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Estimates of Single Sensor Error Statistics for the MODIS Matchup Database Using Machine Learning

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Abstract Text:

Sea surface temperature (SST) is a fundamental quantity for understanding weather and climate dynamics. Although sensors aboard satellites provide global and repeated SST coverage, a characterization of SST precision and bias is necessary for determining the suitability of SST retrievals in various applications. Guidance on how to derive meaningful error estimates is still being developed. Previous methods estimated retrieval uncertainty based on geophysical factors, e.g. season or “wet” and “dry” atmospheres, but the discrete nature of these bins led to spatial discontinuities in SST maps. Recently, a new approach clustered retrievals based on the terms (excluding offset) in the statistical algorithm used to estimate SST. This approach resulted in over 600 clusters - too many to understand the geophysical conditions that influence retrieval error. Using MODIS and buoy SST matchups (2002 - 2016), we use machine learning algorithms (recursive and conditional trees, random forests) to gain insight into geophysical conditions leading to the different signs and magnitudes of MODIS SST residuals (satellite SSTs minus buoy SSTs). MODIS retrievals were first split into three categories: < -0.4 C, -0.4 C ≤ residual ≤ 0.4 C, and > 0.4 C. These categories are heavily unbalanced, with residuals > 0.4 C being much less frequent. Performance of classification algorithms is affected by imbalance, thus we tested various rebalancing algorithms (oversampling, undersampling, combinations of the two). We consider multiple features for the decision tree algorithms: regressors from the MODIS SST algorithm, proxies for temperature deficit, and spatial homogeneity of brightness temperatures (BTs), e.g., the range of 11 μm BTs inside a 25 km^2 area centered on the buoy location. These features and a rebalancing of classes led to an 81.9% accuracy when classifying SST retrievals into the < -0.4 C and -0.4 C ≤ residual ≤ 0.4 C categories. Spatial homogeneity in BTs consistently appears as a very important variable for classification, suggesting that unidentified cloud contamination still is one of the causes leading to negative SST residuals. Precision and accuracy of error estimates from our decision tree classifier are enhanced using this knowledge.

Session Selection:
Taking the temperature of the Earth: challenges, trends, and applications across all Earth surface domains

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