Response to Referee #2

We thank the reviewer for their effort put towards reviewing our manuscript. Our responses below are in black, Time's New Roman and referee's comments are in blue, Calibri font.

General comments: This paper makes an important contribution to the scientific literature by providing estimates of coefficients of sinusoidal cycles in precipitation isotopic composition at global scale. These estimates are useful for analyses of water transit time and water source attribution in hydrological, biological, and geological studies. Regression models are presented that will allow users characterize precipitation isotope cycles at points or as raster grids.

Specific comments:

P 2: additional information on previous geostatistical analyses (Bowen et al. 2014) and products, such as IsoMAP (http://isomap.org), should be included in the Introduction. Please explain how this study improves on previous work (eg., IsoMAP).

We now further discuss other isotope data products. It is important to note that our analysis yields a very different product: maps that show seasonal cycles, rather than predictions of isotope values in specific months or years (e.g., products from Bowen et al.). Statistically, our approach first extracts the seasonal signal from the data, and then interpolates those signals. As such, the values used in the interpolations are a product of an entire time series, not just single points.

Our paper allows readers to immediately understand the location and strength of seasonal cycles in precipitation isotopes. Perhaps most importantly, our method provides information (i.e. sine curve parameters) that is not directly available from isomap.org or the online isotopes in precipitation calculator (OIPC), but is increasingly used in isotope hydrology (e.g., young water fraction calculations). While products from Bowen et al. could be used for alternative calculations of isotope seasonality, that product is not currently available. We are not critiquing Bowen et al.'s method, we are simply offering a different product for use in hydrological analyses and expect that the product will find uses beyond its obvious intended applications.

We now make these points in the introduction.

P 3 L 3-7: The data set used to develop the regressions is large and potentially veryuseful to other users; however, a link to the data is not readily apparent. The authors indicate there is a compiled data set; however, I was unable to identify a link in the cited reference (Jasechko et al. 2016)(the Methods section of that paper indicates they compiled approximately 63K data points). Readers will not be able to reproduce the analysis in this paper without access to the precipitation isotope sample data. It is essential to provide a clear link to the raw data set (with appropriate citations for data sources).

We now cite the data sources in the data table and update the data availability statement so that it specifies how all of the data can be accessed. It is true that these precipitation data were previously analyzed by Jasechko et al. and were obtained via direct download from the IAEA's database (ref. 34 in Jasechko et al. 2016 and http://www-naweb.iaea.org/napc/ih/IHS_resources_isohis.html) and via personal communication with leaders of two national precipitation isotope networks: S. J. Birks (e.g. see ref. 37 in Jasechko et al. 2016) and J. M. Welker (e.g. see ref. 36 in Jasechko et al. 2016). By providing the fitted sinusoid statistics, this paper marks a step forward because it does provide a single compiled dataset of metrics describing precipitation isotope data.

P 4 L 19: the list of potential explanatory variables is reasonable; however, distance to nearest ocean ignores the influence of prevailing wind direction. While perhaps beyond the scope of this paper, it might be possible to include in future analyses. In the meantime, this source of error could be discussed in the Discussion section.

We now expand our discussion of how circulation patterns and storm trajectories relate to isotope patterns.

P 4 L 24-25: Model parameterization does not appear to follow accepted statistical best practices. In stepwise multiple regression, selection of model parameters usually is based on minimizing the Akaike information criterion (AIC) (Akaike 1981) or Bayesian information criterion (BIC), rather than maximizing R2, which could lead to model overparameterization. Colinearity does not appear to have been considered quantitatively, but should be; it often is tested using the variance inflation factor (VIF) (Hair et al. 2005).

We understand that AIC is commonly used, but in our case, we found that minimizing the AIC led to the selection process retaining more terms than were retained by our method; we now mention this in the manuscript. Note that our method was not solely to maximize R^2 values, because we also excluded all coefficient p-values that were not statistically significant ($p < 0.05$). We now report the VIFs. Even if we hypothetically used all of the potential predictor values (which was never the case), all of VIFs are less than 10 (i.e., a commonly used cutoff value).

P 7 L 4: define LC-excess.

LC-excess is now defined (and Landwehr and Coplen 2006 is cited).

P 8 L 10-15: One of the main contributions of this paper is the presentation of models for amplitude, phase, and offset. This allows readers to estimate these cycle characteristics at other sites and/or create raster grids (as the authors have done). This is worth mentioning explicitly in the Discussion.

We now more clearly emphasize this point.

P 9 L 3-4: cannot locate Supporting Information 2.

We opted to not include these until the final version is accepted because of the possibility that reviewers might ask us to alter our algorithm. This supplement will now be included.

Table 1: consider including p-values.

Given the size of the dataset, we prefer to not include p values because they are all extremely small ($p=10^{-6}$ for the weakest of these regression).

References:
Akaike, Hirotugu. 1981. "Likelihood of a model and information criteria." Journal of Econometrics 16 (1):3-14. doi: 10.1016/0304-4076(81)90071-3.

Bowen, Gabriel J, Zhongfang Liu, Hannah B Vander Zanden, Lan Zhao, and George Takahashi. 2014. "Geographic assignment with stable isotopes in IsoMAP." Methods in Ecology and Evolution 5 (3):201-206.

Hair, J.F., W.C. Black, B. Babin, R. Anderson, and R.L. Tatham. 2005. Multivariate data analysis. 6th ed. Upper Saddle River, New Jersey: Prentice Hall.

Jasechko, Scott, James W. Kirchner, Jeffrey M. Welker, and Jeffrey J. McDonnell. 2016. "Substantial proportion of global streamflow less than three months old." Nature Geosci 9:126-129. doi: 10.1038/ngeo2636.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2019-61, 2019.