ABoVE SCIENCE TEAM MEETING
ASTM 8 | May 9-13, 2022
FAIRBANKS, ALASKA

Synthetic Aperture Radar (SAR) detects large gas seep in lake

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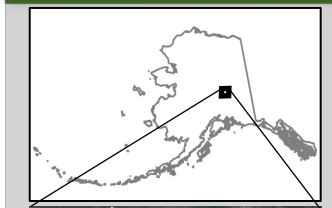
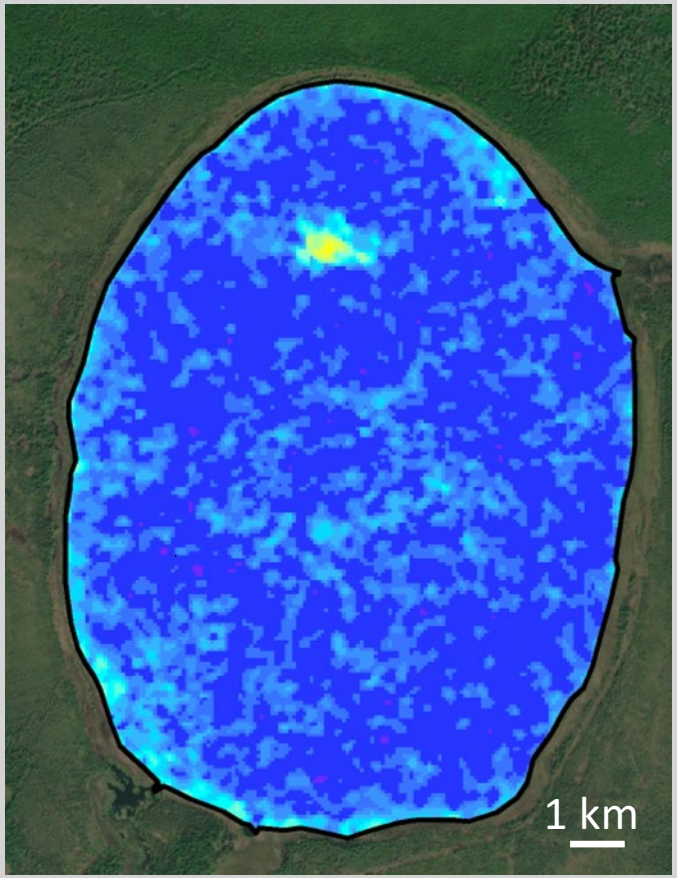
Photo: Oct. 2009
from Walter Anthony et al. 2012, Nature Geoscience

North Blair Lake

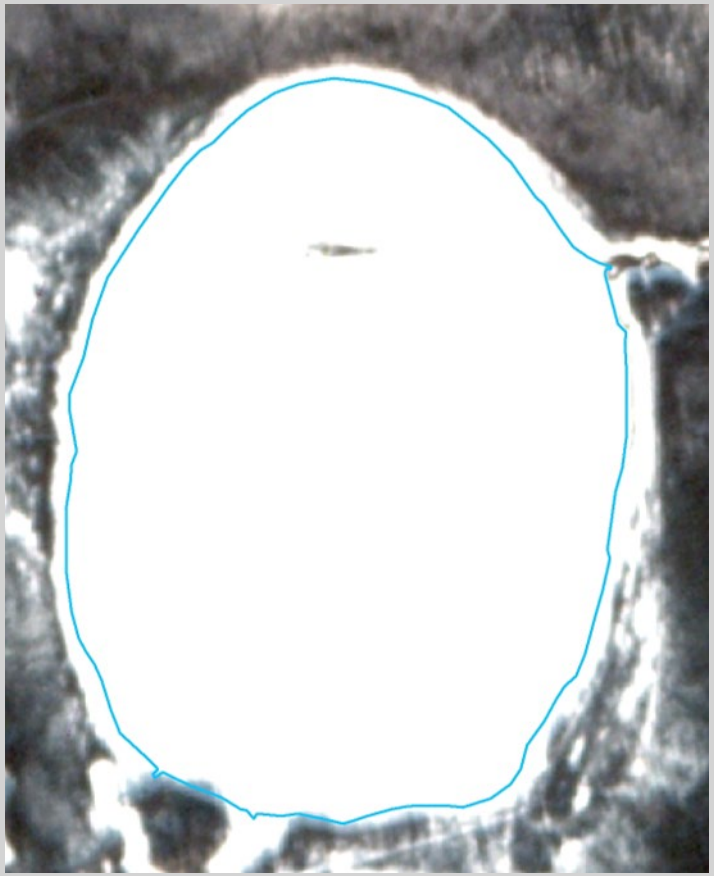


SAR Backscatter (dB)

- > -8
- -8 to -9
- -9 to -10
- -10 to -11
- -11 to -12
- -12 to -13
- -13 to -14
- -14 to -15
- -15 to -16
- -16 to -17
- -17 to -18
- -18 to -19
- -19 to -20
- -20 to -24
- -24 to -28
- < -32



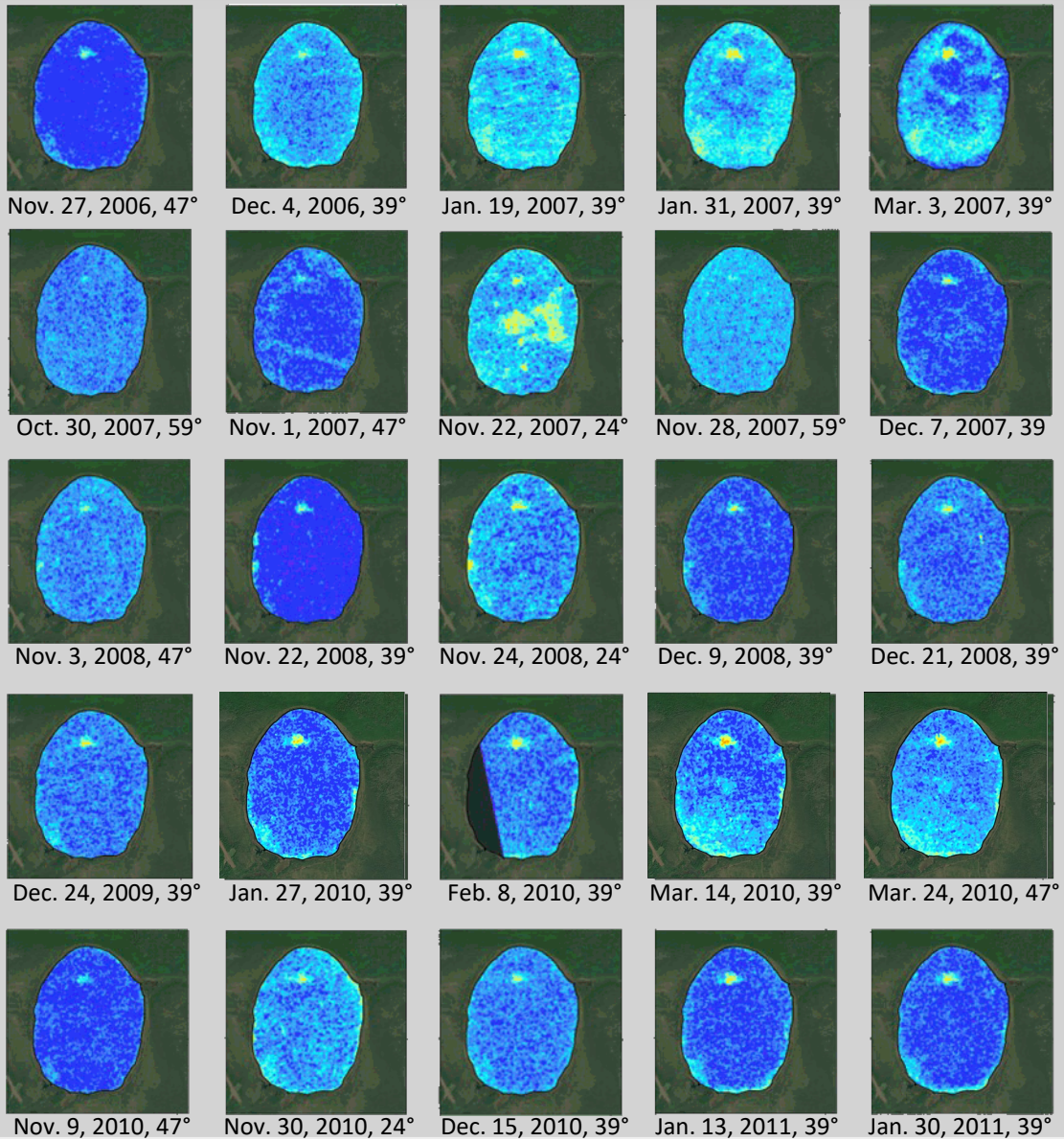
SAR Dec. 7, 2007
L-band Palsar (HH)



Planet Nov. 23, 2021

May 5, 2005

High backscatter feature showed in every available L-band single-pol (HH) image from 1992-2011 (historical JERS-1 not shown here).

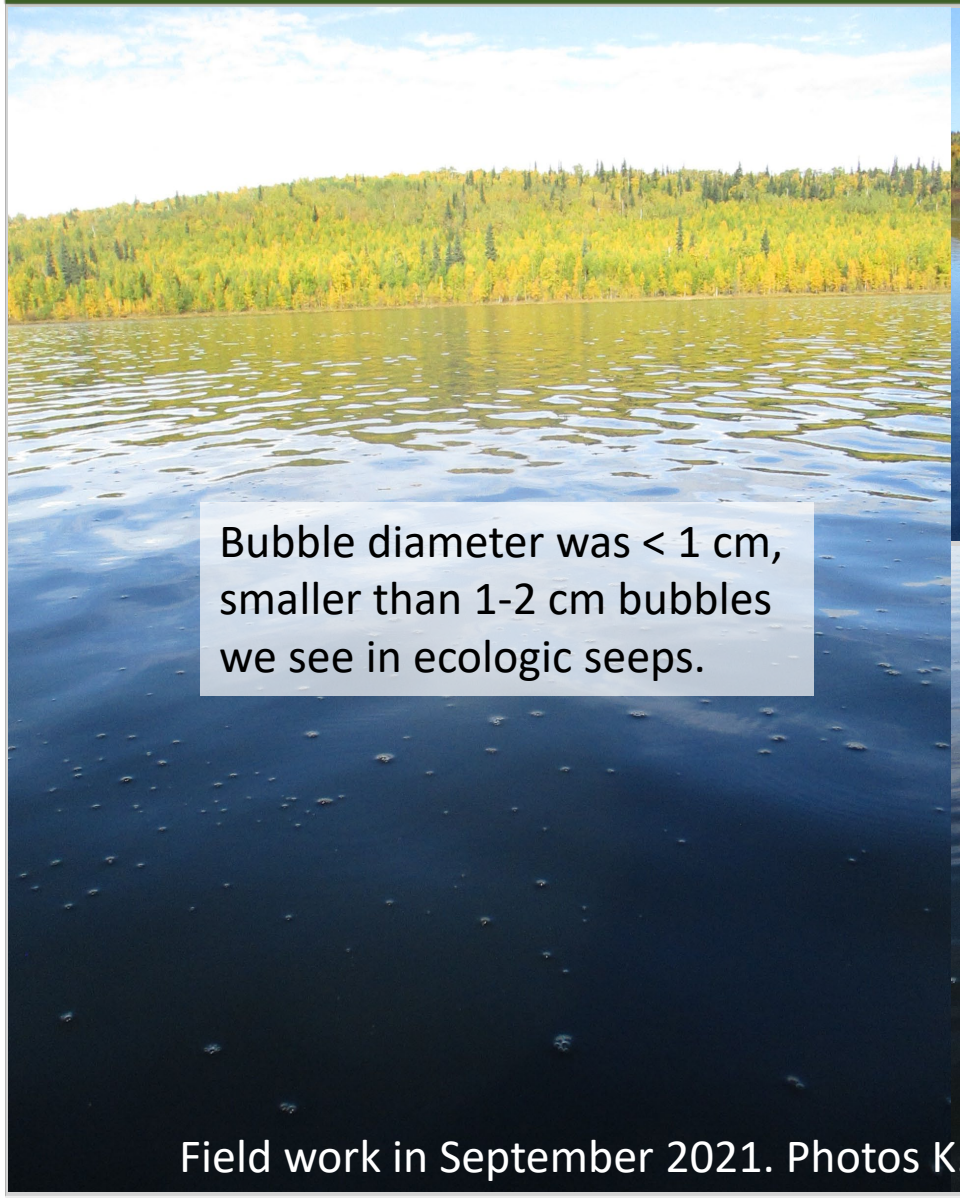


SAR Backscatter (dB)

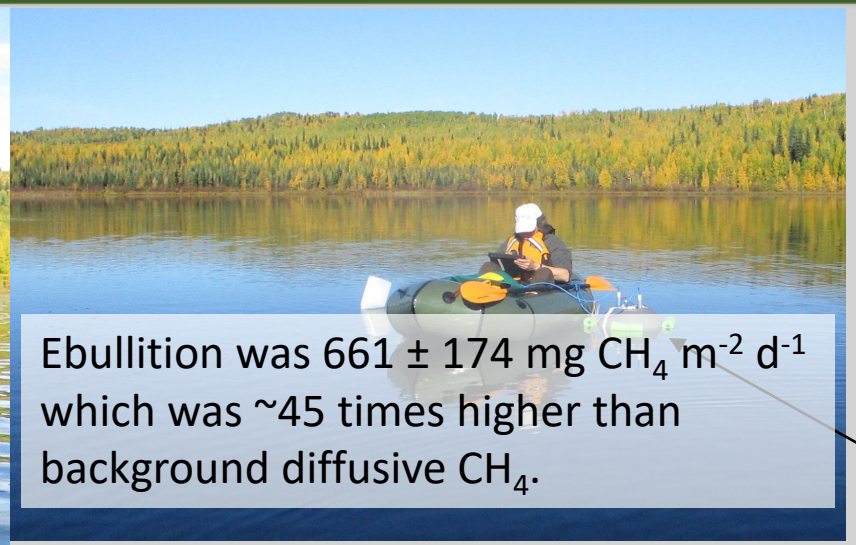
- > -7
- -7 to -8
- -8 to -9
- -9 to -10
- -10 to -11
- -11 to -12
- -12 to -13
- -13 to -14
- -14 to -15
- -15 to -16
- -16 to -17
- -17 to -18
- -18 to -19
- -19 to -20
- -20 to -24
- -24 to -28
- < -32

Field work in September 2021. Photos K. Walter Anthony and P. Anthony

- We found a large (80 x 100 m) seep field at GPS location of high SAR backscatter
- Measured flux outside of seep area and over seep with LGR, a dynamic floating chamber
- Gas samples collected by underwater bubble trap within seep



Bubble diameter was < 1 cm, smaller than 1-2 cm bubbles we see in ecologic seeps.



Ebullition was 661 ± 174 mg CH_4 m^{-2} d^{-1} which was ~45 times higher than background diffusive CH_4.

Bubbles were 6.6% CH_4; low concentration indicating possible groundwater association.

$^{14}C_{CH4}$ age was 18,470 ± 50 years BP.

Stable isotope $\delta^{13}C_{CH4}$ of -44.5 ± 0. ‰ suggests a potential thermogenic origin.

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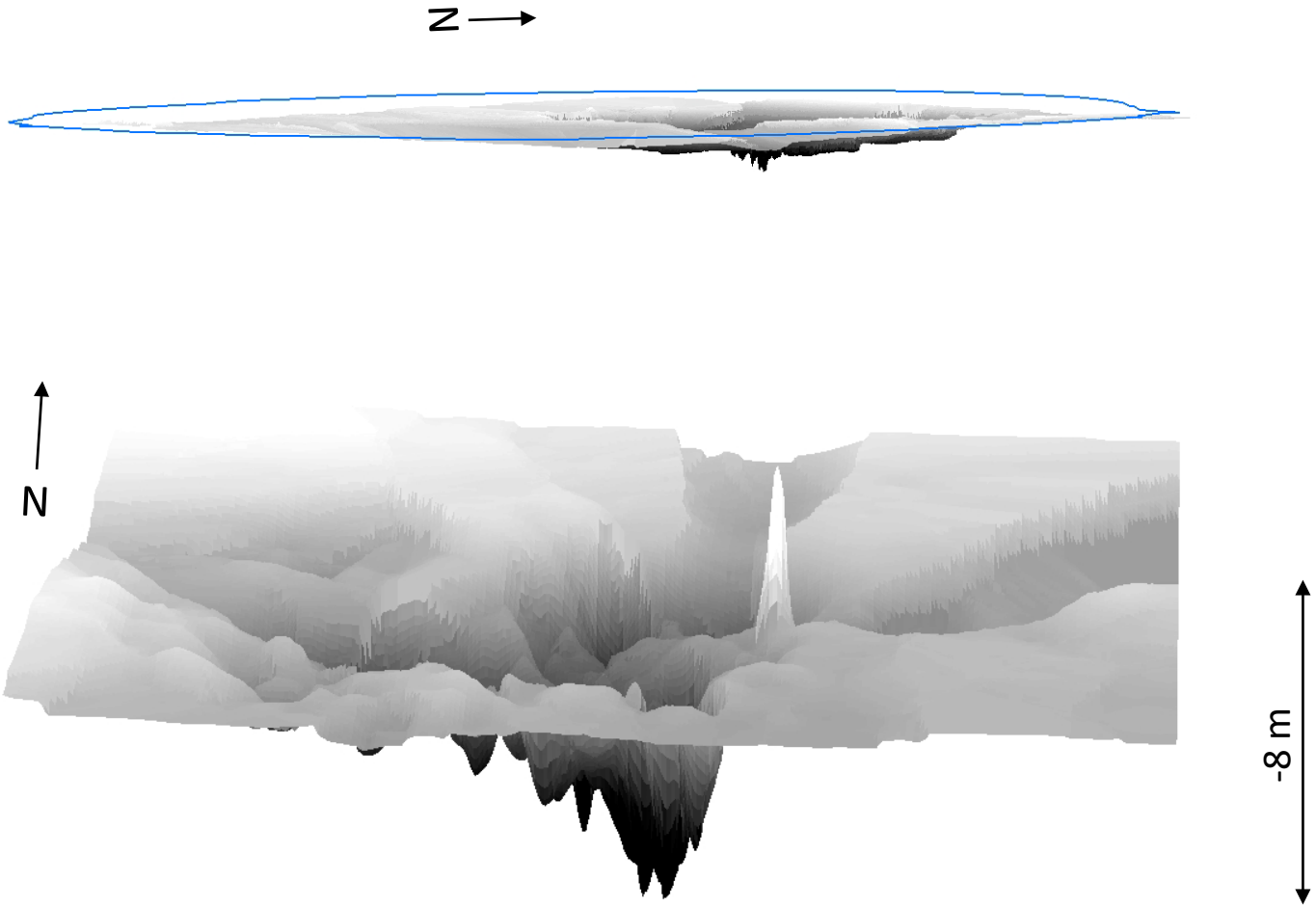
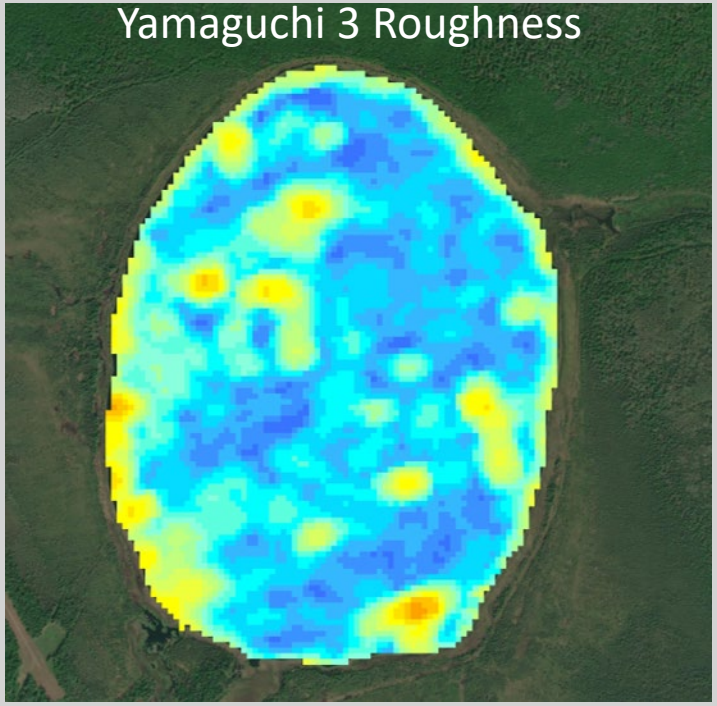
- Gas samples collected by underwater bubble trap within seep

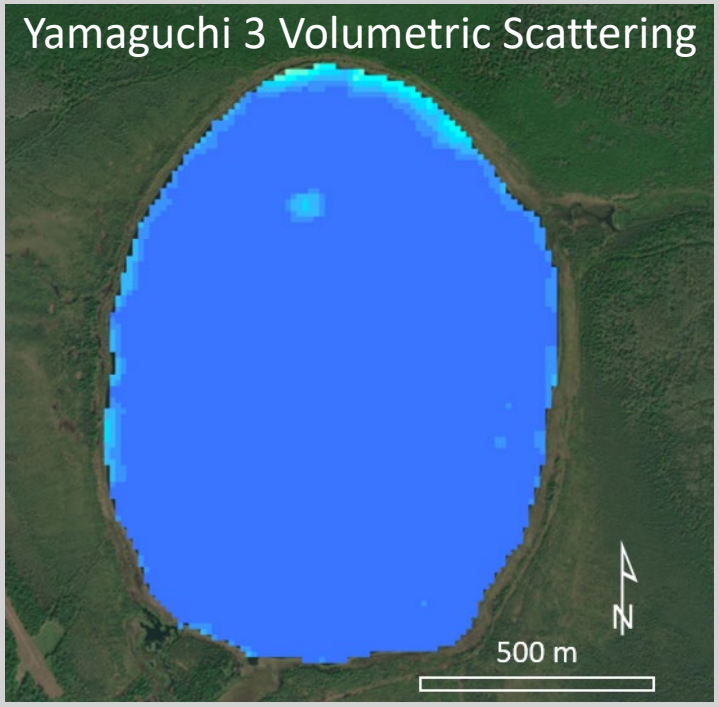


Bathymetry measurements by fieldworkers revealed a pock mark 8 m deep directly below the seep.

Lake depth outside of the seep ranged from ~1-4 m.

L-band Quad-pol polarimetric decomposition, November 27, 2009





Backscatter (dB)

- > -6
- -6 to -7
- -7 to -8
- -8 to -9
- -9 to -10
- -10 to -11
- -11 to -12
- -12 to -13
- -13 to -14
- -14 to -15
- -15 to -16
- -16 to -17
- -17 to -18
- -18 to -19
- -19 to -20
- -20 to -24
- -24 to -28
- -28 to -32
- -32 to -36
- < -36

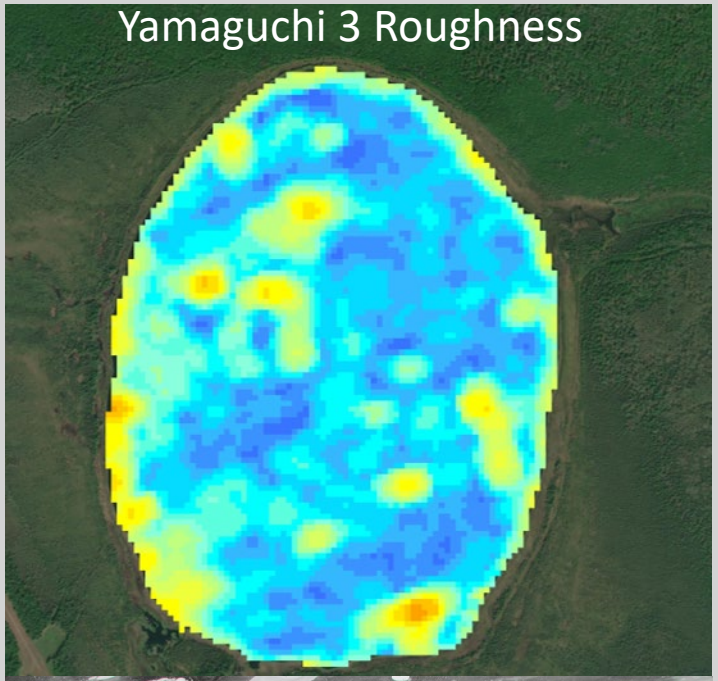
Limited amount of quad-pol data shows

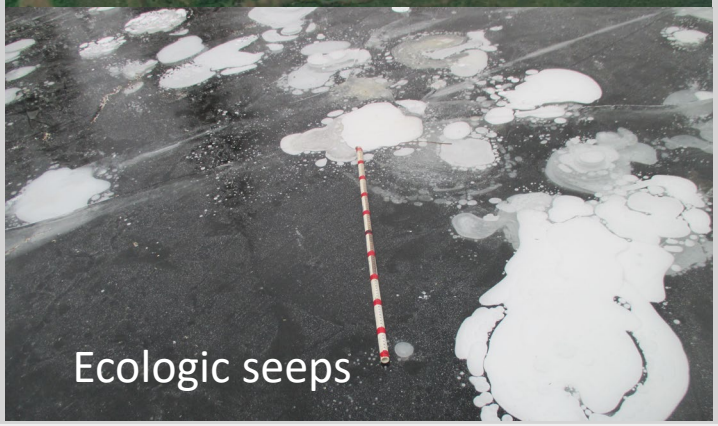
1) Roughness
2) Volumetric scattering

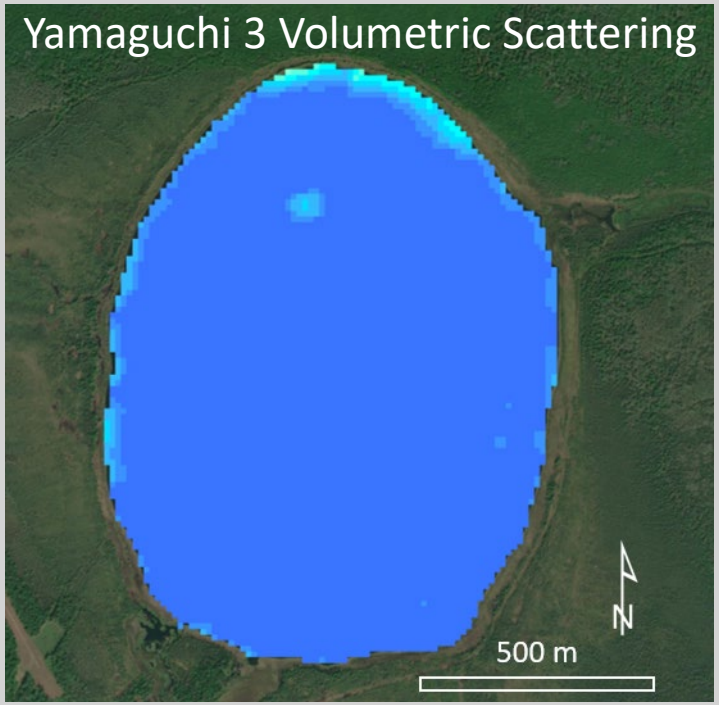
L-band Quad-pol polarimetric decomposition, November 27, 2009

Backscatter (dB)

- > -6
- -6 to -7
- -7 to -8
- -8 to -9
- -9 to -10
- -10 to -11
- -11 to -12
- -12 to -13
- -13 to -14
- -14 to -15
- -15 to -16
- -16 to -17
- -17 to -18
- -18 to -19
- -19 to -20
- -20 to -24
- -24 to -28
- -28 to -32
- -32 to -36
- < -36

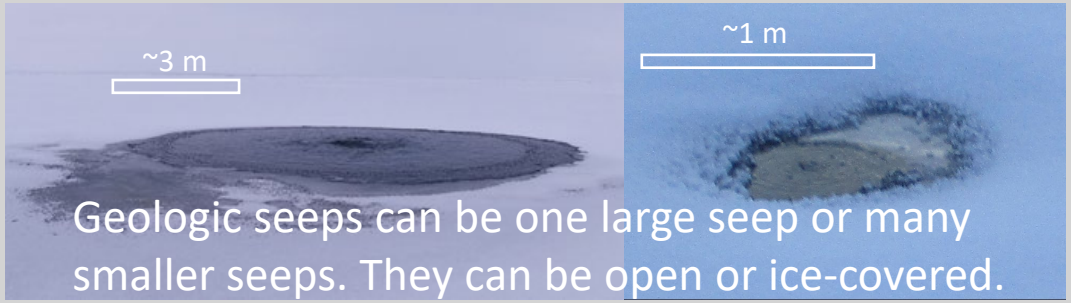






Roughness can indicate ecologic methane

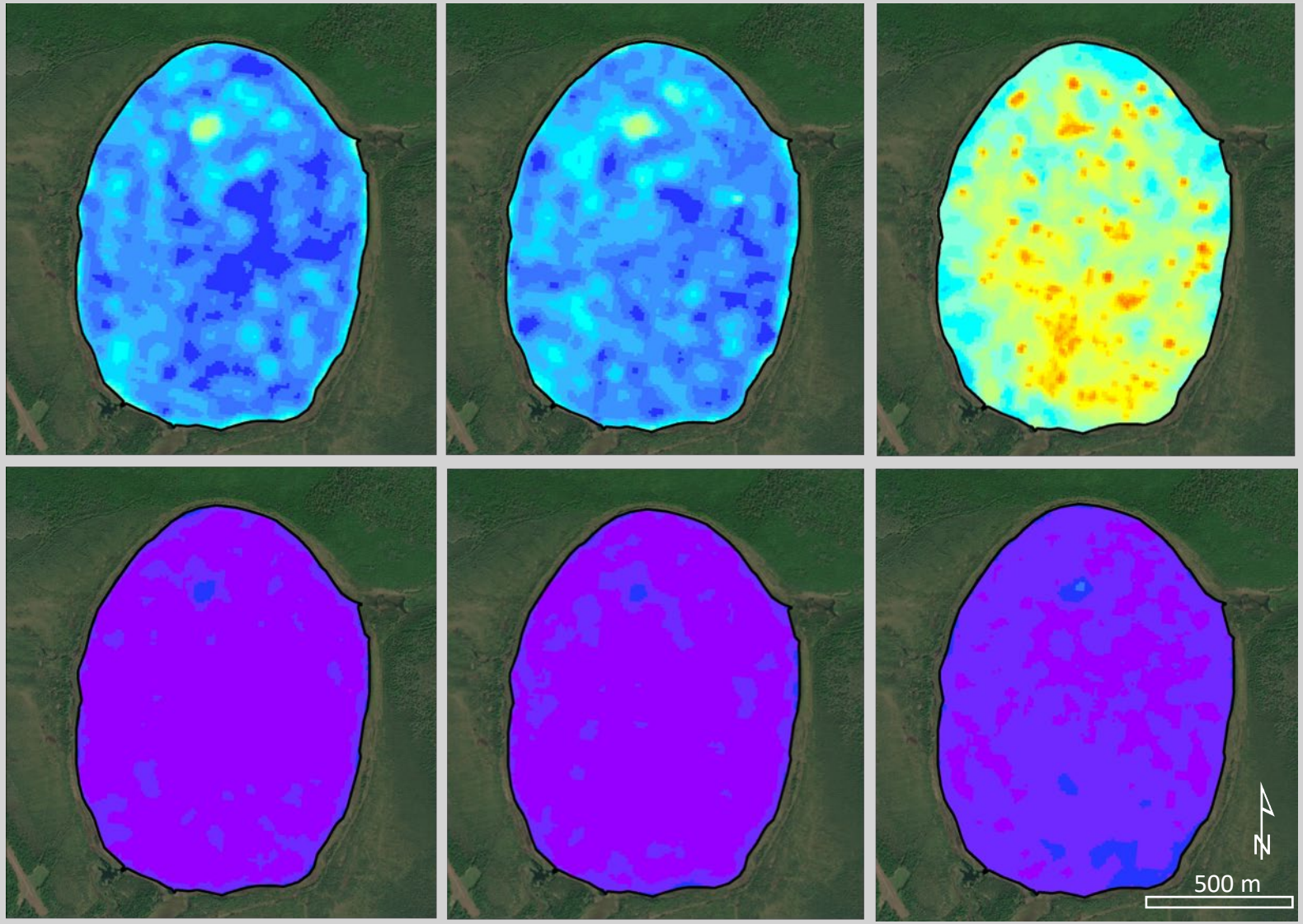
Volumetric scattering does not indicate ecologic methane



Sentinel-1

C-band SAR Backscatter (dB)

- > -6
- -6 to -7
- -7 to -8
- -8 to -9
- -9 to -10
- -10 to -11
- -11 to -12
- -12 to -13
- -13 to -14
- -14 to -15
- -15 to -16
- -16 to -17
- -17 to -18
- -18 to -19
- -19 to -20
- -20 to -24
- -24 to -28
- -28 to -32
- -32 to -36
- < -36



Dual-pol with an eye toward NISAR:

- C-band can affirm presence of seep
- Volumetric scattering can be seen with VH
- Dual-pol NISAR (L-band, launch 2024) will also give more information by providing a cross-pol

Conclusions

- L-band SAR shows large methane geologic seeps as high backscatter features in every L-band image from 1992-2011
- C-band can confirm presence of a seep, although obscured in spring
- Scattering mechanism -- combination of roughness and volumetric scattering
- Upcoming **NISAR** mission will provide current L-band SAR imagery in dual-polarization
- SAR has the potential to be a remote sensing tool that can detect large methane seeps in lakes across a landscape: colleague Natalie Tyler is working on that.

Acknowledgements:

- The authors gratefully acknowledge the Alaska Satellite Facility (ASF) for providing SAR data and post-processing tools and the Alaska Division of Geological and Geophysical Surveys for providing elevation data for SAR terrain correction.
- We thank P. Hanke, A. Bondurant, P. Anthony, A. Anthony, and J. Anthony for invaluable field measurements at North Blair Lake.

- Funding was provided by NASA ABoVE NNH18ZDA001N-TE, PI Chip Miller