Using remote sensing to understand the consequences of climate, sea level changes and increased human activities in the coastal Gulf of Maine-- An interdisciplinary study of land-sea carbon coupling

Abstract

The Gulf of Maine is a semi-enclosed water body with intense coupling between land and sea. It receives large inputs of dissolved and particulate carbon from land run-off as well as the NW Atlantic Ocean. The coupled terrestrial and marine biomes support highly productive ecosystems, as well as extensive agriculture, aquaculture and fisheries. Carbon is the common currency of each system. Interestingly, the connections between the terrestrial and marine carbon budgets are significant to the coastal biomes, yet they remain poorly understood. We propose an interdisciplinary regional study of the Gulf of Maine and its terrestrial watershed that investigates the consequences of climate, sea level changes and increased human activities on the land-sea carbon coupling. This will include the study of various aspects of the variability, forcing, response, consequence and prediction of carbon cycling in the coastal margin. Specifically, we will investigate connections between vegetation cover, land use, hydrology, climate, regional weather, oceanic circulation, and various terrestrial and marine carbon compounds relevant to the carbon balance. Critical to this work would be a thorough understanding of the seasonal to annual fluxes of dissolved and particulate organic carbon from terrestrial sources to the Gulf of Maine via major rivers, and their subsequent fate within the Gulf of Maine. Both types of organic carbon are critical to ocean remote sensing in the Gulf of Maine because of their profound influence on the optical properties of the water. This study would take advantage of several rich data sets (all ongoing): 1) 60-100 years of river runoff data available from the U.S. Geological Survey and Environment Canada, 2) a 6 year NASA-sponsored coastal time series of hydrography, bio-optical properties, and carbon cycle properties across the Gulf of Maine, operated from a ferry, 3) a 3-year time series of bio-optical and physical data at several stationary buoy sites throughout the Gulf as part of the Gulf of Maine Ocean Observing System (GoMOOS), and 4) long-term climate records available for temperature and precipitation (from the USHCN) and the North Atlantic Oscillation (NAO) index. We will propose to maintain continuous ferry sampling during this research, which would extend the complete ferry time series to 9 years, allowing better comparison to climate records, known to vary at decadal time scales. New proposed ferry work would allow improved spatial and temporal resolution of the land-sea carbon coupling the critical region of the fresh and marine water interface. Well-placed optical moorings within the GOMOOS program will allow better fine-scale temporal resolution of the land-sea coupling as terrestrial and marine carbon mixes in the nearshore environment. We also propose a river sampling component to better understand the DOC sources that feed into the Gulf of Maine, the timing of those inputs, and how land-use change, such as ongoing urbanization and deforestation, or climate change might influence the flux of DOC from the land to the sea. Chemical analyses of the terrestrial and marine water samples, with respect to distinct particulate and dissolved carbon pools, will allow a better understanding of the fluxes, transformations, and turnover of these carbon compounds in the coastal environment. We will use the long-term data on runoff in conjunction with historical and newly-acquired data on riverine DOC and nutrient concentrations to compute current and historical fluxes from rivers to the Gulf of Maine. Land cover in Maine is more than 25% wetlands and these wetlands can be important sources of DOC. We propose to evaluate the potential for climate change to influence wetland DOC production. All of the data sources listed above, along with synoptic satellite data, will provide the foundation for scaling-up our observations to the larger space and time scales of variability in the Gulf of Maine ecosystema central goal of our proposed work. In summary, this work will primarily address the question from the NRA: 1) "What are the consequences of climate change and sea level changes and increased human activities on coastal regions"? The work will secondarily address two other NRA questions: How are global ecosystems changing? and How well can cycling of carbon through the Earth system be modeled?.