Editor comments on egusphere-2023-617

Since I have trouble finding a second referee, I will provide a referee comment as editor of this manuscript. However, I will continue trying to find an additional referee so that there will be still two independent referee comments.

This manuscript presents 2 years of continuous water vapor isotope observations obtained at Amsterdam Island in the southern Indian Ocean. The authors find that the observed data do not show a clear seasonality, and that temporal isotopic variations in the data set are associated with synoptic-scale atmospheric weather patterns. The authors highlighted that the abrupt negative water vapor isotope excursions occurred in connection with cold front passages. To understand the physical isotope related mechanisms that cause the isotopic depletion, the authors performed several analyses, such as: comparison with the measurement of gaseous elemental mercury as an indicator of subsidence, back trajectory analysis, and the model experiments using the isotope enabled atmospheric general circulation models. Based on the results, the authors conclude that both the vertical subsidence of water vapor with depleted isotopic content and the isotopic exchange process between rain drops and the surrounding vapor were responsible for the negative excursion of the water vapor isotopes Further, by comparing two isotope enabled general circulation models, the authors find that a higher resolution model is needed to reproduce the observed negative excursions.

The main contribution of this manuscript to the scientific community is to provide new observational data for the southern Indian Oceanic region, where the measurements are sparse. Their interpretation that the abrupt isotopic depletion at the surface is caused by subsiding air with depleted isotopic contentt sounds reasonable. Convective precipitation usually occurs in connection with cold fronts. Further, sudden isotopic depletion in surface vapor is known to occur during or just after the passage of convective precipitation such as squall lines and mesoscale convective systems. In addition, previous studies have also highlighted the contribution of depleted isotopic moisture from the free troposphere. Additionally, taking into account the model experiment, it is well known that the mesoscale or finer resolution model simulations are required to resolve the convective clouds associated with the cold front. Thus, it makes sense that the only higher resolution model can properly reproduce the observed negative isotopic excursions.

General comments

The quality of this draft is above standard and the subject is suitable for publication in ACP. However, I think it may not be easy for every reader to understand this manuscript. Especially for those who are not experts on water isotope processes. I recommend major revisions of the manuscript so that the contents and results of this study become better understandable for any potential reader.

Further, the graphical presentation is rather of low quality. Most of the figures should be improved (increasing the size of the figure itself as well as the font size and the line thickness). Some of the rather important figures of this study are in the supplement and may be moved to the main text or in an appendix to the main text (so that these do not appear in an extra document).

The usage of terms etc. should be done more consistently one way or the other. In some occasions the term “vapor mixing ratio”, “mixing ratio” , “water mixing ratio” or “water

vapor mixing ratio" are used making reading this manuscript very confusing. Then the notation "v" as subscript is used in some occasions, but in many others not. I would suggest to use "v" and "p" to differentiate between vapor and precipitation water vapor and water vapor isotopes throughout the manuscript.

Specific comments

Abstract: The abstract is quite confusing and some transitional sentences, e.g. the first and second paragraph as well as a sentence stating that you use two models for comparison are missing. What is the main focus of your study? The two paragraphs feel like two independent abstracts. One describing the measurements and the conclusions you derive from these and then the measurement-model comparison and the according results of this part of the study. The problem with the focus of study continues throughout the entire study. Additionally, several technical issues in the abstract need to be corrected (see below the list of technical corrections). Since there were so many issues I provide you here a corrected/improved version of your manuscript as a suggestion how it would read much better:

In order to complement the picture of the atmospheric water cycle in the Southern Ocean, we have continuously monitored water vapor isotopes (δ18O) since January 2020 on Amsterdam Island in the Indian Ocean. We present here the first 2-year-long water vapor isotopic record monitored on this site. We show that the vapor isotopic composition, as expected in marine boundary layers, largely follows the vapor mixing ratio. However, we detect 11 cold front periods lasting for a few days where there is a strong degradation of correlation between δ18O and water vapor mixing ratio. These periods are associated with abrupt negative excursions of δ18O, often occurring toward the end of precipitation events. Six of these events show a decrease in gaseous elemental mercury suggesting subsidence of air from higher altitude.
To proof this hypothesis we additionally consider model simulations of these processes, although accurately representing the water isotopic signal during these cold fronts is a real challenge for the atmospheric components of Earth System models equipped with water isotopes. We compare here two of these models. While the European Centre Hamburg model (ECHAM6-wiso) was able to reproduce most of the sharp negative water vapor δ18O excursions, the Laboratoire de Météorologie Dynamique Zoom model (LMDZ-iso) at 2° (3°) resolution was only able to reproduce 7 (1) of the negative excursions. Based on this detailed model-data comparison, we conclude that the most plausible explanations for such isotopic excursions are rain-vapor interactions associated with subsidence at the rear of a precipitation event.

P2, L51: Also in the introduction still the question remains what the purpose of your study is. Is it to confirm/better understand the measurements or to test the capability of the isotope enabled models to reproduce the isotopic processes?

P5, L113-114: The Durmont d'Urville and Concordia stations in Antarctica are not really in the Indian sector, but rather in the Pacific sector. Thus, how these are suitable for understanding the atmospheric water cycle over the Indian basin of the Southern Ocean does not become clear.

Figure 1 caption: What is meant with Magand? Add a link or reference?

P8, L223: What do you mean here with “low altitude”? That the observatory is located at low altitude? Or that the air from higher altitude is transported down to lower altitudes?

P8, L228: Here now subscripts “v” used, but before not.

P9, Figure 2 caption: Why is here the anomaly used?

P9, L247: What exactly are these standards and how are these derived? Not clear! Are these typical relationships between these species? Are these documented somewhere else?

P9, L247: What exactly is denoted by these numbers? The data range?

P9, L254ff: I could not follow you. Why does the data need to be corrected? What did you find here in the relationship that is not as it should be?

P15, L402: How do you know that these peaks occurred during a cold front? No analyses of meteorological parameters indicating a front passage are shown or discussed here.

P14, L403-404: You only picked the 11 excursions with low correlation coefficient between d18Ov and qv. However, according to Fig. 3, there are other negative excursions of d18O besides these 11 cases. If the goal of this study is to show the isotopic features associated with the passage of the cold fronts, the authors should rather pick up the events from the weather chart showing a cold front passage, not from the low correlations alone.

P16, Figure 4: Add a legend so that we can understand which color indicates which data just by looking at it.

P17, L454-455: Sentence not clear since it is grammatically incorrect. Please rephrase.

P18, L475: I still have not seen how you can be sure that there was a cold front passage. How have the cold fronts been detected?

Line 504-506: Rain evaporation occurs under the cloud base, moistening the boundary layer. So, the authors should not underestimate the role of rain evaporation because of the high relative humidity near the surface.

P19, Figure 6: This figure is not clear at all and needs more explanation. The plot represents the observations in the boundary layer, but the theoretical curves are the isotopic changes in the free troposphere? At least Noone (2012) used them to investigate processes in the tropical mid troposphere. What exactly is meant with “inspired” by Noone (2012)? How have these curves been derived? Do you take these from the Noone (2012) paper? Have you calculated/estimated these yourself?

P20, L523ff: Since subsidence is an important aspect of this study and you use Figure S1-S3 for the discussion, I don’t understand why these figures are in the supplement instead of in the main part of the manuscript.

P21, L623: I still haven’t seen any proof that there has been a cold front passage.

P25, L640: It is still not clear what the function of the models are. Are these only used to be evaluated or are these also used to understand the processes behind the peaks in the d18O time series?

P26, L682: What do you mean with “of the s”?

Supplement: The supplement contains too many figures. I think not all of them are really necessary and the number could be reduced. Further, the formatting should be the same as for the ACP paper, that means no underlined headers and the same style for the figures (no underline of the figure caption title and no italic text for the caption text.)

Technical corrections

P1, L33: in → on

P1, L34: remove coordinates. It is not necessary to provide these in the abstract.

P1, L35: either add “water” or just write “isotopic”.

P1, L36: add “water”

P1, L37: Rather “detect” than “evidence”.

P1, L38: move “water vapor” before “mixing ratio”.

P1, L39: Omit “water vapor”.

P1, L44 and 45: Abbreviations “ECHAM5-wiso” and “LMDZ-iso” not introduced.

P1, L46: detail → detailed

P4, L85: stable isotopes in water vapor → stable water vapor isotopes

P4, L85: dynamic→ dynamics

P4, L89: repetition of water cycle processes.

P4, L90: Delete “For this objective” (since this makes no sense in context with the previous sentence) and start sentence with “Several instruments…..”.

P4, L97: comparison enables -> comparisons enable

P4, L108: Add coordinates and elevation for the Durmont d’Urville and Concordia stations.

P4, L111: in → at

P5, L113: delete “the” before water vapor

P5, L114: Rather “measured” or “observed” than ”documented”.

P5, L118: in → on

P5, L120: It should either read "……to help with the interpretation" or "interpreting" of isotopic records.

P5, L123: delete "methodology" and change "trajectory" to "trajectories".

P5, L124: remove "the" and "water vapor" before and after, respectively, $\delta^{18}O$ or write "water isotope $\delta^{18}O$".

P5, L125: "expressed strongly in the water vapor isotope record" -> delete? This seems to be a repetition to what is said in the previous sentence.

P5, L131: degree sign not correct.

P5, L138: Move "respectively" at the end of the text in parentheses.

P6, L145: concentration → concentrations

P6, L145: delete "species"

P6, L147: Rather "belong" or "report to" than "respond".

P6, Fig. 1 caption: Full stop at the end of the last sentence is missing.

P7, L180: models → model

P7, L186. Measurement → measurements

P7, L197: Abbreviations CAMNET and AMNET have not been introduced.

P7, L199: dataset → datasets

P8, L203: add "air" so that it reads "boundary layer air"?

P8, L206: Abbreviation PBM not introduced.

P8, L207: remove "species".

P8, L211-213: Sentence makes no sense ("Even if"……."is still poorly understood"). Please check and rephrase.

P8, L223: Rather "excursions" than "intrusions".

P9, Figure 2 caption: Rather "Correlation between" than "Dependency of".

P10, L277: at LSCE → to LSCE

P10, L277: What does the abbreviation LSCE stand for?

P10, L283: Rather “calculated with” than “assessed”.

P10-11, L288-291: Rephrase. Not FLEXPART is calculating, but you are calculating with FLEXPART. So the sentence should read “Back trajectories……..were calculated with FLEXPART”.

P11, L292: add “the” → of the FLEXPART

P11, L292: in→ as

P11, L293: probability functions?

P11, L299 and L317: Introduce abbreviations of the models LMDZ and ECHAM6.

P12, L324: at → with a

P12, L329: gases → gas

P12, L332: Parentheses around the reference are not correct.

P12, L336: in Cauqoin -> by Cauqoin

P13, Figure 3 caption: In several occasions “water vapor” can be omitted. Use subscripts “v” and “p” instead.

P14, L353: In several occasions: add “vapor”? Or do you refer here to total water?

P14, L368: in → at

P14, L382. Add “a” → in a few hours

P14, L383: delete “water vapor”.

P15, L389: delete “the” before “precipitation”.

P15, L395: Add “vapor”. Or do you mean total water?

P15, L398: on → in

P15, L399: It should rather read “……..based on the / estimated from the correlation of d18Ov and qv”.

P15, L401: “which is” rather than “which are”?

P16, L408: Data model comparison → Model-measurement comparison

P16, L408: delete “water vapor”

P16, L423: set of data → data set

P16, L426: on → in

P16, L427 and 429: What mixing ratio? Water vapor?

P16, L432: two-year →2-year and add “time” before “series” so that it reads “time series”.

P16, L437: I would rather call it “grey shaded areas” than “grey rectangles”.

P16, L437: data series → measurement time series

P17, L441: two-year → 2-year

P17, L447: Section header should appear without being underlined.

P17, L448: two-year → 2-year

P17, L449: decorrelation → anti-correlation ?

P17, L450: Also here, I would rather call it “shaded areas” than “rectangles”.

P17, L452: the series presented on → the time series presented in

P18, L476: water mixing ratios → water vapor mixing ratio

P19, L484: mixing ratio ….of water vapor -> water vapor mixing ratio

P19, L486: correct parentheses around Noone reference.

P21, L539: movement of the atmosphere →movement of the (atmospheric) air

P21, L557: ….a test of the performance …… → as a test bed for the performance

P21, L558: general circulation models equipped with water isotopes -> water isotope enabled general circulation models.

P21, L562: What does SOM stand for?

P24, L619: add “vapor” → water vapor mixing ratio

P25, L624: same here

P25, L636: two-year → 2-year

Figure S1 caption, L73: mixing ratio → water vapor mixing ratio

Figure S1 caption, L69: water vapor $\delta^{18}O$ → $\delta^{18}O$

Figure S1 caption, L80: grey rectangles → grey shaded areas

Supplement, P6, L87: flexpart -> FLEXPART

Figure S2 caption, L89: in → as

Figure S2 caption, L91: ten-day → 10-day

Figure S3 caption, L101: in → as

Figure S3 caption, L102-103 and Figure S3 caption, L114: ten-day →10-day