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Interactive comment on “Detecting moisture transport pathways to the subtropical North Atlantic free troposphere using paired H₂O-delta; D in situ measurements” *by* Y. González et al.

Anonymous Referee #2

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General comments

This study uses multi-year measurements of the isotopic composition of atmospheric water vapour at two sites on Tenerife to build up climatological statistics on the composition and to infer distinct transport pathways. Night-time data is used to factor out the influence of diurnal variation in local boundary layer height. Four pathways are identified: 1) from the extratropical upper troposphere over the Atlantic, 2) transport within the Saharan Air Layer, 3) from the subtropical lower troposphere and 4) descent from the upper troposphere into the local boundary where mixing of water vapour into

the air-mass is experienced. Observations of aerosol are used to distinguish the SAL air-mass.

The data is of high quality and the deductions made from it were sound. A novel aspect was the use of scatter plots of the observations with water vapour mixing ratio and isotopologue ratio as the axes to distinguish different air-masses and mixing lines between them. The observations were found to be bound approximately by a mixing curve and a curve that represents the theoretical relation of isotopologue ratio to mixing ratio associated with Rayleigh distillation, where an air-mass experiences dehydration by condensation during adiabatic cooling. This approach enables the authors to identify “super-Rayleigh” points with evaporation – either from a warm ocean or from falling rain droplets – since such observations cannot be explained by condensation or mixing.

This paper will be of interest to readers interested in atmospheric transport processes in the subtropics and their influence on humidity and other constituent distributions. I recommend publication subject to minor revisions.

Specific comments

p.27222, l.17: The abbreviation “TIL” has been used by several authors in the last decade to refer to the “tropopause inversion layer” and I am not aware of this abbreviation being used before for “temperature inversion layer”. Since it is not used later, I recommend removing this abbreviation.

p.27224, l.8: trajectories were released from points “at the elevations of the IZO and TDE stations”. You need more detail here because the very tall volcano on Tenerife (where the stations are located) will not be well represented in the model used to produce the GDAS1 analyses. Are the trajectories released at the height above sea level of the actual stations? Or are they released at the pressure observed at the stations (time-dependent)? Since the mountain will be much lower and smoother in the analyses than reality, this makes a difference. If height ASL is used, the trajectories will in effect be far from the ground of the model which will have a strong influence on wind speed and direction. If observed pressure is used, the winds may be more consistent with the surrounding winds above the sea (at the same pressure level). However, again the trajectories will be far from the model orography. A 3rd alternative would be to release at 10m above the model orography at each station location, but I doubt this would work well since the mountain outcrops from the marine boundary layer as indicated in Fig.1.

Sections 3.1 and 3.2: I would like to see more physical discussion on the Rayleigh distillation curve. Why does dD decrease so rapidly with water vapour mixing ratio? Also, how do you derive your mixing curves? A brief explanation is warranted for their shape. Usually if two distinct air masses are mixed then tracer-tracer scatter plots form a compact straight line. Would it be more straightforward to use [HDO] as one of the axes rather than dD=1000([HDO]/(RV*[H2O])-1)?

p.27230, l.23: In Fig.8 a dark grey colour marks data with large delta(H2O) (not orange as stated in the text). Need to change text, or perhaps make these points orange in Figs. 8 and 9.

p.27231, l.10: This sentence does not make much sense as it is written. Please reword.

Conclusions: Are air-masses 2 and 4 indistinguishable in an H2O-dD diagram (Fig.10)? Presumably this is why the aerosol obs are required to partition them. You need to say something about this.

Figs. 2 and 3: The time series are too compressed. I recommend expanding them.

Fig.5: needs to be expanded.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 27219, 2015.