# On the discrimination between volcanic ash and desert dust leveraging photometer and depolarization lidar measurements

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This study investigates the potential for automated discrimination between volcanic ash and desert dust aerosols using AERONET (Aerosol Robotic Network) sun photometer data, in support of EARLINET (European Aerosol Research Lidar Network) lidar measurements. The motivation stems from the challenge that both ash and dust exhibit similar optical signatures in atmospheric lidar signals, in fact they are treated as the same type in most automatic aerosol typing techniques, complicating real-time identification during volcanic events. A curated dataset was compiled, including ash-dominated observations from the 2010 Eyjafjallajökull and the 2021 La Palma eruptions and dust-dominated cases from Potenza, in Italy. A set of key optical and microphysical properties, such as single scattering albedo, complex refractive index (real and imaginary parts), absorption Ångström exponent, and coarse-mode radius, was used to train and evaluate several machine learning classifiers. Among these, logistic regression and random forest achieved the best balance between interpretability and accuracy, both exceeding 85% F1 scores (i.e., predictive performance) with strong recall on the ash class. The trained classifier is further tested against a pre-classified EARLINET/AERONET dataset, including only dust observations, demonstrating a solid foundation for at least non heavily polluted sites. This approach provides a promising avenue for integrating sun photometer data into aerosol typing frameworks and offers insights into the most discriminative spectral features separating ash from dust.

**Keywords: aerosol typing, desert dust, volcanic ash, machine learning, aviation**