

Stable isotope composition of precipitation over Central Asia

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The authors present the analysis of stable isotope data in precipitation over central Asia. They used both $\delta^2\text{H}$ and $\delta^{18}\text{O}$ for construction of meteoric water line, although on couple of sites in the manuscript they explicitly stated they used only $\delta^{18}\text{O}$. I suppose the data refer to monthly precipitation samples, since some data were taken from GNIP database. For relation with various climatological and geographical parameters they used only $\delta^{18}\text{O}$ values, which is understandable. However, since they have both $\delta^2\text{H}$ and $\delta^{18}\text{O}$ values, I suggest to discuss also deuterium excess that can also help in studying air mass circulation, altitude effect, seasonal changes, etc. Finally, they develop a model, although it is not an *ab initio* model, but rather an empirical relation between several parameters, to predict/calculate the $\delta^{18}\text{O}$ in precipitation at Urumqi station. I miss some more detailed discussion on comparison between the measured and calculated values, why there are some large deviations, etc., and on a possible application for paleoclimatology, which was mentioned in the very first sentence of Introduction (although the sentence is rather disordered).

The presented results are interesting for the air mass circulation and isotopes-in-precipitation studies on regional scale, but can be important also for other regions. It shows the importance of GNIP database and other local/regional databases for general knowledge on air mass circulation. This is especially important if we think about the recent climate changes that can already be observed in both different seasonal distribution of precipitation and in changes in their isotopic composition. Therefore, the study may be accepted from the topical point of view, however, the manuscript itself contains various deficiencies that should and must be improved before final accepting for publication. I will list my observations and suggestion below separately as General and Specific comments.

My recommendation is: **accept after major revision**.

General comments: (valid for the whole ms)

1. I found the title, the abstract and the content of the whole paper rather confusion. The title implies the analysis of stable isotopes (usually it includes $\delta^2\text{H}$ and $\delta^{18}\text{O}$ values) in precipitation, the abstract talks in the beginning of $\delta^{18}\text{O}$ only (as well as the first line of Introduction), but the a few lines later the meteoric water line is established, and for MWL one needs $\delta^2\text{H}$ data also! Similarly, the first section in Results and discussion is about MWL. The authors should better explain which data they used.
2. The discussion on various dependences of stable isotope composition could be restricted to discussion on $\delta^{18}\text{O}$ data, because $\delta^2\text{H}$ is well correlated with $\delta^{18}\text{O}$ through MWL, as the authors also showed. When they produced MWLs by using $\delta^2\text{H}$ data, it could be informative to use also deuterium excess data.
3. Various statistical methods are used in the manuscript, but some essential data are missing in most of the results, such as uncertainties, number of data, R values, p values for significance of correlations. In addition, care should be taken on the number of significant digits. For example, uncertainties in slope and intercept of the MWL line (line

21 in abstract) are given with 4 decimal digits and without uncertainties. From my experience, if uncertainties were correctly taken into account, no more than 2 decimal places should be presented.

4. Please use $\delta^2\text{H}$ instead of δD .
5. Central Asia is a wide region, and it would be nice to have the countries in the region by their names, add some political map with countries and the main cities in addition to the map of sampling locations (Figure 1), or at list the names of the main cities on map in Figure 1.
6. I am not a native English speaker, however, I have a long experience with scientific paper written in English. I would suggest language check/proof reading.
7. Line 35 – Could you please explain more about what do you mean by paleoclimatological applications? I have not seen any comment further on.
8. I suggest numbering of all equations.

Specific comments: (line numbers refer to the submitted version)

- title: I would strongly suggest reconsidering the title if the content remains the same, or reconsider changes in Introduction and results if the title remains “stable isotope composition”
- abstract –relationship – replace with relation (check for the difference in the meaning), valid for the whole ms
- abstract, line 21 – see general comments on δD and the number of significant digits and uncertainties, and some other data (n, R)
- line 22 – is it a simple arithmetic mean or precipitation-weighted mean’
- lines 19 and 22-23 give repeated information
- line 25 – at certain places, like here, it would be useful to say “dependence of $\delta^{18}\text{O}$ on precipitation amount...” to stress that the amount of precipitation is here a variable; also, please state that the monthly $\delta^{18}\text{O}$ values in precipitation are compared with the monthly precipitation amount
- line 27 – when the gradients are given, it would be nice to have also their uncertainties, number of data, R, significance
- line 28 – the phrase of the type “the latitude was significantly correlated with $\delta^{18}\text{O}$ ” sounds rather strange, since it implicates that latitude is a function of $\delta^{18}\text{O}$! The correct way would be “ $\delta^{18}\text{O}$ value was always significantly correlated with the latitude” and similarly further on, see 184-185
- line 28-29 – line 28 mentions latitude and longitude, while the next line 29 gives gradients $\delta^{18}\text{O}/\text{LAT}$ (this is correct) and $\delta^{18}\text{O}/\text{ALT}$, which is altitude. Please, carefully check these sentences and the given gradient values
- line 37 – 39 – the sentence should be re-written, probably it should be broken into two shorter sentences that make sense; in addition, please reconsider the statement “only $\delta^{18}\text{O}$ was considered in this paper” – see the general comment; you cannot make MWL if you do not have $\delta^2\text{H}$ data in addition to $\delta^{18}\text{O}$
- lines 46 – 50 – I strongly recommend adding a reference to the IAEA web page or some book describing GNIP stations and database

- line 73 – which countries?
- Line 87 – give ref. to Table 1, where all the stations are listed
- Line 98 – which reference studies? Give references.
- Line 99 – Kabul, Afganistan --- and similarly for other cities – name the country
- Line 108 – “Spatial patterns ... were available from all stations”. I do not understand this sentence. How can a single station produce a spatial pattern? Please, re-write.
- Sentence in line 109-110: replace “employed” with “reported”, in the second part of the sentence “ $\delta^{18}\text{O}$ data are represented in precipitation amount-weighted data”. It is not clear. While average annual values are given usually as the amount-weighted mean values, a single monthly values cannot be precipitation weighted (since the integral monthly precipitation is measured for $\delta^2\text{H}$ and $\delta^{18}\text{O}$ values), or I miss something here?
- Line 115 – what was the source of WCI data? Could you give a simple and short explanation of what these indices represent?
- The first sentence in LMWL section (lines 121-123) should be given in the first paragraph of the introduction, and then the statement that only $\delta^{18}\text{O}$ was used here becomes self-contradictory
- Line 123 – what are “precipitation groups”?
- Line 124 – see the comment on statistically correct presentation of data, uncertainties, significant digits...
- Line 128-131 – the explanation seems somehow sketchy or superficial, not very convincing. The MWL line in l.124 is obtained for a very broad area with different characteristics, and the difference between east/west, north/south, high-latitude/low, costal/inland stations and their MWLs is not discussed in the text, although some features are shown in Figure 1 (see the comment on figure 1) and not explained neither in the text nor in figure caption
- Line 136 – is it possible to know some numerical values of lowest winter and highest summer temperature values, some ranges or anything else numerical?
- Line 137 – ref to Figure 2 is wrong – Figure 2 shows the MWL, and not temperature of precipitation amount distributions
- Lines 137 – 138 – I am again confused, first “precipitation amount exhibited two distribution types” and immediately after “three different precipitation patterns ...” ???
- When discussing precipitation distribution in different cities (Figure 3) the position of the cities should be known to the reader, so see the general comment 5
- “line 146 – “what is “a well-distributed seasonal pattern””? Do you mean rather uniform distribution of precipitation amount throughout a year without a specific seasonal peak?
- Line 147 – I do not see Saratov in Figure 3 – see also comments on Figure 3
- Line 158 – “ $\delta^{18}\text{O}$ values were continuously high” is in contradiction to the previous sentence (line 157) that minima are observed in period Dec-Feb. Do you mean that the values are continuously increasing from January to July?
- Line 160 is repeating statement from line 159, one of them should be removed
- Line 162 – “in winter ... the amount of precipitation was very low” – this statement is not justified by data shown in Figure 3, where winter precipitation in Kabul and Teheran are much more abundant that in summer – please, reconsider the statement

- Line 165 – Figure 4 shows the annual average (precipitation-weighted?), average summer and average winter $\delta^{18}\text{O}$ values
- Line 167 to 172 – it would be good to see locations of the mentioned cities on the map
- Line 187 – the given numerical gradient value means exactly what is explained later, so the explanation “implying that...” is not necessary, it should be deleted, and the numerical value directly compared to other values
- Line 189 – the altitude gradient presented here is probably obtained from all stations in Central Asia, from table 1. Perhaps it would be instructive to make separate relation along a single profile, i.e., separately for the stations on the left side of figure 1. It has been shown earlier that the altitude gradients can have very different values even over a limited geographical regions (e.g., Vreča et al., Journal of Hydrology 2006, 330(3-4):457-469, DOI: [10.1016/j.jhydrol.2006.04.005](https://doi.org/10.1016/j.jhydrol.2006.04.005))
- Line 194, line 220, line 225 – references in italic, to be consistent with others, check the complete ms
- Line 201 – the latitude and altitude gradients in this equation are different than those given in lines 187 and 189, the altitude gradient in this equation is much closer to the china gradient (line 188) – how do you explain that’
- Line 239 – 240 – I do not understand the sentence “Moreover,...”. Please, re-write
- Line 246 – here it would be good to add “precipitation amount” to clearly indicate what you correlate
- Line 261 – EASMI is mentioned here, while in line 259 it was SASMI. I believe the interpretation is correct, but no explanation on what these indices represent is missing from the introduction (see comment on line 115) and any comment is practically impossible.
- Line 298 – I do not understand the exception – even when some extreme values are observed, which do not perfectly agree with the model values, the annual cycle is still there. Please, re-write the statement, and list some extreme monthly values and description of meteorological conditions (there should be some extreme conditions, I suppose). In other words, please extend the discussion on the deviation of the model values from the observed ones.
- Figure 8 should be mentioned somewhere in this paragraph; it seems that there is no reference to Figure 8 in the ms
- Line 309 – see previous comments on “groups of data”, statistical presentation of MWL
- Line 318-319 – the same comment on latitude – longitude vs $\delta^{18}\text{O}$ /LAT and $\delta^{18}\text{O}$ /ALT as previously

Figures and figure captions

- Figure 1. I would suggest to add also a political map, i.e., map showing countries in the region. Also, instead of crosses for sampling stations, one can put number from Table 1. What are the white squares on the lower left side of the figure? They appear also on similar figures later.
- Figure 2. Use $\delta^2\text{H}$ instead of δD (in caption and on y-axis description). Explain in caption what are CAMWL and GMWL. In caption CAMWL – but in the legend CMWL – be consistent. CMWL (or CAMWL) equation – reduce to a proper number of significant digits.

Explain in figure caption what different arrows represent. It seems that this figure presents much more than it is described in the text. But please bear in mind that the figure 8 (with its caption) should be self-explanatory and self-understandable. Add legend for x crosses and circles.

- Figure 3. In caption, name which stations are presented. Second sentence – it is not clearly said that the averages were done for each individual month over the observation period. Please use larger font size (compare Figures 6 and 7). Also, I would suggest the same sequences of the stations in all similar figures (2, 6, 7). I do not see Saratov, instead it is Aaratov. What are the units for temperature T and $\delta^{18}\text{O}$ – I see some strange fonts? Please, correct the units.
- Figure 4. Legends – generally, use different symbols for minus sign and for “to” dash, e.g., - and –; for the annual values, the 4th line should be -7.99 – -5.00, legend for the JJA values, 4th row -2.99 – 0.00; for DJF values 4th row -17.99 – -12.00
- Figure 4 and 5 – I would prefer to have underlined in black lines the political borders, to make the map more understandable to readers all over the world
- Figure 6, 7 – if the same cities/stations are presented here as in Figure 3, I would suggest to have the same sequence of stations. In legends, T , P and R are written in italic, but earlier they were not. Please, use consistently either normal or italic font for quantities. Also, put always an empty space between the name of the quantity and its units, for example, change Precipitation(mm) to Precipitation (mm) (all panels in both figures) Also, Figure 7, right column, replace Tengeran with Teheran
- Figure 8. Caption should be more detailed. Add which equation you used (now you need numbering of equations!). Explain what is present on panel a, what on panel b. Larger fonts on axes names. Take care of the number of significant digits on linear fit equation on panel b for slope, intercept and R value

Tables

- Table 1: since all data in column Age are the same, this column is not necessary and should be deleted, and the appropriate explanation of the fish age put into the table caption. Also, the statement “whenever possible” in the caption can be deleted, because all data are presented with standard deviation.

References

The referencing is not consistent throughout the ms, as noted earlier.

Some references are given with the abbreviated, and some with the full journal titles/names; please, be consistent

- Line 389 and 407 and 467 – 18 in superscript
- Line 462 – here is ref. Yao et al 2006b – where is Yao et al 2006a? Or delete b
- Line 464 – there should be more co-authors named
- Line 482 – check the reference/journal: Is it “Desert and Oasis Meteorology”, is there an English version available?
- Line 493 correct “(18O” to “ $\delta^{18}\text{O}$ ” (probably)