ORACLES field campaign observations of clouds and aerosols above cloud by the Research Scanning Polarimeter

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Radiative forcing due to aerosols and clouds are a large source of climate uncertainty, in part due to the difficulty of obtaining accurate observations. It is especially difficult to observe aerosols above clouds, a situation that occurs frequently in some parts of the world, with poorly understood impacts. The NASA ORACLES (ObseRvations of Aerosols above CLouds and their intEractionS) field campaign was devoted to reducing this uncertainty, by deploying instrumented aircraft to the South East Atlantic Ocean in the Austral spring of 2016, 2017 and 2018 [1]. We will discuss observations made by the Research Scanning Polarimeter (RSP), a highly accurate multi-angle polarimetric scanner, and machine learning (neural network, NN) algorithms we are developing for the retrieval of cloud and aerosol properties. Our first step was to establish the retrieval scheme for cloud properties only, since those results can be verified with standard RSP cloud products [2,3]. The NN training was based on simulated RSP total and polarized radiances for a variety of cloud conditions. Based on these results, and inspired by recent developments in NN techniques, we created a refined algorithm for a wider range of conditions, and verified that this methodology is successful for the RSP [4]. Most recently, we have created the training set and began initial algorithm design for a simultaneous (aerosol and cloud) retrieval of aerosols above clouds. This is the ultimate objective of this project, as it utilizes the computational efficiency provided by machine learning techniques. We also discovered that machine learning techniques, since they make no prior physical assumptions, are an effective means to explore those assumptions as they become convolved with the physical realities of observation.

References

[1] https://espo.nasa.gov/ORACLES/content/ORACLES
[2] Alexandrov, M. D., B. Cairns, C. Emde, A. S. Ackerman, and B. van Diedenhoven, 2012: Accuracy assessments of cloud droplet size retrievals from polarized reflectance measurements by the research scanning polarimeter. *Remote Sens. Environ.* **125**, 92–111.
[3] Segal-Rozenhaimer, M., D. J, Miller, K. Knobelspiesse, J. Redemann, B. Cairns, and M. D. Alexandrov, 2018. Development of neural network retrievals of liquid cloud properties from multi-angle polarimetric observations. *J. Quant. Spectrosc. Radiat. Transf.* **220**, 39–51.
[4] Miller, D. J., M. Segal-Rozenhaimer, K. Knobelspiesse, J. Redemann, M. D. Alexandrov, B. Cairns,

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