We are thankful to the reviewer for her/his help in improving the quality of the manuscript. Our detailed responses to the comments are given below in italic

This is an interesting case study of the impacts of BBA. My main comments are :

1. **There is limited use of available observations to evaluate the impacts of the BBA in the model. The paper refers to surface irradiance observations, it would be useful to use these to evaluate the model.**

As stated in the introduction, Chubarova et al. (2012) analyzed the radiative impact of the 2010 Russian wildfires by using their ground-based measurements, including solar irradiance. Unfortunately, such data are not publicly released. However, previous studies that evaluated the WRF Goddard shortwave radiative transfer simulations with solar measurements have demonstrated its skills to simulate surface visible radiation, especially under particulate pollution conditions (Fast et al. 2006, Mashayekhi et al. 2009, Péré et al. 2011).
Those evaluations of the Goddard shortwave radiation module have been now mentioned in the section 2.2 of the revised manuscript:
"For calculation of shortwave radiation, the Goddard model (Chou and Suarez, 1994) including 11 spectral bands from 0.2 to 6 µm is used. Previous studies that evaluated the Goddard shortwave radiative transfer simulations with solar measurements have demonstrated their skills to simulate surface visible radiation, especially under particulate pollution conditions (Fast et al. 2006, Mashayekhi et al. 2009, Péré et al. 2011)".

There are several radiosoundings available (and more 2-m observations, from outside Moscow). These could be used to evaluate the impacts of the direct effect on the boundary layer, low-level stability and dynamics (e.g just plot tephigrams from obs, control and model with BBA impacts). Are these impacts enough to alter the circulation significantly ?

To complete the evaluation of our results, additional comparisons between simulations and meteorological observations have been now included in the revised manuscript.
Discussions of the aerosol direct effect on the 2-m temperature have been extended to the site of Nizhny Novgorod (located 400 km east to Moscow) and air temperature radiosoundings available at Moscow have been also used.
These additional comparisons have been discussed in the revised manuscript by modifying figure 9 and including following comments in the section 3.2 of the revised manuscript:

"Figure 9b-c presents the temporal evolution of the 2m-temperature (averaged over daytime) simulated with and without aerosols along with corresponding observed values at (b) Moscow and (c) Nizhny Novgorod (located at 400 km east to Moscow, see Figure 1). These results show that the presence of aerosols induces a non-negligible decrease of the near-surface air temperature, between 0.5 to 1.6 °C at Moscow and from 0.5 to 1.0 °C at Nizhny. The highest reduction occurs when the ADRF is the most pronounced, respectively during 7, 8, 9 August and 6, 7, 8, 12 August for Moscow and Nizhny (see figure 7). Compared to the observations, the modelled temperature tends to be overestimated over both sites throughout the period, especially when the feedback of the ADRF is not included in the simulation. This result is interesting as WRF is usually known to have a cold bias during the summer season over Europe (Menut et al., 2012), which strengthens the assumption that the ADRF due to the intense aerosol plume could have a regional influence on the air temperature. Indeed, the presence of aerosols reduces the model biases compared to the simulation without aerosols. This ADRF feedback is shown to decrease discrepancies between model and observations from 2-9 % to 0-5 % for Moscow (figure 9-b) and from 3-9 % to 0.5-6 % for Nizhny (figure 9-c). As illustrated in Figure 9-d, the feedback of the shortwave ADRF does not only occur near the surface but also in the boundary layer. For example, the aerosol cooling effect

simulated over *Moscow during 8 August at midday is maximum near the ground (0.8 °C) and then gradually decreases along the boundary layer (0.42 °C at an altitude of 2400 m). Compared to observations, model biases are positive near the surface (as already shown in Figures 9-bc), negligible between 400 m and 1000 m and slightly negative (3-10 %) at higher altitudes. It is interesting to note from figure 9-d that such vertical structure of air temperature difference between both simulations is favourable to a stabilizing effect in the atmospheric boundary layer (ABL)."*

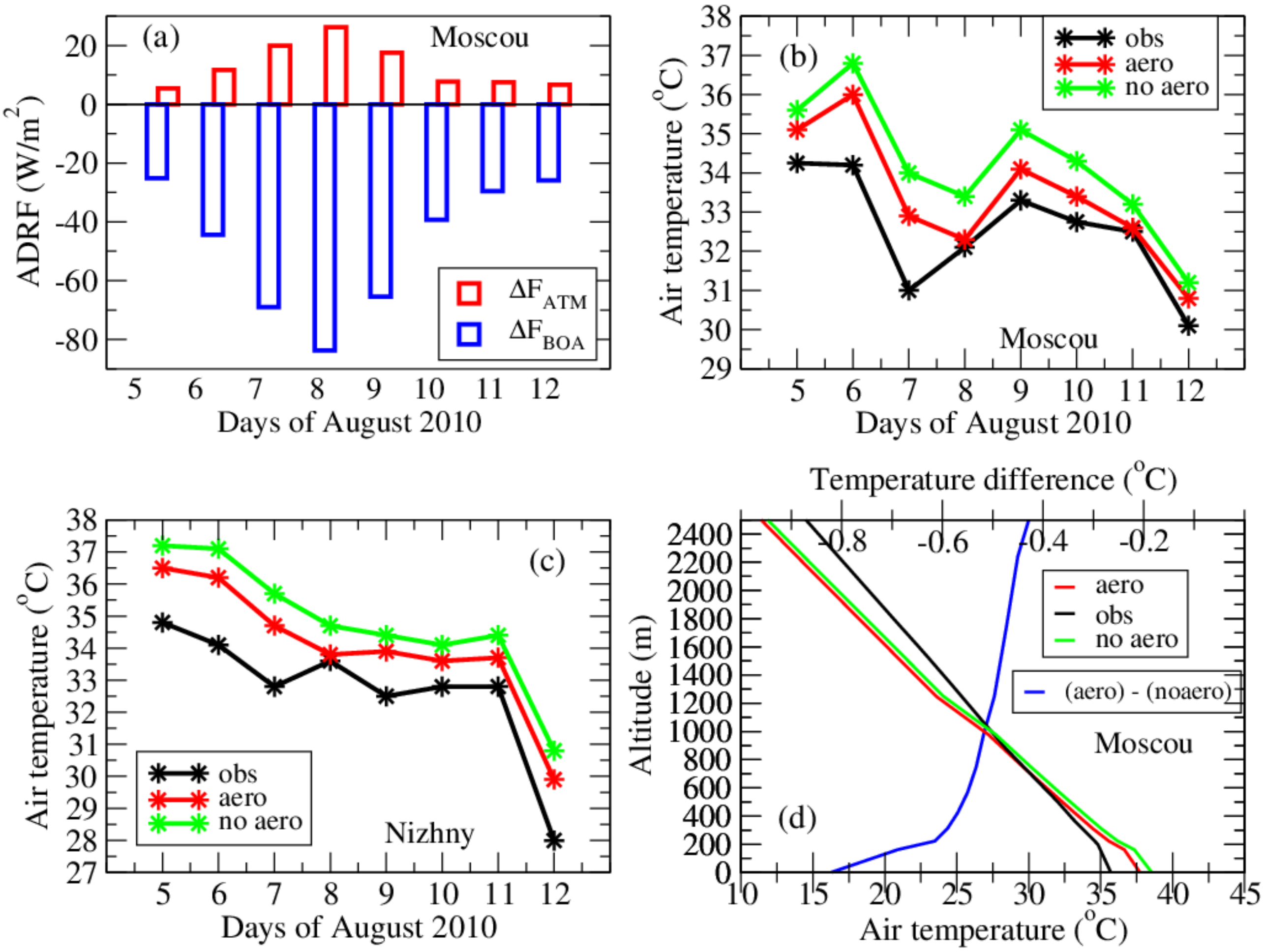

Figure 9: a) Diurnal-averaged shortwave aerosol direct radiative forcing (in W m^2) over Moscow simulated at the surface (ΔF_{BOA}) and within the atmosphere (ΔF_{ATM}). Diurnal-averaged near-surface air temperature (in °C) simulated with and without aerosols and observed at the meteorological station of (b) Moscow and (c) Nizhny Novgorod. (d) Vertical profiles of the diurnal-averaged air temperature for the 8 August at midday, simulated with and without aerosols and observed at the Moscow meteorological station. Temperature differences between both simulations are indicated.

As proposed by the reviewer, we have also improved the discussion about the aerosol direct effect on the atmospheric circulation. In the meteorological community, it is true that tephigrams are generally used to analyze the convective properties of the atmosphere. However, as the main scope of this study is to examine the influence of the ADRF on the dispersion capacity of pollutants, we suggest instead to discuss comparisons between simulated and observed horizontal wind speed.

These additional comparisons have been discussed in the revised manuscript by modifying figure 10 and including following comments in the section 3.2 of the revised manuscript:

"Our simulations indicate that, during daytime, the decrease of the ABL height due to the feedback

of the ADRF is between 13 and 65 %. As a consequence, the collapse of the ABL in presence of aerosols occurs one hour earlier (between 14 and 15 h) compared to the simulation without aerosols (between 15 and 16 h). Such weakening of the ABL development is the result of a lower air entrainment, as the vertical wind speed in the ABL is shown to be reduced by 5 to 80 % (at midday) during 8 August when the feedback of the ADRF is taken into account (not shown). Concerning the horizontal dispersion capacity of particles, figure 10-b indicates that the shortwave ADRF has a much lower impact on the horizontal wind speed. For example, a reduction of only 0.05-0.86 m/s (1-25 %) is simulated during 8 August, suggesting that the dilution of particles would be mainly affected by the weakening of the ABL development and associated vertical wind speed. Compared to observations, the model is shown to correctly reproduce the magnitude of the horizontal wind speed with biases comprised, respectively, between -10 % and 24 % and between -8 % and 35 % for the simulation with and without aerosols (Except for 18 h where discrepancy reaches 70 % for both simulations) ."

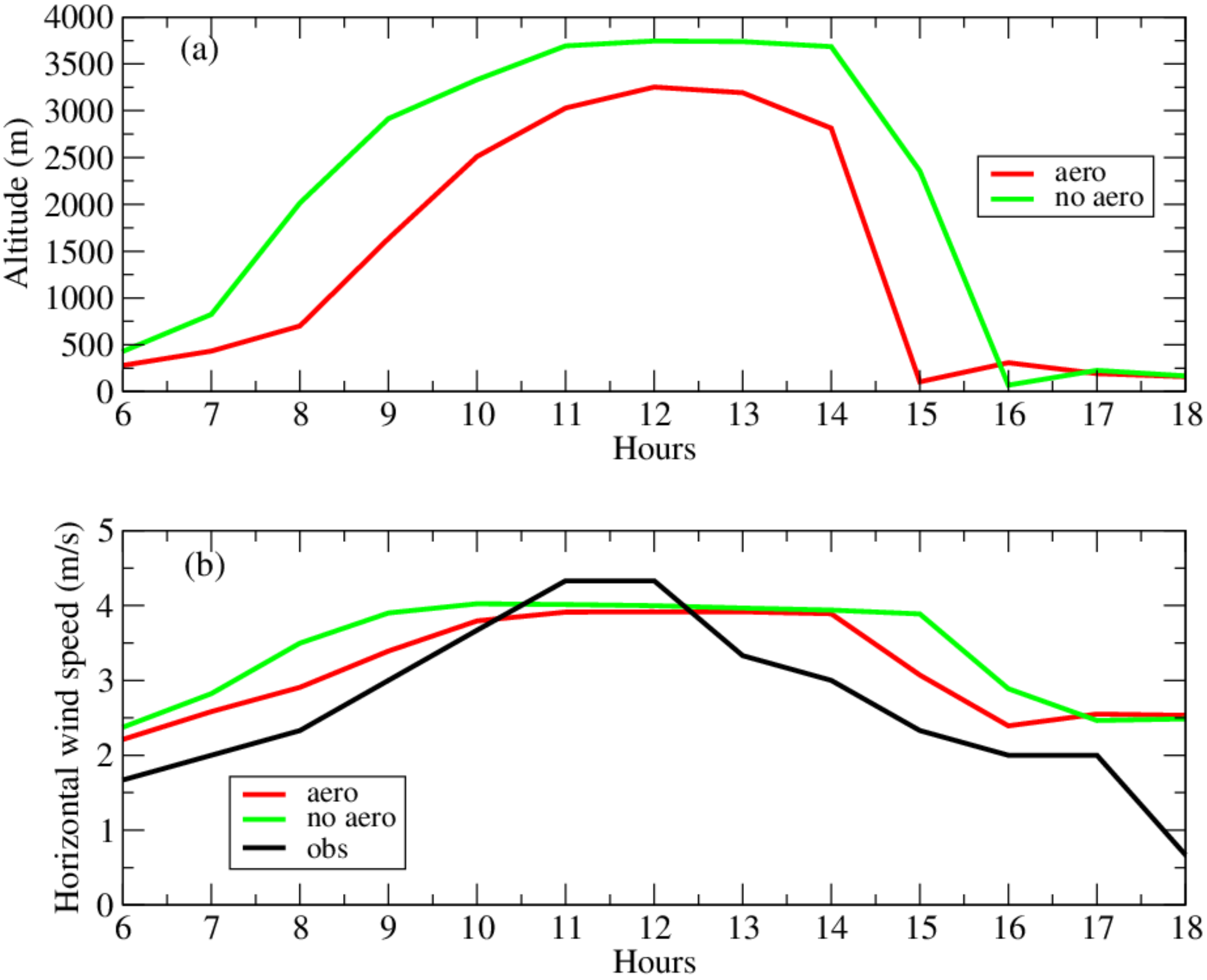

Figure 10: (a) *Temporal evolution of the atmospheric boundary layer (ABL) and (b) near-surface horizontal wind speed (in m/s) during 8 August, simulated with and without aerosols and measured at the Moscow meteorological station.*

References quoted in the response to the reviewer and included in the revised manuscript:

- *Fast, J. D., W. I. Gustafson Jr., R. C. Easter, R. A. Zaveri, J. C. Barnard, E. G. Chapman, G.*

A. Grell, and S. E. Peckham (2006), Evolution of ozone, particulates, and aerosol direct radiative forcing in the vicinity of Houston using a fully coupled meteorology-chemistry-aerosol model, J. Geophys. Res., 111, D21305, doi:10.1029/2005JD006721.

- *Mashayekhi, R., P. Irannejad, J. Feichter, and A. A. Bidokhti (2009), Implementation of a new aerosol HAM model within the Weather Research and Forecasting (WRF) modeling system, Geosci. Model Dev. Discuss., 2, 681–707.*
- *Menut, L., O. M. Tripathi, A. Colette, R. Vautard, E. Flaounas and B. Bessagnet: Evaluation of regional climate simulations for air quality modelling purposes, Clim. Dynam., 40, 2515-2533, doi:10.1007/s00382-012-1345-9, 2012. 15844*
- *Péré, J. C., M. Mallet, V. Pont, and B. Bessagnet (2011), Impact of aerosol direct radiative forcing on the radiative budget, surface heat fluxes, and atmospheric dynamics during the heat wave of summer 2003 over western Europe: A modeling study, J. Geophys. Res., 116, D23119, doi:10.1029/2011JD016240.*

(2) Presentation of the precision and accuracy of the model. There are numerous times when it is stated that there is « good agreement » etc (e.g in conclusions « well captured », « relatively well », « good agreement »). These are slightly meaningless, as one person's « good » is another's « bad ». Please be quantitative where possible. Good enough for what ? You have this quantitative information. This raises point 3 below.

The reviewer is right. Discussions on the performance of simulations have been now rewritten in a more quantitative way.
Specifically, subsequent sentences have been modified as follows in the revised manuscript:

- *P 15839 Lines 16-18:*

“Except for a lack of CALIOP measurements below 0.6 km, the model is within or close to the uncertainty range of observations except at 2 to 4 km where the model tends to largely overestimate CALIOP values (model biases from 30 to 350 % compared to observed median values)”

- *P 15841 Lines 14-18:*

“The model performs relatively well in simulating the temporal evolution of the observed AOT over this region with biases ranging from -40 % to 30 % along the period, except for the 6 and 10 August where CHIMERE underestimates observed values by a factor 2 to 3 due to some model deficiencies in simulating the transport of the aerosol plume over Moscow during these days (see figure 1b)”

- *P 15841 Lines 23-25:*

“In average over the period, the modelled AOT decreases from 1.60 at 300 nm to 0.28 at 1000 nm, which is in accordance with photometric observations (biases less than 35 %). Such a model behaviour is confirmed by the excellent estimation of the Angström exponent (1.45 for CHIMERE and 1.50 for AERONET), indicating that the model is able to accurately reproduce the fine size mode of particles, as displayed in Figure 6-b.”

- *P 15842 Lines 1-10:*

“For the total aerosol distribution, two modes in the accumulation ($r \approx 0.1$-0.3 µm, peak at 0.13 $\mu m^3\ \mu m^{-2}$) and coarse size range ($r \geq 1$ µm, peak at 0.04 $\mu m^3\ \mu m^{-2}$) are modelled. This fits well with

the AERONET fine mode retrieval (r≈ 0.2–0.4 µm, peak at 0.16 µm^3 *µm*$^{-2}$*), although the model simulates a higher volume concentration of very fine particles (for r < 0.1 µm). In parallel, the coarse mode size distribution estimated by CHIMERE is quasi non-existent compared to the observed AERONET one, as the model does not simulate particles with radius above 5 µm.”*

Moreover, the evaluation of the model has been completed by adding a statistical comparison between POLDER and CHIMERE aerosol optical thickness. Results are presented in Table 3 included in the revised manuscript:

Date	NMB (%)	Corr.	Npixels
5 August	10	0.73	6146
6 August	23	0.67	6182
7 August	20	0.73	5880
9 August	23	0.77	5036
10 August	-10	0.75	5360
12 August	130	0.21	6011

Table 3: Statistical comparisons between CHIMERE and POLDER aerosol optical thickness for each day of the studied period. NMB and Corr. are respectively the normalized mean bias (in %) and the spatial correlation calculated as follows:

$$NMB()=\frac{100}{Npixels}\frac{\sum_{i}^{Npixels}\left(P_i-O_i\right)}{\sum_{i}^{Npixels}O_i}$$

$$Corr.=\frac{\sum_{i}^{Npixels}\left(O_i-\bar{O}\right)\times\left(P_i-\bar{P}\right)}{\sqrt{\sum_{i}^{Npixels}\left(O_i-\bar{O}\right)^2}\times\sqrt{\sum_{i}^{Npixels}\left(P_i-\bar{P}\right)^2}}$$

where O_i *and* P_i *are the observation and the model prediction for the pixel i. Npixels is the total number of grid points for the domain. A linear interpolation has been used to make correspondence between CHIMERE and POLDER pixels .*

The following comments have been added in the section 3.1 of the revised manuscript:

“Performances of the model in simulating the AOT spatial features are discussed in terms of normalized mean bias (NMB, in %) and spatial correlation (Corr.) between CHIMERE and POLDER AOT. Results are presented in Table 3. Except for the 12 August, the model is able to reproduce the variation of the aerosol optical thickness due to the transport of the aerosol plume, as shown by the good spatial correlation between POLDER and CHIMERE AOT (R = 0.67-0.77). Moreover, a general agreement is found for the AOT intensity with small biases (-10 % < NMB < 23 %, between 5 and 11 August), indicating a good estimation of vertically-integrated particles loading. However, performances of CHIMERE are less satisfactory for the 12 August with a low correlation (R = 0.21) and large biases (NMB = 130 %, see table 3), which can be explained by the presence of elevated POLDER AOT values (0.8-1.2 at 550 nm) at the eastern boundary of the domain that are not reproduced by the model (0.1-0.2 at 400 nm). Other minor disagreements

between simulations and observations can be noticed such as some local AOT underestimations within the advected plume during 6 and 10 August or some overestimations near the source region during 5, 10 and 12 August. These AOT biases may lead locally to under or over estimate the intensity of the aerosol direct radiative forcing and its potential feedback on the atmosphere."

Finally, discussions on the evaluation of the model has been modified as follows in the conclusions section of the revised manuscript:

" Comparison with POLDER data shows the ability of the model to reproduce the transport and the intensity of the aerosol plume with high spatial correlation (R = 0.67-0.77) and low biases (-10 % < NMB < 23 %), except during the 12 August (R = 0.21, NMB = 130 %). A relatively consistent comparison between CALIOP and CHIMERE aerosol vertical profiles is present below 2 km, where the concentration of particles is the largest. Above an altitude of 5 km, the contribution of free tropospheric particles to the aerosol solar extinction is shown to be negligible. *Over Moscow, observations indicated an important increase of AERONET AOT (340 nm) from 0.7 on 5 August to 2-4 between 6 and 10 August when the aerosol plume was transported over Moscow. The model performed relatively well in simulating the temporal evolution of the observed AOT with biases ranging from -40 to 30 % along the studied period (except for the 6 and 10 August where the model underestimates observed values by a factor of 2 to 3). CHIMERE was able to reproduce the fine mode of the aerosol volume size distribution (simulated peak at 0.13* $\mu m^3\ \mu m^{-2}$ *for* $r \approx 0.1\text{-}0.3\ \mu m$*) retrieved by AERONET (observed peak at 0.16* $\mu m^3\ \mu m^{-2}$ *for* $r \approx 0.2\text{–}0.4\ \mu m$*), which lead to good agreement between the modelled and observed wavelength dependence of AOT (biases less than 35 % in the visible/near-infrared wavelengths). In addition, the model was shown to reproduce the low absorbing efficiency of the aerosol plume (dominated by primary organic species) with modelled elevated SSA (0.97 between 300 and 1000 nm) close to AERONET values over Moscow (0.95–0.96 between 440 and 1020 nm)."*

(3) **Given the model observation differences what are the implications ? i.e please state the limitations of your study. Fig 2 shows a disagreement of a factor of 2. How much does this matter ? Fig 6b shows CHIMERE misses large particles ? What are expected consequences ? Model does not include longwave aerosol effects, does this matter ? CHIMERE top is 500 hPa, is this important ? What is the main limitation : aerosol properties or their vertical transport (which affects subsequent advection) ? How much does the offline nature of the model coupling matter ? This makes your model evaluation much more useful.**

As suggested, the limitations of our methodology, concerning both the modeling of aerosol properties and its transport in the atmosphere, are now presented in a clearer way. In particular, the following parts of the text have been modified as follows in the revised manuscript:

- *Section 2.2, page 15836:*

" It should be noted that aerosol impacts on longwave radiation are not taken into account in RRTM in this version of WRF. This limitation should have a low influence on the estimation of the ADRF since interaction of fine particles (such as biomass burning aerosols) with longwave radiation is shown to be small (Ramanathan and Feng, 2009). […]
Déandreis et al. (2012) have evaluated the impact of coupling a meteorological model to a chemistry model for radiative forcing studies. Their results show a similar ADRF estimation between the off-line and on-line coupling approaches."

- *Section 3.1, page 15839:*

"Except for a lack of CALIOP measurements below 0.6 km, the model is within or close to the uncertainty range of observations except at 2 to 4 km where the model tends to largely overestimate CALIOP values (model biases from 30 to 350 % compared to observed median values). However, this part of the aerosol profile represents less than 30 % of the total aerosol extinction, suggesting that model uncertainties on the extinction vertical distribution remain limited. […]
Finally, Figure 2 shows that the aerosol extinction is negligible above 5 km, thus suggesting that the use of the climatology of Hess et al. (1998) for free tropospheric and stratospheric aerosols should have a low influence in the determination of the shortwave ADRF."

- *Section 3.1, page 15842:*

"In parallel, the coarse mode size distribution estimated by CHIMERE is quasi non-existent compared to the observed one, as the model does not simulate particles with radius above 5 µm. However, the good model performance in simulating the AOT spectral dependence suggests that such underestimation of coarse particles should have a moderate impact on the estimation of the shortwave ADRF over Moscow."

References quoted in the response to the reviewer and included in the revised manuscript:

- *Déandreis, C., Y. Balkanski, J. L. Dufresne and A. Cozic: Radiative forcing estimates of sulfate aerosol in coupled climate-chemistry models with emphasis on the role of the temporal variability, Atmospheric Chemistry and Physics, 12, 5583–5602, 2012.*
- *Hess, M., P. Koepke and I. Schult: Optical properties of aerosols and clouds: The software package OPAC, Bull. Am. Meteorol. Soc., 79, 831–844, 1998.*
- *Ramanathan, V. and Y. Feng: Air pollution, greenhouse gases and climate change: global and regional perspectives, Atmospheric Environment, 43, 37–50, 2009.*

(4) Some of the presentation needs tidying up. Some language would be greatly improved by a native speaker, some figures are unclear/too small (noted below).

We have now put a significant effort in improving the grammar quality. Also, all figures have been re-built with a better resolution.

Specific comments

- **15839 L17 : The model is not « within or close to the uncertainty range of observations. » May be « The model is within or close to the uncertainty range of observations except at 2 to 4 km ».**

The corresponding sentence has been modified according to the reviewer's suggestion.

- **15834 Line 10 : These processes are microphysical not « dynamical ».**

The reviewer is right. This is now corrected in the revised manuscript.

- **15834 : CHIMERE extends to only 500hPa. CALIOP shows BBA to 5 km. How much does this 500 hPa lid matter ?**

As previously discussed in the point 3, we can see on figure 2 that above 5 km the aerosol extinction measured by CALIOP and modelled by CHIMERE with the climatology of Hess et al. (1998) is found to be negligible, which suggests a low influence of free tropospheric and stratospheric aerosols in the determination of the shortwave ADRF for this specific case.

- **15835 line 27 : « explicitly resolved » is unclear. Are they parameterised ? May be « are not represented » is probably better**

This point has been clarified as follows :

"It should be noted that interactions between aerosols and clouds (such as activation of particles in cloud condensation nuclei) are not represented in this configuration of WRF."

- **15842 Lines 16 to 20 : After this quantitative comparison this summary paragraph is too vague and can be much more precise about what the model can and can't do and how this affects your conclusions.**

Thanks to reviewer 's suggestions, the evaluation of the model has been now improved and presented in a more quantitative way in the section 2.2 of the revised manuscript. In addition, discussions on the performances and limitations of our methodology have been also reiterated in the conclusions section of the revised version. Therefore, we have decided to remove this short summary paragraph to avoid redundancies and make the text more concise.

- **15844 Lines 23 to 24, Please refer to Fig 9b here (I missed this on a first quick read).**

This is now done in the revised version.

- **Please compare with radiosoundings**

This is now done in the revised manuscript. Please see response to the point 1 concerning comparisons between modelled and observed temperature profiles over Moscow.

- **I don't think Fig 10b is required ? If surface sensible flux is decreased entrainment will decrease. This vertical velocity is not resolved by the model (and must be parameterised from the surface sensible flux ?)**

The reviewer is right. The figure showing modifications of the vertical wind speed has been now replaced by a figure showing the impact of the ADRF on the horizontal wind speed (Please see response to the point 1.

Language

- **15831 Line 12 : « lower five kilometres of the atmosphere » is better I think**
- **15834 Line 5 : « extends from 43.40 » is better I think**
- **15834 Line 15 : « soil dust is »**
- **15838 Line 1 : « no POLDER data are available »**
- **Line 11 : « rather well » what does this mean ? (See above)**
- **15841 Line 29 (µm3 µm-2) does not need a dot**

The corresponding sentences have been now corrected in the revised manuscript

- **Conclusions would be much better in multiple paragraphs. Please discuss limitations (see above)**

As suggested, discussions on the performances and limitations of the model have been now reiterated in the conclusion section. Also, this section has been now re-organized in two subsections in the revised manuscript:

4.1 Summary and perspectives

4.2 Concluding remarks

As suggested by the reviewer 2, we have now compared (in section 4.2) our results to different biomass burning events that occurred in different regions of the world:

"An important characteristic of the 2010 Russian fires is their high solar scattering efficiency. Elevated SSA values (0.95-0.96 in the visible spectrum) have been already observed over the same region by Chubarova et al. (2011) during the 2002 fire event and could be explained by smoldering conditions (Chubarova et al. 2011, 2012). Such SSA are however higher than values measured for smoke aerosols at other locations. For example, Calvo et al. (2010) obtained a mean SSA of 0.87 (at 440 nm) during a fire episode that occurred over Spain during September 2000. Moreover, a moderate aerosol solar absorption has been measured by Gyawali et al. (2009) (SSA = 0.88-0.93 at 405 nm) during the summer 2008 California wildfires. In numerous cases, the direct radiative forcing of biomass burning aerosols induces significant changes in the atmospheric dynamics at regional scale (Vendrasco et al. 2009, Ott et al. 2010, Randles and Ramaswamy 2010, Tummon et al. 2010, Turquety 2013). For example, Randles and Ramaswamy (2010) and Tummon et al. (2010) showed that the atmospheric heating due to absorbing smoke particles associated to the aerosol-induced surface cooling tend to stabilize the lower troposphere over southern Africa. It is interesting to note that, in our study, even a moderate atmospheric radiative shortwave heating due to very low absorbing smoke aerosols is also favorable to a stabilization of the atmospheric boundary layer. This result is coherent with the modeling sensitivity study performed by Randles and Ramaswamy (2010) indicating that the response of the southern African regional climate to the direct radiative forcing of scattering aerosols could be non-negligible.

In turn, we showed that the lowering of the ABL development due to the ADRF could favor the accumulation of pollutants near the surface. However, the atmospheric shortwave heating induced by absorbing smoke particles could affect the atmospheric circulation and the transport of particles in a different way, over certain regions such as the tropics (Ott et al. 2010) or the equatorial region (Tummon et al. 2010). For instance, Ott et al. (2010) highlighted that the aerosol solar absorption was shown to induce an elevated heat pump mechanism, enhancing the vertical motion and the transport of CO, produced by the Indonesian biomass burnings, from the low troposphere to the tropopause and the stratosphere. The ADRF by smoke particles is also found to affect the precipitation regime and thus aerosol scavenging. It could result either in an intensification or a reduction of precipitation in function of the aerosol-induced changes in the air temperature gradient and low-level horizontal pressure (Vendrasco et al. 2009, Tummon et al. 2010).

The above-mentioned studies, using measurements and modeling experiments, emphasize the great complexity and variety of the atmosphere response to the biomass burning direct radiative forcing. Indeed, not all study results agree on the magnitude and patterns of the feedbacks. Thus, it is necessary to continue efforts in the characterization and understanding of the wildfires radiative impacts."

References quoted in the response to the reviewer and included in the revised manuscript:

- *Calvo A. I., V. Pont, A. Castro, M. Mallet, C. Palencia, J. C. Roger, P. Dubuisson and R. Fraile (2010): Radiative forcing of haze during a forest fire in Spain, Journal of Geophysical Research, 115, D08206, doi:10.1029/2009JD012172*

- *Chubarova N., E. Gorbarenko, I. Nezval and O. Shilovtseva (2011): Aerosol and radiation characteristics of the atmosphere during forest and peat fires in 1972, 2002 and 2010 in the region of Moscow, Journal of Atmospheric and Oceanic Physics, 47, 729-738*
- *Chubarova N., Y. Nezval, I. Sviridenkov, A. Smirnov and I. Slutsker (2012): Smoke aerosol and its radiative effects during extreme fire event over Central Russia in summer 2010, Atmos. Meas. Tech., 5, 557-568*
- *Gyawali M., W. P. Arnott, K. Lewis and H. Moosmüller (2009): In situ aerosol optics in Reno, NV, USA, during and after the summer 2008 California wildfires and the influence of absorbing and non-absorbing organic coatings on spectral light absorption, Atmospheric Chemistry and Physics, 9, 8007-8015*
- *Ott L., B. Duncan, S. Pawson, P. Colarco, M. Chin, C. Randles, T. Diehl and E. Nielsen (2010): Influence of the 2006 Indonesian biomass burning aerosols on tropical dynamics studies with the GEOS-5 AGCM, Journal of Geophysical Research, 115, D14121, doi:10.1029/2009JD013181.*
- *Randles C. A. and V. Ramaswamy (2010): Direct and semi-direct impacts of absorbing biomass burning aerosol on the climate of southern Africa: A Geophysical Fluid Dynamics Laboratory GCM sensitivity study, Atmospheric Chemistry and Physics, 2010, 10, 9819-9831*
- *Tummon F., F. Solmon, C. Liousse and M. Tadross (2010): Simulation of the direct and semidirect aerosol effects on the southern Africa regional climate during the biomass burning season, Journal of Geophysical Research, 115, D19206, doi:10.1029/2009JD013738*
- *Turquety, S. (2013): The Atmospheric Impact of Wildfires in: Belcher C.M. (ed) Fire Phenomena and the Earth System: An Interdisciplinary Guide to Fire Science. Wiley Blackwell*
- *Vendrasco E. P., P. L. Silva Dias and E. D. Freitas (2009): A case study of the direct radiative effect of biomass burning aerosols on precipitation in the Eastern Amazon, Atmospheric Research, 94, 409-421*

Figures :

- **Fig 1 is too small. Dates are far too small to read (as is colour bar). Please label Moscow. It would be useful to say show mean sea-level pressure and 300 hPa winds (or similar) to show meteorology controlling advection and briefly discuss this.**

Figure 1 has been re-built with a better resolution. Also, the synoptic meteorological situation has been now presented in Figure 1a included in the revised manuscript:

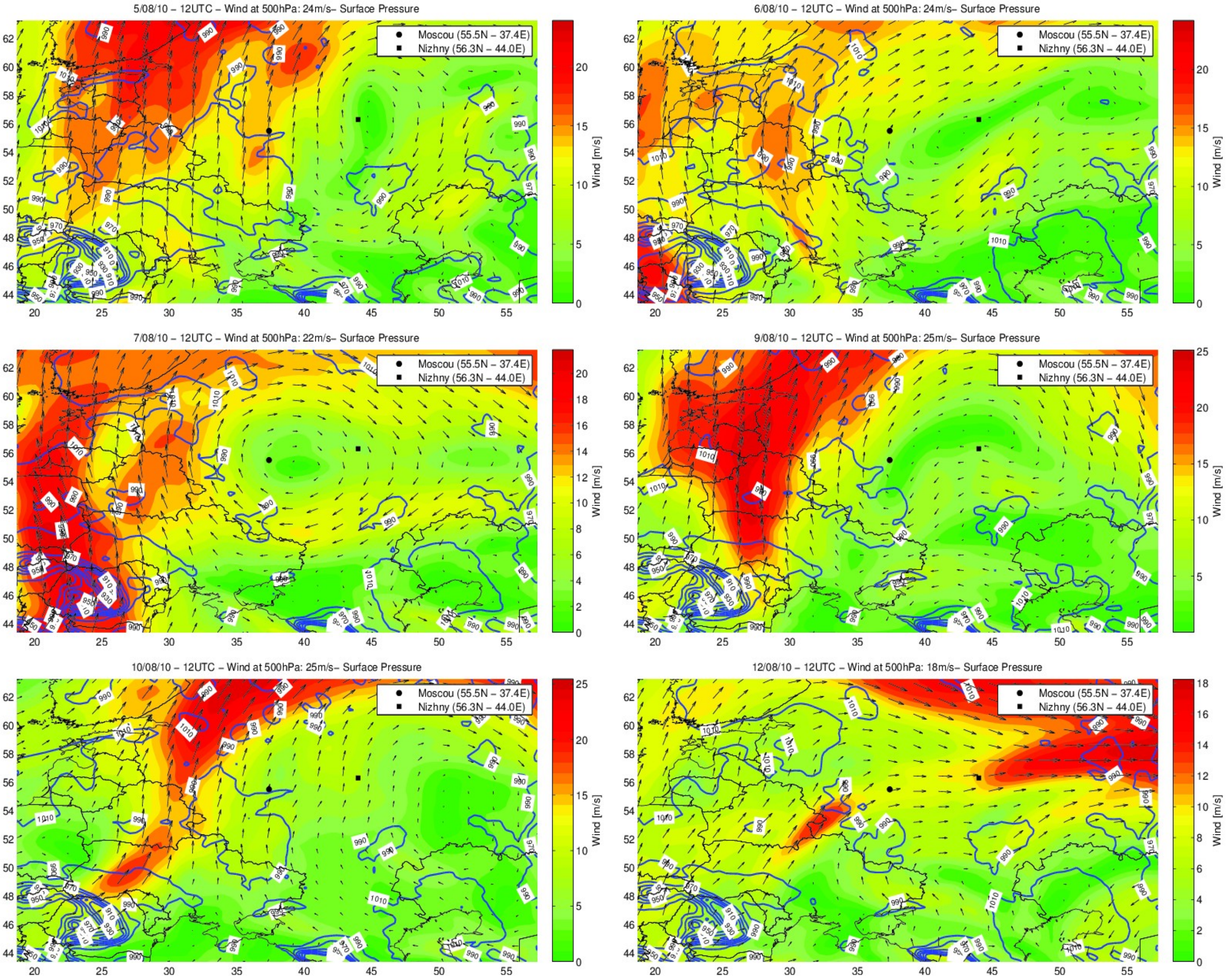

Figure 1a: Surface pressure (blue lines) and 500 hPa wind (black arrows and color scale) at midday, simulated by WRF (without the ADRF feedback) during the studied period. The observatory stations of Moscow and Nizhny Novgorod are indicated.

The following comments have been added in the section 3.1 of the revised version:

"The meteorological conditions over Eastern Europe during the first part of August 2010 were characterized by persistent dry conditions and high temperatures favourable to the development of intensive wildfires reaching a maximum during the second week of the month (Witte et al., 2011). Between 5 and 11 August, an important anticyclonic system was present in Central Russia (Figure 1a), which induced an air mass re-circulation favorable to the accumulation of smoke and urban/industrial particles. The end of the period (12 August) showed a shift in the circulation pattern and the flux became more zonal. The exceptional nature of this specific episode in terms of particulate pollution is shown in Figure 1b with the spatial distribution of the AOT retrieved by the POLDER sensor (at 550 nm) and modelled by CHIMERE (at 400 nm) over Eastern Europe from 5 to 12 August 2010 (no POLDER data are available for the 8 and 11 August 2010)"

Reference quoted in the response to the reviewer and included in the revised manuscript:

- *Witte, J. C., Douglass, A. R., da Silva, A., Torres, O., Levy, R., and Duncan, B. N.: NASA*

Train and Terra observations of the 2010 Russian wildfires, Atmospheric Chemistry and Physics, 11, 9287–9301, 2011.

- **Fig 2. This is one profile. How does the rest of the CALIOP transect compare ? How do you have CHIMERE data above 500 hPa ?**

The small part of the CALIOP transect, crossing the biomass burning plume during the 9 August, presents the same characteristics as the profile shown in Figure 2 (particles confined within the first 5 km of the atmosphere) and similarly compares with the model. Also, as indicated in the response to the point 3, a climatology of aerosol extinction for the free troposphere and the stratosphere has been used for altitudes above 500 hPa (please see table 2 of the revised manuscript). During this specific episode, 500 hPa is about at an altitude of 6 km.

- **Fig 3. Caption says this shows Moscow observations. If it does they are too small to be seen.**

Figure 3 has been now re-built with a better resolution.

- **Fig 9b should be « (°C) » or « (K) »**

Thank you. This is now corrected in the revised version.