Atmos. Meas. Tech. Discuss., 4, C2461–C2482, 2011
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Interactive comment on "Smoke aerosol and its radiative effects during extreme fire event over Central Russia in summer 2010" *by* N. Chubarova et al.

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Received and published: 27 December 2011

The authors are very grateful for the very helpful comments of the reviewers, which helped to significantly improve the quality of the paper. The pdf version of the answer with a new Figure and right formatting is attached in the supplement.

Response to the C2077 reviewer comments: 1. The authors provide very interesting observation of aerosol absorption spectral dependence from UV to visible. However, these properties were derived differently: in visible from AERONET, in UV from matching irradiance measurements. In principle, one can imply that the observed differences in aerosol properties can be caused by differences in type of observations. At the same time, the authors show some irradiance measurements were available in visible too. I would suggest to the author considering to check the consistency of these two types of observation. For example, by trying to model irradiances in visible using AERONET retrieved properties. The authors also could outline more clearly if spectral trends observed in AERONET data agree with the observation of increased aerosol absorption in UV. (it seems they well agree?)

We have rewritten this part of the text. The model comparisons now have been made with one minute resolution data which help to make the consistent comparisons between total shortwave irradiance at BOA (using AERONET RT model), UV300-380 and erythemally-weighted irradiance (TUV model). Yes, we have a very good agreement between measurements and model shortwave irradiance with AERONET SSA values. See the added text: "There is a perfect agreement between model and measured shortwave irradiance. On the whole there is no any bias, standard deviation is about 3%, and maximum difference does not exceed 10%." However, for UV if we use the same SSA we will obtain significant model overestimation. The SSA_UV values for each series of measurements have been retrieved. They are much smaller than in visible. See the text below and the new Figure 11. Table 3 has been removed. "Fig.11 also presents the comparisons made for UV spectrum. When calculating UV irradiance we used here the available SSA values at 441nm. One can see that the application of SSA from visible spectral range has led to dramatic difference between UV measurements and modeling of about 50% at large AOT. Using the approach described above we calculated the SSAUV values, which would give the perfect agreement with UV measurements. According to our estimations the SSAUV should be significantly lower to match model irradiance with UV observations (see Fig.11) both for UV300-380nm and for EW irradiance, which has the maximum in UV-B spectral region. For UV300-380nm irradiance the SSAUV should be around 0.9, and it should be around 0.8 for EW irradiance. This is quite reasonable because the high concentration of organic compounds in smoke aerosol can dramatically increase the aerosol absorption coefficient in UV and especially in UV-B spectral region (Sviridenkov, 2008). At the same time we obtained quite pronounced decrease of SSA values with the AOT500 increase (see Fig.11). The existing dependence between AOT and SSA at extremely high AOT values can be observed due to more fresh aerosol “fire” cloud, which have both larger AOT and higher content of organic component. However, further analysis is necessary to verify the possible uncertainty of the retrievals in these conditions. As a result, we can state that the dramatic UV irradiance loss compared with total shortwave irradiance is explained by several factors: by higher AOT in UV from 0.2 up to 1.2, lower SSAUVïĄ¿0.8-0.9 with the tendency of SSAUV decreasing with AOT increase, and by some additional effects of gas absorption (few percents). “

Fig.11.Comparisons between measurements and modelling (Relative Difference=Measurement/Modelling-1,%) for shortwave irradiance , UV300-380nm and EW irradiance (left axis) and the retrievals of SSA for EW irradiance and UV300-380nm (right axis). See the details in the text.

2. Figure 11 shows the dependence of aerosol radiative forcing as a function of aerosol optical thickness. It seems that the authors did not account for the fact that aerosol radiative forcing depends on solar zenith angle because since direct solar flux at the surface naturally depends on solar zenith angle. For example, the author case see illustrations of this effect in both measured fluxes and modeled from AERONET in the paper by Derimian et al. 2008. I believe if the authors account for the dependence of the forcing on solar zenith angle, the spread in Fig. 11 will decrease and the regression trends will improve. Full reference: Derimian, Y., J. -F. Leon, O. Dubovik, I. Chiapello, D. Tanré, A. Sinyuk, F. Auriol, T. Podvin, G. Brogniez, and B. N. Holben, ”Radiative properties of aerosol mixture observed during the dry season 2006 over M’Bour, Senegal (African Monsoon Multidisciplinary Analysis campaign)”, J. Geophys.Res., 113, D00C09, doi:10.1029/2008JD009904, 2008. The obtained results showed that contrary to the RFE at the BOA the dependence on solar zenith angle is not very large - few Wm-2 in a large range of sza 50-75 degrees. We have included the discussion on

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the recommended paper and other papers in the text. The RFE is very sensitive to SSA that explains the deviation in typical conditions. On the other hand to obtain the climatological effect we need to use all available statistics in clear sky conditions at different SZA, SSA, AOT,etc. The text has been changed. See the text: “Since the radiative aerosol properties were quite similar during the fires 2002 and 2010, we combined all the data in order to obtain the dependence of RFE versus AOT500. In addition, we obtained the average dependence of RFE versus AOT500 for typical clear sky July-August conditions during 2001-2009. For these two groups we combined all available RFE retrievals within the wide range of aerosol characteristics and solar zenith angles in 50-75ïĆř range. Note, that there is only a slight RFE dependence on solar zenith angle within few Wm-2 (Derimian et al., 2008 (Fig.9b there), Haywood and Shine, 1997) at relatively low surface albedo typical for summer conditions. However, using the whole statistics we take into account for these slight changes when characterizing the climatic effect of aerosol.”

3. Figure 6 shows the errors bars for the retrieved size distribution. Those errors bars are not very realistic for the values corresponding to the very small and very large particles (too small). They show look more like in the paper by Dubovik et al. (2000). I understand that those errors bars were taken from the AERONET code output. However, I am aware that those error bars should be corrected for size distribution (for other parameters they are ok). I suggest, either to remove the errors bars for size distribution or contact the AERONET code developers and get updated errors bars for size distributions.

The error bars demonstrate the confidence interval at 95%. They were calculated using the simple standard statistical approach: Conf=1.96*st.deviation/Nˆ0.5. The error bars demonstrate ONLY this standard statistical variation of the analyzed samples. We do not have a task to analyze the real errors of retrievals of size distribution. We changed “error bars “ term to “confidence interval” for better clarification. “Fig.6. Mean aerosol volume size distribution in fire conditions (red), August 2010, and typical August

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conditions (black) with the confidence intervals at 95%. AOT500 values in the legend are the averages corresponding to the samples. Moscow."

Responses to C2284 reviewer comments: General comments: 1. The section "Discussion" does not bring new information and does not raise any new question besides those which are discussed in "Results" and "Conclusions". A lot of numbers from the "Results" and "Conclusions" are repeated here.

We changed the text trying to add in the Discussion part the comparisons with other fire periods mainly Moscow fire 2002. Some new material has been added in this section. We also included the part on visibility in fire conditions 2002 and 2010 there. See the text of the Discussion section: Discussion: "Summer 2010 in Central Russia was characterized by unprecedented high temperatures and by the absence of precipitation. This was expressed in large number of days (17 days) with the extremely dangerous Nesterov's flammability classes N=5, during which the most intensive "fire" cloud was generated over Central Russia. For comparison, in 2002 the number of days with N=5 comprised 12, while in 1972, when the first intensive wildfires were observed near Moscow region, during only 5 days. This matches well the AOT level as well as the level of radiative losses in 2010, 2002 and 1972 (Chubarova et al., 2011b). The largest AOT values and radiative losses were observed in 2010, the smallest ones – in 1972. The analysis of aerosol properties during the extremely intensive wildfires over Central Russia in 2010 has revealed some interesting features. Microphysical properties of smoke aerosol have a noticeable increase of fine mode fraction. It comprises about 70% of total volume content in 2010 and 73% during the fires in 2002 compared with 55% in typical conditions. These results are in an agreement with the data obtained by (Dubovik et al., 2002 and Eck et al., 2003) for biomass burning aerosol. There is also a pronounced shift in fine aerosol mode distribution towards larger radii from reff fine=0.15 ïA■m in typical conditions to the value of 0.24 ïA■m at extremely high AOT during fire events 2010. The real part of the refractive index REFR=1.54 is higher than that in typical conditions (REFR=1.44) while the imaginary part of refractive index is

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much lower (REFI=0.006 compared with REFI=0.010). Changes in size distribution and imaginary part of refractive index significantly have increased the single scattering albedo to 0.95 in visible region compared with SSA=0.89 in typical conditions. On the whole, fire aerosol properties in 2010 are in a good agreement with the results obtained during fire events in 2002. However, the REFR is some higher, possibly, due to extremely high temperatures, which can lead to additional drying the aerosol particles. Aerosol optical thickness at 500 nm has reached its absolute maximum on 7 August with AOT=6.4 in Moscow and AOT=5.9 in Zvenigorod. This is approximately 2 times larger than the previous maximum AOT500 $\sim$3 observed during the fire event in 2002 (Chubarova et al., 2009). Note that these AOT maxima in 2010 were observed together with the unprecedented low visibility of about 100 meters. In 2002 the lowest visibility observed during the fire event was about 500 meters. The irradiance losses also show some peculiar features. The most pronounced losses of solar irradiance were observed on 7 August between 11h and 14h solar time at high solar elevations and extremely high AOT500ïĄ¿6. The maximum losses of solar irradiance in all spectral intervals were observed soon after solar noon at high solar elevation when EW irradiance was attenuated by 97%, UV300-380 - by 91% and shortwave irradiance - by 64%. Note that this is the most severe attenuation of solar irradiance observed in clear sky conditions for the whole period of observations. The largest attenuation during the fires in 2002 has reached 75% for EW irradiance, 62% for UV300-380 and 32% for shortwave irradiance (Chubarova et al., 2009). Model simulations of shortwave irradiance (the AERONET RT algorithm) with exact aerosol input parameters have revealed an excellent agreement with measured values. However, these values can not be used for modeling UV irradiance since in this case the discrepancy between model and measured values can reach more than 50%. The SSAUV values are significantly lower than SSA$\sim$0.95-0.96 in visible spectral region (see Table 2). For 2010 smoke aerosol event the average SSA for UV300-380nm is about 0.9 and for EW irradiance it is about 0.8 with a noticeable tendency to decreasing with AOT increase. At the same time these UV SSA value lies within the range of SSA obtained in UVB spectral region

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in other geographical regions (Bais et al., 2007). We should note that according to our previous calculations (Chubarova et al., 2009) the best agreement between model and experimental UV data (and UV losses) in smoky conditions 2002 was also observed after the application of SSAUV=0.9 for AOT500 not exceeding 3. On overall, model calculations indicated the main reasons of the dramatic UV irradiance loss: higher AOT in UV compared with AOT in visible spectral region and lower SSAUVïĄ¿0.8 (for EW irradiance) and SSAUVïĄ¿0.9 (for UV300-380nm irradiance) with the tendency of SSAUV decreasing with AOT growth. In addition, radiative forcing effects of fire smoke aerosol at the top of the atmosphere were examined and compared with those in typical conditions. We obtained simple RFE approximations as a function of AOT500 for typical and smoke aerosols according to long-term AERONET measurements over Moscow. By using these equations, the assessments of RFE with different temporal averaging (instant and climatological) have been obtained. The results for smoke aerosol were compared with the climatic value for typical non-smoke conditions. For typical August conditions the computed RFE comprise about -20 Wm-2. This value is some higher than the results obtained in (Yu et al., 2006) for summer conditions over this area (-11.1 Wm-2). However, MODIS AOT retrievals used for this estimate is much lower and are about AOT550=0.2. After AOT correction RFE values are in agreement within 10%. In smoky conditions the maximum instant RFE at the TOA has reached -167 Wm-2 at maximum AOT=6.4, which should lead to intensive cooling of the atmosphere. In 2002 the maximum instant radiative forcing effect was much lower (RFEïĄ¿-120 Wm-2) due to smaller AOT not exceeding 3. Even monthly mean RFE effect (-65 Wm-2) in 2010 for August is more than 3 times higher than the typical radiative cooling of non-smoke aerosol. “

2. It is not clear how significant was the increase of the air temperature and how much lower was the precipitation comparing to typical summer conditions in Central Russia. Please, give numbers or show the comparison plot.

The additional information has been included: “Since July the daily mean temperature exceeded 25ïĆřC and in some days - 30ïĆřC. On 29.07 the absolute temperature maximum 38.1°Ðą has been recorded. The temperature anomaly in July was about +8ïĆřC and about 6ïĆřC in August. The total precipitation during the whole July and in the first decade of August was around 8 mm which comprises 8% of the mean climatic value."

3. The discussion on the Nesterov's number might be organized as a separate chapter (3.2).

We decided not to organize a separate chapter but we changed the name of the subsection accordingly to its content: "3.1. Meteorological conditions and temporal variation of aerosol".

4. When you talk about Moscow, do you use the information from others than MO MSU stations? Please, clarify in the text.

When we speak about Moscow we use only the data from MO MSU site. We added this information in the "Data and methods of analysis" section (see the last sentence) and in the abstract: "It should be emphasized that all measurements marked as "Moscow" in the paper refer to the data provided by Meteorological Observatory of Moscow State University (MO MSU)." In abstract: "Different microphysical, optical and radiative properties of aerosol were analyzed during the severe fires in summer 2010 over Central Russia using ground measurements at two AERONET sites in Moscow (Meteorological observatory of Moscow State University - MSU MO) and Zvenigorod (Moscow Region) and radiative measurements at the MSU MO."

5. Do you have the information on the visibility during the event? Would be interesting to include that information as well.

The analysis on visibility has also been included in the discussion part for the extremely high aerosol loading conditions (see the Discussion section). "Aerosol optical thickness at 500 nm has reached its absolute maximum on 7 August with AOT=6.4 in Moscow and AOT=5.9 in Zvenigorod. This is approximately 2 times larger than the previous

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maximum AOT500 ~3 observed during the fire event in 2002 (Chubarova et al., 2009). Note that these AOT maxima in 2010 were observed together with the unprecedented low visibility of about 100 meters. In 2002 the lowest visibility observed during the fire event was about 500 meters. "

Also measurements of the angular scattering coefficients near surface were carried out at Zvenigorod station during smoke events. The estimated maximal value of the volume scattering coefficient at wavelength of 550 nm exceeded 6 km-1. That corresponds to the visual range of about 600 meters.

Specific comments:

p. 6352, line 11 - according to the Table2, the average SSA for fire conditions 2010 was 0.96 The Table has been slightly changed, the value was right. Thank you.

p. 6352, line 12 - explain what AOT is Added

p. 6352, line 13 and further on - AOD in Moscow or at MSU MO? In the final version we have included the sentence which clarifies what we mean under Moscow: In the Abstract: "Different microphysical, optical and radiative properties of aerosol were analyzed during the severe fires in summer 2010 over Central Russia using ground measurements at two AERONET sites in Moscow (Meteorological observatory of Moscow State University - MSU MO) and Zvenigorod (Moscow Region) and radiative measurements at the MSU MO."

And there is a clarification in "Data and Methods of Analysis" section:

"It should be emphasized that all measurements marked as "Moscow" in the paper refer to the data provided by Meteorological Observatory of Moscow State University (MO MSU)."

p. 6353, line 10 - ". . . typical properties of the atmosphere". Typical globally or for the studied area?

Added: “over this area” p. 6353, line 13 - clarify, what are the “other wildfire conditions”

Added: “in different parts of the world”

p. 6353, line 15 - is “Moscow MSU – Moscow State University” – the other name for MSU MO? The information in parenthesis is read as the names of three stations Sorry. “The analysis has been made on the base of datasets from the two AERONET sites (MSU MO and Zvenigorod)” p. 6353, line 15 - “some distance” – not clear how far, indicate the approximate distance We’d like here only to emphasize that the fire emission was not near the sites. This is important for the aerosol properties. The closest fires could be 30- 50km from the site. We think the exact numbers are not very important here. p. 6354, line 16 - what do you mean by “morning and evening conditions”? Explain the difference

We mean another measurement schedule, which is applied at higher zenith angles in morning and evening than that at lower zenith angles around the noon.

p. 6354, line 20 - Eck 1999 – not in the reference list Thank you, added.

p. 6355, line 2 - add “0.5_ <. . . ”

Added. p. 6355, line 2 - is “Version 2.0” same as “level 2.0”? You speak about version first and in the next paragraph move to levels. I suggest to explain what are the different levels and after that mention which data were used in the current study.

The term “ version” means the different algorithms. The term” level” means different quality of the same algorithm (with or without cloud-screening).

p. 6355, line 29 - correction was applied to AERONET level 2 data?

Correction was applied to AERONET level 1.5 data (except for August 7, when we used reprocessed raw data).

p. 6356, line 1 - Was Langley plot method applied when it was possible? Not clear. In an explicit form, no, due to significant temporal variations of AOD.

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p. 6356, line 8 - “raw” means AERONET level 1 data?

No, level 1 uses some additional filtering, see the text: “The AOT values were computed from the raw voltages using individual measurements within a triplet, since limits on triplet variation in the AERONET algorithm even at level 1 have led to removing the data with strong changes.”

p. 6356, line 11 - matching between Zvenigorod and Moscow?

Yes. The inversion product (single scattering albedo, for example, after application of this correction is quite close to Moscow data (around 0.96 in visible).

p. 6356, line 16 - “Moscow” means “MSU MO” or other station? Yes. Changed.

p. 6357, line 16 - suggest to use more concrete than the “heart” geographical location

Sorry, we don’t grasp your idea.

p. 6357, line 18 - write “and in” instead of “and to”

Changed

p. 6357, line 18 - write “the” instead of “these”; define the starting and ending dates of the period

Since we included the additional information on meteorological conditions, we think this is not necessary to add here the exact dates which are mentioned in the sentence below.

p. 6357, line 26 - write “close to zero” instead of “zeroised”

The value in this conditions is not close to zero. It is zeroised. We set zero in this case.

p. 6358, lines 4-10 - what were the N values for the other fire events in Moscow area? Statistics for the years from the “Discussion” part will be interesting to see here.

We decided to put all comparisons with other fire period in Moscow 1972 and 2002 in the Discussion section to make the difference with the Result section.

p. 6358, line 10 - “These creates. . . .” – not clear. Statistics for N show that especially favourable conditions for fires were observed in 2010?

The higher the number N the higher is the potential for fires in the area. We have slightly changed the text. During this period especially favourable conditions for fire inflammation were observed. p. 6358, line 17 - what is “r” here? Correlation coefficient? “r” is used on p. 6355, line 2 to define the Radius

Changed to: “correlation coefficient R=0.76”

p. 6358, line 20 - give the reference the source for back trajectories. Added: NASA/GSFC 7-day

p. 6358, line 26, 25 - use “R” for the correlation coefficient Yes. Used.

p. 6359, line 1 - was the special processing applied for the whole Moscow data set as well? Not clear from the “methods” section. Why the only point is shown on Figure 4? Add the other line for the special processing in Moscow as it is done for Zvenigorod

We added the names of the sites in the section for better clarification. In section 2 there was a special paragraph on this item: “In this analysis special processing was used for the day 7 August 2010 with extremely high AOT for Moscow and Zvenigorod datasets. The AOT values were computed from the raw voltages using individual measurements within a triplet, since limits on triplet variation in the AERONET algorithm have led to removing the data with strong changes. Such variations within triplet can occur in conditions with extremely high aerosol loading. Though these data are not the standard AERONET product, they will be useful in the analysis, since they show real AOT level observed in smoky conditions. “

p. 6360, line 7 - write “5a” instead of “5” Changed. p. 6358, text for Figure 5 - What was the reason to combine figures 5a and 5b into one figure? Figures 5a and 5b contain different information that can’t be compared.

The analysis is done for the same day and it is interesting to see the temporal and spatial variation of "fire cloud".

p. 6360, lines 10-12 - give numbers The numbers are given in the following sentences. We remove the 1 row below for better understanding.

p. 6360, line 16 - delete "I" Thank you. Deleted.

p. 6360, line 18 - which "typical" conditions?

Added "Moscow"

p. 6360, section 3.3 - explain what REFR and REFI tell about Added: "Real and imaginary parts of refractive index (REFR and REFI, respectively) are the important optical characteristics of aerosol and have some specific features for smoke aerosol observed in Moscow compared with the typical values"

p. 6361, line 9 - use "agreement" instead of "accordance"

Changed p. 6362, line 19 - use "high" instead of "higher" Changed.

p. 6362, line 22 - used in present studies? Not clear

We changed "estimates" to "approach". Hope this clarify the text.

p. 6362, line 25 - results form Chubarova et al. (2009) and from present studies are mixed – not clear. SSA was (?) lower than SSA from the Table 2? Which SSA was used to model 2010? In the table 2 SSA =0.96. Why here and further (p.6363, line 16) the given number is 0.95-0.96? Why there is a difference between measured (0.96) and modeled (0.8-0.9) SSA?

In visible we have the estimates of SSA due to the AERONET algorithm. In UV spectral region the values can differ due to changes in spectral optical properties of aerosol. That is why here we used another approach and evaluated the SSA from matching ground-based measurements and modelling. For better understanding we added the index UV to SSA - SSAUV. The text has been changed:

"Unfortunately, SSA retrievals in UV spectrum (SSAUV) are not available in AERONET algorithm. In our previous approach, which has been applied to the data analysis of Moscow fires 2002, we used the approximate model fitting to evaluate the SSA values, which are necessary to apply in the model for obtaining the agreement with UV losses in smoke aerosol conditions."

p. 6363, line 6 - explain "EW radiance" Added "Maximum losses have reached 64% for total shortwave irradiance, 91% for UV radiation 300-380 nm and up to 97% for erythemally-weighted irradiance (EW irradiance) on 7 August at solar elevation h = 47ïĆř within 13-14 h solar time (see Fig.5a)".

p. 6361 3 lines 15-18 - make the sentences more clear. What are the additional effects of the gas absorption?

NO2 as was shown previously (Chubarova et al., 2009) due to its high concentration during the fires is the most effective UV gas absorber. See the following sentence from the text: "In addition, we took into account for additional NO2 absorption during the fire events. This factor can be responsible for the additional 3-9% loss of UV300-380 nm and EW irradiance. "

p. 6363, line 67 - add ". . . . 1.45 for typical conditions" Sorry. We were not able to find the exact place of this comment. We added the number in the Discussion.

p. 6363, paragraph 2 - what do those changes tell about?

These changes tell about the reason why we have much more stronger attenuation of solar irradiance in UV than in total shortwave irradiance.

p. 6363, line 15 - use "lower" instead of "less"

Changed

Tables Table 1 - add statistics for 1972 and 2002 for comparison

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We have a paper devoted to the comparison of 1972, 2002 and 2010 (Chubarova N.E, Gorbarenko E.V., Nezval' E.I., Shilovtseva O.A.: Aerosol and radiative characteristics of the atmosphere during the forest and peat bog fires in 1972, 2002 and 2010 in Moscow suburbs according to the data of Meteorological Observatory of MSU. Journal of Atmospheric and Oceanic Physics RAS, 47, 6, 2011). The time periods of fires were different so it is necessary to add a lot of material for the description of the applied method which has already been fulfilled in that paper. We think that it is not very important to include the numbers here. In the Discussion we added some important comparisons and have a reference to this paper.

Figures Figure 1 âĂć 15h is UTC or local time?

It is local time. Added

Figure 2 âĂć which station? Moscow MSU MO. Added Figure 3 âĂć give the reference for the trajectories source

Added

Figure 4 âĂć in the caption use the explanations for the lines (colors, symbols) instead of the numbers. Or add the numbers to the legend Sorry, but the numbers are both in legend and in caption âĂć use the dates (as in figures 1 or 2) instead of Julian days Changed âĂć give more precisely (section number) the location of the explanations in the text

Figure 5 âĂć divide figure to 2 We would like to leave the figure as is for better understanding the temporal and spatial features of "fire cloud". Figure 6 âĂć give the explanation for error bars

Sorry, maybe we don't understand your comment correctly: we put on the Figure the confidence intervals calculated at 95% using the simple standard statistical approach:

Conf=B *st.deviation/Nˆ0.5,

where B=1.96 corresponds to 95% confidence level when the sample is large. B=2.37 for small sample of fires in 2010 according to the standard statistical tables. . âĂć specify colors in the caption (“fire conditions (red) and in typical conditions (black)”) Specified.

âĂć what are the AOT numbers in the legend – daily mean? Explain in the caption Done: “Mean aerosol volume size distribution in fire conditions (red), August 2010, and typical August conditions (black) with the confidence intervals at 95%. AOT500 values in the legend are the averages corresponding to the samples. Moscow.”

Figure 7 âĂć explain in the caption what are F and C

The caption has been changed. âĂć put the remark that the regression equation is given for fine particles

Done. Paper Figure 8 âĂć mention the colors in the caption

Done

Figure 9 âĂć combine 9a and 9b.

Combined “Fig.9. Spectral dependence of aerosol single scattering albedo (SSA) for Moscow fire conditions in 2010, 2002, and typical conditions with error bars at 95% confidence level in Moscow. In addition, the SSA values over other areas with biomass burning aerosol are shown (Dubovik et al., 2002).”

Figure 10 âĂć change the format for x-axis to “0.5”,”1.0”, ets

Done

Figure 11 - mention short name RFE in the caption

Done.

Please also note the supplement to this comment:

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http://www.atmos-meas-tech-discuss.net/4/C2461/2011/amtd-4-C2461-2011-supplement.pdf

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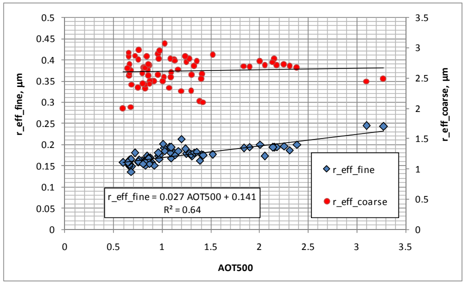

Fig.7. Changes in effective radii of fine (left axis) and coarse (right axis) aerosol modes versus aerosol content (AOT500) during the fire conditions. The regression equation is given for fine mode particles.

Fig. 1.

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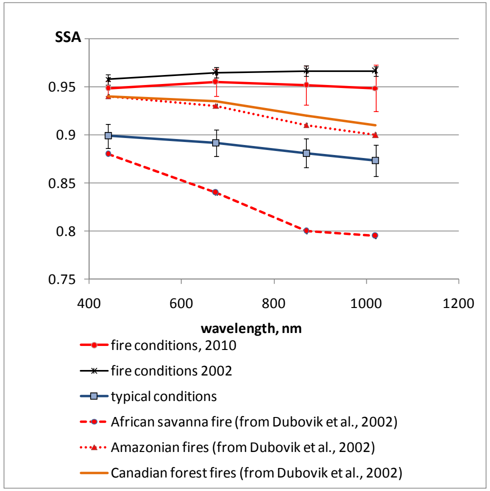

Fig.9. Spectral dependence of aerosol single scattering albedo (SSA) for Moscow fire conditions in 2010, 2002, and typical conditions with error bars at 95% confidence level in Moscow. In addition, the SSA values over other areas with biomass burning aerosol are shown (Dubovik et al., 2002).

Fig. 2.

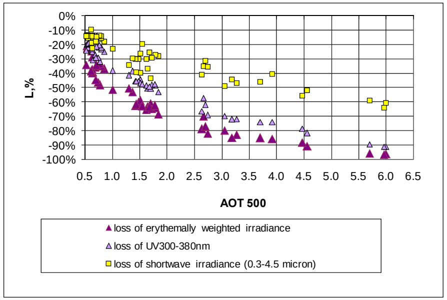

Fig.10. The losses (L, %) of erythemally-weighted UV irradiance, UV irradiance 300-380nm (UV300-380nm), and total shortwave irradiance (300- 4500 nm) as a function of aerosol optical thickness at 500nm (AOT500) during the fire event in 2010. Meteorological Observatory of Moscow State University.

Fig. 3.

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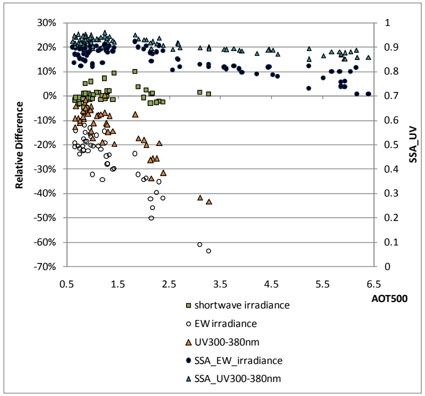

Fig.11.Comparisons between measurements and modelling (Relative Difference=Measurement/Modelling-1,%) for shortwave irradiance , UV300-380nm and EW irradiance (left axis) and the retrievals of SSA for EW irradiance and UV300-380nm (right axis). See the details in the text.

Fig. 4.

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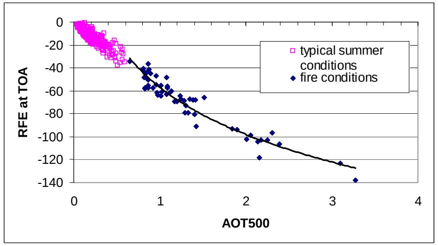

Fig.12. Radiative forcing effects (RFE) at the top of the atmosphere (TOA) as a function of AOT500 in typical conditions (for July-August period) and during fire events 2002 and 2010.

Fig. 5.