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Machine Learning based Precipitation Types Classification from GEO Satellite Observations: Diagnostic Model

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The high spatial, temporal, and spectral resolutions from the new generation of GEO satellites provide opportunities to map precipitation more accurately and enhance our understanding of precipitation processes. The research question addressed in this study is: Which predictors derived from satellite observations are significant in estimating the occurrence of a given precipitation process? Several indices from the Advanced Baseline Imager (ABI) sensor onboard the Geostationary Observing Environmental Satellite (GOES)-16 are derived and matched with surface precipitation types from the Ground Validation Multi-Radar/Multi-Sensor (GV-MRMS) system across the conterminous United States (CONUS). A machine learning (ML) based Random Forest (RF) classification is developed with several categories of predictors, such as ABI brightness temperatures (T_b) from five channels, spectral channel differences and textures, and environmental variables from the Rapid Refresh numerical forecast model (NWP).

The developed RF model displays overall classification accuracy of around 75%. Investigating the model shows that the absence of precipitation (no-precipitation) and convective types are better detected using GOES-16 derived predictors, while the detection of stratiform types is better with the NWP predictors. Simple T_bs detect no-precipitation and hail types correctly, whereas T_b textures contribute to the classification accuracy of warm stratiform and convective precipitation types. The accuracy of all precipitation types identification significantly improved with the addition of NWP predictors along with GOES-16 derived predictors. Overall, the analysis provided new insights on the monitoring of precipitation with GEO satellites and showed novel ways to diagnose ML models.