Dear Referee #1,

We thank you for the positive feedback and critical comments on the manuscript! In the following, the authors will reply to those. Next to the review comments, some more changes to the manuscript have been done:

1. Subsection *2.2.9 Meteorological Instrumentation* was placed in the beginning of section 2.2, i.e. this section is now 2.2.1. The reason for this is that in the following the deposition velocity is always investigated first, followed by the mass concentration and the mass deposition flux.
2. The sections 3.1 and 3.2 were changed to always fulfill the order: Deposition velocity, mass concentration, mass deposition flux.
3. The abbreviations for the deposition flux, the mass concentration and the mass deposition flux were changed to $v_{d,method}$; M_{method} and F_{method} in the whole manuscript to make the text better readable.
4.

General Comments:

Reviewer:
In the whole "Results" section there is too limited discussion of the results of this work compared to existing literature. This should be more articulated for the following aspects: (1) other measurements of the same kind, (2) estimates of dry deposition velocity and (3) dust fluxes.
Response:
To our best knowledge, this paper is the first one dealing with deposition measurements to the ocean in the eastern tropical Atlantic Ocean.
Mass concentration of mineral dust is very often measured by particle sampling. We included some text in section 4.2, which is closer described in the answer of the specific comment: 33051.4-5: Table 3 does not seem to be really informative.
Estimates of deposition velocities are used for model inputs, measurements of deposition velocities are usually done for smaller particles (submicrometer range) and should not be compared with measured deposition velocity of dust. Despite these concerns, we extended subsection 4.1 by a general value of the deposition velocity for supermicrometer crustal particles: "*Duce et al. (1991) gave a value of 1.0 cm/s $\pm$ a factor of 3 for supermicrometer crustal particles. The mean deposition velocity for both methods in the particle range of 1 to 10 µm is 0.2 cm/s and thus 5 times smaller than the value given by Duce et al. (1991). However, in the particle size range between 1 and 4 µm, gravitational settling is not the dominant removal process as described in Duce et al. (1991). With increasing particle size, also the deposition velocity increases reaching a value of 0.83 cm/s at 10 µm which is close to 1.0 cm/s.*"
Many publications of Prospero and other scientist are available for the western Atlantic Ocean, i.e. Barbados. However, as a completely different meteorology exists there and the dust layers most often reach the surface – which is not always the case for the Cape Verde Islands – direct comparison of deposition rates should not be done. Furthermore, those dust depositions result from wet deposition, which is not regarded in this paper. However, in Table 4 (old 5) deposition fluxes in the eastern tropical Atlantic are compared with literature.

Specific comments:

Reviewer:
33027.1-3: the rationale for the work is clear, but I would suggest also placing it in a wider context
Response:
The objectives of this work are addressed more specific in the introduction. However, the authors agree to add one sentence referring to the project SOPRAN, in which this work was carried out. The first sentence of the abstract was changed to:
"*Mass deposition fluxes of mineral dust to the tropical northeast Atlantic Ocean were determined within this study. In the framework of SOPRAN (Surface Ocean Processes in the Anthropocene), the interaction between the atmosphere and the ocean in terms of material exchange were investigated*" at the Cape Verde Atmospheric Observatory (CVAO) on the island Sao Vicente for January 2009.

Reviewer:
33027.16: : "It is shown that..."
Response:
The phrase was changed accordingly.

Reviewer:
33027.18-20: This result is not explicitly described in the manuscript
Response:
The specific value is replaced with the unspecific comment "*difficult to compare*", since no direct comparisons have been done for different dust distributions over the area of interest.

Reviewer:
33029.14-15: try to link better the two paragraphs
Response:
The two paragraphs are linked in a better way by beginning the second one with:
"*From the experimental point of view*".

Reviewer:
33031.11: Due to the number of different instruments it is indeed a good idea to have a clear subdivision of the methods. Still a brief introduction giving an overview would be recommended, in order give the reader a clear reference of the whole sense of the work: in addition/alternative to table 2, this could include e.g. a schematic of the sampling tower (perhaps a picture with indications) and/or a table with all the instruments and what they do, and a workflow diagram synthetizing the procedures of measurements and calculations.
Response:
Thank you for this comment to obtain a better overview of the instrumentation! We changed Figure 1 that way that we excluded the position of the station and inserted it in a new Figure 2 showing the coastline of the island Sao Vicente and a picture of the measuring tower with the position of the different instruments. Furthermore, a scheme (Figure 3) was inserted showing the used instruments for

the different parameters (deposition velocity, mass concentration and mass deposition flux) including the abbreviations used later in the text. Table 2 was skipped. The following text was included to describe the two new Figures:
At the end of section 2.1: "*Figure 2 shows the coastline of the island Sao Vicente with the CVAO marked as red square and a picture of the measuring tower including an overview of the position of the used instruments that are explained in more detail in the following.*"
At the beginning of section 2.2: "*In Figure 3, a scheme is shown including the instruments used to obtain the deposition velocity, mass concentration and mass deposition flux of mineral dust and the abbreviations used later in the text. Two devices were used to measure the deposition velocity and will later be referred to micrometeorological (mm) and profile method (pm). Three devices including one or two instruments were used to obtain the mass concentration of mineral dust and the methods are using the different instruments are called microphysical (mp), optical (op) and gravimetrical (gr). Four combinations of the devices of the first two parameters were used to obtain the mass deposition flux of mineral dust. For the mass concentration and mass deposition flux of mineral dust, also a model was used which will be described later.*"

Reviewer:
33032.23-24: "Both up and down scans…"
Response:
The phrase was changed accordingly.

Reviewer:
33033.12: "Both the mobility…"
Response:
The phrase was changed accordingly.

Reviewer:
33033.15-18: anticipate here you are going to convert both to volume
Response:
The passage in subsection 2.2.5 (old 2.2.4) was changed to underline that mobility and aerodynamic diameter were changed to volume equivalent diameters.
The following text was included before Equations (1) and (2): To combine the mobility and the aerodynamic particle number size distribution," *the mobility and aerodynamic diameters have to be converted to volume equivalent diameters. By knowing the particle density and the shape factor (mineral dust or pure sea salt), either from literature or from measurements, the volume equivalent diameters can be calculated following Equations 1 and 2 (DeCarlo et al., 2004):*"

Reviewer:
33034.9-10: somewhere describe the binning / size resolution deriving from your method
Response:
The authors added two sentences in the paragraph after Equations 1 and 2 in subsection 2.2.5 (old 2.2.4) describing the size resolution:

"*After this conversion, the volume equivalent diameters of both instruments were put into a new grid with a logarithmic equidistant distance of 0.03. The corresponding number concentrations were calculated by a linear interpolation.*"

Reviewer:
33036.8-9: was this a clean room lab? If yes please specify its characteristics
Response:
No, it was not in a clean room lab and the authors added in subsection 2.2.8 (old 2.2.7) that sample handling was performed:
"*inside the measuring container undisturbed from the air conditioner and the instruments*".

Reviewer:
33037.15: In this section too I would suggest trying to be wordier when it comes to putting in place each method in the overall context of the work
Response:
The following text was added before the beginning of section 3.1:
"*The mass deposition flux of mineral dust published in the last years mostly belongs to measurements using sampling methods (e.g., Arimoto et al., 1997) and from global model outputs (Prospero et al., 1996; Ginoux et al., 2001; Zender et al., 2003; Luo et al., 2003). In order to have large pool of values for the mass deposition flux of mineral dust to compare against each other, different methods using the previous described instruments will be introduced in the following. Using the different methods shows the accuracy of each resulting in a range of values for the mass deposition flux of mineral dust and thus increasing the level of confidence of this value. Additionally, methods showing a too large deviation can be determined. As the mass deposition flux of mineral dust can be obtained by using Equation 3, also different methods for calculating the deposition velocity and the mass concentration of mineral dust need to be investigated. Figure 3 gives an overview of the acronyms of the different methods explained in more detail in the following and the used instruments to obtain the different parameters.*"

Reviewer:
33038.10-11: Why? Please specify this
Response:
The H-DMA-APS can only be used up to a diameter of about 1000nm. The number concentration of larger particles in the atmosphere is too less and cannot be investigated with the large DMA used in the system. The following text was thus added in the paragraph before Equation 15 (old 4) in subsection 3.2.1 (old 3.1.1):
There is no information about the number fraction of mineral dust of particles larger than 1000nm "*because the H-DMA-APS was only used up to this diameter. For larger particle diameters, the number concentration is too low leading to insufficient statistics*".

Reviewer:
33039.23-24: What is the relation to the text just above?
Response:

The authors agree that the lines do not directly correspond to Equation 17 (old 6) and brought the text in subsection 3.2.2 (old 3.1.2) in context to the equation by previously adding:
"*Mass absorption coefficients depend on the relative abundance of iron, which is the main absorbing species in the mineral dust. The relative iron abundance during this period was about 1% (Kandler et al., 2009)*".
After the equation, the text was changed to: "*It should be kept in mind that values for the mass absorption coefficients given in the text above are referenced to 1% relative abundance of iron. Thus the derived mass concentrations using this method are referenced to a relative iron abundance of 1%*."

Reviewer:
33041.18: "…which is related to...": please be more specific
Response:
To explain in more detail, the following text was included before Equation 6 (old 9) in subsection 3.1.1 (old 3.2.1):
"*The covariance of T_s and w yields the buoyancy flux, which is related to the sensible heat flux H. As the sensible heat flux cannot be determined directly due to a lack of a direct fast response measurement of temperature T, the buoyancy flux using the sonic temperature T_s instead of the virtual temperature T_v (Foken, 2008) is calculated. The covariance of U and w yields the momentum flux M, from which the friction velocity u_* is calculated by*:"

Reviewer:
33044.13: reference for equation 17?
Response:
The reference of Stull 1988 was added.

Reviewer:
33045.12: same as above, the size binning that was used is described nowhere
Response:
The authors added after Equation 18 in subsection 3.3.1:
"*which again have a logarithmic equidistant distance of 0.03*".

Reviewer:
33048.2-4: (1) the two statements about dust interactions with climate are in contradiction; (2) please add a reference for the mode
Response:
(1) The authors agree that, due to its impact on radiative fluxes and model dynamics, the dust tracer is not entirely 'passive'. Therefore, the phrase "as passive tracer" was omitted.
(2) Several references for the model are already given at the beginning of Section 3.3.4. For the dust radiative feedback in the model, we added an additional reference to Helmert et al. (2007).

Reviewer:
33048.13-14: give longitude/latitude limits (or point to Fig. 4 where this is shown)
Response:

Now, the longitude/latitude limits of the model domain are given in the text in subsection 3.3.4; we also added a reference to Figure 9 (old 7):
"*The model domain, whose south-west and north-east corner is located at (0.2°N, 32.3°W) and (41.1°N, 32.9°E), respectively, covers relevant parts of the Saharan desert and the tropical North Atlantic Ocean (Figure 9).*"

Reviewer:
33048.19: In the following subsection please try to be specific whether you are describing model results or observations. If you are describing model results, then some validation should be provided for the period, for both source activation and the dust event at Cape Verde, by comparing to observations such as e.g. MSG-SEVIRI, MODIS or AERONET. This aspect is partially covered later in the manuscript, associated to the discussion of Figure 7, but relevant aspects should be anticipated here and expanded
Response:
Here, we describe the meteorological conditions using a composite of dust source activations derived from MSG/SEVIRI satellite observations as well as wind vectors and isobars at 925 hPa from ECMWF re-analysis. The text was extended accordingly.
Regarding a more detailed discussion of the performance of the COSMO-MUSCAT model, we think that this would be beyond the scope of this study. The model has already been extensively tested for a case of Saharan dust outbreak towards Europe (Heinold et al., 2007) as well as with observations from the SAMUM field experiments, including available station and remote sensing data (Heinold et al., 2009, 2011). For a 2-year period, Tegen et al. (2013) recently compared COSMO-MUSCAT simulations to a record of Saharan dust source activations retrieved from MSG satellite observations and sunphotometer measurements from the Aerosol Robotic Network (AERONET).

Reviewer:
33048.21-22: Specify if Figure 4 refers to model or observations
Response:
Figure 6 (old 4) is not a model result, but a composite of MSG/SEVIRI observations in combination with re-analysis winds taken from ECMWF. The text passage in the beginning of chapter 4 was extendet to: The wind is indicated as vector for wind velocities larger than 1m/s and the dark grey lines present the geopotential height, both in the 925 hPa level. "*Both fields are taken from the ECMWF ERA-Interim reanalysis data set (Dee et al., 2011).*" Furthermore, dust source activation frequencies "*retrieved from MSG SEVIRI IR dust index images as described by Schepanski et al. (2007, 2009b, 2012)*" are shown.
Additionally, also the picture caption was changed to:
"*Dust source activation frequency retrieved from MSG SEVIRI IR dust index images (shaded colors) for the three events from DOY 12-16, 21-27 and 29-31, respectively, overlayed by ECMWF ERA-Interim 925 hPa wind fields for wind velocities larger than 1 m/s (vectors) and 925 hPa geopotential (contours). The red point indicates the location of the Cape Verde Atmospheric Observatory.*"

Reviewer:
33048.24: "niveau": level?
Response:
Niveau was changed to level.

Reviewer:
33048.24-25: "…modeled dust source...":
Response:
The phrase was changed accordingly.

Reviewer:
33049.1: "…the first mineral dust phase...": episode/event?
Response:
The phrase was changed accordingly using "event".

Reviewer:
33051.4-5: Table 3 does not seem to be really informative
Response:
Table 2 (old 3) was extended showing also the mean values of the three events and some more text explaining the table and comparing with existing literature was added in the text (now section 4.2):
"*The highest value is given by the model for the second event with 227 µg/m³ and is close to the maximum value of 250 µg/m³ given by Ginoux et al. (2001) for mass concentrations of mineral dust in the boundary layer in the Northern Hemisphere, e.g. the Sahara and Sahel region. Calculating the ratio of the maximum and mean values for each method and event (not shown) yields a factor larger than 3 for* M_{mp} *and* M_{op} *(except event 3) and a factor smaller than 3 for* M_{model} *and* M_{gr}*. The better time resolution of the instruments of the first two methods explains this finding.*"

Reviewer:
33052.10: "…overestimated cyclone development…": argument more on how this statement is derived
Response:
The judgment on the overestimation of the modeled dust emission mainly bases on comparisons to sunphotometer and satellite (MODIS) observations of dust-related AOD. The model apparently predicts too strong frontal winds in this case. In order to clarify, an additional reference to Figure 9 (old 7) was added.

Reviewer:
33052.27: concentration/amount would sound more appropriate than "dust events" in this context
Response:
The phrase was changed accordingly using concentration.

Reviewer:
33054.4: "…it is shown that..."
Response:
The phrase was changed accordingly.

Reviewer:
33054.23: "Compared to..."

Response:
The authors changed to 'comparable with' to show that measurements are model can be compared to each other.

Reviewer:
33056.21-23: Actually this is not the case for all the model results reported in Mahowald et al., 2005
Response:
The authors changed "*total suspended particles*" to "*include particles larger than 10μm*".

References:

Arimoto, R., Ray, B. J., Lewis, N. F., Tomza, U. and Duce, R. A.: Mass-particle size distributions of atmospheric dust and the dry deposition of dust to the remote ocean, Journal of Geophysical Research-Atmospheres , 102(D13), 2001.

Dee, D. P., Uppala, S. M., Simmons, A. J., Berrisford, P., Poli, P., Kobayashi, S., Andrae, U., Balmaseda, M. A., Balsamo, G., Bauer, P., Bechtold, P., Beljaars, A. C. M., van de Berg, L., Bidlot, J., Bormann, N., Delsol, C., Dragani, R., Fuentes, M., Geer, A. J., Haimberger, L., Healy, S. B., Hersbach, H., Holm, E. V., Isaksen, L., Kallberg, P., Kohler, M., Matricardi, M., McNally, A. P., Monge-Sanz, B. M., Morcrette, J. J., Park, B. K., Peubey, C., de Rosnay, P., Tavolato, C., Thepaut, J. N. and Vitart, F.: The ERA-Interim reanalysis: configuration and performance of the data assimilation system, Quarterly Journal of the Royal Meteorological Society, 137(656), 553-597, 2011.

Foken, T.: Micrometeorology, Springer, Berlin-Heidelberg, Germany, 308 pp., 2008.

Helmert, J., Heinold, B., Tegen, I., Hellmuth, O., and Wendisch, M. 2007. On the direct and semi-direct effect of Saharan dust over Europe: A modeling study. J. Geophys. Res., 112, D11204, doi:10.1029/2006JD007444.

Schepanski, K., Tegen, I., Todd, M. C., Heinold, B., Bonisch, G., Laurent, B. and Macke, A.: Meteorological processes forcing Saharan dust emission inferred from MSG-SEVIRI observations of subdaily dust source activation and numerical models, Journal of Geophysical Research-Atmospheres, 114, 2009.

Schepanski, K., Tegen, I. and Macke, A.: Comparison of satellite based observations of Saharan dust source areas, Remote Sens. Environ., 123, 90-97, 2012.

Tegen, I., Schepanski, K., and Heinold, B. 2013. Comparing two years of Saharan dust source activation obtained by regional modelling and satellite observations. Atmos. Chem. Phys., 13, 2381–2390, doi:10.5194/acp-13-2381-2013

Figures:

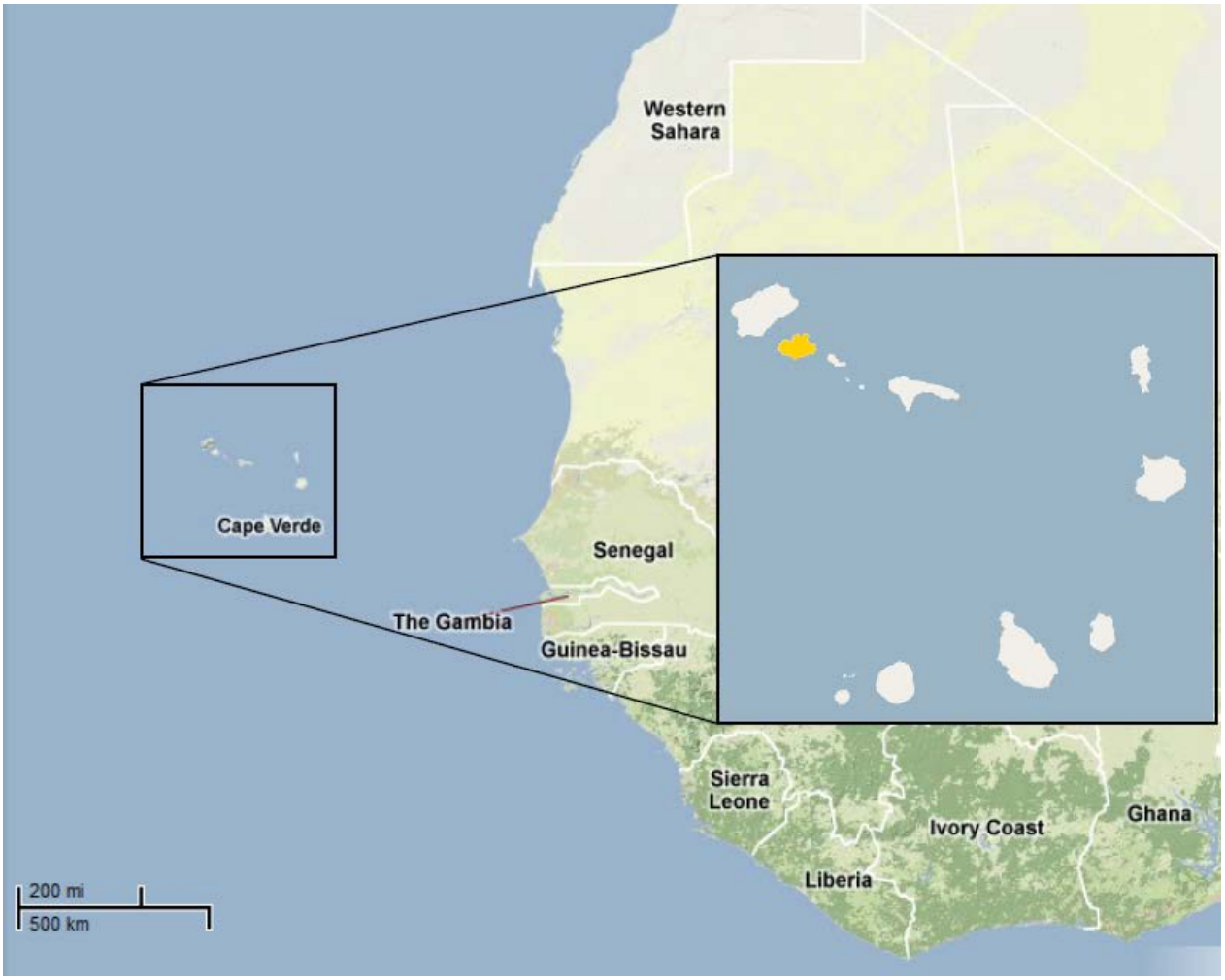

Fig. 1. Geographical position of the Cape Verde Islands ((c) OpenStreetMap and contributors, CC-BY-SA). The orange island shows the position of Sao Vicente.

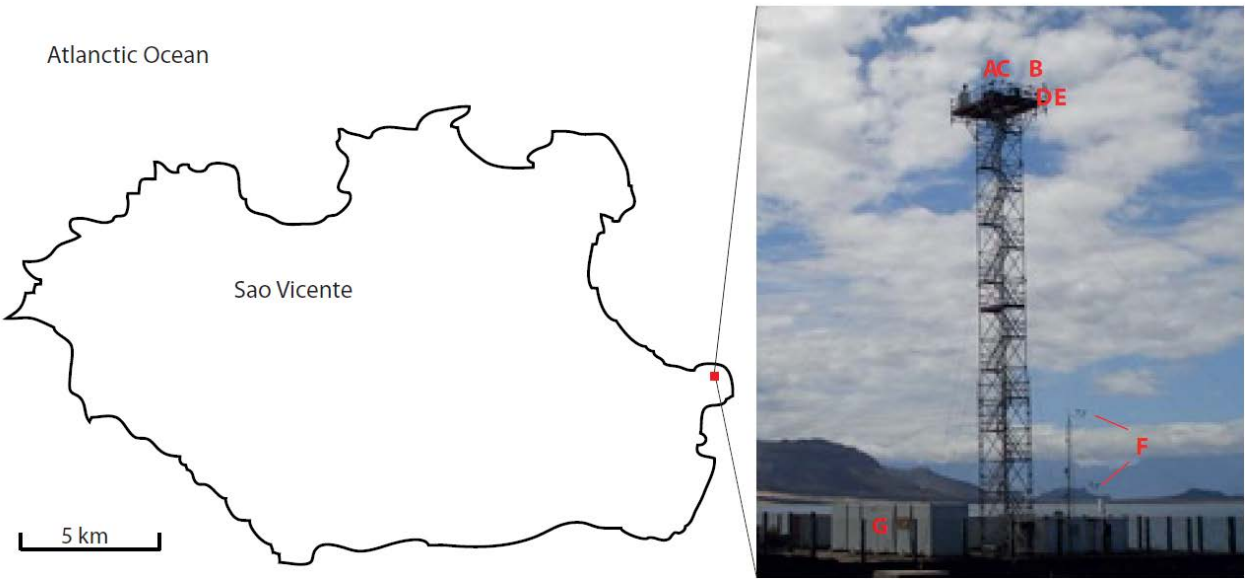

Fig. 2. Position of the Cape Verde Atmospheric Observatory on the island Sao Vicente and a picture of the measuring tower showing the position of the individual instruments.

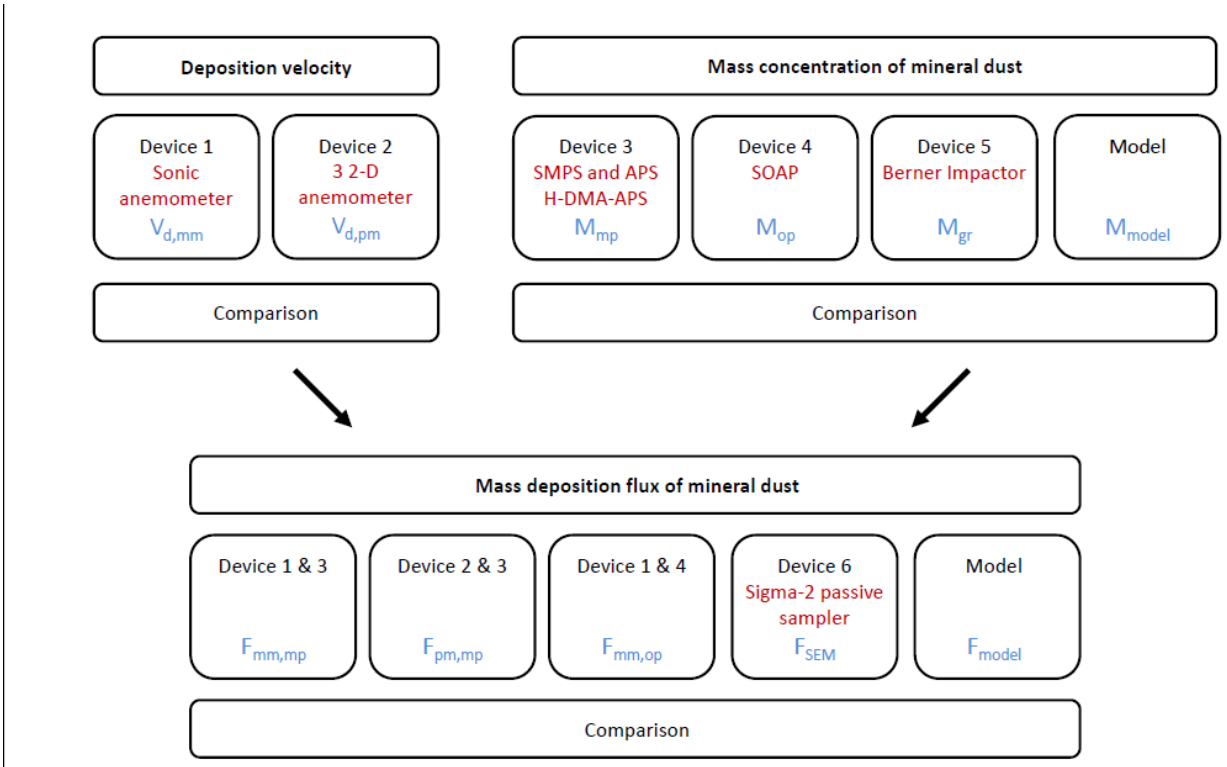

Fig. 3. Scheme of the measuring and evaluation procedure showing the instruments (red) and the used acronyms (blue) for the different methods of the three parameters deposition velocity, mass concentration and mass deposition flux of mineral dust. The methods for the deposition velocity are called micrometeorological (mm) and profile (pm) and for the mass concentration of mineral dust microphysical (mp), optical (op), gravimetrical (gr) and in addition the output of a regional transport model (model) is used. The methods for the mass deposition flux of mineral dust are combinations of the previous methods and additionally from scanning electron microscopy of passive sampled particles (SEM) and from the regional transport model.