# Water Mass Histories Modulate Reef Carbonate Chemistry: A High-Resolution Model for the Florida Keys

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Understanding how upstream benthic communities influence local carbonate chemistry on coral reefs is essential for predicting present-day stress exposure and anticipating escalating environmental stressors in the future, including ocean acidification. We developed a regional statistical modeling framework to predict site-level carbonate chemistry across coral reefs in the Florida Keys. This approach integrates the composition of the local benthic community, seawater connectivity between habitats, and source water chemistry. Using a SLIM 2D hydrodynamic model, we reconstructed water mass histories for 10 reef sites. These trajectories delineate the upstream areas traversed by water prior to sampling—spatial footprints we refer to as "flowsheds." By overlaying flowsheds with benthic habitat maps, we quantify the metabolic influence of upstream seagrass, calcifiers, and noncalcifying algae. This benthic context, combined with environmental parameters (light, temperature, salinity, chlorophyll-a, nitrate) and source water chemistry, informs predictive models of change in dissolved inorganic carbon (DIC) and total alkalinity (TA) at each reef. We use a sensitivity analysis to explore how changes in upstream habitat composition may influence downstream reef chemistry. This approach improves our ability to assess biogeochemical consequences of benthic change and informs scenario-based planning for habitat restoration and resilience in the Florida Keys.