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Interactive comment on "Spatial variability of northern Iberian rainfall stable isotope values: Investigating climatic controls on daily and monthly timescales" *by* Ana Moreno et al.

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We appreciate very much the constructive comments by Rev2 which have certainly helped to improve our manuscript. Here we comment on some issues related to his/her notes which are of particular importance.

1) Shorten and strengthen the structure of the discussion on the climatic controls.

We totally agree with Rev2 ideas to shorten and strengthen the discussion and have mentioned the aspect of the difference in ocean surface isotope composition only once and shortly (now it is only included in section 5.3 and removed from the other lines

indicated by Rev2). Contrarily, we have dedicated more space to the controls at the moisture source following Rev2 advice, with new analyses of the moisture uptake (see below). Another idea to strengthen the structure of the discussion was to remove references to temperature control in p.16 and confine the discussion of temperature and precipitation only to Section 5.2. This is a good idea and, in fact, due to this and following Rev2 comment, we have decided to remove the discussion of temperature and amount of precipitation in relation to the type of rainfall. Thus, the last section of the discussion is only dedicated to changes in d18O according to rainfall types. We have modified Fig. 7 in this regard.

2) Temperature and precipitation amount controls on the variability of the isotopic composition of precipitation.

We agree with Rev2 about the relative role that temperature may exert on our data and about the difficulty to explain this role without fully understanding the implied processes and all the overlapping interactions. Therefore, we have modified this section to modulate our results (eg. indicating the correlation numbers without implying causality). We are aware that behind the "temperature effect" there are many other processes and mechanisms not easy to describe just by employing correlation analyses. This idea is again employed in Section 5 introductory paragraph, as Rev2 suggested.

3) Moisture source identification discussion.

We greatly appreciate Rev2 suggestions on this topic and have included a new analysis to calculate moisture uptake in all events (850hpa trajectories). This idea was also expressed by Rev 3 and it is possibly the most important change we have made in this new version. We use Baldini's method (Baldini et al., 2010) in a more restrictive way (see also Iglesias González, 2019) to identify the locations where moisture uptake processes have been produced during the 48h before the rainfall samples were collected. Taking into account that Iberian Peninsula is surrounded by ocean, together with the fact that most of the rainfall events analyzed in the investigation were produced

by frontal systems and convection events (see synoptic analysis), only 850hPa airmass moisture uptake events have been considered as relevant in our new analysis. In addition, while Baldini et al, (2010) considered moisture uptake processes with an increase in 1h of 0.1 gH2Ov/kgair as significant, in our analysis we only took into account events where moisture uptake process where higher than 0.25 gH2Ov/kgair, so if exists any influence in the rainfall isotopical signal, it would be easier to identify than in other previous studies. With this restricted method, and considering all the events analyzed, more than 3000 moisture uptake events have been identified. These events were analyzed considering seasonal variability and the different locations where the rainfall samples were collected. With this new analysis, we are able to identified changes in the moisture uptake location distribution of the airmasses which produces rainfall events along the Iberian transect. These results are now discussed in detail and represented in a new figure.

4) Seasonality of moisture sources

We mention now in the introduction the role of seasonality of moisture sources. This idea is later revised in the discussion (section 5.3) where it becomes clear after the moisture origin and uptake study.

5) Meteorological context of precipitation events

We appreciate the suggestions made by Rev2 about other studies related to the isotopic composition of different precipitation types. Most of those references are now included in the text. However, Rüdisühli et al. 2020 is included in section 2 when describing which weather system dominates precipitation in which season on the Iberian Peninsula.

Minor comments

We include here our responses to other (minor) comments from Rev2 (those not included here in the letter were minor comments and were just corrected following re-

viewer's suggestions).

- Rev2 considers the abstract is not well structured and not totally clear in the factors we propose as the most important ones. We agree about the fact that all investigated processes are overlapping and we just show a consistent picture from different angles. We have used this idea in the abstract (also it appears at the beginning of the Discussion section).

- Regarding our text about the NAO, we agree with Rev2 who considered it was out of scope since it was not later used in the analyses performed. Thus, we have removed it from this revised version.

- We agree about the importance of the sampling procedure and have highlighted that only at one site (from the 7 sites) we used an automated system (at El Pindal site). More details on that self-built system are now presented. Unfortunately, at the time of the experiment (2006-2008), we have not compared our system with rainfall collected by other automated or manually procedures.

- According to Rev2 comment, we have moved to the method section lines 392-399 in page 13 and better described our method to calculate and represent back trajectories.

- In line with Rev2 about the reason to use disaggregated precipitation time series, we want to remark we follow the procedure carried out by Millan et al. (2005) to account for the meteorological origin of every rainfall event. We decided to apply this approach to analyze differences between isotopes as a function of three moisture source regions, i.e.: (i) Atlantic frontal systems; (ii) convective-orographic storms; and (iii) easterly advections over the Mediterranean sea (back-door cold fronts). It is well-known in Meteorology that the atmospheric dynamics and evaporation behind precipitation from these three components are different. Thus, this procedure allowed us to discern one of the principal influencing factors (type of precipitation) determining rainfall isotopic composition and variability. For instance, we found higher isotopic measurements associated with convective-orographic storms. This explanation was already included in the text,

in Methods, but slightly improved in this new version.

- We have prepared new figures following Rev2 suggestion of splitting Fig 3 into different panels (one per station). We add to every site, the deuterium excess and total precipitation. We include those figures in the supplementary material since we agree they are important but not the focus of this manuscript.

- Rev2 emphasizes the large daily variability of our dataset and this idea is now included in the text. Similarly, we have include a sentence in the short introductory paragraph of the Discussion section making reference to the high complexity of the hydrological cycle with many processes playing a role (or a combination of processes interacting) in the formation of the rainfall isotopic signal.

- In discussion section 5.1, Rev2 points to two sentences or paragraphs that should be moved to section 5.3 and section 5.2. We understand his/her reasons, and have modified these sections to avoid repetitions. Still, the interaction among processes and drivers make inadequate a rigid organization in the discussion and, inevitably, some effects are already introduced in 5.1.

- As suggested by Rev2, we incorporate more often the classification of our studied sites into subregions (Cantabrian coast, Iberian range, Pyrenees and Mediterranean) in the paper (already used to describe the sites, section 2).

- Rev2 indicates that we don't show the important role played by the moisture source in a quantitative and methodologically convincing way. We don't totally agree with this criticism, specially since in Figure 5, the role of moisture source, underlined by the air masses trajectories, is quantified (in percentages of rainfall and in isotopic values). To us, it is evident in Fig.5 the two dominant sources in Borrastre sites, as indicated in the text. In Table 4, the three main synoptic patterns are also quantified for the seven studied sites. In any case, the moisture uptake study carried out in this new version represents a more convincing way of representing the role of the air masses origin.

- We have updated our conclusions following main changes carried out in the new revised version. However, we are not including more discussion on the manuscript about d-excess to not complicate it. A previous version of this study incorporated d-excess data and we found too complicated for us to integrate it in the discussion. We prefer to make those data available (d-excess is represented for every site in the new supplementary figure and data are available at the supplementary tables) giving the opportunity to other experts on that subject to use this large dataset.

Cited references

Baldini, L. M., McDermott, F., Baldini, J. U. L., Fischer, M. J., and Möllhoff, M.: An investigation of the controls on Irish precipitation δ18O values on monthly and event timescales, Clim Dyn, 35, 977–993, https://doi.org/10.1007/s00382-010-0774-6, 2010.

Iglesias González, M. I.: Variabilidad climática del noroeste de la península ibérica durante los últimos 1500 años, descrita por espeleotemas de diversas cuevas del principado de asturias, http://purl.org/dc/dcmitype/Text, Universidad de Oviedo, 2019.

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