

Interactive comment on “The albedo properties of four clean stratocumulus clouds studied during the VOCALS-REX field campaign” by B. Parkes et al.

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This article compares shortwave cloud albedo measured/derived from two different instruments making in-situ measurements on a research aircraft during the VOCALSREX field campaign, which sampled the stratocumulus clouds of the southeast Pacific. Its main contribution is to demonstrate that for solar zenith angles smaller than 65 degrees the delta-eddington method applied to aircraft measurements of effective radius and liquid water path has small errors compared to shortwave radiometric measurements, so microphysical aircraft measurements can be used to reasonably estimate cloud albedo. While this is a useful result, the paper needs major work on its clarity and specificity of

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its reasoning, justifications and purpose. For example, there is much emphasis placed on the result that the albedo derived from microphysical measurements works poorly for large solar zenith angles. But, this is a known consequence of using the delta-eddington method and not a novel finding. While these results possibly could be used to justify a more detailed look at albedo during VOCALS across more platforms, this work may serve better embedded within a more thorough paper. Nonetheless, with enough improvement to the argument flow and explanations other studies might cite this work, allowing them to justify their method succinctly. Cloud albedo is arguably one of the most important quantities to constrain with regard to stratocumulus, and is a key quantity in both model and observational studies. This paper needs to emphasize this more. I therefore recommend this paper be accepted with major revisions. More details regarding my concerns/suggestions are described below:

Although several VOCALS platforms are mentioned, this paper does not address which ones have shortwave radiometric measurements or CDP, so it is not clear whether albedo from microphysical measurements would add missing information to the VOCALS platforms. 1.1) It is not mentioned whether radiometric measurements are common on similar platforms. A) The SW radiometric measurements are collected in cloud on the BAe-146 aircraft as described section 2.2

1.2) The paper states the ability to calculate albedo from microphysical measurements 'enables a more detailed investigation of marine stratocumulus clouds,' but offers no explanation as to what this means. The motivation for the work needs to be clarified. A) The language used has been clarified and a redirection towards validation of the DE method using cloud from VOCALS has been done.

2) One of the main results of the paper is the range of solar zenith angles under which the cloud albedo derived from the Cloud Droplet Probe measurements using the delta-eddington method compares well with the shortwave radiometer measurements. This likely shouldn't be the main focus of the paper because it is already known that the delta-eddington method is subject to large errors at large solar zenith angles

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and in fact the introduction of this paper explains that this method “breaks down” when the cosine of the solar zenith angle is smaller than 0.4, or 66 degrees. On the other hand, the R2 value between the measured and derived albedo within acceptable solar zenith angles is a useful quantity for future reference. A) This has been done, as with comments from Reviewer 1, we now calculate the albedo from the DE method using two different assumptions and show the resultant R2 values.

3) Why are only clean clouds compared? The introduction refers to studies that found aerosol content affects cloud albedo, but in Section 2.2 it is not made clear why you would want to look at only clean clouds. In Section 2.3 it is mentioned that $g=0.85$ is used as it has been found in Twohy et al. (2005) to be appropriate for droplets in a clean environment. However in this paper, the ‘clean environment’ (phrase not used in Twohy et al., 2005) refers to the absence of significant amounts of absorbing soot particles which would affect the asymmetry parameter, not coastal sulfate. A) Nine clouds from six flights are now analysed and these include both clean and sulphate polluted environs.

4) The amount of sulfate aerosol that indicates ‘coastal pollution’ is not quantified clearly. A) This restriction is no longer applied to the data.

5) State briefly in abstract why you compare albedo measurements– what is the motivation? A) We compare albedo methods to validate the DE method in the case of the VOCALS-REX campaign.

6) The fact that the VOCALS-UK flew 13 research flights including investigations along 20S transects is good information for the introduction, but doesn’t seem necessary in the abstract, especially since all 13 flights are not used in the paper, and 20S is only referred to in the introduction. A) We have tidied up this section, we use flights from both polluted and 20S sections.

7) Introduction, line 20-22: mention that the list of measurement platforms involved in the campaign are aircraft and ships where applicable. “The campaign involved the

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NCAR C-130, . . .etc.” may confuse a reader unfamiliar with the campaign. A) We agree and have expanded this section giving descriptions of each platform.

8) Introduction, line 24-26: this appears to be an incomplete sentence. “Data from the . . .operated by the . . .” The abstract indicated that FAAM BAe-146 data is used, but this sentence fragment doesn’t make that clear in the introduction. A) The phrasing is a requirement of use of the FAAM data. We have altered what we can to improve the flow of the paragraph

9) What is the basis for the assumption that uncertainty in liquid water path assumed to be 10%? Also, the sentence that states this assumption may be missing a phrase: “The uncertainty in the liquid water path, both from the liquid water path and the relative. . .” A) The uncertainties have been recalculated for each value of the LWP. See section 2.3 for more details

10) The description of factors contributing to measurement uncertainties is thorough, though it isn’t clear in the paper how uncertainties from the various sources are combined. “The different uncertainties are combined using the standard methods for uncorrelated uncertainties based on Eqs. (1-3).” Although it isn’t necessary to show these methods in full detail, names and references of methods used would help readers who would like to reproduce your calculation of albedo from aircraft data. A) A detailed description of the uncertainties has been added in section 2.3

11) Although not explained, it seems that the cloud albedo compared is the cloud albedo at the level of the aircraft, rather than the top of cloud albedo typically used in albedo investigations. If this is true, explaining this may help clarify the choice of methodology for computing liquid water path based on cloud thickness below the aircraft and the shortwave radiometric albedo computation. A) The albedo is calculated from both methods in cloud and is now detailed in the manuscript.

12) The conclusions state cloud segments were chosen not only to be ‘clean,’ (with no reason given for this) but also to have ‘radiometric data with good satellite coverage,’

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but nowhere in the paper is satellite coverage mentioned nor is satellite data utilized. A comparison with satellite data would require more assumptions and calculations to consider albedo at the top of the cloud rather than at the level of aircraft measurement. A) The inclusion of satellite was a mistake and has been removed, as described above the clouds are no longer required to be 'clean'.

13) While Figs. 2 and 3 are interesting, more explanation regarding why you would compare measurements in this way and what you learn from it is necessary. The relationship seen between effective radius and albedo, and liquid water path and albedo are similar. This is of course similar to the relationship between optical depth and albedo. What is learned from this comparison? A) These comparisons were performed to validate the results with previous experiments. We have removed one result while retaining the effective radius plot which shows the variance in the effective radius in the flights observed.

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