

## Response to Anonymous Referee #2

The referee's comments are in italics, our responses in plain font.

*This manuscript states that it provides an overview of the first results from the Amazon Tall Tower Observatory (ATTO). The ACPD short title is "ATTO overview".*

*Ongoing and future ATTO results will be an incredible addition to Amazonian science. That said, the manuscript in its present form in my own view does not do justice to the project, and I give a rating of "fair" to this ACPD manuscript.*

*The present version of the manuscript appears to me to lack a simple statement as to its purpose. Why do we need this manuscript? The absence of this motivational statement makes preparation of the review quite difficult because I do not know exactly what criteria to evaluate in deciding if the authors have achieved their purpose. Based on the title, a logical inference is to formulate criteria based on the quality of a description of the need for a tall tower and a presentation of early results. The actual manuscript, however, is much different from such criteria, especially with regard to the description of a need.*

We thank the referee for his/her constructive comments. We have added a paragraph at the end of the introduction that makes it clear that this paper is intended as an introduction to and overview for a special issue. The Amazon Tall Tower Observatory is actually more than the tall tower itself, rather, it comprises several smaller towers for pilot and process studies as well as the ecosystem surrounding the towers. This paper is intended to provide the scientific context of ATTO and to serve as an overview paper for the pilot studies. A future paper will discuss the details of the tall tower.

*Here are some suggestions:*

*1. Foremost, there should be a description of the tall tower and its motivation. The actual manuscript emphasizes long-term measurements. This is not a new theme for Amazonia. Those efforts have been under way through many projects, most notably LBA for climate change as well as multiple forestry studies.*

As stated above, there will be a future paper with the details of the tall tower. Nevertheless, we have added some text regarding the motivation for the construction of the tall tower in the introduction.

*2. The motivation for the tall tower is really marginalized in the actual manuscript. Only the sections on turbulence (sections 4.2.x) provide some intellectual motivation for the tallness of the tower. I think instead the introduction should do this job. Why do we need a 325 m tower and what do we get out of it? The manuscript does not presently answer this question. As an example, how about to show the fetch of a 325 m compared to shorter towers in Amazonia, and how about to discuss what that means for a definitive answer about CO<sub>2</sub> uptake or release?*

See the response to comment 1) above.

*3. This manuscript does not discuss measurements from the tall tower. The manuscript states that the tall tower will be completed in 2015. Again, the entire motivation for the manuscript is not clear.*

See the response to the introductory comment above.

*4. The introduction of the manuscript reads like a review paper, a book chapter, or perhaps the introduction to a proposal, rather than a research article. ATTO itself is not mentioned until the end of the long introduction, at which point a list of 9 objectives is summarily presented. How about a complete deletion of the present introduction with a re-work toward a clear motivation for what a tall tower can and will accomplish (this is what is novel), with a downgrade on emphasis of long-term measurements (which are needed but not novel, i.e., this idea is common place and there are various type of long-term measurements already underway for years to decades at other sites).*

The introduction serves to introduce the reader of the special volume to the scientific background and context of the ATTO project. Therefore, to provide this background to a broad range of scientists from many disciplines it is written as a “mini-review”. It is also meant as a common point of reference for the specialist papers in the special issue. While the need for long-term measurements may be well known, it is nevertheless important to emphasize this point for a site that is intended to operate for decades. Besides, to our knowledge there are no continuous long-term high-accuracy measurements of trace gases and aerosols in the Amazon region. The

introduction now contains a section discussing the motivation and concept of the tall tower and an improved description of the objectives.

*5. Parts of section 2 are strange for a research article. Sections 2.2, 2.3, and 2.5 seem to be drawn from a narrative of a travel report. I would suggest for consideration that these sections can be entirely removed and that the manuscript would be focused and improved in consequence.*

As mentioned before, this paper is meant to be a common resource for specialist papers in the ATTO Special Issue. As such, the description of logistical details is appropriate. The text has been tightened up somewhat, however.

*6. Subsections of section 3 are highly heterogeneous in content and quality. Some of them go into much more detail than would be needed in an overview paper, such as repeating in full paragraphs what are standard operating procedures for instruments and techniques (e.g., consider using just a single reference in place of a paragraph). In my view, section 3 should only go into details about aspects that are unique and different to ATTO.*

Here, there is a divergence of opinions among reviewers. While reviewer 1 feels that the methods section is quite brief and requests some more details, this reviewer thinks there is too much detail in some sections. Given that this paper is a team effort and contains contributions from many disciplines, a certain degree of heterogeneity seems unavoidable. For example, the discussion of the CO<sub>2</sub>/CH<sub>4</sub>/CO analyzers needs to be quite detailed, because the performance of the analyzers is specific to individual instruments and traceability is essential to quality assurance of these key data. Similarly, inlet setups are described in detail as they are crucial to the validity of the measurements, and a detailed discussion here allows common referencing in the specialist papers. The methods section was edited throughout for brevity and clarity.

*7. Section 4 relates to results and discussion. Again, these sections are highly heterogeneous in presentation and quality.*

*7a. Section 4.2.4 is an example of what in my view was really done well. This section provides new information based on measurements that are specific to the ATTO site. Sections 4.2.5, 4.2.6, and 4.2.7 are also exemplarily positive in that they provide new and specific information about the ATTO site that promise to be useful as studies there continue in the future, as*

*well as interesting at present to a reader. Each of these sections has a nice concluding take-home statement for the reader about ATTO specific information.*

We thank the reviewer for these positive remarks.

*7b. Let me now give a negative example. Section 4.1.2 essentially provides no research information. It should be deleted.*

At the time the ACPD version of the manuscript was written, this project was in its very early stages. Many of the measurements reported here therefore represent an attempt to define an initial baseline against which the extended records can be evaluated in the future. Nevertheless, significant results have been obtained in the meantime, which are briefly presented in the revised version.

*7c. My quick review is that helpful, informative sections with new research results include: 4.3.2 and 4.3.3. Sections that really do not say anything by way of new data or new insights compared to existing literature (as cited in the manuscript itself) include: 4.3.1, 4.3.4, 4.3.5, 4.3.6, 4.3.7, and 4.3.8.*

In the following, we point out what is new in terms of data and insights in those sections that the reviewer did not feel contained enough novel material:

4.3.1: There are no previously published high-accuracy measurements of CO<sub>2</sub>, CH<sub>4</sub>, or CO in the Amazon forest (or any tropical forest that I am aware of) that span more than the time of an intensive campaign. Even these campaign data are usually not continuous measurements. For CO, for example, only some fragmentary profiles with outdated techniques are in the literature. There are also no continuous data from any mid-continental tropical site for these trace gases. The only comparable data are from flask sampling programs. The ATTO results present clear evidence for a CO source at ground level in the rainforest, something that was only speculated about earlier. They also indicate strong episodic CH<sub>4</sub> sources that remain unexplained.

4.3.4: Systematic measurements of the aerosol optical properties in the central Amazon are still scarce. The only comparable data set is that of Rizzo et al. (2013). Since their site has a significantly greater likelihood of contamination from the Manaus area, having a more remote site for comparison is very important. This section also contains a discussion of the absorption Ångstrom exponent, for which no systematic previous data exist from a remote tropical forest

region. We also present the first results of measurements of refractory black carbon by the SP2 instrument in this type of environment, which produce some quite surprising and not yet fully explained results. Our measurements suggest very strong absorption enhancements in Amazonian particles relative to fresh soot particles, which are likely related to thick coatings with biogenic or pyrogenic organic matter.

4.3.5: Compared to the huge amounts of data available from, for example, Europe and North America, the moist tropics are still a highly undersampled region. Previous studies were limited to short campaign periods and did not cover the full seasonal and intraseasonal variability of size distributions. While this section contains a significant amount of confirmatory information, it is nevertheless important to document that the comprehensive data sets obtained at ATTO agree with the more spotty information obtained previously. Furthermore, this section contains some aspects of the long-term measurements of fluorescent biological particles, which are unique for the Amazon ecosystem. It emphasizes the dominance of fluorescent supermicron bioaerosols in the coarse mode size range in the Amazon. These are the first reported measurements of fluorescent particles with the WIBS system from the Amazon.

4.3.6: Again, there are no previous measurements from Amazonia by an aerosol mass spectrometer that extend over more than a few weeks in the wet season. In the revised manuscript, we include monthly average ACSM data that show the changes in aerosol composition and concentration throughout the annual cycle.

We present here the first measurements of iron oxidation states and solubility in aerosols from a comparable environment. The measurements of crustal elements reported here may be more of a confirmation of previous work, but are reported to provide a comprehensive overview of work going on at ATTO.

4.3.7: In general, there are only a small number of studies that focus on the microstructure of Amazonian aerosols, which is important for understanding their micro-physical properties. Moreover, the previous single-particle studies in central Amazonia have focused on the wet season. Here we present exemplary results that show dry-season aerosols with significant contributions from aged biomass burning and fossil fuel burning. The data presented here show the high degree of mixing and atmospheric aging of the particles. It further emphasizes the thick coating on BC cores, with important implications for the optical properties of the aerosol. The STXM

images from the wet season show the characteristics of coarse-mode primary biological particles. These types of results have not been published previously.

4.3.8: We are surprised that the reviewer feels that this section does not contain new information. We are not aware of a previous publication that quantifies the amounts of monoterpene and sesquiterpene oxidation products in tropical forest aerosols. However, to better point out the new scientific aspects this section has been revised and updated.

*7d. Figure 1 is essential. Figure 2 seems extraneous. And so on. Are 35 figures justified? Or could a very nice job be done with half as many or fewer? Some of the figures represent statistical studies of a full season (which seems appropriate to an overview manuscript) while other figures seem anecdotal to a single or a few days studies (which seems inappropriate to an overview manuscript).*

We disagree with the reviewer concerning Figure 2. Since ATTO is intended to be an observatory with the objective of detecting large-scale, long-term trends, it is important to show the potential sources and sinks of biogenic and anthropogenic species in the fetch region. We represent the anthropogenic sources by mapping population density and the biogenic sources by ecosystem type. The mapped region has been deliberately kept fairly large to provide context. For example, how does the populated region in NE Brazil, which is in the normal fetch of ATTO during the dry season compare to the Sao Paulo region, which rarely affects the central Amazon?

Having figures that display long-term measurements as well as results from intensive campaigns reflects the concept of the ATTO observatory to be both a long-term monitoring site and to host intensive campaigns. Given the large number of studies ongoing at ATTO, we feel that the most effective way of providing an overview is to present a relatively short text and one or a few plots for each program component. We did combine some of the figures into a single plot, however.

*7e. I expect the authors will disagree on some of my classifications of good and bad examples and provide good explanations, but I think they will agree with at least some of the classifications and recognize in all cases opportunities for significant improvements. My point here is not really to attempt to be directive in any way about what should stay in or what should go out in a seriously revised manuscript. Rather, I hope that the authors will make revisions with an eye toward cutting the length of the text significantly and focusing on what is really new and dif-*

*ferent for an overview of the first results from ATTO. The manuscript probably would have benefited from a few more rounds of internal revisions before being sent to peer review. I would encourage the new flavor of the manuscript to emphasize why a TALL tower is motivated or interesting.*

We hope that the revised version will have addressed at least most of the reviewer's concern. Producing a synthesis with such a large number of co-authors and such a large and diverse portfolio is not an easy task. As pointed out before, the motivation for the tall tower has now been included, but specifics and results from the tall tower will be provided in a future paper.

*The ATTO project will be a source of excellent observations and associated science in the years and decades ahead. It would be valuable to the ATTO community for this first manuscript to be really streamlined and focused if it is to continue to ACP so that it can be of a final quality equal to the ATTO project itself. Please accept my criticisms in that context.*