Author responses

We appreciate the constructive comments and suggestions provided by the editor and reviewers for our manuscript titled "**Dataset of Stable Isotopes of Precipitation in the Eurasian Continent**" with the reference **essd-2023-384**. In response to the reviewers' comments, we have diligently revised our manuscript. The revised sections have been highlighted in red in the tracked changes version of the manuscript. The primary corrections and our responses to the reviewers' comments are outlined below.

Responses to the reviewer's comments

Response to Reviewer #1

General comments:

The manuscript titled "Dataset of Stable Isotopes of Precipitation in the Eurasian Continent" (essd-2023-384) effectively compiles stable isotope data from various sources across the Eurasian continent. The data amassed by the authors' research group is notably unique and invaluable. They have meticulously analyzed the meteorological factors that influence stable isotopes in precipitation, considering the diverse climatic conditions across the Eurasian continent. After a thorough review of the data, I am convinced that the quality control measures for the stable isotope data are stringent, rendering it the most comprehensive dataset of its kind globally. The release of this dataset promises to significantly advance research in hydrology and meteorology, particularly concerning stable isotopes in precipitation. I also commend the manuscript for its clear structure and articulate writing style, and I wholeheartedly endorse its publication.

Nevertheless, there are certain aspects that require attention prior to publication. Specifically, the manuscript would benefit from a more detailed explanation of the mechanisms governing the spatial distribution of isotopes. Additionally, the presentation and argumentation within the manuscript could be further refined. Thus, I recommend that the article be considered for publication once these issues are addressed.

Reply: We would like to thank Reviewer 1 for the positive opinion about our work, for important comments and for the time spent on the paper reading and reviewing. We answered all concerns/comments and provided the detailed explanations below.

Major comments:

In the introductory section, the authors address the determinants of stable isotopes in precipitation and their relevance in various domains. However, some arguments lack comprehensiveness and should be meticulously revised and expanded to enhance clarity and thoroughness.

Reply: We have reorganized the introduction and results sections of the manuscript. We have expanded upon these arguments to ensure that readers can have a clearer understanding of the interrelationship between stable isotopes in precipitation and meteorological variables, along with their applications in relevant fields. Furthermore, we have elaborated on the significance of integrating the dataset of stable isotopes in precipitation.

The changes to the manuscript are as follows:

1. Introduction

In recent years, the impacts of global climate change have become increasingly severe, particularly the significant increase in the frequency of various types of extreme weather and climate events (Faranda et al., 2023; Liu et al., 2022; Zhang et al., 2016). The World Meteorological Organization's 2022 report on the state of the climate in Asia shows that the rate of warming in Asia is higher than the global average, with droughts, floods, and heatwaves affecting most parts of the world (State of the Climate in Asia 2022). Severe fluctuations in climatic elements can alter water circulation processes, affect regional climate change, and even change the evolutionary patterns of ecological environments. Among these, stable isotopes in precipitation are an excellent comprehensive tracer, playing an important role in revealing water cycle processes, climate change information, and mechanisms of water resource use in ecosystems (Bowen et al., 2019; Wang et al., 2022). Therefore, in the face of increasingly complex climate conditions, we need more comprehensive

data on stable isotopes in precipitation at various spacetime scales to help understand climate change phenomena.

Stable isotopes in precipitation serve as a crucial medium connecting the hydrological and climatic systems. Precipitation, being both a product of the climate system and a primary source for the hydrological system (Sun et al., 2018), plays a pivotal role. Additionally, stable isotope fractionation accompanying the water cycle not only carries rich climate information throughout its variations but also facilitates the tracing of contributions to various surface water bodies (Hao et al., 2019; Ren et al., 2017; Shi et al., 2022). Although stable isotopes in precipitation ($\delta^{2}H$ and $\delta^{18}O$) constitute a small proportion in natural water bodies, they exhibit sensitivity to changes in climatic factors (Craig, 1961; Dansgaard, 1964). The quantification of precipitation stable isotopes, influenced by factors such as temperature, precipitation, wind speed, relative humidity, and water vapour sources (Gat, 1996; Jiao et al., 2020), deepens our procedural understanding of the water cycle. This quantification provides relevant information about water vapour transport processes and precipitation formation (Kathayat et al., 2021), determination of the proportions of different types of precipitation (Aggarwal et al., 2016), and comprehension of the mechanisms behind extreme events (Sun et al., 2022), offering robust evidence to explore the inherent mechanisms of meteorological events and climate change processes. Water recovery is a significant component of land water flux (Jasechko et al., 2013), but its direct measurement still faces numerous challenges. Deuterium excess (d-excess): $\delta^{2}H = 8\times \delta^{18}O$, a stable isotope quantity sensitive to water recovery effects, remains constant throughout the entire process from water vapor evaporation into the atmosphere to final condensation and rain formation (Merlivat and Jouzel, 1979). Therefore, in current water recovery quantification efforts, precipitation stable isotopes are a primary means (Cropper et al., 2021; Zhang et al., 2021a). $\delta^{2}H$ and $\delta^{18}O$, as important climate tracers, are also employed in reconstructing continental paleoclimate. The accurate understanding of precipitation stable isotopes' response to modern climate lays the foundation for paleoclimate reconstruction. On the other hand, using general atmospheric circulation models to simulate isotope circulation is a

major method for comparing isotope distributions in precipitation under both modern and ancient conditions(Joussaume et al., 1984; Brady et al., 2019). Simultaneously, the comparison between simulated and observed precipitation stable isotopes provides valuable validation for the physical components of atmospheric circulation models (Joussaume et al., 1984; Ruan et al., 2019). In conclusion, the comprehensive data on stable isotopes in precipitation offer more detailed information about the climate and hydrological systems.

In 1961, the International Atomic Energy Agency (IAEA) and the World Meteorological Organization (WMO) began establishing the Global Network for Isotopes in Precipitation (GNIP), which is the world's primary observation system. To date, research on stable isotopes in precipitation primarily relies on the GNIP database. However, GNIP's observations are very unevenly distributed in time and space. Global and regional-scale research on stable isotopes in precipitation mainly depends on model simulations. The relationship between predicted data from models and actual measured data is "comparative"(Joussaume et al., 1984). Although model simulations can compensate for the absence of measured data and are particularly advantageous in revealing the operating mechanisms of large-scale climate systems and water cycles, existing models for stable isotopes in precipitation are often insufficiently accurate. They cannot check long-term trends or characteristics of interannual variation. By integrating independent data to provide a higher density of data, it's possible to enhance the precision of model simulations.

We have compiled stable isotopes in precipitation data from the Eurasian continent since 1961 with the aim of providing more comprehensive data support for the following research areas：

Climate research: stable isotopes in precipitation exhibit geographical and seasonal variations, which can be used to study climate change and the impact of solar radiation. By comparing and analyzing the stable isotopes of precipitation in different regions of the Eurasian continent, long-term climate trends can be revealed, such as changes in precipitation distribution and the evolution of monsoon systems.

Earth system research: stable isotopes in precipitation are not only influenced by

climate and water cycle but also by geological and biological processes. By integrating precipitation stable isotope data from the Eurasian continent, it is possible to investigate in-depth the interactions between different components of the Earth system, such as the interaction between the atmosphere and the ocean, and the water cycle in terrestrial ecosystems. This will contribute to a better understanding of the functioning and changes of the Earth system.

Water cycle research: stable isotopes in precipitation serve as important indicators of the water cycle and can track the sources, evaporation, and precipitation processes of water. By analyzing the spatial distribution and variations of precipitation stable isotopes on the Eurasian continent, it is possible to understand the processes of water evaporation, precipitation, and recycling, revealing the patterns of water resource distribution and changes. This provides support for water resource management and hydrological modelling.

Paleoclimate Reconstruction: Well-established precipitation stable isotope observational data are advantageous for validating paleoclimate models under modern conditions. Simultaneously, they contribute to richer comparative data for stable isotopes in precipitation collected in geological archives.

In the results and discussion section, the depiction of the connections between meteorological variables and stable isotopes in precipitation could be more precise. Numerous elements affect stable isotopes in precipitation, including water vapour transport, phase transitions of water, and evaporation beneath cloud cover. These elements are reflected in broad-scale atmospheric circulation and local geographical disparities. It is crucial to avoid overly simplifying the impact of individual factors. For instance, in line 268, the discussion is limited to the effect of temperature on stable isotopes in precipitation, which is inadequate.

Reply: We fully agree with your remarks regarding a more precise description of the relationship between meteorological variables and stable isotopes in precipitation. In particular, we acknowledge the deficiency pointed out in your comment on line 268, where only the influence of temperature on stable isotopes is discussed. We will address this limitation with significant additions in the discussion section to

comprehensively explore the impact of factors such as water vapor transport, phase transitions of water, and sub-cloud evaporation on stable isotopes. This approach ensures that our discussion delves more deeply without oversimplifying the influence of individual factors. We believe that with these additions, our paper will more comprehensively depict the relationship between meteorological variables and stable isotopes, providing a better reflection of the broad influences of atmospheric circulation and geographical differences. Simultaneously, it will reinforce the importance of integrating stable isotopes in precipitation data.

The changes to the manuscript are as follows:

4.1 Temporal and Spatial Variation Characteristics of Precipitation Stable Isotopes

On a temporal scale, stable isotopes in precipitation exhibit pronounced seasonal variations, with higher values during the summer and lower values during the winter (Figure 4). This is attributed to seasonal variations in evaporation caused by temperature changes, resulting in the evaporative fractionation of stable isotopes in precipitation. Considering the completeness of the time series and regional differences within the Eurasian continent, we constructed a time series of precipitation stable isotopes based on the Köppen climate classification "climate zones. "The temporal changes in precipitation stable isotopes under different climate types show significant differences. In tropical climates (A), the values of precipitation stable isotopes are higher, with low values reflecting enhanced precipitation. The "precipitation effect" in the Eurasian continent is particularly significant in tropical climates (Tharammal et al., 2017), and the composition of precipitation stable isotopes reflects the correlated changes between temperature and precipitation. However, the seasonal fluctuations in tropical precipitation stable isotopes are minimal, and there is a fluctuating trend over approximately 20 years. Most arid climates (B) and temperate climates (C) on the Eurasian continent are under the influence of the westerly system. Before 1980, temperate climates experienced significant fluctuations in precipitation stable isotopes, followed by a stable period of about 30 years. After 2010, an unstable trend has become more pronounced, reflecting an increase in extreme weather events (Yao et al., 2021; Zhang et al., 2012). In arid climate regions, precipitation stable isotopes have

undergone significant decreases. The Central Asian arid region is a typical temperate arid region, and numerous studies have pointed out a "warm and humid" trend in the climate of this region (Wang et al., 2020; Yan et al., 2019). The strengthening of the West Pacific subtropical high, North American subtropical high, and the Asian subtropical westerly jet is believed to increase precipitation in this region (Chen et al., 2011). The enhancement of high-latitude water vapour transport is a major factor influencing the increase in precipitation in the Central Asian arid region, which is also the reason for the decreasing trend in deuterium excess (Fig. 4, c-1). Cold climates (D) and polar climates (E) have the smallest values of precipitation stable isotopes, but they exhibit significant differences on an annual scale and a gradually increasing trend on an interannual scale. With global warming, high-latitude regions will provide more sources of water vapour for the water cycle (Ding et al., 2017).

On a spatial scale, the topographic differences and latitude variations in the region are the primary causes of spatial differences in stable isotopes in precipitation across the Eurasian continent. The multi-year average values of $\delta^{2}H$ and $\delta^{18}O$ at different latitudes are as follows: from 0° to 30°N, they are -30.20‰ and -5.99‰, from 30° to 60°N, they are -58.94‰ and -8.77‰, and from 60° to 90°N, they are -92.98‰ and -12.69‰. The Alps and the Tibetan Plateau form regions of low precipitation stable isotopes that differ from those at the same latitudes. The gradual uplift of the Tibetan Plateau's mountains leads to changes in the atmospheric circulation patterns over a larger area, altering the inherent characteristics of water vapour source regions, vapour transport paths, and precipitation stable isotope values. The response of precipitation stable isotopes to the plateau's climate reflects changes in the large-scale circulation state (Yao et al., 2013). The isotopic variations in the surrounding regions of the Alps reflect differences in water vapour sources due to regional topography (Natali et al., 2021; Rindsberger et al., 1983). Spatial variations in deuterium excess can effectively reflect differences in regional water vapour sources, with average values of approximately 10‰ for tropical and temperate climates. Cold climate regions have lower deuterium excess values, and due to the overlap of arid climates with other climate zones, the distribution range of deuterium

excess values in arid climates is larger. Therefore, it can be hypothesized that if isotope-related variables (e.g., d-excess) are included in climate zone classification criteria, more climate zones influenced by circulation patterns could be identified.

4.2 Seasonal changes in meteoric water line and precipitation stable isotopes

The temporal and spatial variations of stable isotopes in precipitation are greatly influenced by meteorological factors, and the changes in precipitation isotopes are consistent with the climatic regions. Therefore, based on the Köppen climate classification, we performed climate zoning for stable isotopes in precipitation sites. We used the least squares method to fit meteoric water line for different climate regions (Fig.6) and considered the seasonal variations of precipitation stable isotopes in different climate regions (Fig.7). The meteoric water line for different climate types indicate relatively small differences in various climate precipitation amounts in tropical climates. The variations in the slope and intercept of the meteoric water line are determined by the combined effects of precipitation and temperature, with convective precipitation weakening the impact of the "temperature effect." Intense convective rainfall and oceanic water vapour transport bring abundant precipitation to tropical regions. The fractionation mechanisms and variations of precipitation stable isotopes not only reveal the inherent patterns of weather pattern occurrence and development (Sun et al., 2022) but also correlate weather patterns with supply sources, tracing the water sources of surface water bodies (Scholl and Murphy, 2014; Anon, 2017). Stable isotopes in precipitation in arid climates are influenced by secondary evaporation below clouds, and intense unbalanced fractionation processes lead to relative enrichment of stable isotopes in precipitation (Wang et al., 2021; Zhu et al., 2021). Water resources are the most limiting factor for the ecological and social environment in arid climate regions (García-Ruiz et al., 2011). Therefore, compared to other climate regions, water recovery becomes more critical. Stable isotopes in precipitation can accurately quantify water recovery and effectively assess the impact of evaporation on different water bodies in arid regions. The majority of the global population is distributed in temperate regions. Therefore, with global temperature rise, the climate change situation in temperate regions deserves more attention. In

temperate climate zones, the differences in stable isotope composition between different climate types become more significant. In the Mediterranean region controlled by the Summer Dry Warm Climate, the slope and intercept are the lowest, indicating that temperature rise dominates the fractionation of hydrogen and oxygen stable isotopes in precipitation, and the region shows a trend of aridification under long-term average conditions. The westerly system is the main controlling circulation in this region, and the changes in precipitation stable isotopes reflect the attenuation trend of mid-latitude westerly moisture inward migration (Zhu et al., 2023; Shi et al., 2021). In polar climates, the atmospheric water line exhibits higher slope and intercept. The influence of unbalanced fractionation processes after water vapour condensation in cloud systems is relatively small, resulting in a slope close to 8.

The seasonal variation of hydrogen and oxygen stable isotopes in precipitation on the Eurasian continent generally exhibits a pattern of higher values in summer and lower values in winter (Fig.7) (Hydrogen isotopes (δ^2H) in Supplement S3). However, there are still significant differences under different climate zones. The seasonal differences in tropical climates are less pronounced, with the Tropical Sparse Forest Climate (Aw) showing a decrease and increase with the months, possibly due to an increase in precipitation. Temperate and cold climates generally exhibit significant seasonal variations. The deuterium excess in the Eurasian continent shows a lower pattern in summer and a higher pattern in winter, indicating seasonal changes in water vapour sources and transport distances (Zhang et al., 2021a). This overall suggests that the summer climate in Eurasia is more humid, while the winter climate is drier. Deuterium excess usually indicates the degree of imbalance in seawater sources during their evaporation process, and it typically depends only on the environmental conditions of the evaporation source. Compared to δ^2H and $\delta^{18}O$, deuterium excess displays a more stable pattern and is distributed around the global average (10‰). The westerly and monsoon systems are the primary atmospheric circulation systems over the Eurasian continent, carrying water vapour from the ocean inland and gradually weakening. This indicates that the humidity in the vast region of Eurasia is strongly influenced by ocean water vapour. Ocean conditions and large-scale atmospheric

circulation changes can have profound effects on the climate environment of the Eurasian continent.

The differences in precipitation stable isotopes among different climate types are not only responses to different climate characteristics but also provide effective tools for a deeper understanding of the process, climate change mechanisms, water vapour transport between land and sea, and supply relationships between water bodies. The precipitation stable isotopes dataset we have constructed for the Eurasian continent can be combined with traditional meteorological data to provide more information for climate and hydrological research.

Specific comments:

In line 35, the reference to "State of the Climate in Asia 2022" is mentioned. It is important to provide specific citations for this reference in the subsequent text.

Reply: We indeed acknowledge the need to explicitly cite the relevant literature for the mention of "State of the Climate in Asia 2022" on line 35. In the revised manuscript, we will include specific citations to ensure that the references in the text align with the mentioned report.

The changes to the manuscript are as follows:

State of the Climate in Asia 2022: https://library.wmo.int/records/item/66314-state-of-the-climate-in-asia-2022, last access: 21 January 2024.

In lines 54-55, the phrase "spatial 'elevation' and 'latitude' effects" should be revised to "elevation effects".

Reply: The term "altitude effect" refers to the phenomenon where stable isotopes in precipitation gradually decrease with increasing altitude. Accurate expression of professional terminology is crucial for conveying the content of the paper precisely and facilitating reader understanding. However, based on the recommendations of the two reviewers, significant adjustments have been made to this paragraph. We have shifted the focus towards a combined discussion of the applications of stable isotopes in precipitation and the influencing factors. Emphasis has been placed on elucidating the significance of stable isotopes in precipitation in the fields of climate and hydrology. Consequently, we have removed the mentioned content. Additionally, we

have reviewed the entire manuscript for the accurate use of professional terminology to ensure the precision of the paper.

In lines 85-88, it is indeed true that observed data are generally more precise than model validations. However, the role of models should not be overlooked, especially on a global scale. It is important to express this in a balanced and reasonable manner.

Reply: We will emphasize the significance of observational data, highlighting its importance in accurately validating models at both global and regional scales. We will also underscore the role of models on a global scale. In discussing the interplay between models and observational data, we have elaborated on their mutual relationship.

The changes to the manuscript are as follows:

1. Introduction

On the other hand, using general atmospheric circulation models to simulate isotope circulation is a major method for comparing isotope distributions in precipitation under both modern and ancient conditions (Joussaume et al., 1984; Brady et al., 2019). Simultaneously, the comparison between simulated and observed precipitation stable isotopes provides valuable validation for the physical components of atmospheric circulation models (Joussaume et al., 1984; Ruan et al., 2019).

In line 144, for referencing the data, the citation link should be placed after "Water Isotope Network" for better clarity and organization.

Reply: We have adjusted the positioning of the links for citing data sources to ensure the accuracy of data references.

The changes to the manuscript are as follows:

The data collected are primarily from the Water Isotopes website (https://wateriso.utah.edu/waterisotopes/index.html) and the Global Network of Stable Isotopes in Precipitation (GNIP) operated by the International Atomic Energy Agency (IAEA).

In line 180, it is suggested to include the assessment of normality distribution for the data, along with the various statistical tests conducted. This will provide a

more comprehensive analysis of the dataset.

Reply: In the process of revision, we consider it unnecessary to conduct a normal distribution test. The primary purposes of a normal distribution test are as follows: (1) Inference of the applicability of statistical methods – many statistical methods (such as t-tests, analysis of variance, etc.) perform better when data approximates a normal distribution. Through normality tests, one can assess the suitability of applying these methods. (2) Accuracy of parameter estimation – many parameter estimation methods (such as maximum likelihood estimation) are more accurate when data approximates a normal distribution. If the data does not follow a normal distribution, alternative estimation methods may need to be considered. (3) Accuracy of hypothesis testing – in many statistical hypothesis tests, such as the residual normality test in regression analysis, it is required that the residuals of the data follow a normal distribution. If the residuals do not conform to a normal distribution, appropriate adjustments or non-parametric methods may need to be considered. Since our Mann-Kendall (MK) test (Fig.3) and box plots (Fig.4) do not depend on normal distribution, we have therefore removed this part of the content.

We believe the issue with this section lies in the perceived lack of rationale for the MK test. To address this, we have made the following modifications: We constructed time series of stable isotopes in precipitation for different regions based on climate types, analyzing trends and the distribution of stable isotopes in precipitation across different climate zones (Fig.4). Additionally, we performed the Mann-Kendall (MK) test on temperate (C) and frigid (D) climates (Fig.3). The reason for this choice is the relatively unclear boundaries between temperate, frigid, and arid zones.

The changes to the manuscript are as follows:

In addition, we selected the two climatic zones with the most significant differences, namely the tropical and polar zones. The reason for this choice is that the boundaries between temperate, frigid, and arid zones are relatively unclear, with subtle changes in trends. Mann-Kendall (MK) tests were conducted on the temporal variations of stable isotopes in precipitation for both climatic zones (Fig.3). For the tropical climate (A), the stable isotopes of precipitation ($\delta^{2}H$ and $\delta^{18}O$) exhibit multiple non-significant

periods of abrupt changes. There is a significant increasing trend from 1971 to 2005, followed by a non-significant decreasing trend since 2009. Overall, the deuterium excess (d-excess) shows a non-significant decreasing trend, but this trend has weakened after 1990. In the polar climate (E), there is a significant increasing trend before 1973, followed by non-significant periods of both increase and decrease after 1975. However, after 2010, a gradually significant increasing trend is observed. Since 1985, the deuterium excess has undergone a non-significant decreasing process, and after 2010, it gradually reaches a significant increasing trend. The uncertainty of the tests is mainly attributed to the spatiotemporal distribution and volume of the data.

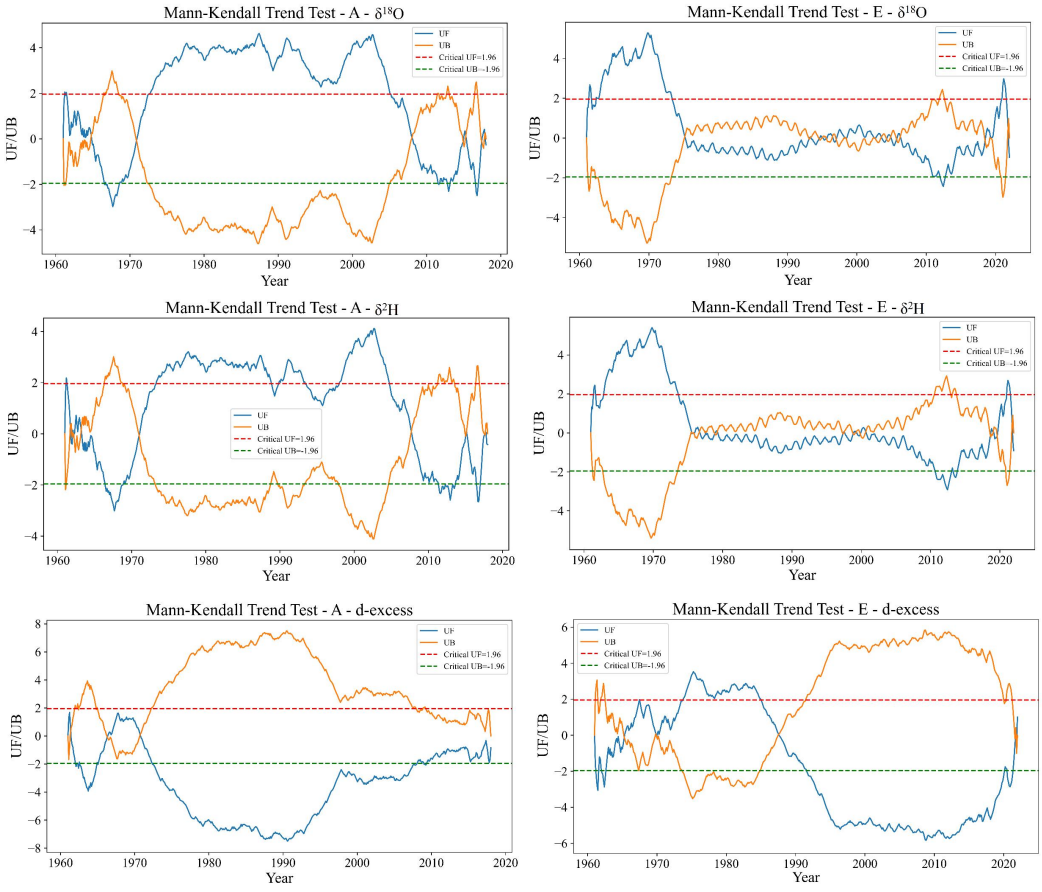


Fig.3 Time series MK test for temperate (C) and cold (D) climates

In lines 189-190, it is mentioned that abnormal values were detected in the data. How were these abnormal values handled?

Reply: Regarding the handling of outliers in the data collection, we implemented the following procedures:

(1) Data Cleaning: We conducted a cleaning process to identify and remove potential

outliers that may arise from recording errors or instrument malfunctions. This ensures that the foundational dataset for analysis is accurate and reliable.

(2) Statistical Methods: We employed statistical methods to identify data points that may deviate from the normal range. For data points identified as outliers, we conducted further validation and made appropriate adjustments in the analysis (Fig.4).

However, we did not address outliers in d-excess. This decision was made because d-excess is calculated based on stable isotopes of hydrogen and oxygen, potentially encompassing pertinent information.

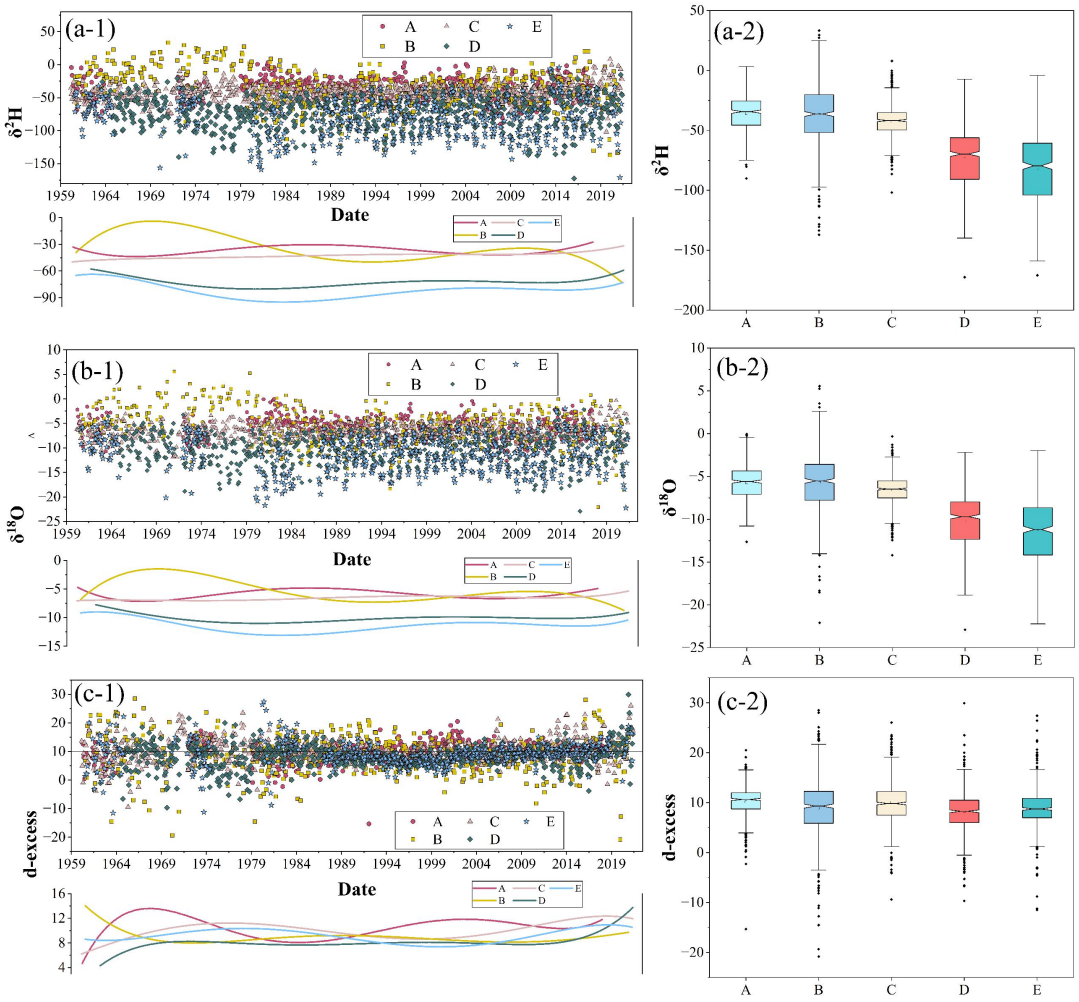


Fig.4 The time series variations of δ^2H, $\delta^{18}O$, and d-excess in the Eurasian continent.

In section 4.1, there is a further discussion on the role of extreme stable isotopes of precipitation. It is suggested to consider adding additional content for discussion.

Reply: We appreciate your suggestion, and in response, we have made substantial

revisions to strengthen the discussion in this section. Building upon the temporal and spatial variations of stable isotopes in precipitation across different climatic zones, we have elucidated the interplay of stable isotopes in precipitation in the context of meteorology and hydrology. Additionally, we have highlighted relevant applications of stable isotopes in precipitation.

The changes to the manuscript are as follows:

4.1 Temporal and Spatial Variation Characteristics of Precipitation Stable Isotopes

On a temporal scale, stable isotopes in precipitation exhibit pronounced seasonal variations, with higher values during the summer and lower values during the winter (Figure 4). This is attributed to seasonal variations in evaporation caused by temperature changes, resulting in the evaporative fractionation of stable isotopes in precipitation. Considering the completeness of the time series and regional differences within the Eurasian continent, we constructed a time series of precipitation stable isotopes based on the Köppen climate classification "climate zones " The temporal changes in precipitation stable isotopes under different climate types show significant differences. In tropical climates (A), the values of precipitation stable isotopes are higher, with low values reflecting enhanced precipitation. The "precipitation effect" in the Eurasian continent is particularly significant in tropical climates (Tharammal et al., 2017), and the composition of precipitation stable isotopes reflects the correlated changes between temperature and precipitation. However, the seasonal fluctuations in tropical precipitation stable isotopes are minimal, and there is a fluctuating trend over approximately 20 years. Most arid climates (B) and temperate climates (C) on the Eurasian continent are under the influence of the westerly system. Before 1980, temperate climates experienced significant fluctuations in precipitation stable isotopes, followed by a stable period of about 30 years. After 2010, an unstable trend has become more pronounced, reflecting an increase in extreme weather events (Yao et al., 2021; Zhang et al., 2012). In arid climate regions, precipitation stable isotopes have undergone significant decreases. The Central Asian arid region is a typical temperate arid region, and numerous studies have pointed out a "warm and humid" trend in the climate of this region (Wang et al., 2020; Yan et al., 2019). The strengthening of the

West Pacific subtropical high, North American subtropical high, and the Asian subtropical westerly jet is believed to increase precipitation in this region (Chen et al., 2011). The enhancement of high-latitude water vapour transport is a major factor influencing the increase in precipitation in the Central Asian arid region, which is also the reason for the decreasing trend in deuterium excess (Fig. 4, c-1). Cold climates (D) and polar climates (E) have the smallest values of precipitation stable isotopes, but they exhibit significant differences on an annual scale and a gradually increasing trend on an interannual scale. With global warming, high-latitude regions will provide more sources of water vapour for the water cycle (Ding et al., 2017).

On a spatial scale, the topographic differences and latitude variations in the region are the primary causes of spatial differences in stable isotopes in precipitation across the Eurasian continent. The multi-year average values of $\delta^{2}H$ and $\delta^{18}O$ at different latitudes are as follows: from 0° to 30°N, they are -30.20‰ and -5.99‰, from 30° to 60°N, they are -58.94‰ and -8.77‰, and from 60° to 90°N, they are -92.98‰ and -12.69‰. The Alps and the Tibetan Plateau form regions of low precipitation stable isotopes that differ from those at the same latitudes. The gradual uplift of the Tibetan Plateau's mountains leads to changes in the atmospheric circulation patterns over a larger area, altering the inherent characteristics of water vapour source regions, vapour transport paths, and precipitation stable isotope values. The response of precipitation stable isotopes to the plateau's climate reflects changes in the large-scale circulation state (Yao et al., 2013). The isotopic variations in the surrounding regions of the Alps reflect differences in water vapour sources due to regional topography (Natali et al., 2021; Rindsberger et al., 1983). Spatial variations in deuterium excess can effectively reflect differences in regional water vapour sources, with average values of approximately 10‰ for tropical and temperate climates. Cold climate regions have lower deuterium excess values, and due to the overlap of arid climates with other climate zones, the distribution range of deuterium excess values in arid climates is larger. Therefore, it can be hypothesized that if isotope-related variables (e.g., d-excess) are included in climate zone classification criteria, more climate zones influenced by circulation patterns could be identified.

In line 209, it is stated that there is an increase in extreme events in the Eurasian continent. It is recommended to include supporting literature references for this argument.

Reply: We agree with your suggestion, and to substantiate the claim of an increase in extreme events over the Eurasian continent, it is necessary to refer to relevant scientific literature.

The changes to the manuscript are as follows:

Before 1980, temperate climates experienced significant fluctuations in precipitation stable isotopes, followed by a stable period of about 30 years. After 2010, an unstable trend has become more pronounced, reflecting an increase in extreme weather events (Yao et al., 2021; Zhang et al., 2012).

In section 4.2, there are several abbreviations for climate types used in the figures to convey important information concisely and effectively. It is suggested to use the full names of the climate types in the text of the article to enhance the readers' understanding of the content.

Reply: We agree that the inappropriate expression could lead to difficulties in comprehension during the reading process. Therefore, we have opted to use specific climate terms for clarification.

The changes to the manuscript are as follows:

In temperate climate zones, the differences in stable isotope composition between different climate types become more significant. In the Mediterranean region controlled by the Summer Dry Warm Climate, the slope and intercept are the lowest, indicating that temperature rise dominates the fractionation of hydrogen and oxygen stable isotopes in precipitation, and the region shows a trend of aridification under long-term average conditions.

However, there are still significant differences under different climate zones. The seasonal differences in tropical climates are less pronounced, with the Tropical Sparse Forest Climate (Aw) showing a decrease and increase with the months, possibly due to an increase in precipitation.

In line 240, the sentence "The substantial reduction..." is incomplete and should

be clarified for better expression.

Reply: In the original manuscript, this explains that global warming will have a greater impact on high-latitude regions in the future. We also noted some unclear expressions in the article. In response, we have made significant modifications to certain sections to ensure logical and coherent presentation of the research content in the manuscript.

The changes to the manuscript are as follows:

Cold climates (D) and polar climates (E) have the smallest values of precipitation stable isotopes, but they exhibit significant differences on an annual scale and a gradually increasing trend on an interannual scale. With global warming, high-latitude regions will provide more sources of water vapour for the water cycle (Ding et al., 2017).

In line 254, when referring to the Köppen climate classification, it is recommended to cite the original references that established this classification system.

Reply: We based our study on the Köppen climate classification, specifically the improved Köppen climate classification map developed by Hylke E. Beck et al. According to their work, they state: "We present new global maps of the Köppen-Geiger climate classification at an unprecedented 1-km resolution for the present-day (1980–2016) and for projected future conditions (2071–2100) under climate change." Therefore, we believe that referencing their work in this manner is justified.

In line 286, how should we interpret the phrase "more stable pattern"?

Reply: The global average d-excess value for precipitation is 10‰. D-excess typically indicates the degree of imbalance during the evaporation process of seawater sources. It usually depends solely on the environmental conditions of the water source region. Throughout the entire process from water evaporation into the atmosphere to eventual condensation and becoming rainwater, this value remains constant. Therefore, when referring to a "more stable pattern," it means that the deuterium excess values are close to the global average.

The changes to the manuscript are as follows:

Compared to $\delta^{2}H$ and $\delta^{18}O$, deuterium excess displays a more stable pattern and is distributed around the global average (10‰). The westerly and monsoon systems are the primary atmospheric circulation systems over the Eurasian continent, carrying water vapour from the ocean inland and gradually weakening. This indicates that the humidity in the vast region of Eurasia is strongly influenced by ocean water vapour. Ocean conditions and large-scale atmospheric circulation changes can have profound effects on the climate environment of the Eurasian continent.

In line 286, it is suggested to clearly state the range of the influence of atmospheric circulation and oceanic moisture on stable isotopes of precipitation in different regions of the Eurasian continent, as reflected in the data. This will help strengthen the argument and make it more comprehensive.

Reply: On one hand, d-excess typically depends solely on the environmental conditions of the water source region. Throughout the entire process from water evaporation into the atmosphere to eventual condensation and becoming rainwater, this value remains constant. On the other hand, the westerly and monsoon systems are the major atmospheric circulation systems over the Eurasian continent. They transport water vapour from the ocean inland and gradually weaken, influencing vast regions of the Eurasian continent. Deuterium excess provides a relatively coarse range (Fig.5), but a more detailed range cannot be effectively determined.

In section 4.3, it is stated that regional differences in stable isotopes of precipitation are attributed to regional differences in meteorological factors. The examples cited from the three references should be elaborated on in detail, specifically relating them to the content of this article.

Reply: This section aims to emphasize the regional differences in the influencing factors of stable isotopes in precipitation. We believe that the cited cases sufficiently illustrate the diversity and complexity of the influencing factors of stable isotopes in precipitation. Therefore, we have not made any changes to this part of the content.

In line 301, the term "Asia and Europe" is used to refer to the Eurasian continent in the title. It is recommended to use consistent professional

terminology throughout the entire text.

Reply: Our corrections are as follows, and we will also check for similar issues throughout the entire manuscript.

4.3 Drivers of stable isotope variation in precipitation in Eurasia

In line 314, how should we interpret the phrase "the resampling process of"? It should be further explained.

Reply: For meteorological variables in the random forest regression model, we resampled reanalysis data based on the locations of isotope sites. However, due to the proximity of some site locations, it led to an increase in data duplication. Therefore, we removed duplicate values. Simultaneously, we have removed this part of the content from the manuscript.

It is recommended that the author provide more detailed definitions and descriptions for complex concepts and processes in order to help readers better understand them.

Reply: We will enhance the explanation of conceptual content and mechanisms in the revised manuscript to improve reader understanding and better highlight the advantages of our dataset. The modifications will primarily be reflected in the "Results and Discussion" section. For detailed changes, you can refer to the responses under "**Major comments:**" or consult the revised manuscript.

In the introduction, the article mentions the future application contributions of the dataset. It is suggested to explicitly state these potential scientific application contributions in the discussion section. This will help enhance the impact of your paper.

Reply: We will consider and incorporate the following content in the revision to explicitly highlight the potential scientific contributions of the dataset: Stable isotopes in precipitation data can provide information about the formation and transport processes of precipitation, aiding in the interpretation of precipitation sources, propagation paths, and their relationship with atmospheric circulation. This contributes to a better understanding of the dynamics and meteorological mechanisms of precipitation. Stable isotopes in precipitation offer a deeper insight into the water

cycle processes, such as the study of land-atmosphere recycled water vapour. Additionally, the dataset of stable isotopes in precipitation provides more inputs for climate models, enhancing the validation of model accuracy. Regarding the revised content for this section, we have provided responses under **"Major comments:"** for your reference.

In Figure 6, "H" and "O" are used to represent variables instead of directly using "δ^2H" and "δ^{18}O". It is recommended to use the more specific notation of "δ^2H" and "δ^{18}O" to avoid confusion and ensure clarity in representing the variables.

Reply: We have made modifications to the figures, using more specific symbols directly representing "δ^2H" and "δ^{18}O" to ensure a clear representation of variables and avoid confusion.

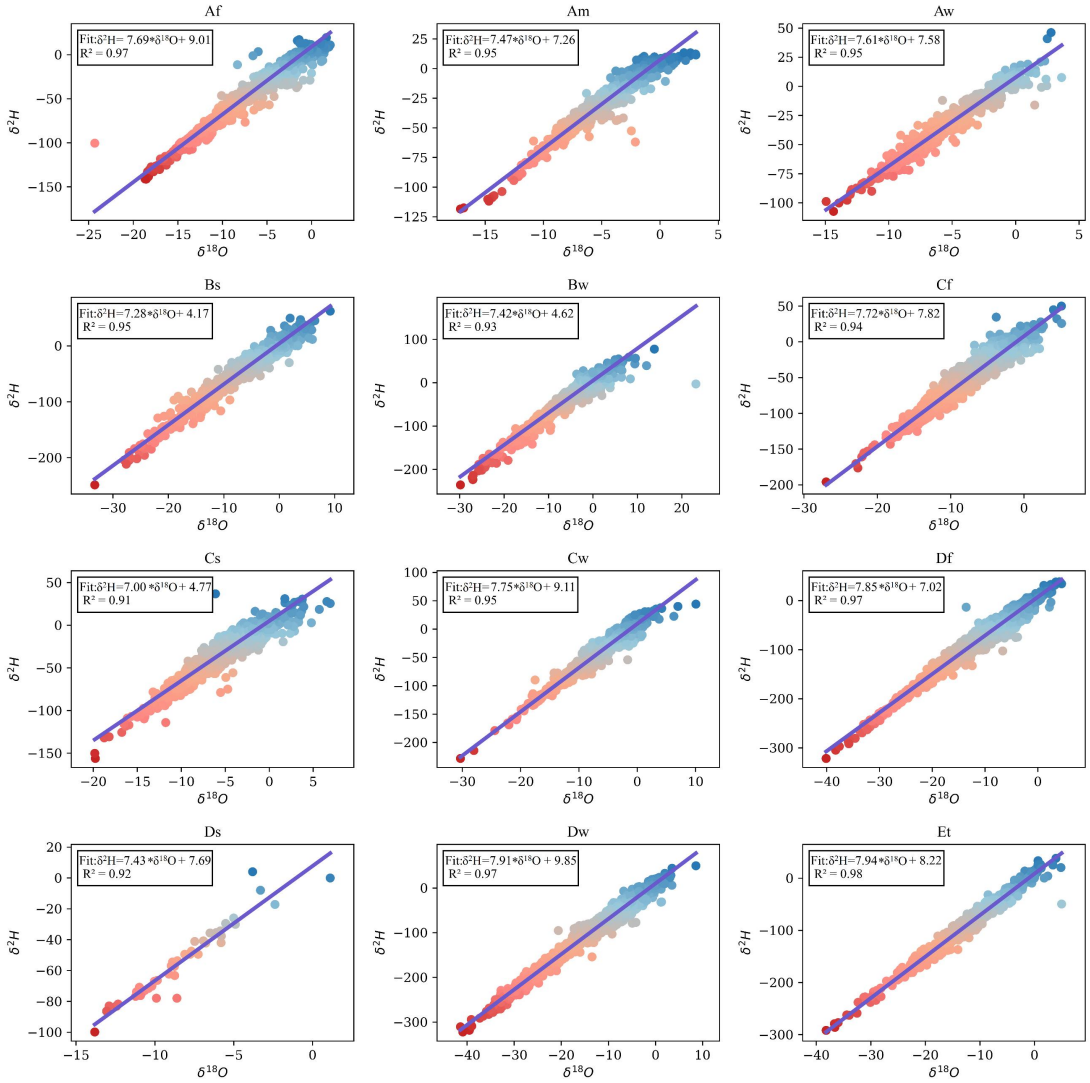
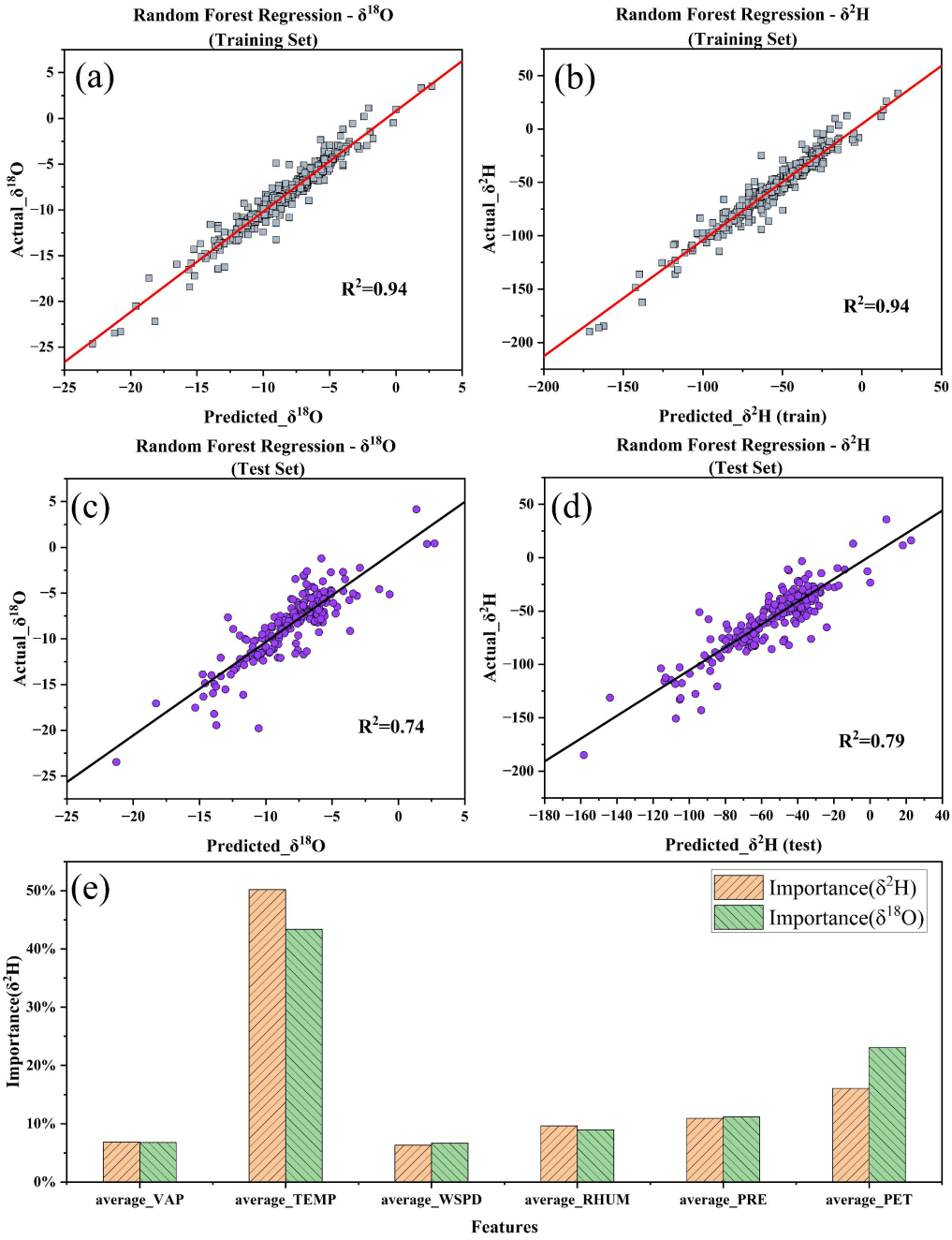


Fig.6 Different meteoric water lines in various climate zones.

In Figure 8, the representation of the isotope is given as "^{18}O" instead of "δ^{18}O". It is advisable to clearly indicate the notation as "δ^{18}O" to avoid any misinterpretation by the readers.

Reply: We have re-generated the result images of the random forest model to ensure clarity and readability.

Modifications are as follows:


Random Forest Regression - δ18O
(Training Set)
(a)
Actual_δ18O
Predicted_δ18O
R2=0.94
Random Forest Regression - δ2H
(Training Set)
(b)
Actual_δ2H
Predicted_δ2H (train)
R2=0.94
Random Forest Regression - δ18O
(Test Set)
(c)
Actual_δ18O
Predicted_δ18O
R2=0.74
Random Forest Regression - δ2H
(Test Set)
(d)
Actual_δ2H
Predicted_δ2H (test)
R2=0.79
(e)
Importance(δ2H)
Importance(δ18O)
Importance(δ2H)
average_VAP
average_TEMP
average_WSPD
average_RHUM
average_PRE
average_PET
Features

Response to Reviewer #2

Stable isotope data in precipitation were compiled in this work starting from 1961 for various locations in Eurasia to facilitate potential applications (such as water resources and climate change studies). Analyses related to temporal and spatial variability and the key meteorological drivers for these isotope data were performed. This compilation of stable isotopes in precipitation can serve as – as discussed in the manuscript – an informative and useful dataset for the studies related to meteorology and climatology, hydrologic cycles, and long-term climate change. However, importantly, the discussions and analyses currently presented do not made it clear in terms of the additional benefits from these isotope datasets over the existing or more traditional/common meteorological and climatological data (especially given that these isotope data start from 1961), leading to the assessments on the scientific merit of this compilation/analysis work difficult. Please see my further comments for additional discussions. Therefore, some major revisions are recommended: including the discussions and analyses to highlight the significance of these isotope data, particularly emphasizing how these data can provide additional benefits over traditional/existing climate datasets.

Reply: We would like to thank Reviewer 2 for the positive opinion about our work, for important comments and for the time spent on the paper reading and reviewing. We answered all concerns/comments and provided the detailed explanations below.

Major comments:

Reading through the manuscript, it is unclear the how these stable isotope data provides additional benefits to end-users or scientific studies over the existing or more traditional datasets (such as reanalysis data as also mentioned and used in the paper). For example, these isotope data in this work start from 1961, which is not as early as some other available meteorological data such as reanalysis data (e.g., starting from 1940 in ERA5). Additionally, the isotope data is, in a way, a type of proxy data, which is affected by various parameters such as temperature and precipitation and therefore, use of isotope data to provide

information on temperature or precipitation is subject to a layer of complexity compared to the direct use of historical temperature and precipitation data. Consequently, one main question I have is how these isotope data provide additional benefits over the existing climate and meteorology data, perhaps the isotope data provides location-specific information? More emphases on the scientific and/or practical merit of these data are therefore needed.

Reply: Traditional meteorological data, with its mature observation system and reanalysis methods, can effectively reveal meteorological and climatic information. However, stable isotope data in precipitation not only serves as a substitute indicator for traditional meteorological data but also has additional advantages compared to conventional meteorological datasets. In summary, stable isotope data in precipitation possesses the following advantages: enhanced process-oriented understanding of meteorological events (Aggarwal et al., 2016). Stable isotope data in precipitation can provide information about the formation and transport processes of precipitation, contributing to the interpretation of precipitation sources, propagation paths, and their relationships with atmospheric circulation. This aids in a better understanding of the dynamics and meteorological mechanisms of precipitation. Climate and environmental indicators: Precipitation isotope data can serve as climate and environmental indicators. They exhibit high sensitivity to climate change and ecosystem responses, making them valuable for studying the impacts of climate and environmental changes. Isotope data can also be used to trace pathways in the water cycle, providing insights into the sources and flow directions of water resources.

Stable isotopes in precipitation serve as a medium connecting the hydrological system and the climate system. Various water bodies, including seawater and land, serve as sources of water vapor, which, in turn, is the "substance source" of precipitation. Therefore, through the process of isotope fractionation in the water cycle, precipitation contains stable isotope markers from its initial sources. Stable isotope data in precipitation can be used to determine the sources and pathways of precipitation. By analyzing the isotopic composition of precipitation in different regions, it is possible to distinguish whether precipitation originates from oceanic or

land evaporation (precipitation from oceanic evaporation typically has higher δ18O and δ2H). This contributes to understanding regional changes in atmospheric circulation, the migration and transport of water vapor. In addition, stable isotopes in precipitation provide a more in-depth understanding of the water cycle process. For example, in the study of terrestrial recycled water vapor, traditional meteorological data-based recycled water vapor models (box models) struggle to differentiate between advective water vapor and evaporative water vapor. In contrast, stable isotope-based recycled water vapor models can directly estimate changes in the contribution of recycled water vapor based on stable isotope sampling at precipitation sites (Zhang et al., 2021). Furthermore, they can differentiate contributions from evaporation and transpiration to precipitation. Stable isotope data in precipitation can enhance the accuracy of atmospheric circulation models. Integrating isotopes into atmospheric circulation models (e.g., GCM, LZMD, ICAM) provides valuable validation for the physical components of atmospheric circulation models through comparisons between simulated and observed stable isotopes in precipitation (Joussaume et al., 1984).

In the revised manuscript, adjustments have been made to the introduction, results, and discussion sections, and a "Summary and Outlook" section has been added. We have discussed the interconnections between stable isotopes in precipitation, climate, and hydrology, elucidating the practical applications of stable isotopes in precipitation. The importance of constructing a dataset of stable isotopes in precipitation has been emphasized.

The changes to the manuscript are as follows:

1. Introduction

Stable isotopes in precipitation serve as a crucial medium connecting the hydrological and climatic systems. Precipitation, being both a product of the climate system and a primary source for the hydrological system (Sun et al., 2018), plays a pivotal role. Additionally, stable isotope fractionation accompanying the water cycle not only carries rich climate information throughout its variations but also facilitates the tracing of contributions to various surface water bodies (Hao et al., 2019; Ren et

al., 2017; Shi et al., 2022). Although stable isotopes in precipitation (δ^2H and $\delta^{18}O$) constitute a small proportion in natural water bodies, they exhibit sensitivity to changes in climatic factors (Craig, 1961; Dansgaard, 1964). The quantification of precipitation stable isotopes, influenced by factors such as temperature, precipitation, wind speed, relative humidity, and water vapour sources (Gat, 1996; Jiao et al., 2020), deepens our procedural understanding of the water cycle. This quantification provides relevant information about water vapour transport processes and precipitation formation (Kathayat et al., 2021), determination of the proportions of different types of precipitation (Aggarwal et al., 2016), and comprehension of the mechanisms behind extreme events (Sun et al., 2022), offering robust evidence to explore the inherent mechanisms of meteorological events and climate change processes. Water recovery is a significant component of land water flux (Jasechko et al., 2013), but its direct measurement still faces numerous challenges. Deuterium excess (d-excess): $\delta^2H = 8\times \delta^{18}O$, a stable isotope quantity sensitive to water recovery effects, remains constant throughout the entire process from water vapor evaporation into the atmosphere to final condensation and rain formation (Merlivat and Jouzel, 1979). Therefore, in current water recovery quantification efforts, precipitation stable isotopes are a primary means (Cropper et al., 2021; Zhang et al., 2021a). δ^2H and $\delta^{18}O$, as important climate tracers, are also employed in reconstructing continental paleoclimate. The accurate understanding of precipitation stable isotopes' response to modern climate lays the foundation for paleoclimate reconstruction. On the other hand, using general atmospheric circulation models to simulate isotope circulation is a major method for comparing isotope distributions in precipitation under both modern and ancient conditions (Joussaume et al., 1984). Simultaneously, the comparison between simulated and observed precipitation stable isotopes provides valuable validation for the physical components of atmospheric circulation models (Joussaume et al., 1984; Ruan et al., 2019). In conclusion, the comprehensive data on stable isotopes in precipitation offer more detailed information about the climate and hydrological systems.

4.1 Temporal and Spatial Variation Characteristics of Precipitation Stable Isotopes

On a temporal scale, stable isotopes in precipitation exhibit pronounced seasonal variations, with higher values during the summer and lower values during the winter (Figure 4). This is attributed to seasonal variations in evaporation caused by temperature changes, resulting in the evaporative fractionation of stable isotopes in precipitation. Considering the completeness of the time series and regional differences within the Eurasian continent, we constructed a time series of precipitation stable isotopes based on the Köppen climate classification "climate zones. "The temporal changes in precipitation stable isotopes under different climate types show significant differences. In tropical climates (A), the values of precipitation stable isotopes are higher, with low values reflecting enhanced precipitation. The "precipitation effect" in the Eurasian continent is particularly significant in tropical climates (Tharammal et al., 2017), and the composition of precipitation stable isotopes reflects the correlated changes between temperature and precipitation. However, the seasonal fluctuations in tropical precipitation stable isotopes are minimal, and there is a fluctuating trend over approximately 20 years. Most arid climates (B) and temperate climates (C) on the Eurasian continent are under the influence of the westerly system. Before 1980, temperate climates experienced significant fluctuations in precipitation stable isotopes, followed by a stable period of about 30 years. After 2010, an unstable trend has become more pronounced, reflecting an increase in extreme weather events (Yao et al., 2021; Zhang et al., 2012). In arid climate regions, precipitation stable isotopes have undergone significant decreases. The Central Asian arid region is a typical temperate arid region, and numerous studies have pointed out a "warm and humid" trend in the climate of this region (Wang et al., 2020; Yan et al., 2019). The strengthening of the West Pacific subtropical high, North American subtropical high, and the Asian subtropical westerly jet is believed to increase precipitation in this region (Chen et al., 2011). The enhancement of high-latitude water vapour transport is a major factor influencing the increase in precipitation in the Central Asian arid region, which is also the reason for the decreasing trend in deuterium excess (Fig. 4, c-1). Cold climates (D) and polar climates (E) have the smallest values of precipitation stable isotopes, but they exhibit significant differences on an annual scale and a gradually increasing trend

on an interannual scale. With global warming, high-latitude regions will provide more sources of water vapour for the water cycle (Ding et al., 2017).

On a spatial scale, the topographic differences and latitude variations in the region are the primary causes of spatial differences in stable isotopes in precipitation across the Eurasian continent. The multi-year average values of $\delta^{2}H$ and $\delta^{18}O$ at different latitudes are as follows: from 0° to 30°N, they are -30.20‰ and -5.99‰, from 30° to 60°N, they are -58.94‰ and -8.77‰, and from 60° to 90°N, they are -92.98‰ and -12.69‰. The Alps and the Tibetan Plateau form regions of low precipitation stable isotopes that differ from those at the same latitudes. The gradual uplift of the Tibetan Plateau's mountains leads to changes in the atmospheric circulation patterns over a larger area, altering the inherent characteristics of water vapour source regions, vapour transport paths, and precipitation stable isotope values. The response of precipitation stable isotopes to the plateau's climate reflects changes in the large-scale circulation state (Yao et al., 2013). The isotopic variations in the surrounding regions of the Alps reflect differences in water vapour sources due to regional topography (Natali et al., 2021; Rindsberger et al., 1983). Spatial variations in deuterium excess can effectively reflect differences in regional water vapour sources, with average values of approximately 10‰ for tropical and temperate climates. Cold climate regions have lower deuterium excess values, and due to the overlap of arid climates with other climate zones, the distribution range of deuterium excess values in arid climates is larger. Therefore, it can be hypothesized that if isotope-related variables (e.g., d-excess) are included in climate zone classification criteria, more climate zones influenced by circulation patterns could be identified.

4.2 Seasonal changes in meteoric water line and precipitation stable isotopes

The temporal and spatial variations of stable isotopes in precipitation are greatly influenced by meteorological factors, and the changes in precipitation isotopes are consistent with the climatic regions. Therefore, based on the Köppen climate classification, we performed climate zoning for stable isotopes in precipitation sites. We used the least squares method to fit meteoric water line for different climate regions (Fig.6) and considered the seasonal variations of precipitation stable isotopes

in different climate regions (Fig.7). The meteoric water line for different climate types indicate relatively small differences in various climate precipitation amounts in tropical climates. The variations in the slope and intercept of the meteoric water line are determined by the combined effects of precipitation and temperature, with convective precipitation weakening the impact of the "temperature effect." Intense convective rainfall and oceanic water vapour transport bring abundant precipitation to tropical regions. The fractionation mechanisms and variations of precipitation stable isotopes not only reveal the inherent patterns of weather pattern occurrence and development (Sun et al., 2022) but also correlate weather patterns with supply sources, tracing the water sources of surface water bodies (Scholl and Murphy, 2014; Anon, 2017). Stable isotopes in precipitation in arid climates are influenced by secondary evaporation below clouds, and intense unbalanced fractionation processes lead to relative enrichment of stable isotopes in precipitation (Wang et al., 2021; Zhu et al., 2021). Water resources are the most limiting factor for the ecological and social environment in arid climate regions (García-Ruiz et al., 2011). Therefore, compared to other climate regions, water recovery becomes more critical. Stable isotopes in precipitation can accurately quantify water recovery and effectively assess the impact of evaporation on different water bodies in arid regions. The majority of the global population is distributed in temperate regions. Therefore, with global temperature rise, the climate change situation in temperate regions deserves more attention. In temperate climate zones, the differences in stable isotope composition between different climate types become more significant. In the Mediterranean region controlled by the Summer Dry Warm Climate, the slope and intercept are the lowest, indicating that temperature rise dominates the fractionation of hydrogen and oxygen stable isotopes in precipitation, and the region shows a trend of aridification under long-term average conditions. The westerly system is the main controlling circulation in this region, and the changes in precipitation stable isotopes reflect the attenuation trend of mid-latitude westerly moisture inward migration (Zhu et al., 2023; Shi et al., 2021). In polar climates, the atmospheric water line exhibits higher slope and intercept. The influence of unbalanced fractionation processes after water vapour

condensation in cloud systems is relatively small, resulting in a slope close to 8.

The seasonal variation of hydrogen and oxygen stable isotopes in precipitation on the Eurasian continent generally exhibits a pattern of higher values in summer and lower values in winter (Fig.7) (Hydrogen isotopes (δ^2H) in Supplement S3). However, there are still significant differences under different climate zones. The seasonal differences in tropical climates are less pronounced, with the Tropical Sparse Forest Climate (Aw) showing a decrease and increase with the months, possibly due to an increase in precipitation. Temperate and cold climates generally exhibit significant seasonal variations. The deuterium excess in the Eurasian continent shows a lower pattern in summer and a higher pattern in winter, indicating seasonal changes in water vapour sources and transport distances (Zhang et al., 2021a). This overall suggests that the summer climate in Eurasia is more humid, while the winter climate is drier. Deuterium excess usually indicates the degree of imbalance in seawater sources during their evaporation process, and it typically depends only on the environmental conditions of the evaporation source. Compared to δ^2H and $\delta^{18}O$, deuterium excess displays a more stable pattern and is distributed around the global average (10‰). The westerly and monsoon systems are the primary atmospheric circulation systems over the Eurasian continent, carrying water vapour from the ocean inland and gradually weakening. This indicates that the humidity in the vast region of Eurasia is strongly influenced by ocean water vapour. Ocean conditions and large-scale atmospheric circulation changes can have profound effects on the climate environment of the Eurasian continent. The differences in precipitation stable isotopes among different climate types are not only responses to different climate characteristics but also provide effective tools for a deeper understanding of the process, climate change mechanisms, water vapour transport between land and sea, and supply relationships between water bodies. The precipitation stable isotopes dataset we have constructed for the Eurasian continent can be combined with traditional meteorological data to provide more information for climate and hydrological research.

5. Summary and outlook

Stable isotopes in precipitation play a crucial role in both the climate and

hydrological systems, exhibiting sensitivity to variations in both time and space. Research indicates significant differences in isotopic values between summer and winter, correlating with seasonal changes in temperature and evaporation. The temporal and spatial variations of precipitation stable isotopes vary significantly across different climate types, reflecting the influence of climate characteristics on isotopic distribution. Terrain and latitude differences are the primary reasons for spatial variations in stable isotopes in precipitation. Meteorological factors have a notable impact on precipitation stable isotopes, as evidenced by the meteoric water line in different climate types, revealing the influence of climate on isotopic fractionation. Observations of precipitation stable isotopes contribute to understanding weather patterns, water vapour sources, and transport pathways, providing important insights into stable isotope variations in arid climates. The integrated dataset of stable isotopes in precipitation from the Eurasian continent that we have compiled can offer more detailed climate and hydrological information. However, future research efforts should focus on improving observational data for Stable isotopes in precipitation. The uncertainties in physical models and machine learning methods need refinement through additional real-world data to enhance the accuracy of predicting precipitation stable isotopes.

The temporal analyses carried out in this work (e.g., Figures 4 and 7) using the compiled isotope data seem to be based on the averages of all data locations in Eurasia, which to me are crude and potentially subject to limitations/bias. For example, in Figure 4, the temporal variability of the isotope data seems to be calculated as averages across all stations for each day (not clearly discussed in the text), which could be problematic depending on the periods of records in different stations: do all stations have a same period of record from 1961 to 2022? Is it possible that more stations/locations have more data during a recent period? If different historical periods have different amounts of stations/locations with available data, taking arithmetic means would inherently cause systematic bias. As this manuscript puts a particular emphasis on the spatial variability, these temporal analyses should at least be conducted for some smaller regions to be

consistent. Such additional analyses may also be useful to demonstrate the merit of these station-level isotope data (related to my previous comment).

Reply: We appreciate your concern regarding the use of integrated stable isotope data for temporal analysis. To address this issue, we have reanalyzed the data, computing time series on a regional basis (Köppen climate zones). The rationale for this division is as follows: the variation in stable isotopic composition of precipitation is significantly influenced by meteorological factors, and within the same climate zone, there is similarity in the variation of stable isotopic composition. To address the issue of site data having different historical periods, we have employed weighted averages. This approach assigns greater weight to sites with longer historical records, better reflecting the trends observed over the long term and mitigating the impact of short-term site data. This introduces a more equitable balance when dealing with data from sites with different historical periods, ensuring consistency with the spatial variability emphasized in our study.

The changes to the manuscript are as follows:

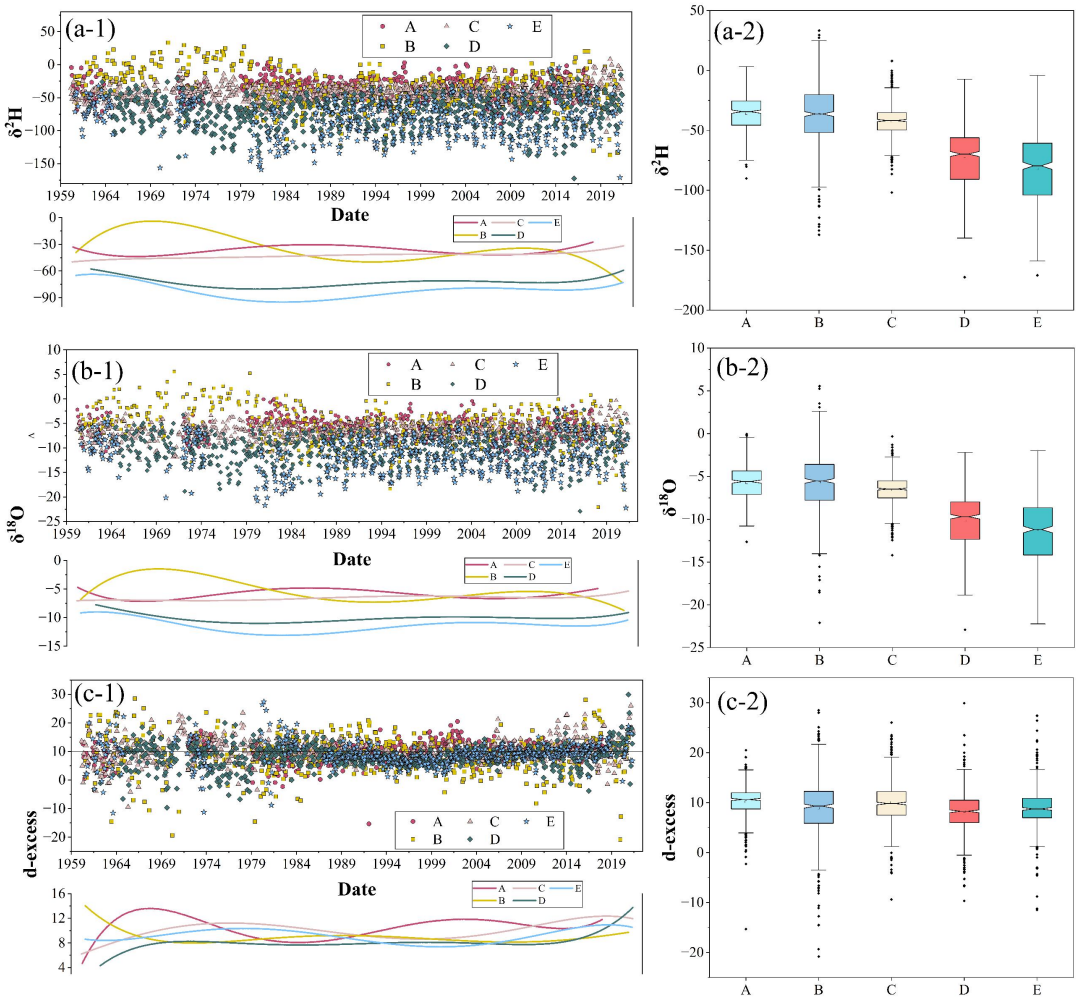


Fig.4 The time series variations of δ^2H, $\delta^{18}O$, and d-excess in the Eurasian continent.

Minor comments:

Lines 14-15: in the main text of the manuscript, it will be helpful to summarize the dimensions of datasets (in addition to here in the abstract) such as a table showing the number of stations at different regions, the periods of records for each station, etc.

Reply: We fully agree with the addition of a table to summarize the dimensions of the dataset, such as the number of sites in different regions, and the recording periods for each site.

Additionally, during the modification process, numerous redundant site counts for the same project were generated because we previously tallied quantities based on site names (some sites had different time samplings, leading to distinct "project IDs"). Now, we have recalculated the site quantity based on geographical coordinates (842

sites).

The modifications in the manuscript text are as follows:

Table S1 Precipitation Stable Isotope Site Information

Site_Name	Latitude	Longitude	Elevation (m)	Earliest Collection Date	Latest Collection Date	Data Source
10-TG-16w	32.9159	91.9596	5126.0000	2008.01.01	2008.01.01	WaterIsotopes.org
12QH18	34.4752	97.7328	4413.0000	2012.05.05	2012.05.05	WaterIsotopes.org
A CORUNA	43.3659	-8.4214	58.0000	2000.02.15	2016.12.15	GNIP
Aba	31.9300	101.7200		2021.07.06	2022.04.04	Measured data
ADANA	36.9800	35.3000	73.0000	1990.01.15	2016.12.15	GNIP
ADZ SG RF	1.2953	103.7711		2015.03.06	2015.03.27	WaterIsotopes.org
Akita	39.4300	140.8000	10.0000	2013.01.27	2014.01.03	WaterIsotopes.org
Akita-kita	39.4800	140.2000	20.0000	2013.02.01	2014.01.07	WaterIsotopes.org
Aktumsuk	45.0918	59.3451		2006.03.15	2006.03.15	WaterIsotopes.org
ALEPPO	36.1833	37.2167	410.0000	1989.12.15	1992.05.15	GNIP
ALEXANDRIA	31.1833	29.9500	7.0000	1961.10.15	2004.04.15	GNIP
ALMERIA AEROPUERTO	36.8464	-2.3569	21.0000	2000.04.15	2016.12.15	GNIP
ALOR STAR	6.2000	100.4000	5.0000	1992.02.15	2016.12.15	GNIP
ALTNABREAC	58.3833	-3.7000	155.0000	1981.08.15	1982.08.15	GNIP
AMDERMA	69.7667	61.6833	53.0000	1981.01.15	1989.09.15	GNIP
AMMAN-WAJ	31.9577	35.8483	900.0000	1999.01.15	2018.12.15	GNIP
ANCONA-MONTE D'AGO	43.5870	13.5153	170.0000	2000.10.15	2018.11.15	GNIP
ANDALO	46.1667	11.0000	1005.0000	1999.09.30	1999.09.30	WaterIsotopes.org
ANIP, HZB Nr. 101287	47.3883	11.2631	990.0000	1993.01.15	2002.12.15	WaterIsotopes.org
ANIP, HZB Nr. 102343	47.0000	11.5167	1450.0000	1991.01.15	2000.12.15	WaterIsotopes.org
ANIP, HZB Nr. 103820	47.5961	13.1644	470.0000	2007.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB Nr. 105734 (Schule)	47.8040	13.7766	425.0000	1973.01.15	1983.12.15	WaterIsotopes.org

ANIP, HZB Nr. 105908	47.3467	13.3950	910.0000	2007.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB Nr. 110551	47.8517	16.8431	121.0000	2004.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB Nr. 110569	47.7431	16.8433	119.0000	1990.01.15	1999.10.15	WaterIsotopes.org
ANIP, HZB Nr. 113324, St. Peter i. Katschtal	47.0283	13.5981	1220.0000	2007.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB Nr. 113498	46.4896	14.5900	550.0000	2007.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB Nr. 113886 Seeberg	46.4225	14.5422	940.0000	2007.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB Nr. 114173 Flughafen	46.6484	14.3185	447.0000	2004.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 100552	47.3115	10.0177	835.0000	2004.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 100776 Rieden	47.4886	9.7366	410.0000	2004.01.15	2012.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 101238 Reutte	47.4833	10.7500	870.0000	2007.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 101345	47.5333	11.7000	904.0000	1996.01.15	2002.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 102210 Obergurgl	46.8667	11.0333	1940.0000	2007.01.15	2011.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 102236	47.0764	10.9700	1180.0000	2007.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 102327 Flughafen	47.2575	11.3539	580.0000	2007.01.15	2014.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 102418 Patscherkofel	47.2088	11.4618	2245.0000	2005.01.15	2009.10.15	WaterIsotopes.org
ANIP, HZB-Nr. 102814	47.5833	12.1667	495.0000	2010.01.15	2014.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 102939	47.2500	10.8833	695.0000	1994.10.15	2002.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 103853 Flughafen	47.7942	13.0017	430.0000	2007.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 104323 Braunau	48.2539	13.0767	360.0000	2005.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 105130	47.6000	13.7833	640.0000	1996.01.15	2002.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 105296 Feuerkogel	47.8167	13.7239	1618.0000	2007.01.15	2013.12.15	WaterIsotopes.org

ANIP, HZB-Nr. 105684	47.9044	13.5722	469.0000	2007.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 106542 Breitenau	47.8464	14.3569	514.0000	2005.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 106567 Planneralm	47.4048	14.2009	1605.0000	2009.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 107011 Lackenhof	47.8700	15.1539	807.0000	2009.01.15	2012.09.15	WaterIsotopes.org
ANIP, HZB-Nr. 107607 Ottenstein	48.5836	15.3408	554.0000	2007.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 107979 Hohe Warte	48.2486	16.3563	198.0000	2005.01.15	2014.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 108456	47.8769	15.8934	495.0000	2007.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 112599 Karlgraben	47.6823	15.5627	775.0000	2008.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 113001	46.7454	12.4078	1075.0000	2009.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 113498 Villacher Alpe	46.6036	13.6728	2120.0000	2007.01.15	2013.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 113522	46.6246	13.6867	907.0000	1993.01.15	2002.12.15	WaterIsotopes.org
ANIP, HZB-Nr. 114280 St. Michael	46.5586	14.7670	527.0000	1993.01.15	2002.12.15	WaterIsotopes.org
ANIP, HZB-Nr. WEISSBACH	47.5833	12.7000	629.0000	1983.01.15	1989.12.15	WaterIsotopes.org
ANip, HZB-Nr.106252	47.6544	14.9809	610.0000	2007.01.15	2013.12.15	WaterIsotopes.org
ANIP, Wasseralm HZB Nr. 110155	47.7350	15.6484	774.0000	1989.01.15	1998.12.15	WaterIsotopes.org
ANKARA	39.9500	32.8800	902.0000	1990.01.15	2016.12.15	GNIP
ANTALYA	36.8800	30.7000	49.0000	1990.01.15	2016.12.15	GNIP
ANY	35.7475	138.4166	526.0000	2010.07.15	2015.06.15	WaterIsotopes.org
Aomori	40.4900	140.4500	5.0000	2013.01.30	2014.01.01	WaterIsotopes.org
AQABA	29.5500	34.9000	2.0000	2002.01.15	2002.01.15	GNIP
Arakawa	35.4300	139.4500	20.0000	2013.02.06	2013.12.28	WaterIsotopes.org
ARKHANGELSK	64.5800	40.5000	13.0000	1981.02.15	1990.11.15	GNIP
ARKONA	54.6789	13.4342	42.0000	1997.06.15	2008.07.15	GNIP
ARMAGH	54.3533	-6.6483	64.0000	2012.05.15	2019.12.15	GNIP

OBSERVATORY						
Artashat	39.9322	44.5214	820.8000	2014.07.06	2015.04.28	WaterIsotopes.org
ARTERN	51.3744	11.2919	164.0000	1997.06.15	2013.12.15	GNIP
ASTRAKHAN	46.2500	48.0300	-18.0000	1981.01.15	2000.12.15	GNIP
AT_0007	47.7351	15.6486		2005.06.07	2005.08.11	WaterIsotopes.org
AT_0007_007	47.7351	15.6486		2005.06.04	2005.06.04	WaterIsotopes.org
AT_0141	47.7267	13.0354	510.0000	2012.05.25	2012.12.04	WaterIsotopes.org
AT_0144	47.7215	12.9843	1396.0000	2012.05.25	2012.10.10	WaterIsotopes.org
AT_1203	46.7156	13.0404	1391.0000	1995.01.01	1995.10.01	WaterIsotopes.org
AT_1207	46.6762	12.9966	705.0000	1995.02.01	1995.09.01	WaterIsotopes.org
AT_2088	48.5239	16.7556	205.0000	2009.01.15	2013.12.15	WaterIsotopes.org
AT_2338	48.3297	14.2586	490.0000	2009.01.15	2013.12.15	WaterIsotopes.org
AT_2402	47.0868	13.1151	1120.0000	1988.01.15	1997.12.15	WaterIsotopes.org
AT_2433	47.0777	15.4489	366.0000	2004.01.15	2013.12.15	WaterIsotopes.org
AT_2434	47.6409	13.8919	710.0000	2011.01.15	2013.12.15	WaterIsotopes.org
AT_2704	48.1833	16.4000	156.4800	2015.01.23	2020.5.16	WaterIsotopes.org
ATHENS-PENDELI	38.0501	23.8667	498.0000	2001.01.15	2018.12.15	GNIP
AVIGNON	43.9128	4.8888	33.0000	1997.04.15	2018.12.15	GNIP
Ayouqui weather station (AYQ)	39.2200	101.6800	1620.0000	2013.07.12	2017.07.08	WaterIsotopes.org
BAB-JANET	35.5722	36.1897	1100.0000	1992.12.15	1993.04.15	GNIP
BAD SALZUFLEN	52.1042	8.7519	135.0000	1990.01.15	2011.12.15	GNIP
BAGDARIN	54.4667	113.5833	903.0000	1996.04.15	2000.10.15	GNIP
BAHRAIN	26.2700	50.6200	2.0000	1970.01.15	2018.10.15	GNIP
Baiyin	36.5400	104.1740		2020.07.25	2021.07.02	Measured data
BAKURIANI	41.7333	43.5167	1665.0000	2008.03.15	2018.12.15	GNIP
BALAS-BALAS	9.2900	123.1700	827.0000	1997.01.15	1998.12.15	GNIP
BALTI	47.7000	27.8833	231.0000	2007.09.15	2015.08.15	GNIP

BANDARBAN	22.2000	92.2000	24.0000	2015.03.15	2018.09.15	GNIP
BANGKOK	13.7300	100.5000	2.0000	1990.01.15	2015.11.15	GNIP
Baoji	34.3693	107.1449		2020.10.14	2021.11.10	Measured data
Baoshan	25.0800	99.1000		2021.05.06	2022.01.14	Measured data
BAOTOU	40.6700	109.8500	1067.0000	1986.03.15	1992.10.15	GNIP
Baotou	40.6500	109.8300		2021.05.13	2021.08.03	Measured data
BARABINSK	55.3333	78.3667	120.0000	1996.06.15	2000.12.15	GNIP
BARI	41.1333	16.8500	24.0000	2001.12.31	2001.12.31	WaterIsotopes.org
BARISAL	22.7000	90.3600	10.0000	2013.05.15	2018.10.15	GNIP
Barisal	22.7210	90.3520		2013.05.06	2015.12.19	WaterIsotopes.org
BASOVIZZA	45.6439	13.8639	397.0000	1999.01.31	1999.01.31	WaterIsotopes.org
BATTIPAGLIA	40.6167	14.9667	71.0000	2001.05.31	2001.05.31	WaterIsotopes.org
Bayan Nur	40.7574	107.4170		2021.05.22	2021.09.15	Measured data
BAYIR	30.7619	36.6769	902.0000	1968.11.15	1968.11.15	GNIP
BEEK	50.9200	5.7800	111.0000	1981.01.15	1992.04.15	GNIP
BEER SHEVA	31.2300	34.7800	270.0000	1965.11.15	1968.01.15	GNIP
BELGAUM	15.8806	74.4933	747.0000	2003.08.15	2005.10.15	GNIP
BELLINZAGO	45.5667	8.6333	190.0000	2000.12.31	2000.12.31	WaterIsotopes.org
BERLIN	52.4672	13.4019	48.0000	1990.01.15	2012.12.15	GNIP
BERN	46.9522	7.4393	511.0000	1990.01.15	2012.12.15	GNIP
BET DAGAN	31.9973	34.8162	39.0000	1984.01.15	2001.05.15	GNIP
BEYROUTH	33.8719	35.5097	19.0000	2003.11.15	2006.03.15	GNIP
Biandianzhan	37.3300	101.5100		2021.11.27	2021.11.27	Measured data
BLOUDAN	33.7250	36.1303	1540.0000	1989.12.15	1993.04.15	GNIP
BOGDARIN	54.6200	113.1300	995.0000	1996.01.31	2000.12.31	WaterIsotopes.org
BOLOGNA	44.4833	11.3333	54.0000	1996.03.15	2001.08.31	WaterIsotopes.org
BONGA	13.0300	123.9200	600.0000	1997.01.15	1998.12.15	GNIP
BOSSEA	44.2333	7.8500	820.0000	2000.11.15	2001.03.15	GNIP
BRAAKMAN	51.3000	3.7500	2.0000	1988.07.15	1992.04.15	GNIP
BRASIMONE	44.0900	11.0800	842.0000	1971.09.15	1986.04.15	GNIP
Brasimone	44.1165	11.1157		1971.09.01	1986.04.01	References

BRATISLAVA	48.1691	17.1119	286.0000	1992.01.15	1992.02.15	GNIP
BRAUNSCHWEIG	52.2914	10.4464	81.0000	1990.01.15	2012.12.15	GNIP
BRAVICEA	47.4000	28.4917	78.0000	2007.09.15	2015.07.15	GNIP
BREST	52.0944	23.7058	136.0000	1981.01.15	1983.12.15	GNIP
BREST PLOUZANE	48.3600	-4.5700	80.0000	1996.04.15	2002.12.15	GNIP
BUCHS SUHR	47.3723	8.0831	397.0000	1994.07.15	2019.12.15	GNIP
BUSAN	35.2306	129.0803	96.8000	2019.02.15	2020.06.15	GNIP
CACERES	39.4667	-6.3333	405.0000	2000.03.15	2015.12.15	GNIP
CAGBULACAO	11.1200	124.6200	200.0000	1997.02.15	1998.12.15	GNIP
CAGLIARI	39.2167	9.1167	25.0000	1998.08.31	1998.08.31	WaterIsotopes.org
CAHUL	45.8000	28.2000	113.0000	2007.09.15	2015.08.15	GNIP
CAIRO	30.0800	31.2800	34.0000	1987.03.15	2003.03.15	GNIP
CAMERON HIGHLANDS	4.4667	101.3833	1430.0000	1996.02.15	2016.12.15	GNIP
CAMPISTROUS	43.1200	0.3800	600.0000	1997.10.15	1998.12.15	GNIP
CAMPO CARLO MAGNO	46.2333	10.8167	1685.0000	1999.09.30	1999.09.30	WaterIsotopes.org
CANINO	42.4667	11.7500	229.0000	1999.08.31	1999.08.31	WaterIsotopes.org
CARPENTRAS	44.9500	5.7800	99.0000	1997.02.15	1998.12.15	GNIP
CASALE MONFERRATO	45.1400	8.4500	116.0000	2002.02.28	2002.02.28	WaterIsotopes.org
CBS	48.0700	114.5200	759.0000	2002.10.01	2003.09.01	WaterIsotopes.org
CEGLIE MESSAPICO	40.6500	17.5167	302.0000	1999.10.31	1999.10.31	WaterIsotopes.org
Centre for Earth Science, IIS	13.0181	77.5693		2010.06.07	2010.09.16	WaterIsotopes.org
CESTAS-PIERROTON	44.7381	-0.7747	59.0000	2007.02.15	2018.12.15	GNIP
CHANGCHUN	43.9000	125.2167	237.0000	1999.05.15	2001.11.15	GNIP
CHANGSHA	28.2000	113.0667	37.0000	1988.01.15	1992.12.15	GNIP
CHARCHES	37.2932	-2.9559	1426.0000	2013.01.15	2015.11.15	GNIP
Chat-11	44.8000	34.2900		2011.01.01	2011.12.01	References
CHENGDU	30.6700	104.0200	506.0000	1986.07.15	1998.05.15	GNIP
CHEONGJU	36.6200	127.4600	62.0000	1999.01.15	2016.12.15	GNIP
CHERSKIY	68.7594	161.3425	30.0000	2005.08.15	2010.06.15	GNIP
Chiba	35.3700	140.6000	20.0000	2013.02.01	2013.12.31	WaterIsotopes.org
Chibi	29.7200	113.8800		2021.04.22	2022.02.22	Measured data

Chichibu	35.5600	138.5100	800.0000	2013.01.31	2014.01.06	WaterIsotopes.org
CHISINAU	46.9667	28.9000	125.0000	2007.08.15	2015.07.15	GNIP
CHONGQING (CUNTAN JIANG)	29.6200	106.6000	192.0000	1992.06.15	1992.10.15	GNIP
CHOPOK	48.9330	19.5830	2008.0000	1991.08.15	1992.02.15	GNIP
ChP-12	44.7556	34.3411		2012.01.01	2015.12.08	References
CHUADANGA	23.6400	88.8500	20.0000	2014.05.15	2018.12.15	GNIP
CIUDAD REAL	38.9892	-3.9203	628.0000	2000.01.15	2015.12.15	GNIP
CKM	36.5355	138.0619	763.0000	2011.08.15	2013.10.15	WaterIsotopes.org
CLUJ	46.7800	23.6100	330.0000	2015.01.15	2016.12.15	GNIP
COMACCHIO	44.6975	12.1858	1.0000	2001.05.31	2001.05.31	WaterIsotopes.org
Cona Lake West	32.0568	91.4201	4623.0000	2011.05.12	2013.10.21	WaterIsotopes.org
Corchia	44.0206	10.2842		2009.10.01	2015.10.01	References
COSENZA	39.3000	16.2500	238.0000	2001.07.31	2001.07.31	WaterIsotopes.org
Coxs Bazar	21.4420	91.9690		2015.03.05	2015.12.18	WaterIsotopes.org
COX'S BAZAR	21.4400	91.9900	5.0000	2014.05.15	2018.10.15	GNIP
CUXHAVEN	53.8713	8.7058	5.0000	1990.01.15	2012.12.15	GNIP
DALBAHCE	39.6667	43.8583	1740.0000	1990.04.15	1991.11.15	GNIP
DAMASCUS	33.4200	36.5200	609.0000	1989.12.15	1993.04.15	GNIP
DARFO-BOARIO	45.8833	10.1833	208.0000	1999.01.31	1999.01.31	WaterIsotopes.org
Datanxiang	38.4600	103.1400		2020.07.24	2021.09.05	Measured data
DAX	43.6833	-1.0667	9.0000	1999.01.15	2005.01.15	GNIP
DE BILT	52.1000	5.1800	2.0000	1981.01.15	1991.10.15	GNIP
DE KOOY	52.9300	4.7800	1.0000	1981.01.15	1987.12.15	GNIP
DEVPRAYAG	30.1406	78.5967	465.0000	2004.06.15	2006.10.15	GNIP
DHAKA	23.9528	90.2792	14.0000	2009.03.15	2018.12.15	GNIP
Dilijan	40.7419	44.8636	2104.2000	2014.07.01	2015.04.21	WaterIsotopes.org
DILIMAN QUEZON CITY	14.6400	121.0400	42.0000	2000.01.15	2016.12.15	GNIP
DINAJPUR	25.6200	88.6600	35.0000	2014.02.15	2018.12.15	GNIP
DIYARBAKIR	37.9011	40.2036	686.0000	2008.09.15	2016.12.15	GNIP
DOBRANI	30.9461	78.6881	2050.0000	2004.08.15	2006.09.15	GNIP
DONG HOI	17.4600	106.6200	1.0000	2014.01.15	2018.12.15	GNIP
DRAIX	44.1333	6.3333	851.0000	2004.02.15	2018.12.15	GNIP

DRESDEN	51.0500	13.7300	113.0000	1997.06.15	2001.01.15	GNIP
DUBROVNIK	42.6600	18.0833	52.0000	2000.09.15	2003.12.15	GNIP
DUDINKA	69.4075	86.1806	66.0000	1990.02.15	1990.12.15	GNIP
DUGOPOLJE	43.5833	16.6000	295.0000	2008.03.15	2009.01.15	GNIP
Dunhuang	40.1141	94.6028		2021.05.13	2021.06.15	Measured data
DURRAH	29.3554	34.9603	0.0000	1968.11.15	1969.04.15	GNIP
EDIRNE	41.6781	26.5592	48.0000	2008.07.15	2016.12.15	GNIP
EL-ARISH	31.0800	33.8300	31.0000	2001.01.15	2003.03.15	GNIP
EMMERICH	51.8300	6.2500	43.0000	1990.01.15	2012.11.15	GNIP
ENISEJSK	58.4500	92.1500	78.0000	1990.01.15	1990.12.15	GNIP
ERLANGEN (GEOZENTRUM)	49.5971	11.0055	270.0000	2010.07.15	2018.12.15	GNIP
ERZURUM	39.9106	41.2756	1758.0000	2008.07.15	2016.12.15	GNIP
ESPOO	60.1801	24.8329	30.0000	2000.11.15	2017.12.15	GNIP
Evaristo_SG	1.2953	103.7711		2014.11.11	2015.11.26	WaterIsotopes.org
FANANO 1	44.2000	10.7833	1280.0000	1999.02.28	1999.02.28	WaterIsotopes.org
FANANO 2	44.2000	10.7834	935.0000	1999.02.28	1999.02.28	WaterIsotopes.org
FANANO 3	44.2000	10.7835	660.0000	1999.02.28	1999.02.28	WaterIsotopes.org
FANO	43.8333	13.0167	12.0000	1999.12.31	1999.12.31	WaterIsotopes.org
Fantan	40.3956	44.6681	1779.0000	2014.07.01	2015.02.02	WaterIsotopes.org
FEHMARN	54.5283	11.0603	3.0000	1997.06.15	2013.12.15	GNIP
Fengjie	31.0183	109.4648		2022.01.25	2022.02.08	Measured data
FIRENZE	43.7667	11.2500	50.0000	2001.06.30	2001.06.30	WaterIsotopes.org
FLEAM DYKE	52.1667	0.2500	30.0000	1980.01.15	1983.12.15	GNIP
FONTAINEBLEAU	48.4042	2.6965	79.0000	2016.04.15	2018.09.15	GNIP
Fukui	36.3000	136.1300	10.0000	2013.02.01	2014.01.04	WaterIsotopes.org
Funabashi	35.4300	140.1000	30.0000	2013.02.01	2013.12.27	WaterIsotopes.org
FUNCHAL	32.6333	-16.9000	58.0000	1990.01.15	2017.02.15	GNIP
Furano	43.1300	142.3500	400.0000	2013.01.29	2013.12.31	WaterIsotopes.org
FUZHOU	26.0833	119.2833	16.0000	1985.10.15	1992.12.15	GNIP

Fuzhou	26.0277	119.2103		2021.12.17	2022.04.20	Measured data
GALLO	41.3000	13.9833	825.0000	1998.09.30	1998.09.30	WaterIsotopes.org
GANGOTRI	30.9967	78.9403	3053.0000	2004.06.15	2006.09.15	GNIP
Ganzi	31.9800	100.0000		2022.01.27	2022.05.01	Measured data
Gaotai	39.3783	99.8192		2020.11.21	2022.02.18	Measured data
GARDANNE	43.4500	5.4500	215.0000	1997.04.15	1998.12.15	GNIP
GARMISCH-PARTENKIRCHEN	47.4828	11.0622	719.0000	1990.01.15	2013.12.15	GNIP
GENOA	44.4200	8.8500	2.0000	1990.01.15	2002.01.15	GNIP
GENOVA-SESTRI	44.4167	8.9500	2.0000	1997.12.31	1997.12.31	WaterIsotopes.org
GILZE-RIJEN	51.5700	4.9300	11.0000	1981.01.15	1988.03.15	GNIP
GIRONA	41.9117	2.7633	129.0000	2000.03.15	2015.12.15	GNIP
GOERLITZ	51.1622	14.9506	238.0000	1997.06.15	2013.12.15	GNIP
Gokase	32.4100	131.1100	550.0000	2013.02.01	2013.12.20	WaterIsotopes.org
GOMUKH	30.9261	78.9403	3800.0000	2004.05.15	2006.09.15	GNIP
GOR'KIJ	56.2167	43.8167	82.0000	1981.01.15	1983.12.15	GNIP
GOSPIC	44.5333	15.3833	564.0000	2008.02.15	2008.12.15	GNIP
GRANIGA	46.0700	8.1100	1100.0000	2000.12.31	2000.12.31	WaterIsotopes.org
GRAZ	47.0778	15.4489	366.0000	1990.01.15	2002.12.15	GNIP
GREIFSWALD	54.0967	13.4056	2.0000	2002.07.15	2013.12.15	GNIP
GRIMSEL	46.5725	8.3327	1950.0000	1971.01.15	2019.12.15	GNIP
GRONINGEN	53.2300	6.5500	1.0000	1990.01.15	2012.12.15	GNIP
Guangyuan	32.4337	105.8300		2021.12.10	2022.05.09	Measured data
GUANGZHOU	23.1300	113.3200	7.0000	2007.01.11	2009.11.14	WaterIsotopes.org
Guangzhou	23.1600	113.2300		2021.12.19	2022.02.22	Measured data
GUILIN	25.0700	110.0800	170.0000	1983.01.15	1990.12.15	GNIP
GUIYANG	26.5833	106.7167	1071.0000	1988.02.15	1992.12.15	GNIP
Guizhou	26.8000	106.7800		2022.01.04	2022.05.11	Measured data
GUTTANNEN	46.6577	8.2927	1055.0000	2002.01.15	2019.12.15	GNIP
GUWAHATI	26.1908	91.7953	54.0000	2003.07.15	2004.10.15	GNIP
Guyuan	36.0100	106.2800		2020.11.20	2022.02.16	Measured data

H-4 RWASHED	32.5025	38.1945	686.0000	1968.11.15	1969.04.15	GNIP
H-5 SAFAWI	32.1991	37.1026	715.0000	1968.12.15	1969.04.15	GNIP
HABAROVSK	48.5200	135.1700	72.0000	1971.01.15	1971.12.15	GNIP
HAERBIN	45.6800	126.6200	172.0000	1986.06.15	1997.08.15	GNIP
Hagi	34.2400	131.2300	5.0000	2013.02.01	2014.01.04	WaterIsotopes.org
HAIKOU	20.0333	110.3500	15.0000	1988.03.15	2000.07.15	GNIP
HAMBANTOTA	6.1167	81.1333	20.0000	1983.01.15	1986.06.15	GNIP
HANOI	21.0453	105.7987	11.0000	2004.09.15	2007.12.15	GNIP
HANOI (IGS)	21.0300	105.8400	15.0000	2015.01.15	2018.12.15	GNIP
Hebei Township	34.7000	100.7857		2021.07.23	2021.09.19	Measured data
Heidelberg	49.8000	8.7000	110.0000	1981.01.31	1988.06.30	WaterIsotopes.org
Hemuqiao watershed	34.3100	119.3400		2017.10.01	2020.05.31	References
HETIAN	37.1333	79.9333	1375.0000	1988.02.15	1992.12.15	GNIP
Hezuo	35.0000	102.9100		2021.03.26	2021.11.11	Measured data
Higashihiroshima	34.2300	132.4200	220.0000	2013.02.01	2013.08.01	WaterIsotopes.org
Hikone	35.1500	136.1200	90.0000	2013.02.01	2014.01.01	WaterIsotopes.org
Ho Chi Minh City	10.0430	106.6880		2013.05.15	2015.12.21	WaterIsotopes.org
HOF-HOHENSAAS	50.3119	11.8758	565.0000	1990.01.15	2013.12.15	GNIP
Hofu	34.2000	131.3400	5.0000	2013.02.01	2013.12.30	WaterIsotopes.org
HOHENPEISSENBERG	47.8008	11.0108	977.0000	1990.01.15	2008.10.15	GNIP
HOMS	34.7500	36.7167	490.0000	1989.12.15	1993.05.15	GNIP
HONG KONG	22.3167	114.1667	66.0000	1990.01.15	2018.12.15	GNIP
Hongqigu	38.2100	102.5000		2019.07.09	2021.09.06	Measured data
HONGSEONG	36.5553	126.6359	62.0000	2018.03.15	2020.08.15	GNIP
Hongya County	29.9066	103.3730		2020.07.22	2022.05.09	Measured data
Huangshuigou	37.6900	101.9100		2021.11.27	2021.11.27	Measured data
Huanjiang County	24.4300	108.1800		2011.06.01	2020.11.01	References
Hulinzhan	37.4100	101.5300		2019.08.19	2021.11.27	Measured data

HYDERABAD	17.4500	78.4700	545.0000	1997.09.15	2001.04.15	GNIP
Hynek_04-AB	40.7544	75.1867	3508.0000	2004.07.15	2004.07.17	WaterIsotopes.org
Hynek_04-CTS	41.7742	78.3999	4457.0000	2004.07.29	2004.07.31	WaterIsotopes.org
Hynek_04-IK	42.6595	77.2028	1620.3333	2004.04.30	2004.08.17	WaterIsotopes.org
Hynek_04-WA	35.8232	74.6504	1426.4640	2004.07.01	2004.07.01	WaterIsotopes.org
Hynek_05-AB	40.7441	75.2155	3760.0000	2005.09.06	2005.09.06	WaterIsotopes.org
Hynek_05-WA	36.8500	75.4281	4719.5232	2004.07.01	2004.07.01	WaterIsotopes.org
Hynek_06-WA	41.4587	76.4511	2253.0816	2004.07.01	2004.07.01	WaterIsotopes.org
Hynek_07-WA	41.4587	76.4511	2253.0816	2004.07.01	2004.07.01	WaterIsotopes.org
Hynek_08-WA	41.7568	75.1089	2567.0256	2004.07.01	2004.07.01	WaterIsotopes.org
Hynek_09-WA	41.7643	75.2801	3054.4008	2004.07.01	2004.07.01	WaterIsotopes.org
Hynek_10-WA	40.8231	75.2893	3031.0000	2004.07.01	2004.07.01	WaterIsotopes.org
Hynek_Bos-Prec	42.6587	77.2031	1644.2500	2004.03.11	2004.05.30	WaterIsotopes.org
Hynek_IK	42.6606	77.2026	1635.0000	2003.07.05	2003.11.25	WaterIsotopes.org
Hynek_IL	42.6452	74.2751	1581.0000	2008.09.03	2008.09.03	WaterIsotopes.org
Hynek_KB	42.9391	78.3258	2258.0000	2003.06.28	2003.06.28	WaterIsotopes.org
Hynek_KYR07	40.8194	75.2281	3010.0000	2007.09.05	2007.09.05	WaterIsotopes.org
Hynek_TAJ07	37.6453	74.3535	4100.0000	2007.09.05	2007.09.08	WaterIsotopes.org
Ichinomiya	35.2200	140.2200	5.0000	2013.02.02	2013.10.01	WaterIsotopes.org
IDLEB	35.9392	36.6067	451.0000	1992.12.15	1993.05.15	GNIP
IKW	35.2231	138.2231	755.0000	2011.05.15	2015.06.15	WaterIsotopes.org
Imizu	36.4200	137.5000	20.0000	2013.01.31	2013.12.31	WaterIsotopes.org
IMPERIA	43.8833	8.0500	10.0000	2001.03.31	2001.03.31	WaterIsotope

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INCHNADAMPH	58.1500	-4.9750	73.0000	2003.12.15	2005.10.15	GNIP
IRKUTSK	52.2700	104.3500	485.0000	1990.01.15	1990.11.15	GNIP
Irkutsk	52.3000	104.2833	469.0000	2011.06.24	2017.04.04	WaterIsotopes.org
Isesaki	36.1500	139.1200	50.0000	2013.02.01	2013.12.27	WaterIsotopes.org
ISFJORD RADIO	78.0700	13.6300	6.0000	1961.07.15	1975.05.15	GNIP
ISO_NS_Birgit	47.7347	12.8843	470.0000	2012.06.18	2012.11.14	WaterIsotopes.org
ISO_NS_GC	47.7885	12.9803	442.0000	2012.05.24	2013.02.01	WaterIsotopes.org
ISO_NS_Rothmannbach	47.7035	13.0363	465.0000	2012.06.23	2012.12.05	WaterIsotopes.org
ISO_NS_Salzburger Hochthron	47.7165	13.0053	1829.0000	2012.05.25	2012.10.10	WaterIsotopes.org
ISO_NS_Veitlbruch	47.7332	12.9738	639.0000	2012.05.24	2012.12.04	WaterIsotopes.org
ISO_NS_Zeppezauer Haus	47.7245	13.0059	1649.0000	2012.05.25	2012.10.10	WaterIsotopes.org
IZMIR	38.4306	27.1511	120.0000	2008.09.15	2016.12.15	GNIP
IZRAA	32.8389	36.2569	580.0000	1989.12.15	1993.04.15	GNIP
Izumi	32.5000	130.2100	15.0000	2013.02.01	2013.12.21	WaterIsotopes.org
JAFFNA	9.6678	80.0065	6.0000	2014.01.15	2018.12.15	GNIP
JAKARTA	-6.1800	106.8300	8.0000	1980.05.15	1997.12.15	GNIP
JAMMU	32.6925	74.8461	367.0000	2003.07.15	2006.09.15	GNIP
JARABLOUS	36.8222	38.0125	351.0000	1991.12.15	1993.05.15	GNIP
JAYAPURA	-2.5300	140.7200	3.0000	1980.01.15	1991.06.15	GNIP
Jingtai	37.1836	104.0630		2020.08.04	2021.08.05	Measured data
Jinta County	39.9843	98.9032		2021.05.14	2022.02.17	Measured data
Jiudun	38.0700	102.4500		2019.07.13	2021.10.08	Measured data
Jiuzhaigou	33.2632	104.2367		2020.07.23	2021.10.18	Measured data
JOHOR BAHRU	1.6000	103.6667	35.0000	2002.03.15	2016.12.15	GNIP
KABUL	34.5700	69.2133	1860.0000	1970.01.15	1989.09.15	GNIP
Kagoshima	31.3700	130.3100	15.0000	2013.03.31	2013.07.31	WaterIsotopes.org
Kakamigahara	35.2400	136.5200	40.0000	2013.02.01	2014.01.01	WaterIsotopes.org

KAKINADA	17.0211	82.2567	8.0000	2003.07.15	2006.09.15	GNIP
KALININ	56.9000	35.9000	31.0000	1981.01.15	1987.07.15	GNIP
KANDALAKSA	67.1500	32.3500	26.0000	1996.01.15	2000.12.15	GNIP
Kapan	39.2047	46.4461	704.0000	2014.07.07	2015.05.06	WaterIsotopes.org
KARACHI	24.9000	67.1300	23.0000	1961.07.15	1973.12.15	GNIP
KARLSRUHE	49.0392	8.3650	112.0000	1990.01.15	2013.12.15	GNIP
Kashgar	39.4704	75.9898		2020.08.29	2021.06.16	Measured data
KBU	47.2800	108.7800	1255.0000	2002.10.01	2003.09.01	WaterIsotopes.org
KEYWORTH	52.8833	-1.0833	60.0000	1985.01.15	1996.12.15	GNIP
KHANTY-MANSIYSK	60.9667	69.0667	40.0000	1996.01.15	1997.03.15	GNIP
KHARKIV	49.9333	36.2833	148.0000	2013.11.15	2016.12.15	GNIP
Kinko	31.1400	130.4700	20.0000	2013.02.01	2014.01.01	WaterIsotopes.org
KIROV	58.6500	49.6167	164.0000	1981.01.15	2000.12.15	GNIP
Kiryu	36.2400	139.1900	140.0000	2013.02.01	2014.01.01	WaterIsotopes.org
KKC	36.2533	137.6686	1529.0000	2010.07.15	2015.06.15	WaterIsotopes.org
KLAGENFURT FLUGHAFEN	46.6483	14.3183	450.0000	1990.01.15	2002.12.15	GNIP
KO SAMUI	9.4667	100.0500	7.0000	1980.01.15	1983.11.15	GNIP
KO SICHANG	13.1700	100.8000	26.0000	1984.06.15	1991.10.15	GNIP
Kobayashi	31.5900	130.5800	209.0000	2013.02.01	2013.12.22	WaterIsotopes.org
Kobayashi2	31.5900	130.5800	668.0000	2013.02.01	2013.12.22	WaterIsotopes.org
KOBLENZ	50.3381	7.6000	85.0000	1990.01.15	2013.12.15	GNIP
Kochi	33.3200	133.2900	30.0000	2013.02.01	2014.01.06	WaterIsotopes.org
KOF	35.6828	138.5664	304.0000	2010.07.15	2015.06.15	WaterIsotopes.org
KOLKATA	22.7978	88.3717	6.0000	2004.07.15	2006.10.15	GNIP
KOMIZA-VIS ISLAND	43.0392	16.0906	6.0000	2000.09.15	2003.12.15	GNIP
KONSTANZ	47.6772	9.1900	443.0000	1990.01.15	2013.12.15	GNIP
KOTA BAHRU	6.1667	102.2833	7.0000	1991.01.15	2016.12.15	GNIP
KOTA KINABALU	5.9300	116.0600	9.0000	2013.04.15	2016.12.15	GNIP
KOZHIKODE	11.2500	75.7800	20.0000	1997.05.15	2007.11.15	GNIP
KOZINA	45.6000	13.9333	497.0000	2000.10.15	2003.12.15	GNIP

K-puszta	46.9600	19.5500		2013.04.02	2017.12.15	References
KRAKOW	50.0617	19.8486	205.0000	1990.01.15	2016.12.15	GNIP
KRENKEL POLAR GMO	80.6167	58.0500	20.0000	1990.02.15	1990.12.15	GNIP
KUALA LUMPUR	2.8833	101.7833	26.0000	2000.01.15	2016.12.15	GNIP
KUALA TERENGGANU	5.3833	103.1000	10.0000	2001.05.15	2016.12.15	GNIP
Kuala Terengganu	5.4120	103.0850		2014.12.04	2016.09.12	WaterIsotopes.org
KUANTAN	3.7833	103.3333	1.0000	2013.04.15	2016.12.15	GNIP
KUCHING	1.5300	110.3400	15.0000	2013.05.15	2016.12.15	GNIP
Kuching	1.4590	119.4130		2014.07.30	2016.02.29	WaterIsotopes.org
Kuju	33.1000	131.1700	550.0000	2013.02.01	2014.01.01	WaterIsotopes.org
KUMAMOTO	32.8133	130.7292	26.0000	2015.04.15	2015.12.15	GNIP
Kumamoto	32.4800	130.4300	30.0000	2013.01.31	2013.12.28	WaterIsotopes.org
KUNGUR	57.4368	56.9593	120.0000	2016.12.15	2018.06.15	GNIP
KUNMING	25.0167	102.6833	1892.0000	1988.02.15	2003.12.15	GNIP
KUOPIO	62.8918	27.6254	116.0000	2005.01.15	2017.12.15	GNIP
KURSK	51.7700	36.1700	247.0000	1996.01.15	2000.12.31	WaterIsotopes.org
Kushimoto	33.2600	135.4500	50.0000	2013.01.31	2014.01.03	WaterIsotopes.org
Kyoto	35.4000	135.4500	140.0000	2013.02.01	2014.01.06	WaterIsotopes.org
Kyuji County	33.4299	101.4830		2021.03.26	2021.10.20	Measured data
LA BREVINE	46.9814	6.6080	1042.0000	1994.01.15	2019.12.15	GNIP
Lake Massaciuccioli	43.8376	10.3524		2007.03.01	2014.03.01	References
lake Shortandy	52.9889	70.2185	390.0000	2015.12.22	2016.11.02	WaterIsotopes.org
LANZHOU	36.0500	103.8800	1517.0000	1985.07.15	1999.07.01	GNIP
L'AQUILA	42.3667	13.3667	710.0000	2001.04.30	2001.04.30	WaterIsotopes.org
LEIPZIG	51.3500	12.4300	125.0000	1990.01.15	2013.12.15	GNIP
LEON VIRGEN DEL CAMINO	42.5883	-5.6511	916.0000	2000.02.15	2015.12.15	GNIP
LEOVA	46.4972	28.3000	156.0000	2007.09.15	2015.08.15	GNIP
Leshan	29.5820	103.7610		2021.12.10	2022.05.26	Measured data
LHASA	29.7000	91.1333	3649.0000	1987.01.15	1992.12.15	GNIP

LICKO LESCE	44.7833	15.3167	463.0000	2008.02.15	2008.12.15	GNIP
LIEGE	50.7000	5.4700	190.0000	1966.01.15	1970.11.15	GNIP
LIESEK	49.3600	19.6800	692.0000	1991.08.15	1992.02.15	GNIP
Lijiaxia	39.9042	116.4000		2020.06.21	2020.09.08	Measured data
LIPTOVSKY MIKULAS-ONDRASOVA	49.0975	19.5900	570.0000	1992.01.15	2016.12.15	GNIP
LISBON-ITN	38.7927	-9.1057	12.0000	2003.01.15	2017.05.15	GNIP
LISTA	58.1000	6.5700	13.0000	1961.02.15	1977.08.15	GNIP
Liujiaxia	33.1900	106.5700		2020.06.21	2021.10.19	Measured data
LIUZHOU	24.3500	109.4000	97.0000	1988.01.15	1992.08.15	GNIP
Lixian	34.2200	105.1500		2020.12.13	2021.11.29	Measured data
LJUBLJANA	46.0950	14.5970	282.0000	1990.01.15	2010.12.15	GNIP
LOCARNO	46.1738	8.7886	379.0000	1990.10.15	2019.12.15	GNIP
Loch a Chem Alltain	58.6569	-4.9362	90.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Loch Bad an Losguinn	57.0882	-5.0415	240.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Loch Bealach Cornaidh	58.2061	-5.0515	428.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Loch Clair	57.5623	-5.3469	93.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Loch Coire Fionnaraich	57.4917	-5.4306	238.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Loch Doilean	56.7501	-5.5868	10.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Loch Dubh Cadhafuaraich	58.1339	-4.2400	400.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Loch Dubh Camas an Lochain	57.9132	-5.5957	24.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Loch Laidon	56.6515	-4.6440	282.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Loch na Achlaise	56.5934	-4.7540	294.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Loch na Creige Duibhe	58.0503	-5.3823	100.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Loch Nan Eion	57.4997	-5.4647	352.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Loch nan Eun	58.2214	-5.0119	164.0000	2015.03.31	2015.03.31	WaterIsotopes.org

Loch Tinker	56.2283	-4.5099	420.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Loch Toll an Lochain	57.7969	-5.2424	517.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Lochan an Dubha	58.0000	-5.1375	84.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Lochan Dubh	56.7828	-5.4475	232.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Lochan Feoir	58.1800	-5.0135	117.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Lochan Fhionnlaidh	58.0448	-5.0665	230.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Lochan Lairig Cheile	56.4203	-4.3393	290.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Lochnagar	56.9584	-3.2333	785.0000	2015.03.31	2015.03.31	WaterIsotopes.org
Longyangxia	35.9870	100.7096		2021.03.08	2021.10.26	Measured data
LUANG-PRABANG	19.8800	102.1300	305.0000	1961.03.15	1964.11.15	GNIP
LUCERA	41.5000	15.3333	219.0000	1998.11.30	1998.11.30	WaterIsotopes.org
L'VOV	49.8167	23.9500	329.0000	1981.01.15	1983.12.15	GNIP
Mado	34.9200	98.2091		2021.03.31	2021.11.01	Measured data
MADRID-RETIRO	40.4120	-3.6781	667.0000	1990.01.15	2015.12.15	GNIP
MALAUSSENE	43.9200	7.1300	359.0000	1997.06.15	1998.09.15	GNIP
MALINSKA-KRK ISLAND	45.1208	14.5261	1.0000	2000.12.15	2001.11.15	GNIP
Mamurogawa	38.5600	140.1500	180.0000	2013.01.30	2014.01.08	WaterIsotopes.org
Manshuitan	37.4900	104.0100		2020.08.04	2020.09.21	Measured data
MANTOVA	45.1500	10.8000	19.0000	2001.01.31	2001.01.31	WaterIsotopes.org
Maqin	34.4775	100.2390		2021.03.03	2021.10.28	Measured data
Maqu	33.9987	102.0727		2021.04.06	2021.09.04	Measured data
MARINA DI RAGUSA	36.8330	14.5500	5.0000	2001.01.31	2001.01.31	WaterIsotopes.org
Matsue	35.2900	133.5000	10.0000	2013.02.01	2014.01.02	WaterIsotopes.org

MDG	45.7500	106.2700	1393.0000	2002.10.01	2003.08.01	WaterIsotopes.org
Meguro	35.3900	139.4000	40.0000	2013.02.01	2014.01.01	WaterIsotopes.org
Meikuang	37.3300	101.5100		2019.05.04	2021.11.27	Measured data
MEIRINGEN	46.7274	8.1868	632.0000	1990.01.15	2019.12.15	GNIP
MILANO	45.4667	9.2000	122.0000	2001.02.28	2001.02.28	WaterIsotopes.org
MILHOSTOV	48.6583	21.7300	104.0000	1991.08.15	1991.12.15	GNIP
Minamiizu	34.3800	138.5100	30.0000	2013.02.04	2014.01.06	WaterIsotopes.org
MINSK	53.9300	27.6300	225.0000	1981.01.15	1983.12.15	GNIP
Miyake	34.4000	139.2900	50.0000	2013.01.31	2013.05.28	WaterIsotopes.org
Miyakonojo	31.4400	131.3000	149.0000	2013.01.31	2013.12.31	WaterIsotopes.org
Miyazaki	31.5400	131.2400	10.0000	2013.02.02	2014.01.06	WaterIsotopes.org
MNG	48.2000	108.5000	1439.0000	2002.10.01	2003.09.01	WaterIsotopes.org
MOCHOVCE	48.2846	18.4757	206.0000	1991.08.15	1992.02.15	GNIP
MODENA	44.6667	10.9167	34.0000	2001.09.30	2001.09.30	WaterIsotopes.org
Molinos	40.7900	-0.4500		2010.03.02	2012.08.29	WaterIsotopes.org
MONACO	43.7324	7.4236	2.0000	1999.07.15	2016.12.15	GNIP
Monatssammelprobe Station Baden Stadtgartenamt	48.0113	16.2348		1985.07.01	1986.02.01	WaterIsotopes.org
MONTE CONERO	43.5498	13.6012	530.0000	2014.01.15	2018.12.15	GNIP
MONTPELLIER	43.5700	3.9500	45.0000	1997.04.15	1998.12.15	GNIP
Morioka	39.4600	141.7000	193.0000	2013.01.31	2014.01.06	WaterIsotopes.org
MORON DE LA FRONTERA	37.1645	-5.6114	87.0000	2000.03.15	2015.12.15	GNIP
MOSCOW	55.7500	37.5700	157.0000	1970.01.15	1979.11.15	GNIP
MTM	36.2511	137.9778	620.0000	2010.07.15	2015.06.15	WaterIsotopes.org
Mulu	4.0500	114.8100		2013.01.01	2017.05.08	WaterIsotopes.org
Mulu Airport	4.0500	114.8100	24.0000	2006.07.03	2012.12.04	WaterIsotopes.org

MURCIA	38.0019	-1.1708	61.0000	2000.03.15	2015.12.15	GNIP
MURMANSK	68.9667	33.0500	46.0000	1981.01.15	1990.03.15	GNIP
Mutouqiao	37.4800	101.5900		2021.11.27	2021.11.27	Measured data
Nagasaki	32.4700	129.5100	20.0000	2013.01.31	2014.01.06	WaterIsotopes.org
Nagoya	35.1500	136.9700		2013.06.12	2017.05.27	WaterIsotopes.org
NAIMAKKA	68.6833	21.5300	403.0000	1990.01.15	1995.12.15	GNIP
NANJING	32.1800	118.1800	26.0000	1988.01.15	1992.12.15	GNIP
Nanyang Technological University	1.3460	103.6790		2013.11.28	2016.10.03	WaterIsotopes.org
Nara	34.4000	135.5000	115.0000	2013.02.01	2014.01.06	WaterIsotopes.org
NBY	35.9452	138.4697	1350.0000	2010.07.15	2015.06.15	WaterIsotopes.org
NEUBRANDENBURG	53.5483	13.1931	81.0000	1997.06.15	2002.06.15	GNIP
NEUHERBERG	48.2200	11.5900	489.0000	1988.01.15	2001.12.15	GNIP
NEW DELHI	28.5800	77.2000	212.0000	1980.01.15	2007.09.15	GNIP
NGN	36.6317	138.1891	354.0000	2010.07.15	2015.06.15	WaterIsotopes.org
Niederschlagsstation Vordernbachalm	47.6604	13.9262	1113.0000	1991.11.28	1992.06.16	WaterIsotopes.org
NIGRO	40.9667	15.6833	385.0000	2002.04.15	2004.03.15	GNIP
Ningqian	37.3700	101.4900		2021.11.27	2021.11.27	Measured data
NIROB	56.7193	60.7333	150.0000	2016.12.15	2018.06.15	GNIP
NOGUERA DE ALBARRACIN	40.4580	-1.5987	1449.0000	2013.01.15	2015.12.15	GNIP
Nonoichi	36.3000	136.3600	40.0000	2013.02.01	2013.12.29	WaterIsotopes.org
NORDERNEY	53.7122	7.1519	11.0000	1997.06.15	2009.12.15	GNIP
NOVOSIBIRSK	55.0300	82.9000	162.0000	1990.01.15	1990.12.15	GNIP
NRK	36.1226	137.6298	1446.0000	2010.07.15	2015.06.15	WaterIsotopes.org
NSK	35.8264	137.8624	1247.0000	2010.07.15	2013.08.15	WaterIsotopes.org
NY ALESUND	78.9167	11.9333	7.0000	1990.01.15	2016.12.15	GNIP
NYON	46.3986	6.2338	436.0000	1992.07.15	2019.12.15	GNIP
ODENSE	55.4700	10.3300	17.0000	1963.03.15	1984.11.15	GNIP
ODESSA	46.4800	30.6300	64.0000	1981.02.15	1983.12.15	GNIP

Okayama	34.4100	133.5500	7.0000	2013.02.02	2014.01.06	WaterIsotopes.org
OLENEK	68.5000	112.4333	220.0000	1996.05.15	2000.08.15	GNIP
OMC	36.5053	137.8703	776.0000	2010.07.15	2015.06.15	WaterIsotopes.org
OMSK	55.0100	73.3800	94.0000	1990.01.15	1990.11.15	GNIP
ORLEANS-LA-SOURCE	47.8332	1.9404	109.0000	1996.03.15	2014.12.15	GNIP
PAGANELLA	46.2000	11.0000	2125.0000	1999.09.30	1999.09.30	WaterIsotopes.org
PALLANZA	45.9167	8.5500	208.0000	2000.12.31	2000.12.31	WaterIsotopes.org
PALMA DE MALLORCA	39.5534	2.6253	3.0000	2000.02.15	2015.11.15	GNIP
PALMYRA	34.5500	38.3000	400.0000	1989.12.15	1993.04.15	GNIP
Panzhihua	26.8900	105.0000		2021.12.26	2022.05.09	Measured data
PARMA	44.8000	10.3333	55.0000	2002.02.28	2002.02.28	WaterIsotopes.org
PASSO PRESOLANA	45.5500	10.6000	1290.0000	1999.01.31	1999.01.31	WaterIsotopes.org
PATNA	25.5736	85.0703	60.0000	2003.08.15	2005.10.15	GNIP
PATRAS	38.2800	21.7900	100.0000	2000.10.15	2019.12.15	GNIP
PECHORA	65.1167	57.1000	56.0000	1981.01.15	1983.12.15	GNIP
PERM	58.0100	56.1800	161.0000	1981.01.15	1990.07.15	GNIP
PETROPAVLOVSK KAMCAT	52.9700	158.7500	24.0000	1996.01.31	2000.12.31	WaterIsotopes.org
PETROPAVLOVSK-KAMCHATSKIY	52.9800	158.6500	24.0000	1996.06.15	1999.12.15	GNIP
PETZENKIRCHEN	48.1500	15.1500	252.0000	1966.03.15	1971.08.15	GNIP
PIACENZA	45.0167	9.6667	61.0000	2001.02.28	2001.02.28	WaterIsotopes.org
PIAN DELL ELMO	43.3431	13.0611	950.0000	2000.10.15	2002.05.15	GNIP
Pianosa	42.5859	10.0795		2014.11.01	2018.12.01	References
PINGLIANG	35.5333	106.7000	1570.0000	2003.05.15	2004.04.15	GNIP
Pingliang	35.5428	106.6847		2021.01.24	2022.02.06	Measured data
PIOMBINO	42.9167	10.5333	21.0000	2000.01.31	2000.01.31	WaterIsotopes.org
Piombino	42.9328	10.5111		1997.10.01	2000.01.01	References
PISA	43.7167	10.3833	5.0000	1999.12.31	1999.12.31	WaterIsotopes.org

Pisa	43.7177	10.4222		1992.11.01	2004.12.01	References
PISA (CENTRAL)	43.7100	10.4000	12.0000	1992.11.15	2002.02.15	GNIP
PLITVICE	44.8806	15.6189	580.0000	2004.01.15	2005.06.15	GNIP
PODERSDORF	47.8517	16.8431	121.0000	1965.05.15	1968.12.15	GNIP
PONTA DELGADA	37.7700	-25.6500	175.0000	1990.01.15	2016.12.15	GNIP
PONTREMOLI	44.3667	9.8833	236.0000	2002.04.30	2002.04.30	WaterIsotopes.org
Pontremoli	44.3753	9.8763		2000.05.01	2002.03.01	References
PONTRESINA	46.4914	9.8982	1724.0000	1994.07.15	2019.12.15	GNIP
Port Blair	11.6600	92.7300		2012.05.02	2016.12.11	WaterIsotopes.org
PORTO	41.1333	-8.6000	93.0000	1990.01.15	2017.06.15	GNIP
PORTOROZ	45.4667	13.6167	2.0000	2000.10.15	2006.12.15	GNIP
POTENZA-TITO SCALO	40.6333	15.8000	632.0000	1999.08.31	1999.08.31	WaterIsotopes.org
PRAGUE	50.1162	14.3929	184.0000	2012.10.15	2018.12.15	GNIP
PRODROMOS	34.9500	32.8300	1378.0000	1964.03.15	1966.12.15	GNIP
PUERTO DE NAVACERRADA	40.7931	-4.0106	1894.0000	2013.01.15	2015.12.15	GNIP
PUSCHINO	54.1800	158.0200	303.0000	1998.04.15	2000.03.15	GNIP
Qinghai-Linye	37.3200	101.5200		2021.11.27	2021.11.27	Measured data
Qintu Lake	39.0300	103.3600		2020.07.03	2021.10.08	Measured data
QIQIHAR	47.3833	123.9167	147.0000	1988.02.15	1992.12.15	GNIP
RAFAH	31.2833	34.2333	73.0000	2001.01.15	2003.03.15	GNIP
RAMATA N1	57.9343	24.9804	49.0000	2016.02.15	2017.08.15	GNIP
RAMNICU VALCEA	45.0353	24.2842	237.0000	2012.01.15	2016.11.15	GNIP
RAQQA	35.8972	39.3417	246.0000	1991.12.15	1992.05.15	GNIP
REGENSBURG	49.0422	12.1019	365.0000	1990.01.15	2013.12.15	GNIP
REYKJAVIK	64.1300	-21.9300	14.0000	1992.07.15	2018.12.15	GNIP
RIARDO	41.2667	14.1500	110.0000	1998.12.31	1998.12.31	WaterIsotopes.org
RIFUGIO GRAFFER	46.2000	10.6000	2263.0000	1999.09.30	1999.09.30	WaterIsotopes.org
RIGA	56.9360	24.0955	2.9300	2016.04.15	2018.12.15	GNIP
RISHIKESH	30.1122	78.3025	356.0000	2005.07.15	2006.09.15	GNIP
RIVO	46.5189	13.0122	615.0000	1998.03.31	1998.03.31	WaterIsotopes.org
Riyadh, Compound	24.7956	46.7588	612.0000	2009.04.03	2012.12.18	WaterIsotopes.org

Riyadh, no coords	24.7200	46.7200	612.0000	1975.01.18	1979.01.22	WaterIsotopes.org
Riyadh, Office	24.6795	46.7318	612.0000	2009.03.28	2013.03.23	WaterIsotopes.org
RIZE	41.0244	40.5200	136.0000	2008.07.15	2016.12.15	GNIP
RJAZAN	54.6167	39.7167	135.0000	1981.01.15	1983.12.15	GNIP
ROCCAMONFINA	41.2833	13.9833	620.0000	2000.10.31	2000.10.31	WaterIsotopes.org
Rokkasyo	40.5700	141.2100	30.0000	2013.02.01	2013.12.27	WaterIsotopes.org
ROORKEE	29.8678	77.8939	274.0000	2003.07.15	2006.10.15	GNIP
ROSIA MONTANA	46.3000	23.1300	0.0000	2015.01.15	2016.12.15	GNIP
ROSTOV-NA-DONU	47.2500	39.8200	77.0000	1981.01.15	1990.12.15	GNIP
ROVANIEMI	66.4969	25.7552	107.0000	2003.11.15	2017.12.15	GNIP
RYORI	39.0300	141.8100	260.0000	1980.01.15	2006.09.15	GNIP
S. GEMINI	42.6167	12.5500	350.0000	2001.02.28	2001.02.28	WaterIsotopes.org
S. PELLEGRINO IN ALPE	44.7333	9.9167	1520.0000	1999.12.31	1999.12.31	WaterIsotopes.org
S.Anna di Stazzema	43.9746	10.2727		2014.01.01	2018.12.01	References
Saalfelden, HZB-Nr. 103929	47.4349	12.8509	795.0000	2007.01.15	2013.12.15	WaterIsotopes.org
SABAUDIA	41.3000	13.0167	17.0000	2001.03.31	2001.03.31	WaterIsotopes.org
Saga	33.1500	130.1900	5.0000	2013.02.01	2013.12.21	WaterIsotopes.org
SAGAR	23.8261	78.7625	551.0000	2003.07.15	2005.07.15	GNIP
SAINT CATHRENE	28.6800	34.1000	1350.0000	2001.03.15	2001.04.15	GNIP
Sakai	34.3200	135.2700	10.0000	2013.02.01	2014.01.01	WaterIsotopes.org
SALEHARD	66.5300	66.5300	16.0000	1996.10.31	2000.12.31	WaterIsotopes.org
SALEKHARD	66.5333	66.6667	16.0000	1996.01.15	2000.12.15	GNIP
SALLENT DE GALLEGO - LA SARRA	42.7897	-0.3290	1460.0000	2013.01.15	2015.12.15	GNIP
SALUGGIA	45.2333	8.0333	194.0000	2000.10.15	2001.10.15	GNIP
SAN PELLEGRINO IN ALPE	44.1890	10.4763	1520.0000	1993.03.15	2002.02.15	GNIP

San Pellegrino in Alpe	44.1893	10.4805		1993.03.01	2002.02.01	References
Sanchalukou	37.4300	101.5500		2021.11.27	2021.11.27	Measured data
SANTA CRUZ DE TENERIFE	28.4634	-16.2553	35.0000	2000.02.15	2015.12.15	GNIP
SANTA MARIA DI LEUCA	39.7964	18.3686	30.0000	1999.10.31	1999.10.31	WaterIsotopes.org
SANTANDER	43.4911	-3.8006	52.0000	2000.02.15	2015.12.15	GNIP
SARATOV	51.5667	46.0333	166.0000	1981.01.15	1984.09.15	GNIP
SARNICO	45.6667	9.9500	197.0000	1999.01.31	1999.01.31	WaterIsotopes.org
SASSARI	40.7272	8.5603	225.0000	2000.01.31	2000.01.31	WaterIsotopes.org
SATKHIRA	22.7167	89.0833	10.0000	2015.04.15	2018.09.15	GNIP
SCERNI	42.6333	14.0333	287.0000	2001.09.30	2001.09.30	WaterIsotopes.org
SCHLESWIG	54.5275	9.5486	43.0000	1997.06.15	2013.12.15	GNIP
Schneealpe, Lurgbauer	47.7111	15.6369		2005.06.04	2005.08.11	WaterIsotopes.org
SEEHAUSEN	52.8911	11.7294	21.0000	1997.06.15	2013.12.15	GNIP
Sendai	38.1600	140.5200	50.0000	2013.02.01	2013.12.31	WaterIsotopes.org
Sera	34.3500	133.3000	400.0000	2013.02.10	2013.12.20	WaterIsotopes.org
Seto	35.1200	137.1000	304.0000	2013.02.01	2014.01.06	WaterIsotopes.org
Sevan	40.5658	45.0083	1937.0000	2014.07.05	2015.04.20	WaterIsotopes.org
SGD	36.5213	138.3497	1322.0000	2010.07.15	2015.06.15	WaterIsotopes.org
SGD2	36.5317	138.3250	1249.0000	2010.07.15	2015.06.15	WaterIsotopes.org
Shangchigou	37.6300	101.8500		2021.11.27	2021.11.27	Measured data
SHB	50.2500	106.2100	626.0000	2002.11.01	2003.09.01	WaterIsotopes.org
SHG	36.7108	138.4947	1594.0000	2010.07.15	2015.06.15	WaterIsotopes.org
SHIJIAZHUANG	38.0333	114.4167	80.0000	1990.01.15	2003.11.15	GNIP
SHILLONG	25.5700	91.8800	1598.0000	1969.01.15	1978.10.15	GNIP
Shirahama	33.4100	135.2000	10.0000	2013.02.01	2013.12.12	WaterIsotopes.org

Shizuoka	34.5800	138.2200	30.0000	2013.02.01	2014.01.03	WaterIsotopes.org
SIENA	43.3167	11.3500	322.0000	2002.02.28	2002.02.28	WaterIsotopes.org
Siena	43.3140	11.3314		1998.01.01	2002.02.01	References
Simf	44.9800	34.1500		2009.11.01	2011.12.01	References
SINGAPORE	1.3500	103.9000	32.0000	1972.12.15	1975.12.15	GNIP
SINOP	42.0250	35.1583	32.0000	2008.07.15	2016.12.15	GNIP
SION	46.2203	7.3385	482.0000	1994.07.15	2017.11.15	GNIP
SIRACUSA	37.0667	15.3000	17.0000	2001.01.31	2001.01.31	WaterIsotopes.org
Sisian	39.5083	46.0336	1580.0000	2014.08.22	2015.06.27	WaterIsotopes.org
SON LA	21.3200	103.9100	600.0000	2017.04.15	2018.12.15	GNIP
SP-12	45.0522	33.9753		2012.01.01	2015.12.08	References
ST. GALLEN	47.4269	9.4008	779.0000	2004.01.15	2019.12.15	GNIP
ST. PETERSBURG	59.9667	30.3000	4.0000	1981.01.15	1990.03.15	GNIP
St.2 Ploneralm	46.6969	13.0407	1625.0000	1995.01.01	1995.12.01	WaterIsotopes.org
St.3 Buschgrede	46.6845	13.0341	1260.0000	1995.01.01	1995.12.01	WaterIsotopes.org
St.4 Hanser	46.6736	13.0341	910.0000	1995.01.01	1995.10.01	WaterIsotopes.org
St.6 Dellach/Drau	46.7414	13.0833	627.0000	1995.01.01	1995.09.01	WaterIsotopes.org
STARA LESNA	49.1362	20.3065	721.0000	1991.08.15	1992.02.15	GNIP
STUTTGART	48.8281	9.2000	314.0000	1990.01.15	2013.12.15	GNIP
SUWIEDA	32.7056	36.5700	1020.0000	1989.12.15	1993.04.15	GNIP
Suzhou District	34.4775	100.2390		2021.05.18	2022.04.30	Measured data
SVYATOHIRS'K	49.0400	37.5770	66.0000	2015.04.15	2016.12.15	GNIP
SWA	36.0455	138.1087	760.0000	2010.07.15	2015.06.15	WaterIsotopes.org
SYLHET	24.9100	91.8453	20.0000	2009.05.15	2018.08.15	GNIP
TAASTRUP	55.6700	12.3000	28.0000	1965.11.15	1971.03.15	GNIP
Taipei(Taiwan)	25.1638	121.4750	365.0000	1997.06.30	1998.12.31	WaterIsotopes.org
Taiwan_ALS	23.5100	120.8100	2413.0000	2002.05.01	2006.11.01	WaterIsotopes.org
Taiwan_BL	24.2300	121.3200	2350.0000	2005.06.01	2008.01.01	WaterIsotopes.org
Taiwan_CY	23.4800	120.4600	27.0000	2002.05.01	2005.09.01	WaterIsotopes.org

Taiwan_HC	24.7500	121.0000	34.0000	2003.01.01	2004.12.01	WaterIsotopes.org
Taiwan_HL	23.9700	121.6500	50.0000	2003.07.01	2006.05.01	WaterIsotopes.org
Taiwan_HY	23.3000	120.3200	69.0000	2002.05.01	2003.09.01	WaterIsotopes.org
Taiwan_IL	24.6800	121.8000	24.0000	1993.07.01	1994.09.01	WaterIsotopes.org
Taiwan_KH	22.6300	120.2700	2.0000	2005.12.01	2006.09.01	WaterIsotopes.org
Taiwan_KL	25.1300	121.7100	27.0000	2004.06.01	2006.05.01	WaterIsotopes.org
Taiwan_LS	24.2700	121.1600	1980.0000	2003.06.01	2004.09.01	WaterIsotopes.org
Taiwan_MG	22.6700	120.6900	740.0000	2005.07.01	2006.06.01	WaterIsotopes.org
Taiwan_PL	23.9700	120.9800	732.0000	1999.04.01	2002.01.01	WaterIsotopes.org
Taiwan_PT	22.0300	120.6900	54.0000	2006.01.01	2007.11.01	WaterIsotopes.org
Taiwan_TC	24.1200	120.6800	34.0000	2001.06.01	2007.10.01	WaterIsotopes.org
Taiwan_TD	22.8400	121.0900	250.0000	2004.05.01	2007.11.01	WaterIsotopes.org
Taiwan_TP	24.9800	121.5100	5.0000	2004.03.01	2006.12.01	WaterIsotopes.org
Taiwan_TT	23.9900	120.6900	75.0000	2001.07.01	2006.11.01	WaterIsotopes.org
Taiwan_TY	24.9500	121.0200	105.0000	2004.01.01	2006.11.01	WaterIsotopes.org
Taiwan_WL	24.3500	121.3100	1800.0000	2006.12.01	2008.12.01	WaterIsotopes.org
Taiwan_YL	23.3300	121.3100	130.0000	2005.01.01	2007.08.01	WaterIsotopes.org
Taizhou	30.2674	120.1528		2020.12.14	2022.03.12	Measured data
Takamatsu	34.2000	134.2000	10.0000	2013.02.01	2013.12.12	WaterIsotopes.org
TAMBOV	52.7333	41.4667	139.0000	1982.08.15	1983.12.15	GNIP
TARQUINIA	42.2500	11.7500	133.0000	2001.05.31	2001.05.31	WaterIsotopes.org
TARSOGNO	44.4500	9.6167	768.0000	2001.03.31	2001.03.31	WaterIsotopes.org

TARTU	58.2639	26.4614	70.0000	2013.07.15	2018.12.15	GNIP
TASHKENT	41.2700	69.2700	428.0000	1971.01.15	1971.12.15	GNIP
TAWAU - AIRPORT	4.3170	118.1210	15.0000	2007.07.15	2008.12.15	GNIP
TBILISI	41.7500	44.7667	427.0000	2008.04.15	2018.12.15	GNIP
TEHERAN EAST	35.7400	51.5800	1350.0000	2000.10.15	2004.05.15	GNIP
TEHRI	30.3528	78.4833	640.0000	2004.07.15	2006.10.15	GNIP
TERNEJ	45.0300	136.6700	68.0000	1996.05.31	2000.12.31	WaterIsotopes.org
TERNEY	45.0000	136.6000	68.0000	1996.04.15	2000.11.15	GNIP
THESSALONIKI	40.6700	22.9600	32.0000	2000.10.15	2003.08.15	GNIP
THONON-LES-BAINS	46.3722	6.4708	385.0000	1992.02.15	2018.12.15	GNIP
TIANJIN	39.1000	117.1667	3.0000	1988.04.15	2001.12.15	GNIP
Tianshui	34.5809	105.7249		2020.12.23	2021.06.29	Measured data
TIRUNELVELI	8.7278	77.7183	4.0000	2003.07.15	2004.10.15	GNIP
TKY	36.1425	137.4223	1342.0000	2011.06.15	2013.12.15	WaterIsotopes.org
TODI	42.7833	12.4000	400.0000	2001.10.31	2001.10.31	WaterIsotopes.org
Tokushima	34.4000	134.2900	10.0000	2013.02.01	2013.12.27	WaterIsotopes.org
TOKYO	35.6800	139.7700	4.0000	1973.01.15	1979.12.15	GNIP
Tongling	30.9200	117.8100		2021.02.18	2022.02.17	Measured data
Tongren County	35.5200	102.0180		2021.03.30	2021.10.26	Measured data
Tongwei	35.2110	105.2422		2020.07.14	2021.09.05	Measured data
TOPOLNIKY	47.9601	17.8620	118.0000	1992.01.15	1992.02.15	GNIP
TORTOSA	40.8203	0.4933	50.0000	2000.02.15	2015.11.15	GNIP
TOULOUSE (UNIV. ECOLAB)	43.5583	1.4694	156.0000	2011.07.15	2012.12.15	GNIP
TRENT	46.0667	11.1333	312.0000	1997.12.31	1997.12.31	WaterIsotopes.org
TRIER	49.7478	6.6581	265.0000	1990.01.15	2013.12.15	GNIP
TRIESTE	45.6486	13.7800	14.0000	1997.12.31	2003.12.15	WaterIsotopes.org
UDH	47.3200	110.6700	1033.0000	2002.10.01	2003.09.01	WaterIsotopes.org
UDINE	46.0619	13.2422	113.0000	1996.12.31	1996.12.31	WaterIsotopes.org

UHLIRSKA	50.8325	15.1478	823.0000	2006.05.15	2018.12.15	GNIP
UIT_001	69.6800	18.9600	73.0000	2019.09.06	2021.09.05	WaterIsotopes.org
Uji	34.5400	135.4800	25.0000	2013.02.01	2013.07.31	WaterIsotopes.org
ULAANBAATAR	47.9333	106.9833	1338.0000	1990.06.15	2001.03.15	GNIP
UMN-EL-JEMAL	32.3055	36.2447	575.0000	1968.11.15	1969.04.15	GNIP
URBINO	43.7167	12.6333	485.0000	2001.10.31	2001.10.31	WaterIsotopes.org
Utsunomiya	36.3300	139.5400	115.0000	2013.02.01	2014.01.07	WaterIsotopes.org
UTTARKASHI	30.7292	78.4467	1140.0000	2004.06.15	2006.10.15	GNIP
VAIRANO	41.3333	14.1333	155.0000	1998.08.31	1998.09.30	WaterIsotopes.org
VALENCIA	39.4806	-0.3664	11.0000	2000.03.15	2010.12.15	GNIP
VALENTIA	51.9300	-10.2500	9.0000	1990.01.15	2018.12.15	GNIP
VALLADOLID	41.6408	-4.7544	735.0000	2000.02.15	2015.12.15	GNIP
VALLE AGRICOLA	41.4333	14.2500	680.0000	1998.08.31	1998.08.31	WaterIsotopes.org
Vanadzor	40.8386	44.4361	1376.0000	2014.07.01	2015.04.22	WaterIsotopes.org
VERONA	45.4500	11.0000	59.0000	1997.12.31	1997.12.31	WaterIsotopes.org
VIENNA	48.2486	16.3564	198.0000	1990.02.15	2020.12.15	GNIP
VILLACHER ALPE	46.6031	13.6714	2156.0000	1990.01.15	2002.12.15	GNIP
VILSANDI	58.3828	21.8142	6.0000	2013.07.15	2018.12.15	GNIP
VOLOGDA	59.2833	39.8667	118.0000	1981.01.15	1983.12.15	GNIP
Wadi Hanifa, Riyadh	24.6200	46.6600	612.0000	1974.03.28	1974.03.28	WaterIsotopes.org
WALLINGFORD	51.6000	-1.1000	48.0000	1990.01.15	2015.12.15	GNIP
WASSERKUPPE RHOEN	50.4972	9.9428	921.0000	1990.01.15	2013.12.15	GNIP
Weather station Burabay new	53.1296	70.2799	309.0000	2016.04.24	2016.05.08	WaterIsotopes.org
WEIL AM RHEIN	47.5958	7.5944	249.0000	1990.01.15	2013.12.15	GNIP
WELLAMPITIYA	6.9506	79.8795	5.0000	2009.01.15	2018.12.15	GNIP
WIERINGERWERF	52.8000	5.0500	-4.0000	1990.01.15	1992.04.15	GNIP
WROCLAW	51.1165	17.0295	118.0000	2004.05.15	2009.05.15	GNIP
WUERZBURG	49.7703	9.9578	268.0000	1990.01.15	2013.12.15	GNIP
Wuhai	39.6700	106.8200		2021.04.24	2021.07.16	Measured data

WUHAN	30.6200	114.1300	23.0000	1992.06.15	1998.05.15	GNIP
WULUMUQI	43.7800	87.6200	918.0000	1986.02.15	2003.12.15	GNIP
Wuqia	39.7200	75.2500		2012.08.01	2019.03.01	References
XIAN	34.3000	108.9300	397.0000	1985.09.15	1992.07.15	GNIP
Xi'an	34.2700	108.9500		2020.07.21	2020.10.13	Measured data
Xianxi	28.3143	109.7400		2021.11.27	2022.05.19	Measured data
Xichang	27.8952	102.2641		2021.04.28	2021.08.13	Measured data
Xinghai County	35.5900	99.9900		2021.03.27	2021.11.03	Measured data
Xiyingwugou	37.5300	102.1000		2019.10.15	2021.11.27	Measured data
Ya'an	30.3000	103.0000		2020.08.06	2020.10.14	Measured data
Yabulai weather station (YBL)	39.3000	102.7000	1250.0000	2013.07.18	2016.07.24	WaterIsotopes.org
YAKUTSK	62.0800	129.7500	107.0000	1996.10.15	2000.12.15	GNIP
Yamagata	38.1200	140.1800	130.0000	2013.01.30	2013.12.30	WaterIsotopes.org
Yamaguchi	34.8000	131.2800	20.0000	2013.01.31	2013.12.27	WaterIsotopes.org
Yangkou cave	29.0300	107.1800	2140.0000	2012.03.01	2016.12.01	WaterIsotopes.org
YANGOON	16.7700	96.1700	20.0000	1961.05.15	1963.12.15	GNIP
YANTAI	37.5300	121.4000	47.0000	1986.03.15	1991.04.15	GNIP
YCR	45.0522	33.9753		2010.10.01	2010.12.01	References
Yerevan	40.2003	44.5183	1134.0000	2014.07.06	2015.06.17	WaterIsotopes.org
Yichun	27.8000	114.3800		2021.12.26	2022.04.30	Measured data
YINCHUAN	38.4833	106.2167	1112.0000	1988.02.15	2000.08.15	GNIP
Yokohama	35.2800	139.3500	60.0000	2013.02.01	2013.12.31	WaterIsotopes.org
Yumen	34.4775	100.2390		2021.06.15	2022.02.17	Measured data
ZADAR	44.1200	15.2400	5.0000	2000.09.15	2003.12.15	GNIP
ZAGREB-GRIC	45.8167	15.9833	157.0000	1996.01.15	2003.12.15	GNIP
ZARAGOZA AEROPUERTO	41.6606	-1.0042	263.0000	2000.03.15	2015.11.15	GNIP
ZAVIZAN-VELEBIT	44.8167	14.9833	1594.0000	2000.09.15	2003.12.15	GNIP

Zeku	35.0352	101.4644		2021.01.20	2021.11.15	Measured data
ZHANGYE	38.9300	100.4300	1483.0000	1990.01.15	2003.11.15	GNIP
ZHENGZHOU	34.7200	113.6500	110.0000	1986.02.15	1992.07.15	GNIP
ZINNWALD	50.7311	13.7514	877.0000	2001.02.15	2014.02.15	GNIP
ZITTAU	50.9000	14.8000	240.0000	2012.11.15	2018.12.15	GNIP
ZUNYI	27.7000	106.8800	844.0000	1986.02.15	1992.05.15	GNIP

Lines 36-37: “development trends of climate change” can probably be revised as something like “regional climate change”.

Reply: Based on your suggestion, we have modified the phrase "developing trends in climate change" in lines 36-37 to "regional climate change." This modification more accurately describes the scope and focus of our study.

The changes to the manuscript are as follows:

Severe fluctuations in climatic elements can alter water circulation processes, affect regional climate change, and even change the evolutionary patterns of ecological environments. Among these, stable isotopes in precipitation are an excellent comprehensive tracer, playing an important role in revealing water cycle processes, climate change information, and mechanisms of water resource use in ecosystems (Bowen et al., 2019; Wang et al., 2022).

Lines 74-76: need citations here, and also in Lines 85 when quoting “comparative”,

Reply: We accept this suggestion, and the revisions to the manuscript are as follows:

The relationship between predicted data from models and actual measured data is "comparative"(Joussaume et al., 1984).

Line 111: it is unclear how these isotope data starting from 1961 can help study paleoclimate.

Reply: Understanding past climate, assessing current climate, and foreseeing future climate are crucial aspects of climate research. A more comprehensive dataset of stable isotopes in precipitation forms the foundation for a profound understanding of the "current climate." Modern observations of stable isotopes in precipitation can be utilized to validate and assess the accuracy of paleoclimate models. By comparing the

model-simulated stable isotope ratios with observational data, the model's performance in simulating past climate states and precipitation patterns can be evaluated. This contributes to enhancing the credibility and predictive capability of paleoclimate models. We have elaborated on this in the "Introduction" section and Section "4.3."

The changes to the manuscript are as follows:

1. Introduction

The accurate understanding of precipitation stable isotopes' response to modern climate lays the foundation for paleoclimate reconstruction. On the other hand, using general atmospheric circulation models to simulate isotope circulation is a major method for comparing isotope distributions in precipitation under both modern and ancient conditions (Joussaume et al., 1984; Brady et al., 2019). Simultaneously, the comparison between simulated and observed precipitation stable isotopes provides valuable validation for the physical components of atmospheric circulation models (Joussaume et al., 1984; Ruan et al., 2019). In conclusion, the comprehensive data on stable isotopes in precipitation offer more detailed information about the climate and hydrological systems.

Paleoclimate Reconstruction: Well-established precipitation stable isotope observational data are advantageous for validating paleoclimate models under modern conditions. Simultaneously, they contribute to richer comparative data for stable isotopes in precipitation collected in geological archives.

4.3 Drivers of stable isotope variation in precipitation in Eurasia

Physical models with different driving mechanisms can meet various usage needs, including paleoclimate reconstruction. For example, CAM3 simulation outputs precipitation oxygen isotope data (Lin et al., 2024). Machine learning is a novel approach for predicting stable isotopes in precipitation, and European simulation practices indicate that oxygen isotope simulations have shown good results, while simulations for hydrogen isotopes remain challenging (Nelson et al., 2021). In general, uncertainties in both physical models and machine learning need continuous improvement and refinement through real-world data. Additionally, an accurate

understanding of the influencing factors of stable isotopes in precipitation is fundamental for achieving successful predictions through machine learning.

Lines 180-181: were these statistical tests performed for individual stations or the averages across all stations? Given the spatial variability, it is more appropriate to carry out the analyses for individual stations or at least some smaller regions than the whole Eurasia.

Reply: In the original manuscript, statistical tests were based on overall data from all sites. Considering the feedback from both reviewers, we believe that limiting the statistical tests to individual sites or smaller regions is reasonable, especially given the spatial variability across the Eurasian continent. We selected the two climatic zones with the most significant differences (tropical and polar zones) and conducted Mann-Kendall (MK) tests on the temporal trends of stable isotopes in precipitation for these two climatic zones (Fig.3). The rationale for this choice is the relatively unclear boundaries between temperate, frigid, and arid zones. Of course, discussions on the stable isotopic characteristics of precipitation in other climatic zones and types will be detailed in the "Results and Discussion" section of the revised manuscript. For instance, Figure 4 analyzes the temporal trends and distribution of data for different climatic zones.

The changes to the manuscript are as follows:

In addition, we selected the two climatic zones with the most significant differences, namely the tropical and polar zones. The reason for this choice is that the boundaries between temperate, frigid, and arid zones are relatively unclear, with subtle changes in trends. Mann-Kendall (MK) tests were conducted on the temporal variations of stable isotopes in precipitation for both climatic zones (Fig.3). For the tropical climate (A), the stable isotopes of precipitation ($\delta^{2}H$ and $\delta^{18}O$) exhibit multiple non-significant periods of abrupt changes. There is a significant increasing trend from 1971 to 2005, followed by a non-significant decreasing trend since 2009. Overall, the deuterium excess (d-excess) shows a non-significant decreasing trend, but this trend has weakened after 1990. In the polar climate (E), there is a significant increasing trend before 1973, followed by non-significant periods of both increase and decrease after

1975. However, after 2010, a gradually significant increasing trend is observed. Since 1985, the deuterium excess has undergone a non-significant decreasing process, and after 2010, it gradually reaches a significant increasing trend. The uncertainty of the tests is mainly attributed to the spatiotemporal distribution and volume of the data.

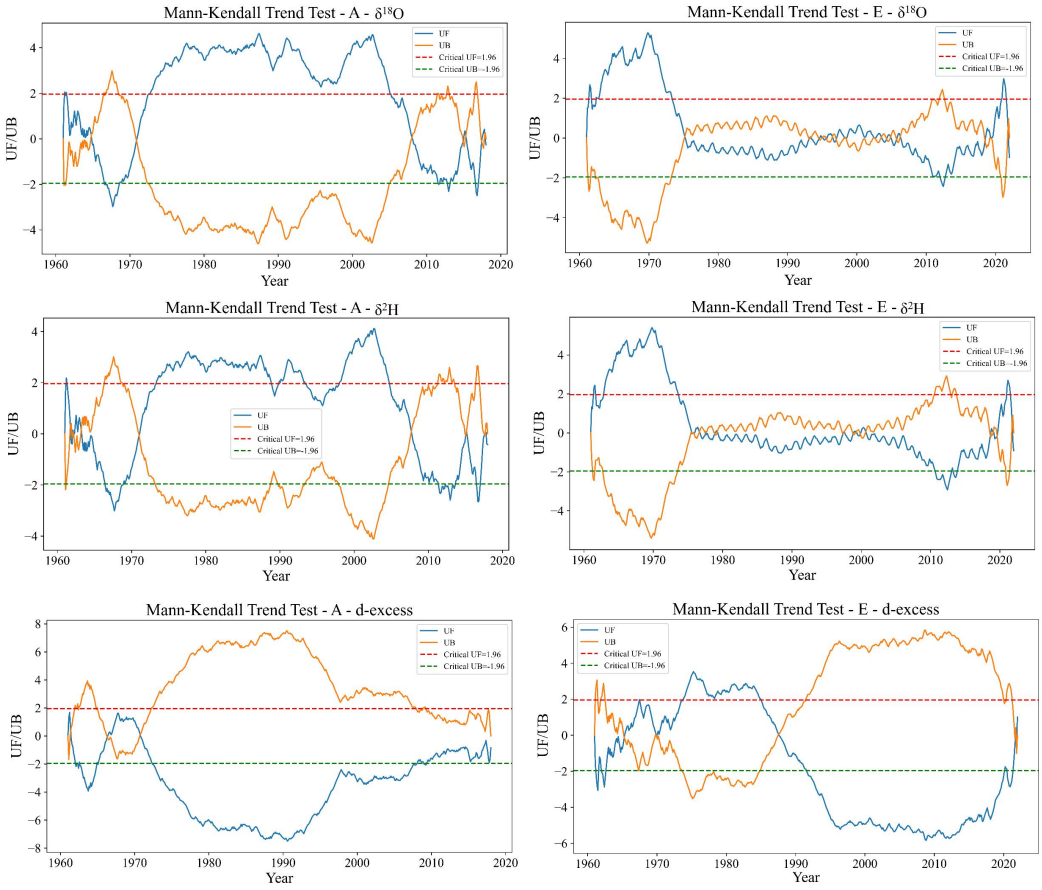

Fig.3 Time series MK test for temperate (C) and cold (D) climates

Figure 3 is not discussed in the main text.

Reply: Figure 3 presents the Mann-Kendall (MK) test results for the time series of all sites. Based on your comments on "Lines 180-181," we recognize that this test indeed did not account for spatial differences. Therefore, in the revised manuscript, we have removed Figure 3. Following the Köppen climate classification, we have divided the stable isotopes in precipitation sites into sub-regions based on climate types. We then reconstructed the time series for stable isotopes in precipitation within these sub-regions and conducted trend and changepoint tests on the new time series. Please refer to our response to "Lines 180-181" for details on this modification.

Lines 207-210: the increase of temporal variance is quite substantial is Figure 4.

Can some statistical tests be carried out to verify the possible causes, e.g., the correlation between the data in Figure 4 and the regional temperature/precipitation. Please also refer to my previous comment related to the potential systematic bias when calculating station-averages.

Reply: As pointed out in your comments under "**Major comments:**" we overlo oked spatial variability in the time series for all sites, and representing unique values on the time series using the arithmetic mean of the sites. We acknowle dge that this has been a major contributor to the increased errors in the time s eries. To address this, we have conducted climate zoning for the Eurasian conti nent and calculated using a weighted average. However, we did not address ou tliers in d-excess, as it is derived from the calculation of hydrogen and oxygen stable isotopes, as shown in Fig. 4.

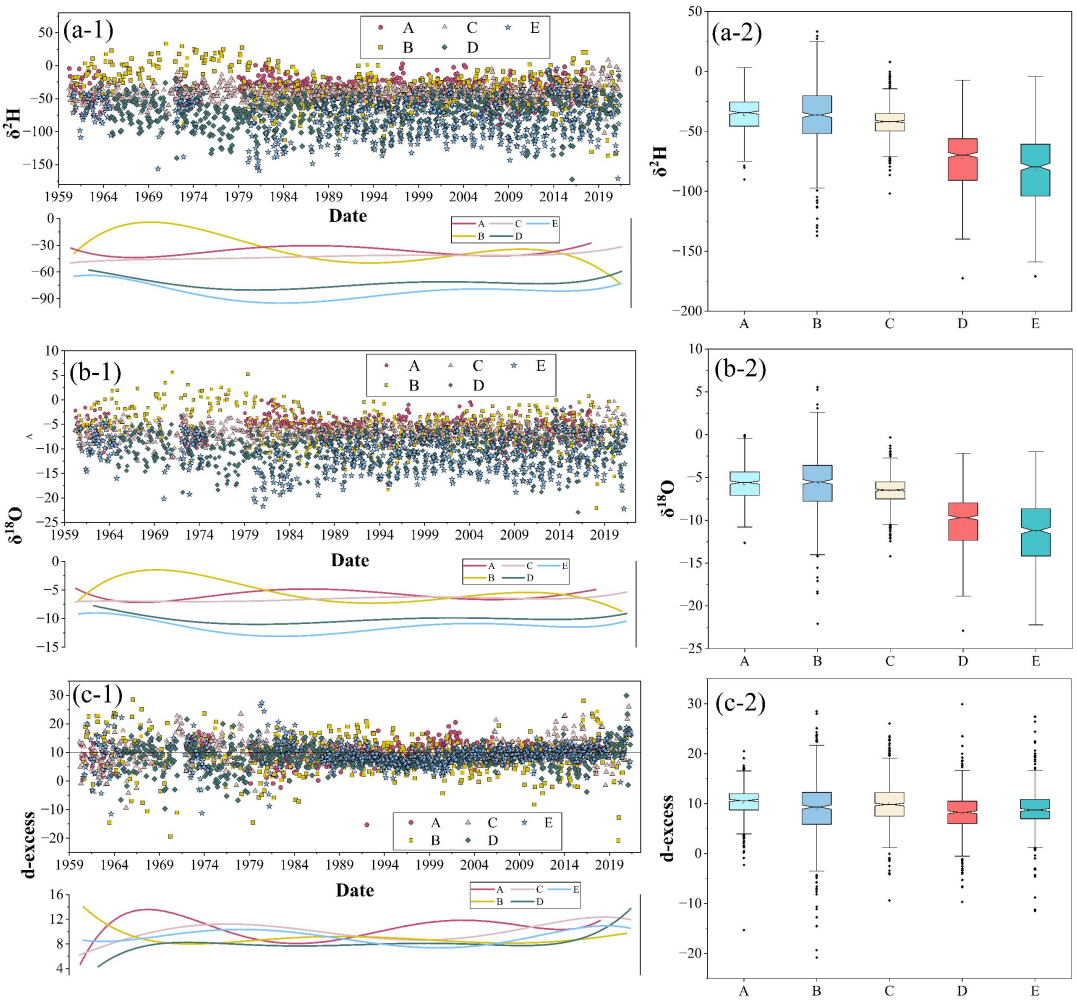

Fig.4 The time series variations of δ^2H, $\delta^{18}O$, and d-excess in the Eurasian continent.

Lines 252-253: what are "atmospheric precipitation lines"? Is this a common terminology, if not, please explain/clarify in the text.

Reply: This was an oversight in our writing process. We will correct it in the revised manuscript and verify for similar errors throughout the document. The accurate expression is "meteoric water line." The linear correlation line between hydrogen and oxygen isotopic compositions in atmospheric precipitation globally or in specific regions is referred to as the "meteoric water line." Craig (1961) collected samples of natural atmospheric water (including river water, lake water, rainwater, and snow) from various locations worldwide and determined the concentrations of hydrogen and oxygen stable isotopes—D (^{2}H) and ^{18}O—using a mass spectrometer. The results showed a linear relationship between the $\delta^{2}H$ and $\delta^{18}O$ of hydrogen and oxygen-stable isotopes in global precipitation. It is also known as Craig's Meteoric Water Line or the Global Meteoric Water Line of Craig (GMWL of Craig).

The changes to the manuscript are as follows:

4.2 Seasonal changes in meteoric water line and precipitation stable isotopes

The temporal and spatial variations of stable isotopes in precipitation are greatly influenced by meteorological factors, and the changes in precipitation isotopes are consistent with the climatic regions. Therefore, based on the Köppen climate classification, we performed climate zoning for stable isotopes in precipitation sites. We used the least squares method to fit meteoric water line for different climate regions (Fig.6) and considered the seasonal variations of precipitation stable isotopes in different climate regions (Fig.7). The meteoric water line for different climate types indicate relatively small differences in various climate precipitation amounts in tropical climates. The variations in the slope and intercept of the meteoric water line are determined by the combined effects of precipitation and temperature, with convective precipitation weakening the impact of the "temperature effect." Intense convective rainfall and oceanic water vapour transport bring abundant precipitation to tropical regions.

Lines 286-289: I couldn't follow the discussions here, what does it mean by "are distributed around the global average"? And how does this indicate that the

moisture in Eurasia is strongly influenced by oceanic water vapor?

Reply: The average d-excess value for global precipitation is 10‰, with d-excess typically indicating the degree of imbalance during the evaporation of seawater sources. It generally depends only on the environmental conditions of the water source region, and this value remains constant throughout the entire process from water evaporation into the atmosphere to eventual condensation and rainfall. The westerly and monsoon systems are the primary atmospheric circulation systems over the Eurasian continent, transporting water vapour from the ocean inland and gradually weakening. Therefore, regions approaching this value are likely influenced by maritime water vapour.

The changes to the manuscript are as follows:

Compared to $\delta^{2}H$ and $\delta^{18}O$, deuterium excess displays a more stable pattern and is distributed around the global average (10‰). The westerly and monsoon systems are the primary atmospheric circulation systems over the Eurasian continent, carrying water vapour from the ocean inland and gradually weakening. This indicates that the humidity in the vast region of Eurasia is strongly influenced by ocean water vapour. Ocean conditions and large-scale atmospheric circulation changes can have profound effects on the climate environment of the Eurasian continent.

Lines 310-311: the predictors used here are not independent, e.g., evapotranspiration is affected by the parameters like temperature and wind speed. Does this possible interdependency affect the results and conclusions? Some more careful analyses and discussions are needed to assess the possible interdependency between the different predictors (especially when the importance of predictors is assessed in this case).

Reply: Random Forest regression models can enhance prediction accuracy and robustness by constructing multiple decision trees and averaging their results. Due to its design, Random Forest can effectively handle correlations between features. Here are key points:

Feature Selection: Random Forest randomly selects a subset of features when building each tree, reducing the impact of high correlations between features, as not all

features are used in every model.

Overfitting Reduction: Correlations may lead to model overfitting, but Random Forest mitigates this risk by averaging predictions across multiple decision trees.

Furthermore, Random Forest regression models are commonly used for prediction and classification. In this study, we employed the Random Forest regression model solely to assess the importance of key meteorological variables on the stable isotopes of precipitation. Therefore, multicollinearity between variables is not a severe issue. For Random Forest regression models, a better practice is to directly assess model performance and variable contributions through cross-validation and feature importance evaluation (Vystavna et al., 2021).

However, we have also made improvements to address the issues with the random forest model (Fig. 8). On one hand, we have removed duplicate values generated during the resampling of meteorological variables and represented stable isotope values of precipitation at the station by using weighted averages, thereby mitigating the impact of data errors on the model. Additionally, we introduced cross-validation for the model (Table S3) to assess the robustness of the results. The findings indicate that the random forest model performs well on both the training and testing sets, with superior predictive performance for the target variable $\delta^{18}O$ compared to the target variable $\delta^{2}H$. This is evident from the smaller root mean square error (RMSE) and mean absolute error (MAE) for $\delta^{18}O$, along with a higher R^2. The comparably higher values of RMSE and MAE for $\delta^{2}H$ can be attributed, on one hand, to the numerical range and volume of $\delta^{2}H$, and on the other hand, based on existing studies on stable isotope predictions in precipitation, the values fall within a reasonable range (Nelson et al., 2021). Therefore, we can assert that the assessment of the importance of meteorological variables for stable isotope evaluation in precipitation, as utilized in this study, is reasonable and accurate.

Table S3 Random Forest Model Assessment Indicators

	RMSE	MAE
δ^2H	16.87	11.02
$\delta^{18}O$	2.17	1.42

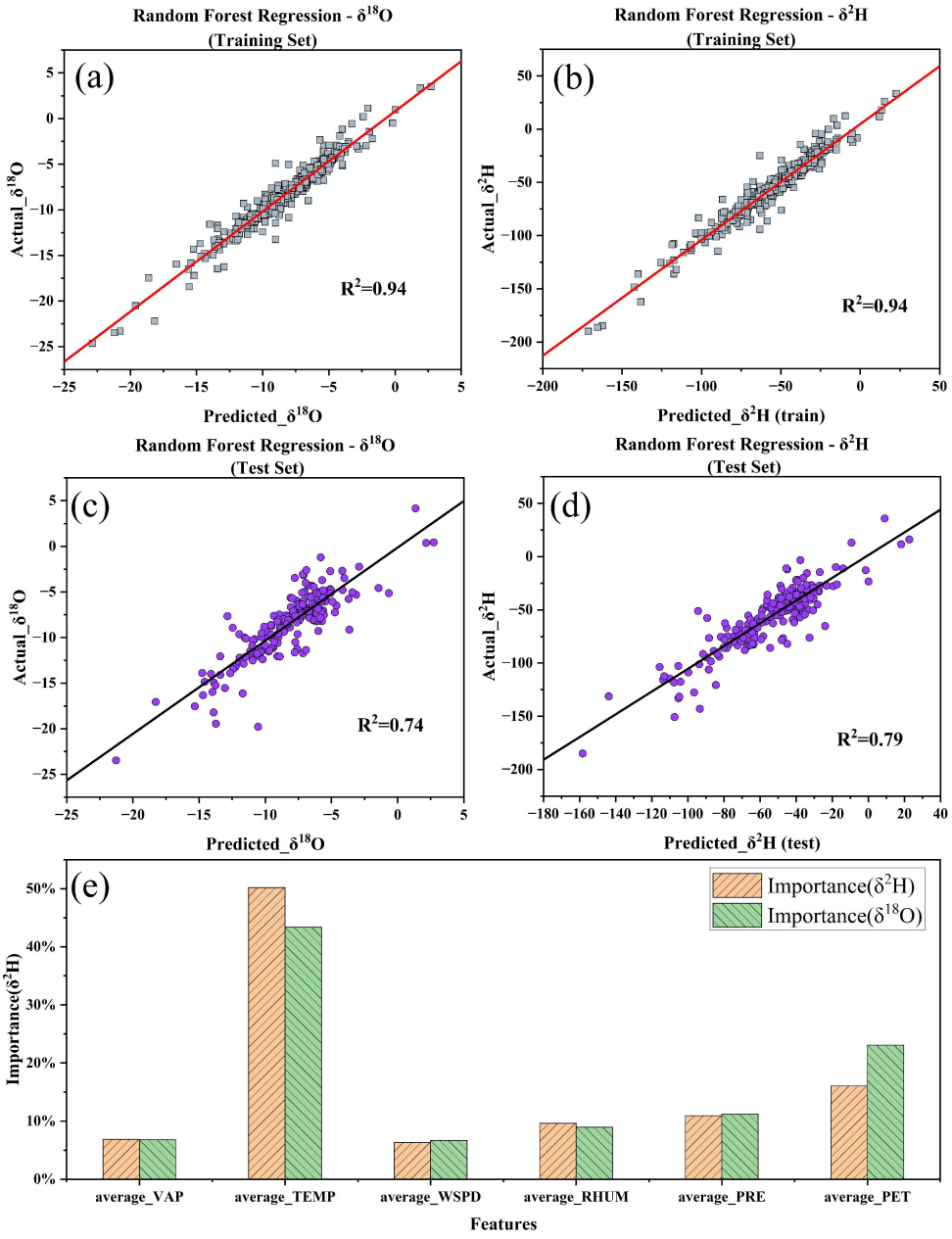

Fig.8 Results of Random Forest Regression Analysis for δ^2H and $\delta^{18}O$ in Relation to Meteorological Variables.a: Regression results for the training set of $\delta^{18}O$, b: Regression results

for the training set of δ^2H, c: Regression results for the testing set of $\delta^{18}O$, d: Regression results for the testing set of δ^2H, e: Importance of meteorological variables for δ^2H and $\delta^{18}O$.

Reference:

Aggarwal, P. K., Romatschke, U., Araguas-Araguas, L., Belachew, D., Longstaffe, F. J., Berg, P., Schumacher, C., and Funk, A.: Proportions of convective and stratiform precipitation revealed in water isotope ratios, Nature Geosci, 9, 624–629, https://doi.org/10.1038/ngeo2739, 2016.

Craig, H.: Isotopic Variations in Meteoric Waters, Science, New Series, 133, 1702–1703, 1961.

Joussaume, S., Sadourny, R., and Jouzel, J.: A general circulation model of water isotope cycles in the atmosphere, Nature, 311, 24–29, https://doi.org/10.1038/311024a0, 1984.

Nelson, D. B., Basler, D., and Kahmen, A.: Precipitation isotope time series predictions from machine learning applied in Europe, Proc. Natl. Acad. Sci. U.S.A., 118, e2024107118, https://doi.org/10.1073/pnas.2024107118, 2021.

Vystavna, Y., Harjung, A., Monteiro, L. R., Matiatos, I., and Wassenaar, L. I.: Stable isotopes in global lakes integrate catchment and climatic controls on evaporation, Nat Commun, 12, 7224, https://doi.org/10.1038/s41467-021-27569-x, 2021.

Zhang, F., Huang, T., Man, W., Hu, H., Long, Y., Li, Z., and Pang, Z.: Contribution of Recycled Moisture to Precipitation: A Modified D-Excess-Based Model, Geophysical Research Letters, 48, e2021GL095909, https://doi.org/10.1029/2021GL095909, 2021.