

Responses to Reviewer #2

General Comments

This article provides basic information about VOCALS science goals/hypotheses (well stated) and summary of the participating observing systems and sampling strategies (pretty well done). Figures and Tables are pretty well done. The font size is too small in some cases.

We thank the reviewers for their constructive comments. We have attempted to increase the font size in figures where this may pose a problem with readability.

What is a bit surprising is that a basic meteorological summary was not provided, other than one sentence that I recall. Similarly, almost no samples of the unique VOCALS data that was acquired are shown, nor are any early science highlights/ results listed. This is pretty standard in such papers, especially given the time that has passed. Is there a companion paper that does this?

The decision was made to split off the meteorological description into a separate paper. This paper is nearing completion and will be submitted to ACP shortly.

In addition, the decision was made NOT to include science results in this paper. We agree that this is not the standard procedure, but I have been frustrated with some of the overview papers I have seen thatn either describe the sampling nor give a very good picture of the scientific results. We believe that for a big project like VOCALS, a resource such as this paper (which is admittedly rather dry) will serve a useful purpose of documenting what was done, and will cut down the need for repetitious discussions of observational sampling methodology in subsequent scientific papers so that such papers can focus somewhat unhindered on the key scientific results.

Except for brief summary of various trajectory model calculations, the modeling component of VOCALS is not described.

This was also pointed out by both of the other reviewers, and has now been corrected, since we now include a description of the associated modeling work.

Science Issues

20773, 9: The statement that “Aerosol effects on warm clouds are poorly understood” seems inaccurate. Much has been learned about this issue in the 35 years since Twomey first published on this topic. While understanding can definitely be further improved, we know a lot and “poorly” exaggerates the state of affairs when applied so globally to warm clouds.

We have attempted to make it clearer (albeit in a succinct way given the focus here) in the revised manuscript why aerosol effects on warm clouds remain poorly understood and modeled in large scale models. The statement has been revised to *“Aerosol indirect effects on warm clouds remain poorly treated in large scale numerical models (Lohmann and Feichter 2005), chiefly because the overall impact of aerosols on cloud radiative properties depends upon numerous complex small scale and mesoscale dynamical responses which result in macrophysical cloud changes (Stevens and Feingold 2009).*

20774, 1-5: This statement doesn't seem well supported by the cited paper which states that "We hypothesize that these fluctuations in droplet concentration are a result of the large scale meteorology and their correlation with cloud macrophysical properties should not be used as evidence of aerosol effects." So, maybe the statement is not unreasonable as regards the magnitude of the effect, and potential consequences (following sentence), but would be more congruous if corresponded to the main conclusion of that paper.

The causes of the spatial and temporal variability in cloud *macrophysical* properties may well be associated with the large scale meteorology which also drives to some extent the spatial and temporal variability of the aerosols. The statement we make on page 20774, 1-5 is not concerned with *macrophysical* effects (i.e. influences on cloud cover, thickness etc.), so I don't understand the reviewer's argument that the statement is not supported by the cited paper. The cited paper is where the numerical values originate, hence the citation. Nevertheless, since the statement caused confusion, we have attempted to modify it to the following:

"In the absence of cloud macrophysical responses, the reduced droplet effective radii resulting from increased concentrations of cloud droplets would increase the reflected solar radiation, and estimates of the component of the TOA solar radiation due to geographic variability in effective radius alone are $\sim 10\text{--}20\text{ W m}^{-2}$ or 20–40% of the mean reflected shortwave (George and Wood, 2010). The magnitude of these estimates is such that the indirect effects of aerosols on clouds could lead to significant decreases in the amount of solar radiation entering the ocean, with significant implications for the ocean heat budget. However, we do not yet fully understand the controls on cloud droplet concentration in the MBL, and it is possible that meteorological controls (e.g. precipitation sinks) in addition to aerosol sources may play a significant role. Further, we are beginning to understand that cloud responses to aerosols are not solely due to the Twomey effect alone, and that fast feedbacks can both enhance and counteract the Twomey effect (e.g. Ackerman et al., 2004; Wood 2007; Xue et al., 2008)."

20774, At 4 occurrences (and 2x in Table 1), I was thrown by the usage of "fresh water" as descriptor of water in the ocean. I thought conventional usage of "fresh water" meant water without significant salt content. This cannot be the meaning here (water from upwelling, occurring well below the surface). The authors should use some alternate terminology to communicate their meaning.

The term fresh water means "relatively fresh". It certainly does not mean fresh as in without significant salt. We have attempted to make this clearer in the revised version.

Table 2: A simple succinct listing of the cloud probes that were deployed on each aircraft should be provided. Much detail is given about the aerosol measurements, but, except for the G-1, the cloud measurements are summarized too briefly as "cloud water and cloud microphysics". I believe the cloud measurements will also be key to addressing the science hypotheses, and cloud specialists probably care about what probes were used.

We have included these in the revised manuscript.

20780, and other places (Table 3, 4, 5, 2/7 and associated text): There is inconsistent level of information given about sondes. For a couple of the systems, it is explicitly stated that RS92G sondes

were used. For others, no info is provided. Given lower tropospheric focus here, this is not so big an issue, but it seems to me that if this info is worth giving for one system, then it should be provided for all the sonde systems.

We have now included these in the revised manuscript.

Section 4.2: The summary of XS missions flown (Table 8) is fine. I might have stated in text that there were 3 instances where full multi-aircraft XS pattern was successfully flown.

Done

No such information is given about the other mission types, except for the intercomparison legs. Maybe such info can be pulled out of the platform mission summary tables (Tables 6-10), but those tables had variable level of information detail and it would be challenging to do. Particularly for the POC missions (2), I would like to see some sort of summary like Table 8.

This is a good suggestion. We have now included a table summarizing the various POC sampling missions across platforms.

For others, maybe some quantification of how much flight time was devoted to these patterns would suffice.

We have attempted to do this in the text.

Alternatively, or maybe additionally, the authors could add annotation to the Tables (6-10) to indicate in what patterns the aircraft platform participated on each mission day. I think that would be effective. I reiterate that the level of detail in the Aircraft Mission Summaries (Tables 6-10) is quite uneven. Some communicate a lot, others not very much. Obviously, the former are more useful than the latter.

This has been done under the column Mission/Location. We have attempted to make the information content of the tables 6-10 more even.

Technical corrections

20769: Meaning of VAMOS needs to be given right away. A simple footnote would do.

Footnote now included

20773, 15: "Earth's"

20773, 19: suggest "small" for "low"

20774, 20 "its"

20775, 2: "role in"

20779, 4: "Aircraft Studies"

All corrected

20779, 8-9: At first usage, I suggest refer to Fig 2 where Point Alpha is shown. I missed this until way later in the paper and kept wondering about it.

Done

20788, 18: “. . .ocean fronts. . .”. Similarly, at 20821: suggest “cyclonic and anticyclonic eddies”.

Adjusted

20789, 6: “Tenth GOES” is not conventional terminology. GOES-10 is pretty universal.

I am told that this is the official line. We include the acronym GOES-10 right after this.

20789, 9: “. . .for the region bounded by . . .”

Changed

20794, 21: maybe

I’m not sure here what the reviewer is referring to.