

***Interactive comment on “An episode of extremely high PM concentrations over Central Europe caused by dust emitted over the southern Ukraine” by W. Birmili et al.***

**W. Birmili et al.**

Received and published: 22 January 2008

**Reply to the Anonymous Referee 2**

First, thank you for your referee comments. We have addressed the points you raised individually below. Your comments are repeated in italics while our reply appears in normal typeface. All minor formatting issues have been corrected for in the revised manuscript unless mentioned.

*Specific Comments, “The Title should spell out the meaning of PM...”*

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



This was considered in the revised version as requested.

*“Values of PM, extinction and optical depth are quantified. These should be related to typical clean background conditions to place the event into context.”*

We agree. The corresponding values for clean background conditions have been added in Sect. 4.3. and in the conclusions section.

*Introduction, “1.1 should be expanded to include other sources of dust that impact the global climate. Saharan dust may account for most of the dust but what about Asian dust sources? ...”*

A corresponding paragraph was added to Section 1.1.

*“What specific health issues are related to various dust sources and what impacts do these aerosols have on climate.”*

The health effects of dust aerosols are uncertain if the general population is concerned. The issue is now briefly discussed in Section 5.6 with two more references.

*“What is the magnitude of radiative forcing, degree of uncertainty and prediction of climate impact in a warming world?”*

We added a general statement on the radiative forcing in Section 1.1. For the specific case of March 24, 2007 we refrain from a calculation, since the radiative forcing depends sensitively on single scattering albedo, which we do not know as a function of height. We could use rules of thumb, which yield a radiative forcing of about  $15 \text{ W m}^{-2}$ . These values could be calculated, in fact, by every reader and are not very accurate.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

*Measurements section; 2.1 “What is the resolution of MSG satellite imagery over the study area?”*

Over the Ukraine, its spatial resolution is 4 km x 7 km.

*“It is a bit confusing that the MODIS website became available as of 11 June 2007. Does this mean activated or when images become available...”*

Internet sites change with time, therefore we intended to refer to a web page in its particular version as we accessed it on a particular date. Since this type of reference seems, however, to cause confusion the date was dropped.

*“2.2 sun photometer is generally one word.”*

We do not agree. In the literature one finds the notations “Sun photometer”, “sun photometer” and “sunphotometer”. Sun photometer is actually more often written as two separate words than as one word. After some discussion among our co-authors we have decided to use “Sun photometer” much for the same reason that we respectfully capitalize the “Sun”, and the “Earth”, whom we owe not less than our existence. For us, the “Sun” is not simply a thing like, e.g., “aerosol”.

*“The AERONET data is in fact not “continuous” but sampled at specific airmass increments I believe with temporal gaps and no measurements are made at night; clarify.”*

This aspect has been clarified in Section 2.2. (“Measurements are made during day-time in 15 min intervals, as long as the Sun is not obscured by clouds.”)

*2.3 “point of curiosity related to Table 1 in the appendix; why are so few observations available from Osterreichisches and Bayerisches?”*

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

The number mentioned referred to the number of sites where the dust plume could actually be detected. This has now been clarified in Table 1.

2.4 *“In this section, as in the entire manuscript, strive to use similar units...”*

Particle diameters and wavelengths are now generally  $\mu\text{m}$ , except when speaking about the nucleation mode in Section 4.2.

*“This section contains too much detail perhaps and could be shortened. Might a table of methodologies, size ranges measured with references be used to summarize and then provide a more general overview?”*

As suggested by the referee, much of the information on measurement techniques was included in a new Table, which allowed to greatly condense Section 2.4.

2.5 *“References or links to “official guideline VDI and DIN EN ISO 11885 should be given.”*

Done.

*“2.6 could be cut and pasted into section 3.2, eliminating any redundant information.”*

Done.

*“Meteorological overview This section needs some work. Rewrite to make it succinct and to the point. Figure 1 is not very legible and I feel should be eliminated. Many readers are not familiar with such charts.”*

The meteorological overview (now Section 3.2.) was completely rewritten according to your suggestion. Likewise, Figure 1 was eliminated.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper



*“Highlight the boxed area blown up in Figure 5 in Fig. 4 rather than using an arrow.”*

We have discussed this comment extensively. However, came to the conclusion that it is somewhat misleading to put a box, or frame around the dust source region. The MSG dust index Figure is filled with plenty of information in different colours etc. A problem is that Figure 4 precedes Figure 5, and a reader who looks at the MSG dust index image might be irritated by the box, which explains itself only after having looked at Figure 5.

The intention of the arrow is to direct the untrained viewer towards the magenta-coloured dust plume. This is certainly achieved. Since coastal lines and national boundaries are visible in the Figure it is straightforward to link the dust plume to the geographic region. In conclusion, we prefer to keep the arrow. To improve the situation, however, the arrow was re-centered more closely onto the dust plume.

*“Can you speculate on why the filaments form along what appears to be the mean wind direction? This is a curiosity more than anything but one that others will share.”*

We do not know with certainty what happened here exactly, but the attempt of a speculative explanation is now provided in the end of Section 3.1.

*“Hot spots are indicated in the imagery, possibly due to fires or emission plumes. What, if any, effect might the mixing of this air with dust have on the chemical analyses, particle size analysis etc. Is there a source of BC here, smaller particles?”*

Biomass burning would produce particles rich in black carbon and mainly smaller than  $1\ \mu\text{m}$ . The potential role of biomass burning is now broadly discussed in the dedicated section 5.3.

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

*“Two reasons are given why Saharan dust was not mixed in the plume. A 3rd and 4th may be worth investigating or mentioning. 3. Is there no chemical fingerprint that distinguishes desert dust from the Chernozem (soil); it seems there should be.”*

We had originally planned a very sensitive fingerprint analysis based on isotope ratios. However, that analysis turned out to be not practically feasible based on the aerosol sample material available. Unfortunately! An issue is that an event such as March 24, 2007 was not foreseeable, and we were only able to process data and filter sample material that had been collected within the routine measurement programs.

*“4. The size spectra of Saharan dust is distinctive from that derived for this event. This is evident in the AOD measurements and derived Angstrom Exponent as well (e.g., Figure 10).”*

The Ukrainian plume consists of coarse dust, plus some effects of continental haze superimposed. The continental haze explains the distinctness from the pure Sahara AOD measurements. This is now discussed in more depth in Section 4.3.

*“Aerosol measurements in Central Europe The section should be carefully edited to keep the discussion as clear as possible...”*

Done.

*“Aerosol optical depth (AOD) is generally used where particle optical depth is in this paper. What is the accuracy of AERONET AOD and can you verify the instrument was calibrated routinely over the six years of service represented in Figure 10?”*

Calibrations were conducted regularly. We added the missing information according to your suggestion in Section 2.2.

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

*“In discussion related to AERONET data some elaboration and reference is required. The definition of Angstrom exponent  $A$  should be given with some reference and mention of its use as an indicator of relative particle size. It is misleading to say  $A$  is derived from the interval 440–870 nm suggesting a fit to all wavelengths within the interval was made. I believe the fit is to the 440 and 870 pair of wavelengths. Reference is made to particles  $> 1.2 \mu\text{m}$  as related to  $A$ . How is this threshold determined from a number that gives only relative information?”*

Reference is now made to Ångström (1961). To our best knowledge, AERONET performs a fit through all four wavelengths across the interval 440–870 nm. 1.2 micron is a threshold value based on observational experience. Since it requires a rather lengthy explanation for its justification the statement about 1.2 micron was dropped and rewritten as “indicative of coarse particles”

*“4.2.2 Can you speculate more specifically about the source of carbon? Is it possible to determine the location of the hot spots in the satellite images and whether these may contribute, being in the transport pathway? Is the CO<sub>2</sub> concentration high relative to climatological values? Carbon content will affect radiative properties significantly so this point might be worth investigating further.”*

This issue is now extensively discussed in the new discussion Section 5.3., and has been mentioned in the conclusions and the abstract. Our impression is that despite a few visible fires, biomass burning does not have a major impact on the observed dust plume. Individual smoke plumes from fires are almost invisible and much weaker compared to the intensity of soil dust emission. We included CO and CO<sub>2</sub> measurements into the discussion: CO and CO<sub>2</sub> at the station Neuglobsow (near Berlin) do not show enhanced values on March 24 compared to the days before and after. Unfortunately these gas data are still preliminary, so we cannot show them explicitly in the paper. Of course, the radiative properties will change along with increasing carbon content, but this issue is beyond the scope of this paper, which illustrates a case study only.

4.4.3 *“The point being made is not very clear. Try to reword and combine with above Section 4.4.2 that refers to similar analyses (Fig. 12). 4.4.4 try to get to the main point (dust PM10 accounts for 80%) with a more direct explanation.”*

The mentioned sections have been greatly condensed. Section 4.4.4 was condensed into a single sentence and incorporated into Section 4.4.3.

*“Discussion Consider making this section a more general narrative instead of cutting it into short sections, avoiding too much redundancy.”*

The entire conclusions section was rewritten. However, we kept its division in sections, since these cover clearly identifiable topics.

*“5.5 should be elaborated to include more recent concerns and speculations. Are there scenarios (model predictions) in IPCC perhaps that predict deforestation/desertification in various regions that will enhance dust emissions?”*

IPCC (2007) reports that global climate change will lead to increased desertification and weather extremes, but is not very specific, where. In any case, this reference was embedded into the discussion in Section 5.5.

*“Concerns are global because Asian dust, for instance, can be transported to Europe as well as to North America, with its associated toxic, industrial emissions. It is clear from the climatology that dust from the Ukraine has not had a major impact on Central Europe but dust from the Sahara may have. Is there any evidence of increased frequency or intensity of dust from that region?”*

Not yet. A major drawback is that sensitive observational techniques, such as lidar, have only been operational for a bit more than 10–15 years. Another issue is that

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)



Saharan dust arrives in Europe only in diluted form, which reduces its impact on ground-based concentrations. In any case, the distinction between the Ukrainian dust plume and Saharan dust intrusions is now better highlighted in Section 5.2.

Wolfram Birmili, on behalf of the High PM Concentrations Team.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 12231, 2007.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper