# A Novel Approach on Determining Oceanic Carbonate System Parameters Through Machine Learning and Remote Sensing

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Monitoring the global distribution and long-term series changes of the various oceanic carbonate parameters (e.g. pH, total alkalinity (TA), dissolved inorganic carbon (DIC), fugacity of CO2 (fCO2), partial pressure of CO2 (pCO2), and aragonite saturation state (Ωar)) is critical to understanding ocean acidification, marine ecology and environment alterations arising from global climate change. Current determination of these parameters relies on measurements and modeling from in situ water sampling using research vessels, which is expensive, time-consuming, and releases large amounts of CO2 which ironically contributes to climate change. In this study, a novel oceanic carbonate parameter determination approach through remote sensing and machine learning (ML) is proposed. Satellite-derived latitude (LAT), longitude (LON), chlorophyll-a (Chla), sea surface temperature (SST) and mixed layer depth (MLD) data from 2002-2020 were used as model inputs to four machine learning (ML) models: Random Forest (RF), K-Nearest Neighbors (KNN), Voting Regression (VR), and Linear Regression (LR), which were then evaluated by modeled oceanic carbonate parameters derived from in situ measurements. Before training, satellite data was interpolated and resampled to a spatial resolution of 1 deg x 1 deg using the Climate Data Operator software. Across all ML models, VR performed best, achieving coefficient of determination (R2) > 0.96 and mean absolute percentage error (MAPE) < 0.021 for Ωar, TA, and DIC, as well as achieving R2 > 0.79 and MAPE < 0.029 for pH, fCO2, and pCO2. This approach represents a time-efficient, cost-effective, green, and high spatiotemporal-resolution alternative to current in situ-based oceanic carbonate parameter determination methods.