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Dynamics of a subglacial meltwater plume revealed by continuous subsurface monitoring directly on the calving front

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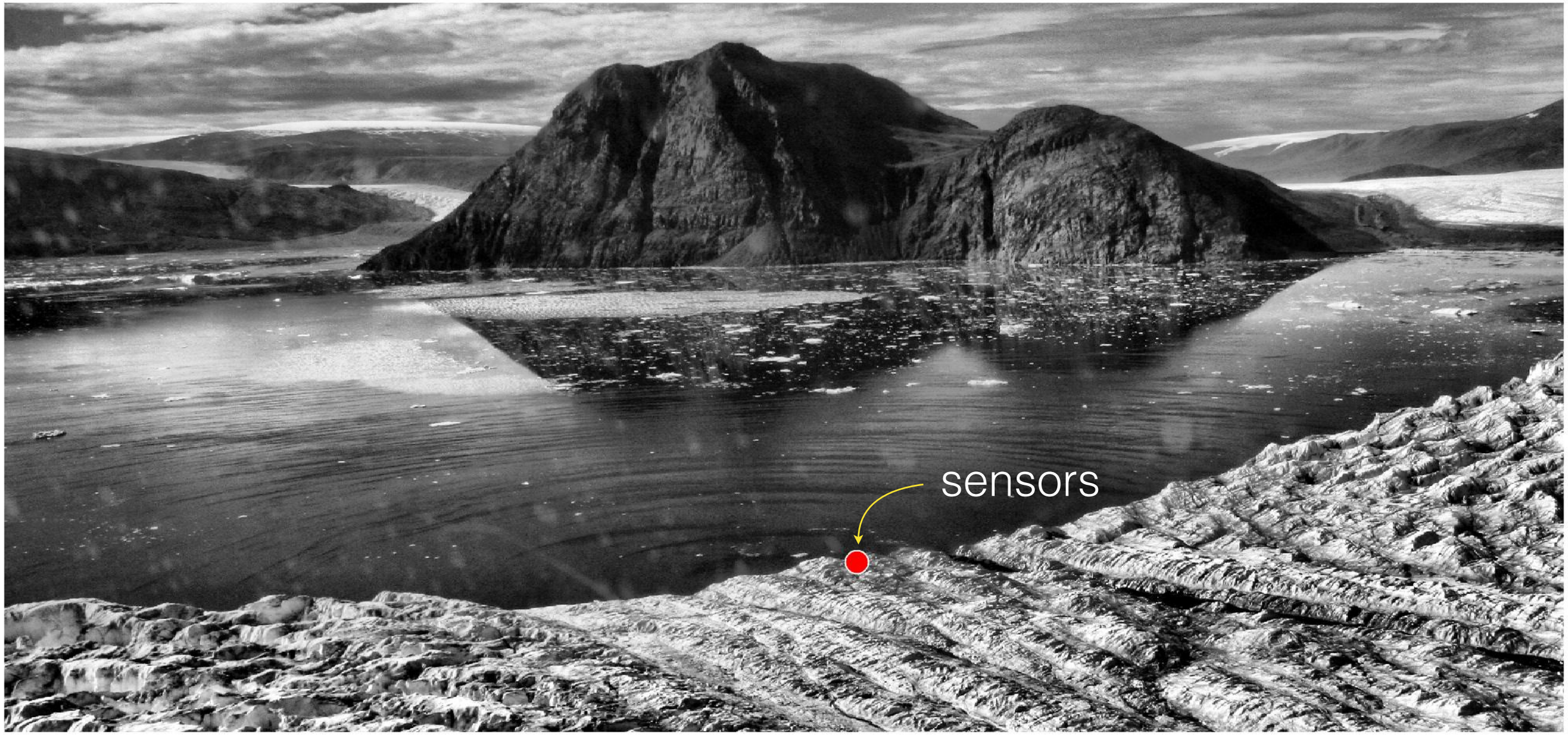


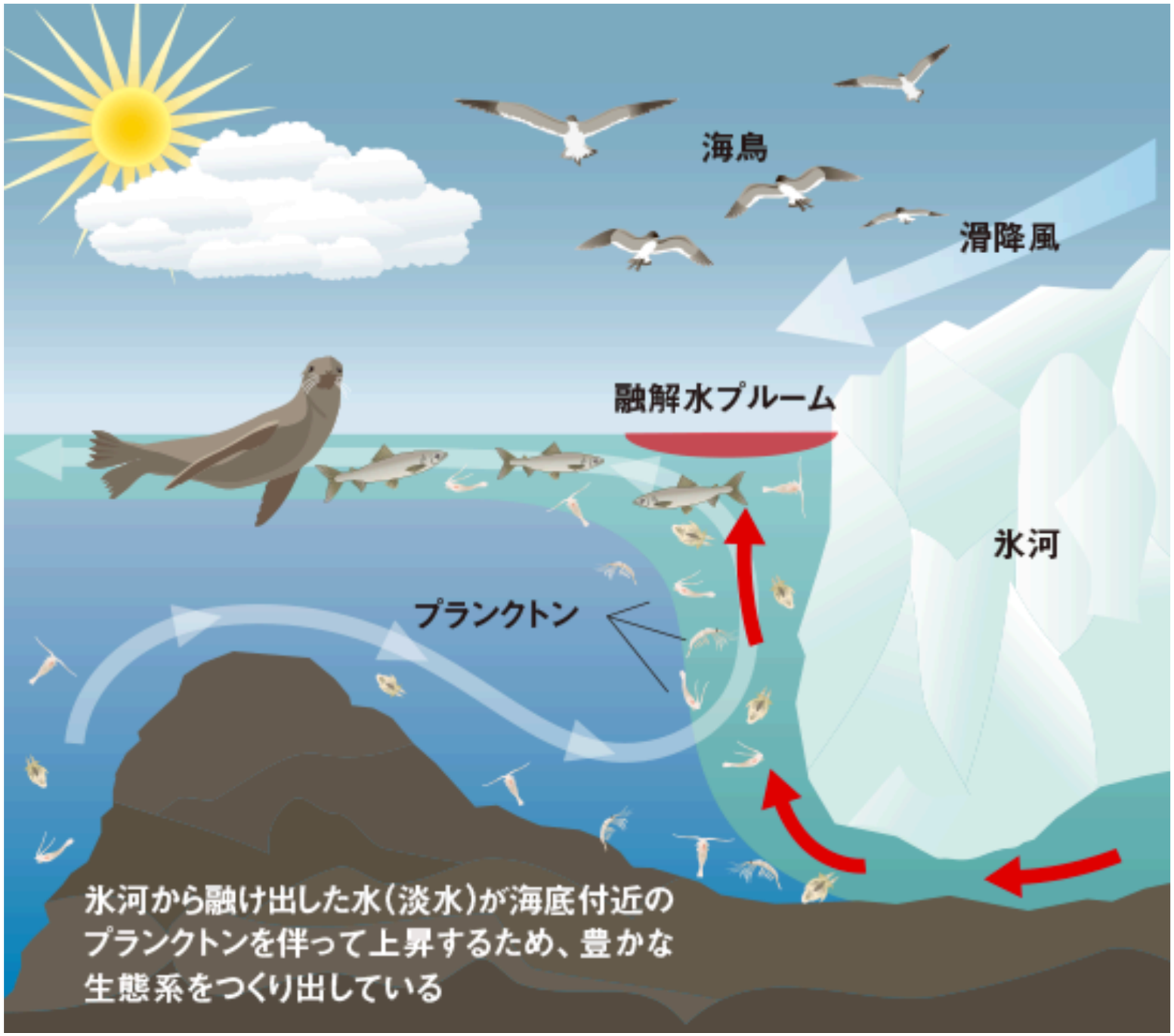
Helicopter view of the deployment site,
July 17, 2017, © Podolskiy E.

Location of Bowdoin Fjord in NW Greenland
[from Podolskiy and Sugiyama, JGR-Oceans, 2020]

Subglacial discharge plume as seen in July 2019 directly from the calving front of Bowdoin Glacier
[from Podolskiy, GRL, 2020]

Cartoon of a subglacial discharge plume

+QUIZ time!



[from 機関誌『水の文化』*64号, 2020*]

Recently this kind of illustration has appeared in so many publications, that it is hard to be original.

Therefore, here is its version in Japanese with a quiz for you!

It will improve your language skills and make it obvious why plumes are so important for the ice-ocean interaction studies!

QUIZ:

1. find “glacier” in Japanese
2. find “plankton" in Japanese
3. find "sea birds” in Japanese
4. find “plume” in Japanese
5. do you think artist’s depiction of the subaqueous ice cliff, with no significant undercutting, is reasonable? (mind the sill)
6. do you think some other animals are missing? (recently we realized there are more visitors to our glacier fjord, but not sure why [Podolskiy and Sugiyama, JGR-Oceans, 2020])

Filling observational gap or asymptotic excitement about the plumes

July, 2019, © Podolskiy E.

today, we are in proximity, indeed, but …

…what is still the key gap?

-> high-resolution time series

"Ocean observations that are unprecedented in their spatial detail and proximity to a Greenlandic tidewater glacier are reported" [Slater et al., 2018]

"the first direct measurements in a buoyant plume" [Bendtsen et al., 2015]

"… the difficulty of making sustained measurements near the glacier terminus… In situ measurements … are critical" [Carroll et al., 2015]

Remote-controlled surface vehicles, helicopter-borne XCTD, CTD-instrumented seals [e.g. Mankoff et al., 2016; Bendtsen et al., 2015; Everett et al., 2018]

getting closer-and-closer to a plume

year

Deployment of the sensors over the calving front, July 13, 2017

© Kanna N.

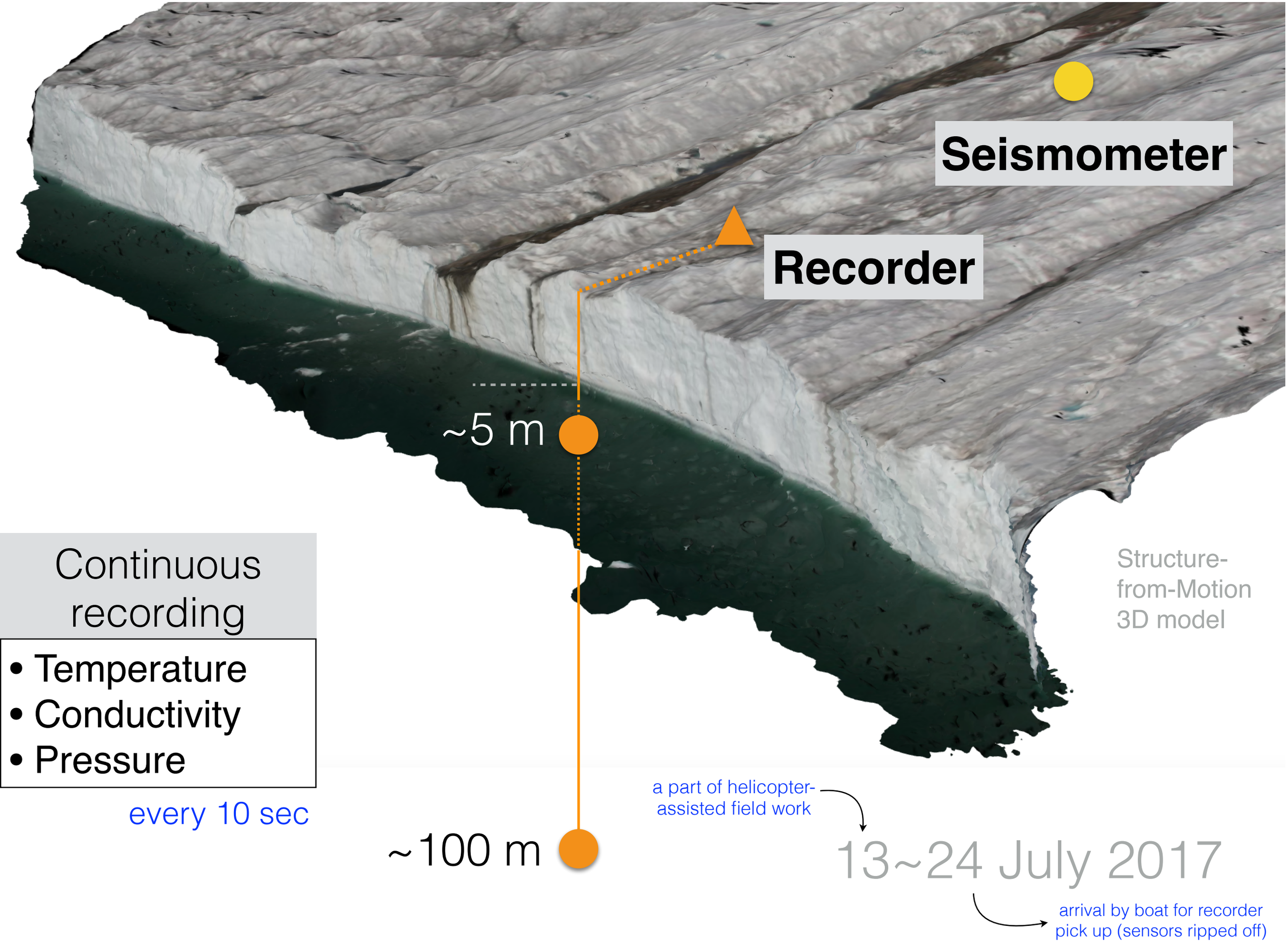
Recording system screwed to ice,
July 13, 2017

Oxygen mask! - for reducing
excitement :)

© Kanna N.

Deployment of a sensor into water with a ballast and a protection pipe against cable cuts at the ice edge, July 13, 2017

© Sugiyama S.

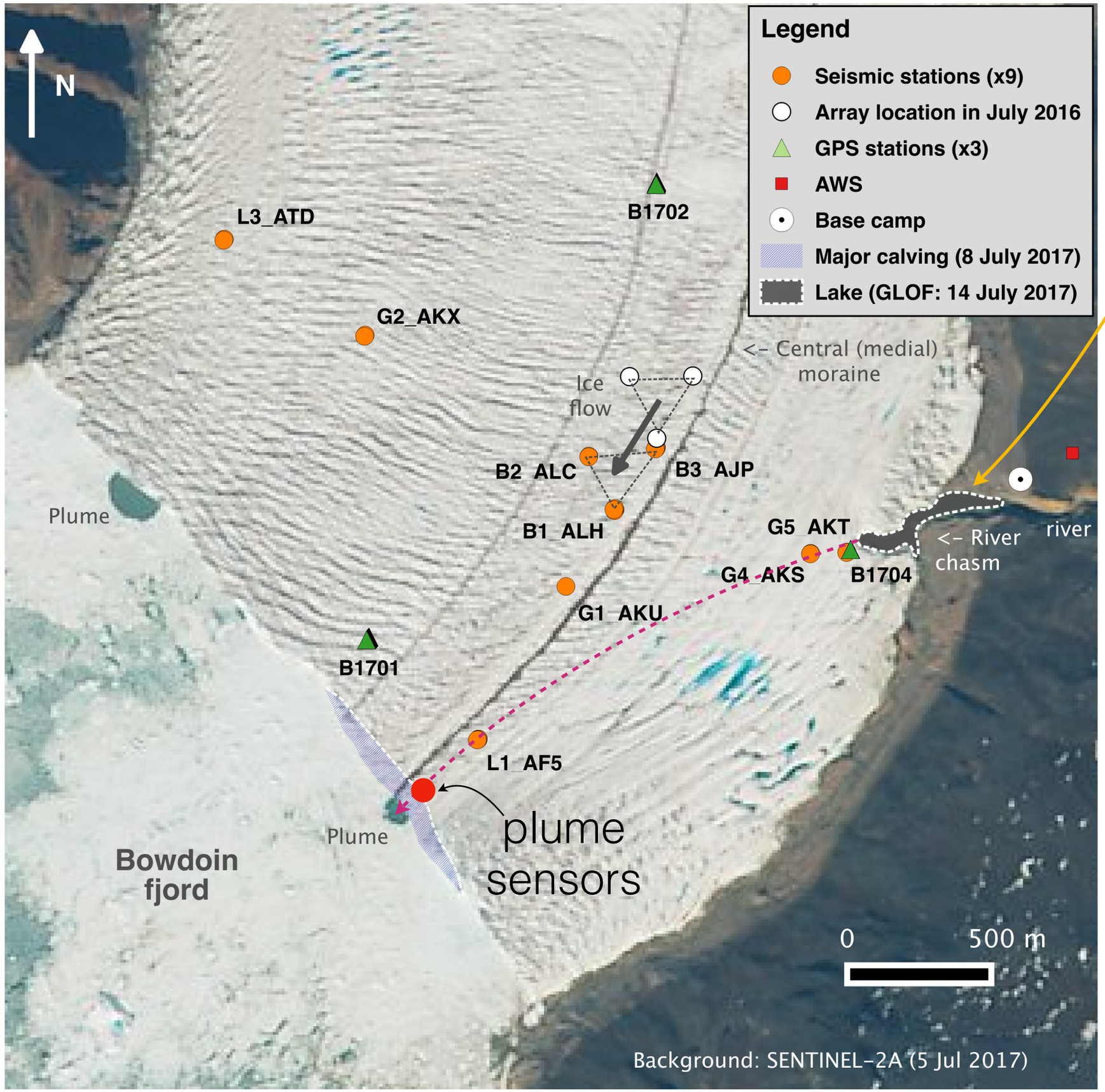


Continuous recording

- Temperature
- Conductivity
- Pressure

every 10 sec

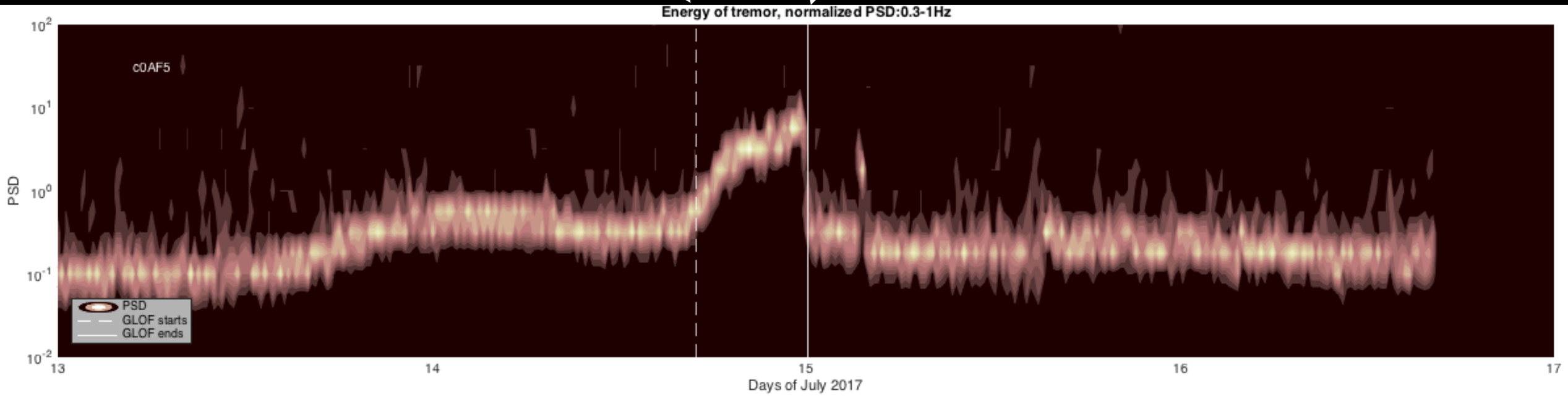
Bowdoin Glacier (6-16 July 2017)



On the very next day (!) after deployment, on July 14, 2017, an ice-dammed lake at the margin of the glacier drained subglacially. Amazingly, water left the glacier exactly via the instrumented plume…

seismic network was established in collaboration with VAW, ETH-Zurich

Glacial Lake Outburst Flood and seismic tremor



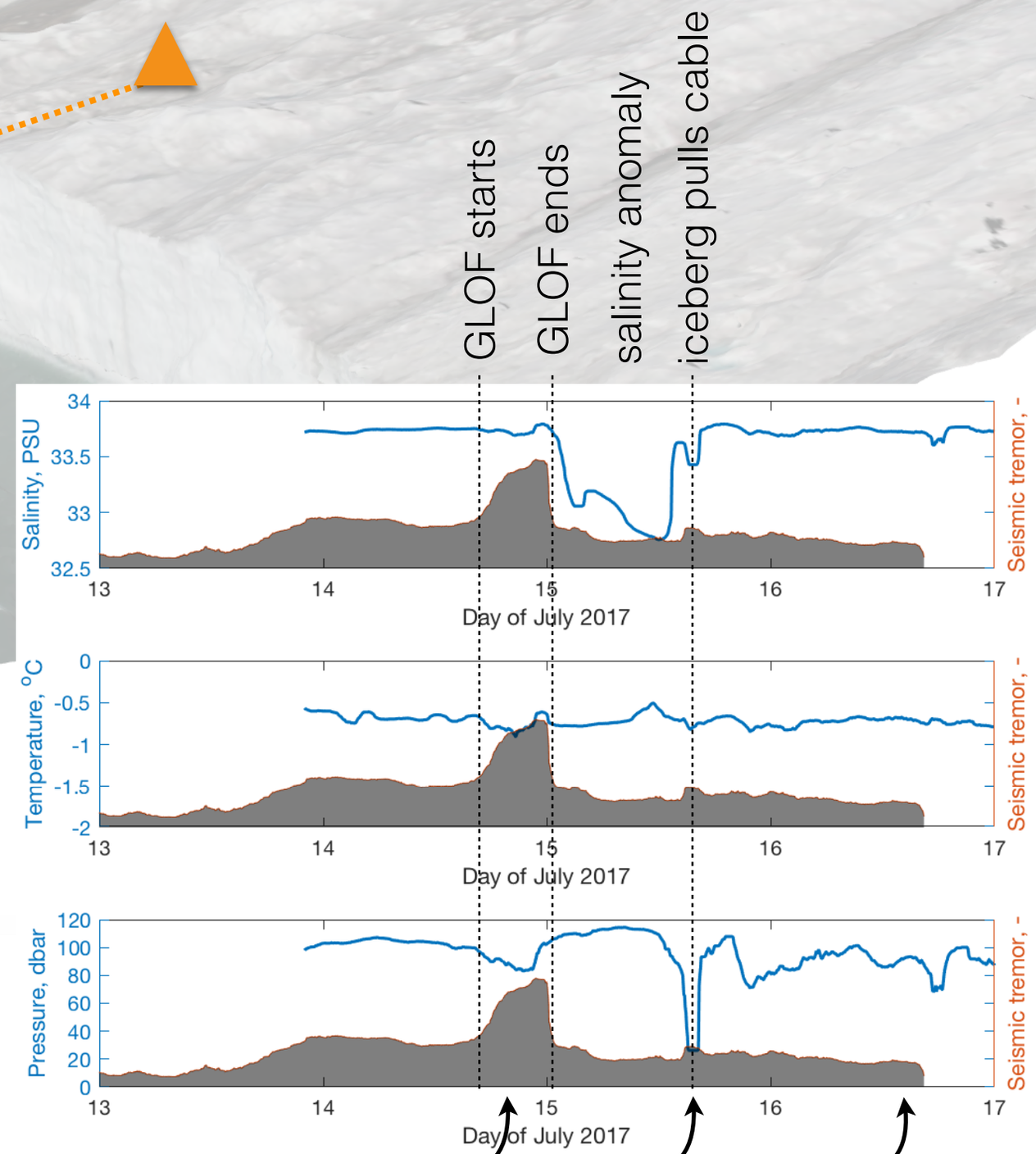
Camp
July, 2017, © Podolskiy E.

Water level
Drain
July, 2017, © Podolskiy E.

In the meantime at the plume …

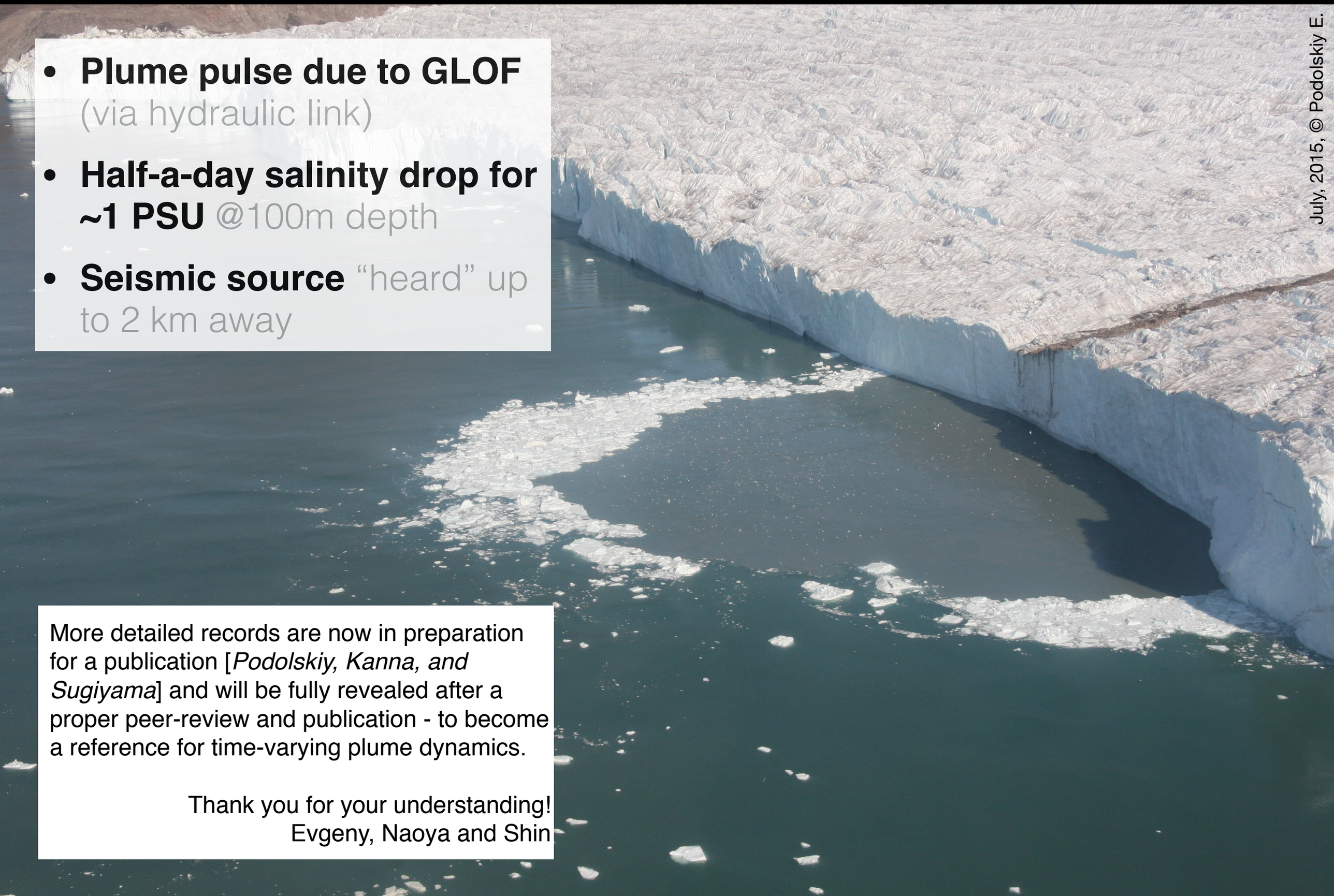
*time-series were filtered with 2-hour-long median filter

~100 m



sensor can be pushed upward by GLOF, icebergs and plume current

What do we find so far?



- **Plume pulse due to GLOF** (via hydraulic link)
- **Half-a-day salinity drop for ~1 PSU** @100m depth
- **Seismic source** "heard" up to 2 km away

More detailed records are now in preparation for a publication [*Podolskiy, Kanna, and Sugiyama*] and will be fully revealed after a proper peer-review and publication - to become a reference for time-varying plume dynamics.

Thank you for your understanding!
Evgeny, Naoya and Shin