Enhancing hailstorm assessments over Brazil: XGBoost-Based Classification of Convective Storms using GOES-16 ABI data

04. How will AI/ML and Cloud base systems accelerate the use of satellite data

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This study presents an enhanced assessment of operational hailfall risk in Brazil, with a focus on maintaining physical interpretability and leveraging the satellite data available. Firstly, a spatialite database was built by tracking convective storms associated with hailfall through the clean-window channel of the Advanced Baseline Imager (ABI) on the GOES-16 satellite. For each storm polygon, we have extracted critical features such as the minimum brightness temperature, mean, standard deviation, and dynamic behaviors (spontaneous generation, continuity, split, and merge). Our analysis currently includes an expanded dataset from over 14,000 hailstorm reports across Brazil from June 2018 to September 2023, enabling the tracking of more than 11,000 storm cells associated with those reports. The introduction of a deeper feature analysis has unveiled new insights into the temporal and spatial variability of hailstorm characteristics detectable from the GOES-16 ABI bands. These variations across different times of the year and regions within Brazil underscore the complex nature of hailstorm development and its dependency on local atmospheric conditions. By integrating these findings, our ensemble of gradient boosted trees classifiers has achieved a 90% precision rate in detecting positive hailstorm cases, with an overall accuracy of 87%. Furthermore, we employ Shapley Additive Values analysis to explore the model's parameters, offering a deeper understanding of the influential features for hailstorm prediction. This approach not only strengthens the model's interpretability but also assures the physical consistency of our findings. The operational capabilities of our study are augmented by evaluating the algorithm's proficiency in hailstorm detection using legacy data from a prior generation of the GOES Satellite IMAGER sensor, affirming its above-average performance and suitability for long-term studies. By incorporating these novel insights into hailstorm dynamics, our research provides a robust tool for real-time risk assessment. It also expands the applicability of the algorithm to a broader meteorological context, paving the way for future studies on hailstorm predictability and risk mitigation in Brazil.