Atmos. Chem. Phys. Discuss., 9, C3154–C3163, 2009
www.atmos-chem-phys-discuss.net/9/C3154/2009/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Land use change suppresses precipitation" *by* W. Junkermann et al.

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Received and published: 23 July 2009

We would like to thank the reviewer for her/his useful comments and suggestions.

Reviewers comment: Page 11483, lines 21-22: Please clarify the statement. It does not read logically. Response: The sentence was modified to: This pattern is most probably due to a combination of regional processes rather than to large scale circulation changes.

Reviewers comment: Page 11484, line 2: The authors quote Ayers (2005) for stating that "current state of research indicated the difficulties to relate rainfall depletion to increased anthropogenic aerosol numbers". These difficulties do exist. However, compelling evidence for the role of aerosols suppressing precipitation in a case study of shallow clouds over Australia was presented by Rosenfeld et al., (2006) and the references therein. That paper also refutes the concerns of Ayers (2006) with respect to

the previously published evidence of aerosols suppressing precipitation. Response: A sentence was introduced and the two additional citations were included: Despite this complexity now several studies not only in Australia revealed growing evidence that actually anthropogenic air pollution leads to a regional reduction of precipitation intensity (Rosenfeld et al., 2006, 2008(b), Bigg, 2008).

Reviewers comment: Similar microphysical studies were conducted in California (Rosenfeld et al., 2008). The authors should quote and take into account these highly relevant papers to the background of their study and proposed conclusions. Response: See above

Reviewers comment: Page 11484, line 20: Should the title of section 2 be "Experimental Design"? Response: changed as suggested

Reviewsers comment: Figure 2: The horizontal cross section shows particles > 10 nm at concentrations > 15,000 at the western area and <1,000 cm-3 in the eastern edge. But both vertical profiles (east and west) show similarly high concentrations of >15,000 cm-3 at heights lower than about 600 m. Please resolve this apparent contradiction. Response: In the original graphics we just generated deleting the western or eastern profiles from one figure with all data to show the difference in the vertical profile compared to the full range. Hence all the data of the horizontal flights covering small and large numbers are still inside the original version of both internal figures of fig. 2 without separation between west and east. The figures were modified and the data from the horizontal flight tracks removed.

Figure 5: a. Please explain better all the colors. Response: Ascents and descents are now assigned in thentext and the figure captions to the respective colors.

b. Can the later time of the flight in the eastern area explain the higher cloud base there? Please show the difference between the ascending and descending profiles in the west area. Please specify the times in the day for the ascending and descending segments in the east and west vertical profiles. Please update the text respectively.

Response: A few lines were included into the text: Within the three hours from 11:00 to 14:00 local time between the first ascending profile and the last descending profile a slow further growth of the planetary boundary layer thickness can be expected, explaining part of the very high difference between west and east although in the one hour intervals between the two profiles on each side no significant corresponding growth was observed.

Reviewers comment: Page 11488, line 21: Do the authors refer here to drop size in radius or diameter? Droplets above a threshold radius of 15 micrometer are necessary to induce growth of raindrops. According to Table 1 it appears that the authors counted drops with a diameter > 15 micrometer. The interpretation has to be changed respectively, or drops with diameter > 30 micrometer have to be counted and replace the provided factor of 2.4. Response: As mentioned by the reviewer radius and diameter were screwed up. Actually the required droplet size triggering precipitation should be a minimum of 14 um. Our clouds were not precipitating. This does not change the contents of the paper but needs some modifications in the text as well. Thus there are only marginal numbers of droplets of the required size. This has implications also for the table where the line with the droplet numbers was removed as the statistics do not allow to include any reasonable numbers. Instead of this statement another figure was added (Fig.6) with the size distributions of the two cloud regions. Yellow in the west with lots of small droplets, green in the east with larger droplet sizes. This figure shows the difference in the cloud microphysics better than two values in the table.

Table 1: The difference between cloud base temperatures is 4 degrees C. It is not likely to explain a 100 hPa difference in cloud base pressure. Please add to the table also the cloud base heights and re-check cloud base pressure in the naturally vegetated area. Furthermore, according to Figure 4d the cloud base heights are at about 1100 and 1500 m at the west and east areas, respectively. This is consistent with a 4 degree difference in their base temperature. But the height of 1500 m should be at around 850 and not 800 hPa.

Response: The temperature difference of the ground has to be taken into account. The difference between ground and cloud base in the east according to the table is 14 degrees compared to 6 degrees in the west. The 8 degrees at a height between 1000 m and 2000 m are consistent with $\sim$100 hPa pressure difference. The 800 and 900 hPa in the table were taken from the pressure at the lowest droplet level observed and rounded to the next 10 hPa. Fig. 4 is a different day without clouds. This figure is necessary to show the difference in the water vapour over the agriculture under bright sunshine. It is less pronounced in the case of figure 5, probably due to the reduced radiation flux under the clouds. The figure captions were modified accordingly with winter and summer conditions

References: Rosenfeld D., I. M. Lensky, J. Peterson, A. Gingis. Potential impacts of air pollution aerosols on precipitation in Australia. Clean Air and Environmental Quality, 40, No.2. 43-49, May 2006. Rosenfeld D., W.L. Woodley, D. Axisa, E. Freud, J.G. Hudson, A. Givati, 2008: Aircraft measurements of the impacts of pollution aerosols on clouds and precipitation over the Sierra Nevada. J. Geophys. Res., 113, D15203, doi:10.1029/2007JD009544. Response: The two additional references were included into the text

Please also note the Supplement to this comment.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 11481, 2009.

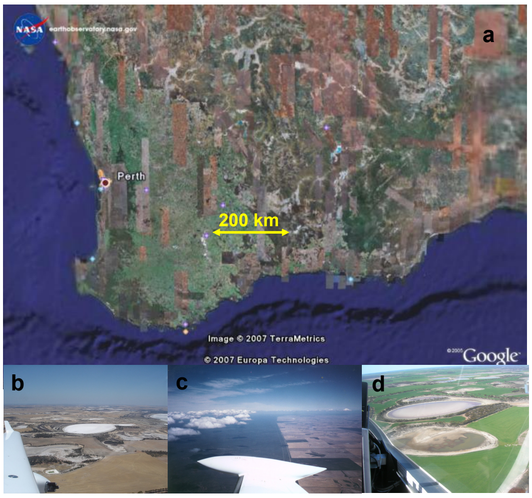

Fig. 1. Fig. 1: Western Australia seen from the satellite (a), summer (b) and winter (d) surface conditions in the agricultural region and the State Barrier Fence area (c), in yellow the location of the fligh

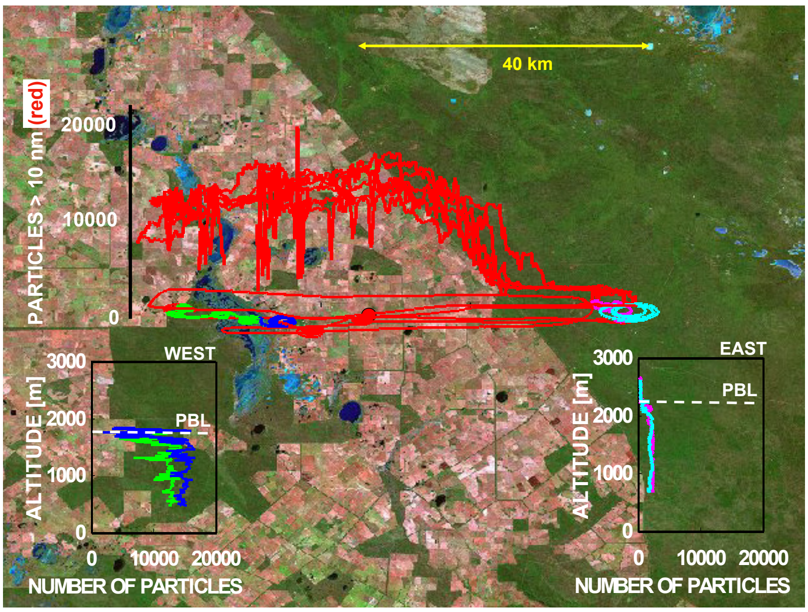

Fig. 2. Fig. 2: Flight patterns crossing the State Barrier Fence, 9.12.07, summer season, Number of ultrafine particles (> 10 nm, red) on six horizontal flight legs, and vertical profiles east and west of the

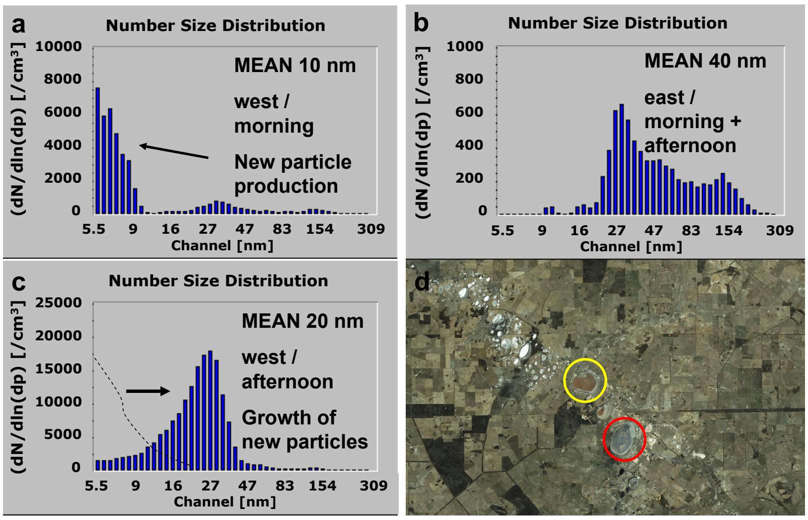

Fig. 3. Fig 3: Diurnal change of size distributions under calm conditions (wind speed below 2.5 m/s). Nucleation mode particles were found only over the northern Lake (Lake Stubbs, yellow), not over the south

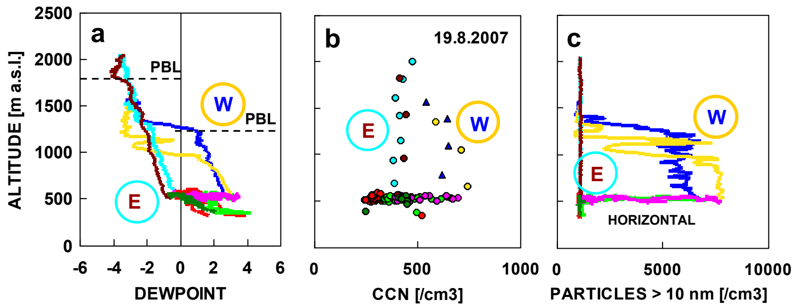

Fig. 4. Fig. 4: Dewpoint (water vapour, used to define PBL) (a), (b) calculated CCN (see text), (C) vertical distributions above the agriculture (W, yellow and blue), and above the natural vegetation (E, ligh

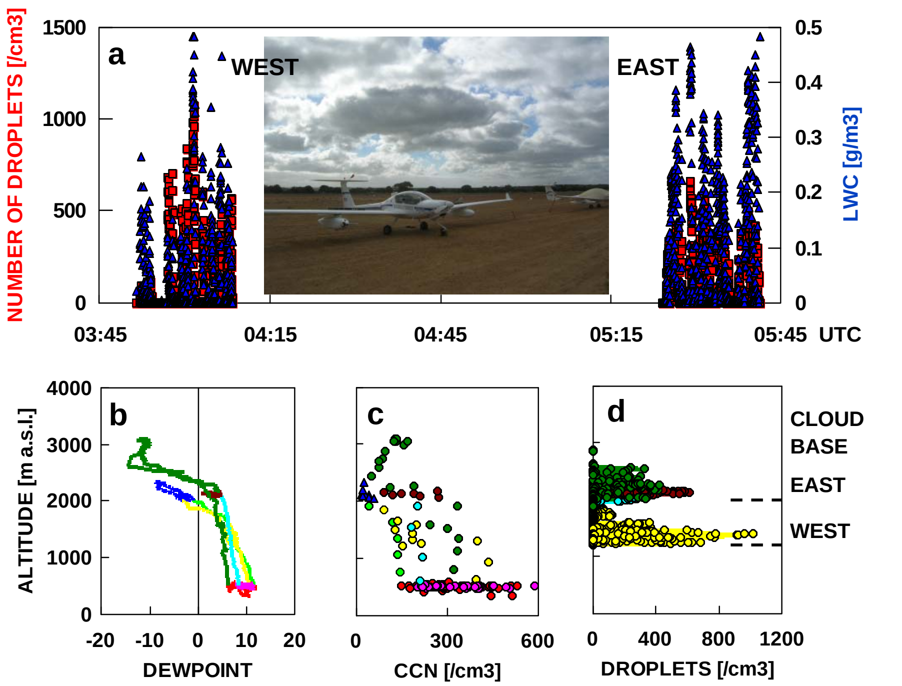

Fig. 5. Fig. 5: Cloud day (21.8.2007, winter). Upper panel: red squares: number of droplets / cm3, blue triangles: liquid water content. The left group of data was measured in the west (agriculture), the righ

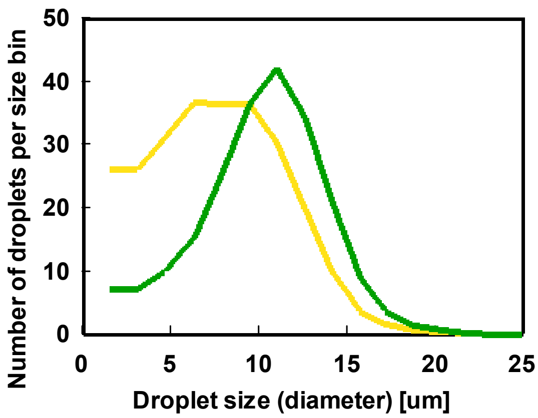

Fig. 6. Figure 6. Droplet size distributions over agriculture (yellow) and natural vegetation (green). Both droplet spectra do not reach the threshold for precipitation formation.