

Estimating the position of polarization neutral points with a polarized Cimel sun photometer

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When viewing the atmosphere with a polarimetric instrument, it is possible to observe four neutral points (which have a zero, or near zero, degree of polarization). These phenomena occur due to the additive polarization effects of multiple scattering in the atmosphere and from the ground/ocean balancing with the polarization pattern due to Rayleigh scattering. The position of the neutral points depends on several factors, including the position of the Sun, the aerosol conditions in the atmosphere, surface reflectance, and the observation wavelengths [1-3]. Recent work has illustrated the potential use of neutral points in navigation [2] and atmospheric turbidity studies [3], but more data collection is needed to improve our understanding of how these factors can change the neutral point position.

In this work, we explored the potential to use the data from polarized Cimel sun photometers (CE318-TP9) deployed in the AERosol RObotic NETwork (AERONET) to estimate the positions of neutral points. The wide availability of AERONET data recorded with different surface reflectance and aerosol conditions could provide new insights into the relationship between these factors and the neutral point position. We analyzed the data recorded during polarized principal plane scans from AERONET sites in multiple continents. This scan sequence records measurements in 5° steps from horizon to zenith to horizon in the solar principal plane. We estimated neutral point positions by finding zero-crossings in the signed degree of linear polarization vs scattering angle curves. In this talk, we discuss this estimation method and compare the results with simultaneous images of the atmosphere from a hyperspectral polarimeter.

References

- [1] C. Bellver, “Influence of particulate pollution on the positions of neutral points in the sky at Seville (Spain),” *Atmospheric Environment*, **21**(3), 699–702 (1967), doi:10.1016/0004-6981(87)90051-5.
- [2] G. Li, Y. Zhang, S. Fan, Y. Wang and F. Yu, “Robust Heading Measurement Based on Improved Berry Model for Bionic Polarization Navigation,” *IEEE Trans. Instrum. Meas.*, **72**, 1-11 (2023), doi: 10.1109/TIM.2022.3225030.
- [3] C. M. DeLeon, W. R. Espinosa, Y. Long, J. A. Shaw, M. Kupinski, “Observing and simulating the polarization neutral point dependence on atmospheric turbidity,” *Proc. SPIE 13615, Polarization Science and Remote Sensing XII*, 1361505 (2025), doi: doi.org/10.1117/12.3062931.

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