Authors Reply to Referee 2 (R2)

General comments

This paper addresses the question on the importance of wildfires fingerprint on the European aerosol load. The authors use long-term (2002-2007) remote sensing observation of the Aerosol Optical Thickness (AOT) and fires combined with atmospheric transport simulation to evaluate the role of the fires play on the aerosol load at the continental scale. As the authors show, the impact of fires is visible over Europe. The regions most impacted by wildfires emissions are Eastern and Western Europe, as well the Scandinavia; the calculated impact maximizes in April. Another important conclusion is on the fine fraction AOT attributed to the wildland fires. The manuscript is for the most part clearly written, the method is described with enough information to reproduce the results. The manuscript is within the scope of ACP. However, besides the comments mentioned in the section "Specific comments" I kindly ask to consider the possible influence of the error of the Hysplit trajectories on the results. Overall, from the literature, one can estimate the total error to be anywhere from 15 to 30% of the travel distance. This error might change the results considerably. Trajectories accuracy should be taken into account. The agreement between the results obtained with backward and forward trajectories might be one of the proofs that the air mass trajectories technique might be used in those studies.

Unfortunately, it is very difficult to compare trajectories to actual observations. In this respect, only model inter-comparisons are usually performed. As reported by the Reviewer, the Hysplit website indicates that '*Overall, from the literature, one can estimate the total error to be anywhere from 15 to 30% of the travel distance*'.
(http://www.arl.noaa.gov/ documents/workshop/NAQC2007/HTML_Docs/trajerro.html)
Note however that, in our study, the weight of each trajectory on the FWTD decreases exponentially with time (Section 2.3.1). Therefore this percentage error is further reduced in our case and we don't expect this aspect to change the results considerably. This indication has been added to the revised text.

Specific comments

R2.1 - p.2318, line 7. To my knowledge peatland fires, and, as a consequence, forest fires in central Russia are most crucial for the atmospheric composition changes.

We rephrased the relevant sentence in the Abstract.

R2.2 - Schematic figure on the seasonal difference in the air mass transport directions to Europe as an addition to Figure 1 (monthly mean fire counts) will better explain difference in AOT and FFAOT between the target regions. Meteorological fields in spring are mentioned to be favourable to eastern transport, how about other seasons? Can the minor impact which is found in Western Europe and Mediterranean be explained by the other than eastern transport? As a possible reference, Stefan et al. (Physics and Chemistry of the Earth, Parts A/B/C Volume 35, Issues 9-12, 2010, Pages 523- 529) might be used; some statistics for the air mass origin/transport can be obtained also from seasonal averaging of the Hysplit trajectories. Figure with the actual wind speed/direction scaled to area including Europe and surroundings might also be used together with Figure 1 for the better explanations of the results presented in Figures 4 and 5.

To avoid an overloading of the manuscript we prefer not to include new Figures with mean wind fields (in fact, another Reviewer even suggested to remove the only one present in the manuscript). Seasonal air mass transport directions to Europe can be easily found in the literature (e.g. Chubarova 2009) and we now added a reference to that paper in the Introduction.

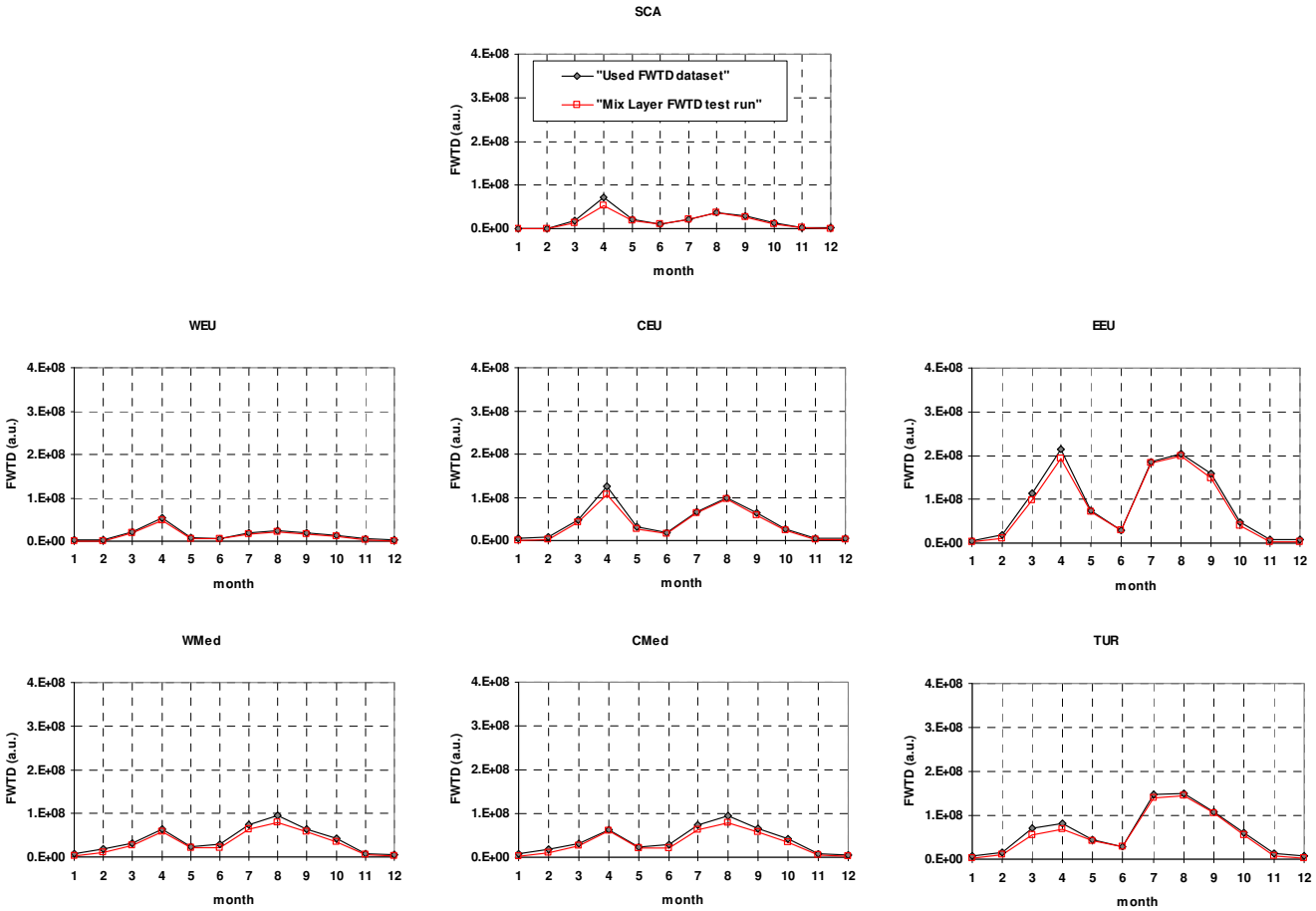
R2.3 - p.2324, line 3. What is the lifetime for the biomass burning aerosols? What is the fraction of the biomass burning aerosols left after 5 or 7 days of transport? Why the 10-days length of the air mass

trajectories was chosen? I assume that for the same computation expanses the 5(7)-days trajectories with lower than 2.5 deg horizontal resolution would give more accurate results.

The lifetime of aerosols (including the biomass burning ones) depends on transport and removal mechanisms as advection, dry and wet deposition. It typically ranges from 1 to 10 days. Limiting the trajectories computations to 5-7 days does not reduce the computation time significantly (while refining the starting point grid from 2.5° to 1° increases it by a factor of 5). It is true that the accuracy of each trajectory decreases with increasing length but note that, as now clarified in Section 2.3.1, the exponential decay introduced in Eq. 1, '*also reduces the impact on the FWTD quantity of the total error expected on each single trajectory (estimated as 15-30% of the travel distance)*'.

R2.4 - There is an option in the Hysplit tool to calculate the mixing layer depth (=boundary layer height). I wonder why that option was not used to be sure the air parcel was within the boundary layer when travelling forward. The part of the trajectory before (if) the air parcel leaves boundary layer should only be used in the calculations. I agree that the differences in the results for the forward trajectories for different starting point are not always significant, even though not negligible. However if to consider the height of the starting point, in northern latitudes (above 60_N) in winter the boundary layer height decreases often to 300-400m, and can be only few tens of meters occasionally. I suggest to make a test run for Scandinavia considering the boundary layer height obtained with Hysplit.

We thank the Reviewer for highlighting this point. We did a sensitivity test for the years 2002-2003 excluding those trajectories for which the starting altitude (500 m) was above the HYSPLIT-computed mixing layer (note that it does not matter if the trajectory is above it during its path as the Aerosol Optical Thickness refers to the whole atmospheric column). The results of the test (red curves in the Figure below) indicate this effect to be not significant.



In this study we then prefer to use the computations without ML control since 1) accuracy of the HYSPLIT-computed mixing layer is not known, and 2) this option produces minor changes in the results, but reduces the trajectory dataset (by up to 40% in the winter months).

We now inserted a comment on this aspect rephrasing part of the original text as follows: '*Some sensitivity tests were performed by 1) changing the trajectories starting altitude within the first 1000 m and 2) eliminating those trajectories for which the fixed starting altitude was above the model-estimated 'atmospheric mixing layer' in the starting cell. Both tests showed minor (< 10%) changes in the results. Since the 'mixing layer' control reduced the trajectories dataset of about 10% in summer and up to 40% in winter, this option was not used in the results presented here.*'

R2.5 - Chernobyl accident can be mentioned as an example of the transport, but separately form the agricultural fire activity maximum (as it is on line 26, p.2319).

The reference to the Chernobyl accident in this sentence has been removed.

R2.6 - p.2322, line 21. Since you use MISR AOT in the combination with the fires characteristics, please mention the MIST AOT accuracy for the biomass burning cases.

At present, in the manuscript we refer to the most updated comparison with AERONET observations by Kahn et al. (2010). This gives good agreement of MISR AOT with ground-based 'truth', in the limits indicated in the text. We revised the sentence to make this message clear as follows: '*… about three-fourth of MISR measurements are within ±20% of corresponding AERONET measurements, and about half are within ±10%. Scenes with a large fraction of dust or smoke, generally display smaller agreement. Focusing specifically on the 'Biomass Burning' category, the MISR mean AOD is well within the envelopes given above*'.
Note however, that the AOT conditions addressed in our study are mostly not 'pure' biomass burning cases but rather a mix between long-range transported BB and local (natural plus anthropogenic) aerosols.

R2.7 - p.2325, line 22. Provide the R for each of 7 target regions

R values are now included in Table 1.

R2.8 - p. 2332, lines 10-14. Please add fitting line for April-July for the comparison.

Since the April-to-July months are affected by aerosol transport from America, such period cannot be assumed as 'background condition' as necessary for the fit.

R2.9 - p. 2332, lines 14-18. Please explain in the text or in the Figure 8 caption the white spots on the maps around England and in Scandinavia.

Done

R2.10 - Conclusions should be formulated more clearly. I also suggest to move lines 13-24 from page 2331 to introduction (if you just formulated the existed knowledge) or show in the Discussion and Conclusions section how the existed knowledge on the topic was enlarged using the method discussed in the manuscript.

The Conclusion section has been revised. However, we would prefer to leave the sentence of Section 2.3 (lines 13-24) where it is. It does refer to existing knowledge (results in Sthol, (2007) as properly indicated) but this is functional to comment on the CF factors obtained at that point of the manuscript. To our opinion, it would rather be out of context in the Introduction.

R2.11 - The results on the intercontinental transport studies are not mentioned in the Discussion and Conclusions section.

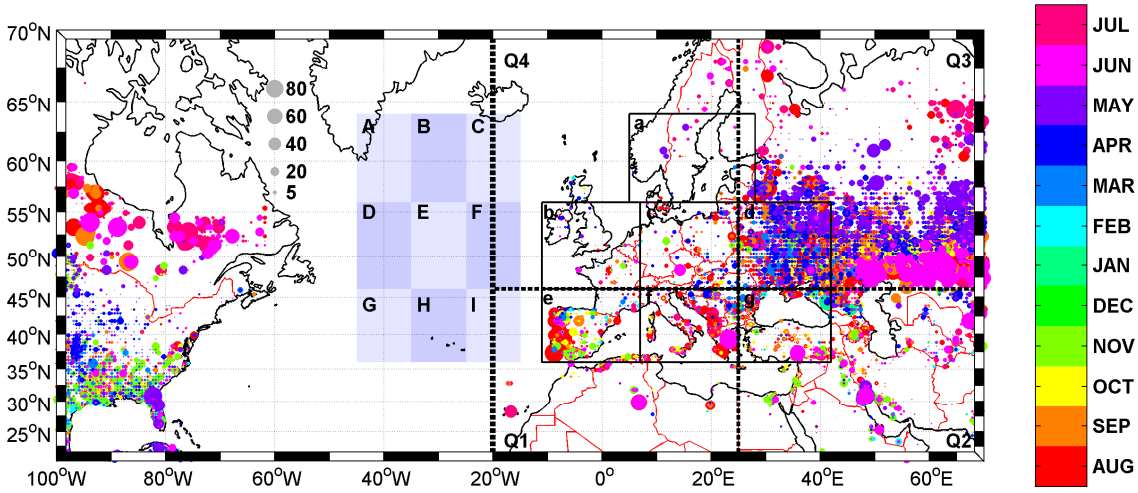
Actually, these were mentioned (p. 2334 lines 15-16). We slightly modified the sentence in the revised version which now reads: '*Possible contamination of these results from*

***intercontinental transport of pollution from North America is shown to be almost negligible and limited to the Western Mediterranean region*'.**

Technical comments:

R2.12 - p. 2322, line 3. Figure 1 is too heavy and not easy to read. Instead of shaded color I suggest to use letters a-g as the panels are named on figures 4-6.

We re-plotted the figure as suggested by the Reviewer (see below). However, in our opinion the original figure is more readable than this one, as its shaded colours provide a more immediate visualization of the selected regions. However, we have no objections at using the suggested version below if the Reviewer/Editor still believe it is better than the original one.



R2.13 - p.2324, line 4. I suggest using the following format 20_W instead of -20_ (as it is in the Figure 1 caption).

Done

R2.14 - p.2326, line 25. Write "standard deviation" or "st.dev" instead

Done

Altogether, I recommend to publish the manuscript after making the tests (for Scandinavia, as an example, winter or spring period) on the comparison of the results taking into account the trajectory accuracy and boundary layer height and after taking into account other minor modifications.