We thank Joseph Prospero for very helpful and valuable comments which improved several aspects of the paper. A list of comments including our response is given below.

<u>Response to Joseph Prospero:</u>

1.) *However there are some concerns about some aspects of the paper. Throughout B12 they refer to previous work on Iceland, especially the work of Thorsteinsson et al. [2011, T11] and to an earlier version of the recently-published Prospero et al., [2012, P12] who report on six years of dust measurements made on the island. In doing so B12 implies that their results are consistent with those of T11 and P12. However, while there is general agreement that there is significant dust activity on Iceland and that large amounts of dust are transported over the ocean, the sources implied in B12 differ considerably from the conclusions of T11 and P12. These differences suggest either that the event reported in B12 is unusual with regard to sources or that the modeling and the interpretation of the limited aircraft aerosol data were incorrect.*

It was not our intention to imply that the dust case investigated in the manuscript is completely similar to the cases studied by T11 and P12. The work by T11 and P12 is cited in the paper to represent this previous and very valuable research on Icelandic dust storms. However, especially the events which produce occasional dust episodes in Reykjavik described by T11 differ from the one described in B12. This is described in more detail in our response to point 3 below.

2.) *The modeling studies in B12 as depicted in Figure 8 suggest that the highest dust concentrations are found inland over central Iceland in the extreme north of the modeling domain. In this regard it should be noted that Figure 8 covers a relatively small area of southeast Iceland. This implies that at the time of the modeling the dust was coming mainly from interior terrains, the terrains identified by Arnalds as cited in B12. However, given the limited domain shown in Figure 8 we cannot see the origin of these high dust values. I would suppose that a considerable fraction of the dust in the northern part of Figure 8 is advected from the North, not generated within the high-resolution grid box (1km, G3) but rather in the 5km grid box (G2). MODIS images on 26 and 28 February show large areas of bare ground outside the G3 box. It would be helpful if the coverage in Figure 8 extended further to the North although it is recognized that the high-resolution domain is restricted to the area in Figure 8. The results from this larger domain should be presented in the paper so that the reader has a better sense of the dust sources that feed into the G3 domain.*

It is now described in the paper that some of the dust shown in this Figure (note that the Figure is now number 9 in the revised version) may have been transported there from the outer domains (i.e. from the north-east, as north-easterly winds prevailed on the flight day). However, comparing the wind field (Figure 8 of the revised version) with the vegetation map for G3 (not shown) and looking at the time evolution of dust mass mixing ratios for all three model domains reveals that large amounts of dust are most likely produced within G3 directly. This is especially true for the dust maxima around Myrdalsjökull. As dust fluxes are not part of the WRF/Chem model output, the extent to which errors in dust production in G1 and G2 influence the dust simulations for G3 remains uncertain (this has been added to section 4.1.1, last paragraph).

The wording related to the dust sources around Myrdalsjökull used in the abstract and the results section of the paper has been changed. It is now described that these sand fields are among/contribute to the low visibility observed by the aircraft, rather than stating that these are the primary dust sources.

There is a significant underestimation of snow cover for G2 and G1 which results in errors in dust production in these areas. This is now pointed out more explicitly in the revised version of the paper (section 4.1.1, last paragraph). It would therefore be misleading to extend the area shown in Figure 9 to the outer model domains, especially since the air was clear during flight leg 9 over central Iceland. The fact that the air was clear during flight leg 9 is now given in section 2 of the revised manuscript.

3.) *In any case, while those inland terrains are known sources of dust, they are not the ones that are normally associated with the large dust events cited in T11 or P12. T11 reports on two years of data on PM 10 measurements made in the Reykjavik area and at air quality stations on the southeast coast. Amongst other presentations, they show time series of PM10 measurements and winds during six major dust events in 2008 (which I assume were the six largest of the year). The dust concentrations were comparable to those reported in B12 and P12. However in T11, in all cases winds were from the east and southeast. Indeed, in their conclusions T12 specifically states, "Periods of high (>100 µg m3, 30-min values) levels of particulate matter pollution (PM10) in Reykjavík are directly related to aeolian sediment transport from the sandur [proglacial sand deposit] region at Landeyjasandur [west of Vatnajökull ice cap] some 100 km ESE of the capital city." The jet (red area in B12 Figure 7) shows strong easterly flow which would could well serve to carry dust from the ice-cap-linked sandur sources to Reykyavik if, indeed, such sources had been activated in the model. (In this regard, were PM 10 measurements made in Reykjavik on the flight day? T11 shows measurements throughout this period.)*

As shown in Figure 1 of the manuscript, north-easterly winds prevailed over Iceland on the flight day. Moreover, large parts of Landeyjasandur (located along the south-east coast of Iceland at approximately 63.73° N, 20.67° W to the west of Myrdalsjökull) were located inside the low wind speed wake region, which did not favor the production of wind-blown dust at this area. The prevailing north-easterly wind directions precluded dust transport towards Reykjavik which is in agreement with visibility observations. This difference to the dust events studied by T11 and P12 is now described in the conclusions section of the revised paper.

Manned meteorological stations at Reykjavik and Keflavik (located just 60 km south-westwards of Reykjavik, see Figure 4 of the revised version for the location of this station) reported visibilities of 70 km or more on the flight day. This is now described in section 2 of the revised manuscript, together with a description of observed visibilities from manned meteorological stations at south-western Iceland in general. The meteorological observations from Keflavik are in agreement with observations from researchers on board the aircraft, who reported that the air was very clear during take-off (see beginning of section 2).

4.) *Similarly P12 reports on six years of quasi-daily dust measurements made on the island of Heimaey, situated off the southeast coast of Iceland. P12 shows that low dust concentrations are often present in the region. However on occasion intense dust events are observed. All major dust events are linked to the sandur deposits in the region of the Myrdalsjökull and Vatnajökull ice caps. Six of these major events were captured in MODIS and SeaWiFS satellite images which show large plumes emitted from these specific sources and carried far to the south and east of Iceland. The conclusions of P12 are in agreement with those stated in T11, "There is a long history of glacial outburst flood events that have affected large areas of the floodplain (40 -50 km2) and deposit material that is susceptible to aeolian entrainment (Smith and Dugmore, 2006). Arnalds (2010) identified Landeyjasandur as a major dust plume source area in his recent review of Iceland dust sources and this is confirmed by the events analyzed in this [T11] paper. Satellite images show that sandur regions around the glaciers in Iceland are prone to aeolian sediment transport and that a significant amount of dust is transported to populated areas, like Reykjavík." In contrast B12 in Figure 8 suggests that the major sources lie to the north of the Myrdalsjökull and Vatnajökull source regions.*

See answer to points 2 and 3 above.

5.) *It is notable that B12 Figure 2 shows very high winds between the Myrdalsjökull and Vatnajökull ice caps. One would expect sources in this region to be activated under such conditions. MODIS shows* *that these source areas were snow-free on 26 and 28 February.*

The MODIS image from 25 February (Figure 6 of the revised paper), which is assumed to be representative of the snow cover on the flight day, shows that some sandy areas along Iceland's south coast between Myrdalsjökull and Vatnajökull were snow free. Indeed, sources to the west of Vatnajökull (located outside the high-resolution domain) also seem to be activated in the simulations and may have contributed to the low visibility inside the wake area. This is now described in the conclusions section of the revised manuscript. Note however, that some overestimation of snow cover occurs to the south-east of Vatnajökull by using USGS for the flight day leading to some underestimation of dust production in this area (this has been added to section 4.1.1 of the revised version).

6.) *I am not a modeler and, thus, I cannot comment in depth on the modeling schemes. In B12 the authors discuss how they adapted their model to the unique conditions on Iceland with regard to vegetation cover and other terrain characteristics. However, in the absence of knowledge about dust source terrain responses, they found it necessary to use test values of "α" (the erodible soil fraction). In this manner they arrived at values of α that yielded the best fit to their measurement data. Given that major dust events as reported in T11 and P12 are derived from sandur deposits and given the unusual nature of these soils, it is not clear how these soils might respond relative to the conventional soil classifications and test values of α used in the model. In this regard, it should be noted that the satellite images cited in P12 (and the one in T11) show that the sandur dust sources were typically seen as clearly-defined localized "point" sources, i.e., dust "hot spots". Because of the small-scale and unique character of these hot-spot sources, the modeling scheme might not be capable of capturing their activity. These factors could explain why B12 sees so little dust coming from the sandur deposit region in southeastern Iceland.*

We have excluded the sentences on finding more accurate α values by comparing test runs with the measurements (section 3.1.1 of the old paper version, section 4.1.1 in the revised version) from the manuscript. The reason is that the magnitude of measured particle mass mixing ratios is now poorly simulated by the model, after correction of PCASP measurements to account for optical properties of darker desert dust (see answer to point 7 below). Only very broad recommendations exist on how to choose the α values. However, the values used in the present study have been chosen on the basis of these recommendations and are therefore in agreement with the recommended values.

We are thankful for the comment on the usefulness of the USGS vegetation map for simulating Icelandic dust storms which is an important point to be mentioned in the paper. We have therefore included the following paragraph in the conclusions part of the manuscript:

"Although the snow free sand fields over South and West Iceland seem to be reasonably represented by the USGS data set, simulations may improve by testing other vegetation maps in order to simulate Icelandic vegetation characteristics more realistically. Moreover, it should be checked how the representation of vegetation in the model corresponds to the localised dust hot spots shown by satellite images in previous studies (e.g. Thorsteinsson et al., 2011; Prospero et al., 2012). Note however, that WRF/Chem has been used here primarily to better characterise the type of particles sampled by the aircraft and that this aim was achieved satisfactorily using the USGS vegetation map."

7.) *Regarding the aerosol measurements themselves, I recognize that the flight was not intended to study aerosols and consequently the instrumentation was limited. However I have a concern about the measurements made by the Passive Cavity Aerosol Spectrometer Probe (PCASP), ". . .an optical particle counter which counts and sizes aerosols in 15 channels between 0.1 µm and 3.0 µm diameter. The instrument measures the intensity of light backscattered by particles that pass a laser beam." In our experience, the dust color is a gray-to-black which is consistent with the dust being derived from the sandur deposits. Indeed one can see in Google Earth that the most active source* *areas around the ice caps are quite dark. Consequently one might expect that size measurements (and count response) based on light scatter (i.e., the PCASP) will be affected. Was any consideration give to that aspect?*

We are very thankful for this comment on the optical properties of Icelandic dust, as it had a quite strong effect on the PCASP particle mass mixing ratios shown in the paper. The PCASP measurements have now been corrected to account for optical properties of darker dust following the method described by Rosenberg et al. (2012, the reference is given in the revised paper version). Phil Rosenberg (University of Leeds) who applied the corrections is now co-author on the paper. The corrections are described in section 3 of the revised paper and the Figures showing PCASP data were changed accordingly. The corrected PCASP particle mass mixing ratios (Figure 12 of the revised version) show much larger values compared to the uncorrected data. The magnitude of the model simulations of particle mass mixing ratio now agrees less well with the measurements compared to the old version of the paper. However, the magnitude of particle number concentrations, as well as the shape of particle mixing ratios and number concentrations, have not changed much. The results section of the paper has been changed accordingly.

8.) *In any event, there is a large gap between the PCASP with an upper limit of 3 μm diameter and the cloud particle instruments which have a lower limit of 25 μm diameter. This gap is important from the standpoint of long range transport which would mostly consist of particles under 25 μm diameter with a large fraction of the mass falling between 3 μm and 10 μm diameter.*

Unfortunately, the Fast Forward Scattering Spectrometer (FFSSP) which would cover the gap between PCASP and 2DC did not operate correctly during the flight, so that data for this size range is not available for the present study. A short paragraph has been added at the end of section 3 of the revised paper describing this fact.

9.) *The authors comment on a peak in particle number concentrations observed at 18.9W. They suggest that "It could be due to volcanic emissions or sulfate produced from DMS not included in the model set up." It seems unlikely that the DMS source could be significant in February when primary productivity is extremely low. Thus DMS emissions are expected to be quite low. Prospero et al. [1995] in their Heimaey aerosol measurements found an extremely strong seasonal cycle in methanesulfonic acid (MSA) concentrations with values close to zero in winter and early spring. Also the long-distance transport of pollutants cannot be completely excluded. Prospero et al.[1995] show that on occasion pollution events can be transported from across the polar regions; I do not know if the CO measurements would be useful in identifying such events. Some insights on this issue could be provided by the PCASP aerosol size data. Although the size range measured by the PCAS is limited (0.1 to 3.0 um diameter), these data might present some insights on the hypothesized contribution from sulfate relative to dust and sea salt. It would be interesting and informative to have a figure that shows changes in relative size distribution (say below 0.5 or 1.0 um and that in the larger size range).*

The issue regarding the peak which occurred at 1900 m height in PCASP particle number concentrations has now been solved. The peak only occurred in PCASP channel 1 which should actually be excluded from any analysis (http://www.faam.ac.uk/) as this channel is prone to electrical noise. We have therefore excluded channel 1 from the results shown in the paper. This means that PCASP measurements of particle number concentrations now agree much better with the simulations (see Figure 12 of the revised paper) at 1900 m height. Consequently, the comments on contribution of DMS emissions and anthropogenic emissions to the peak in particle number concentrations at 1900 m height have been removed from the paper.

In our opinion, the carbon monoxide measurements shown in the paper (Figure 7 of the revised version) are a good indicator for anthropogenic pollution as chemical processes or the effect of wet scavenging can be neglected for this specie. Carbon monoxide has been used for investigating pollution transport across the polar regions in previous studies (e.g. Sodemann et al. 2011, the reference is given below).

A Figure (number 13 in the revised version) has been added to the paper showing particle number size distributions for the whole PCASP size range for three different regions. This Figure demonstrates the change in size distribution from the wake towards the jet. It shows that the number of aerosols at larger diameters was much larger inside the wake, which is in agreement with the WRF/Chem simulations of dust in this area. Moreover, a Figure (number 14 in the revised version) showing scattering ratios from the aircraft's nephelometer is now included in the paper. This Figure shows that fine mode particles did not dominate over larger mode particles and indicates a change in particle composition in the jet area. The latter is consistent with the the simulations, for which dust aerosols dominate inside the wake, while sea salt dominates inside the jet. The nephelometer data and size distributions are now discussed in the results section of the new version of the manuscript.

Reference for Sodemann et al. (2011):

Sodemann, H., Pommier, M., Arnold, S. R., Monks, S. A., Stebel, K., Burkhart, J. F., Hair, J. W., Diskin, G. S., Clerbaux, C., Coheur, P.-F., Hurtmans, D., Schlager, H., Blechschmidt, A.-M., Kristjánsson, J. E., and Stohl, A.: Episodes of cross-polar transport in the Arctic troposphere during July 2008 as seen from models, satellite, and aircraft observations, Atmos. Chem. Phys., 11, 3631-3651, doi:10.5194/acp-11-3631-2011, 2011.

10.) *Indeed, it would be very helpful to see PCASP data over the entire flight track of the island. If the sources are indeed located over the central part of Iceland, you should see strong changes along the northwestern leg of the flight triangle; data along the southeast leg would also provide "background" aerosol data that could be extremely useful in the context of the general source identification problem. This data would also help to resolve the conflict with the CALIPSO results (Section 5) which suggested that there was dust over the northwestern areas of Iceland.*

The paper focuses on flight legs 3 to 5 (ranging from 1900 m to 400 m height) as the dust event was confined to the area investigated during these parts of the flight. The air over central Iceland was clear on the flight day. Moreover, measurements from flight legs 6 to 9 were taken at much higher altitudes. It is expected that the background aerosol concentration at these high altitudes differs from the one below 2 km height. They are therefore not used for deriving a background aerosol concentration here.