Final Response — our replies are given in blue between the referee comments.

C. D. Litton (Referee)
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The paper describes a simple, low-cost device that correlates well with measurements from more expensive and sophisticated instruments and that has the potential to fill a need for more extensive coverage of ambient particulates not currently realizable with existing devices. I am wondering what it would take, and at what cost, to modify the existing device to obtain more detailed information relevant to particle size, number rather than mass concentrations, particle surface areas, and, possibly, particle chemistry. I think much of this could be done in the framework of the current device by looking at multiple scattering angles. While I realize the need to validate/verify performance using acceptable mass measurement standards and to define responses that provide equivalent mass readings, we may also be missing or oversimplifying other particle metrics that are more germaine to adverse health effects such as particle numbers, surface areas and morphologies.

Reply: We are grateful for the recognition of the need for these and similarly affordable devices to fill gaps in ambient particle monitoring data. The off-the-shelf sensor module we sourced for evaluation is a relatively self-contained unit, with scant documentation, and our aims did not include reverse-engineering it. Rather, we sought to characterize its behavior using methods available to any exogenous observer or end-user. A dedicated sensor manufacturer or research lab with appropriate resources might profitably absorb the cost of improving on this manufacturer's design—any IP claims notwithstanding. However, it is beyond our expertise to say. We further agree that mass concentrations are only one of the metrics available to characterize aerosol properties (as we suggest on p 607 line 27), and that it is quite plausible that some alternative summary measures may show stronger associations with corresponding adverse health effects, although PM2.5 is by far the most dominant metric used for this purpose. Future research seeking to similarly characterize off-the-shelf aerosol sensors or instruments should also examine alternative metrics, especially as reference data for these other metrics begin to accumulate at routine monitoring locations.

D. C. S. Beddows (Referee)
Received and published: 29 January 2014

An excellent paper reporting the research and development associated with the, "Calibration of a low-cost aerosol sensor". By publishing this work, potentially new possibilities open up which were once limited by budgets and the expense of equipment. I now look forward to a similar device measuring particle number appearing in the literature.

Minor comments to consider which may enhance the paper:

1. Pg 614, Line 14. Not sure what you mean by, "absent any confounding, we should see no associations".
2. When introducing: (a) the PPD42NS and (b) the PANDA, simple diagrams illustrating how they work would help the reader's understanding.

Reply: We thank the referee for their encouraging assessment of our study and its implications. Regarding point #1, we thank the referee for drawing attention to the rough prose in our original explanation. We have revised the sentence in question and the surrounding text as follows. (In so doing, we take the opportunity to revise a reportable R^2 value from 0.05 to 0.02 — a typo with no implications for any conclusions; nevertheless, we regret our error.)

Original

Variations in light (*L*), temperature (*T*), and relative humidity (RH) had negligible effects. Models of hourly data from the reference instrument (BAM), using only these variables as predictors, served as negative controls: absent any confounding, we should see no associations. Indeed, Table 1a shows that variability in 1 h BAM data was not explained by *L* or *T*. Also, in a longer study (see Sect. 3.5), 24 h BAM data were uncorrelated with 24 h RH (R^2 = 0.02). Since the BAM-1020 dries its intake air by heating, we conclude that the slight association (R^2 = 0.24) observed between RH and BAM at 1 h timescales was due to a simple case of confounding: both PM2.5 and RH were generally elevated at night. Table 1b shows that variation in 1h Shinyei data was also unexplained by *L* or *T*. As in the case of the BAM, there was a slight association with 1h RH (R^2 =0.27), but this can also be attributed to confounding. And, when 24 h averages from a longer study (Sect. 3.5) were examined instead, there was negligible correlation (R^2 = 0.05). Finally, Table 1c shows that the addition of 1 h RH resulted in a negligible increase in the proportion of variance explained (R^2 = 0.59 vs. 0.58). Accordingly, we omitted *L*, *T*, and RH from subsequent models.

Revised

We did not observe convincing associations with light (*L*), temperature (*T*), or relative humidity (RH). Tables 1a and 1b show that neither 1 h data from the BAM nor 1 h data from the PANDAs could be explained by *L* or *T.* Though 1 h RH measurements had some ability to predict 1 h BAM responses (R^2 = 0.24), 24 h averages did not (R^2 = 0.02; see Sect 3.5). This can be explained as a simple case of confounding at the 1 h timescale, rather than a causal association. Both $PM_{2.5}$ and RH were elevated at night; moreover, since the intake air for the BAM-1020 is actively dried by heating, there is no mechanistic explanation for the observed association between 1 h RH and 1 h BAM responses. Correlations of RH with PANDA responses at 1 h and 24 h timescales were not appreciably different (R^2 = 0.27 and 0.01, respectively). Accordingly, we omitted *L*, *T*, and RH from subsequent models.

We also thank the referee for suggestion #2. The choice to lead with a figure showing data from PANDAs, but not a diagram or photo, was deliberate. Our goal was to frame this paper differently than the typical “validation study” of a single “device”. We are interested in *systems for producing data:* hence the acronym, Portable and Affordable Nephelometric Data Acquisition System (PANDAs). The interested mechanical engineer—who might easily improve on our rudimentary packaging of the PPD42NS sensor and supporting electronics—is kindly referred to the first diagram in the Supplement (Fig S1), as well as to Table S1 for a list of materials. In addition, the source code for our firmware is openly available online at <http://tinyurl.com/AMTD-PANDAs-firmware>. More specific requests for information will be gladly fielded insofar as is possible.

For the engineer interested in the inner workings of the PPD42NS sensor itself, manufacturer’s diagrams and accompanying explanations of operating principles, which are presumably copyrighted, are readily available online and by request from the manufacturer (see reference on p 608 lines 22-23). Those with the keenest interests may enjoy the “de-construction” document, produced by a 3rd party, that is publicly archived at <http://tinyurl.com/PPD42NS-deconstruction> (PDF).