A review of “A global survey of aerosol-liquid water cloud overlap based on four years of CALIPSO-CALIOP data” by A. Devasthale and M. A. Thomas

This paper presents an analysis of CALIPSO lidar data to determine the frequency and vertical structure of events where aerosol layers are present above cloud. This information is of considerable importance in improving the estimates of both aerosol direct and indirect effects, as well as better understanding potential biases in retrievals of cloud properties from passive satellite sensors.
Unfortunately, although the statistics present in the paper are interesting and certainly reaffirm the potential importance in aerosol-over-cloud situations, the authors haven't taken full advantage of the data provided by CALIPSO, or presented their findings in a sufficiently clear and fluent way. I thus feel the paper should not be accepted for publication in Atmos. Chem. Phys. before the following concerns have been addressed by the authors.

General

- Surely the use of only those profiles which contain the highest detection confidence, for both cloud and aerosol layers, in determining the frequency of aerosol-over-cloud events will have a significant effect on this statistic. The authors acknowledge that their method will produce a conservative estimate, but I think “lower limit” would be a more accurate description. Given the importance of quantifying the frequency of aerosol-cloud overlap, I'm surprised the authors have not put more effort into coming up with a better estimate.
  I accept that using the only highest quality detections makes sense when calculating the vertical extent of the layers and their separation, but it seems counter productive in computing the overall frequency. At the very least, I think a comparison of the frequency of aerosol-over-cloud events based on all detections (both high and low confidence) and those with high confidence flags would provide some indication of the scale of underestimation which could be attributed to the difficulty in detecting all such events.
- The stated reason for investigating the geometrical thickness of the aerosol and cloud layers (pp22114) is that this parameter is also important in determining the radiative impact of the layers. This is true, but the optical thickness, which is included in the CALIPSO products used by the authors, is a much more direct measure of their radiative impact. Why have the authors not used this data (rather than, or in addition to, the geometrical thickness)? If the data is reliable, it should be used to address the authors' stated aims.
- I think the abstract is too long and presents too much detail of results of the paper.
- The plots presented in the paper are, in general, too small. Figures 1, 3 and 4 in particular have rather small global maps, with quite large, identical colour bars, surrounded by large areas of white space. The panels in figures 5, 6 and 7 are also very small, making it difficult to make out their details. It should be possible to improve the formatting to make the figures substantially clearer.
- Grammatically, the paper contains many errors. In particular, the use of the definite article “the” is poor and inconsistent. I've included many detailed grammatical corrections below, but the authors should have the paper carefully proof read before its final submission.
- The results section could do with more references when relating the observed variations in aerosol-cloud overlap frequency to the known transport of aerosols. For example, the transport of dust by the Somali jet and the transport of biomass burning aerosol over the Andes.

Specific corrections and suggestions

Each point below refers to a specific page and line number in the text:

pp22110,ln01: The first sentence isn't grammatically clear. I suggest replacing with “Simulating the radiative impacts of aerosols located above liquid water clouds presents a significant challenge” or similar.

pp22110,ln03: Replace “Particularly, absorbing” with “In particular, absorbing”

pp22110,ln05: Again, this sentence isn't well structured. I suggest replacing with “It is not possible to reliably obtain information on such overlap evens from existing passive satellite sensors” (The presence of CALIPSO doesn't mean the information from the passive sensors is suddenly improved)

pp22110,ln08: Delete “an”

pp22110,ln13: Insert “of” between “percentage” and “cases”

pp22110,ln14: I suggest moving the “(AAO case)” to before the coma and “b)”

pp22111,ln05: First sentence is not grammatically correct. I suggest “The last few years has seen intense research into both the direct and indirect radiative effects of aerosols”. Note that if the authors want to show that this research has spanned decades, the supporting references should extend back further than 2005.

pp22111,ln07-08: A wide range of aerosol-cloud radiative effects have been postulated, however, as I understand it, only a relatively few have been unambiguously observed.

pp22111,ln13: The sentence beginning “Many aspects are thought...” doesn't make sense.

pp22111,ln21: The authors should clarify what they mean by “the most complex situations are present in the atmosphere”: complex in what way? Do they mean difficult to model, difficult to measure, complex in terms of radiative or physical interaction between the aerosol and cloud?

pp22112,ln14: I suggest the end of the final sentence of point 3 is restructured to read “(MODIS), where potential climate monitoring capabilities demand high accuracy retrievals”

pp22114,ln03-04: I believe that it would be usual practice to not use the definite article (“the”) when referring to CALIPSO and CALIOP, unless the form “the CALIPSO satellite” and/or “the CALIOP instrument” are used.

pp22114,ln07: Insert “an” between “for” and “aerosol”.

pp22114,ln08: (also ln11) Sentence should read “... detected with the highest confidence”

pp22114,ln09: Replace “We then search if” with “We then check if”

pp22114,ln16: Replace “would give” with “gives a”

pp22114,ln20: Replace “we can also relate how closely they are present in the atmosphere” with “the vertical separation of the layers is also apparent”. The following sentence is also poor; replace with “The closer the distribution is centred along the 1-to-1 line of the joint histogram, the smaller is the vertical separation of the aerosol and cloud layers.”

pp22114,ln24: Replace “abilities” with “features”.

pp22115,ln01: Referencing the same paper (Omar et al., 2009) twice in successive sentences isn't necessary. Also, replace “While” with “By”. I also think it should be stated why separate statistics for smoke aerosol (as opposed to the other types identified by CALIOP) should be generated.

pp22115,ln05: Add a coma after “globally”

pp22115,ln06: Reword this sentence thus: “Since large scale circulation has a first-order impact on the transport of aerosol over the oceans,....”

pp22115,ln13: Insert “the” between “coasts of” and “North”.

pp22115,ln18: Insert a coma after the word “occur”.

pp22115,ln19: Reword the end of this sentence thus: “low level liquid clouds are common.”

pp22115,ln21: Replace “over to Southeast” with “over the South-East”

pp22115,ln28: The phrase “precisely capture these overlap events” doesn't make sense in this context. Reword this sentence thus: “The spatial patterns of overlap frequency and their seasonal variations are shown in Figs. 3 and 4.”

pp22116,ln01: Add “the” before all-aerosol-overlap. In general, all uses of “AAO case” and “SAO case” need to be preceded with “the”.

pp22116,ln04: Likewise, references to “JJA months” (etc) should be preceded by “the”. Alternatively, the DJF, MAM, JJA and SON acronyms could be used without the “months” suffix, which would negate the need for the leading “the”.

pp22116,ln04: Remove the reference to the figures in the brackets (these are already referenced in this paragraph).

pp22116,ln19: Replace “in high amounts” with “in large amounts”.

pp22116,ln24: Insert “the” before “Somali jet”.

pp22116,ln26: Insert “the” before “monsoon months”. The following sentence should be reworded thus: “The observed overlap by smoke aerosols is mostly off the western coast of Southern Africa,....”

pp22117,ln01: Insert “the” before “western coasts”

pp22117,ln14: Insert “the” before “bulk of”

pp22117,ln21: Replace “tendency that the” with “tendency for the”

pp22117,ln22: Replace “layers increases” with “layers to increase”

pp22117,ln26: The sentence beginning “The spatio-temporal variability” is written as a statement of indisputable fact without any justification. I suggest it be reworded to include a phrase like “can be attributed to”, or “we attribute this to”, so that it is clearly presented as the authors' own conclusion.

pp22118,ln02: Remove the “the” from before the words “nearby” and “large”.

pp22118,ln08: Remove the “the” from before “Fig. 5”

pp22118,ln09: The “the” before “intra-annual” isn't necessary.

pp22118,ln12: The authors state that the transport of biomass burning over the Andes to the Pacific Ocean is a likely source of the observed variability seen in the 0-30 South latitude band. A reference to a publication detailing observations of such transport (at globally significant levels) should be provided to support this claim.

pp22118,ln16: Replace “The northern hemispheric latitude band (i.e. 0-30N)” with “The 0-30N latitude band”.

pp22118,ln17: Remove the “the” from before “pure”

pp22118,ln26-28: These two sentences don't scan well and aren't necessary. The information provided by the percentage figures vague (70-80% for instance) and is presented as accurately, and far more elegantly, in figure 7. This information is again presented in the same format in the conclusion section (pp22119,ln25) – here I would again provide a reference back to figure 7.

pp22118,ln25: Add “the” before the words “poles” and “tropics”.

pp22119,ln06: Replace “extended on a” with “extended to a”.