"Carbon cycle and multiple stresses at the land-ocean interface: biogeochemical perspectives"

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Organic matter is synthesized in terrestrial biospheres and is transported to the ocean along a leaking pathway. Subsidized by land carbon and nutrient export, the coastal ocean is a site of intense carbon and nutrient cycling, generally net heterotrophic, and a source of carbon dioxide (CO_2) to the atmosphere during preindustrial time. Human actions have altered the carbon cycle and fluxes in coastal waters and turned the coastal ocean into a sink of CO_2 due to increased atmospheric CO_2 concentration and anthropogenic carbon and nutrient export from the land. Synthesis of coastal ocean CO_2 data collected in the past three decades suggests that the air-sea CO_2 gradient has changed sign (from source to sink) and is increasing, making the coastal ocean an increasingly important sink of atmospheric CO_2 and likely a source of CO_2 to the open ocean via lateral transport. In recent decades, coastal waters have faced multiple anthropogenic and climate-induced stressors including warming, sea level rise, eutrophication, and bottom water hypoxia. More recently, ocean acidification (OA) has emerged as a new stressor. While OA has been primarily considered an open ocean problem, it manifests more dramatically in coastal waters as it interacted and often synergized with other stressors, like eutrophication. This lecture will review carbon transport and transformation along the aquatic pathway from the land to the ocean, in particular, the cycling and fluxes of carbon in coastal waters, with an emphasis on biogeochemical understanding and perspectives. I will explain the carbon cycle and coastal acidification from first principles and examples from North American, European and Asian coastal waters.

Under the current climate and global change context, rapid industrialization and urbanization in the Asia and Oceania regions have resulted in many challenges, as well as opportunities for ecosystem and biogeochemical research. I will analyze some of these new challenges in the region and emphasize that comparative researches with "old" issues in the western countries will be highly beneficial to our understanding of carbon cycle, environmental changes, and ecosystem responses. One example is the more recent development of eutrophication in surface water and hypoxia and acidification in bottom water of the East China Sea shelf off the Changjiang River, versus a similar but "old" problem in the Northern Gulf of Mexico off the Mississippi River and many eutrophication and hypoxia locations in European coastal waters. Another good example comes from the Delaware River, USA and the Pearl River in China. In both cases, deoxygenation and acidification occurred as a result of human activity, but with a half century of time lag (first, point and non-point city sewage discharge into the estuaries, and then, a gradual water quality improvement through better sewage treatment facilities). Such geographic and temporally contrasting comparative studies will provide excellent opportunities for us to understand the carbon cycle and biogeochemistry and the interaction of multiple stressors from human actions and climate changes.