Environment

Tracing Greenhouse Gases Emissions of the Yellow River Estuary Helps Accurately Estimate Carbon Emission from Intertidal Zone

Nitrous oxide (N_2O) and methane (CH_4) are key radiatively active greenhouse trace gases which have been recognized to contribute to global warming by 5% and 25%, respectively. The quantification of trace gases is a subject of great interest because accurate information is required to determine the contribution of these gases to global greenhouse gas fluxes. The coastal marsh ecosystem is characterized by high temporal and spatial variations involving topographic feature, environmental factors and astronomic tidal fluctuation. Above all, the intertidal zone between terrestrial and aquatic coastal ecosystems may represent a high dynamic interface of intense material processing and transport, with potentially high decomposition and associated greenhouse gases emission.

In the past two decades, considerable efforts have been made to quantify the N_2O and CH_4 fluxes in different coastal ecosystems. In China, the studies on N_2O and CH_4 emissions from coastal marshes started quite late (in the 2000s), primarily focusing on the coastal tundra marshes in Antarctica and the coastal marshes in the Yangtze River estuary and the Min River estuary. However, few studies

In situ observation of greenhouse trace gases. (Photo courtesy Dr. SUN)

have reported on coastal marshes in northern estuaries, such as the Liao River estuary and the Yellow River estuary.

Dr. SUN Zhigao and coworkers from the Yantai Institute of Coastal Zone Research, Chinese Academy of Sciences carried out systematic studies to quantify the N_2O and CH_4 fluxes from intertidal zones, evaluate the potential influences of exogenous nitrogen (N) loading on emissions, and estimate the annual N_2O and CH_4 inventories. Their latest research results have been reported in the journals of *Chemosphere, Plant and Soil and Ecological engineering*.

Their study identified the spatial and temporal variations of N_2O and CH_4 emissions and determined the key affecting factors based on two-year *in situ* observation data. They found that, dissimilar to previously published results, seasonal variations of N_2O fluxes were not dependent on temperatures but related to the limited carbon (C) and mineral N in sediments during summer and autumn and the frequent freeze/thaw cycles in surface sediments during spring and winter. They also discovered that seasonal variations of CH_4 fluxes were not dependent on temperatures. Instead, they were related to the interactions of abiotic factors (sediment moisture and salinity) and the variations of limited C and mineral N in sediments, and were closely correlated with sulfur (S) biological cycling.

According to their study, the total sulfur (TS) and sulfate (SO_4^{2-}) were abundant in sediments and the S biological cycle coefficients were high (0.8625~0.9014), indicating that both SO_4^{2-} dissimilatory reduction process (performed by sulfate reducing bacteria, SRB) and microbially mediated AOM (anaerobic oxidation of methane) process (performed by a consortium of anaerobic methanotrophic archaea (ANME) and SRB) would be enhanced under anoxic condition, which further inhibited CH_4 emissions. From the perspective of C and S coupling, the mechanism could better explain why the CH_4 emissions across the intertidal zone were very low.

The research also evaluated the global warming potential (GWP) of N_2O and CH_4 emissions and the effects of N loading on emissions. Different from previous studies, they observed large spatial variations of N_2O and CH_4 fluxes (especially CH_4) across the intertidal zone (158.3% and 7856.3%, respectively), and revealed the importance of seasonal N_2O or CH_4 contributions (particularly during non-growing season) to the estimation of local N_2O or CH_4 inventory. Their result also showed that N_2O and CH_4 emissions from the intertidal zone would be enhanced with increasing N loading to the Yellow River estuary.

Field work at Yellow River estuary. (Photo courtesy Dr. SUN)

Prof. Bodelier from the Institute of Ecology of the Royal Netherlands Academy of Arts and Sciences hailed this study as “an important innovation research to accurately estimate the C emission from intertidal zone”.

For future research, Dr. SUN and his colleagues from the Yantai Institute of Coastal Zone Research will emphasize the importance of seasonal N_2O and CH_4 contributions (particularly during non-growing season) to the estimation of local inventories, and synthetically consider both the large spatial variations of N_2O and CH_4 fluxes across the intertidal zone and the potential priming effects of exogenous N loading to the Yellow River estuary on N_2O and CH_4 emissions.