

Observation of the Subglacial Lake in the David Glacier area in Victoria Land

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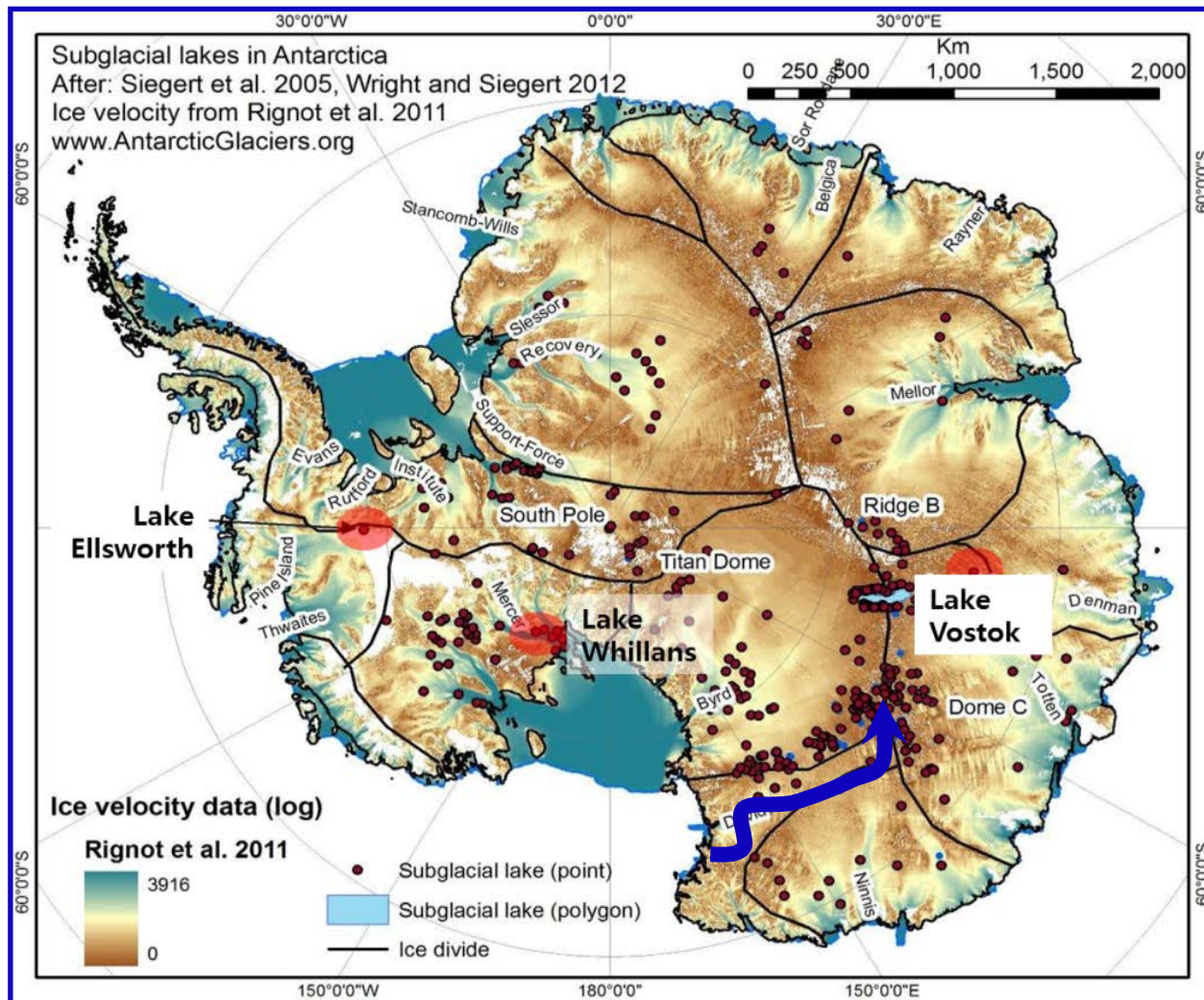
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Research Background and Purpose

- Big science and convergence technology
- Korean Route study (2017~2020)

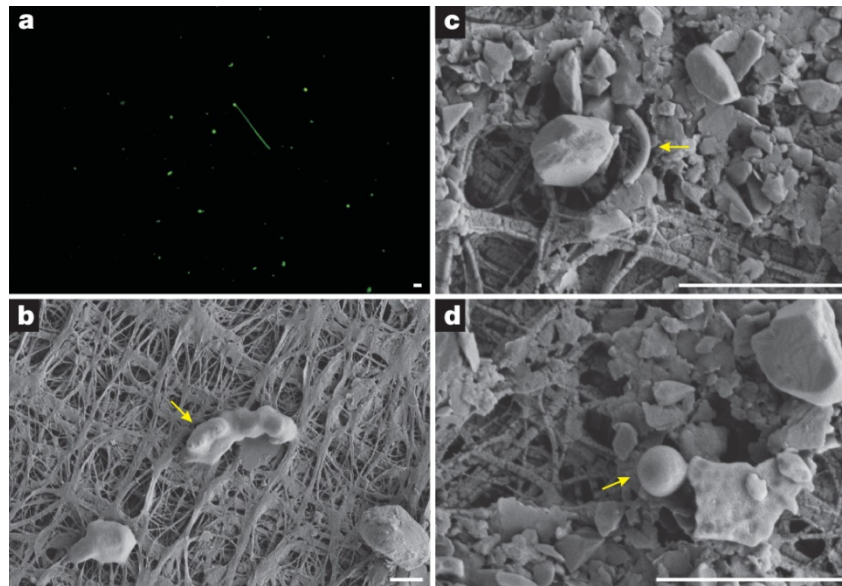


- 2,000m Depth
- hot water drilling
- 3,000m Depth
- Deep ice drilling

Research Background and Purpose

- Why does man try to study subglacial lakes in the Antarctica?
- What is happening under thousands of meters of glaciers?
- If there were creatures, how did they have been evolved over time in an isolated environment?

➔ Subglacial lake research to get a step closer to a clearer scientific truth.



Micro-organisms found in Whillans Lake in the Antarctic subglacial lake

Brent C. Christner *et al.* (2014) *Nature* 512, 310-313

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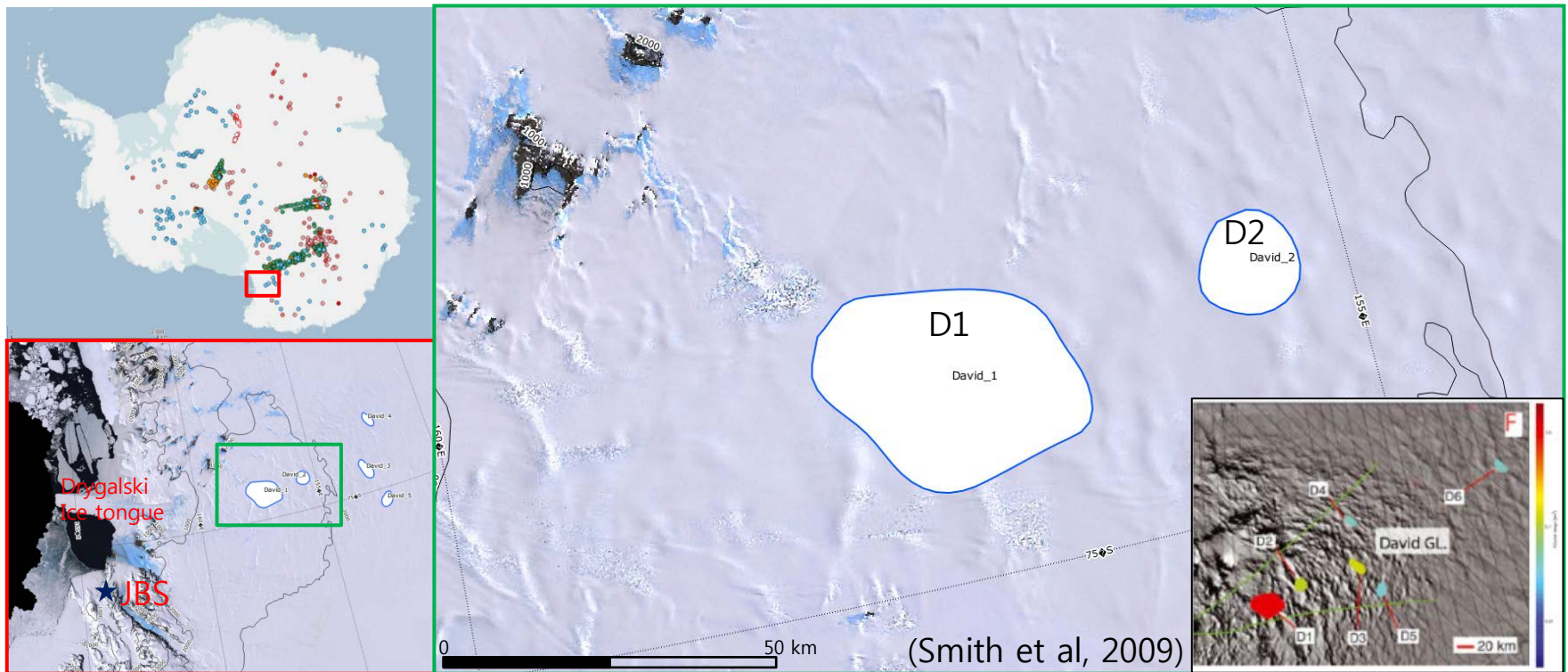
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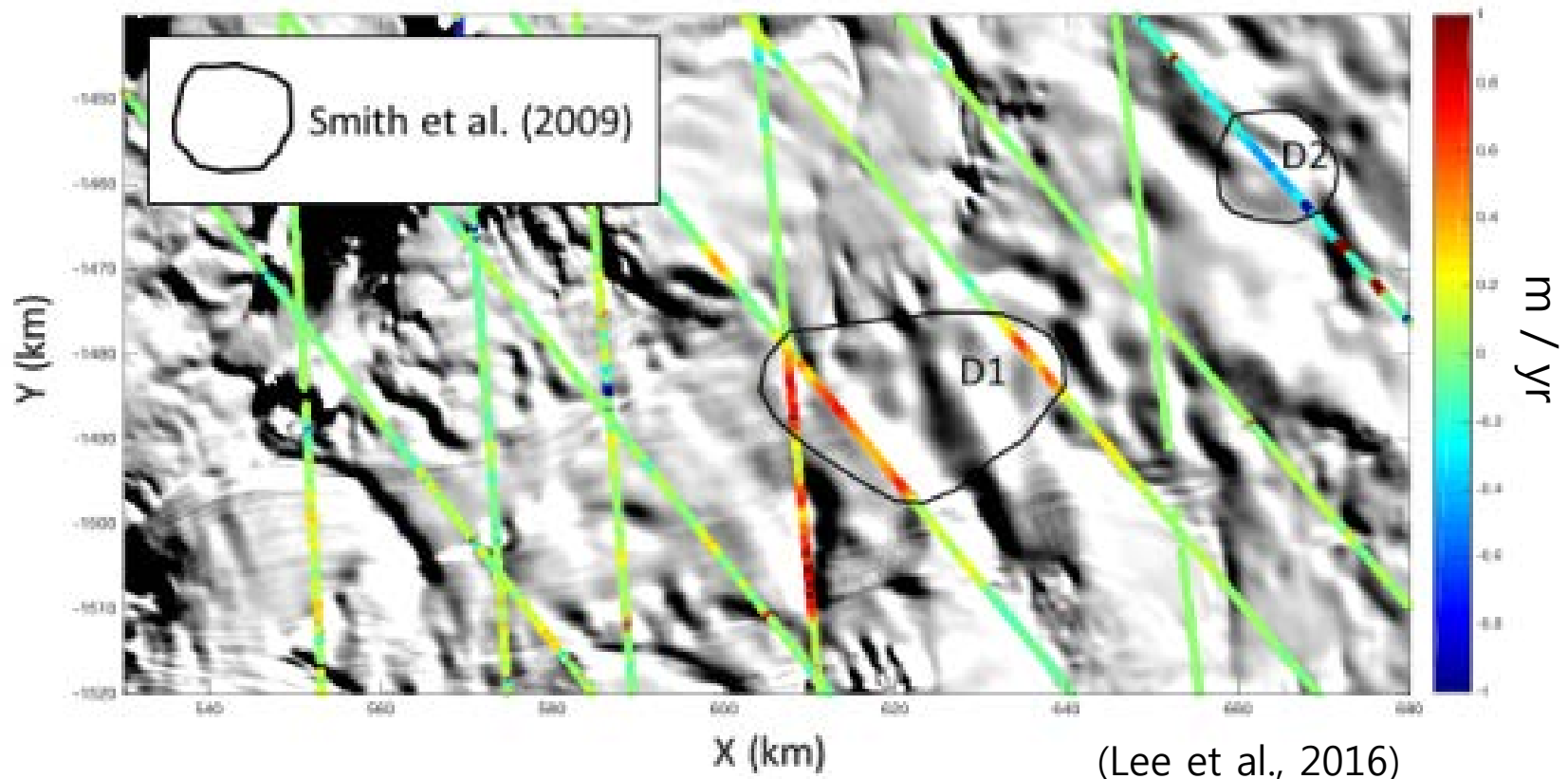
The David Glacier area in Victoria Land - D1 and D2 Lakes

- 6 lakes were identified by Smith et al. in David
- The david1 and david2 lake are large and famous



ICESat Observation (2003-2009)

- Identified by observing the change in elevation of the ice surface with increasing or decreasing pressure due to the filling and draining of water
- The ICESat data show a change maximum $\pm 1\text{m/yr}$ in the annual mean



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Ice Penetrating Radar for Helicopter Developed by UTIG

- 2016, KOPRI and UTIG (University of Texas Institute for Geophysics) developed a customized ice radar for the helicopter
- Radio waves can reach depths of several kilometers in glaciers



Test Flight Ice Penetrating Radar

- Test flight in Canada and Antarctica



IPR Installed in Helicopter

Helicopter inside



Helicopter outside



- The laser altimeter measures the distance to the helicopter and glacier surface.

Ice Penetrating Radar Specification

HERA	Parameters	
Central Unit	Peak power Center frequency Pulse repetition frequency (PRF) stacking Sampling rate Digitizer resolution Maximum penetrating depth in ice Combined dynamic range	8 kW 60 MHz 6,250 Hz 32x 50 MHz 14 bits > 4,000m 120 dB
Antenna	Type Gain Bandwidth	2x dipole 5.8 dBi, one-way 15 MHz

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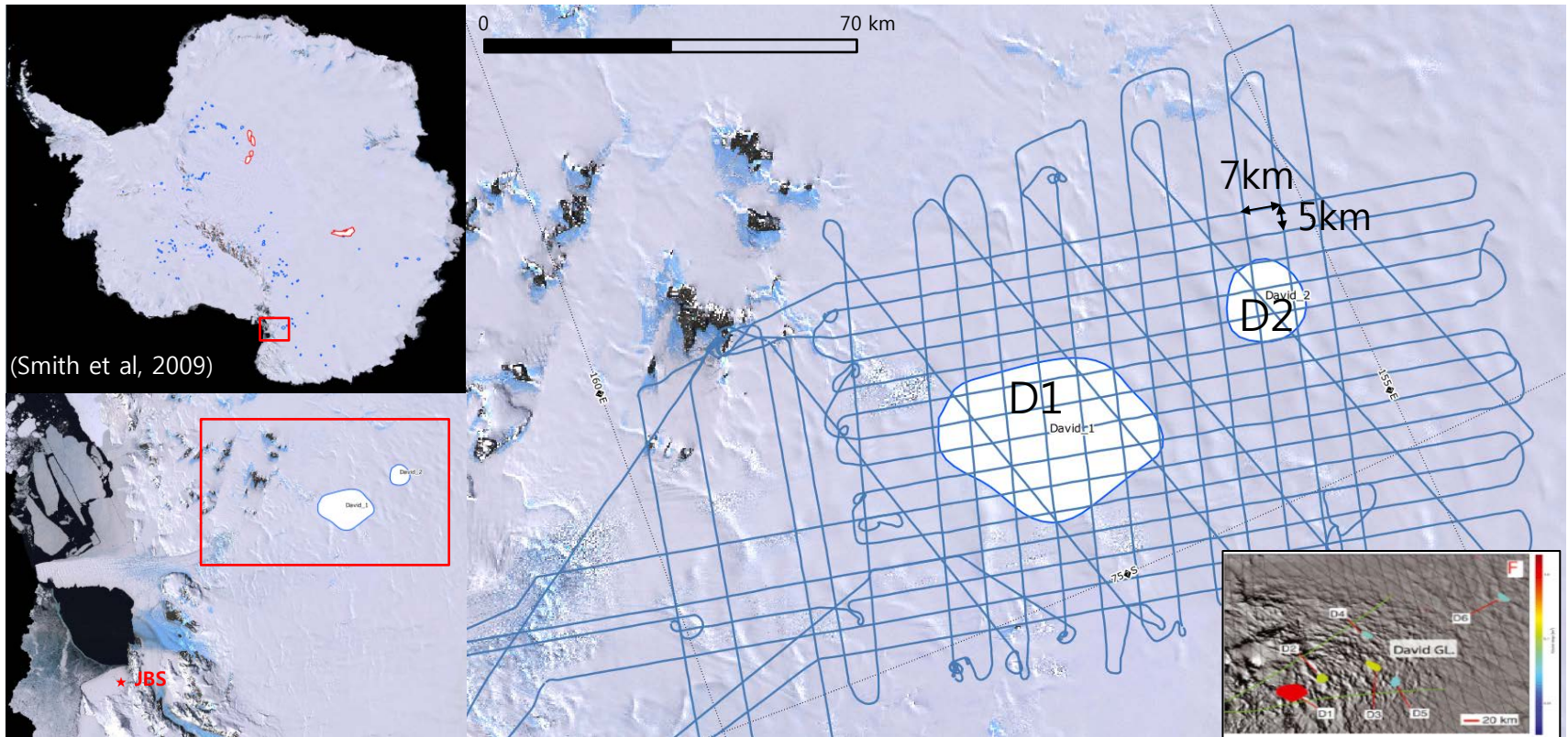
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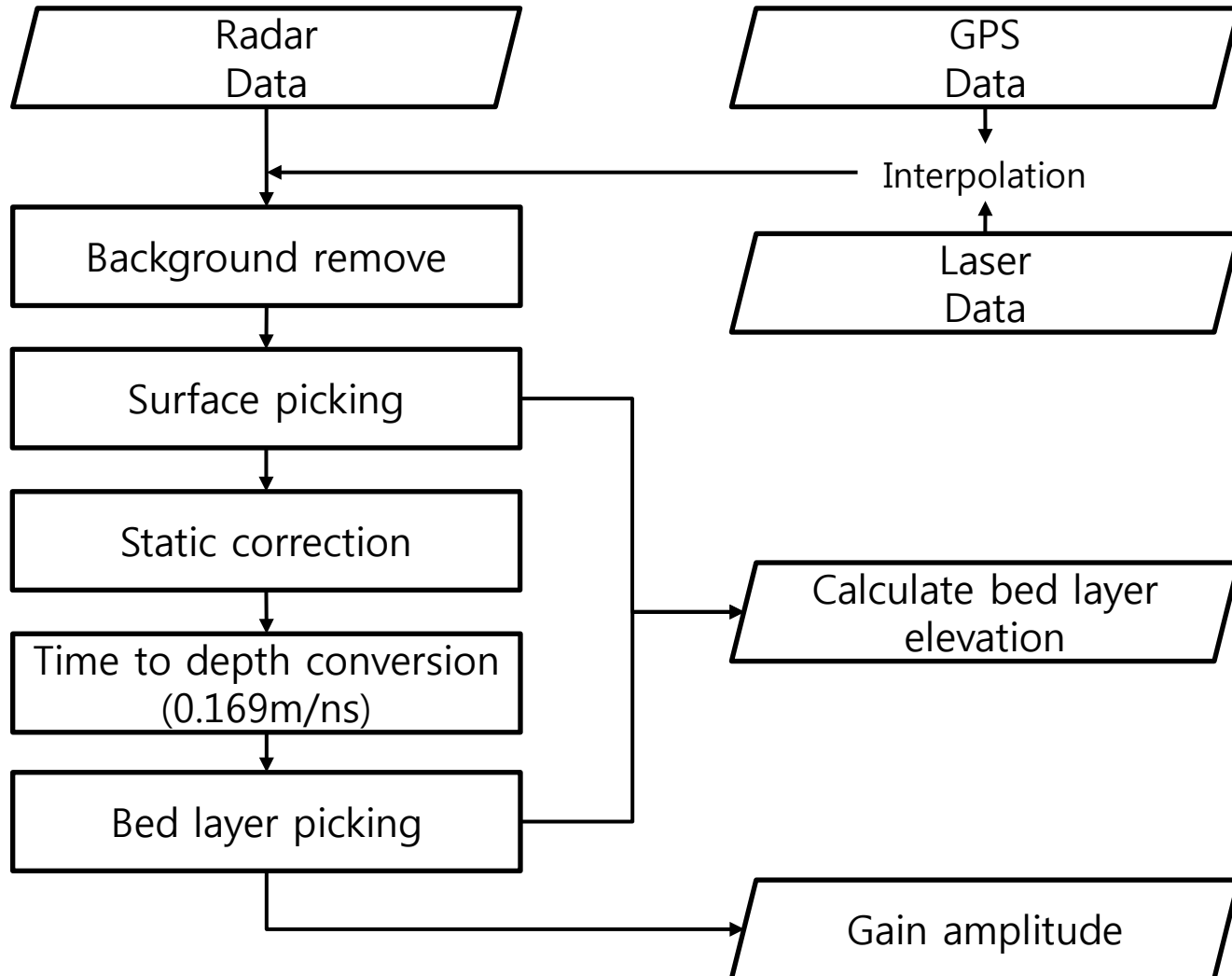
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D1, D2 Lake Survey in 2016/17 Season

- D1 and D2 lake were surveyed with a grid of 5 x 7 km in David glacier
- It surveyed about 3,540km over 5 times

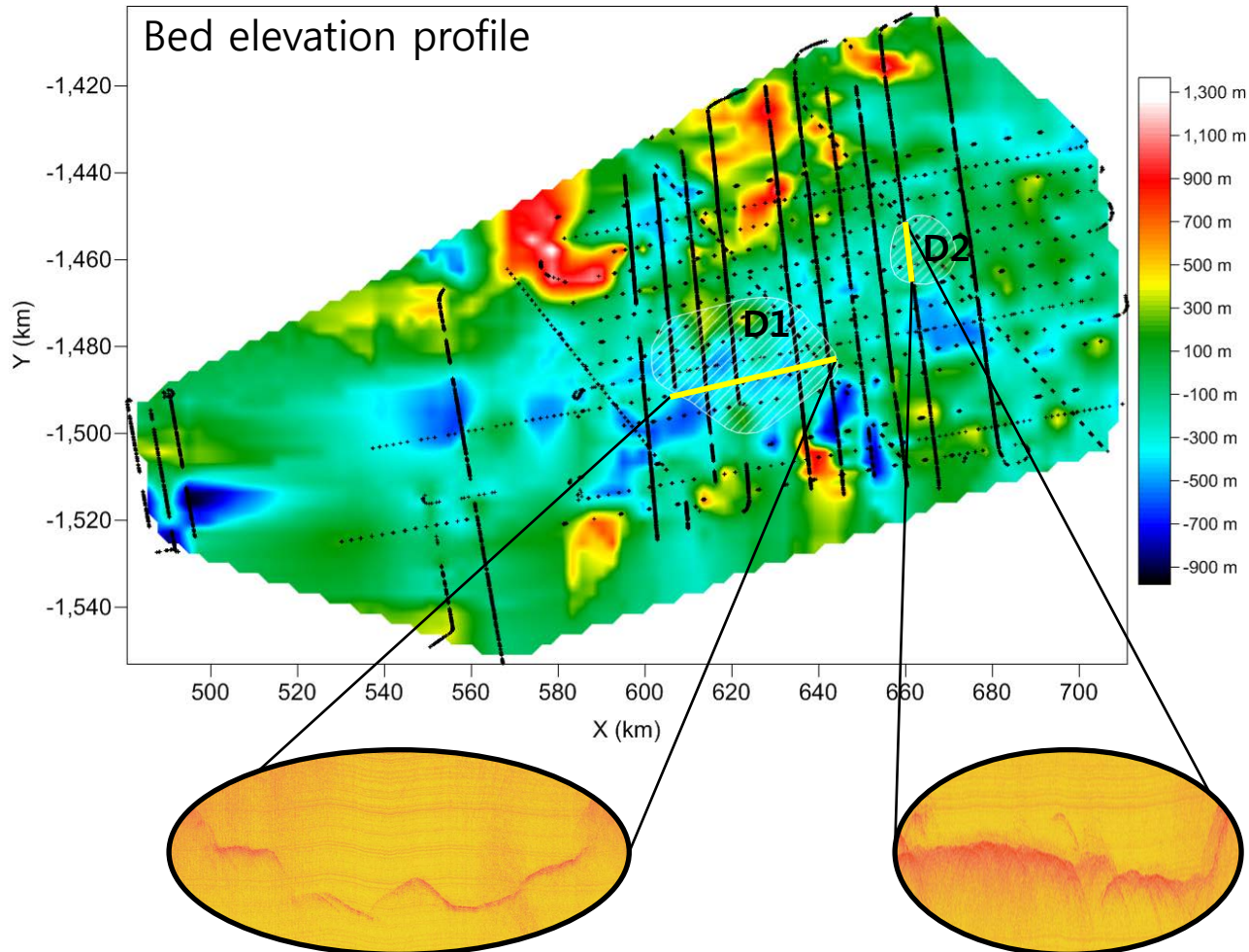


Processing – Flow Chart



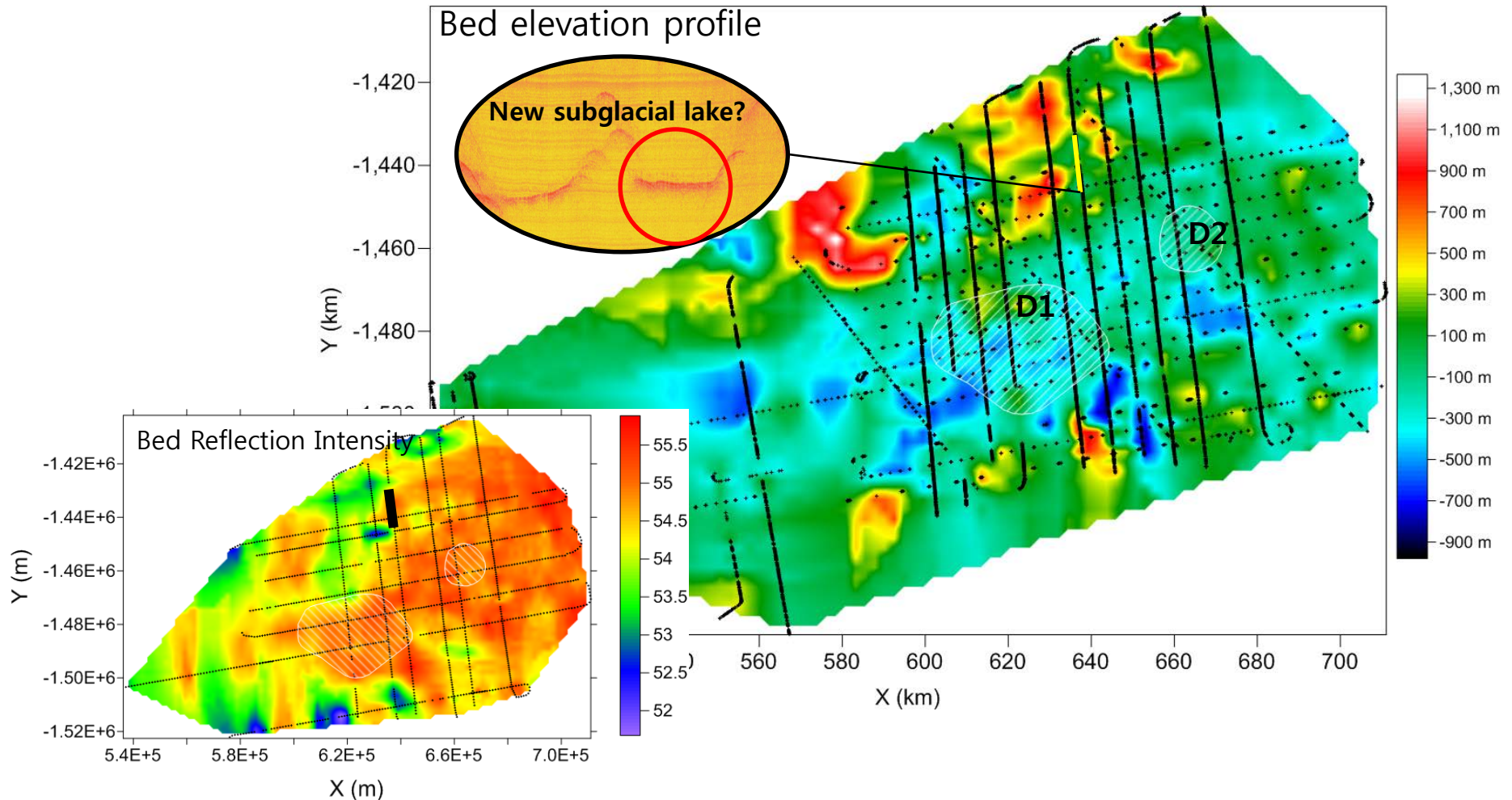
Survey Result in 2016/17 Season

- Calculated from radar results
- Bed elevation of D1 lake is low than MSL. But the flat reflection which is a typical reflection signal of the lake was not observed in the radar

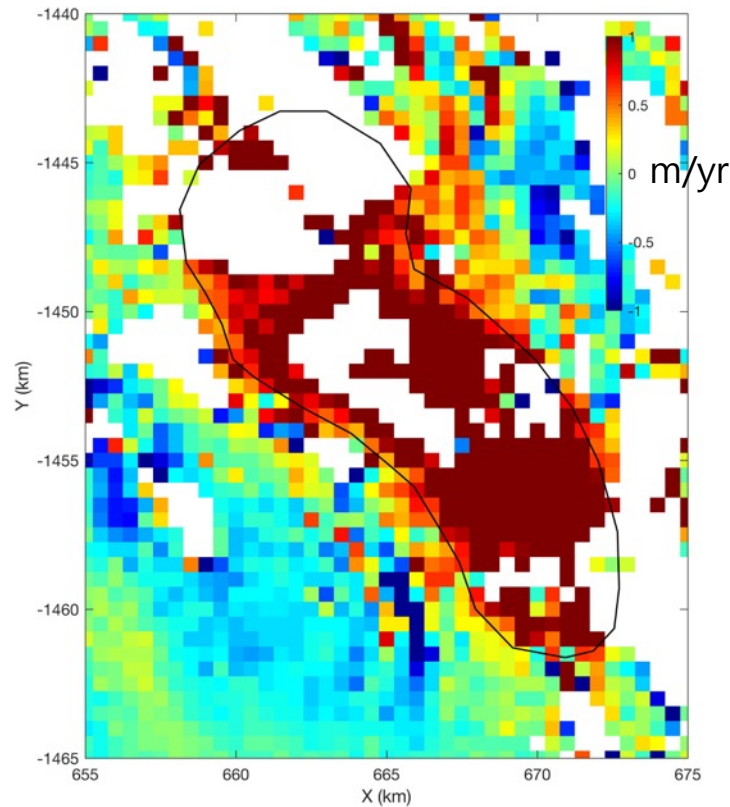


Survey Result in 2016/17 Season

- Flat and high intensity reflections were observed in other areas not in the D1 and D2 areas.



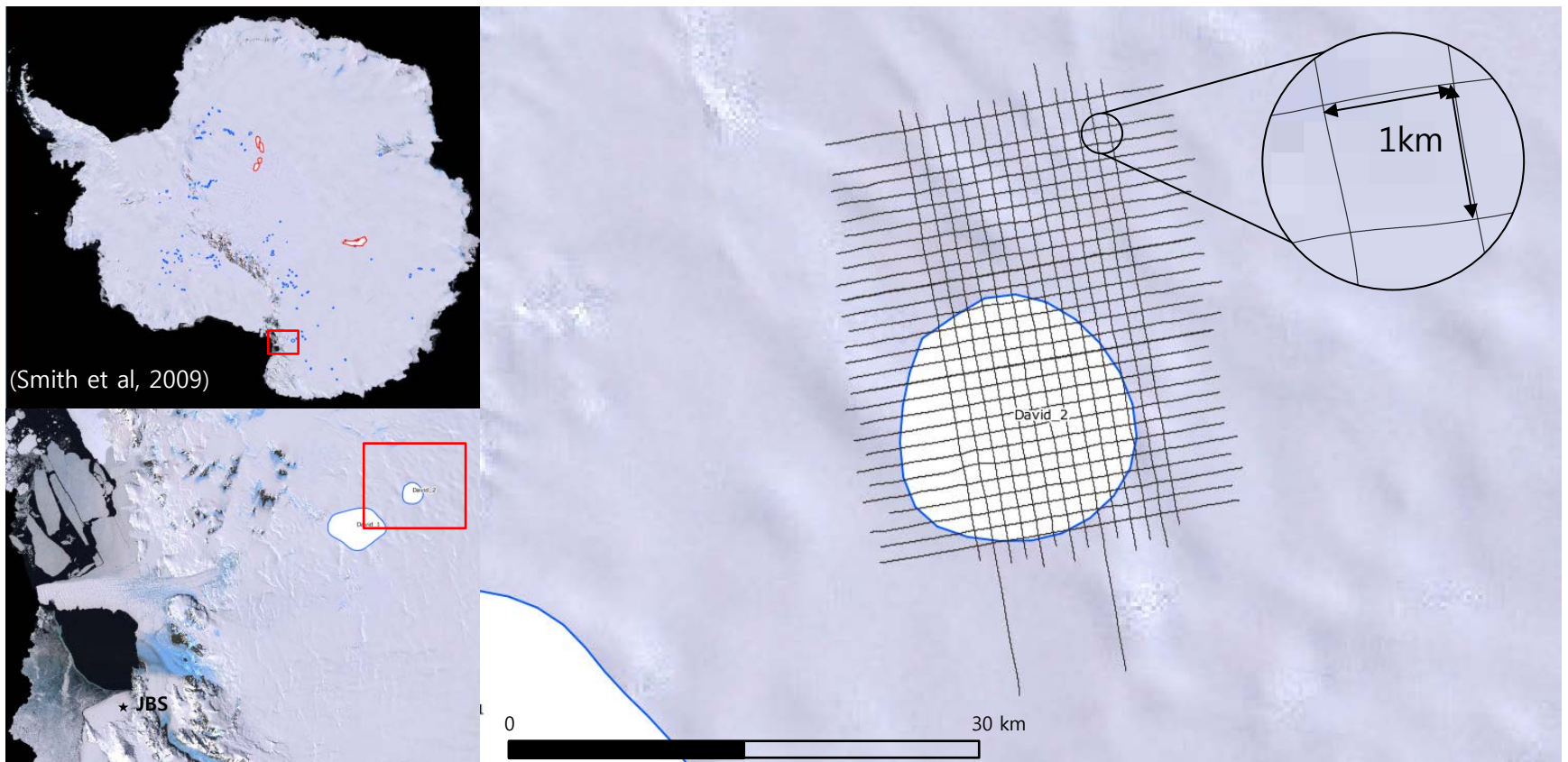
Cryosat-2 elevation change on the D2 (2013-2017)



- The new boundary of D2 lake was described from Cryosat-2 elevation change. The true boundary may be narrower than this boundary, because of the viscoelastic response of ice sheet due to the water level change (From Lee)

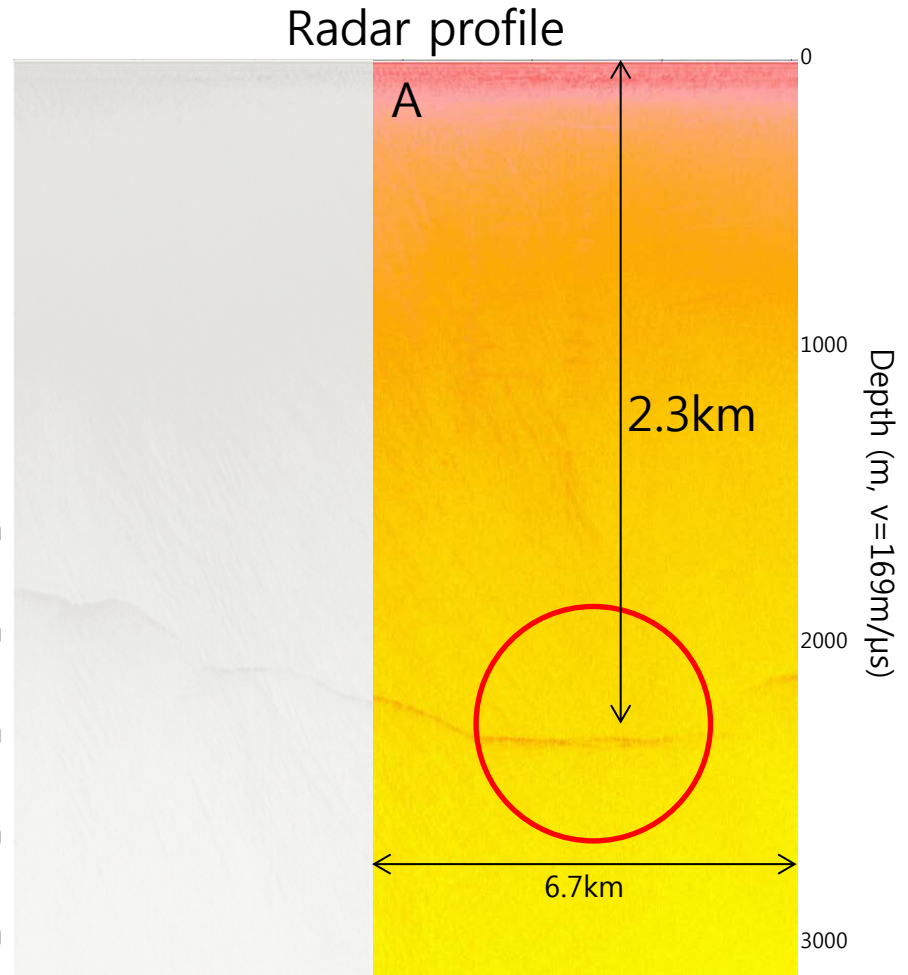
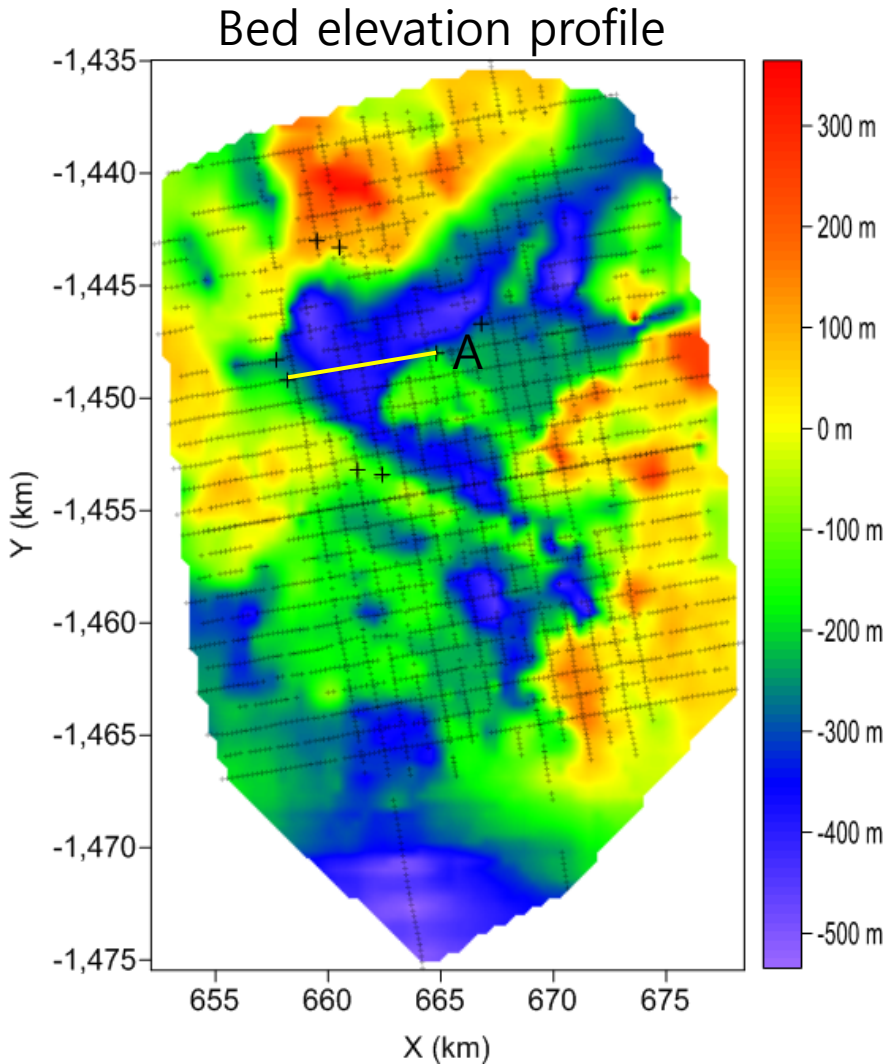
D2 Lake Survey in 2018/19 Season

- Based on the Cryosat-2 data
- D2 lake was surveyed with a grid of 1 x 1 km last season.
- It surveyed about 1,100 km



IPR Survey Result on D2 in 2018/2019

- Bed elevation profile of the D2 area calculated from the radar results

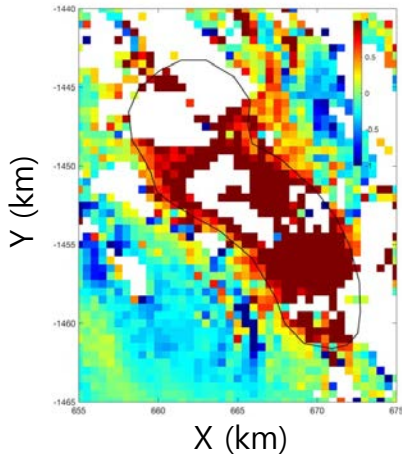


IPR Survey Result on D2 in 2018/2019

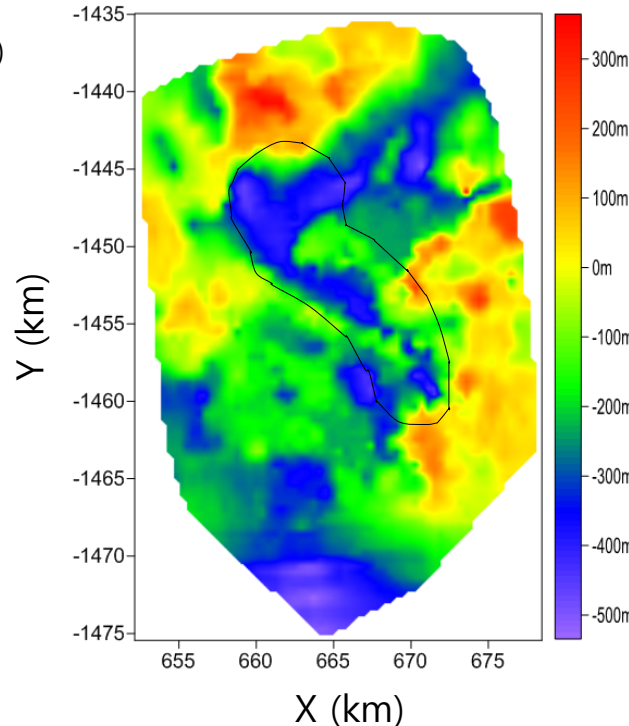
- The reflection intensity and the valley structure of the bed elevation profile within the black boundary suggest the presence of water.
- These results also show results similar to those of Cryosat-2 data.

$$BRI = \frac{\log A_{bed} (\sqrt{\epsilon_{ice}} - \sqrt{\epsilon_{water}})}{\log A_{surface} 4\pi z (\sqrt{\epsilon_{ice}} + \sqrt{\epsilon_{water}})}$$

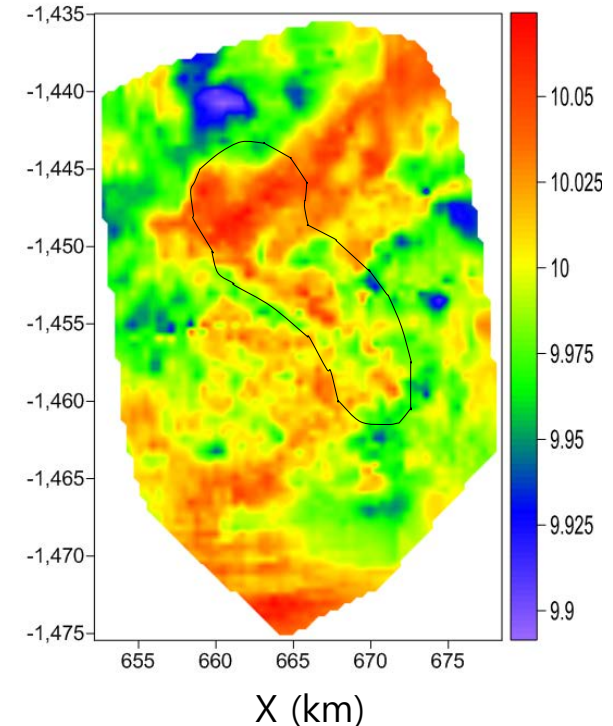
Cryosat-2 elevation change (13'-17')



Bed elevation profile



Bed Reflection Intensity



$$\epsilon_{ice} \cong 3 - 3.15$$

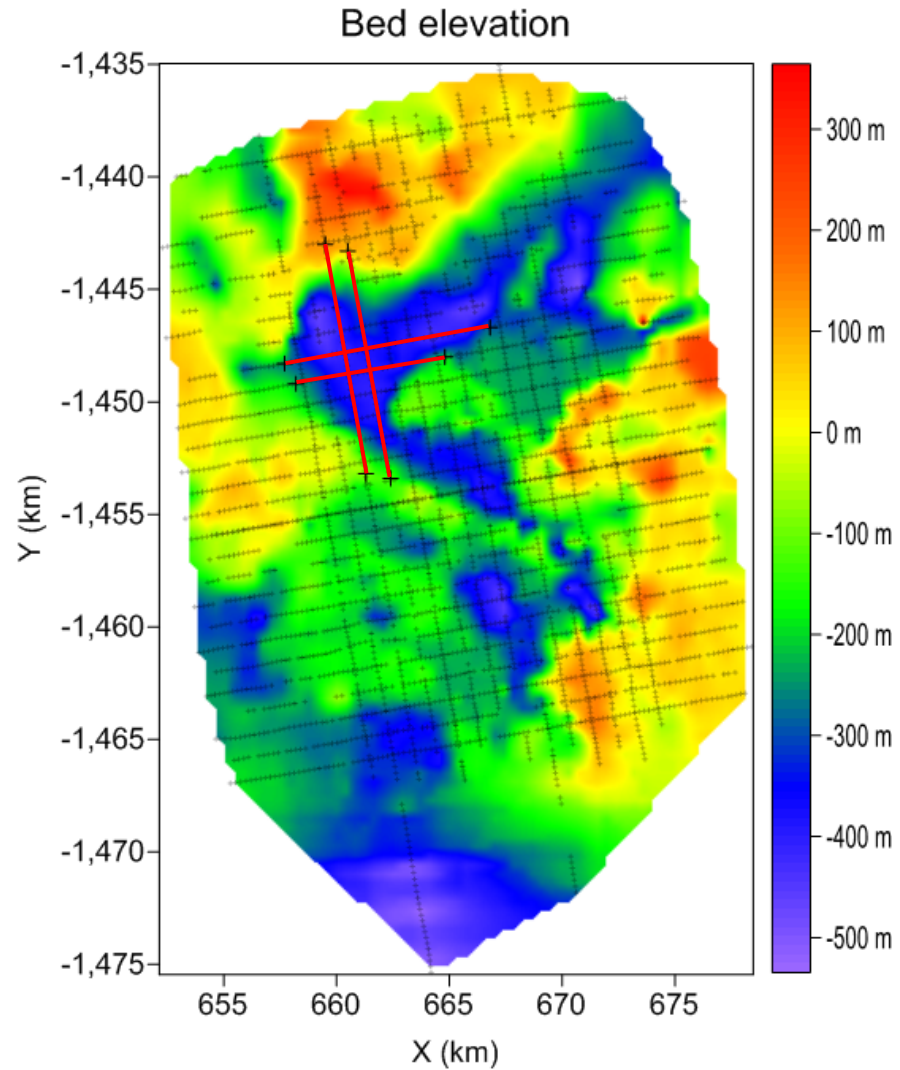
$$\epsilon_{fresh\ water} \cong 81 \text{ (Reynolds, 2011)}$$

Conclusion

- The radar results obtained in the D2 area where glacier surface changes are interpreted as suggesting the existence of ice glaciers.
 - The shape of subglacial bed is likely to have water in valley and its bed reflection intensity is high as well.
- In order to accurately identify the presence and quantity of water, seismic surveys will be conducted in the area in the coming season.

Future work

- **Seismic** survey in 2019/20 season
- 10 days, 12 members
- D2 Lake



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Thank you



극지연구소

Korea Polar Research Institute