BLUE CARBON: A CASE STUDY IN SOUTH FLORIDA

Peter K. Swart, Amel Saied, Greta J. Mackenzie, Michael Lutz, and Chaojin Lu

PROJECT OBJECTIVES

- Compare the flux and the storage of organic carbon in a relatively natural portion of the South Florida Ecosystem with one which has been heavily anthropogenically affected.

PROJECT RATIONALE

There can be little doubt that the increase in the concentration of CO_2 in the atmosphere which has taken place over the past 300 years has resulted primarily from the combustion of fossil fuels. This is recorded in atmospheric changes made since ~ 1960 as well as records contained in the $\delta^{13}C$ values recorded in the skeletons of organisms such as sclerosponges and CO_2 trapped in ice cores. Figure 1 for example, shows records from two long-lived sclerosponges from the Caribbean and from two Antarctic ice cores. All show the tremendous decrease in $\delta^{13}C$ values starting in the 18th century. Initially these decreases were a result of the burning of coal, but by the start of the 20th century they were augmented by emissions from the internal combustion engine. Carbon stored in coastal ecosystems in the form of seagrasses, mangroves, salt marshes, and other coastal ecosystems, also known as blue carbon, does not have the ability to eliminate this increase, but can modify the rate of future change. While terrestrial forests and grass lands (green carbon) have historically been thought of as the most important temporary storage site of carbon, it has gradually become apparent that coastal areas may be more significant. This realization necessitates a reexamination of the

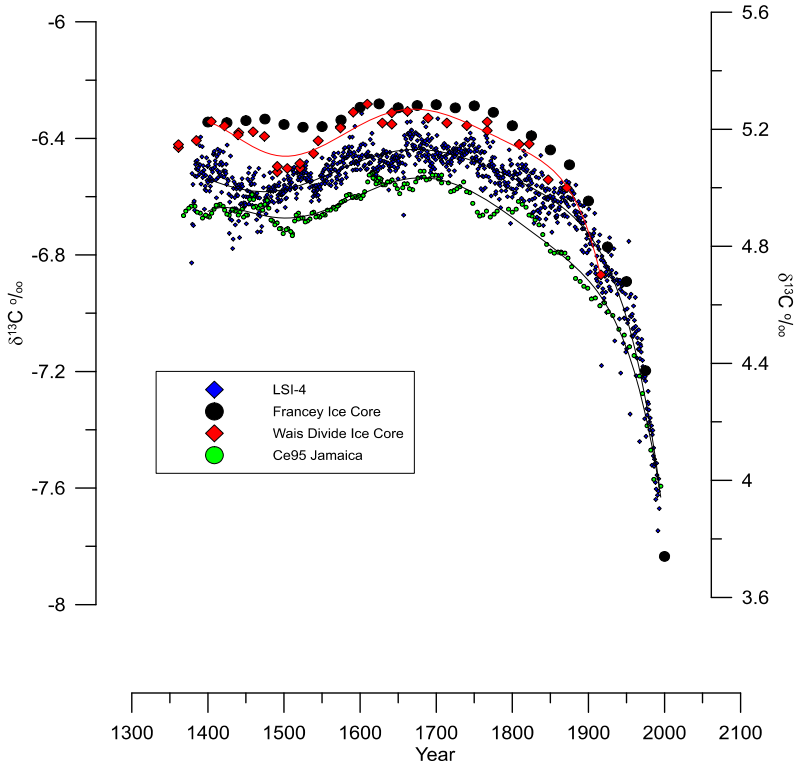

Figure 1: The $\delta^{13}C$ values measured in two sclerosponges, one from the Bahamas (LSI-4) (Waite, 2011; Waite et al., 2020) and one from Jamaica (Ce-95) (Böhm et al., 2002) (scale on right axis) together with $\delta^{13}C$ values of CO_2 from gas trapped in ice cores from the Antarctic (Bauska et al., 2015; Francey et al., 1999). Superimposed on the anthropogenic trend there are variations in the $\delta^{13}C$ values attributed to variations in the organic productivity.

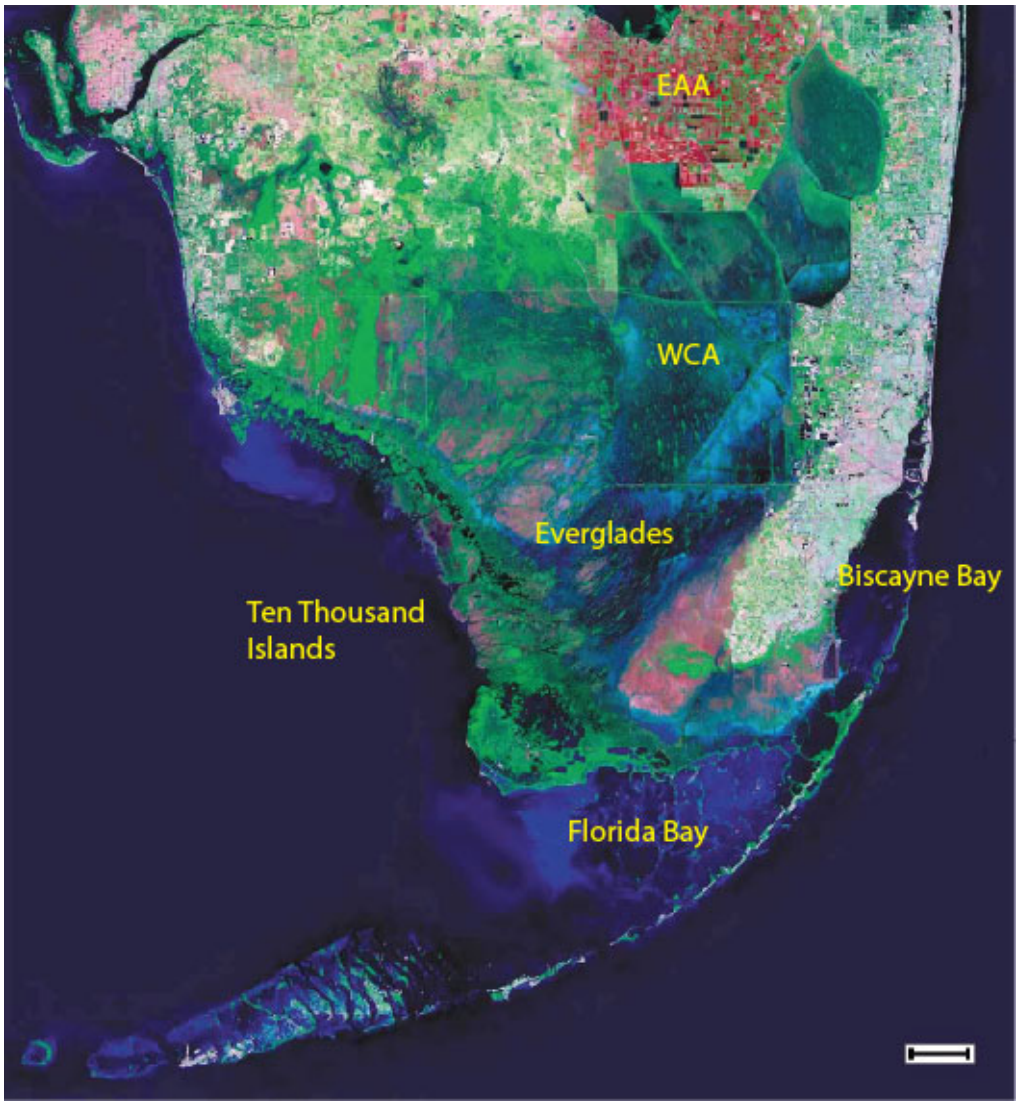

Figure 2: Satellite image of South Florida showing the Everglades, Everglades Agricultural Area (EAA), Water Conservation Area (EAA), Biscayne Bay, Ten Thousand Islands, and Florida Bay. Most of the population is concentrated on the coastal ridge, the white area, between Biscayne Bay and the Everglades.

anthropogenic influences on such fluxes and storage. In this project we will assess the storage and flux of carbon in the coastal ecosystems of South Florida and examine how this has been impacted by anthropogenic activity.

APPROACH

South Florida is not only home to some of the most important calcium carbonate producing systems, but also to large amounts of organic-rich environments in the form of seagrass beds, mangrove forests, and coastal wetlands that merge seemlessly into terrestrial environments such as the Everglades. Superimposed on this transition is a metropolitan area, home to several million people and the accompanying destruction of natural ecosystems.

The unmodified landscape of South Florida was originally an area of significant blue and green carbon storage. This study aims to investigate fluxes between the terrestrial and marine environments and to compare the natural habitat with the modified anthropogenic system.

WORK PROPOSED

Over the past 30 years we have been investigating carbon fluxes into the marine environment. A large amount of these data are contained in the work of Lutz (1997) and the measurements of the concentrations of organic material made in water samples collected by the Southeast Environmental Research Center at Florida International University (Briceño, 2008). A record of changes is recorded in cores taken in Florida Bay (Halley and Roulier, 1999; Prager and Halley, 1999) as well as in the skeletons of scleractinian corals (Anderegg et al., 1997; Hudson et al., 1989; Smith et al., 1989; Swart et al., 1999, 1996)

(Anderegg et al., 1997; Hudson et al., 1989; Smith et al., 1989; Swart et al., 1999; Swart et al., 1996)(Fig. 2). More data will be collected starting in 2022 targeting the anthropogenic component of the system mainly targeting Biscayne Bay. Water and sediment samples will be analyzed from a wide range of locations and compared with the fluxes previously measured in Biscayne Bay and the more natural portions of the system.

SIGNIFICANCE

This study will provide an assessment of the impact of major anthropogenic development on blue and green carbon storage. Such an assessment will be important not only for South Florida, but also for many other areas where there is exploitation of the coastal environment for purposes of human settlement and industrial development.

REFERENCES

Anderegg, D., Dodge, R.E., Swart, P.K., Fisher, L., 1997. Barium chronologies from South Florida corals-Environmental Implication. In: Lessios, H.A., Macintyre, I. (Editors), 8th International Coral Reefs Symposium. STRI, Panama, pp. 1725-1730.

Bauska, T.K. et al., 2015. Links between atmospheric carbon dioxide, the land carbon reservoir and climate over the past millennium. Nature Geoscience, 8(5): 383-387.

Böhm, F. et al., 2002. Evidence for preindustrial variations in the marine surface water carbonate system from coralline sponges. 3(3): 1-13.

Briceño, H.O., 2008. Water Quality Monitoring Project. Southeast Environmental Research Center.

Francey, R.J. et al., 1999. A 1000-year high precision record of $\delta^{13}C$ in atmospheric CO_2. Tellus Series B-Chemical And Physical Meteorology, 51(2): 170-193.

Halley, R.B., Roulier, L.M., 1999. Reconstructing the history of eastern and central Florida Bay using mollusk-shell isotope records. Estuaries, 22(2B): 358-368.

Hudson, J.H., Powell, G.V.N., Robblee, M.B., Smith, T.J., 1989. A 107-Year-Old Coral From Florida Bay - Barometer Of Natural And Man-Induced Catastrophes. Bulletin Of Marine Science, 44(1): 283-291.

Lutz, M.J., 1997. A carbon isotope study of the flux of organic material in a sub-tropical carbonate estuary, Florida Bay, University of Miami, Miami, 102 pp.

Prager, E.J., Halley, R.B., 1999. The influence of seagrass on shell layers and Florida Bay mudbanks. Journal Of Coastal Research, 15(4): 1151-1162.

Smith, T.J., Hudson, J.H., Robblee, M.B., Powell, G.V.N., Isdale, P.J., 1989. Fresh-Water Flow From The Everglades To Florida Bay - A Historical Reconstruction Based On Fluorescent Banding In The Coral Solenastrea-Bournoni. Bulletin Of Marine Science, 44(1): 274-282.

Swart, P.K. et al., 1999. The use of proxy chemical records in coral skeletons to ascertain past environmental conditions in Florida Bay. Estuaries, 22(no. 2B): 384-397.

Swart, P.K. et al., 1996. The stable oxygen and carbon isotopic record from a coral growing in Florida Bay: a 160 year record of climatic and anthropogenic influence. Palaeogeography, Palaeoclimatology, Palaeoecology, 123: 219-237.

Waite, A., 2011. Geochemical constraints into multi-decadal climate variability: Proxy reconstruction from long-lived Western Atalntic corals and sclerosponges, University of Miami, Miami, 225 pp.

Waite, A.J. et al., 2020. Observational and Model Evidence for an Important Role for Volcanic Forcing Driving Atlantic Multidecadal Variability Over the Last 600 Years. Geophysical Research Letters, 47(23): e2020GL089428.