

A Novel Method of Predicting Ocean pCO₂ Using a Polynomial Model

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Understanding pCO₂ is essential for assessing the ocean's role in the global carbon cycle. However, in many current methods for predicting pCO₂, satellite-derived measurements for regional waters are often inferred, leading to inaccurate predictions. Commonly-used variables such as temperature, salinity, and chlorophyll biomass don't account for the long-term pCO₂ trend or other unmeasurable factors influencing pCO₂. This study introduces a Taylor polynomial-inspired model to predict pCO₂ using temperature and time-dependent variables. The model's novelty lies in its usage of time-dependent variables that capture unknown and unmeasurable seasonal factors affecting pCO₂ at specific locations while reflecting the long-term pCO₂ increase. Historic temperature and pCO₂ measurements from 40 buoy stations located worldwide provided the basis for model training. The model offers an interpretable alternative to complex machine learning models, capturing the general pCO₂ trend with a smooth curve from the highly variable data. It is able to detect unique cyclical, seasonal cycles of pCO₂ worldwide, essential for understanding the pCO₂ cycles that could affect local industries and marine life. The model also captures long-term pCO₂ trends years earlier than NOAA predictions, proving critical in early prevention of ocean acidification. The R² improvement of 0.27 and RMSE improvement of 10.04 μatm in pCO₂ predictions demonstrate the model's ability to identify short and long-term fluctuations. Furthermore, the model is cost-efficient as it relies on available data, avoids the computational expenses of complex machine learning approaches, and provides smooth, interpretable predictions, making it an affordable and accessible solution for pCO₂ forecasting.

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