Response to Reviewer 1:

We would like to thank you for your positive comments and helpful suggestions. We revised our manuscript accordingly and are providing below a point-by-point response to each comment.

Main comments

1. In the manuscript, the authors mentioned the precipitation, temperature, and streamflow data in the study area (p.5 l.108) but gave only a URL (http://hhsy.casnw.net). How to download the data is not mentioned. Given the importance of the precipitation, temperature, and streamflow data to the use of datasets in this manuscript, I strongly recommended adding meteorological stations and hydrological monitoring points in the Study Area section and explaining how to apply for and download these data.

Response: To address this comment, we have added the locations of meteorological and stream gauging stations in Fig. 1, and also described how to access these data in detail in the revised manuscript.

The sentences read now as:

"*The hydrometeorological monitoring network in the study area is composed of five automatic meteorological stations and one stream gauging station (Fig. 1), which are maintained and operated by the Qilian Alpine Ecology and Hydrology Research Station, Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences (http://hhsy.casnw.net). Researchers with reasonable request for the precipitation, air temperature and streamflow data in the study area can apply for via email. The website for the specific contact information is: http://hhsy.casnw.net/lxwm/index.shtml.*"

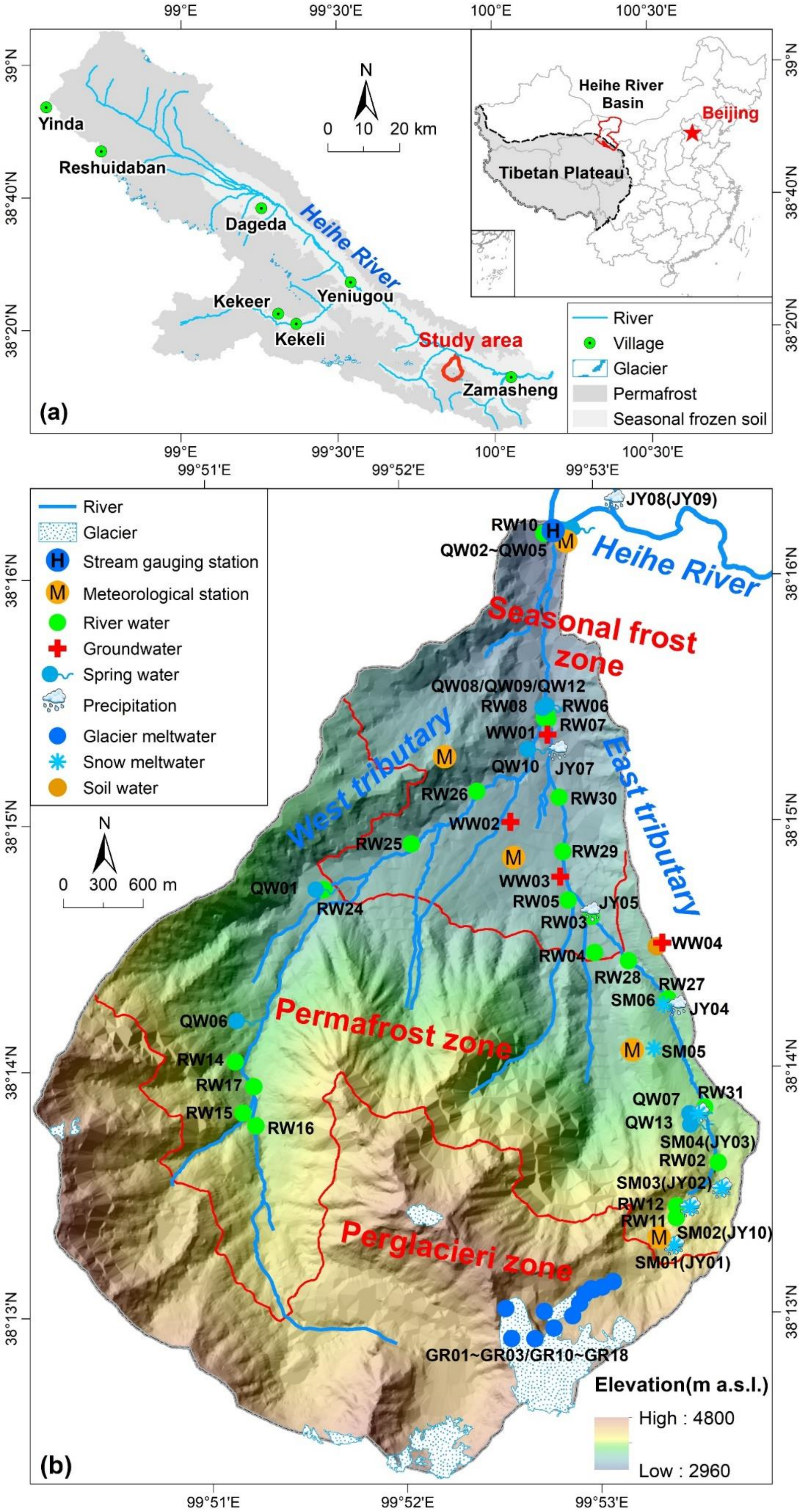

Figure 1. (a) The location of the study area in the headwater regions of the Heihe River Basin; and (b) the Hulugou catchment showing the topography and the monitoring and sampling sites. The permafrost distribution and elevation data are obtained from the National Tibetan Plateau Data Center (http://data.tpdc.ac.cn), and the resolution of elevation data is 5 m.

2. As a descriptive manuscript related to the field monitoring data, it should present the details about the study area as much as possible. However, the study area description in the manuscript, such as permafrost and planation surface, is too broad. It does not promote my understanding of the conditions at these sites. Can the authors provide some pictures of each typical landform, the well group layout, and the core lithology of the borehole? Furthermore, please add a geological map of the study area.

Response: We now have added the pictures showing each typical landform, the well group layout, and the core lithology of the borehole, as shown in Fig. 2, Fig. 3, and Fig. 4. In addition, we have put the geological map in the supplementary file.

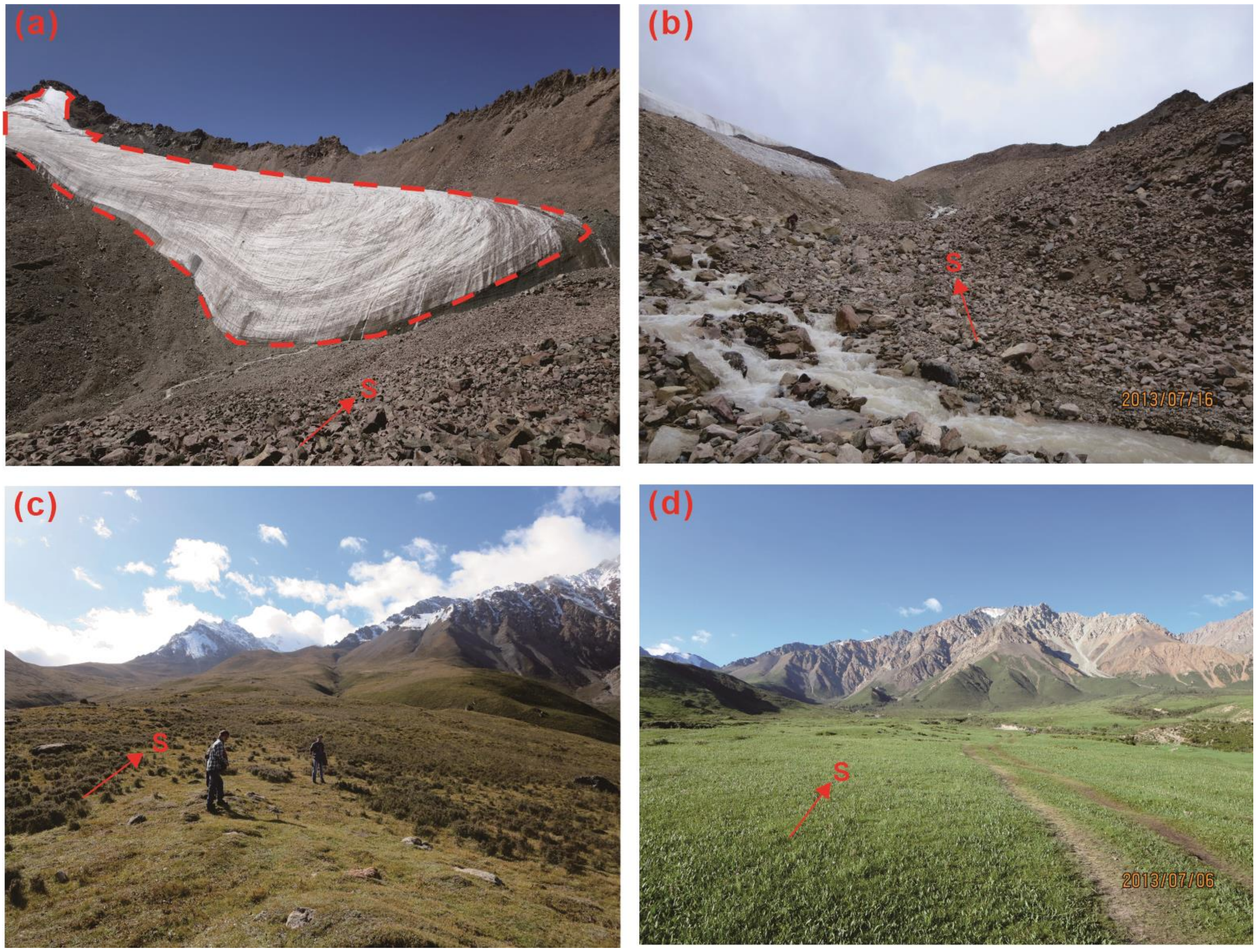

Figure 2. Pictures showing (a) the glaciers in the south of the study area, (b) the moraine sediments in the periglacial zone, (c) the planation surface in the permafrost zone, and (d) the piedmont alluvial plain in the seasonal frost zone.

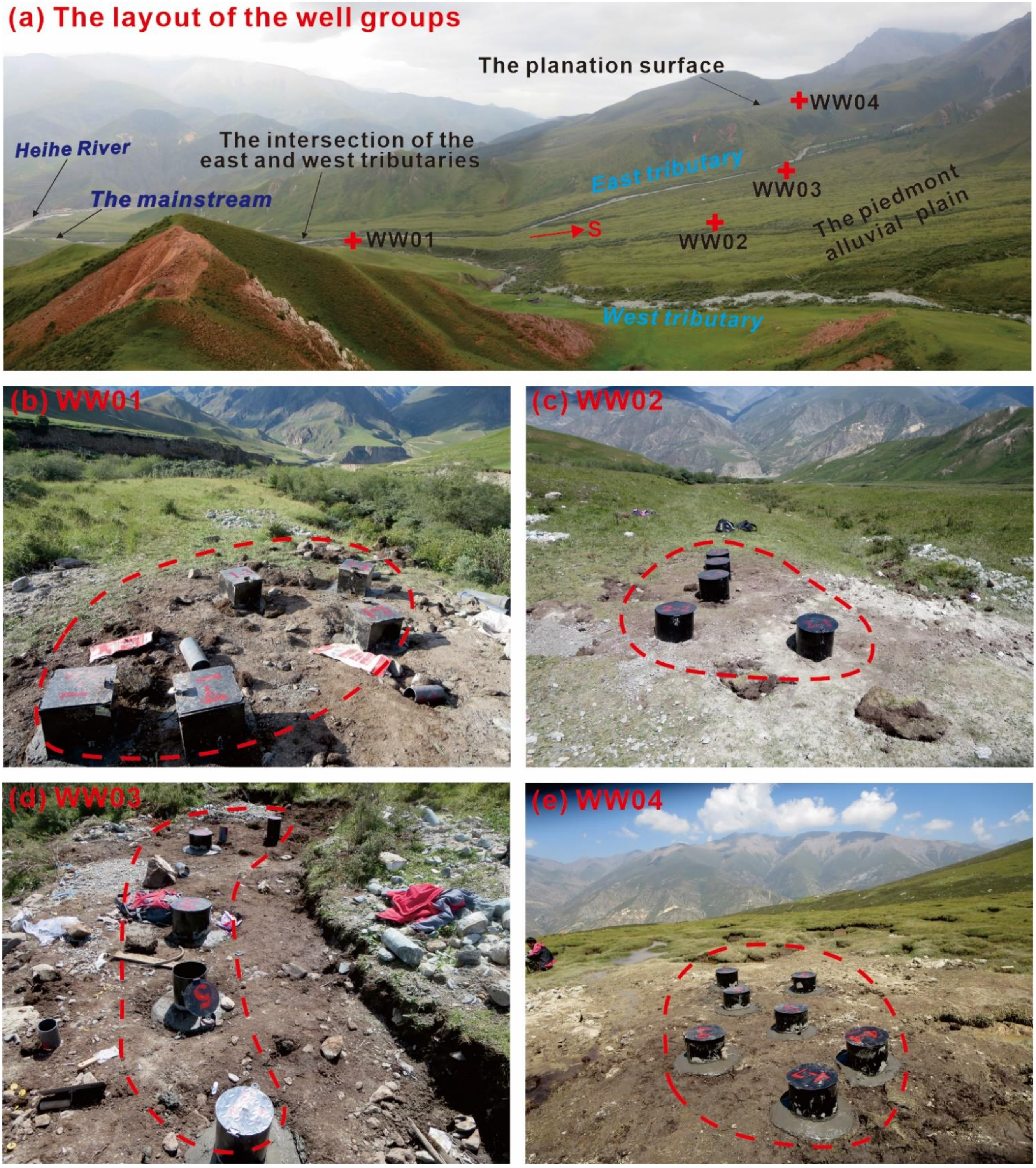

Figure 3. Pictures showing (a) the field scene of layout of all well groups in the study area, (b) the well group WW01, (c) the well group WW02, (d) the well group WW03, and (e) the well group WW04.

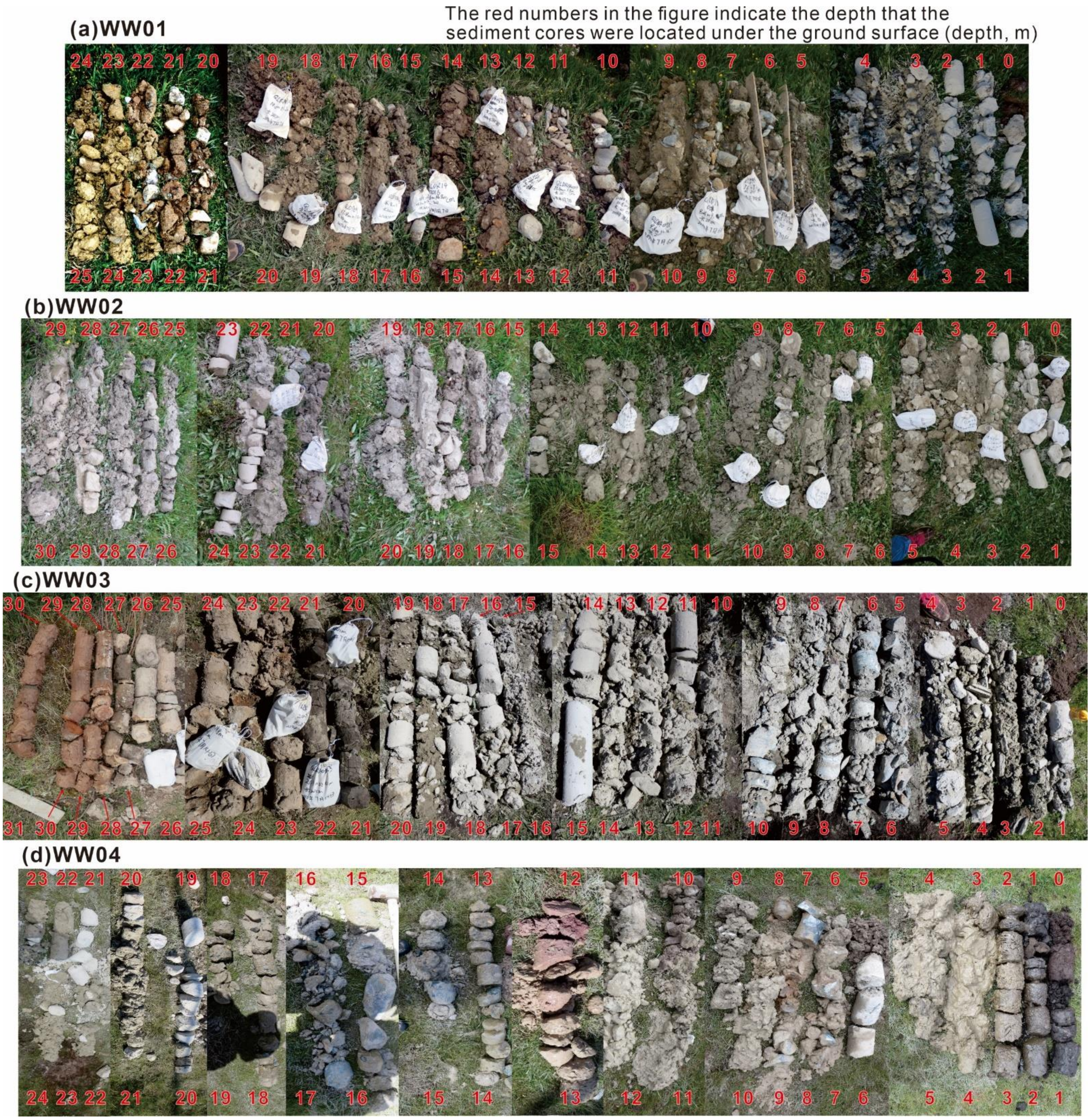

Figure 4. Pictures showing the core lithology at different depth below ground surface from well group (a) WW01, (b) WW02, (c)WW03, and (d) WW04.

The geological map of the study area.

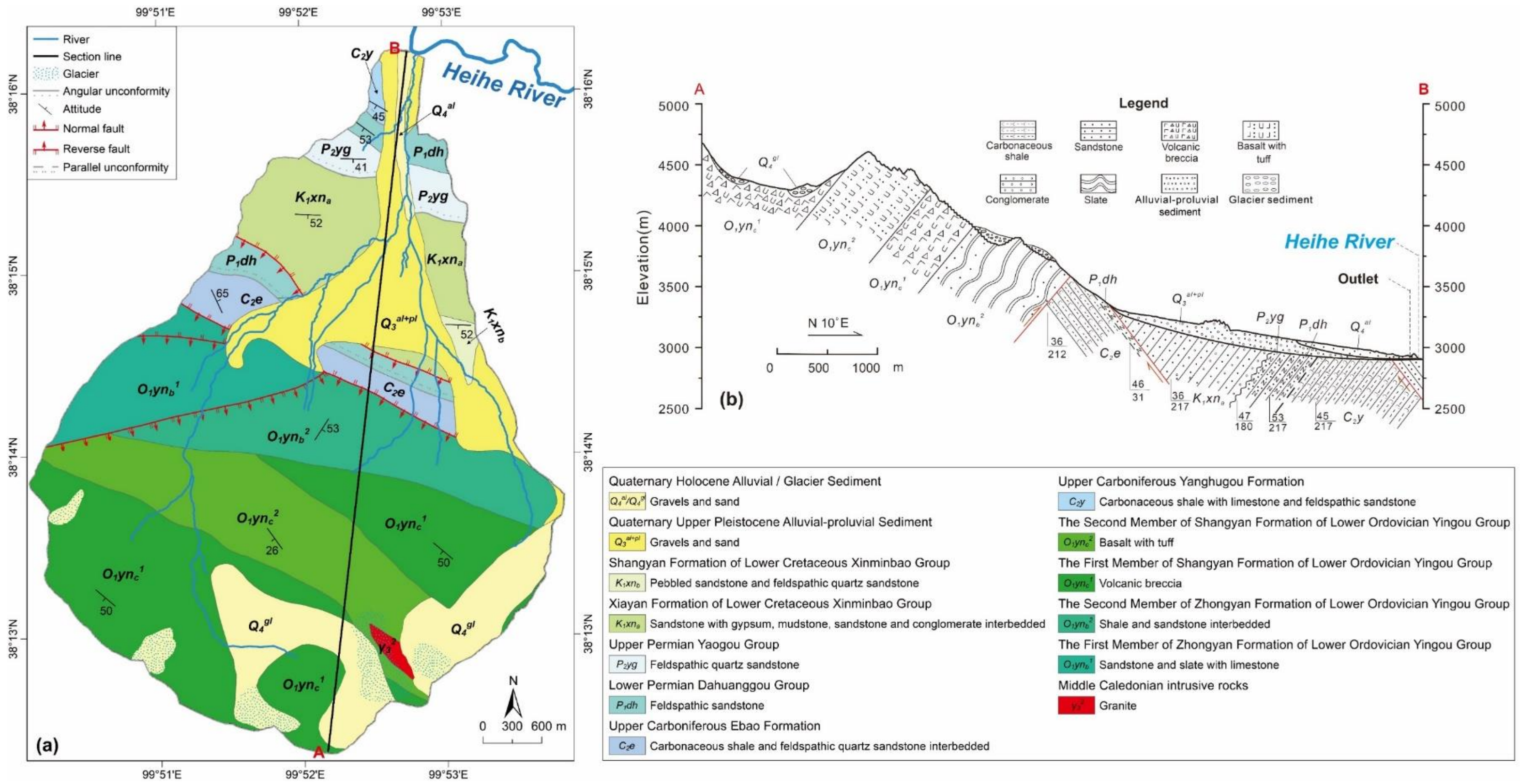

Figure S1. (a) Geologic map of the study area; (b) a geological cross section (Modified from Liu, 2013; Ma et al., 2017; Chang, 2019).

References

Chang, Q.: Water Sources of Stream Runoff in Alpine region and their Seasonal Variations: onA Case Study of Hulugou Catchment in the Headwaters of the Heihe River, Ph.D. , School of Environmental Studies, China University of Geosciences Wuhan, 158 pp., https://doi.org/10.27492/d.cnki.gzdzu.2019.000112, 2019.

Liu, Y.: Using hydrochemical and isotope tracers analying to delineate hydrologic process in cold alpine watershed in rainy season, Ph.D., School of Environmental Studies, China University of Geosciences Wuhan, 104 pp., 2013.

Ma, R., Sun, Z., Hu, Y., Chang, Q., Wang, S., Xing, W., and Ge, M.: Hydrological connectivity from glaciers to rivers in the Qinghai–Tibet Plateau: roles of suprapermafrost and subpermafrost groundwater, Hydrol. Earth Syst. Sci., 21, 4803-4823, https://doi.org/10.5194/hess-21-4803-2017, 2017.

3. In the alpine area with extreme weather conditions, the sensor's accuracy is especially essential in the quality assurance of field monitoring data. And to gain this, a priority is to conduct systemic sensor calibration. However, no information about the sensor calibration can be found in the manuscript. Therefore, I highly recommend reinforcing the information about the processes and results of sensor calibrating in the manuscript.

Response: All temperature sensors were calibrated in the laboratory before use. We placed each temperature sensor in water under eight different temperatures (-40 ℃, -30 ℃, -20 ℃, 0 ℃, 10 ℃, 20 ℃, 30 ℃, 40 ℃) and the temperatures were measured using the sensors. The slopes and the correlation coefficients between measured vs. actual values for all sensors were in the range of 0.998–1.003.

Similarly, all pressure sensors were placed under the condition of the nine different pressures (10 kpa, 50 kpa, 100 kpa, 150 kpa, 200 kpa, 250 kpa, 300 kpa, 350kpa, 399 kpa), and the pressures were measured by these sensors. The slopes and the correlation coefficients between measured vs. actual values for all sensors were in the range of 0.999–1.001.

We have added the description of sensor calibration in the supplementary file of the revised manuscript.

4. Similarly, detailed information about the processes of water sampling is vital to evaluate the quality of hydrochemical and isotopic data. Unfortunately, I cannot find any information regarding this. So, it is suggested to provide detailed information (better with some photos) about sampling processes of different water reservoirs, including precipitation, glacier meltwater, groundwater, etc. In addition, the accuracy controlling of analytical results needs to be explained.

Response: We have added some photos showing water sampling process in the revised manuscript, as shown in Fig. 5. The river water and glacier meltwater samples were collected under the natural flow conditions and the stirring up of the sediments at the bottom of the river were carefully avoided. For the self-spraying spring water, samples were collected at the center of the effluent flow at the spout. The spring water samples that were not self-spraying were collected after the stagnant water was drawn out. For the groundwater, at least 3-PV waters were purged from the wells before sampling to ensure the old waters were drained out.

A device that was made of stainless steel as shown in Fig. 5e was set to collect snow meltwater samples in the field sites. The upper cover of the device was removed so that snow could fall into it. A small hole was opened at the bottom of the device and connected to the polyethylene pipe. When the temperature rose, the snow melted inside the device and the meltwater could slowly flow from the pipe into the polyethylene bottle at the other end of the pipe. In this way, the snowmelt water samples were collected.

To collect precipitation, a device as shown in Fig. 5f was used. Precipitation samples were collected by using a circular funnel of 14-cm in diameter made of polyethylene which was cleaned with ultra-pure water before each precipitation to remove and dry fallout accumulated in the preceding dry period. Precipitation passed through a polyester screen inserted in the top of the funnel into a polyethylene bottle at the bottom of the funnel. To minimize dry (dust) deposition, a ping-pong ball was set in the funnel. This device was held in place by a stainless steel cylinder and was reinforced by stones around it.

The sampling processes for different water reservoirs were described in the revised manuscript.

During measurement of major ions, DOC, DIC in the laboratory of our university, the standard curve was carefully prepared and the stability of instrument was tested before measuring the samples. The correlation coefficients of standard curves were greater or equal to 0.9999. The quality control samples (the chemical or isotopic concentrations of water were known) were tested at every five-eight measured samples to check the data quality. The deviation between measured and true (reference) values for the quality control samples was less than 5 %, so as to ensure the stability of instrument. When the measurements of major ions concentrations were finished, we also calculated the charge balance for the water samples and the errors were within ± 5%. Since some samples were sent to the professional analysis institutions (including the laboratory of the Huazhong University of Science and Technology, and the Third Institute of Oceanography, Ministry of Natural Resources), which have been certified by professional laboratory qualification, the data quality should be ensured. We have added the content about the accuracy controlling of analytical results in the revised manuscript.

Figure 5. Pictures showing the sampling processes for (a) river water, (b) glacier meltwater, (c) spring water, and (d) groundwater in the field sites. The collection devices for snow meltwater and precipitation were shown in (e) and (f), respectively.

Minor comments

These are my minor comments, in order of appearance:

1. p.7 l.150: Please explain the data source for the permafrost range in figures 1(b) and 1(c) and the source and resolution of elevation data in Figure 1(c)? In addition, the phrase 'spring water' was used in the manuscript, while the word 'spring' was used in Figure 1(c). Please keep consistent.

Response: The data source for the permafrost range and the elevation in Figures 1(b) and 1(c) are obtained from the National Tibetan Plateau Data Center at website http://data.tpdc.ac.cn. The resolution of elevation data is 5 m in Figure 1(c). We have modified the caption of Figure 1 in the revised manuscript. Please refer to the response to Main comments #1.

2. p.12 l.203: What does '/' mean in Table 2? Is it the same as 0%? Please explain clearly.

Response: The '/' symbol in Table 2 is same as 0%. To be consistent, we have changed the '/' symbol to 0. Please refer to new Table 2 in the revised manuscript.

3. p.13 l.210: The interval of temperature monitoring seems to have been forgotten to mention.

Response: We have added the interval of temperature monitoring (30-minute intervals) in the revised manuscript.

4. p.14 l.224: In Figure 3, the lines used to represent the groundwater level are broken. Is it due to missing data or something else? There is a similar problem in Figure 4 (p.15 l.233). It is recommended to tabulate the available data in the manuscript.

Response: The main reason for the broken lines in the hydrographs is that some groundwater level data are missing because that the groundwater tables were deeper than wells screen depths during cold periods. The missing data for temperature is due to some problems of the sensors, such as damage or power failure. We have tabulated the available data in the revised manuscript, as shown in Table 1 and Table 2.

Table 1. The periods with available groundwater level data.

Well group no.	Borehole depth (m)	Data available periods
WW01	5	2014/08–2014/12, 2015/07–2015/12, 2016/07–2016/12, 2018/08–2018/12, 2019/07–2019/12
	10	2014/08–2015/01, 2015/06–2016/01, 2016/06–2017/01, 2017/06–2018/01, 2018/06–2019/01, 2019/06–2020/01, 2020/06–2020/08
	15	2014/08–2015/02, 2015/06–2016/02, 2016/06–2017/02, 2017/06–2018/02, 2018/06–2019/01, 2019/06–2019/09
	25	2014/08–2015/02, 2015/06–2015/07, 2015/09–2019/08
WW03	20	2014/08–2014/10, 2015/04–2015/06, 2015/07–2020/08
	30	2014/08–2014/12, 2015/04–2020/08
WW04	1.5	2014/09–2015/01, 2015/07–2016/01, 2016/09–2017/01, 2017/04–2017/07, 2018/07–2019/12, 2019/08–2019/12, 2020/07–2020/08
	24.3	2015/08–2016/07

Table 2. The periods with available ground temperature data.

Well group no.	Depths (m)	Periods of data available
WW01	0.2, 1	2014/09–2017/07, 2018/07–2020/07
	0.5, 1.5	2014/09–2017/07, 2018/07–2019/09
	2, 3, 5	2014/09–2018/11
	10, 13, 23	2014/09–2019/07
WW02	0.2, 1, 1.5	2014/09–2019/05, 2019/07–2020/08
	0.5	2014/09–2018/09, 2019/07–2020/08
	2, 3, 5	2014/09–2014/10, 2015/01–2017/04, 2017/08–2020/08
	10, 15, 30	2014/09–2020/08
WW03	0.2, 0.5, 1, 1.5	2014/09–2016/07, 2016/9–2020/06, 2020/07–2020/08
	2, 3, 5, 10, 18.5, 29	2014/09–2020/08
WW04	0.2, 0.5, 1, 1.5	2014/09–2020/08
	2, 3, 4.7, 6.7	2014/09–2019/04, 2019/07–2020/06
	11.8, 17.2	2014/09–2019/07
	23.6	2014/09–2015/09

5. Section 4.2, 4.3, 4.4, and 4.3: These sections involve various analysis methods of water samples. A table is suggested to add to make a summary about these methods.

Response: We have added Table 3 to summarize the analysis methods in the revised manuscript.

Table 3. Summary of the analytical methods used for measuring water chemical and isotopic compositions.

Indicators	Analytical instrument	Model of the instrument
T, pH, DO, EC, and ORP	A portable water quality analyzer	HQ40d, Hach, USA
Anions (Cl^-, Br^-, NO_3^-, and SO_4^{2-})	Ion chromatography	IC 761/813, Metrohm, Switzerland
		Dionex ICS 1100, Thermo Elemental, USA
Ca^{2+}, K^+, Mg^{2+}, Na^+, Si, Sr, and Fe	Inductively coupled plasma atomic emission spectroscopy	IRIS INTRE II XSP, Thermo Elemental, USA
DOC	High-temperature catalytic oxidizer	Multi N/C 2100 TOC, Analytik Jena AG, Germany
		Aurora 1030W, OI, USA
DIC	Mass spectrometry	Delta V advantage, Thermo Elemental, USA
	High-temperature catalytic oxidizer	Aurora 1030W, OI, USA
^{13}C	Mass spectrometry	Delta V advantage, Thermo Elemental, USA
	Spectrometry	G2131-I, Picarro, USA
^{2}H and ^{18}O	Mass spectrometry	Finnigan MAT253, Thermo Elemental, USA
	Spectrometry	L2130-I, Picarro, USA
^{3}H	Liquid scintillation	QuantulusTm 1220, PerkinElmer, USA
^{14}C	Mass spectrometry	3MV Tandetron AMS, HVEE, Netherlands

Technical comments

1. p.7 l.150: Since many monitoring and sampling sites belonging to different types were involved, it is recommended to rearrange Figure 1 to obtain a better visual effect.

Response: We have rearranged the layout of Figure 1 in the revised manuscript. Please also refer to the response to the Main comments #1.

2. p.10 l.152: ‘Table 1 (continued)’ should be changed to ‘Table 1. (continued)’.

Response: Change was made as suggested.

3. p.13 l.209: Please check the resolution of the pressure sensor (HOBO U20–001–02, ONSET, USA). The resolution should be 0.41 cm, not 0.21 cm.

Response: We have corrected the error in the revised manuscript.

4. p.13 l.210: The wire length of the temperature sensor (HOBO S–TMB–M0017, ONSET, USA) is only 17 m. Just out of curiosity: how to measure the temperature to a depth of 30 m?

Response: There are extension cables (HOBO S–EXT–M025, ONSET, USA) for measuring temperatures at deeper depths. We have added the description for the use of extension cables in the revised manuscript.

5. p.13 l.213: Please check the resolution of the temperature sensor (HOBO S–TMB–M0017, ONSET, USA). The resolution should be ±0.03 °C, not 0.03 °C.

Response: Change was made as suggested.

6. p.14 l.224 and p.15 l.233: It is tough to see the differences described in your text from Figures 3 and 4 because the x-axis covers a range as long as six years. Please consider adding another plot or subplot with a shorter time span.

Response: We have added the subplots showing the change of groundwater table depth and temperature within one hydrological year in Figure 6 and 7 in the revised version.

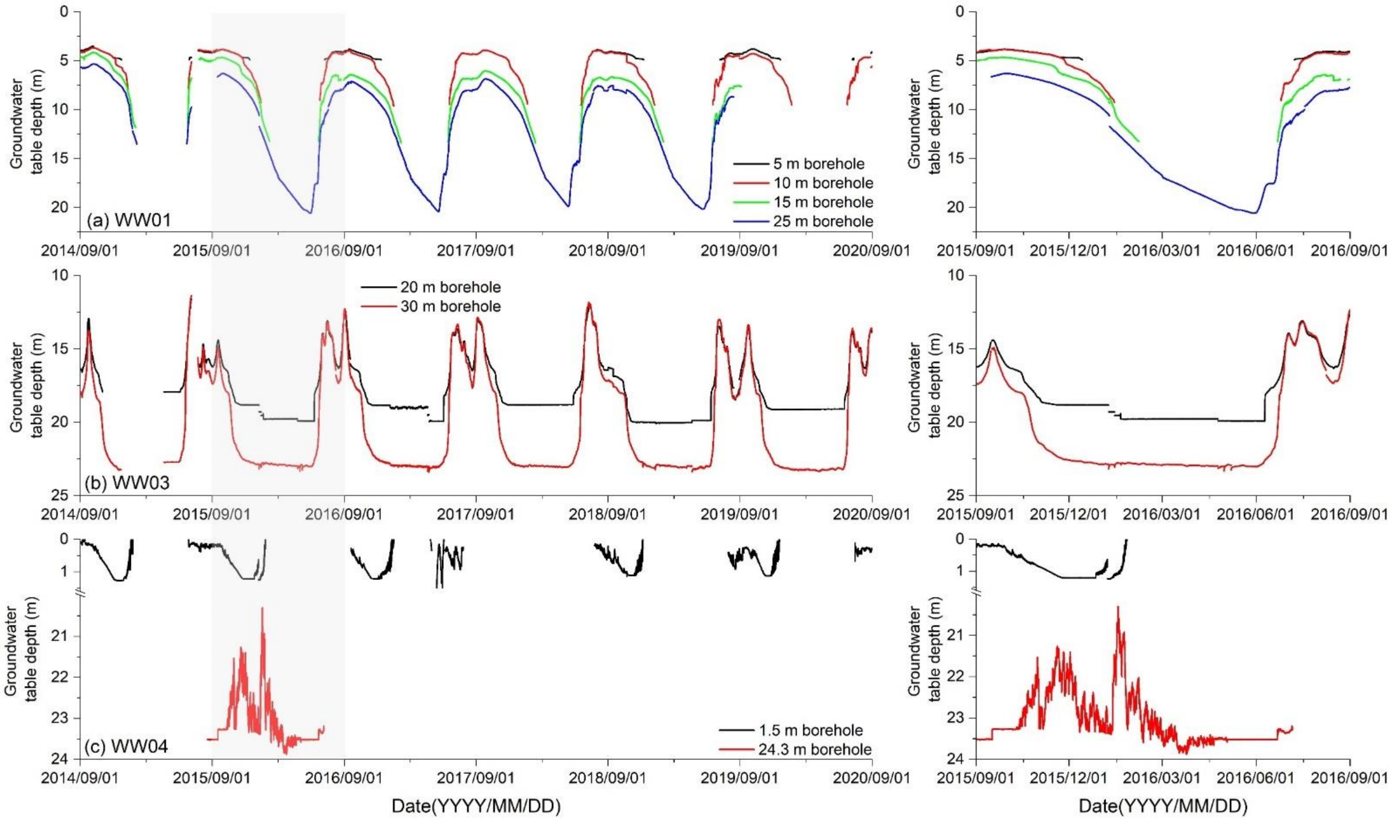

Figure 6. The mainplots (left) showing the change of the groundwater table depths along with consecutive six years, and the subplots (right) highlighting the change of groundwater table depths within one hydrological year.

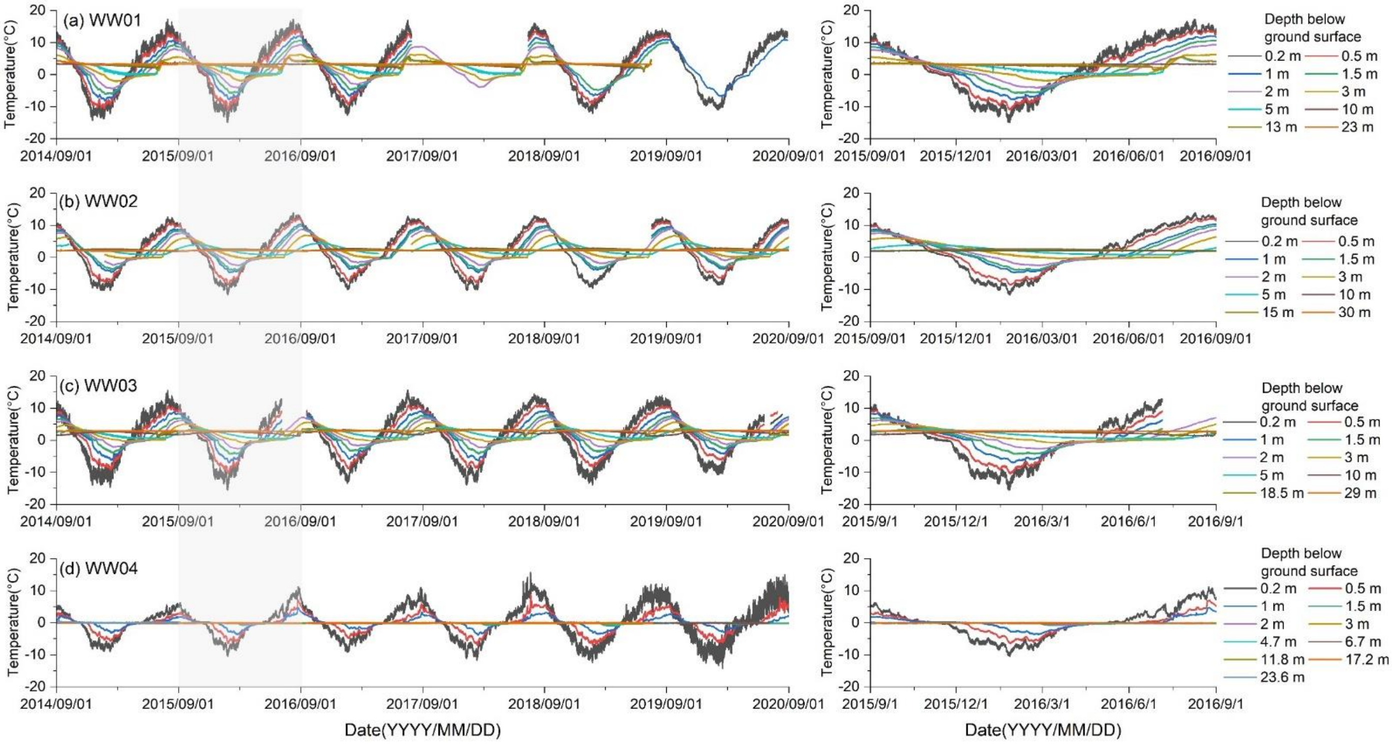

Figure 7. The mainplots (left) showing ground temperatures change at different depths along with consecutive six years, and the subplots (right) highlighting the change of ground temperatures at different depths within one hydrological year.

7. p.16 l.260: Please double-check the pore diameter of the filter membrane used for DOC water sampling. It should be 0.7 μm.

Response: It is 0.7 μm and we corrected it.

8. p.18 l.291: 'ppb' is generally not used to represent the unit of measurement precision. It is suggested to be replaced by 'ug/L'.

Response: Change was made as suggested.

9. p.18 l.300: A space is missing in 'of' and '^{13}C'.

Response: Change was made as suggested.

10. p.28 l.590 and p.28 l.608: The URLs of the two references cannot be opened. Please double-check.

Response: After inspection, only the URL of the reference in p.28 l.608 cannot be opened. Therefore, we have changed the URL that can be opened in the revised manuscript, as follows: http://en.cnki.com.cn/Article_en/CJFDTOTAL-ZRZZ201303004.htm.

The dataset

These comments concern only the dataset itself given at https://doi.org/10.5281/zenodo.5184470

1. There seems to be a language problem with the title of the dataset. Please correct it.

Response: We have corrected the error. Please refer to the latest version of the dataset (https://doi.org/10.5281/zenodo.5915151).

2. Please add elevation data for each site in the datasets.

Response: We have added elevation data for each site. Please refer to the latest version of the dataset (https://doi.org/10.5281/zenodo.5915151).

3. Please simplify the analysis results. For example, the DOC concentration in precipitation was not measured using the total organic carbon analyzer (Multi N/C 2100 TOC, Analytik Jena AG, Germany). Thus, this column can be deleted from the datasets.

Response: We have simplified the dataset and deleted the column of the DOC concentration in precipitation. Please refer to the latest version of the dataset (https://doi.org/10.5281/zenodo.5915151).

4. It seems that some groundwater level data were missing. Please explain the reasons for the data missing (please refer to Minor comment #4).

Response: Thanks for your suggestion. Some missing groundwater level data is because that the groundwater tables were deeper than wells screen depths during cold periods and thus not shown in the figure.