Activity report at the Lake Monoun and Nyos for the regular monitoring

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Aim of the activity

The activity was carried out for the regular monitoring of lake water to estimate the amount of CO2aq accumulated in the lake water quantitatively.

Observation at Lakes Monoun and Nyos

The CTD casting was carried out on the working raft near the center of East basin of Lake Monoun and on the working raft in the central area of Lake Nyos. The lake water was sampled at various depth by use of Niskin sampler and MK syringes. The location of water sampling was identical to that of CTD casting.

Results

Lake Monoun

The profile of water temperature is shown in Fig 1a and 1b. The profile of conductivity is shown in Fig 2. As shown in Fig 1a and 1b, the "shoulder" of temperature profile around -85 to -80m was elevated in 2011 to 2014. The trend turned to the subsidence in 2015. The length of subsidence between 2014 and 2015 is about 3.4m. If the subsidence is brought by the removal of bottom water, the flux of removal should be 530 m^3/day assuming that the cross section of East basin at -80m is about $7x10^4$ m^2, and assuming that the input of thermal water through bottom is neglected. The pumping system driven by a solar panel has been working since Dec 2013. The pumping system are removing the bottom water with the rate, 3 m^3/day. Therefore, the subsidence of the shoulder is attributed not to the pumping system but to the decreased flux of hot fluid through the bottom of lake. A similar subsidence is also found in the profile of conductivity (Fig 2). However the relationship among the profile of each year is complicated because the vertical portion of profile just beneath the shoulder does not agree such as in the case of temperature (Fig 1a). The disagreement of the vertical

portion beneath the shoulder is due to the lack of calibration for the electric conductivity of CTD. The secular change in the amount of total CO_2 (Fig 3) shows a gradual increase since 2011 after the stop of degassing pipe flow in 2009. Probably the amount in March 2015 is out of the increasing trend.

Lake Nyos

The profiles of temperature and conductivity are shown in Fig 4 and 5, respectively. Both profiles show a steady subsidence of the hypolimnion, which is attributed to the removal of bottom water through the three degassing pipes. In Fig 6, the secular change of CO_{2aq} amount in lake water is shown. After the installation of two additional pipes, the rate of removal has been enhanced. Probably the amount in March 2015 will be plotted on the extrapolation of the regression line going through the points in 2011 to 2014.

Sampling of lake water

The sampled lake water is listed in Table 1. For the intra-comparison of analytical result, some samples (Code: 1, 2, 11, 12, 21, 22, 32) were duplicated and distributed to Tokai University and IRGM

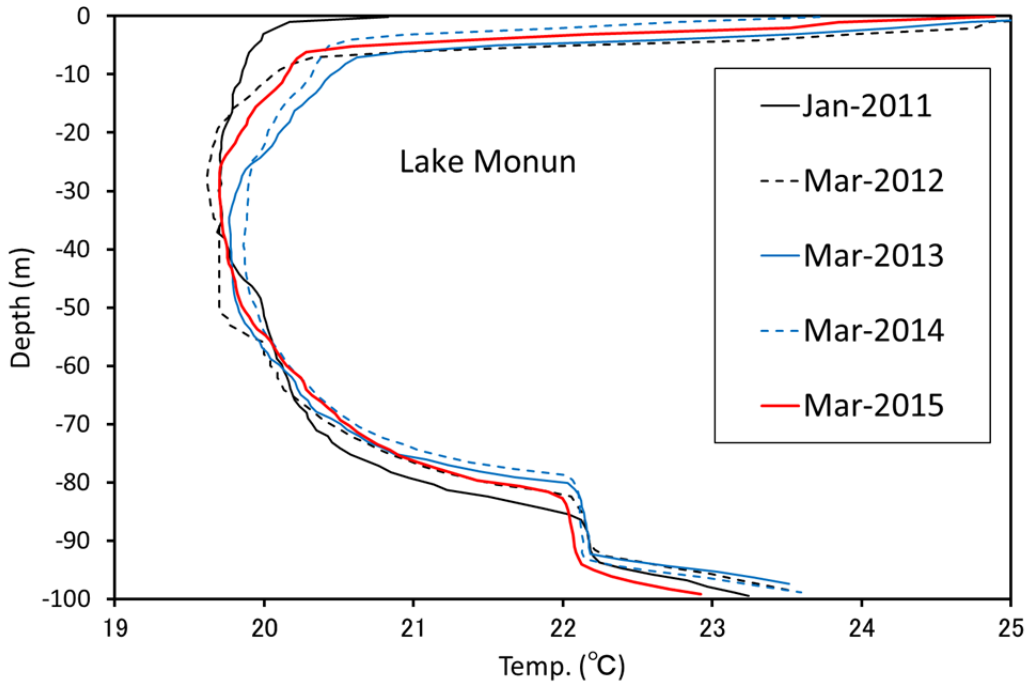

Fig.1a. Temperature profiles at Lake Monoun

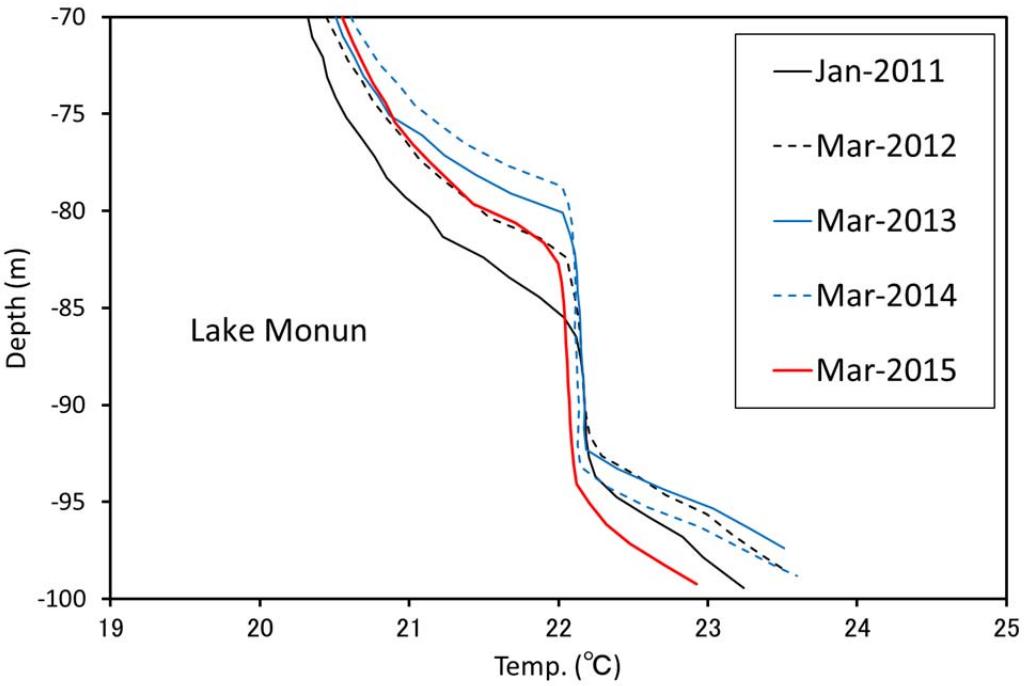

Fig.1b. Temperature profiles at Lake Monoun for the enlargement in deep region

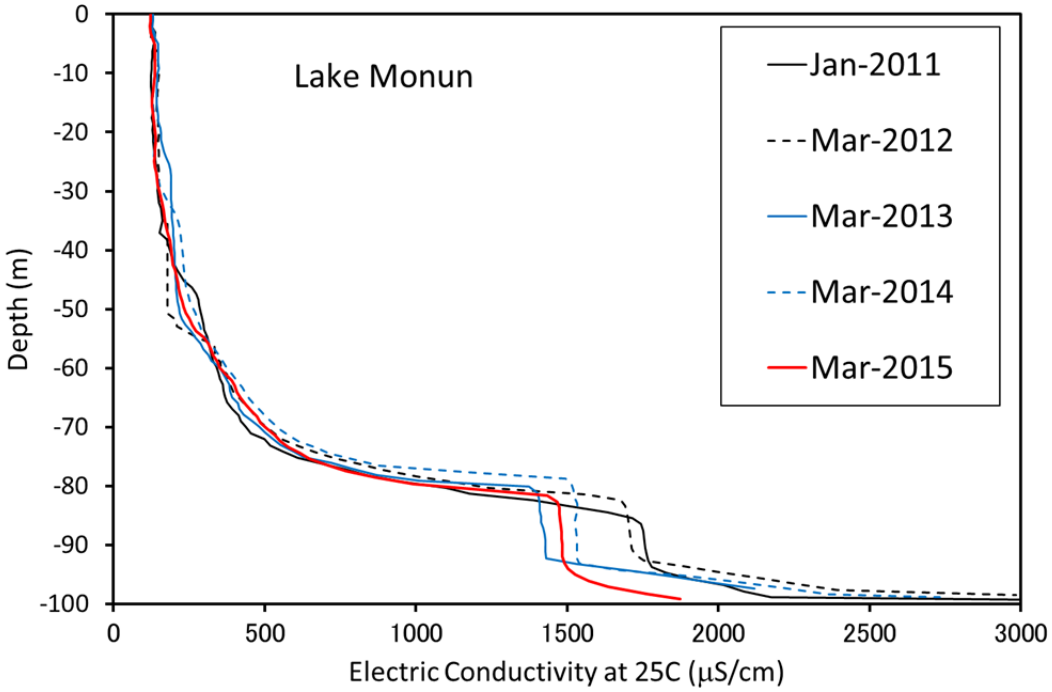

Fig.2. Electric conductivity of water in Lake Monoun

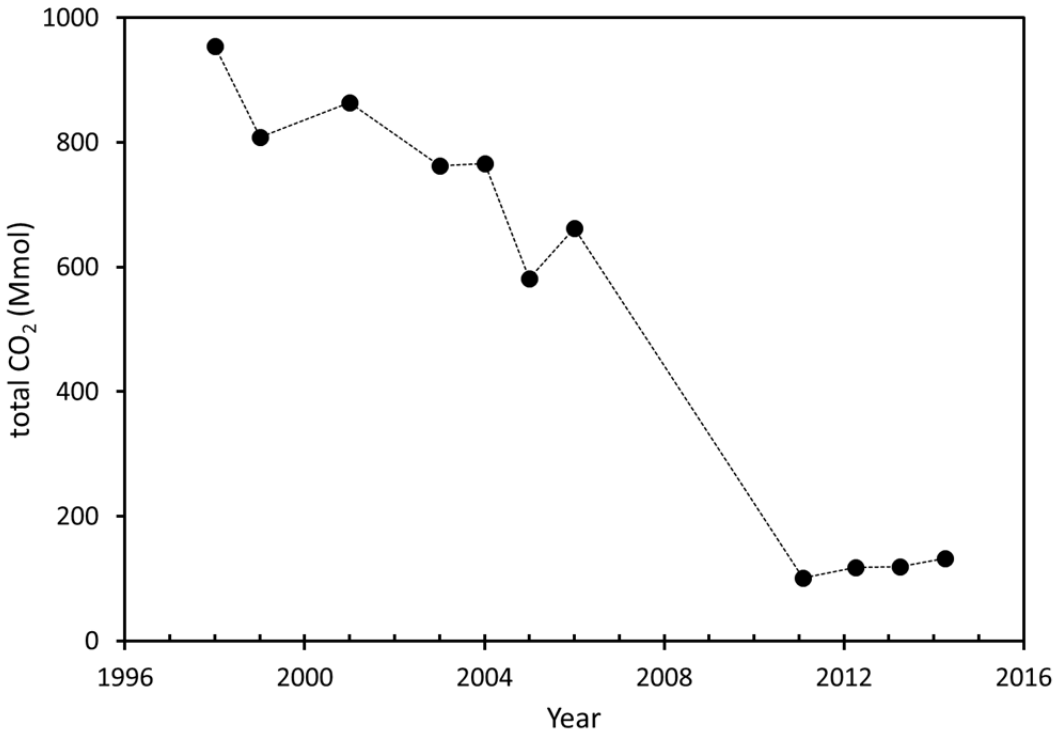

Fig.3. Total CO2 amount accumulated in the East basin of Lake Monoun

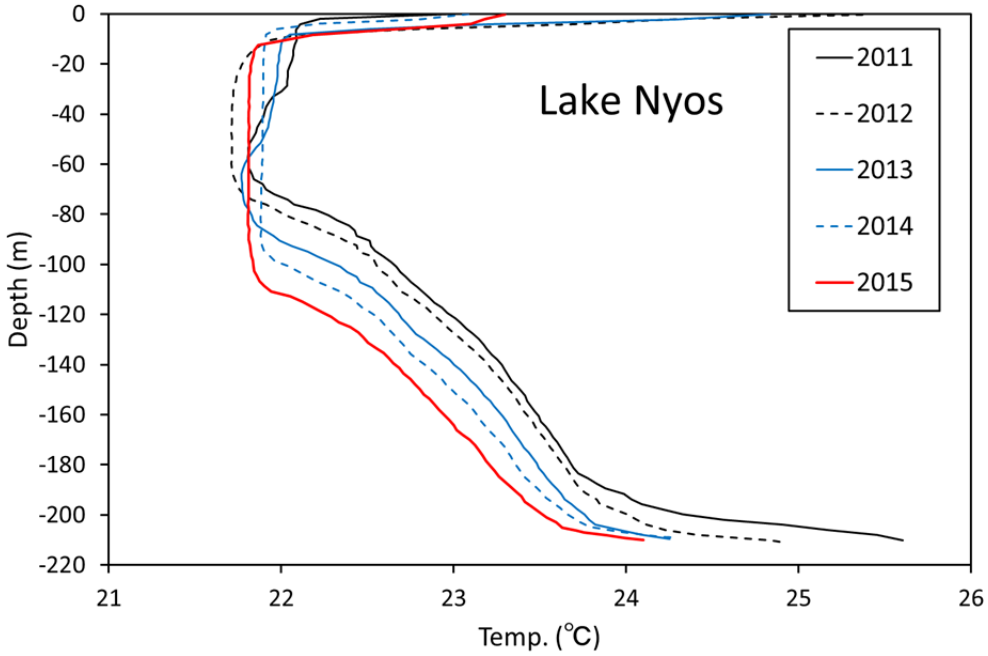

Fig.4. Temperature profile at Lake Nyos

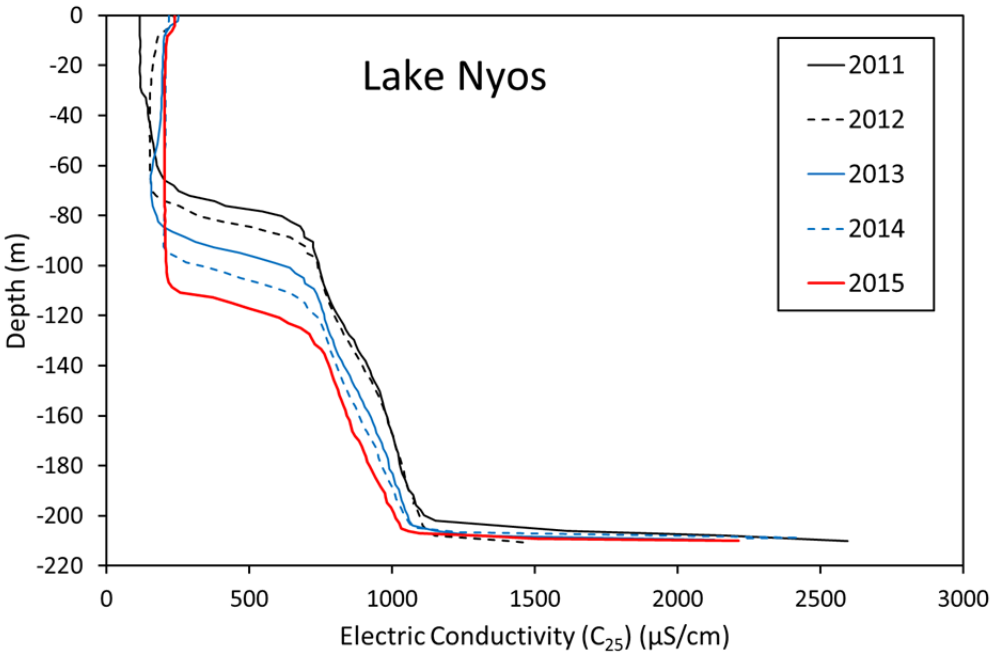

Fig.5. Electric conductivity profiles in Lake Nyos

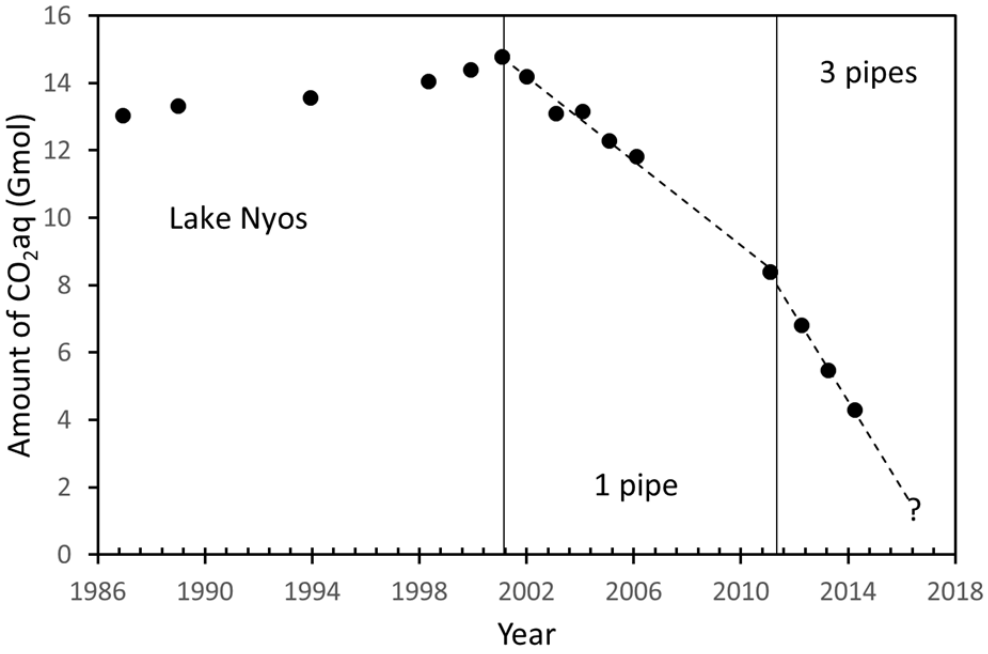

Fig.6. Amount of CO2aq accumulated in the lake water of Nyos.

Table 1. Lake warer sampled at Monoun and Nyos

Code	Location	Date	Depth	Categry	Number of sample	Analyst
		yyyy/mm/dd	m			
1	Monoun, East basin	2015/3/2	−96	MK syringe	2	Tokai U, IRGM
2	Monoun, East basin	2015/3/2	−95	MK syringe	2	Tokai U, IRGM
3	Monoun, East basin	2015/3/2	−90	MK syringe	1	Takai U
4	Monoun, East basin	2015/3/2	−85	MK syringe	1	Takai U
5	Monoun, East basin	2015/3/2	−80	MK syringe	1	Takai U
6	Monoun, East basin	2015/3/2	−75	MK syringe	1	Takai U
7	Monoun, East basin	2015/3/2	−70	MK syringe	1	Takai U
8	Monoun, East basin	2015/3/2	−50	MK syringe	1	Takai U
9	Monoun, East basin	2015/3/2	−30	MK syringe	1	Takai U
10	Monoun, East basin	2015/3/2	0	MK syringe	1	Takai U
11	Monoun, East basin	2015/3/2	−96	Niskin	2	Tokai U, IRGM
12	Monoun, East basin	2015/3/2	−95	Niskin	2	Tokai U, IRGM
13	Monoun, East basin	2015/3/2	−90	Niskin	1	Takai U
14	Monoun, East basin	2015/3/2	−85	Niskin	1	Takai U
15	Monoun, East basin	2015/3/2	−80	Niskin	1	Takai U
16	Monoun, East basin	2015/3/2	−75	Niskin	1	Takai U
17	Monoun, East basin	2015/3/2	−70	Niskin	1	Takai U
18	Monoun, East basin	2015/3/2	−50	Niskin	1	Takai U
19	Monoun, East basin	2015/3/2	−30	Niskin	1	Takai U
20	Monoun, East basin	2015/3/2	0	Niskin	1	Takai U
21	Nyos, center	2015/3/4	−206	Niskin	2	Tokai U, IRGM
22	Nyos, center	2015/3/4	−203	Niskin	2	Tokai U, IRGM
23	Nyos, center	2015/3/5	−200	Niskin	1	Takai U
24	Nyos, center	2015/3/5	−190	Niskin	1	Takai U
25	Nyos, center	2015/3/5	−180	Niskin	1	Takai U
26	Nyos, center	2015/3/5	−160	Niskin	1	Takai U
27	Nyos, center	2015/3/5	−140	Niskin	1	Takai U
28	Nyos, center	2015/3/5	−120	Niskin	1	Takai U
29	Nyos, center	2015/3/5	−100	Niskin	1	Takai U
30	Nyos, center	2015/3/5	−60	Niskin	1	Takai U
31	Nyos, center	2015/3/5	0	Niskin	1	Takai U
32	Nyos, center	2015/3/5	−206	MK syringe	2	Tokai U, IRGM
33	Nyos, center	2015/3/5	−203	MK syringe	1	Takai U
34	Nyos, center	2015/3/5	−200	MK syringe	1	Takai U
35	Nyos, center	2015/3/5	−190	MK syringe	1	Takai U
36	Nyos, center	2015/3/5	−180	MK syringe	1	Takai U
37	Nyos, center	2015/3/5	−160	MK syringe	1	Takai U
38	Nyos, center	2015/3/5	−140	MK syringe	1	Takai U
39	Nyos, center	2015/3/5	−120	MK syringe	1	Takai U
40	Nyos, center	2015/3/5	−100	MK syringe	1	Takai U
41	Nyos, center	2015/3/5	−60	MK syringe	1	Takai U
42	Nyos, center	2015/3/5	0	MK syringe	1	Takai U