

## Second Review of Dodson and Small-Griswold: Turbulent and Boundary Layer Characteristics during VOCALS-REx

Although the manuscript has been improved, my general impressions remain much the same, which can be summed up as: “A large number of pages and figures, not commensurate with the information content.” I still see value in the manuscript’s broad documentation of data from the campaign.

I had hoped for a clean, sharp, synthesis in the second round but unfortunately that was not the case. In an attempt to be complete, the authors lose sight of the essence of their work. Heavy **Synthesis** is required.

In addition, grammatical errors persist throughout the paper. The reader encounters sloppiness already in the abstract. (VOMOS?, LFH, “Data was...”). This is inexcusable from native English speakers. I note some grammatical errors below but it’s an incomplete list.

### A comment from my first review:

#### *4) Section 2.1: Shortwave absorption doesn’t only occur at cloud top.*

- You are correct, solar absorption does not occur only at cloud top (although this is where it is primarily confined). We have clarified this statement in lines 157-160 of the new manuscript.

The revised text says “shortwave absorption, which is largest near cloud top due to the scattering of solar radiation limiting absorption lower in the cloud layer (Hignett,1991).

But Hignett 1991 states on Pg 1474: “In contrast to the longwave cooling, the heating which results from absorption of shortwave solar radiation is distributed more deeply in the cloud layer”. Please do some reading on this topic and revise to better reflect the knowledge in the field.

Below I give examples of problematic text and places that need improved analysis. More than this would require me to sit down and rewrite paragraphs and I’m not going to do that.

### **Abstract:**

What is “evaporation away from the surface”? Is it evaporation from the surface, or evaporation some distance from the surface? And if the latter, where? You can calculate this from the qc flux profiles.

What does “completely offset from one another” mean? Do you mean spatially offset? I waded through the paper and looked at the figures and still don’t get it. It’s a key result!

The inability of the LW cooling to mix through deeper boundary layers is not a new result! Begin your sentence with: “As shown previously ...” and then refer to the papers later (as you do).

Lines 10/11 require work. Sentence structure, grammar.

### **Introduction:**

Long and unnecessarily wordy

“subgride”?

Line 71: grammar (maintain consistent tense)

Line 76: Here and elsewhere: “height throughout the depth of the boundary layer”

Line 82: what do you mean by “Convection in the STBL is limited?” By definition, Sc are convective. They may not penetrate very high because of the capping inversion. Please reword.

Line 91 and throughout: “dryer” is a machine that dries your clothes. “drier”.

Line 91/92. These parentheses within parentheses are very distracting.

Line 124: Lewellen et al. 1996

Line 128: vertical velocity skewness is a strong function of diurnal cycle as shown in VOCALS.

### **Data and Methods**

Line 153: Although probes failed on some of the days, the key cloud probes are ones that measure LWC. Surely there were other probes measuring bulk LWC (Hot wire, JW, Gerber PVM?) The aerosol data aren't even used in this paper, except as a possible indicator of reduced drizzle. And w'N' analysis is so inconclusive that I see no reason to keep it.

Line 178: “e.g., using Reynolds composition” -- an example of how a little effort can make the sentence more readable.

Line 204: “assumption that the flow is isotropic”.

Why was isotropy never directly calculated (see below)?

Line 221: structure function (n=2)

Line 254: “the error bars would not plot”?? this sentence needs rewriting.

Line 263: What does “this” refer to? An equation? If so say so and refer to the Eq. number.

### **Synoptic**

Long and low in information content

Line 286: remove “as was found in

Various places: “minimums” ???

Line 334: metrics instead of dictators.

Line 335, grammar

Line 342: what does “per measurement” mean?

Line 357 grammar

Line 365: aircraft typically measure aerosols in their dry state. Please check this was not the case here.

Line 376: helped to produce

Line 386 “that”

Line 298: What is mixed layer cloud thickness in this context? Since you’re comparing LCL and cloud base, I think you mean mixed layer thickness from surface to cloud base.

Line 405 grammar

Line 413: rewrite as “By these metrics 28% of...”

Line 420: “relatively consistent” in terms of what? Depth?

## Results

Line 435: grammar

Line 436/437: (Table 3) will suffice.

Line 458 “are” not “will be”.

Line 460: “Based on” not “From just analyzing..”

Line 465 grammar

Line 480: driven by

Change TO11, TO 12 to RF11, RF12 (or vice versa) for consistency

Line 491: Can be → is

Line 497: Given that  $z_i$  decreases...

Table 4 gives correlations that sometimes don’t fit specific cases. The later focus on Nov 1 should be brought in. How well do Nov 1 and 2 follow the broad correlations?

Line 514: “Physically this makes sense” does not make sense. There are many studies showing aerosol causing increases and decreases in LWC.

Line 516: What are ‘enhanced latent heating effects’? Do you mean ‘enhanced latent heating’? And if so where?

Fig. 13: Please add a line on your plots for the anisotropy ratio =  $2w'w'/(u'u'+v'v')$ . It goes a long way in showing the source of TKE and its relationship to top-down/bottom-up driven turbulence. Add discussion as necessary.

Line 581: “downdrafts are smallest”. Do you mean smallest areal coverage?

I’m not convinced that this paper has shown anything interesting about  $w'N'$ . The plots are incredibly noisy and no clear results are shown. So why clutter the paper with results like this. Please go back through the paper with a similar view on other plots and remove if they don’t yield a clear result. You will be doing yourselves a real service in the long run.

A moot point perhaps but on your figures for  $w'N'$ ,  $cc-1$  is not a standard unit.

Figure captions are meant to be cryptic. Please remove all “Note that..” from figure captions.

Figure 16 caption doesn’t even say its Nov 1.

Line 619: Theta is normalized 0 to 1 (min=0; max = 1).

But since theta keeps increasing above the BL, this would typically place the unit value at the highest point of your profile. So how did you normalize theta? The plot suggests you did this correctly.

Line 625: Where is the evaporation occurring? It makes a difference. Why not calculate the divergence of the qc flux.

Pgph starting line 629: there's another factor and that is less dilution of cloud water in response to entrainment.

Line 632 grammar

Line 638 it's more about the cooling profile than the precip rate, as you discuss later. Please shorten/tighten descriptions.

Line 646: What are 'latent heating effects'? Don't you just mean 'latent heating'?

Line 652 and abstract/conclusions, "away from the surface" is highly imprecise language, and since this is a key result please make your arguments crystal clear.

The profiles show no sub-cloud drizzle that would destabilize the sub-cloud layer. Does LWC include drizzle/rain?

As mentioned above, please tie this discussion of Nov 1 back to the broader correlations and point out differences if they exist, or simply note consistency. I couldn't wade through the text one more time to figure it all out.

Line 652: "activation" not "activation through condensation". Please stick to accepted terminology.

Line 664: I don't believe you have evidence of aerosol activation in updrafts at cloud base. Your measurements are far too noisy to draw this conclusion. Updraft velocities are just not strong enough to raise supersaturation at cloud top.

Why is this not simply evaporation in downdrafts? And as I said earlier, since you can't really say much about aerosols, why dilute your message with distracting, uncertain results?

Line 655, poorly mixed BLs can be locally well coupled by local, penetrative updrafts.

Line 671: Can you explain why the consistency in wind direction across the inversion should translate to mixing across the inversion? It's possible that mixing occurs but this isn't a way to address it. The theta jump is about 4K.

Fig. 13: Why are there 2 identical blue lines for RF12 and 13 when the caption and legend lump them together?

General comment on SHF and LHF: these are generally defined at the surface so please clarify. Eqns 2, 3 give the definitions. You should define them as  $w'q'$ ,  $w'\theta'$ !

## Conclusions

Conclusions need to be tightened/clarified.

Line 703: entrainment acts to increase  $z_i$ .  $Z_i$  is a number that can increase or decrease but not deepen.

Line 710: please add appropriate reference

Line 711: grammar

Line 712/713: this is a convoluted sentence. Deepening BLs entrain drier air and therefore increase surface LHF

Line 715: Again, please tell us what you mean by evaporation away from the surface.

Line 713: again explain: "completely offset one another"

Line 738: grammar