

Review of

Field Measurements of Aerosol Production from Whitecaps in the Open Ocean

doi: 10.5194/osd-9-3359-2012

by Norris, Brooks, Moat, Yelland, de Leeuw, Pascal, and Brooks

There is a lot of good material in this paper. The authors have measured near-surface ocean bubble concentrations, near-surface aerosol concentration over the open ocean, and whitecap coverage. All these variables combine to produce estimates of the sea spray generation function. The science is generally sound; most of my comments deal with the presentation.

1. The size range of the spray droplets observed (i.e., $R_{80} < 10 \mu\text{m}$) is more relevant to the direct and indirect aerosol effects on radiation and climate than to spray-mediated heat, moisture, and momentum transfer (which results, mainly, from droplets with $R_{80} > 10 \mu\text{m}$). The authors should mention these applications in their Abstract and Conclusions.
2. Page 3362, line 7. Only saline droplets shrink until they reach equilibrium. Freshwater droplets can evaporate entirely. It's surprising how many people do not realize this difference. It might be good to point it out here.
3. Page 3362, line 13. The $<$ and $>$ symbols are messed up.
4. Page 3366. The sentence that begins in line 5 with "During analysis" is pretty contorted and thus doesn't read well.
5. With the discussion at the end of the first paragraph on page 3367, it might be good context to mention that, besides Wu (1993), the current study is the only one to establish the simultaneity of increases in aerosol concentration and wave crests.
6. At the bottom of page 3367 and elsewhere (e.g., page 3374), I am unsure why bubble spectra from Mårtensson et al. (2003) are at all relevant. These spectra came from a glass beaker with a volume of about 1 liter and were created by forcing air through a glass filter in the beaker. That is, these bubble spectra are totally artificial. Comparing them with your open ocean observations attributes much more meaning to them than they deserve. I'd recommend removing most of the discussion of the results from Mårtensson et al.
7. The discussion in the first paragraph in Section 3.3, which regards Figure 6, is hard to follow because of the faulty legend in Figure 6. Page 3369 mentions the SEASAW whitecap parameterization, but neither the legend in Figure 6 nor its caption helps us identify which line is the SEASAW parameterization.
8. In the line above Eq. (3), W must be the actual whitecap coverage (whitecap area per unit surface area), not the percent coverage.

9. The approach described on page 3370 in the paragraph that starts in line 14—multiplying the aerosol number concentration with the whitecap coverage and dividing by a time scale—is the same as used by Monahan et al. (1982, 1986). That history is worth mentioning here.

10. The discussion in the first paragraph on page 3371 refers to Figure 7. This figure has two unique features. For droplets with R_{80} less than about $1\ \mu\text{m}$, the SEASAW data are above even surf-zone measurements. For droplets with radii above $1\ \mu\text{m}$, the SEASAW data have no wind speed dependence. In the second and third paragraphs on page 3371, the authors seem to be explaining the high values of the SEASAW data, but the logic seems backwards. If bubble concentrations were higher in the surf zone, wouldn't the spray generation be higher?

I did not see that the authors even attempted to explain why they saw no wind speed dependence in the larger droplets in Figure 7.

As I mentioned earlier, I do not think the Mårtensson et al. results provide a meaningful comparison in Figure 7. Moreover, the only other comparisons in Figure 7 are to data collected in the surf zone (namely, Clarke et al. and de Leeuw et al.); and the authors themselves describe how whitecap, bubble, and spray conditions are different between the open ocean and the surf zone. Hence, why not compare apples with apples. The spray generation functions of Monahan et al. (1986, bubbles-only term) and Andreas (1998, 2002) are open-ocean expressions that are more comparable to the SEASAW observations. In my casual comparison, these and the SEASAW data are in the same range for R_{80} between about 1 and $10\ \mu\text{m}$, the lower limits of Andreas's functions.

11. Page 3371, line 16, mentions the $3\text{-}\mu\text{m}$ droplets of Mårtensson et al. in Figure 7, but this size is not apparent in Figure 7. I think the de Leeuw et al. result covers it.

12. Figure 2, panel e, is identified as the “total” particle number concentration. This description is misleading because CLASP is able to see only droplets with ambient radii between 0.12 and $9.25\ \mu\text{m}$ (see page 3365, line 2). Clarify this statement by including in the caption the range of sizes that the CLASP measures.

13. Figure 3, again, is the “total” number concentration; but as with Figure 2, these totals include only droplets with radii from 0.12 to $9.25\ \mu\text{m}$. Again, mention the CLASP range in the caption.

14. In Figure 6, Callaghan et al. (2008) are mentioned in the caption but not identified in the figure. Moat et al. (2011) are mentioned in the legend but not identified in the caption or in the text. Moreover, Moat et al. is not listed in the references. What is the gray line in the figure? It isn't identified either.

15. In Figure 7, the orange line is identified as 20 March; but in Figures 4 and 8, the orange line is labeled 30 March. Are these labels correct?

Here are some proofing and other editorial issues.

16. The manuscript contains some long paragraphs. I'd start new paragraphs here:
Page 3368, line 6, with "For the smallest."
Page 3369, line 2, with "The variability."
Page 3372, line 22, with "For aerosol."
Page 3372, line 29, with "At large particles (sic) sizes."
17. Page 3361, line 9, "bubbles rise"
18. Page 3363, line 26, "measurement."
19. Page 3372, lines 22–26. This is a long and convoluted sentence. Rewrite.
20. Page 3373, line 3. "Micron" is no longer an acceptable S.I. unit—use micrometer.
21. Page 3373, line 5, "is matches"?
22. Page 3373, lines 4–8. This is another messy sentence that needs rewriting.
23. Page 3373, lines 20–24. Rewrite this sentence into shorter segments.
24. Page 3374, lines 17–21. Rewrite this long sentence.
25. Page 3375, line 19. By "the shelving beach," do you mean the shoaling beach? I don't know what a shelving beach is.

References

- Andreas, E. L., 1998: A new sea spray generation function for wind speeds up to 32 m/s. *J. Phys. Oceanogr.*, **28**, 2175–2184.
- Monahan, E. C., D. E. Spiel, and K. L. Davidson, 1986: A model of marine aerosol generation via whitecaps and wave disruption. *Oceanic Whitecaps and Their Role in Air-Sea Exchange Processes*, E. C. Monahan and G. Mac Niocaill, Eds., D. Reidel, 167–174.
- Wu, J., 1993: Production of spume drops by the wind tearing of wave crests: The search for quantification. *J. Geophys. Res.*, **98** (C10), 18,221–18,227.

Ed Andreas
21 November 2012