A Testbed for Air-Sea CO_2 Exchange at the MVCO Air-Sea Interaction Tower (ASIT)

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Air–sea fluxes of carbon dioxide (CO_2) play a critical role in regulating Earth's climate and govern how much anthropogenic CO_2 the oceans absorb. While many estuarine and coastal environments are significant sources of atmospheric CO_2, the ocean as a whole acts as a carbon sink, taking up roughly a quarter of human emissions. However, there are still significant uncertainties in how these fluxes are parameterized with important implications for global climate models and emerging marine carbon dioxide removal (mCDR) strategies. These uncertainties arise primarily from difficulties in making direct and sustained measurements of CO_2 fluxes and the physical and biogeochemical process that drive them. **We are proposing to make sustained, continuous direct covariance (DC) measurements of air-sea CO_2 exchange at the Martha's Vineyard Coastal Observatory (MVCO) Air-Sea Interaction Tower (ASIT) along with an extensive suite of supporting physical and biochemical measurements.**
The cabled infrastructure at ASIT will enable continuous measurements for ~ 1 year to provide unprecedented temporal resolution of CO_2 flux ranging from hours to seasons. These direct flux observations will be complemented by concurrent measurements of wind stress, latent and sensible heat fluxes, solar and IR radiative fluxes, rainfall, net heat flux, SST, sea-state (including wave statistics and qualitative information about wave-breaking), current profiles, air and ocean-side CO_2 concentrations, *pH*, O_2, temperature, salinity and chlorophyll fluorescence. The goal is to provide a more complete understanding of the physical and biogeochemical processes that ultimately drive air-sea gas exchange. A primary hypothesis of the proposed research is that sea state, and specifically surface wave breaking and bubble mediated gas exchange, fundamentally control CO_2 flux and explain the significant differences between parameterizations derived from open ocean versus more sheltered environments. In addition to addressing our direct science hypotheses, the proposed research will provide significant opportunities for collaborations on a range of both basic and applied research questions related to marine carbon cycling and sequestration. Our proposed activities are synergistic with all currently funded OVSV projects and will establish ASIT as a testbed to develop new sensors for carbon cycle research, evaluate existing biogeochemical sensors, and validate mCDR strategies. A broader goal of this proposal is to establish the MVCO/ASIT as a premier location for carbon-based marine research by showcasing its unique capabilities to support long-term continuous measurements spanning the air-sea interface.