COMPASS-FME: Early Successes in Data Synthesis and Modeling Analysis

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Project Abstract:
Tight coupling of models, model-derived hypotheses, observations, and experimentation is central to the COMPASS-FME approach to improving predictive understanding of coastal TAI processes. We designed and carried out a set of focused data syntheses, model analyses, uncertainty quantification exercises, and sensitivity analyses to inform where, when, and how to carry out early observation and experimentation elements of COMPASS-FME. These initial activities also helped us to clarify which process representations are lacking within current modeling frameworks, and at which spatial scales new process representations might need to be included to improve system-level prediction.

Our data synthesis work focused on areas in which models such as ELM-PFLOTRAN (used in a number of COMPASS-FME activities) tend to have prediction difficulties. These include (i) understanding how top-of-column CO2 flux is affected by changes in water availability and drainage; (ii) examining how seawater inundation alters vegetation dynamics, and the mechanisms driving these changes; (iii) quantifying water biogeochemistry and quality variation through time and space in the COMPASS-FME domain; and (iv) probing the degree to which coastal marsh plant production is driven by growing season phenology, tidal flooding, and species-specific effects. A final 'functional zonation' task focuses on spatial synthesis and inference and will be used to scale results and models across the project.

In the area of modeling analyses, we carried out two studies using the ELM-PFLOTRAN framework to quantify modeling uncertainty and parameter sensitivity for new representation of coastal wetland vegetation types, and subsurface biogeochemical processes. We used a coupled modeling approach that integrated vegetation, soil, microbial processes, and hydrology within the coastal TAI. We learned that both C3 and C4 plant types are both important to overall predictions, but that the vegetation parameterizations for the C4 types need greater focus to reduce uncertainty. We also identified a suite of vegetation processes which should be prioritized for further study, including controls on leaf phenology, controls on plant respiration, rates of mortality, and parameters influencing the decomposability of soil organic matter. Results from our modeling investigation of subsurface biogeochemistry showed that the redox dynamics of the coastal wetland sites can be captured reasonably well, and highlighted some new measurements that should be included at the COMPASS-FME sites.