

Interactive comment on “Atmospheric trace metals measured at a regional background site (Welgegund) in South Africa” by Andrew D. Venter et al. (Ref. No.: acp-2016-845)

Anonymous Referee #3

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General Comments:

This is an easy to read and well written discussion paper on the analysis of trace metals in aerosol samples collected from a site in central South Africa. The extent and originality of the contribution to the understanding aerosol trace metal contributions are not new globally, but rather across the region, as is highlighted by the authors. The analytical methods employed are well established in literature. The figures/table are clear and evaluation of the generated results and their integration with the existing body of knowledge is sufficient. There is correct use of references and their presentation in a reference list.

The authors would like to thank Referee #3 for this very positive review on this paper and acknowledging the relevance of this work, especially, for this understudied region, i.e. southern Africa. As indicated in this paper only a few studies on atmospheric trace metal concentration have been conducted in South Africa that are published in peer-reviewed journals or available in the public domain. We also would like to thank Referee #3 for pointing out that the analytical methods employed in this study are well established in literature. Although there are deficiencies associated with the analytical method employed, i.e. unable to dissolve and extract silicate minerals, these analytical methods are commonly utilised for the analysis of atmospheric trace metals. This paucity was recognised and discussed by the authors (start of Section 1). We also thank Referee #3 for indicating that the results presented were adequately integrated with the existing body of knowledge.

Each of the scientific questions raised and technical corrections suggested by Referee #3 were addressed as indicated below in order to further improve the scientific content of the manuscript. All changes in the manuscript are indicated with track changes.

Scientific Questions:

Pg 8 Line 24 to 27. This statement should be explored further in this study and supported by clear justification based on the understanding of long range transportation of pollution in the region. Is this statement supported by e.g., trajectory analysis of air masses to Welgegund?

We thank Referee #2 for pointing out the significance of indicating the long range transport of pollution influencing this region. In an effort to address this comment 96-hour overlay back trajectories arriving

hourly at Welgegund were compiled for the entire sampling period and included as supplementary material. From this back trajectory analysis the influence of air masses passing over the major pollutant source regions is evident, especially, with regard to pyrometallurgical smelters and mining activities located in the western Bushveld Igneous Complex. Referee #2 also requested justification of the possible long-range and local sources of wind-blown dust. Furthermore, Section 3.1 and 3.2 was combined and restructured according to a suggestion made by Referee #2. The following text was included in the last paragraph of Section 3.1 in the revised manuscript:

“From Figure 2 and 3 it is evident that a major source of trace metal species in all three size fractions can be considered to be wind-blown dust typically comprising Fe, Ca, Mg, Al, K and Ti (Polidori et al., 2009). As mentioned, Welgegund is a regional background location affected by air masses passing over large pollutant source regions and a relatively clean background area (Figure 1). In Figure S1 96-hour overlay back trajectories arriving hourly at Welgegund for the entire sampling period (24 November 2010 until 28 December 2011) are presented. From Figure 1 and S1 it is evident that Welgegund is frequently impacted by long range transport of air masses passing over the relatively clean background region in the west (between north- and south-west). It is evident from Figure 1 that the arid Nama-Karoo biome is situated within this region west of Welgegund, which could be a potential regional source for wind-blown dust. In addition, Jaars et al., 2016 also indicated the extent of agricultural activities within a 60 km radius from Welgegund, which could be a significant local source of wind-blown dust. In addition, Figure S1 indicate that Welgegund is also frequently affected by air masses moving over the western Bushveld Igneous Complex, which is associated with a large number of pyrometallurgical smelters (e.g. ferrochrome, platinum and base metals) and mining activities (Venter et al, 2012, Tiitta et al., 2014; Jaars et al., 2014). This source region could therefore contribute to regional elevated levels of Fe, Cr, Ni, Zn, Mn and V measured at Welgegund. Venter et al., 2016 indicated that Cr(VI) concentrations were elevated in air masses that had passed over the western Bushveld Igneous Complex with the majority of Cr(VI) in the smaller PM_{2.5} size fraction. The possible sources of trace metal species measured at Welgegund will be further explored in section 3.5.”

Pg 11 Line 14. Throughout the manuscript, the phrase 'standard limit' has been used. Please note that a STANDARD is the limit value. Therefore to avoid redundancy, use STANDARD without limit.

The phrase “standard limit” was replaced with the term “standard” throughout the document.

Pg 11 Section 3.5. For the average concentrations, where are the standard deviations and how significant are they? How would these deviations affect the PCFA receptor modelling results, if at all they do?

For the PCFA all the concentrations determined with ICP-MS for each of the metal species in the PM₁ size fraction were included, i.e. the concentration of each metal species determined for each PM₁

sample collected was included. The instrument took three readings for each concentration point from which the relative standard deviation (%RSD) was calculated. The %RSD for all the metals analysed with ICP-MS ranged between approximately 0.2 and 5%, with the %RSP generally being below 2%. Therefore, these low %RSDs are not considered to influence PCFA results reported.

Technical Corrections:

Pg 2, Line 27 should be referenced IPCC, 2014.

“IPCC 2014” was changed to “IPCC, 2014” in the text.

Consistency in the use of AND or & in references siting

We thank Referee #3 for pointing this out. “&” was replaced with “and” in the reference citations and -list throughout the manuscript.

Pg 3, Line 28 should be referenced WHO, 2005

“WHO 2005” was changed to “(WHO, 2005)” in the text.

Pg 4 Lines 4, 5 and 6 and Pg 11 Line 11 “Government Gazette” should be defined based on author DEAT or DEA depending on the years.

“Government Gazette” was defined based on author “DEAT” and “DEA” in the text as follows:

“...regions being classified through legislation as air pollution priority areas, i.e. Vaal Triangle Airshed Priority Area (DEAT, 2006), Highveld Priority Area (DEAT, 2007) and Waterberg-Bojanala Priority Area (DEA, 2012). Air quality outside...” and “...the European Commission Air Quality Standards (ECAQ, 2008) and the South African National Air Quality Standards of the South African Department of Environmental Affairs (DEA) (DEA, 2009). There are currently only...”

The references in the “Reference” list was also changed accordingly:

“DEA, Department of Environmental Affairs. 2009. National Environmental Management: Air Quality Act, 2004 (ACT NO. 39 OF 2004) National ambient air quality standards, Government Gazette, 24 December 2009, pp. 6-9.

DEA, Department of Environmental Affairs. 2012. Notice 495 of 2012. Department of Home Affairs, National Environmental Management: Air Quality Act, 2004, Declaration of the Waterberg National Priority Area, South African Government Gazette No. 35345 on 15 June 2012; Correction notice (154):

Waterberg-Bojanala National Priority Area, South African Government Gazette No. 36207 on 8 March 2013.”

DEAT, Department of Environmental Affairs and Tourism. 2006. Declaration of the Vaal Triangle Airshed Priority Area in terms of section 18(1) of the National Environmental Management: Air Quality Act 2004 (Act no. 39 of 2004), Government Gazette, 21 April 2006.

DEAT, Department of Environmental Affairs and Tourism. 2007. Department of Environmental Affairs and Tourism. Declaration of the Highveld as priority area in terms of section 18(1) of the National Environmental Management: Air Quality Act 2004 (Act no. 39 of 2004), Government gazette, 23 November 2007.

Pg 5 Line 11, Use full text on first mention e.g., Desulfurization (DeSOx) / Denitrification (DeNOx) equipment.

The text was changed as follows:

“...with other large point sources, such as two coal-fired power stations (without desulphurisation (de-SOx) and denitrification (de-NOx)) and large pyrometallurgical...”

Pg 5 Line 26, Expand ICP-MS on first mention.

ICP-MS was written out in full and abbreviated on Pg 6 line 3 (Section 2.2) (in the original manuscript submitted) where it was first mentioned in the text.

Pg 11 Line 23 Should this be 2.5×10^4 or 10^{-4} ? Please check Table 1 as well.

Thank you for Referee #2 for pointing this out. This value was checked and the correct value is 2.5×10^{-5} , which was changed in the text and in Table 1.

For references, check for consistency in the use of DOI/doi throughout the discussion paper.

“DOI” was changed to “doi” throughout the Reference list.