Matthias Schneider short comment

The paper presents and interprets δD and {H2O,δD} pair distributions obtained from IASI spectra for the North Atlantic region. It gives interesting insight into the possibilities of such measurements for investigating tropospheric moisture pathways. Similar studies have already been made during the project MUSICA and the respective results are published in several papers: Schneider et al. (2015), Dyroff et al. (2015), González et al. (2016), Schneider et al. (2016). The MUSICA works have been focused on demonstrating the quality and the potential of the remote sensing data whereas this study focuses more on the scientific interpretation of the data. So there are similarities but also clear differences with respect to the MUSICA studies and this new work is very interesting for the scientific community. However, I think it would be important to relate this new work better to the previous MUSICA studies, mention the similarities, and highlight the new aspects.

We thank Dr. Schneider for having taken the time to comment on our manuscript. We agree with him that similar studies have been conducted in the framework of the MUSICA project. The different seasonal δd-q signatures above Izana have been observed from our IASI retrieval for a few years (i.e. Lacour J.-L. ULB PhD thesis in 2015) and much work has been done trying to understand the link with the dynamics of the region. It is the purpose of the present study to improve our knowledge of the influence of the regional atmospheric dynamics on the water vapor budget over the Northeastern Atlantic, and of the processes leading to the seasonal q-δd distribution. We agree with him that some references on MUSICA work related to the sensitivity of q-δd pairs to moisture pathways in that region were missing and we believe this has been now corrected.

First, I would very much like to see a statement in the Abstract and/or in the Introduction Section telling the reader that for this new study IASI data generated by the ULB IASI retrieval processor (Lacour et al., 2012; Pommier et al., 2014) are used. In this new study the subtropical North Atlantic moisture pathways are studied for the first time with the ULB IASI retrieval processor data. The here presented data are not generated by the MUSICA MetOp/IASI retrieval processor (Schneider and Hase, 2011; Schneider et al., 2016). The MUSICA MetOp/IASI data have already been used previously for documenting the different moisture pathways in the subtropical North Atlantic region. The technical details of these retrieval processor differences should maybe not be discussed in an ACP manuscript however, I think it is important to mention that there are different processors. The reason is that the retrieval processor differences can importantly affect the products (Worden et al., 2012, http://www.atmos-meas-tech.net/5/397/2012/): For instance, while the MUSICA processor works with a broad spectral window (Frank and Hase, 2011; Wiegele et al., 2014) similar to the new TES retrieval processor (Worden et al., 2012), the ULB IASI processor fits smaller spectral windows (Lacour et al., 2012). A brief summary of the differences of the processors is given in the Appendix of Schneider et al. (2016).

We agree that the information on the retrieval processor might not be clear for the reader. This is now clarified in the introduction:

> In this study, we use δD and humidity profiles retrieved from IASI at ULB/LATMOS (Lacour et al., 2012; Lacour et al., 2015).

This is also clearly stated in the data section.

We added the missing references about the identification of moisture pathways from IASI and FTIR MUSICA products.

> From in situ measurements at Izana, González et al. (2016) have shown that different airmass pathways could be detected in H2O-δD pairs distribution. The sensitivity of δD observations to different moisture pathways have also been reported from ground based FTIR and IASI measurements (Schneider et al., 2015) within the MUSICA project (Schneider et al., 2016). Here, we use IASI H2O and δD ULB/LATMOS retrieval products (..)

Second, I would like to recommend setting the here presented data interpretation approaches and the achieved results better in relation to the respective MUSICA activities. In my opinion it would be good to clarify what aspects have already been addressed in the MUSICA papers and what aspects go beyond previous MUSICA works. For example the interpretation of the MUSICA NDACC/FTIR and MUSICA MetOp/IASI {H2O,δD} remote sensing data as shown in Schneider et al. (2015 and 2016) is very similar to what is shown in this new paper in the Sections 3.1, 3.2, and 3.3. Some differences exist in the use of the backward trajectories (in the MUSICA studies the trajectories end at the last condensation point and here they can go beyond the condensation point) and this new work provides an analysis of individual months (taking the summer 2012 as example), whereas the MUSICA studies are mainly limited to an analyses of the overall situation.

> Aspects that have not been addressed by the respective MUSICA studies or that have been addressed by using a different approach could then be better highlighted: For instance, Section 3.4 presents a geographically expanded picture if compared to the MUSICA studies and Section 4 shows that quantifying the strength of the Saharan boundary layer mixing signal is possible by a simple backward trajectory analyses whereas in MUSICA the link to the Saharan boundary layer has been documented by coinciding observations of dust concentrations. The discussion of pathways (Section 5) has similarities to the MUSICA works, but also offers interesting new aspects, like the consideration of a wider geographic region. The clear message from the example study of July 2012 is that such satellite data can be really helpful for investigating geographically varying moisture pathways.

There are indeed similarities with previous work done within MUSICA but we believe the general approach proposed here is somehow different than the previous studies you report and can thus not be compared easily. We went through our manuscript again and made sure the previous works are properly addressed. Similarities with the work by Gonzalez is also now better addressed. (See referee #2 comments). Schneider et al. (2015 and 2016) clearly showed the sensitivity of δD to different air parcels trajectories, which is now clearly acknowledged in our manuscript but we do not think it is a good idea to compare every similarity in that study. In Section 3.1 3.2 and 3.3 of our paper we use the sensitivity of δD to different moisture sources to show that we have a clear signal associated to the arrival of the SHL. The message of the section 3 is the concomitant signal in δD and the SHL. The use of backward trajectory analyses is frequent in isotope analysis and we believe it is not worth to mention that some differences occur from one backward trajectory analyze to another. We agree with referee that we could link the section 4 with Schneider et al. (2015) concerning the coincidence of dust and high δd values. So we added:

> Schneider et al., (2015) already documented the link between high δD values and the continental origin of the airmass by coinciding observations of dust concentrations.

I have furthermore an important remark on the discussion provided in Section 2.4 and on the use of {H2O,δD} pair remote sensing data. As shown in Schneider et al. (2016, and references therein) it is important to ensure that the H2O and δD remote sensing products represent the same vertical altitudes, otherwise defective interpretations of the {H2O,δD} pair distributions are very likely. For this purpose the MUSICA {H2O,δD} pairs are generated by an a posteriori processing (the Type 2 product, which ensures that the {H2O,δD} pair distributions can be correctly interpreted). I think it would be important to clarify how this problem has been addressed for the here presented {H2O,δD} pair data.

We are aware of the post processing methodology the referee proposed to ensure that δD and humidity vertical profiles are representative of the exact same vertical profile. We agree that such post processing simplifies the interpretation of δd-H2O pairs for quantitative purpose. However in this study, we did not apply the post processing method on our IASI retrievals. The reason for that is the data used in that study have been processed a long time ago (the a posteriori processing on IASI data is now operational) and after verification on some samples of our data, we found that applying the post processing does not affect significantly the interpretation of our results. Moreover it is fine from an optimal estimation point of view to do so (in that case the smoothing contribution to the error is greater for δD than for H2O and δD are less precise than q). We show an example of the post processing in Figure S1 for one day of data above the North Atlantic (0-40°N/40°W-5°E) for data at 3.5 km and data at 5.5 km. As one can see there are indeed changes. The changes are especially important for humid data at 3.5 km (remind that we do not use data at 3.5 km) within convective area which is because when degrading the humidity profile at δD resolution, the vertical resolution (of H2O) becomes larger and at this altitude, more sensitive to the boundary layer which is very humid within this area. At 5.5 km there are also differences but the latter are unlikely to affect our analysis in δD-q space. We should also be careful when translating the results of Schneider et al., 2016 to our retrievals. As you mentioned the retrieval schemes are different and are likely to be differently sensitive. For example, we indeed use a relatively small spectral range centered on HDO maximum Jacobians and avoid fitting a large region where there is a lot of information on H2O. Our retrieval is thus not optimized to provide high resolution vertical profile of H2O and their AVK are more similar to δD ones than in the MUSICA retrieval scheme. Nevertheless, while we believe the post-processing should not affect the interpretation of the present study, it is worth noting that the a posteriori processing has recently been adopted in the processing of IASI data for simplifying the analysis made by end-users.

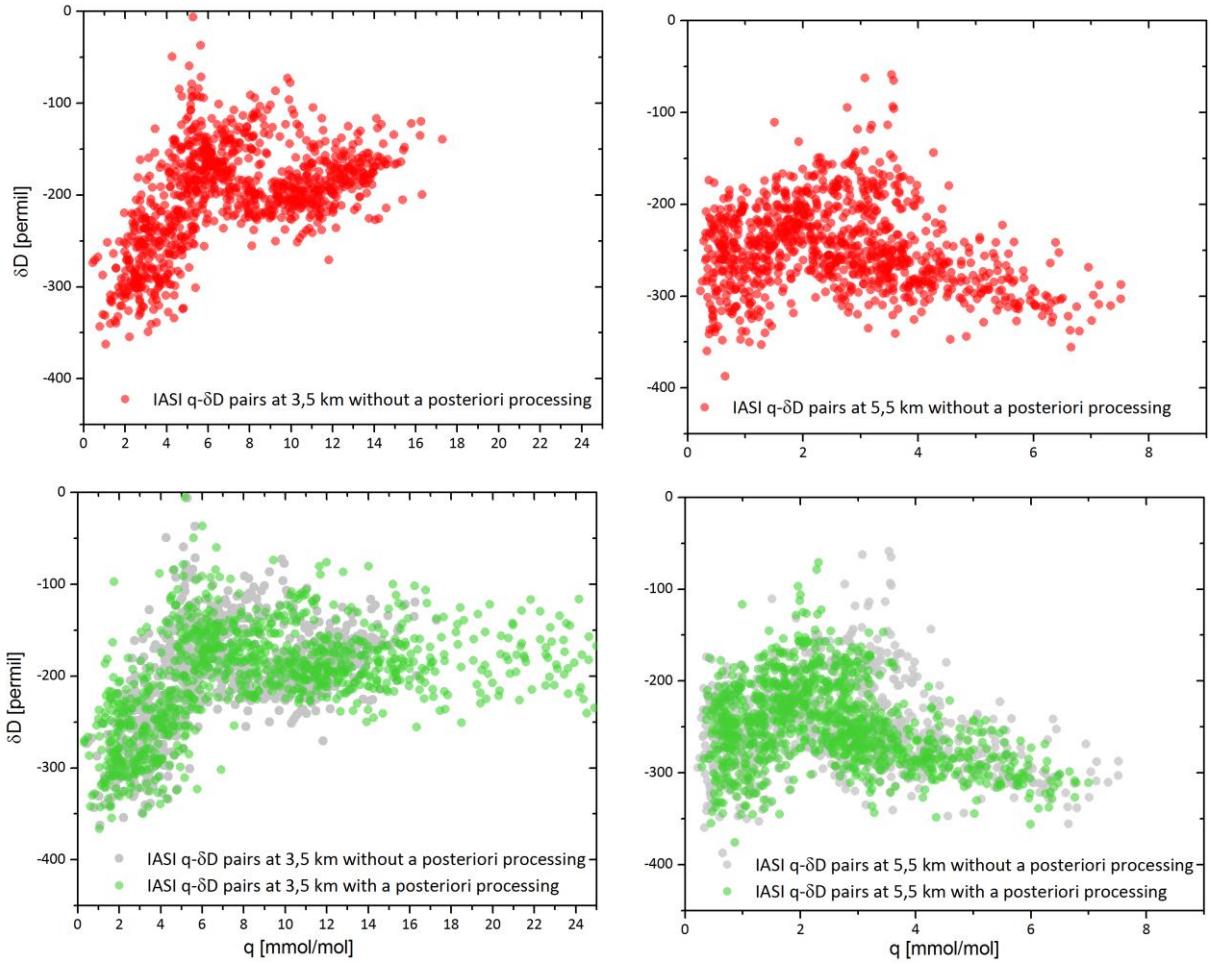

Figure 1 Differences between retrieved δD -q pairs at 3.5 and 5.5 km with and without a posteriori processing

In the data section, we now specify that the sensitivity of Dd and q are not the same:

> It is also important to mention that the δD and humidity retrieved profiles are not exactly representative of the same atmosphere, the humidity profile having more vertical information than δD. It is thus important to keep in mind that when δD-q pairs are considered, the δD estimate is representative of a thicker layer of the atmosphere than the q estimate.

I think it would be also important to mention that the transport out of the Saharan boundary layer to the atmosphere above the Canary Archipelago has been studied since many years mainly by the aerosol community (there are leading experts at the Izañ Observatory) and there are a lot of publications available, which I would like to recommend considering (e.g. Rodriguez et al., 2011, http://www.atmoschem-phys.net/11/6663/2011/ or Rodríguez et al., 2015, http://www.atmos-chemphys.net/15/7471/2015/, and references therein). Also interesting in this context could be to have a look on the works published for a current ACP/AMT special issue (http://www.atmos-chemphys.net/special_issue382.html).

We feel that discussing the transport of aerosols towards the Izana Observatory is out of the scope of the study and for the sake of clarity and conciseness we have decided not to dedicate a specific paragraph on the aerosol transport.

As a minor remark I would like to recommend not talking about ‘‘data above Izaña’’ (Izaña is a hill on Tenerife Island and the name of an observatory on this hill). When talking about a region that covers actually the whole Canary Archipelago I would like to recommend using something like ‘‘data representative for the Canary Archipelago region’’. Finally, I would like to recommend considering for the Introduction Section a reference to the review of Galewski et al. (2016, Rev. Geophys., 54, doi:10.1002/2015RG000512).

We now speak of the Canary Archipelago region.

We now cite the review paper by Galewsky.