Designing and Evaluating NASA SPoRT Center's DustTracker-AI Model for Detecting Dust in NASA/NOAA Geostationary Satellite Imagery

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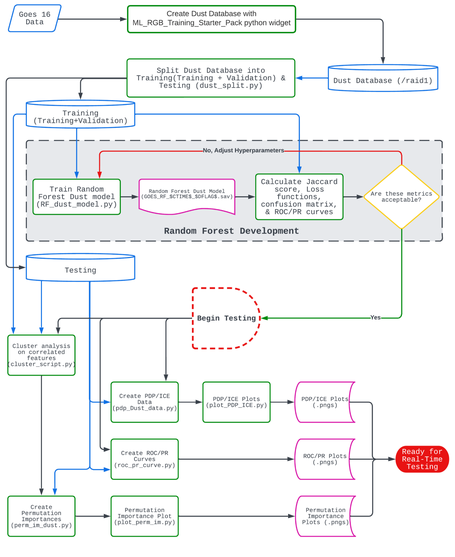
INTRODUCTION

- Near real-time identification of airborne dust in satellite imagery is important for mitigating the adverse effects of dust storms on human activities.
- False color Red-Green-Blue (RGB) imagery has been used for dust detection, but it has limitations and can be difficult to interpret.
- The NASA Short-term Research and Transition (SPoRT) center has developed a night-time dust detection random forest (NT-DustTracker-AI, Berndt et al. 2021) model using NASA/NOAA Geostationary Operational Environmental Satellite-16 (GOES-16) Advanced Baseline Imager (ABI) infrared imagery as inputs.
- The SPoRT center has partnered with the NOAA National Weather Service to evaluate the model for use in weather forecasting operations, and preliminary results have been positive.
- The SPoRT center has expanded the model to cover both day and night, continuing to use infrared imagery as inputs. This new model, known as DustTracker-AI, has shown good agreement with available dust observations.

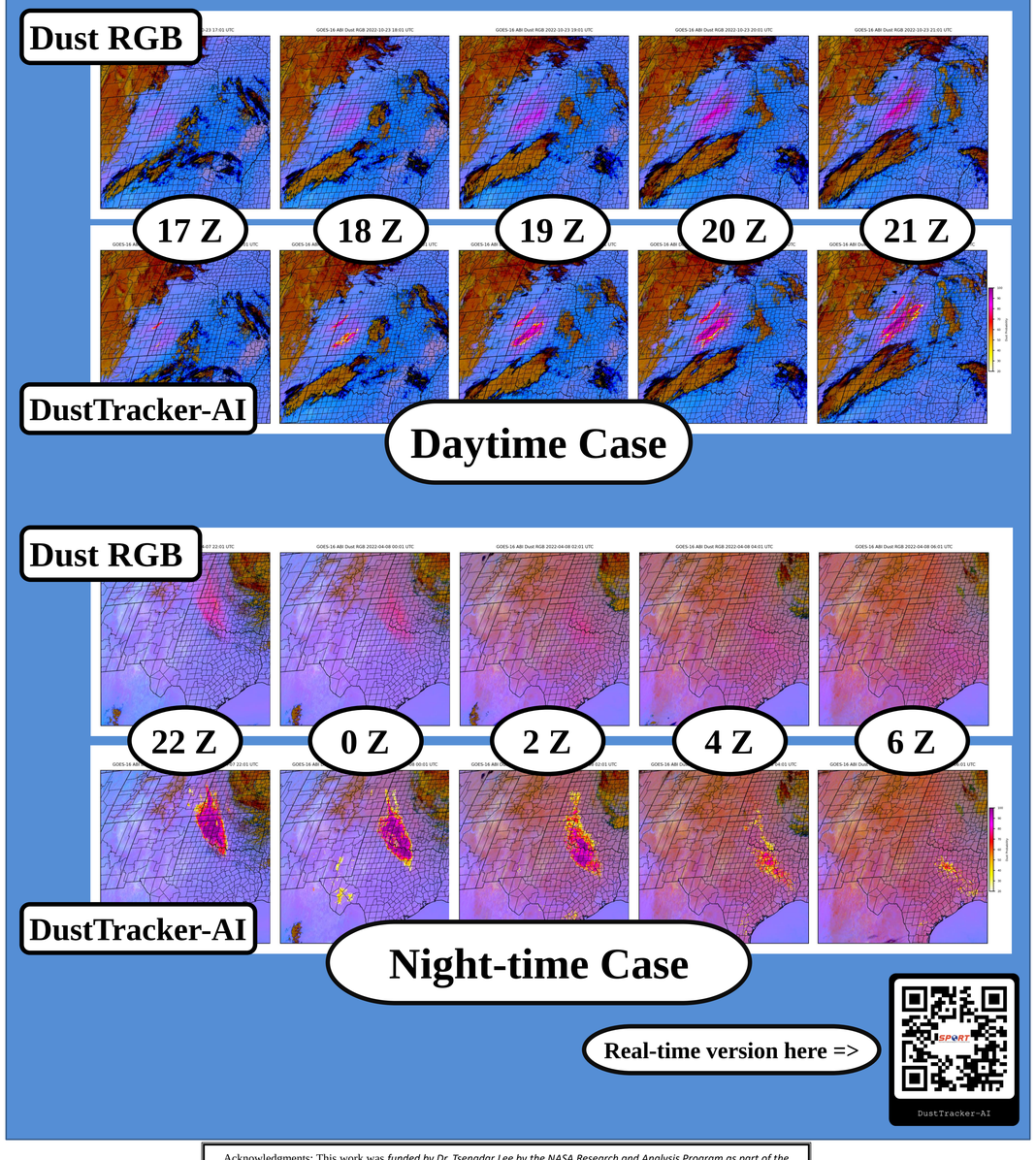
METHODS

Development of the DustTracker-AI model:

- Inputs: GOES-16 ABI data, specifically the IR bands, select band differences, and dust red, green, and blue components from March 2017 – April 2021
  - 66 cases, 212 distinct images covering a SW U.S. domain.
  - Cases randomly split into training (60%), validation (20%), and testing (20%) while maintaining equal temporal distribution.
- Dust database created using domain experts to identify areas of dust in the GOES-16 ABI Dust RGB. These areas are used as "truth" labels in training the DustTracker-AI model.

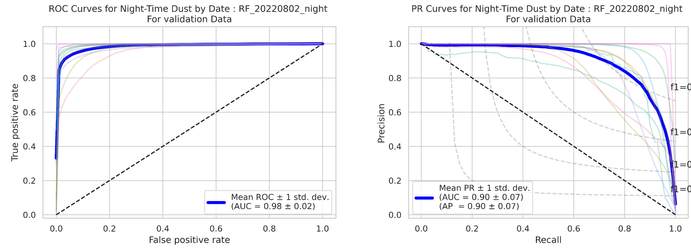


Preliminary results demonstrate SPoRT's DustTracker-AI ability to accurately classify dust throughout the day and night in the southwest United States.

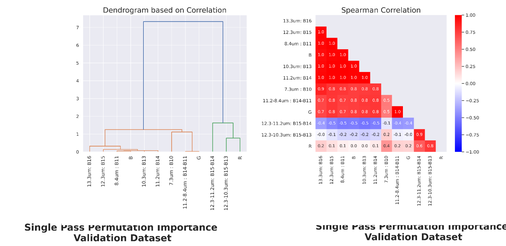


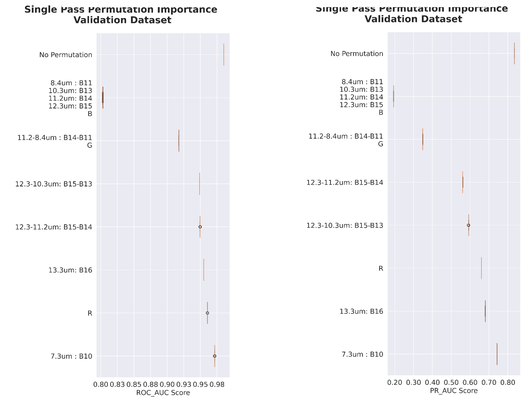
VALIDATION

- We validated the updated model with similar techniques to Berndt et al., 2021.
- Both the ROC and PR curves have AUC >= 0.9



- In addition to calculating validation metrics, we analyzed which features are most important to DustTracker-AI. We used a single pass permutation importance technique adjusted for highly correlated variables.





SUMMARY/FUTURE WORK

Overall, the new DustTracker-AI product, with added day-time cases, classifies dust events accurately with similar metrics to NT-DustTracker-AI in Berndt et al. 2021. With the combination of the Dust RGB product, DustTracker-AI adds confidence to end-users. However, there are still limitations to this product such as thin dust lofted by thunderstorm outflow and false alarms associated with sun angle. DustTracker-AI struggles to correctly classify this type of dust.

The future of the DustTracker-AI model will be to:

- Expand training dataset with new unique dust cases such as storm outflow dust and false alarams.
- Test other spatial domains globally.

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