Carbon Dioxide and Methane Emissions from Diverse Zones of a California Salt Marsh
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Introduction
With high primary productivity and low organic matter decomposition rates, salt marshes sequester carbon from the atmosphere and contribute to mitigation of climate change. However, the role of wetlands in carbon sequestration is offset by CO$_2$ and CH$_4$ emissions whose magnitudes remain coarsely constrained. In fact, wetlands are recognized as the single most dominant natural source of global methane emissions (Ciais et al., 2014).

Although extensive research has been focused on wetland greenhouse gas (GHG) dynamics and factors that control them, our current knowledge is limited on GHG fluxes from tidal wetlands, especially those under the influence of a Mediterranean climate. Previous studies have suggested that water level, soil temperature, salinity, and vegetation may have significant influences on CO$_2$ and CH$_4$ emissions from freshwater wetlands. For tidal marsh ecosystems, Poffenbarger, Needelman, & Megonigal (2011) concluded that high salinity (over 18 ppt) will in general suppress methanogenesis and lead to negligible methane fluxes.

The aim of this study is to investigate the patterns of gaseous carbon emissions from a tidal wetland on the central coast of California. The research questions are:

1) What are the spatial and temporal patterns of CO$_2$ and CH$_4$ fluxes from a coastal/tidal wetland under a semiarid Mediterranean climate?

2) How are CO$_2$ and CH$_4$ fluxes related to local environmental characteristics, such as air temperature and soil carbon content?

Data
The study was conducted in Carpinteria Salt Marsh Reserve, part of a 93 ha estuarine tidal wetland located 12 km east of Santa Barbara, California (34°24′N, 119°31′W). Four zones (as listed below) were selected from the salt marsh as shown in Figure 1 on the next page. These zones represent a gradient of grouped environmental factors including surface elevation, tidal regime, salinity, and vegetation cover.

Zone 1: Low marsh with unrestricted tidal connectivity
Zone 2: Low marsh with restricted tidal connectivity (Sadro, Gastil-Buhl, & Melack, 2007)
Zone 3: Salt flat (hypersaline; no vegetation cover)
Zone 4: Transition zone between marsh and upland

Greenhouse gas fluxes were measured with a dark static chamber technique on a biweekly basis from September, 2015 to May, 2016. Three chamber bases were deployed in each zone in early August 2015, roughly 30 to 40 meters from each other. At each sampling spot, a chamber top was installed on each chamber base, and 30 ml of gas was extracted with syringes from the chamber headspace every 20 minutes over the course of an hour. The gas samples were then
transported to the lab and analyzed with a gas chromatograph (Shimadzu GC-14A). Surface water salinity was recorded when applicable, and air and soil temperatures were recorded during gas sample collection.

In addition to flux measurements, soil cores up to 50 cm deep were extracted near the chambers in August 2015 (before the start of flux measurements) and in June 2016 (after the end of flux measurements). Each core was then divided into three layers: top 10 cm, 10 – 30 cm, and 30 – 50 cm. Further processing and measurements include bulk density, soil organic matter content (loss on ignition), soil pH, electrical conductivity, particle size distribution and soil carbon and nitrogen content. Except for bulk density which was measured at field moisture content, the other measurements were performed on oven-dried and sieved soil samples. Besides soil data collection, aboveground biomass inside each chamber was harvested at the end whose weight was recorded after stabilized at 65°C.

**Results**

The gaseous carbon fluxes showed significant spatiotemporal variability. Integrated over the study period, the marsh-upland transition zone had the highest CO₂ fluxes at 292 g C/m², followed closely by the lower marsh zones (271 g C/m² and 189 g C/m²), which were one order of magnitude higher than the CO₂ fluxes from the salt flat (23 g C/m²). Seasonally, CO₂ fluxes were 2.5 to 3.5 times higher during the warmer months (Sept – Oct, Mar – May) than the colder months (Nov – Feb) across all zones. The CH₄ fluxes were more temporally heterogeneous, but overall the CH₄ emissions from the lower marsh zones (1.37 g C/m² and 0.41 g C/m²) surpassed those from the salt flat (0.054 g C/m²) by an order of magnitude, and the marsh-upland transition zone was a net methane sink (-0.029 g C/m²).

Soil properties differed noticeably by zone and by depth. Generally speaking, soils from lower marsh zones were more acidic than those from the salt flat or the marsh-upland transition zone. They also had higher electrical conductivity and greater soil carbon content. The soil properties align well with their environmental settings and their carbon content match the spatial pattern of gaseous carbon fluxes.

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**Bibliography**


