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Interactive comment on "Importance of the Saharan Heat Low on the control of the North Atlantic free tropospheric humidity deduced from IASI δD observations" *by* Jean-Lionel Lacour et al.

Anonymous Referee #1

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In this manuscript, satellite observations of the isotopic composition of free-tropospheric water vapor are used to investigate the processes shaping the moisture budget over the subtropical North Atlantic in summer. The study highlights the importance of the Saharan Heat Low in facilitating the uplift and westward transport of moisture from the continental boundary layer to the oceanic free troposphere. The isotope data are used to shed light on seasonal, interannual and spatial variations in the associated moisture transport and mixing processes. In my view, this is a convincing study that provides important mechanistic insights into the subtropical water cycle and demonstrates the usefulness of isotope observations for such process investigations. I still have quite a few comments that mainly relate to the presentation of the methods

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and results, which in my opinion could be improved at several places. Nevertheless, most of these comments should be easy to resolve for the authors. Note that the manuscript contains several minor language errors, and I do not attempt to list all of them (I think these could be eliminated in the copyediting stage).

Specific Comments:

Title: I think the wording of the current title is a bit awkward. What about 'Importance of the Saharan Heat Low in controlling the North Atlantic free tropospheric humidity budget deduced from IASI dD observations'?

Abstract/Introduction: The last part of the abstract (from line 7) and last part of the introduction are a bit unconnected to the rest (read more like a report, first we did .., then . . .). I'd try to improve the connection between the different parts (SHL, interannual and spatial variability).

Abstract: One additional sentence on the more general implications of the work would be good.

Page 2, lines 3-4: 'the dryness of...': I don't understand this. Also in a moist atmosphere the humidity can be variable (even more in absolute terms).

P 2, 21: 'representation' is probably not the correct word; 'understanding'?

P 2, 29-30: 'the seasonal cycle . . . in summertime' is a bit contradictory

P 3, 19: 'filtered based on the residual fit': What does this mean?

Section 2.1: Please add some information on the averaging procedure. For instance, above Izana, do you first calculate daily means by averaging over the individual observations and then monthly means? May there be a bias due to the diurnal cycle? Do you weight the isotope observations by moisture content?

Section 2.3: More details on the trajectory setup would be helpful. At which altitude and time of the day are the trajectories initialized? May there be a bias due to temporal

mismatches between observations and trajectories? Wouldn't it be good to quantify also the uncertainty due to different starting altitudes (by using more than one trajectory per day), since also the satellite observations do represent a vertically extended layer?

P 4, 11: Which reanalysis data set do you use (add reference)?

P 4, 14 and P5, 8: Does q denote specific humidity or mixing ratio? Please use a consistent nomenclature.

P 5, 14-15: 'intense convective activity': I'd be more specific at this point. As I understand the Worden-paper, it is the recycling/evaporation of precipitation that leads to this increased depletion.

P 5, 23: There is also a relatively abrupt increase in q. In my view, the differences in autumn are more pronounced.

Figure 2: From inspecting this figure, the individual values (e.g, for July) shown in panel b do not seem to average to the value shown in panel a. Do you weight by q? Is this really what one should do when calculating such a multi-annual mean value?

P 6, 15: 'before...': I don't understand this insertion. Is it really required? At least you don't need the acronym.

Figure 4: Axis labels should be added to the first row. 'daily variations' is unclear; do you show daily averages or individual observations? Are the Rayleigh and mixing models the same as in Fig. 1 (with the same end members)? Over which levels has the temperature lapse rate been computed? This lapse rate is currently not discussed in the main text (but should be, I think).

P 9, 10: What is the data source for the precipitation amount? Also the reanalysis, which would mean that it's actually a model forecast? What is the accumulation period? This should be mentioned, as it may introduce some uncertainty.

Figure 5: 'Daily variations': see above. Please specify how the Richardson number is

calculated. The vertical velocity is not discussed and could thus be removed. Potential temperature could be shown as an alternative (which would probably also illustrate the deep mixed layer for the green box).

Section 3.4: In my opinion, this section disturbs the flow of the paper. I would shift it after section 4, as it provides a transition to the detailed spatial analysis in section 5.

P 11, 20 – P12, 2: I don't understand this sentence (the connection between the seasonality in q and the mixing processes).

Figure 7: The two upper panels could be combined by adding the red line to the uppermost panel.

Figure 9: The caption says that the ratio in b and c was normalized by the number of air masses from the African continent, but the main text and the axis label suggest that it is normalized by the total number of air masses.

P 14, 7: The wording of the first sentence is unclear.

P 14, 17: 'very similar values' instead of 'always the same value' (it does vary a bit due to changes in SST)

Figure 11: Note that each point represents one location over the North Atlantic. Why do the arrows indicate linear pathways (your simple models describe curved paths in the q-dD space)?

P 16, 12: 'can easily be distinguished': This is a bit subjective. How do you do this? Are the circles just positioned subjectively? Are all data points within the circles shown in panel a of Fig. 12 (this should be explicitly mentioned in the caption)?

P 17, 25: 'processes . . . are horizontal': I don't think that this can be concluded from the present analysis. I'm pretty sure that the descent or ascent of air masses is important for shaping these patterns (as you have demonstrated, e.g., for the SHL).

Figure 12: S2 and S3 are interchanged in panel c. Why are there gaps in the geo-

graphical locations of the pathways in the tropics in panel d? More general: Are the pathways defined in geographical or in the q-dD space? Why and how? For instance, in panel c there are some green points (P3) that I would visually attribute to P4.

P 19, 3: Figure 12e instead of 11

Section 5.2: I think some discussion should be added to this section. How unambiguous is the definition of the different pathways? Basically, one could reach every position in the q-dD space (in between your simple models of Fig. 1) by combining different Rayleigh and mixing lines.

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