Atmos. Chem. Phys. Discuss., 10, C7983–C7987, 2010
www.atmos-chem-phys-discuss.net/10/C7983/2010/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "An aircraft case study of the spatial transition from closed to open mesoscale cellular convection over the Southeast Pacific" *by* R. Wood et al.

Anonymous Referee #1

Received and published: 25 September 2010

This manuscript provides an extensive description of the boundary layer, aerosol, cloud, and precipitation variability across a well-defined boundary between closed and open cells in the south-east Pacific. It extends our knowledge of the physical variations across the boundary between these two types of mesoscale convection, and provides a plausible conceptual based model for understanding this transformation. As such, this study provides a valuable baseline on which to base and evaluate numerical simulations of the spatial transition using models of varying complexity. Although the major elements of this manuscript are acceptable as presented for publication, several

issues should be addressed to help clarify the presentation and further support the conclusions. Although the manuscript is generally well written, it is much longer than the attention span of the typical reader (and reviewer). In its current form this contribution would be on the order 25-30 pages in a traditional journal. A reduction of about 25% in the length and the number of figures would help focus some of the very detailed discussions given and force a more streamlined synthesis of the results.

Major Issues:

Abstract: A shorter more succinct abstract would provide a better summary of the principal findings of this work. The more speculative conclusions (see below) should be removed unless properly supported in the main text.

The possible contributions of the diurnal variability to the differences in the C-130 flight made in the early morning and the BASE-146 observations made in the late afternoon (12 hours later) needs to be more thoroughly addressed. There is some mention of this point in the text, but little in the discussion of the possible impact of any diurnal variability. Is there any variability observed in the GOES satellite images that could address this issue?

There are contradictory statements about the possible role of precipitation in the formation and maintenance of the POC. In the abstract the authors state that "Mean cloud-base precipitation rates inside the POC are several mm day-1, but rates in the closed cell region are not greatly lower than this, which suggests that precipitation is not a sufficient condition for POC formation from overcast stratocumulus". But in pages 11-12 the results presented indicate that in the overcast region, cloud base precipitation rates of about 2 mm day-1 are shown to be present in about 25% of the cloudy columns and those with Zmax as high as 10 dBZ (about 10 mm/day) corresponds to 2% of the columns. In the POC, however, these heavily precipitating regions of 10 mm/day occur at a rate that is 3 fold higher than those in the solid cloud and in the transition zone the occurrence of heavy drizzle is reported to be about 15 times higher than

ACPD

10, C7983–C7987, 2010

that in the closed cell. Thus, the meaning and intent of the statement in the abstract is unclear, since there seems to be substantial differences in the character and the extent of drizzle in the solid, POC, and transition region. Some clarification in the abstract would be useful, since at the end of section 3.3 the authors state that".. there is a fundamentally different nature to the precipitation inside the POC compared with the surrounding overcast clouds, with a broader distribution of Zmax and locally stronger precipitation." This point is also relevant concerning the discussion given on page16 in the first sentence of first paragraph where the authors indicate that "A striking feature, observed with both in-situ and radar data, is that the mean precipitation rate at the cloud level in the overcast region is significant (3-4 mm day$-$1) and about three quarters of that in the POC (4-5 mm day$-$1)." What is the basis for this assertion and the statement in the abstract? This may be discussed earlier in the text, but it appears to be at odds with the discussion on pages 11-12.

Page 13: Although the surface sensible heat fluxes reported as less than 15 Wm-2 are small, the contribution of the moisture flux to the virtual sensible heat flux is substantial and helps give a virtual heat flux of 25-30 Wm-2. Although this is still less than the 70-90 Wm-2 nighttime radiative flux divergence at cloud top, during the daytime it may be of similar importance to the energetics of the boundary layer as the radiative forcing.

On page 14 It is unclear how the mean boundary layer depth is determined. It appears to be based on the soundings shown in Fig. 7, since no radar or lidar estimates are available for the BAE146; But the values are reported as averages; thus it is unclear if more that the two soundings (one from the POC and the other from the solid cloud) are used to make this average. If this is the case, the sample size may be insufficient to show that the difference ($\sim$ 100 m) between the two flights is significant or that the single sounding in each area for each flight is sufficient to discuss any differences or similarities. Radar cloud tops will only be available from the C-130 flights. If soundings were used, how significant are the differences in the heights between the two flights? Is there any horizontal variability within the POC and closed cell regions? Some clarifi-

ACPD

10, C7983–C7987, 2010

cation of these points is warranted. There is no reference to the soundings or the other observations that might have been used to develop the discussion here. Some of the results from the C-130 radar observations might help in establishing the uncertainty. Thus, it might be useful to move this discussion to a point after the observations are discussed.

The analysis and discussion of the entrainment processes includes some speculative aspects that have not been identified as such. Energy and moisture budgets are used to estimate entrainment rates for the combined POC and solid cloud area. It is unclear what these results add to the manuscript. This estimate of the entrainment rate has to do little with the differences in the entrainment rates between the solid cloud and the POC. The vertical velocity variance estimates made in the two regions is used to infer that the entrainment rate in the POC is less than that in the solid cloud. However, the turbulence in the POC may be substantially less homogeneous in nature than that in the solid cloud, since the strong updraft and downdraft elements may occupy a much smaller area than in the solid cloud area, which may affect the significance of the vertical velocity variance reported due to poor sampling statistics. If the significance of entrainment estimates and the inversion height uncertainty for the POC and solid cloud areas cannot be established, then the speculation that the subsidence over the POC may be less than that over the solid cloud should be eliminated.

In Section 6 the discussion of the aerosol characteristics and variations between the POC and the solid cloud is very long and tedious. In the end it is unclear (or at least one looses track) of what has been learned from these observations about the aerosol and characteristic in the POC and the solid cloud. There is very little given in the conclusions on this point. A good synthesis of the results with fewer details would be useful. The speculative statements that are in this section might work better in the conceptual model discussion.

Despite a very long and detailed section entitled Discussion and Conceptual Model, the Conclusions section is relatively short (shorter than the abstract). In both sections there

ACPD

10, C7983–C7987, 2010

is relatively little discussion of the aerosol observations that was discussed extensively in the text of the manuscript.

Minor Issues:

Overall the writing is well done; but since some major reduction in the length of the manuscript is needed, only limited comments are provided on minor editing issues that can be addressed in the final version.

Section 2.2: It might be better to start with a full paragraph that includes an introductory sentence etc. The one sentence paragraph that starts this section is informative, but reflects a style more appropriate for a research report rather than a formal publication. This style is also reflected in the way the results are presented with more detail in some cases than required and th inclusion of some results that are not relevant to the focus of the manuscript.

Page 8; first paragraph: It would be useful to give the general nature and time of the C-130 flight in the same manner as given for the BAE-146 flight.

Page 12, Sec. 3.3: The second sentence is unclear, since 60% from the more sensitive WCL is not substantially less than the 55-60% reported from the radar.

Page 15; Sentence at bottom of the page is incomplete.

Page 23; last sentence of second paragraph; Sentence needs to be edited to eliminate an extraneous verb.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 17911, 2010.