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 R^2 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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