

Interactive comment on “Around the world in 17 days – hemispheric-scale transport of forest fire smoke from Russia in May 2003” by R. Damoah et al.

Anonymous Referee #2

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General Comments: This paper investigates an important topic. It presents the analysis of a hemispheric-scale transport event of forest fire smoke utilizing the combination of satellite observations and a Lagrangian particle dispersion model simulation. As the authors point out, this may be the first time that an air pollution event was observed circling the entire globe. Overall, I thought it was a nice application of satellite data and its relationship to a long-range transport event. However, I do have some recommendations for revisions or suggestions for further analysis. They are discussed below.

Major Specific Comments:

1. Introduction: In the introduction the authors lay down some groundwork by dis-

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cussing forest fire and biomass burning emissions and the role that fires play as a major natural disturbance in forests. a. The second paragraph discusses the long-range transport aspect of boreal forest fires and includes examples of such transport (i.e., Canadian fires have been observed over Europe); except there is no mention as to the timeline or lifetimes of these events. And since the title of this paper is centered on "17 days", I think some discussion as to the lengths of some of these events should be added. b. Also in the second paragraph, there is a reference to some research by Wotawa and Trainer (2000) that discusses the effect that Canadian forest fires can have on carbon monoxide and ozone in the southeastern U.S.. However there is no mention as to what kind of effect (quantitative or otherwise). Are you referring to an increase in photochemistry of these trace gases due to the fires or transport into this region of these trace gases? Please clarify this statement. c. In the third paragraph, the authors discuss Russian forest fires and their assertion that Russian fires have been much less well studied. I looked into some Russian fire research and found several papers that discuss Boreal forest fires in Russia using the AVHRR instrument (i.e., Kajii et al. (2002), Boreal forest fires in Siberia in 1998: Estimation of area burned and emissions of pollutants by Advanced Very High Resolution Radiometer satellite data, JGR, 107(D24)). I suggest looking into some of this research (including some by Amber Soja (currently in press) and Anatoly Sukhinin) and include some of the research/estimates in this paper. d. In the fourth paragraph, the authors discuss the burned areas for Russian forests and are attempting to place the year 2003 in context to other high years. The authors start off by discussing "a long-period average estimate", but do not say what a "long-period" is. They should clarify for the reader what kind of base this timeline is formed from. They then discuss the year 1987 and state that it was an extreme year and that 2003 was even worse. Was 1987 the worst year (in the long-period) until 2003? Some discussion of what kind of long-period timeline you are using would help to put the year you are spotlighting into context. e. One minor comment, you may want to put into context how much land 19x106 ha represents.

2. Tools and Methodology: In this section the authors describe the instruments used for

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observing the smoke and the model used to simulate the origin and transport of these smoke plumes. a. The section starts off with short descriptions of the instruments used to observe the fires (MODIS, GOME) and the smoke plumes (MODIS, SeaWIFS, TOMS). However the descriptions should contain more information and/or references of instrument resolution and of prior use of these instruments in observing such phenomena. The MODIS instrument description does contain some of this information, however Sea WIFS and especially TOMS does not. This would help the reader to better understand what these instruments can see (pixel-size) and that they have been used to observe smoke plumes before. b. According to the paper, the FLEXPART CO tracer was compared with CO observations in a previous study. This comment is a little confusing and more explanation might help in clarifying the differences between this manuscript and the referenced paper.

3. Results: In this section the authors qualitatively compare the model simulation output and the satellite observations as the smoke travels around the globe. a. In Figure 1, the authors use the NO₂ total column measurement from GOME as a comparison with the MODIS fire product. Based on the fact that MOPITT has been used to analyze biomass burning episodes (Edwards et al., 2003, Tropospheric Ozone over the tropical Atlantic, JGR, 108 (D8), doi:10.1029/2002JD002927, 2003), I would think that it would be a good comparison here as well. Maybe a comment as to why you chose GOME NO₂ versus MOPITT CO or perhaps an AIRS or AVHRR product as a comparison with MODIS fire products would help clarify, especially considering the authors mention that there are differences between what the two instruments (GOME and MODIS) see. Using or discussing some of these other instruments might be a good way to corroborate the observations. b. The authors then go into a discussion of Figure 2, which is a look at the CO tracer column simulations from FLEXPART using both ECMWF and GFS from 18 May through 31 May 2003. I think showing the global picture over this time period is a good way to segue into the regional discussion. c. Section 3.1: The discussion starts off by looking at Figure 3.d, which is the SeaWIFS image, then goes into a meteorological discussion, and then a simulation analysis. The order of the figures

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and the paragraph discussion does not flow well. One suggestion would be to discuss the meteorological set-up first, so the reader gets an idea of the pattern, and then go into what the FLEXPART simulation is showing, and then finally what the instrument observes. d. Section 3.2: The same general comment/suggestion, in terms of readability, can be said for this section as well. Some other comments/questions; why is MODIS used here for the visible image and SeaWIFS used for the other two regional analyses (3.1 and 3.3)? Also, the TOMS aerosol index is used here as a comparison and not used anywhere else. I think further explanation of this is needed, since TOMS aerosol index might be picking up more than smoke plumes. e. Section 3.3: Again, one suggestion might be to make this section more readable by first discussing the meteorological set-up for this period, then what FLEXPART simulated and then a look what SeaWIFS saw. You might want to consider a separate discussion of lidar results and how they relate to what is being seen, including any references to previous lidar research involving smoke transport or observations. I also think that an explanation of the ECMWF versus GFS profiles in figure 6.b should be addressed (there are differences). You mention back trajectories (which are not shown) and I believe they would add a lot to corroborating the assertion that what you are seeing over Leipzig Germany actually originated from the smoke plumes over Norway.

Some general comments that affect Sections 3.1, 3.2 and 3.3 are the following: a. Is the GFS analysis adding any benefit? You do show some comparisons but some of the GFS analysis discussed but not shown. And no conclusions seem to be drawn by using it. b. The only time you mention in-situ observations are in Section 3.3. It is also the place where back trajectories are mentioned. Did you consider adding some analysis similar to this into Section 3.1 and 3.2? I think back trajectory analysis would be very beneficial.

Minor Comments and Technical Corrections:

1. In several instances, references were not listed according to date. 2. Introduction, 2nd paragraph: The first sentence does not read well, particularly the phrase "further

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strong emission source". Please clarify. 3. Introduction, 4th paragraph: The 2nd sentence begins with a year. It should be reworded so it does not begin with a number. 4. Introduction, 4th paragraph: The last sentence appears to be missing a word. It reads "At the end of the 2003 fire season, more 19x106 ..."; while I believe it should read "At the end of the 2003 fire season, more than 19x106 ...". It is missing the word "than". 5. Section 3.2, last paragraph: I believe the last word should be plural. 6. Section 3.3, last paragraph: End of the 3rd sentence I believe should read "... western Germany on 27 May (Fig. 5c) " not "... western Germany from 27 May (Fig. 5c) ". 7. For each section it might flow better if the authors add the timeline that each region was impacted after the title (i.e., 3.1 Smoke over Alaska (19-22 May 2003)). 8. In the print version, the country outlines in the FLEXPART figures (3 (a,b,c), 4 (c,d,e), 5 (a,b,c)) are very difficult to make out. The on-line version is a little easier.

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