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Atmospheric Chemistry and Physics Discussions

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

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

Reviewers comment: Page 11483, first paragraph: In the literature review on particle formation in the Australian environment the authors use relatively old references by Bigg et all. There was more work done in the past few years but only on the east coast of Australia. I would like to point out to the authors several publications from the group from Queensland University of Technology on particle formations on the east subtropical coasts. Hai Guo, et al. "Size distribution and new particle formation in subtropical eastern Australia", Environmental Chemistry, Vol. 5 No. 6 Pages 382 - 390, 2008. G. R. Johnson, et al. "The Hygroscopic Behavior of Partially Volatilized Coastal Marine Aerosols Using the VH-TDMA Technique." Journal of Geophysical Research, 2005, 110, 2005 and a recent one: R. L. Modini, et al: "New particle formation and

growth at a remote, sub-tropical coastal location", Atmos. Chem. Phys. Discuss., 9, 12101-12139, 2009 Response: the references of Guo, and Modini were included into the manuscript as well as the publication of Saiz-Lopez et al (see below)

Reviewers comment: Page 11484, 1st paragraph. The authors point out to the review by Ayers (2005) "... current state of research indicated the difficulties to relate rainfall depletion to increased anthropogenic aerosol numbers...". I would like to point out to the authors one more publication from Australia (Brisbane area) showing statistically highly significant negative trends with rainfall and air pollution in contrast to the discussion by Ayers. E.Keith Bigg, "Trends in rainfall associated with sources of air pollution", Environmental Chemistry, Vol. 5 No. 3 Pages 184 - 193,2008

Response: This reference was included into the introduction together with two recent papers by Rosenfeld et al. an additional sentence was added to the paragraph (in italics)

A recent critical review of the current state of research indicated the difficulties to relate rainfall depletion to increased anthropogenic aerosol numbers (Ayers, 2005) as precipitation is an effect of both, cloud dynamics and aerosol driven cloud microphysics and it would be difficult to separate these. 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: Page 11486, line 9. "Instead, all ultrafines were found exclusively over the agricultural land." You compare your findings with findings by Suni et al. 2008 who have observed large particle production from Eucalypt forests. I am not aware how dense the forest is in your area of observation compared to the ones in Suni et al. (whose observations were in a dense Eucalypt forest). If the area east of the fence did not have that dense forest maybe that could be one of the reasons that you did not observe strong particle production. Please comment on this.

Response: The differences to the density of the boreal forests in Finland is not as large. To comment on this question the following text was inserted:

The apparent lack of nucleation mode particles over the natural vegetation might have two reasons, the very low concentration of sulphur dioxide required for nucleation from biogenic precursors or the dry environmental conditions compared to east Australia which affect the biogenic emission cycles. The density of trees in the area is comparable to the boreal forests in Finland, which act as strong precursor emitters.

Reviewers comment: Page 1186 line 21. You have observed clear particle formation above the salt lakes. It is not clear if the higher particle concentration on the west side of the fence is due to production only from the lakes or is it a combination of the production from the lakes and the agricultural area? I would think the later. Response: The observed particle distributions were independent on the vegetation cover (with or without wheat) and the shape of the size distributions directly allows to identify the source areas. A sentence was included. The shape of the size distributions allows tracing back the time since nucleation occurred. Already in a short distance from the lakes fresh particles were strongly reduced, an evidence for the exclusive production from salt lakes, neither from soil nor agricultural vegetation.

Reviewers comment: Page 11487, line 3, "However, the aerosol chemistry might be similar to aerosols present in coastal environments with a large contribution of organo-halogen compounds." I am not sure if the lakes are dry or not. If they are dry it is not likely that the organo-halogen compounds are involved but more likely molecular iodine (see reference: A. Saiz-Lopez, et al: "Modelling molecular iodine emissions in a coastal marine environment: the link to new particle formation", Atmos. Chem. Phys., 6, 883-895, 2006.). The same comment also refers to page 11490, 4th paragraph. Response: One of the statements in the paper is that the emission is due to the increased ground water table which reaches the bottom of the lakes. Thus the lakes in the agriculture are moist, the ones in the natural vegetation are dry. The sentence was modified to: However, the aerosol chemistry in the groundwater coupled lakes might be similar to

aerosols present in coastal environments with a large contribution of organo-halogen, possibly iodine, compounds (Saiz-Lopez et al., 2006)

Reviewers comment: Page 11487, second paragraph. Was the CCN concentration displayed on figures 4b and 5b calculated as explained in this paragraph? If yes please state that clearly. Response: YES, ... as shown in Fig. 4 and 5,. . .. was added

Reviewers comment: Page 11487, line 27. "However, the exclusive appearance of ultrafine particles above the wheat fields...". In a previous paragraph you claim that particles were produced from surface emissions from salt lakes. Please clarify this, is it salt lakes or wheat fields, or both? This issue expands on several other places. Response: see above, the comment to Page 1186 line 21, the salt lakes are the sources but dispersion of the fresh particles covers most of the agricultural area.

Technical corrections

Reviewers comment: Figure 2. I found figure 2 rather hard to follow as the graphs overlay the aerial photography and the colours overlap. Maybe the graphs could be put below the aerial photography. Response: The figure was modified and the different colors of the horizontal flight legs as well as the data from horizontal flight legs in the figure inserts were removed as recommended also by reviewer #1 which makes the figure more easy to read.

Reviewers comment: Figure 3. If you remove the grey background the particle size distributions would be more clear. Response: We didn't change the layout of the figures but the internal figure axis descriptions were modified with larger font sizes to reach a better readability.

Reviewers comment: Figure 4. Does figure 4c present the same information as on the lower inserts of figure 2.? If yes remove one of them. Response: No. The lower inserts in figure 2 show the conditions in summer, the figure 4 shows winter clear sky data with significantly higher evaporation rates and water vapour contents over the

agriculture, fig. 5 shows winter cloudy conditions. Summer and winter conditions are now explicitly mentioned in the figure captions.

Please also note the Supplement to this comment.

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

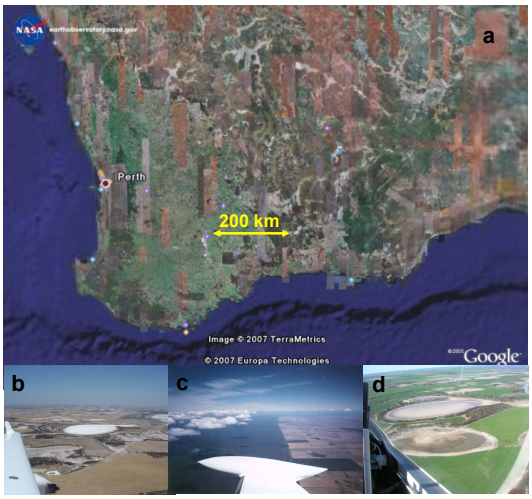

Fig. 1. Fig. 1: Western Australia seen from the satellite (a), summer (b) and winter (d) surface conditions in the agricultural region and the State Barrier Fence area (c), in yellow the location of the fligh

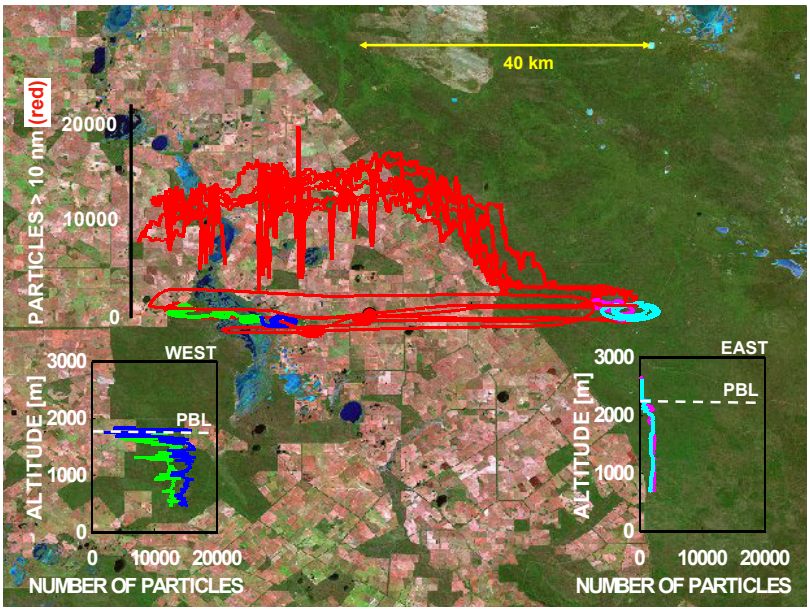

Fig. 2. Fig. 2: Flight patterns crossing the State Barrier Fence, 9.12.07, summer season, Number of ultrafine particles (> 10 nm, red) on six horizontal flight legs, and vertical profiles east and west of the

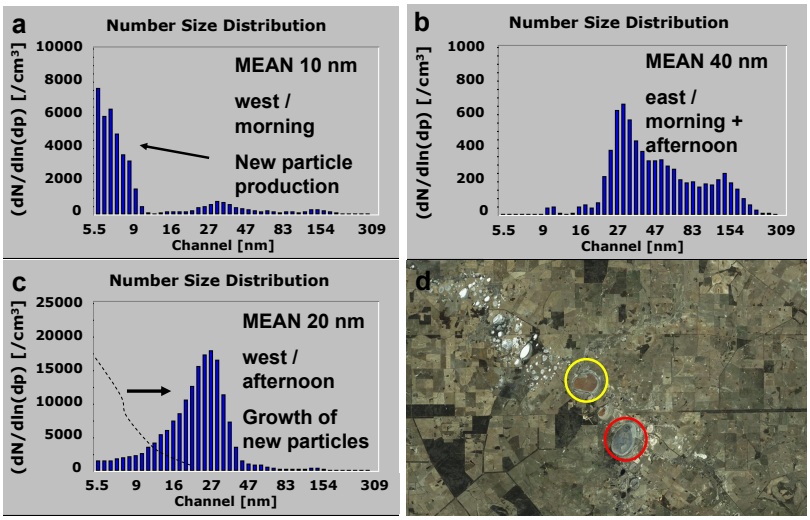

Fig. 3. Fig 3: Diurnal change of size distributions under calm conditions (wind speed below 2.5 m/s). Nucleation mode particles were found only over the northern Lake (Lake Stubbs, yellow), not over the south

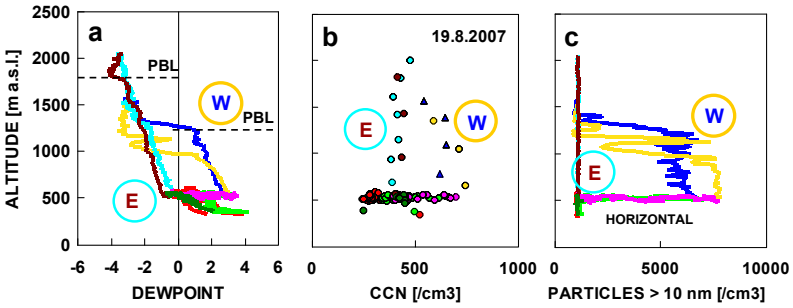

Fig. 4. Fig. 4: Dewpoint (water vapour, used to define PBL) (a), (b) calculated CCN (see text), (C) vertical distributions above the agriculture (W, yellow and blue), and above the natural vegetation (E, ligh

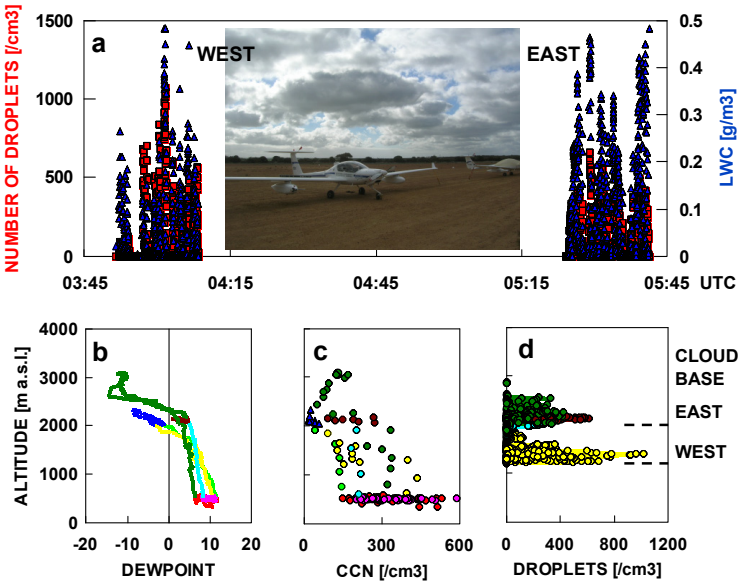

Fig. 5. Fig. 5: Cloud day (21.8.2007, winter). Upper panel: red squares: number of droplets / cm3, blue triangles: liquid water content. The left group of data was measured in the west (agriculture), the righ

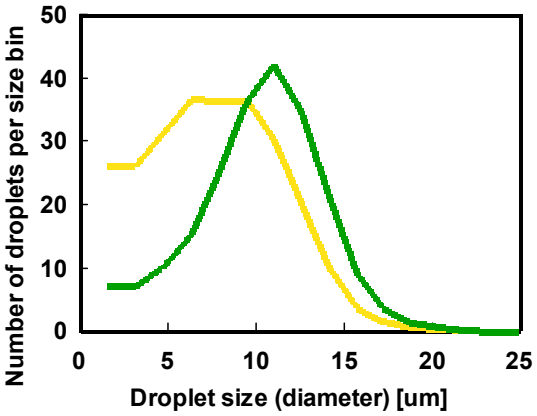

Fig. 6. Figure 6. Droplet size distributions over agriculture (yellow) and natural vegetation (green). Both droplet spectra do not reach the threshold for precipitation formation.