RC2: 'Iso2k review', Anonymous Referee #2, 30 Mar 2020

Response to Anonymous Referee #2:

We thank the reviewer for the feedback and constructive comments on this manuscript. Below, we detail the revisions we will undertake in order to address the reviewer's comments. The original review is copied in **bold text** and our responses appear in plain text. We greatly appreciate the feedback and we believe the revised manuscript will be substantially improved.

- Bronwen Konecky
On behalf of all authors

Konecky et al. present a large compiled dataset of isotopic tracers of the hydrologic cycle spanning the last 2000 years. This database clearly represents a huge coordinated data synthesis effort, and the authors should be lauded for their efforts to provide a standardized metadata template to facilitate intercomparison across studies and proxy types. In addition, I appreciate the authors have gone through the effort to maintain a link between datasets and the original study/citation the data were derived from. My sense is that this dataset will be highly cited, and enable new studies of Common Era hydroclimate. Furthermore, the authors have provided a roadmap for how this dataset is to be versioned and built upon; the expectation is that it will only improve in quality and utility through time. Therefore, I recommend that this study be published after a few minor comments below are addressed.

We are pleased the reviewer found the database to be promising.

Minor "science" comments:

1. I understand that the discussion of controls on isotope ratios of the different "archive types" in section 3 are meant to be brief, as an exhaustive discussion of controls on each proxy type would increase the length of this paper several times over! However, I would argue for a slight expansion (and correction of small errors) in the description of controls on tree-ring cellulose. First, the 27‰ offset observed by Sternberg et al.1986 was between cellulose and water, not the cellulose precursors (L. 415-416). Cellulose synthesis from these precursors also permits exchange with water at carbonyl oxygens, so the offset between the isotope ratios of the precursors and water is likely to be different than the offset between cellulose and water, especially if the sugars are no longer in the leaf (as in tree rings).Second, I'm not sure that I understand what's meant by "as the biosynthetic fractionation is relatively constant" at L. 416 – leaf waters certainly vary in space and time rather dramatically (e.g., West et al. 2008 Plos One), and therefore, the sugars produced using these leaf waters would also have different isotope ratios. Third, some of the signal found in the leaf is dampened before being used in tree-ring cellulose as a fraction of oxygen in leaf-exported sugars exchange with xylem water in the trunk (e.g., Roden et al. 2000 GCA). Therefore, tree-ring cellulose d18O values reflect both changes in plant water sources through time (e.g., changes in xylem water isotope ratios) as well as changes in environmental conditions (e.g., more enrichment of leaf waters/sugars via a drier atmosphere, for example). Some of Paul Szejner's recent work

has shown this clearly for the North American Monsoon, for example (Szejner et al. 2016 JGR).

Thank you. We appreciate these points. The text on the biochemical fractionation has been corrected and improved. We clarify that variability in tree-ring cellulose 18O is primarily influenced by the 18O of source water and leaf water, which are influenced by climate and environmental factors. We replaced the paragraph from lines 410-421 of the Discussion paper with the new paragraph below:

The wood in tree rings (tree-ring cellulose) is one of the few terrestrial proxy archives that can be directly constrained to calendar years (McCarroll and Loader, 2004; Schweingruber, 2012). Information about climatic and environmental changes on seasonal-to-annual time scales is recorded in tree-ring cellulose $\delta^{18}O$. The $\delta^{18}O$ of tree-ring cellulose is influenced by (i) the $\delta^{18}O$ of source waters, and (ii) factors influencing $\delta^{18}O$ of the leaf water and (iii) a fractionation related to the isotopic exchange of carbonyl oxygen of cellulose intermediates with cellular waters (derived from enriched leaf water and unaltered xylem or source waters), resulting in an overall ~27‰ enrichment of cellulose $\delta^{18}O$ relative to cellular waters (Barbour et al., 2004; Gessler et al., 2014; Roden et al., 2000). This fractionation is regarded as a constant in mechanistic models (e.g., Cernusak et al., 2005; Roden et al., 2000) and so cellulose $\delta^{18}O$ variability mainly reflects the $\delta^{18}O$ of source water and leaf waters. The $\delta^{18}O$ of the source water is closely related to the $\delta^{18}O$ of precipitation-derived soil water (Bowen et al., 2019). As such, the primary climatic signal that controls $\delta^{18}O$ of tree-cellulose varies by location, depending on the climatic signals controlling precipitation $\delta^{18}O$ (Section 1.2). For example, tree-cellulose $\delta^{18}O$ records have been interpreted to reflect temperature at mid- to high-latitude sites (e.g., Churakova (Sidorova) et al., 2019; Porter et al., 2014; Saurer et al., 2002; Sidorova et al., 2012), and precipitation amount in tropical or monsoonal sites (Brienen et al., 2013; Managave et al., 2011). As the $\delta^{18}O$ of the soil water is also affected by evaporation of the soil water, precipitation minus evaporation (P-E) influences $\delta^{18}O$ tree-cellulose (Sano et al., 2012; Xu et al., 2018). Water vapour pressure deficit between the leaf intercellular space and the ambient atmosphere in conjunction with the leaf physiological traits control the extent of evaporative enrichment of the source water in ^{18}O in the leaf and hence $\delta^{18}O$ of the leaf water and tree-cellulose (Kahmen et al., 2011; Szejner et al., 2016).

Minor 'science' comment #2

L. 420 – could it also be the case that this cellulose d18O signal is due to changes in the d18O of the vapor that is the source of this precipitation? There's been a fair amount of work in the past decade that has suggested the relationship between local precipitation amount and d18O is fairly weak compared to precipitation processes (e.g.,microphysics) and moisture transport history (e.g., Dayem et al. 2010 EPSL, Konecky et al. 2019 GRL, Vimeux et al. 2011 EPSL, Bowen et al. 2019 among others).

We agree that cellulose d18O can reflect factors other than temperature and precipitation amount, such as moisture source, precipitation microphysics, and transport history. We revised the text here to clarify that the climatic controls on the d18O of cellulose are largely driven by the climatic controls on d18O of precipitation, which are discussed in Section 1.2. See the above revised paragraph. We also added a reference to section 1.2 and also added the reviewer's suggested citations to that section.

Minor technical comments:

1. Supplemental Table S2 - rows 769-778 seem to be missing a full reference for pub1.

These rows have a full reference for pub1 (Moreno et al., 2012, QSR, complete with doi). However, the formatting of special characters appears to have been incorrect, which may have led to problems viewing the publication reference. We fixed this as well as other special character errors in Supplemental Table S2.

2. L. 207: publicly-available -> publicly available

Fixed.

3. L. 411. Seasonal to annual -> seasonal-to-annual

This line was edited for clarity.

4. L. 451 - comma placement? The second half of this sentence doesn't seem to line up with the first.

The second half of the sentence L. 451 was rephrased. "...foraminifera calcite is systematic **i.e.** the $\delta 18O_{sw}$ can be reconstructed…"

5. L. 448 - seasonally-biased -> seasonally biased
Changed

6. L. 625 - what are these percentages based on? L. 621 suggests that the percentages in L. 625 should perhaps add to 100%

This is indeed a bit confusing as written. Therefore, we clarified the text in this paragraph so that the percentages are out of stable isotope records, rather than being out of all the records in the database (which included 255 ancillary records).

We thank the Reviewer again for these helpful suggestions.