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Combining in-situ measurements with GRASP retrievals – towards complete extinction profiles

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We developed a new method for creating complete vertical profiles of aerosol extinction. The approach combines remote, in-situ, and airborne measurements to generate comprehensive profiles of aerosol extinction that account for coarse and fine aerosol modes separately. The GRASP Open aerosol retrieval algorithm is used in conjunction with remote LIDAR and sunphotometer data to estimate aerosol extinction profiles within the LIDAR's range. Ground-based in-situ measurements of particle size distribution are then used to calculate coarse and fine aerosol extinction coefficients with the help of Mie theory. Additional information on vertical aerosol variability near the surface is obtained by including UAV-based observations with optical particle counters. The profiles are completed using an analytical interpolation technique that is optimized to generate smooth and continuous extinction profiles throughout the troposphere, which are consistent with columnar aerosol optical depth measurements.

The study demonstrates the feasibility of generating accurate and calibrated aerosol extinction profiles using the proposed method, as shown by the case studies conducted at a Central European background station [1]. The researchers performed data-denial experiments to confirm that the inclusion of UAV-based measurements enhances the accuracy of the reconstructions by providing crucial information on aerosol profiles near the ground. The proposed method is potentially useful for studies of aerosol concentration and evolution in regions with significant pollution near the surface, such as many highly industrialized areas in central and southern Poland.

Overall, the new methodology seems to be a potent tool for generating comprehensive aerosol extinction profiles. However, the limited number of studied test cases prohibits us from drawing broader conclusions on the method's usefulness in varying meteorological, orographic and pollution conditions. Additional studies and fine-tuning is still required for better understanding of the method's strengths and drawbacks.

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Keywords: multi-instrumental aerosol measurements, atmospheric aerosol, extinction profile; aerosol optical depth, UAV

References

[1] Szkop, A.; Fernandes, A.; Pietruczuk, A. Towards a Multi-Instrumental Approach to Closing Aerosol Optical Extinction Profiles. Atmosphere 2022, 13, 1443. https://doi.org/10.3390/atmos13091443