Land-sea interactions of tidal and sea breeze activity regulate mangrove carbon sink

Xudong Zhu1,2, Zhangcai Qin2,3, and Lulu Song4
1Xiamen University, Xiamen, China (xdzhu@xmu.edu.cn)
2Southern Marine Science and Engineering Guangdong Laboratory, Zhuhai, China
3Sun Yat-sen University, Zhuhai, China (qinzhangcai@mail.sysu.edu.cn)
4Institute of Urban Environment, Xiamen, China (llsong@iue.ac.cn)

Coastal mangrove wetlands experience unique land-sea interactions including periodical tidal activity and land/sea breeze cycle. However, the influence of tidal and sea breeze activity on net ecosystem exchange of carbon dioxide (NEE) between mangrove and the atmosphere has not yet been investigated. In this study, temporal variations in mangrove-atmospheric NEE and its direct and indirect environmental controls were examined based on a three-year dataset of continuous eddy covariance and auxiliary measurements in a subtropical estuarine mangrove wetland of southeastern China. The results showed this mangrove wetland acted as a consistent carbon sink over the three-year period (mean NEE of -1233 g C m⁻² year⁻¹) with the strongest carbon sink capacity in spring, and the impacts of environmental factors on mangrove NEE varied across time scales: (1) half-hourly daytime carbon influx was regulated by photosynthetically active radiation (PAR) with down-regulation effects from high temperature and vapor pressure deficit (VPD), while half-hourly nighttime carbon efflux was dominated by air temperature with additional suppression effects from tidal inundation and rain; (2) the importance of environmental factors in controlling daily NEE decreased in the order of PAR, air temperature, sea breeze, VPD, tidal salinity, and tidal inundation; (3) the seasonality of monthly NEE was strongly regulated by tidal inundation and rain. This was the first study to examine both direct and indirect effects of tidal and sea breeze activity on mangrove NEE using long-term continuous eddy covariance measurements, and to confirm the importance of previously neglected indirect effects of tidal and sea breeze on mangrove carbon sink. Strong negative correlations between mangrove carbon sink and air temperature/tidal inundation implied that mangrove wetland could become a weaker blue carbon sink in response to global warming and sea level rise in the future.