Reply to referee A. Folch

We thank the referee for the constructive comments. We include here the comments in blue and our replies in black.

Ref: Results are presented only for one episode occurring on 1-2 July. Why this particular one? Considering that the eruption was more intense during the first 3 days (4-6 June), the clouds reaching BsAs on 6-7 June could probably be a much better study case. The authors should say if there is any particular reason for not showing results during these days (may be presence of meteorological clouds impeding observations?)
Answer: Because of the large amount of information that was presented (synoptic charts, time series of several parameters and dispersion diagrams of relationships between parameters), the original length of the manuscript was too much to be published. It included 27 figures and a similar number of pages and it resembled somewhat a report. That is the reason that only was case was fully documented for this manuscript. All four cases included originally were similar in their synoptic situation (with predominantly high pressure dominating the region) and there were no clouds. If needed, we could submit the time series for the other cases, as supplemental material, but we considered that one example was sufficient to document the situation and then all the cases were included in the dispersion diagrams and frequency distributions.

Ref: Results form Fig. 4f and 4g are very interesting. Measurements are always below one standard deviation, indicating a possible influence of the cloud on local meteorology. However, a temperature decrease of 4C (P1516:L4) seems large, and I wonder to which extent this value depends on the averaging period (which includes much colder months). I would suggest the authors to work more on this. For example, is this decrease also observed during the other episodes?
Answer: In order to calculate the average diurnal evolution of all variables (without volcanic influence), we utilized the period from mid-April (already fall) to 31 July (winter), after the end of the episodes of volcanic influence. During this transition from fall to winter, there is obviously a tendency climatologically for colder episodes as winter progresses.
In order to provide more evidence that the average diurnal evolution is representative of the period, we have estimated the climatological mean temperature and standard deviation (for the period 1985-2006) corresponding to the two days presented (1-2 July) from the database of the National Weather Service (station Aeroparque: AEP, very close to our site). The figure illustrates that the climatological values are consistent with the mean values determined in Fig. 4f, both well above the temperatures observed during the case study.

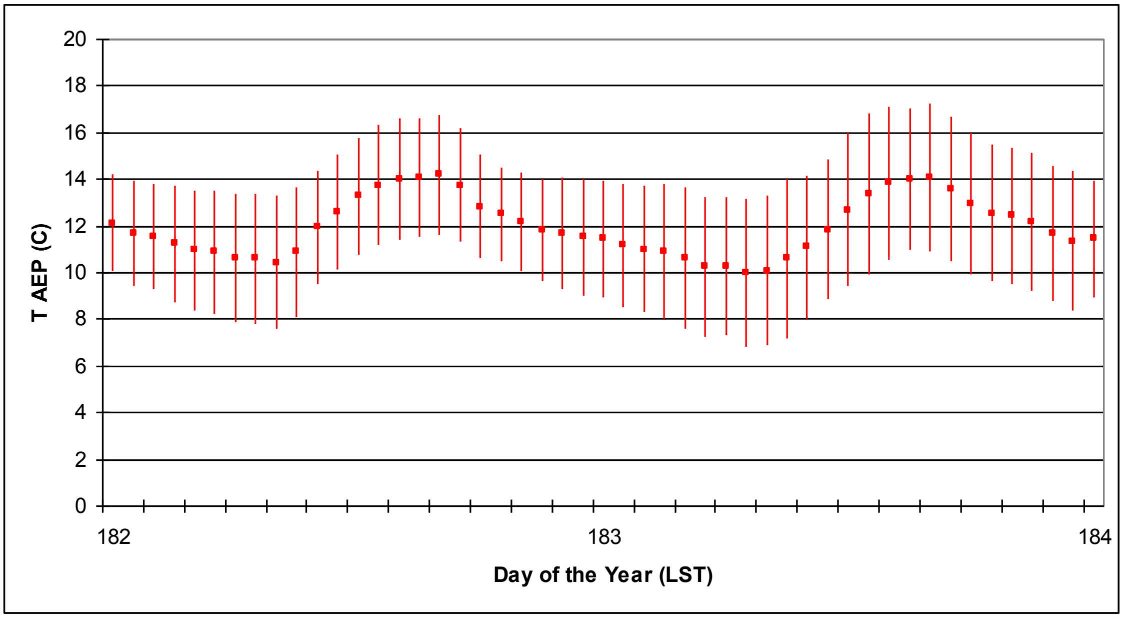

Figure I. Climatological diurnal evolution for 1 and 2 July at a nearby station (AEP) for our research site. The average values and one standard deviation (vertical bars) were estimated based on the period 1985-2006.

We include here the time series corresponding to the other case studies (Figs. II, III and IV), so the reviewer can have all the information that was processed for this paper.
As can be noted from these additional figures, in two other cases the temperature is also below the average that we estimated and only the last case, 7-8 July show some periods of above average temperatures. The case shown in the manuscript shows the largest decrease in temperature.

In the manuscript we suggest that the ash may have blocked the solar radiation and kept the temperature somewhat reduced. Unfortunately, the weather station used during the campaign did not include radiation sensors to fully verify this point.

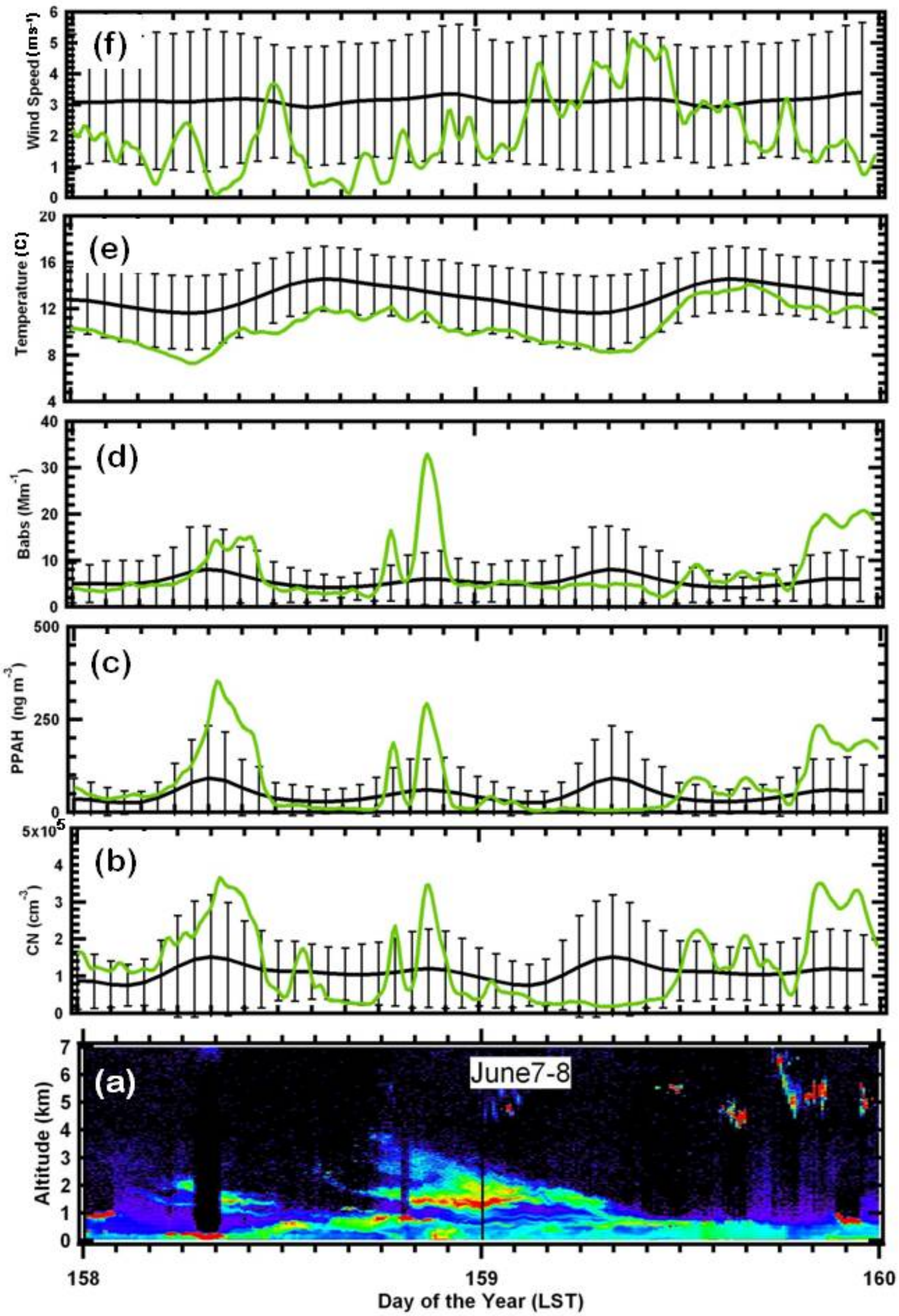


Figure II. Time series for the period June 7-8, 2011 showing a) the vertical profile of aerosol extinction coefficient, b) CN concentration, c) PPAH concentration, d) absorption coefficient, e) temperature and f) wind velocity. The black solid lines are the daily average background from days with no volcanic ash and the vertical bars are one standard deviation. The green lines show the ten-minute averages observed those days.

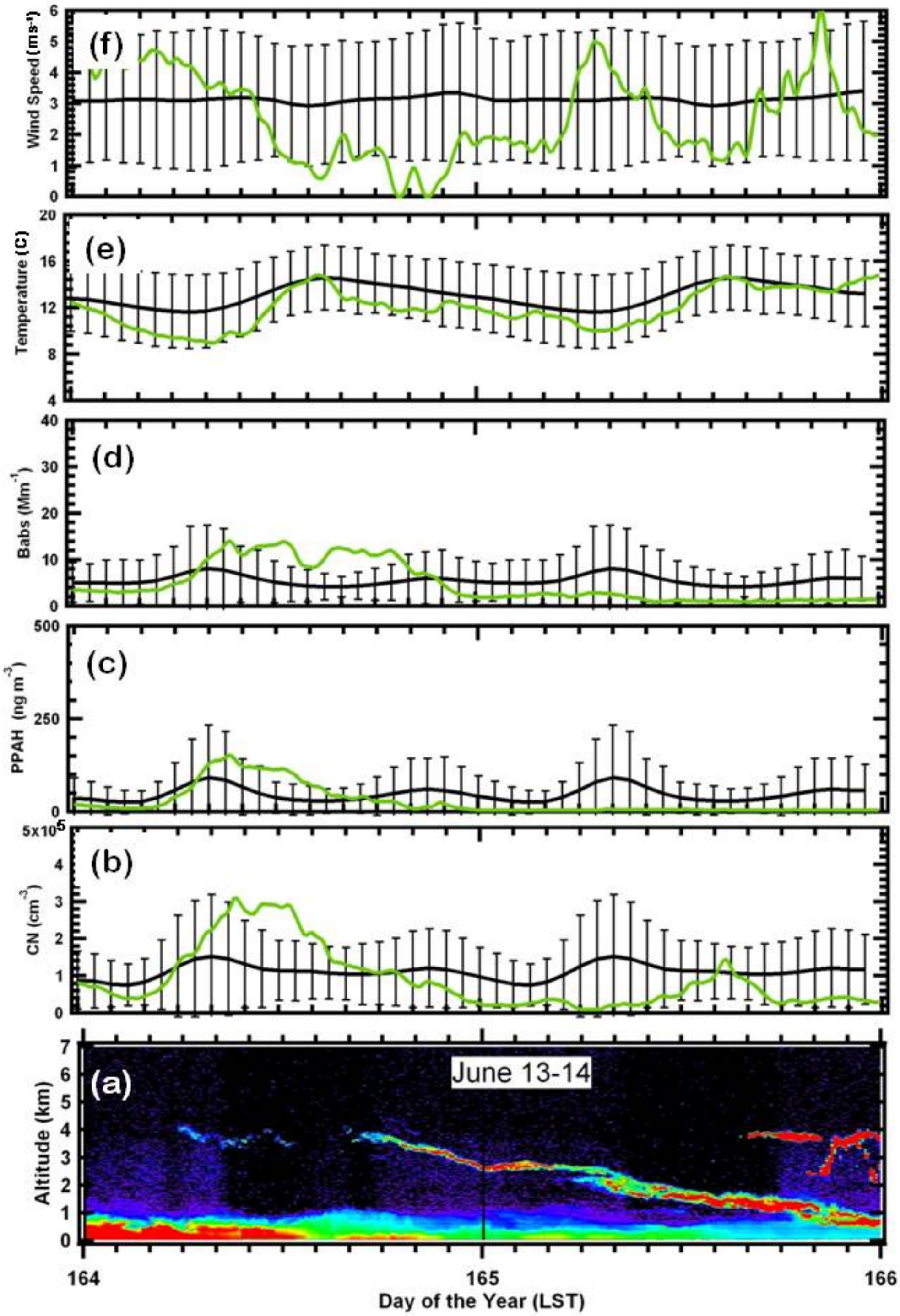


Figure III. Same as Fig. 2 but for June 13-14, 2011.

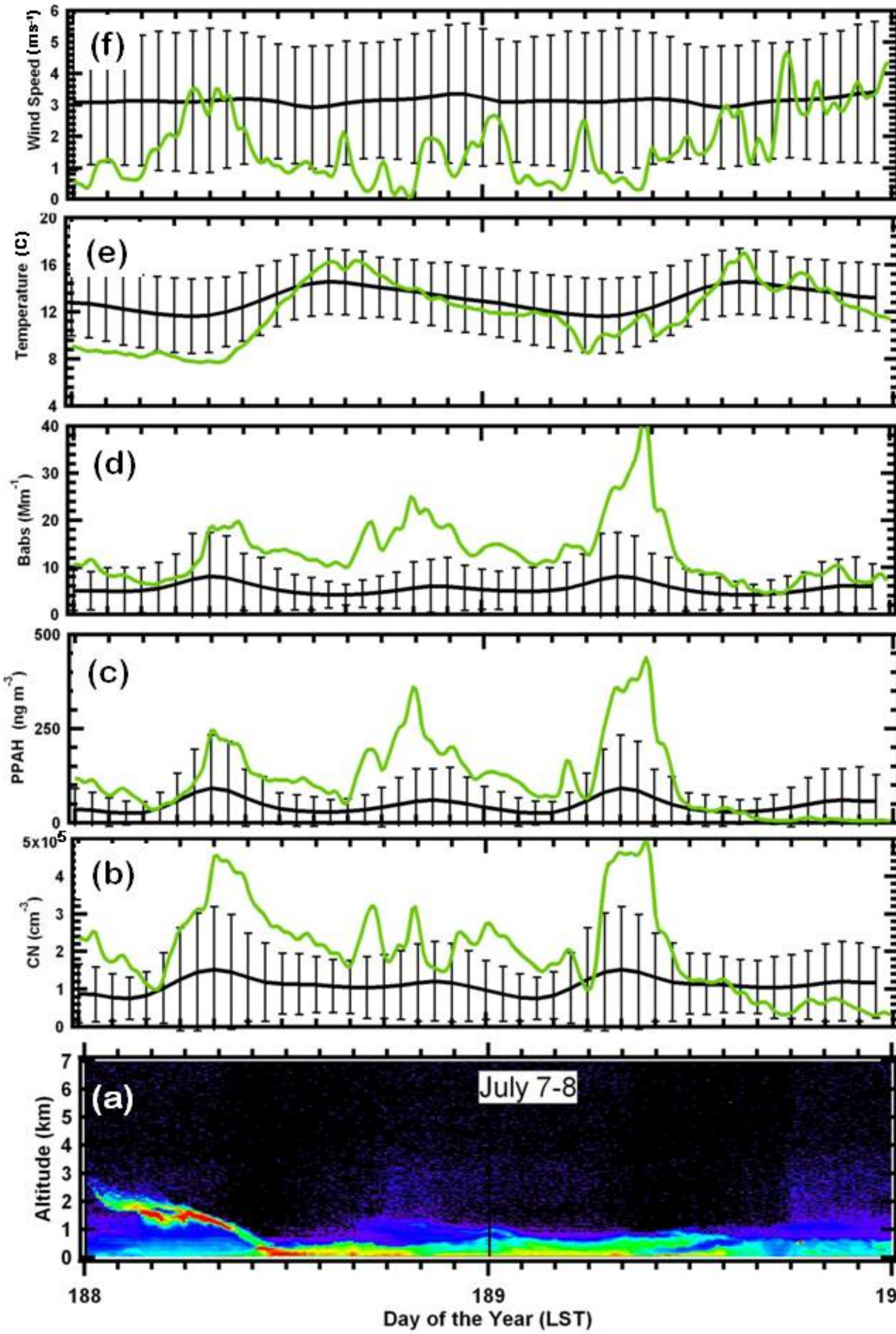


Figure IV Same as Fig. 2 but for the period July 7 and 8, 2011.

In order to support our statement that the temperature decrease may be related to the presence of ash in the atmosphere blocking solar radiation, we present here the near surface temperature (from NCEP Reanalysis-2) and the AOT derived from MODIS on Aqua and Terra (Figure V). The leftmost panel shows the spatial distribution of the near surface temperature before the volcanic plume reached Buenos Aires. Note that the near surface temperature shows a spatial distribution similar to the spatial distribution of the AOT. We are not implying necessarily cause and effect, just a noteworthy spatial correlation. All episodes listed in Table 1 were analyzed similarly. This Figure has now been incorporated into the revised version of the manuscript as Figure 5.

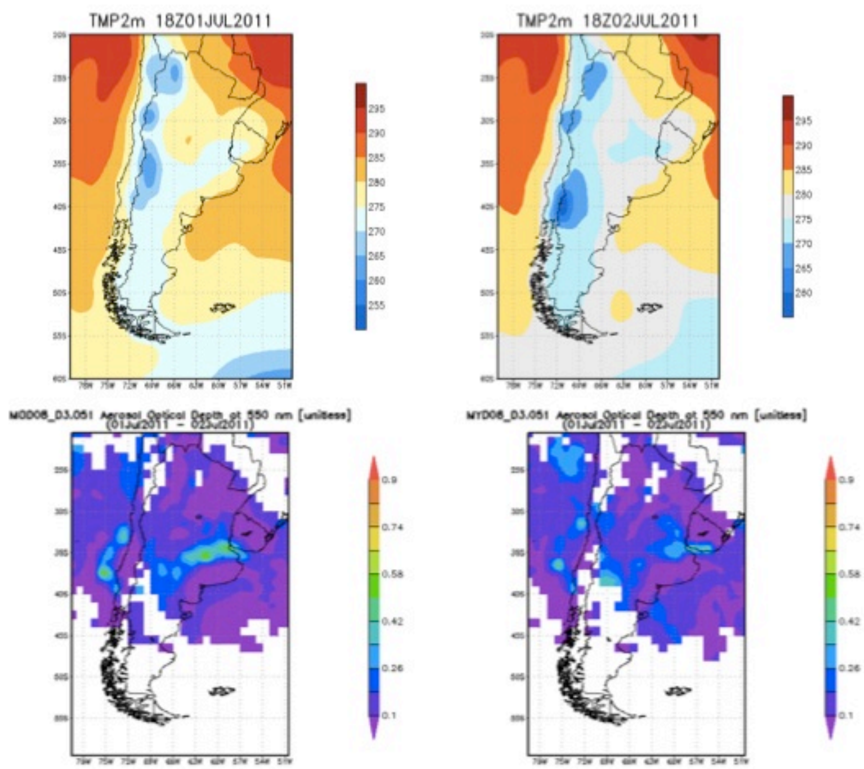


Figure V. Top panels correspond to the spatial distribution of the near-surface temperature (derived from NCEP-Reanalysis 2 database) for 18 UTC on 1 and 2 July 2011. The bottom panels correspond to the observed AOT from MODIS for the same 2 days.

Ref: The authors mention in many parts of the text that that they analyze “particle properties” (e.g. P1511:L13, P1515:L4, P1514:L7, etc). However, they do not measure aerosol physical properties (e.g. size or shape) but only optical properties and particle mass/number concentration. This adds some confusion. I am not an expert in aerosol measurements but to my knowledge, measurement of physical properties requires of multi-wavelength instrumentation (e.g. to determine the Amstrong exponent), which was probably not available here. This, and the limitation of their measurements to discriminate aerosol types, should be mentioned.

Answer: During the campaign we had a Lasair II equipment to measure size distributions of aerosol particles, but the data were not presented in this manuscript. The Armstrong exponent is only a parameterized way of describing the size distribution and the reviewer is correct that with our Vaisala ceilometer cannot compute it. In order to avoid confusion we have removed the words ("aerosol physical properties") and only mention aerosol concentration and optical properties.

Ref: The source of PM10 concentration measurements is not discussed nor mentioned in Table 2. Is it an air quality station? Please give some more explanations in P1514:L7.

Answer: Yes, the $PM_{10}$ measurements are obtained by an air quality station funded by the city government, labeled Estacion Cordoba (see photo below). This has now been included in the revised text.

The monitoring is performed with automatic equipment (TEOM with $PM_{10}$ inlet, THERMO Scientific) consistent with the US EPA normativity. This has now been included in the text.


Technical corrections

- Change "volcanic plume" to "volcanic cloud" throughout the text.

Not sure why the referee prefers the word "cloud" to "plume". Cloud typically refers to a physical phenomenon with the presence of water (at least 2 phases and often all 3 phases) in the form of microphysical hydrometeors and have well known internal dynamics depending on the cloud type. While the initial plume close to the eruption may contain water vapor (and also liquid and solid, depending on the height of the plume), once it is far away from the source (as in this study) the plume most likely does not contain liquid and/or solid water. Note the one of the co-authors (DB) is currently a member of the International Commission on Clouds and Precipitation (under IAMAS) and the lead author (GBR) has been a past member. The text was not modified.

- P1509:L7. “began an eruptive process on” → “erupted on”
Changed.

- P1509:L7. Specify if 2.45pm refers to LT or UTC.
Clearly noted on text now.

- P1509:L8. The eruption was NOT from Puyehue strato-volcano but from vents in the Cordón Caulle volcanic complex. This error is repeated several times in the text. Please correct.
Corrected

- P1509:L8. “Southern Volcanic Zone” → “Southern Andes Volcanic Zone”
Corrected

- P1509:L24-26. To be precise, the responsible for issuing warnings in the South of South America is the BsAs VAAC, hosted by the Argentinean Weather Service.
Clarified in revised text.

- P1513:L15. Eq (1) should read 0.553 according to Fig 1.
Changed in Eq (1)

- P1513:L15. Here I do not understand well. The fit to compute the extinction from the backscattered power is derived from measurements between 20-60m and then used at all heights up to 7km (eq.1)? Is this correct?
Yes. The rationale for doing this is the following: the extinction coefficient in calculated from surface in situ measurements. We want to relate them to the raw counts from the ceilometer, in order to have measurements with which to estimate the optical depth from the ceilometer. We do this when the boundary layer is well mixed, so that the surface extinction is representative of the ceilometer raw counts in the layer. The relationship is then applied to all raw counts obtained from the ceilometer.

- P1514:L4. “particle properties” → “particle optical properties”
Since sometimes the phrase “particle properties” do not necessarily refer to “particle optical properties”, we have chosen to replace “properties” for “measurements”.

- P1514:L22. Figures 2 and 3 show meteorological data. From which source?
The meteorological conditions during the event were studied using the reanalysis dataset for the National Centers of Environmental Prediction, National Center for Atmospheric Research (Kalnay et al, 1996). This information has now been included in the revised version.

- P1516:L7. Volcano days → days with volcano influence
Changed throughout the text.

- P1518:L5. Check English
Not sure what the error was. The first sentence was changed into the passive voice and the third sentence was rewritten.

- P1518:L22. Heights of 10km occurred only during 4-6 June. The eruptive column was much lower afterwards.
Noted in the revised text.

- P1522:L5. Not so sure about this conclusion. AOT measurements from different sources do not seem very consistent from Fig7.
The word consistency was removed, and the text modified to indicate that all platforms observed enhanced AOT linked to the volcanic plume.

Table 2. I would add a column showing the frequencies of measurement for PSAP, nephelometer and ceilometer. Also, other instrumentation not deployed at UBA (AERONET, MODIS) could be added.
Table 2 includes the sampling frequency and the text mentions that the data were averaded to 10 minute resolution for the analysis.

- Fig 4. No color-scale provided for Fig4a
The figure now has the color scale.

- Fig 7. Do not understand the green code on day 191. . .ceilometer measurements are much higher than during other days marked in red or yellow. . .
The green is based upon the measurement of the ceilometer, located only 1 km from the airport. The ceilometer AOT values (red bars) are not much higher than during other days. The AERONET sunphotometer indicates very high AOT (blue bar), but is located farther away from the airport and the approach and landing patterns do not pass over the site where the sunphotometer is located.