

# Kilimanjaro Field Report — 27 September to 10 October 2023

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Logistics with SENE (Summit Expeditions and Nomadic Experience; based in Moshi): ~25 crew + some porters for resupply + 19 porters who helped carry down the stations (some did multiple carries).

## **Fieldwork Summary**

27.09 - Our planned start to the mountain was delayed due to a missing document from TANAPA. The superior institution (TAWIRI) “authorized” a park fee waiver for us after months of negotiation by Doug, but not all personnel were informed and a request to TANAPA was not sent in time, due to a misunderstanding about a final report.

28.09 - Still no fee waiver from TANAPA, because of public holiday. Annoying negotiations by Whatsapp and e-mail, resulting in loss of another day on the mountain. We also couldn't work at the archive because UWC was closed (because of the holiday).

29.09 - Finally we got our long-promised park fee waivers and started walking from Umbwe Gate at about 14:00. Overcast, but mostly dry, some rain on arrival at Umbwe Cave Camp (ca. 2900m).

30.09 - Hiked to Barranco Camp (ca. 3950m). Fair weather during the morning hours enabled good views to Kibo's southside and the glaciers remnants there. Light rain and dense fog in the afternoon.

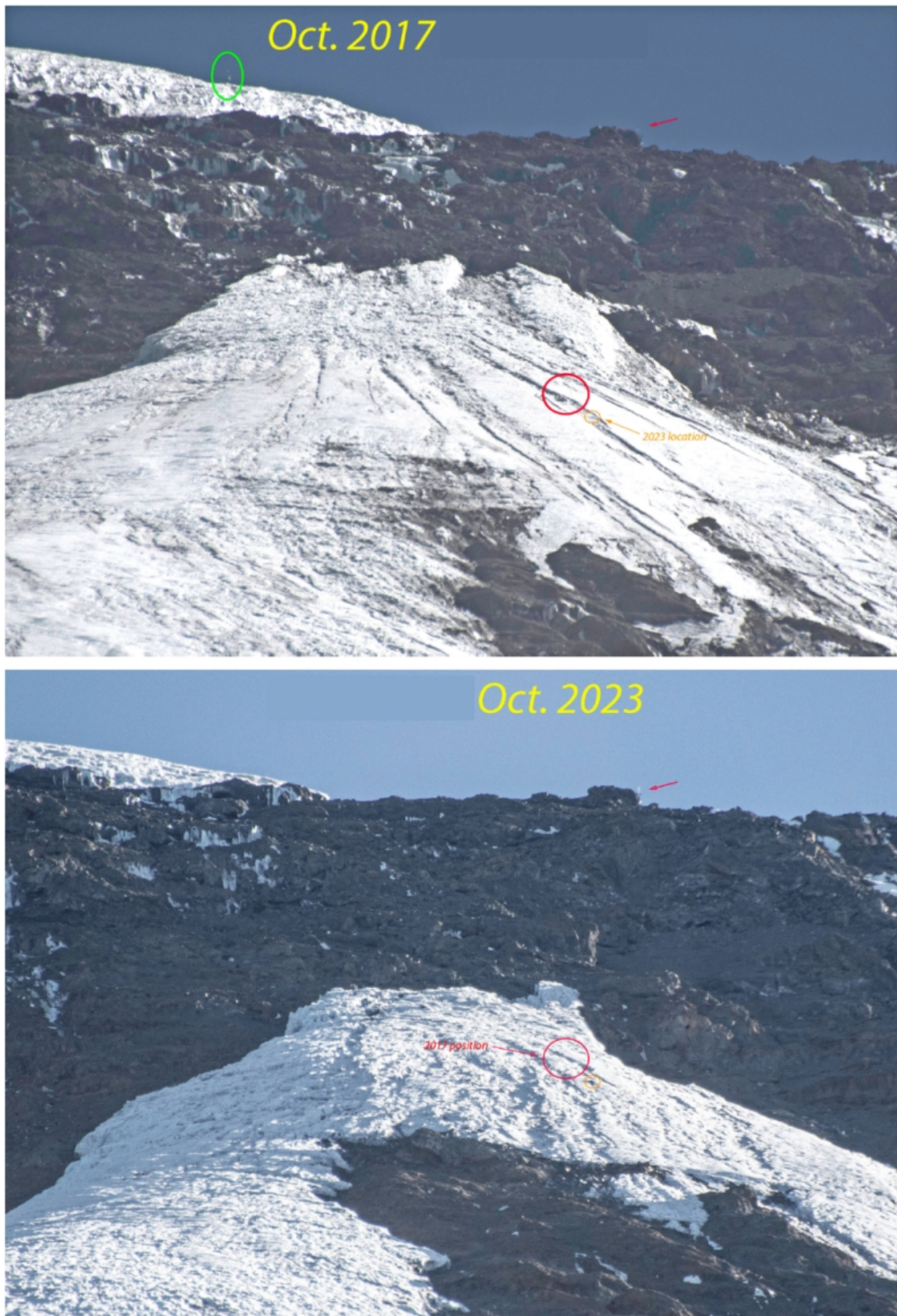
01.10 - We decided to spend five nights acclimatizing to maximize our ability to work at the summit. We used the foggy day for an acclimatisation hike to Arrow Glacier Camp (ca. 4850m) and down via Lava Tower Camp.

02.10 - Early start to Karanga Camp (ca. 4000m) to avoid slow crowds on the “Breakfast Wall” above Barranco, allowing views of the south-side glaciers before typical morning convection. Diamond Glacier looks quite dirty. Haim Galciens and Decken Glacier are more or less gone. Kersten Glaciers is split up in two parts, the lower part will split up again soon. No signs of AWS4 visible, however, Doug was able to make tele shots where he could identify AWS4 back home on the screen (see Figure 1). Weather stayed dry and sunny basically the whole day – our forecasts were all more or less correct (own from September 28<sup>th</sup>, Thomas Mölg's and Alex Radlherr's from ca. October 1<sup>st</sup> via Signal). This provided confidence in forecasts for our scheduled hike to the peak (early October 4<sup>th</sup>): rain and strong winds...

03.10 - After many days of hardly any sleep, Doug decided to stay another night at Karanga Camp, with medication brought up by Simon. Emily and Mike walked to Barafu Camp (ca. 4700m). Very sunny, but getting more and more windy.

04.10 - After a short and windy night, Emily and Mike started to hike up at around 4:00 am – together with guides Jackson and Godlisten. It was very windy, in the upper part of the camp even some tents were broken. Additionally, conditions were harshened by freezing rain, drizzle and fog. Stella Point (ca. 5750m) was reached at about 10:00 am. Continuous drizzle ended,

but there was still occasional riming and short showers – mostly liquid, also at the top (Uhuru Peak, 5895m), sometimes as graupel.



**Figure 1** Upper and lower part of Kersten Glacier as seen through a zoom lens from the trail between Barranco and Karanga Camps. The red (orange) circle indicates the position of AWS4 in October 2017 (2023). It has fallen over in 2014. The green circle shows AWS3, which fell over latest in 2018. The red arrow points to the relay station of AWS4 which was detached during this trip. (photos by D. Hardy)

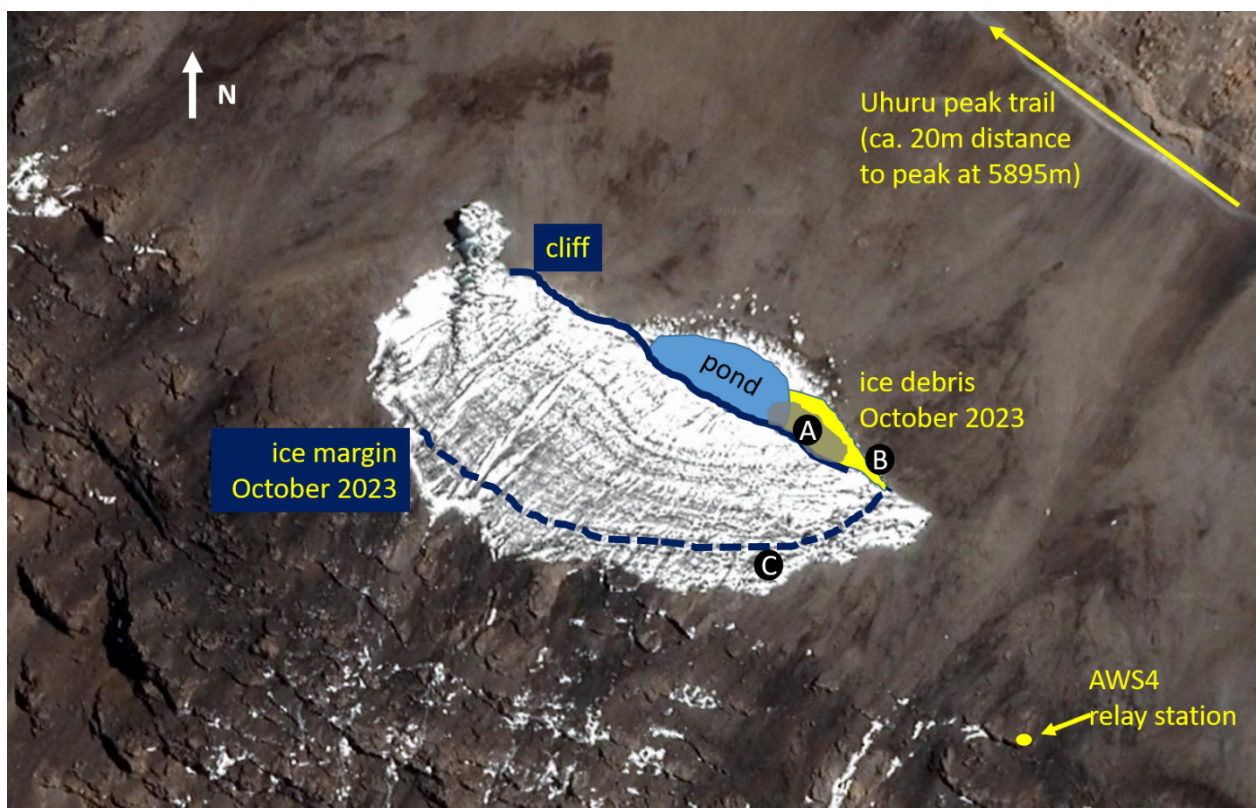
## Southern Ice field (Kersten Glacier)

From Stella Point we directly headed towards the relay station of AWS4, which used to be found easily. However, due to fog and now missing ice bodies, it could only be found with the help of GPS. A pile of some 10 stakes (from Doug, ca. 5850m) was found on the way, and another two stakes, lying on the ground to the east of the relay station, were added to it.

Detaching the stations was tough, because of the wet conditions (mostly graupel at that time), but rather straight forward. The station was in overall good condition, although there was some rust and corrosion inside the logger box. Surprisingly, there was no SD card in the respective slot. Later we realized that it was taken away by Doug in 2017 already, who knew already that AWS4 has fallen over (which happened most likely during 2014).

Mike unsuccessfully tried to get a view of AWS4. Fog was too dense along the flanks down to the lower part of Kersten Glacier to see the station.

The relay station was carried up some 70 meters altitude to the pile of stakes by five persons (porter Gabriel joined in the meantime) and deposited there in order to bring it down the mountain later. Carrying it up was harder work than expected. It is a huge difference if you have to carry 20+kg load up or down under these conditions. This experience was a first step back from the plan to recover AWS4.



**Figure 2** Overview of the upper part of Kersten Glacier. Based on a Googlemaps view, presumably from 2021. (A) depicts the area where AWS3 is buried, cf. green circle in Figure 1. (B) is where the segment of the original AWS3 was found (cf. Figure 8). At (C) the segments of the temperature string tower were found (cf. Figure 10).



**Figure 3** The relay station of AWS4 as it was found on October 4<sup>th</sup>, 2023. The pictures were taken by M. Winkler, just before the detachment of the station.



**Figure 4** The depot for the relay station and a pile of PVC stakes about half way between Kersten Glacier and the Uhuru Peak trail. Porters picked up the material from here and carried it down between October 5<sup>th</sup> and 6<sup>th</sup>, 2023. (picture by E. Collier)

Afterwards we reached Uhuru Peak (ca. 12:00). It was still windy and densely cloudy along the flanks, also rain showers occurred from time to time, but on the crater rim and the crater itself it got more and more sunny. So Emily and Mike got the chance to investigate the fate of AWS3.

At the left (Eastern) margin of the Kersten Glacier ice cliff (facing North, towards Uhuru Peak) there are ice block debris (ca. 40x20m, at least some 8m high, see Figure 2, Figure 7 and Figure 8), to the right of those there is a frozen pond (estimated 80x20m). The ice cliff acts as a dam for it, as the cliff/glacier further retreats, the pond will drain towards the South. Under the ice debris one segment of the AWS3 smart stake was found. Most likely it is the lowest segment that had to be left in the ice when the station was redrilled on February 1<sup>st</sup>, 2009.



**Figure 5** AWS3 on the uppermost part of Kersten Glacier (installed on February 8<sup>th</sup>, 2005) at 5873m and a mast tower with a temperature string about 10 meters to the East of it. The latter was installed in July 2005, and it was set out of order and detached (except the mast) before 2008. The picture was taken by N. Cullen in July 2005.



**Figure 6** Pictures from September 2009 (by M. Winkler) showing the segments of the temperature string tower (left and center) and the AWS3 (right) that had to stay in the ice. The spare part of the temperature string tower (left) was recycled when redrilling AWS3. Remnants of the temperature string sensors can be seen in the center picture. The arrows point to the two black tapes, that led to secure identification of the segments in 2023 (see Figure 10).



**Figure 7** The Easternmost section of the North-facing cliff of the Upper Kersten Glacier in October 2023 (photo by M. Winkler). The cliff is overhanging, on the right one can see the frozen pond, in the center there is the ice debris, that most likely covered AWS3.



**Figure 8** M. Winkler standing on the ice debris at the margin of Kersten Glacier, looking for AWS3, that very likely is covered right beneath or some meters behind him. The big picture was taken by E. Collier on October 4<sup>th</sup>, 2023. The insert photo shows how the single mast segment of the AWS3 mast (Figure 6; right) was found below the debris. The small photo was taken by M. Winkler; Oct 4<sup>th</sup>, 2023, virtually at the same place than big picture (point (B) in Fig. 2).



**Figure 9** M. Winkler looking for AWS3 on the Eastern remnants of the upper part of Kersten Glacier on October 4<sup>th</sup>, 2023. E. Collier photographed him. He could not find the station on the ice or at its lower margins, which makes it very certain that the station fell over the cliff and was buried by ice debris or maybe also in the pond seen in Figure 7.



**Figure 10** E. Collier found the two mast segments of the temperature string tower that had to remain in the ice. The place of discovery was the lower (Southeastern) edge of the upper remnant of the Kersten Glacier (point (C) in Fig. 2). The arrows mark the tape traces that led to identification (cf. Figure 6; left and center). The picture was taken by M. Winkler on October 4<sup>th</sup>, 2023.

The GPS coordinate of the AWS3 suggests that the station is covered by the debris, possibly very close to the pond, but most likely not rather in the pond. This could be further confirmed by Mike who walked on the ice body (from the Northeast) up to the cliff and found no sign of the station, neither on the ice nor at its lower (= Southern) margin. Another two mast segments were found Southeast of the ice remnant (at approx. 5820m). Those two parts could be clearly identified as the two lowest segments of a temperature string tower that was installed about 10m East of the AWS3 in July 2005. (The uppermost segment of this tower has been taken away when the measurements there were stopped in 2006 or 2007. Another segment was recycled when AWS3 was redrilled in 2009. Two segments stayed in the ice. They melted out, fell over and slid to the South between 2010 and 2015.)

It got clear that AWS3 cannot be recovered before it melts out, which might not be the case within the next 3-5 years. The status of the ice debris and the frozen pond can easily be observed from Uhuru Peak. Therefore, it should be possible to get pictures from time to time.

Finally, we got back to Uhuru Peak, descended down to Crater Camp and the remnants of Furtwängler Glacier and reached our camp at the Northern Ice Field at mid-afternoon.

05.10 — Very cold and windy conditions continued. However, over the crater it mostly was sunny. Clouds were only forming at the mountain's flanks but they did hardly put the crater and its rim in fogs.

### **Northern Ice field**

First thing in the morning, Mike and Emily retrieved four years of data of as-of-yet unknown quality from AWS2 and then dismantled the station.



**Figure 11** AWS2 as found on its last day (October 5<sup>th</sup>, 2023). Strong winds during the preceding 48 hours caused some riming of the sensor. (picture by M. Winkler)





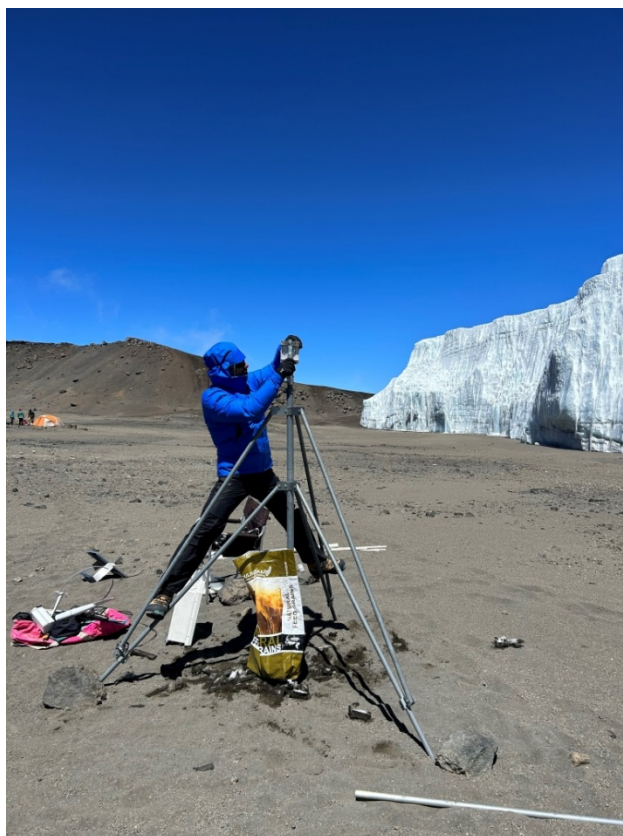
**Figure 12**

Sensors of AWS2 in the morning of October 5<sup>th</sup>, 2023 (Picture: M. Winkler)



**Figure 13**

The dry conditions on the summit of Kilimanjaro are good for electronic parts. After 18 years the logger and cables looked as if they were brought here yesterday. (AWS2 interior photographed by M. Winkler on October 5<sup>th</sup>, 2023)



**Figure 14** M. Winkler is dismantling AWS2 under harsh (cold and windy) conditions during the morning hours of October 5<sup>th</sup>, 2023. The picture was taken by E. Collier.

Doug and Simon arrived at the summit around lunchtime. After a brief rest we all walked up to the NIF, where the glacier surface was covered by 25-50 cm tall penitentes. Mike rigged a fixed rope for those without crampons. Finally, this was not needed because the ice surface was rather soft, allowing the SENE crew to help carry down AWS components as we disassembled them. All three stations were nearly horizontal, due to ablation of the surface; bending of the NOAA station mast was likely also associated with riming and wind load.

Working together, after 2.5 hours the three stations were disassembled. Cables were cut outside enclosures. By dark everything had been moved down to camp, awaiting further disassembly.



**Figure 15** The three masts of AWS1 have all been fallen over. The surface of the Northern Icefield was covered with penitentes. (picture by M.Winkler, October 5<sup>th</sup>, 2023)



**Figure 16** M. Winkler, D. Hardy, S. Mtui (from left) and E. Collier (who took the picture) are dismantling the sensors from the main mast of AWS1 on Kibo's Northern Ice Field on October 5<sup>th</sup>, 2023. The view is towards the Southeast.



**Figure 17** With the help of many motivated porters and guides AWS1 was carry down to the camp in many parts (picture: M. Winkler, October 5<sup>th</sup>, 2023)

06.10 — Due to no sleep that night because of the wind and the dust, and the fact that the main work objectives were completed, Mike and Emily left the summit and descended directly to Mweka Gate. Doug spent the morning disassembling equipment and preparing loads, then set off to document changes to the NIF at the eastern end and between the two sections of the former icefield. With stable-but-windy weather and the stations safely recovered, sleep became much easier.

07.10 — Doug descended to Millenium camp. Mike and Emily had a rest and again visited the Kilimanjaro archive.

08.10 — Doug descended to Mweka Gate. Mike and Emily made a trip to Moshi (Mbuyuni market). We all met at Simon's farm to organize gear for donation to TAWIRI (see list below) as well as to have a celebratory lunch with the whole crew.

09.10 — Sorted and packed equipment at SENE. After an interesting visit with Desmond Brice-Bennett, with stories of Africa since the 1950s, we cleaned out all storage at Marangu Hotel, as it is up for sale.

10.10. Some more sorting and packing and final lunch at SENE. We departed from Kilimanjaro airport in the late afternoon.

### **Equipment and Storage**

- Donated:
  - all solar panels, mounts, and enclosures, plus NIF batteries and hardware, to TAWIRI
  - one Zarges box with old equipment (ropes, plastic containers etc) to SENE
  - UIBK batteries, masts, antenna from relay station to SENE and crew
- Returned to UIBK:
  - one Zarges box
  - all instruments and loggers recovered from AWS2 and AWS4-relay and brought to Innsbruck except for one temperature sensor that was discarded
    - 1x CR1000, 1x radio from the relay station
    - 1x CR23X, 1x SR50a, 1x CNR1, 1x Young anemometer (white), 1 IR-temperature sensor, 1x combined T/RH-sensor from AWS2
- Returned to UMass & NOAA:
  - dataloggers in enclosures; all instruments (including damaged net radiometer)
- Stored the ice drill (six flights and a cutter end; four flights (and the cutter) belonging to UIBK (bought years ago from Doug) and two flights to Doug), one steel ice axe and the tools at SENE

### **Other Activities**

- Gave a public talk at Kilimanjaro Mountain Club (KMC) event at UWC/ISM in Moshi on 25 September 2023 to facilitate electronic access to archive



**Figure 18** E. Collier (who made the selfie), D. Hardy and M. Winkler (from left) at their public talk at KMC on September 25<sup>th</sup>, 2023.

- Searched the physical KMC archive (moved from Marangu Hotel to UWC/ISM in Moshi in September 2023) for mentions of snowfall prior to observational period



**Figure 19** The archive of the KMC at the International School in Moshi was studied by E. Collier. She took notes on special weather events during past climbs to Kilimanjaro that are connected to tropical cyclones in the Indian Ocean. (pictures: M. Winkler, October 7<sup>th</sup>, 2023)