Appendix A

Systematic review methodology

To review the state of the art of aerosol studies in urban areas using depolarization lidar systems, we followed a systematic-review methodology based on Siddaway (2019) [39]. Since this M.Sc. thesis is the first lidar-related work developed in the Environmental Optics research line of Universidad EAFIT's Applied Optics group, this manuscript is intended to be used as a reference for introducing new students to the topic. For this reason, the state-of-the-art methodology is described in detail below.

Scoping

In the first stage of the systematic review we formulated a clear, specific, and answerable research question: How to characterize urban aerosols using depolarization lidar systems? We examined only a tight research area in order to make the review simpler, faster and easier; therefore we limited the review to studies of urban aerosols that used the depolarization lidar technique. In the second step we sought for previous systematic reviews of our research question, or one related. We found that literature reviews about depolarization lidar systems have been done in the past, however, these are not systematic and are not up to date.

Planning

In the second stage, we broke the research question down into individual concepts to create search terms, which helped find as many potentially relevant articles to include as

possible in the next stages. The aim was to conduct an exhaustive and thus representative search of all the previous studies on the topic of interest, having a balance between sensitivity (number of relevant works found) and specificity (relevant articles). The search terms used were: «(de)polariz(s)ation lidar», «urban/anthropogenic aerosols», and «characterization».

Afterward, we formulated preliminary and objective inclusion/exclusion criteria based on the knowledge of the field. These criteria were applied in the initial stages of the literature searching and sifting processes. The preliminary inclusion criteria were:

- Peer-reviewed papers.

- Depolarization lidar for **aerosol** studies.

- Measurements performed in **urban** areas, preferably on **valley** zones.

- Aerosol **characterization** using the **linear depolarization ratio**.

- Report of calibration and signal processing techniques.

- Time frame: 2000 – 2020.

Identification (searching)

In the third stage, we used the search terms in three different databases (ScienceDirect, SpringerLink, and IEEEXplore), which we considered are relevant to the area and we could access through the University's subscription. We also performed the search on three of the EGU (European Geosciences Union) open access peer-reviewed journals. The objective was to find as many available published works which addressed the research question as possible, operationalized through the defined search terms. After carefully examining the results of a first search, we determined that the time frame used in the inclusion/exclusion criteria was not appropriate, so we adjusted it to papers published between 2010 and 2021.

In ScienceDirect, we used the search equation «"polarization lidar" OR "depolarization lidar" OR "polarisation lidar" AND "aerosol" AND "urban"» and found 166 works published between 2010 and 2021. After examining the subject areas and reading all the titles, only 64 that seemed to fit the inclusion/exclusion criteria were selected for the screening stage. In SpringerLink, we used the search equation «depolarization, AND lidar, AND aerosol, AND urban», finding a total of 75 works: 47 papers, 27 chapters of books, 7 conference papers, and 1 reference work entry. We discarded the chapters of books and the reference work entry since those works didn't fit the "peer-reviewed papers" criterion. After reading the titles, 31 of the 47 articles and 0 of the 7 conference papers were selected for the next stage. Finally, in the IEEEXplore database we used the search equation «(("All Metadata":depolarization) AND "All Metadata":lidar)», finding 11 articles and 10 conference papers, which were discarded.

The three EGU journals selected were Atmospheric Measurement Techniques (AMT), Atmospheric Chemistry and Physics (ACP) and Geoscientific Instrumentation, Methods and Data Systems (GI). In these three journals we searched for lidar-related works published between 2010 and 2021. In ATM, we found 249 articles, 21 of which that seemed to fit the inclusion/exclusion criteria were selected for the screening stage. In ACP, we got 180 search results, but only 16 papers were included for the next stage. Finally, in GI we only found 1 search result, which we included for further screening.

Screening

After the 144 relevant articles were identified, we exported the references to Mendeley in order to collate the search results. Thereafter, we proceeded to read the title and abstract of all the relevant works found to see which ones fully met the inclusion criteria. Out of the 144 articles, only 14 whose title and abstract suggested that the article was potentially eligible for inclusion in the state of the art were carefully read in the last stage of the systematic review, and are presented in the results section of this report.

Eligibility

In the final step of the systematic review, the focus shifted from sensitivity to specificity, so we carefully made sure potentially eligible articles were indeed relevant and appropriate for being included in the state of the art. We sifted the full-text version of the 14 potentially eligible articles to check that each one was indeed suitable for being included. The reading was focused on whether or not each published work met the inclusion/exclusion criteria. Articles finally identified for inclusion, were carefully and thoroughly read to extract all the relevant information. The extracted information is related to the inclusion/exclusion criteria and thus cover definition or conceptualization, measures/key variables, research design, participants, year of publication, data/results, study design, setting, etc.

A total of 14 original journal articles were selected for inclusion out of the 144 that used lidar system for studying atmospheric aerosols. The selected articles are presented in Table 3.1, organized from oldest to newest. The selected papers are temporally distributed like this: in 2012, 2015, and 2020 were published two; only one was published in 2013 and 2016; while six were published in 2017. Most of the studies were carried out in Asiatic countries (one in Japan and in Tajikistan, two in Korea, and six in China), two were performed in Europe (France and Germany), and one in South Africa.