Mission report of the field work at Lakes Nyos and Monoun by Tokai University and IRGM researchers (Feb.- March, 2014)

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Submitted on 27th March 2014

Activities at Lake Nyos

Purpose

a) Setting the Automatic Observation Buoy (AOB) in the lake
b) Sampling lake water for chemical and isotope analysis
c) CTD (conductivity temperature and depth profiler)
d) Capacity building of Cameroonian scientists
   d-1) Water sampling techniques and CTD observation
   d-2) Maintenance of AOB sensors
e) Retrieving the climate data

Participants

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Zenilite Buoy Co. Ltd: H Yoshida

26th Feb 2014

Moving from Yaounde to Bamenda by car

27th Feb

Moving from Bamenda to the lodge at Lake Nyos by car
Calibrating pH sensor of CTD with a pH standard solution (pH=6.86) at the Nyos lodge

28th Feb

Anchorage of working rafts at the central region in the lake

Preparation of deployment and setting of AOB

1th March

<u>CTD observation at the central working raft</u>

Variation of the temperature, conductivity, pH and O_2 concentration profiles were obtained with the CTD (IDRONAUT Ocean Seven 316). The observation was carried out on the working raft (e in Fig 1).

<u>Installation of Li-batteries in temperature and conductivity sensors for AOB</u>

The installation was carried out by Japanese and also Cameroonian researchers in the house of lodge. The batteries will be changed to new ones after two years. To prevent the intake of dust, the change of batteries should be carried out under a clean environment.

2th March

<u>Temporary setting of AOB in lake</u>

AOB was tentatively set in Lake Nyos (g in Fig 1). Five sensors were fixed on a stainless wire suspended from the main body of AOB. Two sensors were kept aside for the replacement in case of failure in the future. The length of stainless steel wire was 206m. The diameter of the metallic part of wire was 6mm. The wire was coated with a plastic skin. The end of wire was tied to a float on water surface tentatively. The bulk weight of the wire and the five sensors is about 200kg. The effective data acquisition and transfer through Iridium satellite were confirmed by H Yoshida.

<u>Retrieving the climate data</u>

Verification of the status of the climate station at Nyos indicated that the two pressure sensors had collapsed but all the others were functioning well. However, there was a communication problem between the CR3000 (data logger) and the computer, necessitating reconfiguration of the software (loggernet). Communication was established and the data successfully downloaded at Nyos on March 2nd and on the 5th at Monoun.

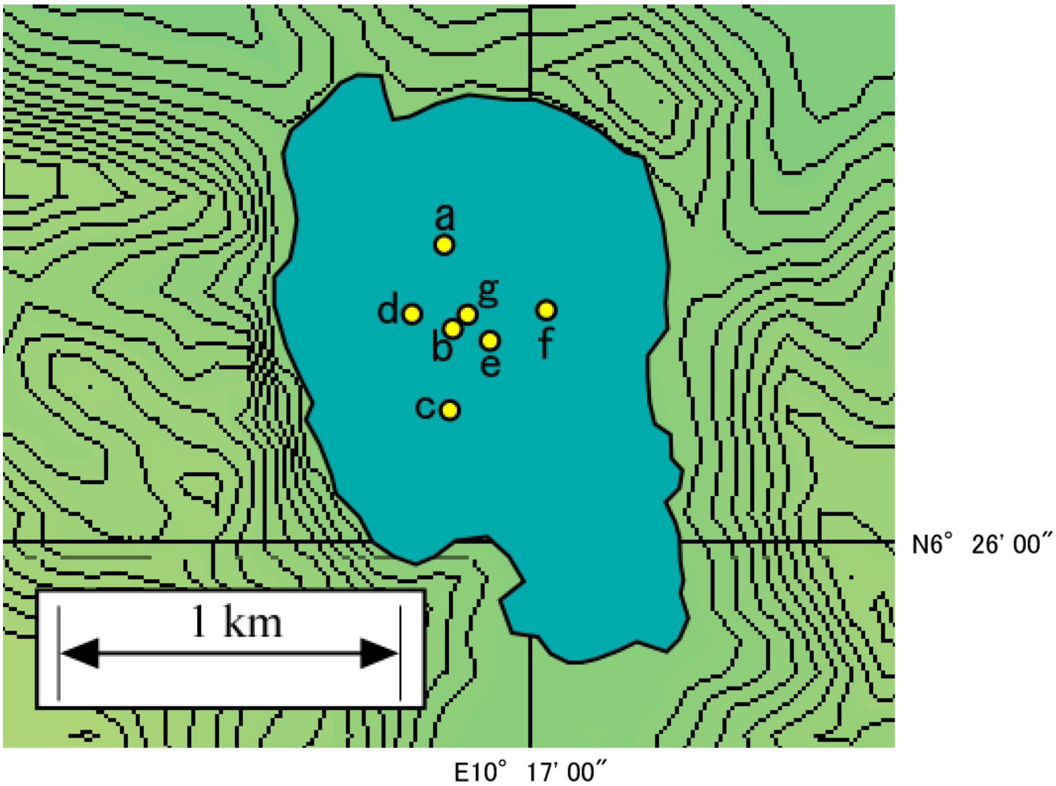

Fig 1. Locations of objects on Lake Nyos. a, b and c: degassing pipes. d: climate (meteorological) station. e: working raft for water sampling and CTD observation. f: degassing pipe controller. g: AOB (Automatic Observation Buoy).

3th March

Sampling of lake water at various depth by use of Niskin sampler

Duplicated raw and acidified water samples were collected at the following 17 depths (m), -208, -206, -204, -202, -200, -195, -190, -180, -160, -140, -120, -100, -80, -60, -40, -20, 0, by use of Niskin sampler. The volume of both samples was about 100ml. The raw water sample will be used to determine the concentration of anions such as, F^-, Cl^-, Br^-, NO_2^-, NO_3^-, SO_4^{2-}, with IC (Ion-Chromatograph). They are also used for the determination of isotope ratios (D/H and $^{18}O/^{16}O$) with an IR Laser absorption spectrometer (Picarro). The sampled lake water was filtered through a disk syringe filter of pore size 0.45 micron meter. The 80-90ml of the filtered lake water was acidified by 5ml 30vol% of pure HNO_3 solution to prevent deposition of oxide compounds. One of the duplicated samples of raw and acidified lake water will be analyzed by the researchers of Tokai University. Another sample will be analyzed in the IRGM Nkolbisson Lab to compare the results. For the work of water sampling, a winch powered by gasoline engine was used to reduce human power, thus facilitating and limiting data collection to a single day. We sincerely thank Mr K Nishio who designed and produced the winch.

4th March

MK sampling of lake water

In order to determine the total CO_2 (CO_2aq + HCO_3^-) concentration, 30ml of lake water was mixed with 10 ml of 5M KOH in situ at the following depths (m); -206, -204, -202, -200, -190, -160, -140, -120, -100, -80, -60, 0. A 50 ml of plastic syringe filled with 10 ml of 5M KOH solution was attached on the MK sampler (Fig 2). At the mouth of syringe, a thin needle was attached, the end of which was opened. We must be careful when handling the syringe because KOH solution is very corrosive to human skin. The wearing of goggles is recommended when you handle the MK syringe. Contacts with the eye or skin could seriously damage his or her horny coats. If your finger touches the KOH solution, you need to wash your finger immediately. The MK sampler was deployed at the specific depth by use of the winch. Then, a metallic weight (messenger) was sent to the MK sampler along the wire of winch. The messenger triggered a mechanical system to pull the syringe, resulting in the mixing with lake water. The KOH solution fixes the CO_2aq as carbonate ion along the following reaction.

$$2KOH + CO_2 = 2K+ + CO_3^{2-} + H_2O \qquad \text{eq.1}$$

The total weight of syringe containing KOH solution should be measured in laboratory prior to the sampling. The weight of syringe after the sampling was again measured in laboratory to estimate the exact amount of sampled lake water. Then, pure water is added to the solution in the syringe to make up exactly 100ml and stored in plastic bottles. The amount of carbonate in the solution can be determined by a micro-diffusion HCl titration.

Fig 2. MK sampler. A plastic syringe filled with 10ml of 5M KOH solution is attached on the sampler.

Setting of AOB

We have tried to set AOB completely. However, an entanglement happened between the stainless steel wire and a rope connecting AOB and the floats (f1 in Fig 3). The entanglement was solved finally. However the complete setting of AOB was suspended to next day.

5th March

Setting of AOB

We finished the complete setting of AOB as shown in Figs 3 and 4. The five temperature and conductivity sensors (s1 to s5 in Fig 4) were fixed on the stainless steel wire at the following depths (m); -4, -120, -160, -200, -204. In the deepest sensor (s5), a pressure sensor was exceptionally built in. The estimated depth by the pressure sensor was -202m, suggesting a proper setting of sensors at the planned depths. The photographs of AOB and the floats are shown in Fig 5 and 6. The temperature and conductivity values observed by AOB were identical to those obtained by the CTD. An excellent agreement was confirmed both for temperature and conductivity between them (Figs 7 and 8).

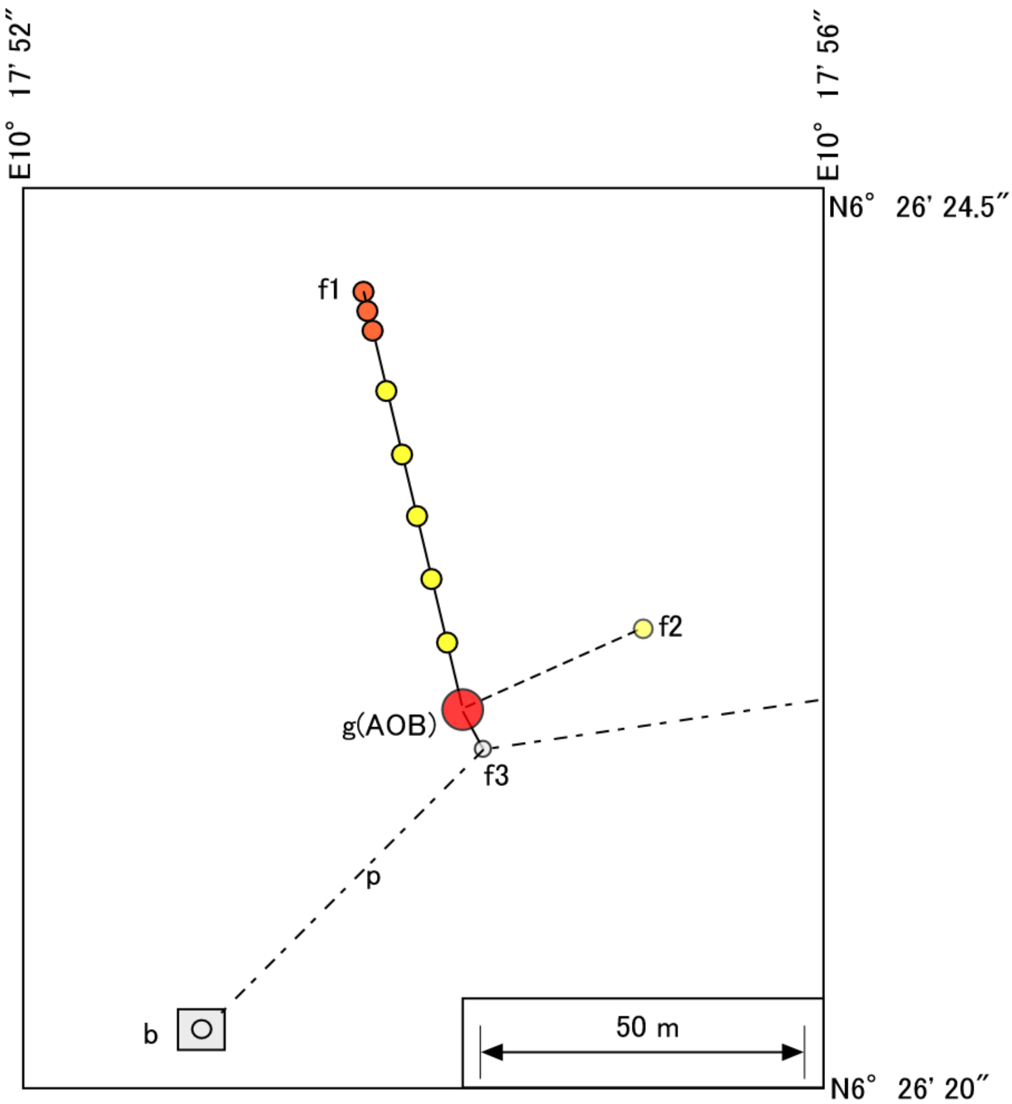

Fig 3. Arrangement of AOB and additional components. b: the central degassing pipe. f1, f2, f3: floats. Beneath f1 a heavy sinker was settled on the bottom of lake. The f1 is connected to the sinker by a rope. The f2 is the float connecting to a rope for the maintenance of sensors. p: a hose for the degassing pipe controller which has not been functional currently. The f3 is tied to the hose (p).

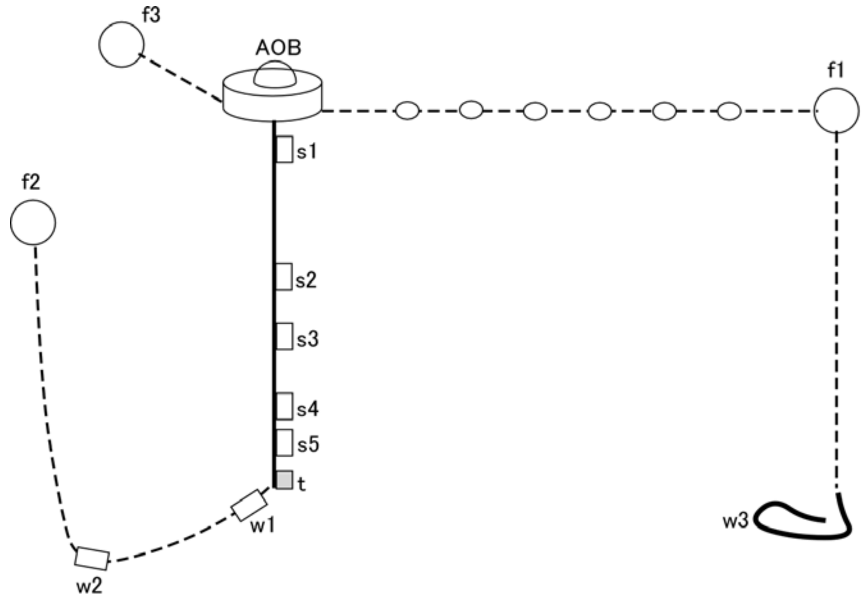

Fig 4. The schematic configuration of AOB and the additional components. f1, f2 and f3: floats. w1, w2 and w3: sinkers. The w3 is a very heavy metallic chain which is impossible to be pulled up. The weight of w1 and w2 is about 10 kg. The bold straight line is the 6 mm stainless steel wire coated with plastic skin for the suspension of five sensors (s1 to s5). t: the terminal device of sensor. The broken lines and curve indicate the connection by rope. The f2 and the attached rope are used for the maintenance of sensors. By pulling up the rope beneath f2, the end of stainless wire can be taken out of the lake water, which is necessary when the internal batteries in sensors have to be replaced.

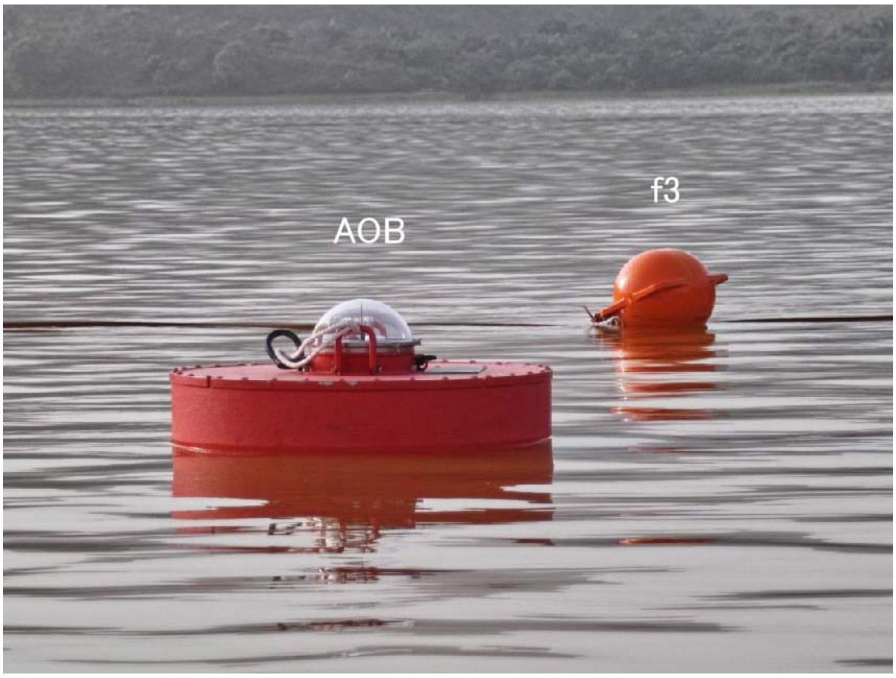

Fig 5.　AOB and f2 floated on the lake water.

Fig 6.　AOB and f1 floated on the lake water.　b: fountain at the central degassing pipe.　The right side of the upper photo overlaps with the left side of the lower photo.

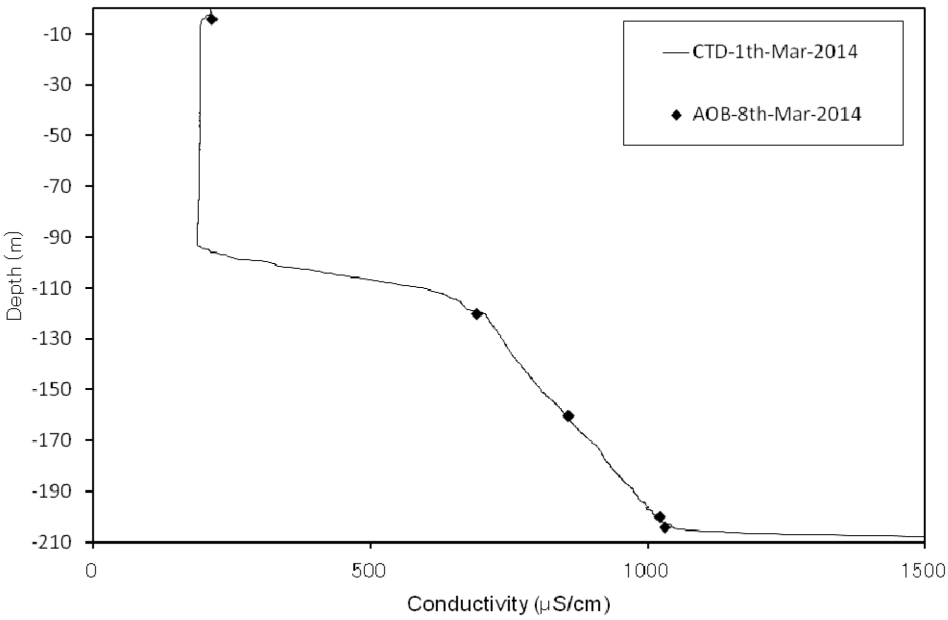

Fig 7. Comparison of conductivity values by CTD (curve) and AOB (symbol).

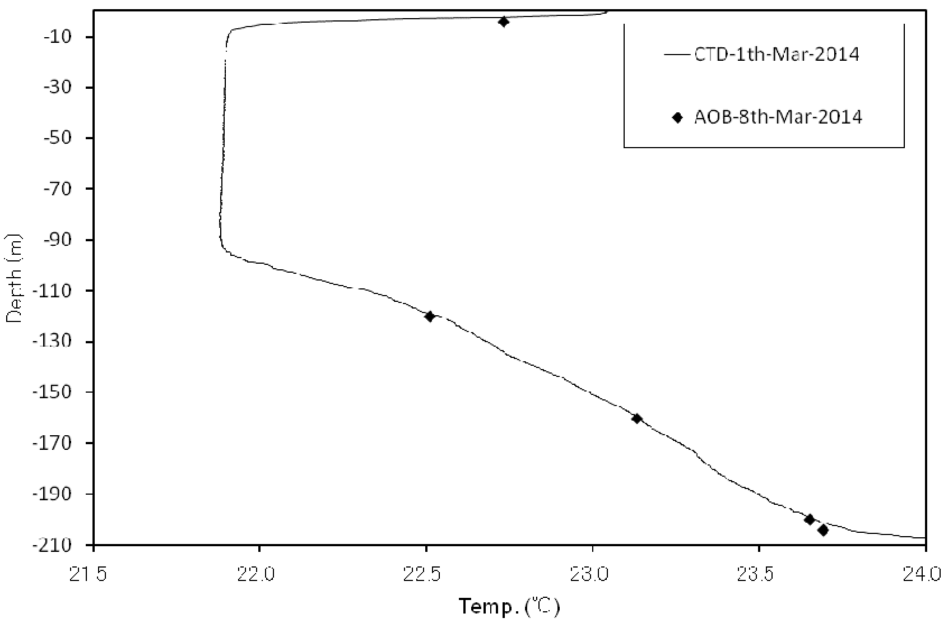

Fig 8. Comparison of temperature values by CTD (curve) and AOB (symbol).

Activities at Lake Monoun

Purpose

a) Sampling lake water for chemical and isotope analysis
b) CTD observation
c) Capacity building
   c-1) Water sampling techniques and CTD observation

Participants

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IRGM: A Ako, R Tawedi, M Ayissi

5th Mar 2014

Moving from Lake Nyos to Bafoussam by car

6th Mar 2014

CTD observation

Three casts were made on lake Monoun at the following points; the eastern deepest basin (e in Fig 9), the central basin (c) and the western basin (w).

Sampling of lake water at various depths by use of Niskin sampler

Duplicated raw and acidified water samples were collected at the following 10 depths (m); -96, -95, -90, -85, -80, -75, -70, -50, -30, 0, by use of Niskin sampler at point e in Fig 9. The volume of both samples was about 100ml. The details on the sampling were same as those for lake Nyos.

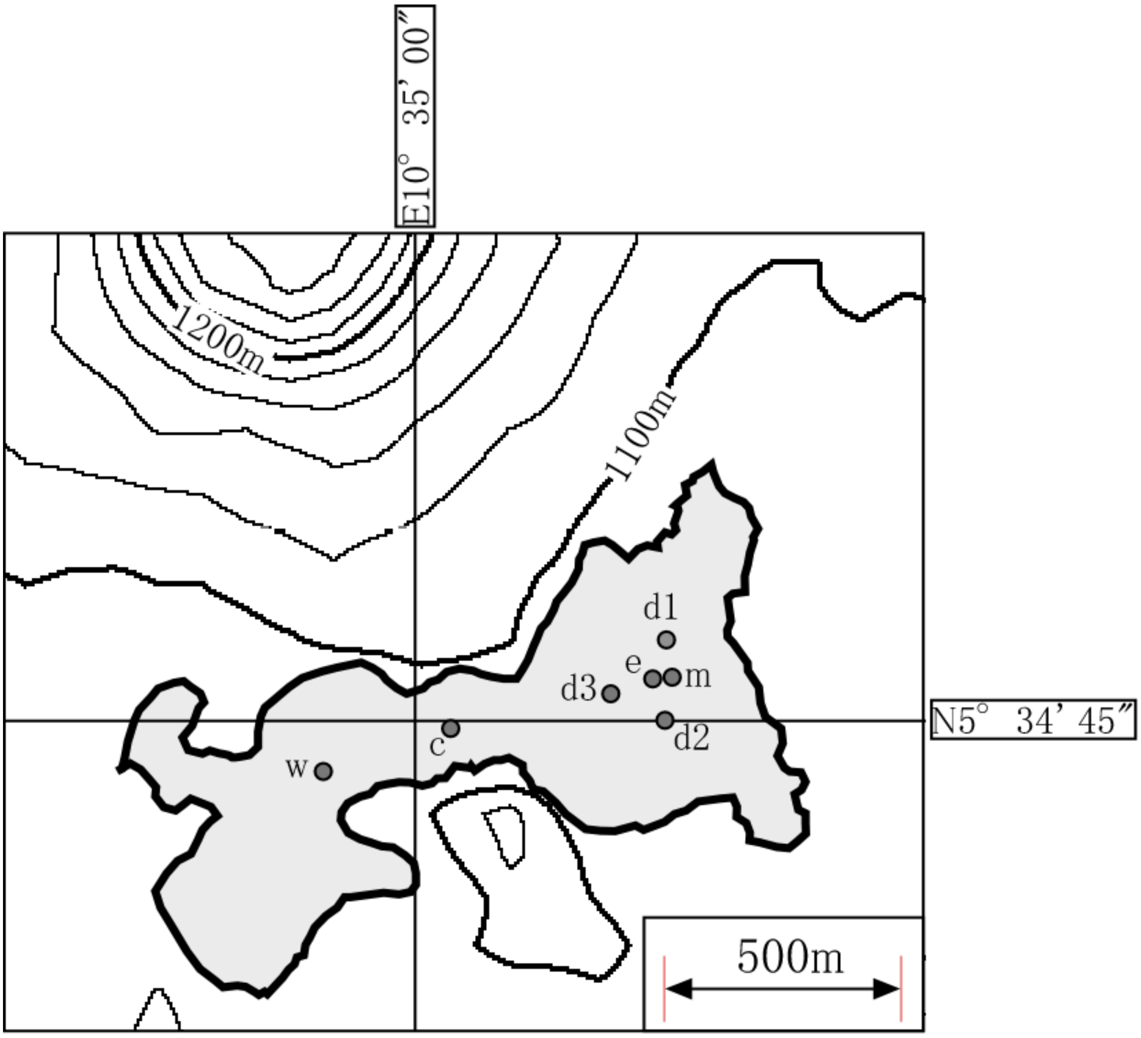

Fig 9. Location of CTD observation and water sampling at Lake Monoun. d1, d2, d3: degassing pipes. m: climate station. e: the point for CTD observation and water sampling. c and w: the point for CTD observation at the central and western basins, respectively.

7th Mar 2014

CTD observation

The cast at point w on 6th March gave an inappropriate data in terms of conductivity. The reason of failure was the clogging of conductivity sensor by mud. A cast was repeated at the western basin (w in Fig. 9).

MK sampling of lake water

In order to determine the total CO_2 (CO_2aq + HCO_3^-) concentration, 30ml of lake water was mixed with 10ml of 5M KOH in situ at the following depths (m); -96, -95,

-90, -85, -80, -75, -70, -50, -30, 0. The details on the sampling were same as those for lake Nyos.

Acknowledgements

We sincerely thank the director of IRGM, Dr J V Hell for logistical support for our fieldwork. Our sincere thanks also extend to the JICA coordinator of SATREPS-NyMo project, Ms A Inaba who arranged the hotels and car for Japanese researchers, as well as the car drivers who brought us to Lakes Nyos and Monoun from Yaounde safely over the long distance. We also thank IRGM's support staff and other persons living by the lakes for their help with the cooking and physical works.