Anonymous Referee #2

In this manuscript, the authors present the isotopic composition of water vapour in the subtropical North Atlantic free troposphere investigated with IASI measurements. This work can be seen as a further step of previous water vapour isotopologues studies carried out in the same region, involving in-situ, ground-based and space-based techniques. In these studies, the observed H2O-δD distribution was characterized as a function of the origin of the airmasses. Here, the authors focus on summer time, where H2O-δD distributions show the mixing between dry and depleted upper tropospheric air with humid and enriched boundary layer air transported within the Saharan air layer. The novelty of the work relies on the identification of the Saharan Heat Low (SHL) as the mechanism controlling the moisture budget in the subtropical Atlantic during summer. This work also shows a simple technique for interpreting the interannual variations of δD as a function of the fraction of western to eastern airmasses arriving at Izaña. Overall, this is a well-written and very interesting manuscript. I recommend publication subject to minor revisions.

The Authors would like to thank the reviewer #2 for reviewing this manuscript and for providing comments. Our answers to referee's comments are shown in blue and changes in text are shown in grey.

The specific comments described below are in relation of a general concern of lack of highlighting previous works developed in this region, which would help to justify the used tools and support the findings.

SC#1. Section 2.1 IASI δD retrievals: The authors use δD IASI retrievals to demonstrate the role of the SHL on the seasonal cycle of the water isotopologue budget above the North Atlantic in summertime. The 5-year ERC Project MUSICA focused on the long-term, global and high-resolution observations of tropospheric H2O-δD. This project used Izaña as a multiplatform site for improving the retrievals of ground-based FTIR and IASI sensors, by comparing with in-situ measurements and airborne profiles. Besides the relevance of the named project on the results of this work, there is no specific mention of it. I recommend including in line 20 of section 2.1, the more recent results of IASI observational errors that can be found in Schneider et al. (2015*, 2016, 2017*), and discuss the use of different approximations for the IASI retrievals.

* Schneider et al., Atmos. Meas. Tech., 8, 483–503, doi:10.5194/amt-8-483-2015, 2015

**Schneider et al., Atmos. Meas. Tech., 10, 507-525, doi:10.5194/amt-10-507-2017, 2017.

We followed your recommendation concerning the lack of references to the work done within the MUSICA project in that region. More references on previous work related to the sensitivity of δD to airmasses history are added in the introduction. See also our more detailed reply to Matthias Schneider who also pointed out a lack of discussion on the MUSICA work.

We also now make sure that it is clear for the reader that we use the retrieval of δD from IASI developed at ULB/LATMOS and not the MUSICA one. Concerning the description of IASI error, we thus only refer to the corresponding error characterization works (Lacour et al.,2012 and Lacour et al., 2015).

SC#2.

Section 2.2 TES δD retrievals: Please include a line describing the observational error for TES retrievals (section 2.2).

Added:

> The observational error on δD retrieved values from TES has been evaluated to 30‰ (Worden et al., 2012; Herman et al., 2014).

SC#3. Section 3.1 Seasonal cycle of water vapour and its isotopic composition over Izaña: Is the composite seasonal cycle representative of different years? Are this data in agreement with the inter-annual variability observed with the in-situ records at Izaña? Please, check and discuss.

Yes the composite is realized from 5 years of IASI data (2009-2013). However, it is difficult to compare with in situ data at Izana since the ground-based data described in Gonzalez et al.(2015) is for the years 2012 to 2013 at one site and 2013 to 2015 for another site, hence with little temporal overlap with our dataset.. Moreover Gonzalez et al. (2015) showed there was an important diurnal cycle of δd due to the development/displacement of the boundary layer with night measurements being the most representative of the free troposphere. A comparison of in-situ measurements with IASI ones is thus not straightforward and would require the development of a cautious frame to do so properly. Nevertheless, this would be a work of interest.

SC#4. Section 3.3 Relationship between the SHL and the summer enrichment over the Atlantic: The four clusters described in the δD-q distribution plot (Figure 5a) were already observed in the situ-measurements at Izaña. Please, link and discuss the observations. I would also like to see some references on the discussion on the dynamics of the Saharan Air Layer.

Referee is right, this is a link we should have made.

> Noteworthy, the four boxes delimiting the different δD-q signatures (here defined arbitrarily) are very similar to the dissociation of in situ δD measurements by Gonzales et al., 2016 based on the temperature of the last condensation of air parcels.

We also add a discussion on the SAL:

> The spatial pattern drawn by the high seasonality of δD can be linked to the dynamics of the SAL. Tsamalis et al. (2013) have shown that the SAL displays clear seasonal cycle (both in latitudinal extent and in vertical structure), using 5 years of data from the space-borne Cloud-Aerosol Lidar with Orthogonal Polarization (Winker et al., 2010). The SAL occurs at higher altitudes and farther north during the summer than during winter. Near the African coastline, the SAL is found between 5-30°N in summer, its northern edge being observed just north of the Canary Islands. The northern edge of the SAL migrates to 15_N during the winter, and is generally observed to be south of the Canary Islands from September to May (see Figure 2 of Tsamalis et al. 2013). During the summer, the SAL is found to be thicker and higher off the coast of Africa, between 1 and 5 km above mean sea level, while it is observed between 1 and 3 km during the winter (see Figure 4 of Tsamalis et al. 2013), i.e. below the altitude of maximum sensitivity of IASI-derived δD products.

SC#6. Please correct typo in page 15, line 17. It is read “2103”, instead of “20

Corrected, thank you.