

## ***Interactive comment on “The Aerosol Characterization from Polarimeter and Lidar (ACEPOL) airborne field campaign” by Kirk Knobelspiesse et al.***

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This paper is an overview of the ACEPOL airborne field campaign. Its purpose is to document ACEPOL's initial hypothesis, science objectives, atmospheric conditions, field deployment, airborne and ground-based instruments, and scientific outcomes. It is, for the most part, well structured, clear, and well-written. I consider the necessary revisions minor as they do not involve any extensive data analysis. However, others might consider them major as they are beyond the correction of a few typos. Overview publications of airborne field campaigns are unique and, in my opinion, very useful. I recommend this manuscript for publication only after the following comments and

C1

suggestions are addressed.

Overall comments . Data archive and availability should ideally be described in one place instead of many (e.g., in each instrument sections 3.1.1- 3.1.4 and section 3.4) . Consider adding a table of ACEPOL (and possibly PODEX) related papers (e.g., published, in review, in prep i.e. conferences or technical reports), instruments involved and the science objectives they mainly address . Section 2 (Objectives) should state and describe ACEPOL's objectives more clearly and describe how ACEPOL has addressed each one of them. . Consider explaining more clearly how ACEPOL differs from or complements PODEX . Consider describing ACEPOL vicarious calibration in more details and which instruments are concerned . Some figures need further description and analysis, especially the ones showing scientific results such as spectral AOD comparison, reflectance (e.g., Fig. 4, 8, 9) . As an illustration, consider showing Aerosol Optical Depths derived from AirMSPI, RSP and SPEX (in addition to AOD from AirHARP on Fig. 4)

Detailed comments Line 34 (and any other place in the manuscript): It should say HSRL-2 instead of HSRL2. Line 47: “While existing passive … (Mishchenko et al., 2004).” This statement could use more information. Line 55: “previous ocean color satellite instruments” could use some examples Line 74: CATS needs a reference, possibly McGill et al. [2015] McGill et al., 2015; McGill, M. J., J. E. Yorks, V. S. Scott, A. W. Kupchock, and P. A. Selmer (2015), The CloudAerosol Transport System (CATS): A technology demonstration on the International Space Station, Proc. SPIE 9612, Lidar Remote Sensing for Environmental Monitoring XV, 96120A, doi:10.1117/12.2190841. Line 87: replace “at” by “the” in “high altitude vantage point of at aircraft.” Line 87: consider replacing “perhaps” by “to our knowledge” Line 99: objectives are (i) test new observations systems, (ii) develop new algorithms, or (iii) validate orbital observations. Consider giving a subsection to each of these three objectives and provide more information. For example, current section 2.2. would fall under objective (iii). Section 2.1 describes how ACEPOL relates to ACE and PODEX.

C2

Consider including this in the introduction instead (giving it its own section outside of section 2). Line 101: "For that reason, a wide range of observation conditions were desired". Consider including examples of easy or challenging atmospheric conditions for specific MAPs or Lidars retrievals. Line 103: How were targets prioritized? Line 106: If the objectives are as general as "(i) test new observations systems, (ii) develop new algorithms, or (iii) validate orbital observations" (line 99), then BRDF, BPDF and ocean color algo. might still fall under (ii) and (iii)? Line 121: Consider listing MAPs and lidar(s) during PODEX. Were ACEPOL and PODEX designed to address the same science objectives? Were synergistic algorithm(s) involving MAPs and lidars not possible during PODEX? Why? Line 132: Can the authors add any publication, even in preparation, that will use ACEPOL data for a CALIOP/CATS validation effort? Line 133: Does SRON have different objectives than the overarching ones on Line 99 (albeit more specific to SPEX)? Is there a reason to single out SRON in the objective section? Section 2.3 seems redundant with section 5.4 (and possibly 5.5) Line 137: NASA PACE mission needs a description as soon as introduced (instead of on line 164) Line 146: Is there no published reference for AirHARP? Line 161: HARP CubeSat instrument needs a reference too, possibly Vanderlei et al. [2016]. J. Vanderlei Martins, "HARP: Hyper-Angular Rainbow Polarimeter CubeSat," ESTO Science and Technology Forum, June 14, 2016, URL: [https://esto.nasa.gov/forum/estf2016/PRESENTATIONS/Martins\\_A1P2\\_ESTF2016.pdf](https://esto.nasa.gov/forum/estf2016/PRESENTATIONS/Martins_A1P2_ESTF2016.pdf) "HARP Hyper-Angular Rainbow Polarimeter," USU/SDL, URL: <http://www.sdl.usu.edu/downloads/harp.pdf> Does it have a scheduled launch date? Consider adding a reference to section 5.2 here. Line 163: "will provide global coverage two days," I don't understand this statement. Line 170: AirHARP AOD seems to reach 1 at 440 nm on Fig. 4d. Can you describe this briefly and possibly how it compares to other MAPs? Line 172: Here "McBride et al., 2019" instead of "McBride et al., 2019 in preparation" on line 158. Line 174: consider discussing data availability for AirHARP? In Fu et al., 2020, it says "Note that aerosol retrievals from AirHARP measurements are not included in this paper because the data were not available when

### C3

performing the analysis presented here" Line 184: "see section 5.3" instead of section 6.3 Line 196: change to Fu et al. [2020] Fu, Guangliang, et al. "Aerosol retrievals from different polarimeters during the ACEPOL campaign using a common retrieval algorithm." (2020). Line 229: consider referring to section 3.4 for data availability and to Fu et al. [2020] (and any other publications I am missing) concerning RSP-ACEPOL specific analysis Line 248: "Fu et al., 2020" Line 279: "Muñller et al., Sawamura et al." need years. Another good reference for HSRL-2 might be Burton et al. [2018] Burton, S. P., et al. "Calibration of a high spectral resolution lidar using a Michelson interferometer, with data examples from ORACLES." Applied optics 57.21 (2018): 6061-6075. Line 281: correct to "extinction" instead of "depolarization" at 355nm (i.e., 3 beta + 2 alpha and depolarization at 3 wavelengths for HSRL-2 instead of 2 beta + 1 alpha and depolarization at 2 wavelengths for HSRL-1) Line 313: consider replacing "inversion products" by aerosol intensive properties (single scattering albedo, size distribution etc.). Line 322: should say aerodynamic diameter Line 324: should say "gaseous criteria for ..."? Line 334: consider describing "ACEPOL vicarious calibration efforts" and which remote sensing instrument this concerns. Line 339: consider adding a reference for "Reagan sunphotometer", possibly Bruegge et al., [1990] that describes this sunphotometer. This paper also references Shaw et al. [1973] Bruegge, Carol J., et al. "In-situ atmospheric water-vapor retrieval in support of AVIRIS validation." Imaging spectroscopy of the terrestrial environment. Vol. 1298. International Society for Optics and Photonics, 1990. Shaw, G.E., Reagan, J. A., and Herman, B. M. (1973), Investigations of atmospheric extinction using direct solar radiation measurements made with a multiple wavelength radiometer, J. Appl. Meteorol. 12:374-380. Line 349: The difference between Reagan and microtops AOD at specific wavelengths (Fig. 8) should be explained in the text Line 386: correct "Figure 10 Flight tracks for the ACEPOL field campaign.is a graphical illustration of ACEPOL flight tracks.". Also, "Details on the characteristics of each flight are in Table 4" seems to be a repeat of line 374 Line 388: consider explaining "somewhat unusual conditions" Line 391: "constrain observations by": consider specifying which airborne remote sensing instrument (or

### C4

algorithm) needs to be constrained Line 415: “test of retrieval capability”. Consider briefly reporting the results from Fu et al. [2020] or any other relevant publication as an example Line 425: consider more specifics on how ACEPOL data are used in the ACCP efforts (e.g., used to constrain canonical cases in theoretical studies or to attribute instrument specific uncertainties or to attribute scores to different candidate satellite architectures in respect to specific science objectives?) Line 441: consider adding any studies underway (i.e., studies that use ACEPOL-AirHARP to help HARP CubeSat design and algorithm) Line 445: MAIA will provide speciated PMs (said on Line 457). This is one step further from aerosol “typing”. Line 454: delete “total and” in “retrieve total and AOD” Line 457: “A geostatistical regression modeling framework will be used to transform column aerosol optical and microphysical properties to speciated, near-surface PM concentrations”. Consider possibly adding Kalashnikova et al. [2018] here and any other (more) relevant publication Kalashnikova, O. V., Garay, M. J., Bates, K. H., Kenseth, C. M., Kong, W., Cappa, C. D., et al. (2018). Photopolarimetric sensitivity to black carbon content of wildfire smoke: Results from the 2016 ImPACT-PM field campaign. *Journal of Geophysical Research: Atmospheres*, 123. <https://doi.org/10.1029/2017JD028032> Line 459: consider adding any studies underway (i.e., studies that use ACEPOL-AirMSPI to help MAIA design and algorithm) Line 472: Fu et al. [2020] Line 475: is this still happening in May 2020 (under COVID-19)? Line 476: MAMAP and NanoCarb need to be introduced and described Line 478: consider describing how ACEPOL-related airSPEX data will help those upcoming deployments as Section 5 is about “value (of ACEPOL) for future missions” Conclusion: please consider re-stating the ACEPOL objectives and how they were addressed, as well as recapping the value of ACEPOL in future missions (e.g., PACE, MAIA, HARP CubeSat, ACCP) Figure 4d: “tau” should be “AOD” next to the color bar. Figure 8: What does “Junge” stand for? Also the difference between Reagan and microtops AOD at specific wavelengths should be explained in the text Figure 9: What does “HDRF” stand for?

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C5

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C6