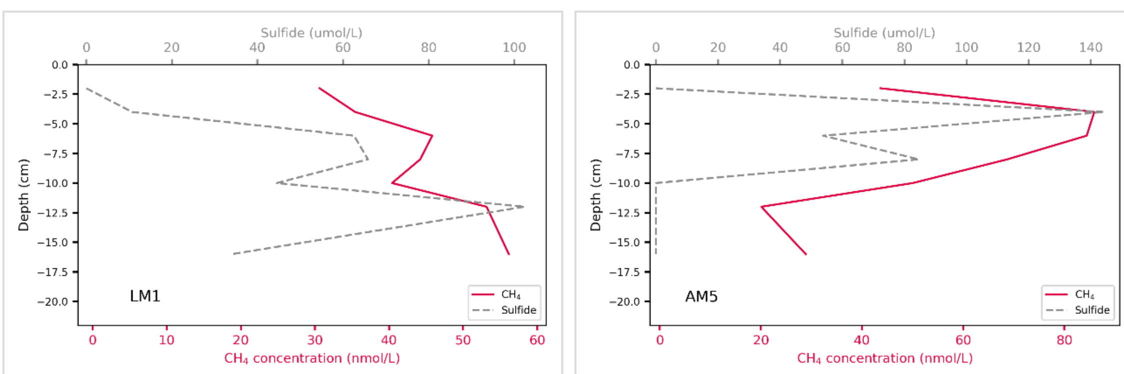

Figure S2. CH_4 and sulfide concentration profile in sediment porewater collected in August 2019. (a) LM1; (b) AM5.

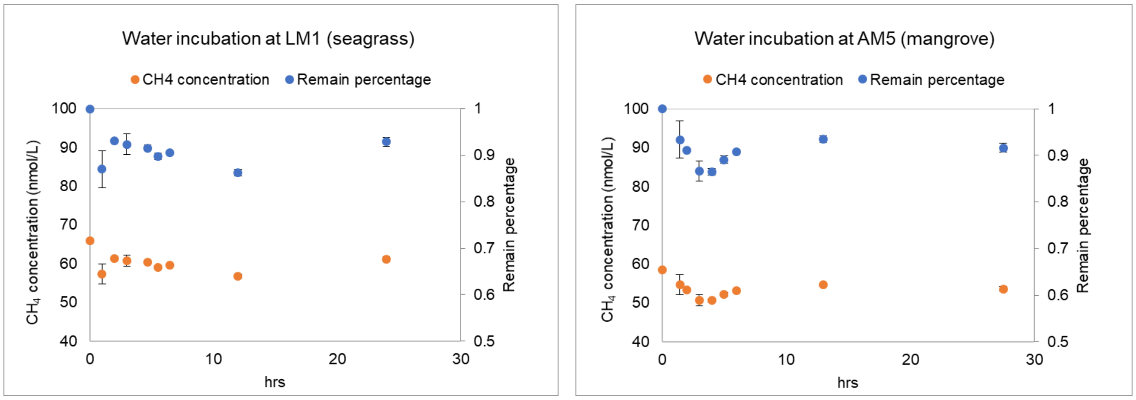

Figure S3. Water incubation results. Left: LM1, seagrass; Right: AM5, mangrove.

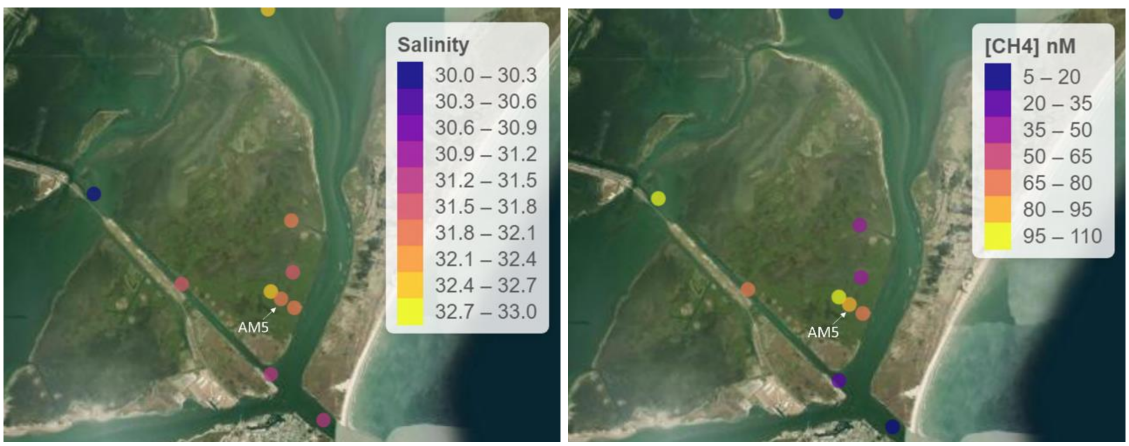

Figure S4. Salinity and dissolved CH_4 concentration at Harbor Island waterways in July 2019.

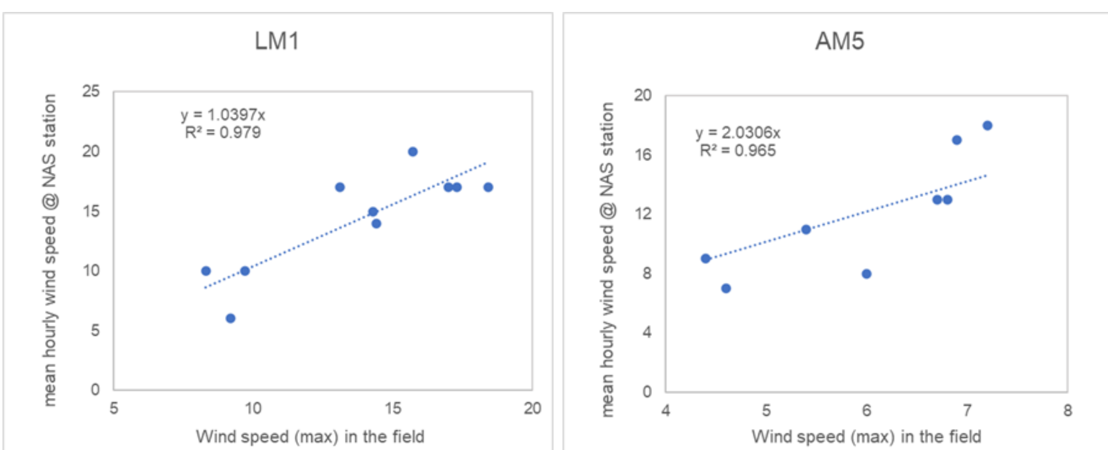

Figure S5. Comparison of in-situ maximum wind speed (1m) during sampling and hourly mean wind speed at the metrological station (10 m).