Ewha, Where Change Begins

EWHA WOMANS UNIVERSITY

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Dear Editor Attila Demény,

With this letter, we are submitting our detailed point-by-point responses to the editor's and reviewers' comments regarding the major revision of our manuscript, entitled "A spatially resolved 39-month dataset of stable water isotopes in precipitation over Jeju volcanic island, Korea," submitted for publication in *Earth System Science Data (ESSD)*. We sincerely appreciate their constructive comments and have outlined below how each issue is being addressed. The manuscript is currently being revised accordingly, and we expect to submit the revised manuscript and accompanying data files shortly after the submission of this response letter.

Reply to the comments by the reviewer 2

1. General Comments

Lee et al. present monthly isotope precipitation data collected from 15 monitoring stations across the Jeju volcanic island in South Korea. The dataset spans the period from September 2000 to December 2003, allowing the analysis of seasonal variability. Considering the topography of the island, this isotope dataset is also useful to study the mechanisms behind the altitude effect.

Answer: We appreciate the reviewer's concise summary and recognition of the value of the dataset for characterizing seasonal variability and isotope–elevation relationships across Jeju Island. The 15 monitoring stations are distributed across the island and span elevations from 5 to 1,230 m a.s.l., providing a spatially and temporally resolved observational basis for characterizing the network-wide relationships between station elevation and precipitation $\delta^{18}O$ and $\delta^{2}H$ values during 2000–2003.

In the revised manuscript, particularly in Sect. 3.2, we will clarify that the observed decreases in precipitation $\delta^{18}O$ and $\delta^{2}H$ values with increasing elevation are consistent with processes common to mountainous regions, including orographic uplift, cooling and condensation of ascending air masses, and progressive rainout. Within the sampled elevation range and observation period, the dataset therefore provides observational constraints on the isotope vs. elevation relationship, although it does not independently distinguish among all contributing atmospheric mechanisms. We will also make clear that Jeju Island's volcanic geology is not interpreted as a direct control on precipitation isotope composition.

First, it's a good thing that this data, collected more than 20 years ago, is being published rather than left to gather dust in a drawer. The paper fits the scope of the journal, even if some improvements in the presentation of the data and its analyses are necessary before acceptance for publication in ESSD. Especially, there are many repetitions about how useful the data could be, missing information about the meteorological data and IsoGSM outputs, and sections that should be re-written in the discussion section. Also, there are several statements about local climate conditions without citing any reference or showing any maps.

Answer: We appreciate the reviewer's recognition of the value of recovering and openly publishing this historical dataset and the confirmation that the manuscript falls within the scope of ESSD. We agree that substantial improvements are needed in the presentation, documentation, and interpretation of the data, and we will revise the manuscript accordingly.

First, we will substantially reduce repeated statements concerning the potential applications and broader usefulness of the dataset. The Abstract and Introduction will retain only concise statements emphasizing the value of recovering, documenting, and openly publishing observations collected more than two decades ago. Repetitive, speculative, or application-oriented statements in the combined "Results and discussion" section and Summary will be substantially shortened.

Second, we will retain Sect. 3 as a combined "Results and discussion" section and remove the standalone Discussion section. The former temporal and spatial discussion subsections will be condensed and integrated into the corresponding results subsections. Quantitative observations and statistical results will be presented first, followed by only the interpretation needed to place the observed patterns in context. The model–observation comparison will be retained in a substantially shortened form as an independent consistency check on broad seasonal variability and island-scale mean differences, rather than as validation of the observations or an evaluation of local spatial patterns. Extended theoretical and application-oriented discussions will be removed.

Finally, we will provide a transparent and internally consistent description of the IsoGSM4 comparison. The revised manuscript will identify the exact IsoGSM4/IsoGSM-HR product and data record used, its T248 spectral resolution and nominal horizontal grid spacing of approximately 50 km, ERA5 spectral nudging, the coordinates and geographic setting of the three selected grid points, the precipitation filtering procedure actually applied, the isotope calculations, and the spatial and temporal averaging procedures. We will clarify that the three neighboring grid points cover Jeju Island and its immediate marine surroundings and that their mean represents an island–nearshore regional approximation. It does not resolve the island's detailed topography or local and mesoscale precipitation processes.

These revisions will reduce repetition, improve the transparency of the meteorological and model-data analyses, distinguish demonstrated results from possible interpretations, and focus the manuscript on dataset description, quality control, principal observational patterns, limitations, and documented reuse potential.

2. Specific Comments

The same statements about the how useful the dataset could be are repeated all along the paper. For example, lines 62-24 and 66-68 are very similar, again at lines 84-85, 198-201, 218-221, 250-253, and so on. This is way too repetitive and, contrary to the authors' intention, it makes loose impact about the value of this data.

Answer: We thank the reviewer for identifying the excessive repetition of statements concerning the potential usefulness of the dataset. We agree that this repetition weakens, rather than strengthens, the presentation of its value. We will therefore systematically remove or consolidate such statements throughout the manuscript. The value of recovering, documenting, and openly publishing observations collected more than two decades ago will be stated briefly in the Abstract and explained once, in relation to the observational gap, at the end of the Introduction. Sect. 2.2 will provide only the regional scientific context and explain how the present data publication complements previous application-focused studies. The combined "Results and discussion" section will focus on the observations, data quality, quantitative analyses, limitations, and only the interpretation necessary to place the observed patterns in context. General statements about potential applications will be removed from the temporal, spatial, and model–observation subsections. The Summary will retain only one concise statement concerning independent reuse of the archived data.

Statements concerning groundwater recharge, cave hydrology, paleoclimate interpretation, regional isoscape development, and isotope-enabled models will not be presented as outcomes demonstrated by this study. Claims that the dataset directly calibrates or validates these applications will be removed. The IsoGSM4 comparison will be retained only as a limited island-scale consistency check. Only one brief and explicitly qualified statement on potential cave and speleothem relevance will be retained, clarifying that the 2000–2003 observations may help constrain plausible precipitation-isotope inputs when combined with independent information on recharge and cave processes, but cannot independently calibrate paleoclimate reconstructions.

For example, the final statements of the Introduction will be consolidated into the following sentence:

"By recovering, documenting, and openly archiving these observations, this study preserves a previously inaccessible record of spatial and seasonal variation in precipitation $\delta^{18}O$ and $\delta^{2}H$ across Jeju Island during 2000–2003 for independent reuse and comparison with subsequent monitoring."

These revisions will remove unnecessary repetition and allow the value of the dataset to be demonstrated through its documentation, observational coverage, transparency, and accessibility rather than through repeated statements about potential applications.

At lines 66-68, I do not agree so much with the authors. First, I am not very convinced on how this data could be useful for paleoclimate reconstruction. The sampling period is rather recent, and the time length is rather short (39 months), meaning it is not possible to investigate important climate changes related to interannual variability for example. For the modeling side, of course this is useful, but an isotope-enabled GCM (so global scale), even at high resolution such as 50 km like IsoGSM, cannot resolve the effects due to the topography of the island (maybe there is even no land mask for this island in the simulation setup). So, I would tone down a bit this statement. One aspect, which could be interesting, would be to use a regional isotope-enabled model such as IsoRSM with moisture tracking ability.

Answer: We agree with the reviewer that the original statement overstated both the paleoclimate and modeling applications of the dataset. The September 2000–December 2003 record is too short to characterize broader interannual or long-term climate variability and cannot independently calibrate or validate paleoclimate reconstructions. We will therefore remove statements implying that the dataset can be used directly for paleoclimate reconstruction.

Where paleoclimate relevance is retained, the observations will be described only as a time-bounded instrumental-period reference documenting spatial, elevational, and recurring seasonal variation in precipitation $\delta^{18}O$ and $\delta^{2}H$. For cave-monitoring or speleothem studies, they may help constrain plausible precipitation-isotope inputs to recharge zones only when combined with independent information on recharge elevation, seasonal infiltration, cave hydrology, dripwater monitoring, and calcite–water isotope fractionation. These processes are not evaluated directly in the present study.

We will also distinguish the broader potential of the observational dataset for future model evaluation from the limited purpose of the present IsoGSM4 comparison. IsoGSM4 has a T248 spectral resolution and a nominal horizontal grid spacing of approximately 50 km. Although this is comparatively high resolution for an isotope-enabled global model, its grid scale remains mismatched to Jeju Island's detailed topography, individual slopes, local isotope–elevation relationships, and local-to-mesoscale precipitation processes. The present comparison will therefore be restricted to an island-scale consistency check on broad seasonal variability and mean model–observation differences. It will not be presented as a validation of the observations or as an evaluation of island-scale topographic effects.

Three neighboring model grid points covering Jeju Island and its immediate marine surroundings were used. Geographically, the central grid-point center is located on Jeju, whereas the western and eastern centers lie over adjacent waters; these geographic locations do not by themselves establish their classification in the model land–sea mask. In the revised manuscript, we will report the exact monthly product, grid-point coordinates, grid selection, spatial and temporal averaging procedures, and any author-applied precipitation threshold. Because the monthly CSV does not itself contain a land–sea mask or land-fraction field, we will report the model mask classification only if it can be verified from the corresponding model fixed field; otherwise, its absence will be stated explicitly as a limitation.

Lee et al. (2013) used lower-tropospheric water-vapor δ^2H observations, IsoGSM simulations, and 120 h HYSPLIT backward trajectories to examine seasonal atmospheric transport over Jeju Island. We will cite that study only as regional atmospheric context. Because it did not analyze the individual precipitation samples in the present dataset, its results will not be used to assign specific moisture sources or transport pathways to those samples.

We agree that a regional isotope-enabled model such as IsoRSM, operated at an appropriately finer regional resolution and combined with suitable moisture-tracking diagnostics, may be better suited to investigating Jeju-scale topographic effects and moisture-source contributions. The present observations may provide a benchmark for such future analyses. New regional modeling and moisture tracking, however, are beyond the data-focused scope of the present paper and will not be added in this revision.

Reference

Lee, J., Worden, J., Koh, D.-C., Yoshimura, K., and Lee, J.-E.: A seasonality of δD of water vapor (850–500 hPa) observed from space over Jeju Island, Korea, *Geosciences Journal*, **17**, 87–95, https://doi.org/10.1007/s12303-013-0003-5, 2013.

Related to the point above, "long-term" sounds a bit odd to me considering the dataset is "only" 39-month long.I suggest to replace long-term by a more neutral and descriptive term such as pluriannual for example.

Answer: We agree with the reviewer that "long-term" is inappropriate for describing the temporal coverage of this dataset because it could imply that the record is sufficient to characterize robust interannual or decadal climate variability. We will therefore remove or replace "long-term" throughout the author-written text wherever it refers to the dataset, monitoring period, or observational record. We will generally use the exact description "the September 2000–December 2003 observational record" and, where a shorter term is needed, "multi-year dataset" or "multi-year observational record." We prefer "multi-year" to "pluriannual" because it is more idiomatic in English while conveying the same neutral meaning suggested by the reviewer.

The revised manuscript will clarify that the dataset documents spatial patterns, seasonal variability, and isotope–elevation relationships during the observation period. It will not be presented as sufficient for characterizing long-term climate trends, robust interannual variability, or climatological normals.

Data in the excel file: Add a README tab with the description of the site, coordinates and altitude information of each monitoring site. This very important information is missing in the excel file. Moreover, I cannot understand the tab "Sampling Points", please write in English and provide the right information.

Answer: We appreciate the reviewer's identification of the missing site metadata and the unclear purpose of the former "Sampling Points" worksheet. We agree that the submitted workbook did not provide sufficient information to identify the isotope-monitoring sites or trace the associated meteorological data. We will therefore substantially revise the workbook.

First, we will add a README worksheet describing the dataset, its temporal and spatial coverage, worksheet contents, variable definitions and units, available analytical information, quality-control and missing-value conventions, data provenance, and known limitations. The README will direct users to a new Site_Metadata worksheet containing information for all 15 isotope-monitoring sites. This information will include the site ID, English and Korean names, latitude and longitude in decimal-degree and degree–minute–second formats, coordinate reference system (WGS 84; EPSG:4326), elevation, administrative location, observation period, number of isotope observations, site description, and metadata source. The monitoring sites span elevations from 5 to 1,230 m a.s.l. Island-sector and elevation-zone classifications will be identified as derived descriptive fields rather than original measurements.

Second, we will clarify that the former "Sampling Points" worksheet did not list the isotope-monitoring locations. Instead, it recorded the meteorological reference stations associated with the isotope sites. We will translate and reorganize this information into an English-language, machine-readable worksheet entitled Meteorological_Source_Mapping. It will identify the isotope site, year, archived meteorological control-station name or names, variables, and the estimation method recorded in the source material. A separate Meteorological_Stations worksheet will provide KMA station identifiers, station types, study-period coordinates and elevations, and registry provenance.

We cross-referenced the archived control-station names against the KMA station-history registry and will report the matched station identifiers and coordinates applicable to 2000–2003. These are retrospective registry matches and will not be presented as processing metadata retained from the original interpolation. The archived source identifies the estimation method only as an inverse-distance method and preserves the site-, year-, and control-station assignments. It does not retain the original IDW exponent, interpolation distances, station weights, daily source records, or temporal-aggregation code. We will state this limitation explicitly and will not reconstruct or fabricate the missing parameters. Great-circle distances calculated from the documented site and KMA station coordinates will be labelled as reconstructed distances and not as the distances used in the original interpolation.

Consequently, the revised workbook will allow users to trace the meteorological values to the archived control-station assignments and reproduce the manuscript analyses from the published monthly values, but it will not claim exact reproduction of the original meteorological preprocessing without additional archival records or author confirmation.

Third, we will add an Observations worksheet containing 462 station-month records with paired $\delta^{18}O$ and $\delta^{2}H$ measurements and corresponding precipitation and air-temperature data. The meteorological worksheets contain 488 station-month records, each with precipitation and air temperature. Of these, 462 coincide with paired isotope observations and 26 contain meteorological data only. The latter records will be retained, while the corresponding isotope values will remain absent and will not be reconstructed or imputed.

Finally, we will correct the station-column association for R9–R13. In the submitted workbook, the columns labelled R9, R10, R11, R12, and R13 contained data corresponding to R12, R13, R9, R10, and R11, respectively. The revised workbook will reassociate these columns with the correct station identifiers based on the original sample identifiers and station metadata. This operation corrects the station association without numerically modifying values as part of the reassociation; separate source-table alignment and precision checks will be documented independently.

These revisions will provide the requested site information, explain the purpose of the former “Sampling Points” worksheet, improve machine readability and provenance, and distinguish information that is fully traceable from original interpolation parameters that are no longer available.

Data availability: There is no link and/or information about the standard climatic data. They need to be provided as well. IsoGSM data need to be cited as well. Considering the acknowledgement “The authors thank Kei Yoshimura and Hayoung Bong for sharing their model data.”, I suppose the data are from IsoGSM4-HR at T248 spatial resolution (around 50 km), nudged to ERA5, right? Please add the citation and DOI of the Zenodo dataset in the data Availability section (https://zenodo.org/records/15073235, https://zenodo.org/records/14681370, and https://zenodo.org/records/14676091 I suppose).

Answer: The reviewer correctly identifies two omissions in the submitted manuscript. We will revise the manuscript, workbook documentation, and Data availability section to clarify both the meteorological-data provenance and the exact IsoGSM4 product used in the model–observation comparison.

First, the revised precipitation-isotope dataset, available through the Geo Big Data Open Platform (https://doi.org/10.22747/paper_data.20260219.42), will include the site-specific monthly precipitation amounts and mean monthly air temperatures used in the figures and statistical analyses. These archived monthly series were derived from observations at nearby Korea Meteorological Administration stations.

The revised workbook will provide a README, an English-language Meteorological_Source_Mapping worksheet, and a Meteorological_Stations worksheet documenting the archived control-station assignments, KMA station identifiers, variables, units, study-period coordinates, observation periods, and missing-value conventions. The Methods section will describe this provenance and cite the KMA Open MET Data Portal. Relative humidity will be removed from the manuscript because it is not included in the archived quantitative dataset used in the analyses.

We will also state the limitations of the surviving meteorological documentation. The archive does not retain the original IDW exponent, interpolation distances, station weights, daily KMA inputs, or daily-to-monthly aggregation code. These missing parameters will not be reconstructed or fabricated. Any great-circle distances included in the revised workbook will be labelled as distances reconstructed from the documented coordinates, not as the distances used in the original interpolation. The archived monthly series will therefore allow reproduction of the analyses reported in the manuscript, and the source-station assignments will be traceable, but the original meteorological preprocessing cannot be reconstructed exactly.

Second, the revised manuscript will identify the model output as IsoGSM4, also referred to as IsoGSM-HR, at T248 spectral resolution with a nominal horizontal grid spacing of approximately 50 km and spectral nudging to ERA5. We will reproduce the comparison using the raw, non-filtered monthly IsoGSM-HR CSV isotopologue fields for 2000–2003 (Bong and Yoshimura, 2025b), following the variable definitions and dataset documentation provided by Bong and Yoshimura (2025a).

The revised text will state explicitly how $\delta^{18}O$ and $\delta^{2}H$ were calculated from the monthly isotope-precipitation variables. If grid-point months with monthly precipitation below 0.2 mm d^{-1} are excluded, this will be identified as a study-specific screening step applied to the monthly CSV fields. It will not be described as the provider's pre-aggregation Filtered_0.2mm_per_day product. Zenodo record 14676091 is an alternative monthly NetCDF distribution and will not be cited as an input source because it is not used in the revised comparison.

The Zenodo records state that the data are publicly accessible but that use requires permission from the creators. Because the model data were provided for this study by Hayoung Bong and Kei Yoshimura, we will confirm the permission status, acknowledge them, and state that the model output was used with permission. The original IsoGSM framework will also be cited following Yoshimura et al. (2008).

Consistent with our response concerning the manuscript structure, the IsoGSM4 configuration and extraction procedure will be described at the beginning of Sect. 3.3, immediately before the comparison results. We will report the selected grid-point coordinates, exact variables, screening procedure, δ calculations, spatial and temporal averaging, and the number of contributing grid points. Because the monthly CSV does not provide a land–sea mask or land-fraction field, we will report the geographic locations of the grid-point centers relative to Jeju Island and will provide a model-mask classification only if it can be verified from the corresponding model fixed field. Otherwise, the absence of that information will be stated explicitly.

The comparison will be presented only as an island-scale consistency check on broad seasonal variability and mean model–observation differences. It will not be described as a validation of the station observations or as an evaluation of Jeju Island's detailed topographic and spatial isotope patterns.

Bong, H. and Yoshimura, K.: Enhancing the Representation of Atmospheric Water Isotopes with Higher-Resolution Global Modeling (IsoGSM4) [Data set], Zenodo, https://doi.org/10.5281/zenodo.14681370, 2025.

Yoshimura, K., Kanamitsu, M., Noone, D., and Oki, T.: Historical isotope simulation using Reanalysis atmospheric data, J. Geophys. Res., 113, D19108, https://doi.org/10.1029/2008JD010074, 2008.

About IsoGSM, There is no description of the model setup in the paper. Please add it: model version (IsoGSM4), spatial resolution, nudging to ERA5, citations, etc…). You talk about 3 grid cells (line 309), please provide the coordinates.

Answer: The reviewer is correct that the model configuration and data-extraction procedure require explicit documentation. Consistent with our response to Reviewer 1, we will add this information to the substantially shortened model–observation subsection within Sect. 3, "Results and discussion."

The revised subsection will identify the model output as IsoGSM4, also referred to as IsoGSM-HR, at T248 spectral resolution with a nominal horizontal grid spacing of approximately 50 km. It will also explain that the simulation was spectrally nudged to ERA5. This nudging constrains the simulated large-scale atmospheric circulation toward the reanalysis but does not allow the model to resolve Jeju Island's detailed topography or local and mesoscale precipitation processes. The revised manuscript will cite the original IsoGSM framework (Yoshimura et al., 2008), the main IsoGSM4 dataset documentation (Bong and Yoshimura, 2025a), and the exact monthly IsoGSM-HR product used in the comparison (Bong and Yoshimura, 2025b).

For the comparison with the observations, we will use three neighboring model grid points centered at 33.31° N, 126.09° E; 33.31° N, 126.56° E; and 33.31° N, 127.03° E. These points represent the western, central, and eastern parts of the island and its immediate surroundings. We will refer to them as "model grid points," rather than "grid cells," and will clarify that their average provides only an island-scale approximation.

At each grid point, monthly values with simulated precipitation below 0.2 mm d^{-1} will be excluded before the precipitation isotope ratios are calculated because isotope ratios associated with near-zero precipitation are numerically unstable. Precipitation $\delta^{18}O$ and $\delta^{2}H$ values will be calculated from the corresponding model isotopologue precipitation fields, and d-excess will be derived as $\delta^{2}H - 8\delta^{18}O$. The three retained grid-point values will then be averaged for each monthly time step and compared with the corresponding island-wide station mean. The standard deviation across the retained grid-point values will be shown as the shaded band in the corresponding revised figure. We will state explicitly that this band represents spatial variability among the selected model grid points, not model uncertainty.

These additions will provide the information required to reproduce the model-data extraction and comparison while making clear that the coarse-resolution model output will be used only as an independent consistency check on the principal seasonal patterns, not as a validation of the observations or as a representation of island-scale topographic effects.

Bong, H. and Yoshimura, K.: Enhancing the Representation of Atmospheric Water Isotopes with Higher-Resolution Global Modeling (IsoGSM4) [data set], Zenodo, https://doi.org/10.5281/zenodo.14681370, 2025a.

Bong, H. and Yoshimura, K.: [IsoGSM-HR, monthly, 1970–2024, surface temperature, (water isotope) precipitation, and 2 m specific humidity] [CSV format]: Enhancing the Representation of Atmospheric Water Isotopes with Higher-Resolution Global Modeling [data set], Zenodo, https://doi.org/10.5281/zenodo.15073235, 2025b.

Lines 86-91: please provide information about the period, reference, and show some plots.

Answer: The reviewer correctly points out that the original paragraph did not identify the period or source of the meteorological values and did not clearly distinguish the study-period observations from long-term climatological normals. We will revise this paragraph accordingly.

For general climatic context, we will cite the 1991–2020 climatological normals provided by the Korea Meteorological Administration (KMA, 2021) and Lee et al. (2013) for the regional seasonal changes in atmospheric moisture transport associated with the East Asian monsoon. We will remove the unsupported statements assigning specific air-mass sources to winter and summer precipitation.

We will also clarify that the temperature values reported in the original paragraph are not long-term climatological averages. They represent the site-specific mean monthly air temperatures associated with the isotope-monitoring network during the sampling period from September 2000 to December 2003. Across the 488 available station-month records, these values range from −3.4 to 27.9 °C, with an overall mean of 12.7 °C. The previous sentence stating that annual precipitation exceeds 1,600 mm in most regions will be removed because it was presented without a clearly defined averaging period or reference dataset.

Rather than adding a separate atmospheric-circulation analysis, the revised paragraph will explicitly direct readers to the two meteorological panels in Fig. 2, which will show the island-wide monthly mean air temperature and precipitation amount during the sampling period. The figure caption will specify the observation period, averaging procedure, units, and data source. The complete station-level monthly precipitation and air-temperature values will also be provided in the revised dataset.

The revised manuscript text will read:

"Jeju Island is influenced by the East Asian monsoon and exhibits pronounced seasonal and elevational variability in temperature and precipitation (KMA, 2021; Lee et al., 2013). During the sampling period from September 2000 to December 2003, the site-specific mean monthly air temperatures associated with the isotope-monitoring network ranged from −3.4 to 27.9 °C, with an overall mean of 12.7 °C. The corresponding monthly air-temperature and precipitation series are shown in Fig. 2 and provided with the revised dataset. These values describe meteorological conditions during the sampling period and should not be interpreted as long-term climatological normals."

Korea Meteorological Administration (KMA): Climatological Normals of Korea (1991–2020), KMA Open MET Data Portal, available at: https://data.kma.go.kr/normals/index.do

Line 147: define also the d-excess.

Answer: Thank you for this suggestion. Because d-excess is a derived parameter rather than an independently measured isotope variable, we have defined it separately in both the Abstract and Sect. 3.1 as $d = \delta^2H - 8 \times \delta^{18}O$ (Dansgaard, 1964). It was calculated from the measured δ^2H and $\delta^{18}O$ values for each precipitation sample.

Section 3.1: It would be nice to plot also the individual records, and not only the average.

Answer: We appreciate this suggestion. In the revised Supplement, we will add Fig. S1 presenting all 462 individual precipitation $\delta^{18}O$ observations from the 15 monitoring sites (R1–R15) during the sampling period from September 2000 to December 2003. Each available measurement will be plotted at its recorded sampling date, and the monitoring sites will be distinguished by color. The legend will also provide the elevation of each site.

The island-wide monthly means will remain in the main figure because they provide a concise representation of the overall seasonal pattern. Supplementary Fig. S1 will show the complete station-level variability underlying those averages without overcrowding the main figure with multiple overlapping time-series lines. Missing observations will not be interpolated or imputed.

We will refer explicitly to this figure in Sect. 3.1 using the following sentence:

"The individual station-level precipitation δ¹⁸O observations underlying the island-wide monthly averages are shown in Fig. S1. The observations demonstrate substantial between-site variability within individual sampling months, whereas the island-wide means provide a concise summary of their temporal variability."

The complete individual $\delta^{18}O$, $\delta^{2}H$, and d-excess records will also remain available in the revised dataset.

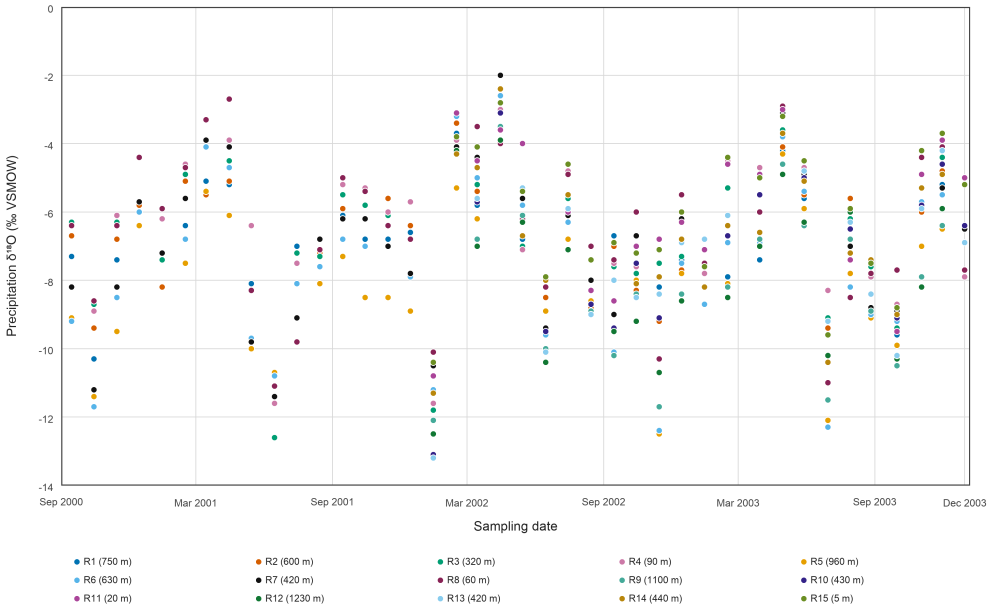

Figure S1. Individual precipitation $\delta^{18}O$ observations from the 15 monitoring sites (R1–R15) on Jeju Island from September 2000 to December 2003. Each symbol represents an individual monthly precipitation sample, and colors identify the monitoring sites. Site elevations are provided in the legend. $\delta^{18}O$ values are reported in ‰ relative to VSMOW.

Lines 179-185: again, it would be nice to show map of typical climate conditions in summer and winter (temperature, precipitation, winds or water vapor transport, humidity, etc…). The authors can use local meteorological station data or ERA5.

Answer: The reviewer raises an important point. We agree that the original statements concerning seasonal humidity, moisture sources, and atmospheric circulation would require supporting meteorological fields if they were retained. We will therefore revise the relevant subsection substantially.

Rather than introduce a separate set of seasonal maps and an additional atmospheric analysis, we will remove or moderate the source-attribution and mechanistic statements that are not directly supported by the present observations. In particular, we will no longer interpret low summer d-excess as direct evidence of maritime moisture or high winter d-excess as direct evidence of continental moisture. The revised text will explain that d-excess can be influenced by source-region evaporation conditions, cloud processes, sub-cloud evaporation, and atmospheric transport, and that it cannot provide a unique moisture-source attribution by itself.

We will also remove the inference that the stronger correlation of d-excess with air temperature than with precipitation amount demonstrates a dominant control by source humidity or evaporation conditions. Because air temperature, precipitation amount, and d-excess all exhibit pronounced seasonal variability, these correlations will be presented only as descriptive statistical relationships and will not be used to establish causality.

Meteorological context specific to the sampling period will instead be provided in the revised Fig. 2, which will show the monthly air temperature and precipitation amount from September 2000 to December 2003 together with the isotope observations. The Methods section and revised dataset documentation will identify the meteorological-data source, reference-station mapping, variables and units, aggregation and interpolation procedures, and treatment of missing observations.

Previous regional atmospheric studies, including Lee et al. (2013), will be cited only as background concerning seasonal moisture transport over Jeju Island. Because that study examined lower-tropospheric water vapor rather than the individual precipitation samples analyzed here, it will not be used to assign specific moisture sources to the present observations.

As the revised manuscript will no longer contain specific atmospheric-process claims that require spatial meteorological fields, we will not add separate summer and winter ERA5 maps. Although seasonal ERA5 composites could provide descriptive regional context, using temperature, humidity, winds, or water-vapor transport fields to attribute the observed isotope variations would require a dedicated circulation, trajectory, or moisture-tracking analysis beyond the data-focused scope of the present paper. The revised manuscript will therefore remain focused on the observed isotope data, their documented meteorological context, and the limitations of the possible atmospheric interpretations.

Section 3.2: The authors refer to the figure 4, but this section is more related to the Figure 6 about the altitude effect.

Answer: The reviewer is correct that the relevant discussion in Sect. 3.2 concerns the isotope–elevation relationships presented in Fig. 6, rather than the spatial-distribution maps presented in Fig. 4. We will therefore correct the corresponding cross-references in Sect. 3.2 to cite Fig. 6. Fig. 4 will be cited only where the spatial distributions of precipitation $\delta^{18}O$, $\delta^{2}H$, and d-excess across Jeju Island are described. We will also systematically check all figure citations and captions throughout the revised manuscript to ensure that each reference corresponds to the appropriate analysis.

Lines 211-214: again, show it. You can use ERA5 data to check the moisture circulation.

Answer: The reviewer is correct that the original sentence attributed the observed d-excess patterns to specific moisture sources without presenting the circulation or trajectory evidence required to support that interpretation. We will therefore remove the quoted sentence and the other unsupported source-attribution statements from Sect. 3.2.

We considered adding seasonal ERA5 circulation fields. However, the precipitation samples represent monthly cumulative collections that integrate multiple precipitation events and potentially different transport pathways. Consequently, seasonal-mean ERA5 fields would provide only broad atmospheric context and could not be matched uniquely to the isotope composition of individual monthly samples. Moreover, ERA5 wind and humidity fields alone would not establish moisture origin without sample-resolved backward trajectories or a quantitative moisture-tracking analysis.

The corresponding text in Sect. 3.2 will be revised as follows:

"In contrast to precipitation $\delta^{18}O$ and $\delta^{2}H$, d-excess exhibited a weaker relationship with elevation. Spatial variability in d-excess can reflect source-region relative humidity and evaporation conditions, as well as cloud and sub-cloud kinetic effects and atmospheric transport. Because the monthly samples integrate multiple precipitation events, their d-excess values cannot be uniquely attributed to continental or maritime moisture sources without event-resolved trajectory or quantitative moisture-tracking analyses."

We will therefore not use ERA5 circulation fields to assign moisture sources to the individual observations. Previous regional studies, including Lee et al. (2013), will be cited only as general atmospheric context and will not be treated as direct evidence for the moisture origins of the present precipitation samples.

Section 4: "Discussion" sounds odd for a data paper. I would call it more "Technical validation", in order to show for which purpose this data can be used.

Answer: We appreciate this helpful suggestion. We agree that a standalone section entitled "Discussion" is not well suited to the data-focused scope of an ESSD paper. We will therefore remove the separate Discussion section and reorganize the manuscript into Sect. 3, "Results and discussion."

The former temporal and spatial discussion subsections will be substantially condensed and integrated into the corresponding results subsections. Quantitative observations and statistical results will be presented first, followed by only the interpretation necessary to explain the observed patterns. Extended theoretical discussions, repetitive descriptions of potential applications, and unsupported atmospheric interpretations will be removed.

Rather than rename the entire former Discussion section "Technical validation," we will retain one concise subsection that combines the IsoGSM4 comparison with a carefully qualified discussion of the dataset's potential relevance to paleoclimate interpretation. The revised Sect. 3 will therefore contain the following subsections:

- 3.1 Temporal variations in precipitation isotopes
- 3.2 Spatial variations and isotope–elevation relationships
- 3.3 Comparison with IsoGSM4 output and potential relevance to paleoclimate interpretation

The first part of Sect. 3.3 will present the IsoGSM4 model–observation comparison as an independent consistency check on the broad seasonal patterns. It will not be described as a technical validation of the station observations because the approximately 50 km model grid cannot resolve Jeju Island's detailed topography, local isotope–elevation relationships, or mesoscale precipitation processes. The model configuration, selected grid-point coordinates, averaging procedures, precipitation threshold, data source, and limitations will be stated explicitly.

The second part of Sect. 3.3 will retain a concise discussion of the dataset's potential relevance to paleoclimate interpretation. We will clarify that the 39-month record is too short to characterize long-term climate variability or to provide a stand-alone calibration or validation of paleoclimate reconstructions. Its more specific value is that the observed spatial and seasonal variability in precipitation $\delta^{18}O$, including the isotope–elevation relationship, can help constrain plausible modern precipitation-isotope inputs to cave recharge zones. When combined with independent information on recharge elevation, seasonal infiltration, cave hydrology, dripwater monitoring, and calcite–water isotope fractionation, the dataset may assist future interpretation of cave dripwater and speleothem $\delta^{18}O$ records.

This organization will address the reviewer's concern regarding the standalone Discussion section while retaining a focused and appropriately qualified explanation of how the dataset may support future isotope-enabled modeling and paleoclimate studies.

Line 224: Remove the "long-term" term, which is misleading, all along the manuscript.

Answer: The reviewer is correct that the term "long-term" overstates the temporal coverage of the 39-month record. Consistent with our response to Reviewer 1 regarding the limited temporal scope of the dataset and its paleoclimate relevance, we will remove this term from all author-written parts of the manuscript.

Where the term refers to the dataset or monitoring period, it will be replaced with the more precise expressions "39-month record" or "record covering September 2000–December 2003." Where necessary, we will use "multi-year" only as a general descriptor. We will also revise statements concerning temporal applications to clarify that the dataset can characterize spatial patterns, recurring seasonal variability, and isotope–elevation relationships during the observation period, but cannot resolve broader interannual-to-decadal variability or temporal trends beyond that period.

We will systematically check the Abstract, main text, Summary, tables, figure captions, and Supplement to ensure consistent terminology throughout. The term will be retained only if it occurs within the official title of a cited publication or dataset.

Line 227: We do not use isotope data to calibrate isotope-enabled GCMs. The data is used to evaluate models and check the missing processes.

Answer: The reviewer is correct that the original use of "calibrating" was technically inappropriate. Precipitation isotope observations are not used here to adjust model parameters. Instead, they provide an observational basis for evaluating whether isotope-enabled models reproduce the observed variability and for documenting systematic differences between model and observation that may indicate processes that are absent or inadequately represented.

We will therefore remove references to "calibrating isotope-enabled models" and replace them, as appropriate, with "evaluating isotope-enabled models," "model–observation comparison," or "observational benchmark." We will also remove the potentially overstated reference to "multi-year seasonal stability."

The corresponding sentence will be revised as follows:

"Compared with short-duration event-based sampling or single-site records, this 39-month, multi-site dataset provides an observational benchmark for evaluating how isotope-enabled models reproduce precipitation-isotope variability during the observation period and for documenting systematic model–observation differences. Such differences may help diagnose processes that are absent or inadequately represented in the models, although the comparison alone cannot uniquely determine their causes."

In the IsoGSM4 subsection, the comparison will be restricted to the broad seasonal variability and island-scale model–observation differences because the approximately 50 km model grid cannot resolve Jeju Island's detailed topography or local isotope–elevation relationships. All references to calibrating isotope-enabled models will be checked and revised consistently throughout the manuscript.

Line 232-233: remove this sentence.

Answer: We agree that the sentence overstates the applicability of the fitted sinusoidal curves, particularly with respect to model and proxy calibration. We will therefore remove it. In the revised "Results and discussion" section, the sine functions fitted to monthly precipitation $\delta^{18}O$ and $\delta^{2}H$ values will be described only as empirical summaries of the recurring seasonal patterns observed during the sampling period. The fitted baseline, amplitude, and phase will provide concise descriptors of the central value, magnitude, and timing of the observed seasonal variation. The fitted curves will not be presented as physical models of isotope fractionation or as tools for model or proxy calibration.

The section 4.2 is kind of repetition of the results section. Some parts could be shortened a lot.

Answer: We agree that the former Sect. 4.2 substantially repeated the spatial results and contained more theoretical discussion than necessary for a data paper. We will therefore remove it as a separate discussion subsection.

The essential non-repetitive content will be substantially condensed and integrated into Sect. 3.2, "Spatial variations and isotope vs. elevation relationships," within the combined "Results and discussion" section. The revised subsection will present the quantitative isotope–elevation relationships and observed directional differences first, followed by only the interpretation necessary to place these results in context.

Decreases in precipitation $\delta^{18}O$ and $\delta^{2}H$ values with increasing elevation will be described as being consistent with atmospheric processes common to mountainous regions, including orographic uplift, cooling and condensation, and progressive rainout. Interpretations of directional differences will be limited to patterns directly supported by the observations. Unsupported attribution to particular moisture sources, prevailing wind trajectories, or windward–leeward effects will be removed.

Repetitive descriptions of the spatial results, extended theoretical background, speculative mechanistic interpretations, and repeated statements concerning potential applications will also be deleted. The dataset's principal reuse potential will instead be summarized concisely in the Abstract, Introduction, and Summary.

Section 4.3: Add the description of the model here or, better, add a sub-section IsoGSM in the section 2.

Answer: We appreciate this constructive suggestion and have considered both options proposed by the reviewer. In the revised manuscript, we will follow the first option by providing the IsoGSM4 description at the beginning of Sect. 3.3, immediately before presenting the model–observation comparison results.

We will not add a separate IsoGSM subsection to Sect. 2 because the model output is not used to generate or process the observational dataset and is applied only in the model–observation comparison. Presenting the model configuration and extraction procedure immediately before their sole application will keep Sect. 2 focused on the monitoring network, sampling procedures, isotope analyses, and data screening while maintaining a clear connection between the model methodology and the corresponding results.

The opening paragraphs of Sect. 3.3 will specify the model version, IsoGSM4 (IsoGSM-HR); the T248 spectral resolution and nominal horizontal grid spacing of approximately 50 km; spectral nudging to ERA5; the relevant model and dataset citations; and the DOI of the exact monthly product used in the comparison. We will also provide the coordinates of the three selected model grid points—33.31° N, 126.09° E; 33.31° N, 126.56° E; and 33.31° N, 127.03° E—the precipitation threshold of 0.2 mm d^{-1}, the calculation of $\delta^{18}O$, $\delta^{2}H$, and d-excess, and the spatial and temporal averaging procedures.

Only after this methodological description will we present the model–observation comparison, its limitations, and the potential relevance of the dataset to future paleoclimate interpretation. The comparison will be described as an independent consistency check on broad seasonal variability rather than as a technical validation of the station observations.

Sect. 3.3 will therefore be entitled “Comparison with IsoGSM4 output and potential relevance to paleoclimate interpretation,” with the model description and processing procedure presented before any comparison results.

Line 315-316: Show it!

Answer: The reviewer is correct that the model–observation differences should be demonstrated quantitatively and visually rather than stated only descriptively. We will therefore revise Fig. 7 to show the observed and simulated seasonal cycles of precipitation $\delta^{18}O$, $\delta^{2}H$, and d-excess together with the corresponding model-minus-observation differences. The figure caption will define the spatial and temporal averaging procedures and clarify that positive differences indicate higher model values.

We will also report the seasonal mean differences explicitly in Sect. 3.3. During November–April, the mean model-minus-observation differences will be reported as +1.4 ‰ for $\delta^{18}O$, +5.9 ‰ for $\delta^{2}H$, and −5.1‰ for d-excess. During May–October, the corresponding differences will be reported as +0.3 ‰, +1.8 ‰, and −1.2 ‰, respectively. These results will demonstrate that the model–observation differences are larger during the cold season than during the warm season and that the cold-season differences are also evident in the derived parameter d-excess.

We will not attribute these differences to a specific moisture source or precipitation mechanism. Because the monthly precipitation samples integrate multiple events and IsoGSM4 does not resolve Jeju Island’s detailed topography or local and mesoscale precipitation processes, the comparison alone cannot determine the causes of the seasonal differences. Possible explanations will therefore be presented only as model limitations requiring further investigation rather than as demonstrated mechanisms.

Line 321: The model is not coarse (~50 km) considering this a global model. Such very high resolution for a GCM is quite rare (usually, this is 200 and 100 km). Instead, I would say to go further, we need a regional model or an icosahedral model (NICAM-wiso) with the ability to resolve convection.

Answer: The reviewer is correct that describing the approximately 50 km resolution of IsoGSM4 as “relatively coarse” was misleading. This resolution is comparatively high for an isotope-enabled global model. We will therefore remove this wording and clarify that the relevant limitation arises from the scale mismatch between the model grid and Jeju Island's detailed topography and local-to-mesoscale precipitation processes, rather than from the resolution of IsoGSM4 relative to other global models.

The corresponding sentence will be revised as follows:

"Despite its comparatively high spatial resolution for an isotope-enabled global model, IsoGSM4 cannot resolve Jeju Island's detailed topography or precipitation processes occurring at scales substantially smaller than its approximately 50 km grid. Further investigation of these processes will require a higher-resolution regional isotope-enabled model or a global non-hydrostatic modeling framework capable of explicitly representing convection, such as NICAM-WISO, applied at an appropriate spatial resolution (Tanoue et al., 2023)."

We will also moderate the interpretation of the model–observation differences. The revised manuscript will identify unresolved local and mesoscale precipitation processes as a possible contributor to the cold-season differences, but it will not attribute those differences uniquely to model resolution. This distinction will be consistent with the role of the IsoGSM4 comparison as an island-scale consistency check rather than a process-attribution analysis.

Tanoue, M., Yashiro, H., Takano, Y., Yoshimura, K., Kodama, C., and Satoh, M.: Modeling water isotopes using a global non-hydrostatic model with an explicit convection: comparison with gridded data sets and site observations, J. Geophys. Res.-Atmos., 128, e2021JD036419, https://doi.org/10.1029/2021JD036419, 2023.

Lines 327-328: show it.

Answer: The reviewer is correct that the original text attributed the comparatively small warm-season model–observation differences to a specific circulation mechanism without directly demonstrating that mechanism. Because the present study will not include a dedicated analysis of atmospheric circulation or moisture transport, we will remove the quoted sentences from the model–observation comparison rather than retain an unsupported causal explanation.

In particular, we will remove the statements that summer precipitation over Jeju Island is governed primarily by the Meiyu–Baiu frontal system, that this system is driven by a pressure gradient between the North Pacific High and the Siberian High, and that it produces a sustained southwesterly moisture influx over Jeju Island. Although previous studies describe the East Asian summer monsoon, the Changma–Meiyu–Baiu rainband, and low-level moisture convergence as important regional climatic features (Ninomiya and Akiyama, 1992; Kim et al., 2010), these references will not be used to explain the seasonal model performance without supporting analysis.

The revised model–observation subsection will instead report only the demonstrated seasonal differences:

"During May–October, the mean model-minus-observation differences were +0.3 ‰ for $\delta^{18}O$, +1.2 ‰ for $\delta^{2}H$, and −1.2 ‰ for d-excess, whereas the corresponding differences during November–April were +1.4 ‰, +5.9 ‰, and −5.1 ‰, respectively (Fig. 7). Thus, the model–observation differences were smaller during May–October than during November–April. Because atmospheric circulation and moisture transport were not analyzed directly, the present comparison does not determine the processes responsible for this seasonal contrast."

General information concerning the East Asian summer monsoon and Korean summer precipitation will be retained only as regional climatic context in Sect. 3.1 and will be supported by the cited literature.

Ninomiya, K. and Akiyama, T.: Multi-scale features of Baiu, the summer monsoon over Japan and East Asia, *J. Meteorol. Soc. Jpn.*, **70**, 467–495, https://doi.org/10.2151/jmsj1965.70.1B_467, 1992.

Kim, K.-Y., Roh, J.-W., Lee, D.-K., and Jhun, J.-G.: Physical mechanisms of the seasonal, subseasonal, and high-frequency variability in the seasonal cycle of summer precipitation in Korea, *J. Geophys. Res.-Atmos.*, **115**, D14110, https://doi.org/10.1029/2009JD013561, 2010.

*Lines 334-335: No this is not the problem. The problem is that a GCM cannot resolve such convective processes and parameterizations will never fix completely the issue. You need a higher-resolution model where the convection is modeled (and not parameterized), such as the icosahedral model NICAM***.** *The section 4.4 is not convincing at all and should be removed.*

Answer: The reviewer is correct that the original text treated the problem primarily as one of model-physics refinement, whereas the more fundamental limitation is that convection occurring at scales substantially smaller than the model grid cannot be explicitly resolved. We will therefore delete the original sentences proposing refinement of sea–air interaction and mesoscale-convection parameterizations as the principal solution.

We will replace them with the following:

"Despite its comparatively high spatial resolution for an isotope-enabled global model, IsoGSM4 does not explicitly resolve local and mesoscale convective processes over Jeju Island, which must instead be represented through parameterization. Improvements to parameterizations may reduce model errors in their bulk effects, but they cannot remove the underlying scale limitation or explicitly represent the individual convective systems. Investigation of these processes will require an isotope-enabled convection-permitting regional model or a global non-hydrostatic modeling framework such as NICAM-WISO, applied at an appropriate spatial resolution (Tanoue et al., 2023)."

Because the present comparison does not directly analyze winter precipitation processes, we will describe unresolved convection as a possible contributor to the cold-season model–observation differences rather than as their uniquely demonstrated cause. The revised discussion will therefore distinguish the scale limitation of IsoGSM4 from the specific causes of the observed seasonal differences.

We also agree that the former Sect. 4.4 was not sufficiently supported and was disproportionate to the data-focused scope of the paper. This subsection will be removed as a standalone section, and its extended and speculative application-oriented discussion will be deleted. In accordance with our response to the reviewer's earlier comment regarding paleoclimate applications, the revised Sect. 3.3 will retain only a brief and explicitly qualified statement that the 39-month dataset may provide a modern spatial and seasonal precipitation-isotope baseline for interpreting cave recharge inputs. It will not be presented as sufficient for calibrating paleoclimate proxies or evaluating long-term climate variability.

Thank you very much for your time, effort, and patience in handling our manuscript. We look forward to your favorable consideration and to the opportunity for publication in Earth System Science Data.

Sincerely,
Jeonghoon Lee