



# SWOT and the Cryosphere

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# SWOT and the Cryosphere?

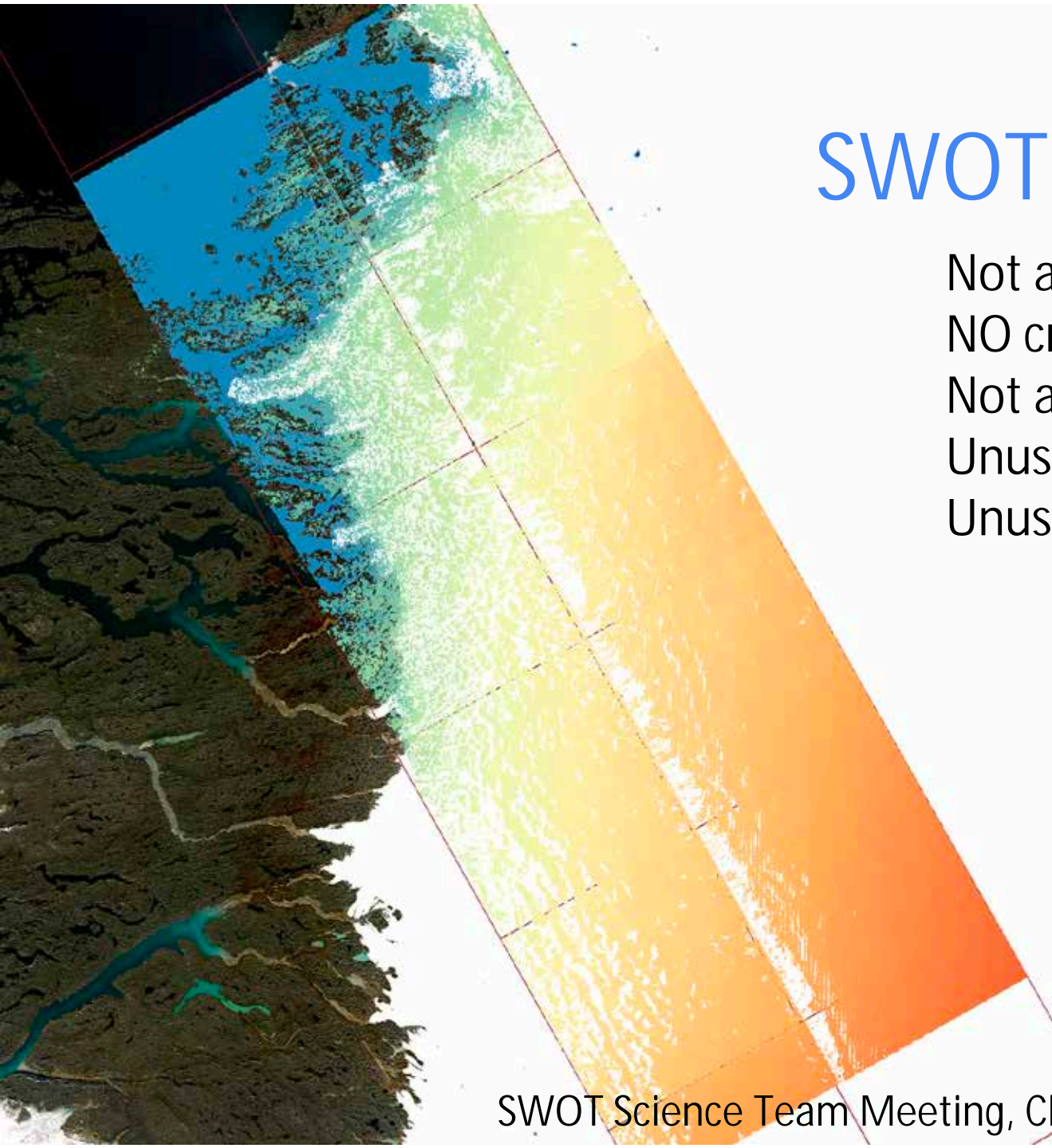
Not a cryosphere mission

NO cryosphere mandate

Not a motion detector (not repeat-pass InSAR)

Unusual incidence angles

Unusual wavelength



# SWOT and the Cryosphere?

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NO cryosphere mandate

Not a motion detector (not repeat-pass InSAR)

Unusual incidence angles

Unusual wavelength

*Yes, but...!*

Phenomenal polar coverage!

Should penetrate ice & snow less!

Will obtain WSEs simultaneously!

(both supra- and proglacial)

Ice is problematic for SWOT hydrology products!

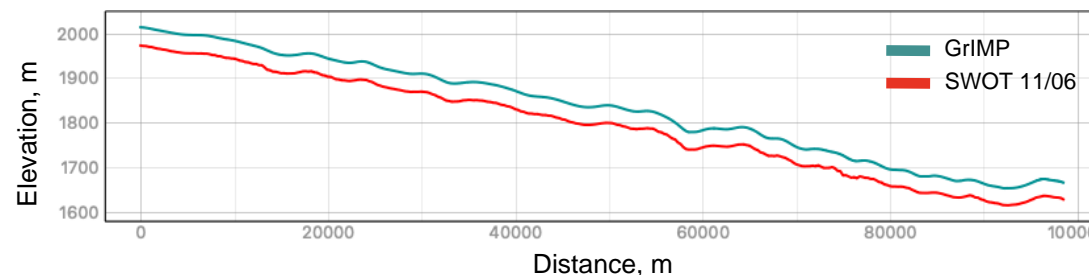
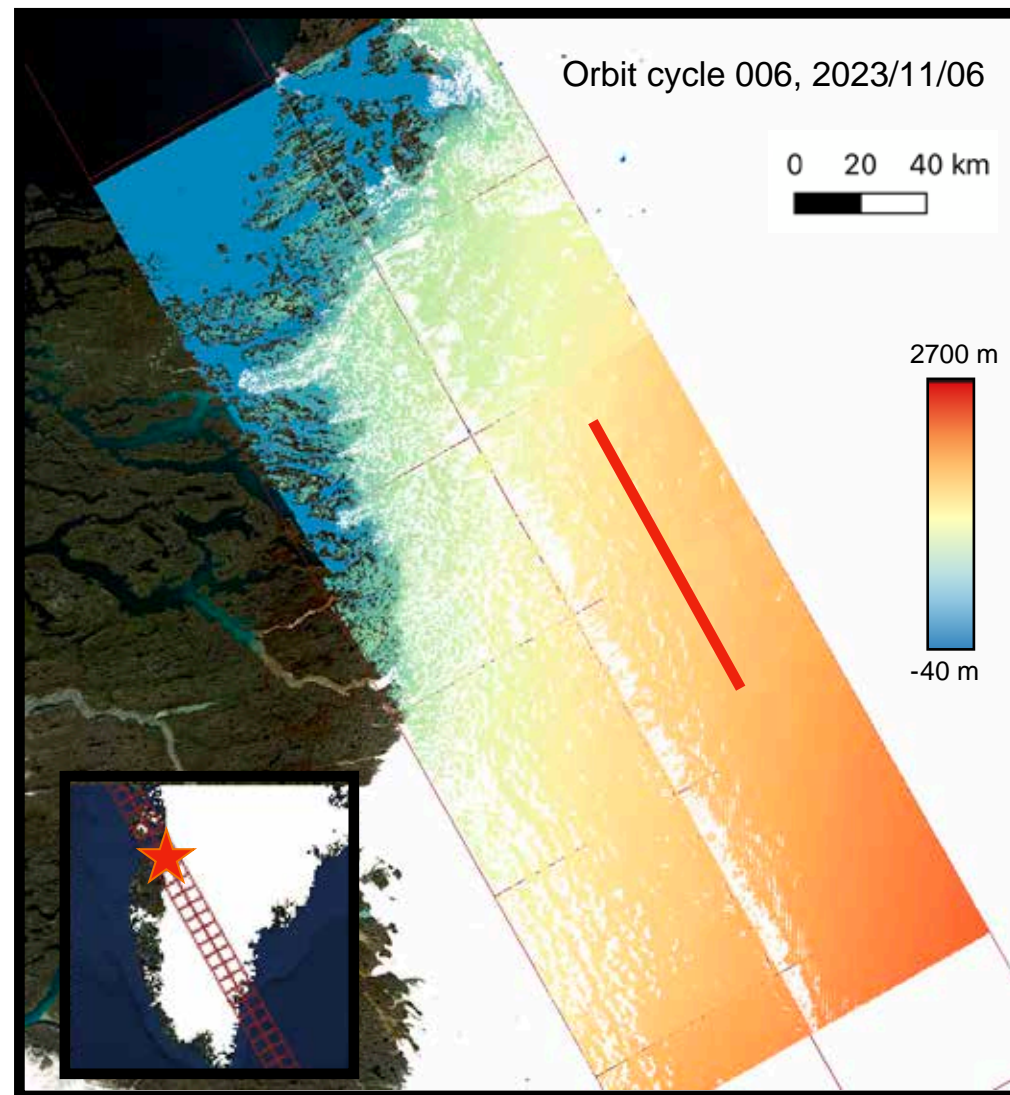


# Initial Results

## Ice sheets/continental interiors

- L2\_HR\_Raster standard product successfully measures ice sheet elevations over Greenland interior
- All pixels included in the standard raster product were bright enough in radar backscatter to be detected as “water” by the high rate (HR) processing algorithms.
- Resultant elevations comparable to profile shape from Greenland Ice Mapping Project (GrIMP) DEM from 2019-2020 (I. Howat & Ohio State University, 2022).

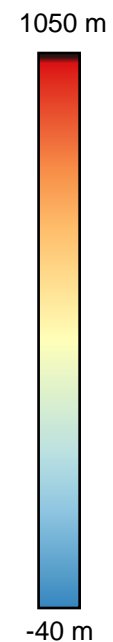
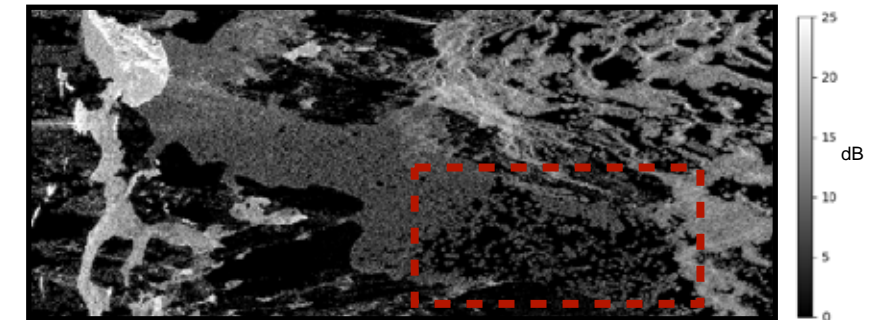
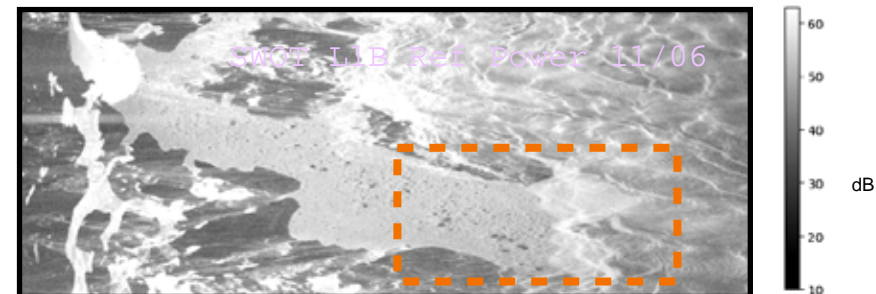
**For some cryosphere applications, may be able to use the standard HR high-level products “off the shelf”**



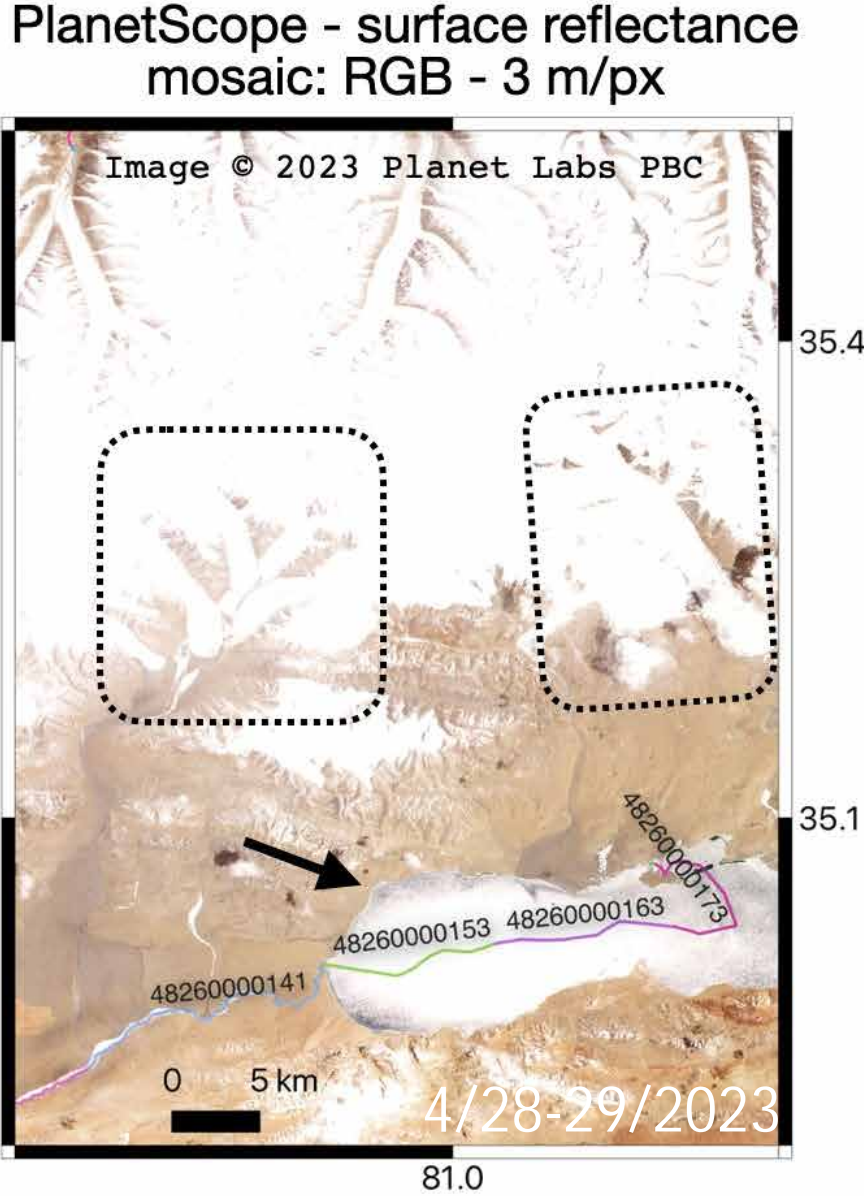
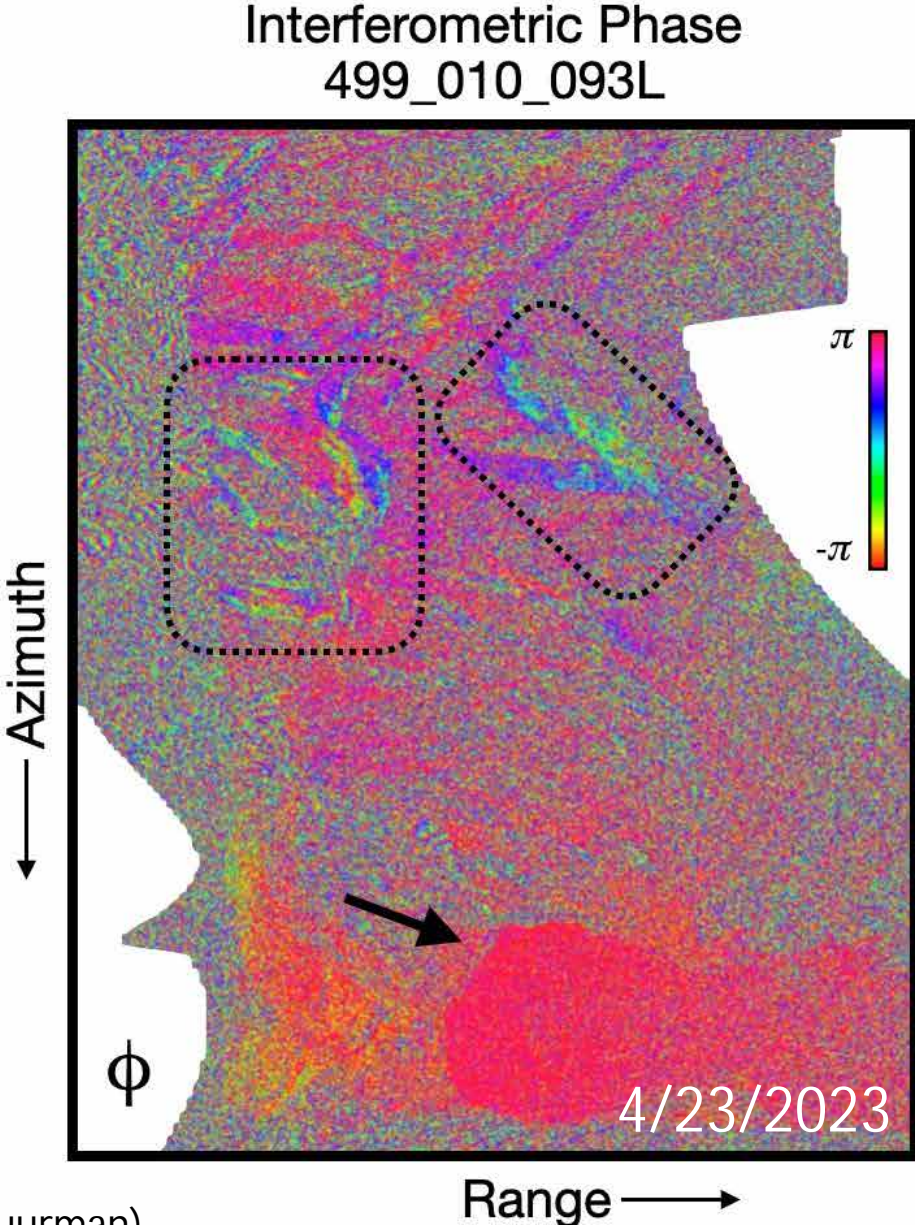


# Initial Results

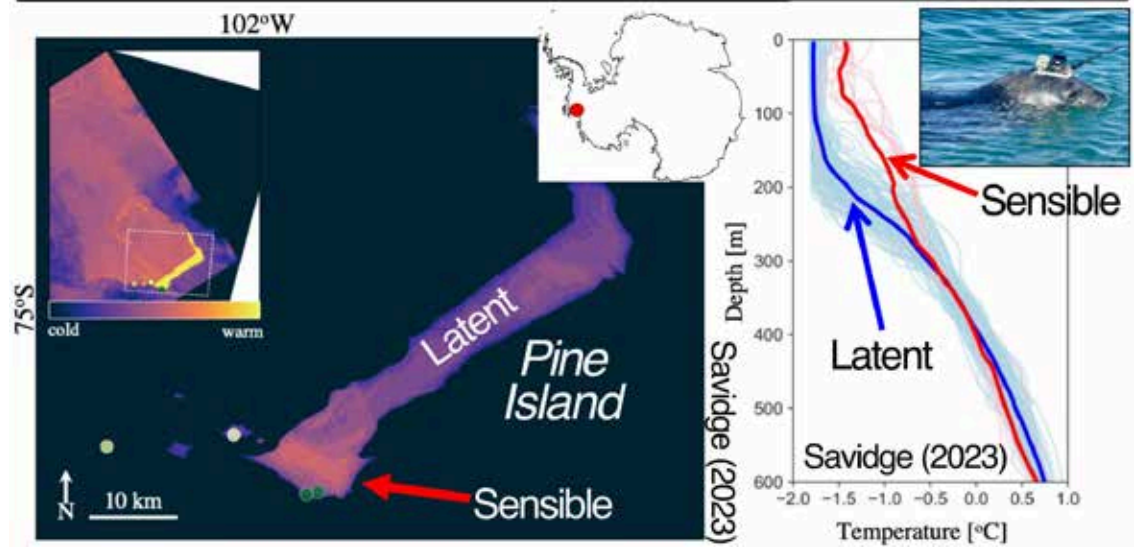
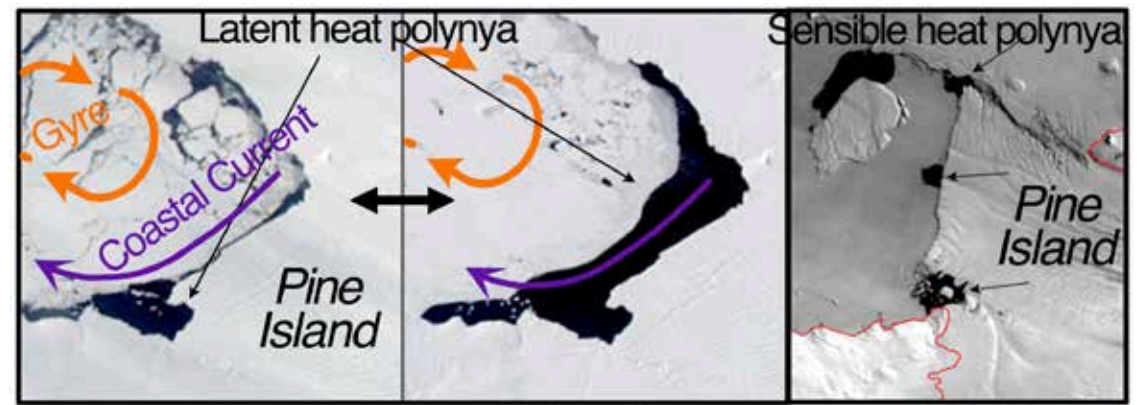
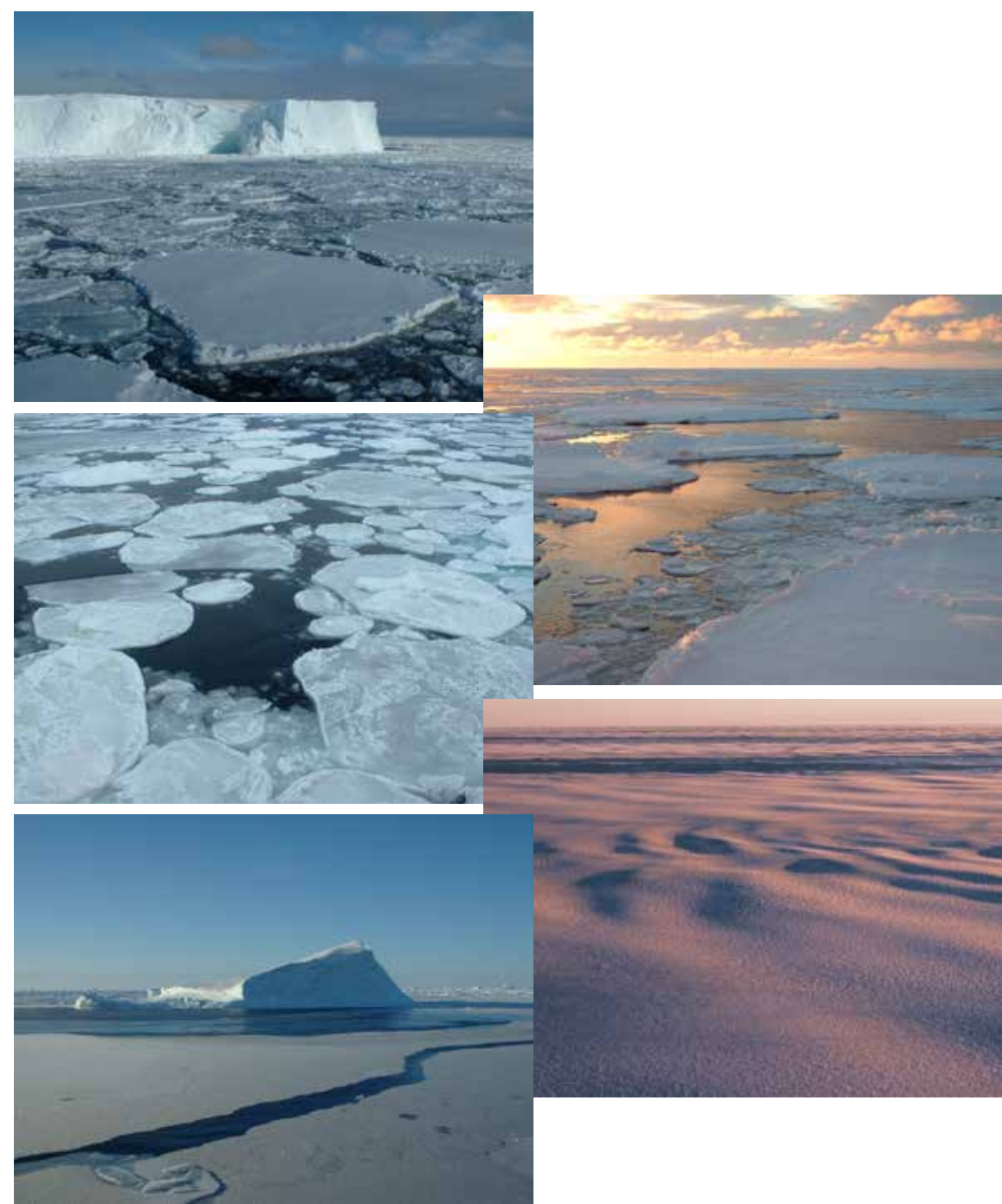
Coastal glaciers: Jakobshavn Glacier



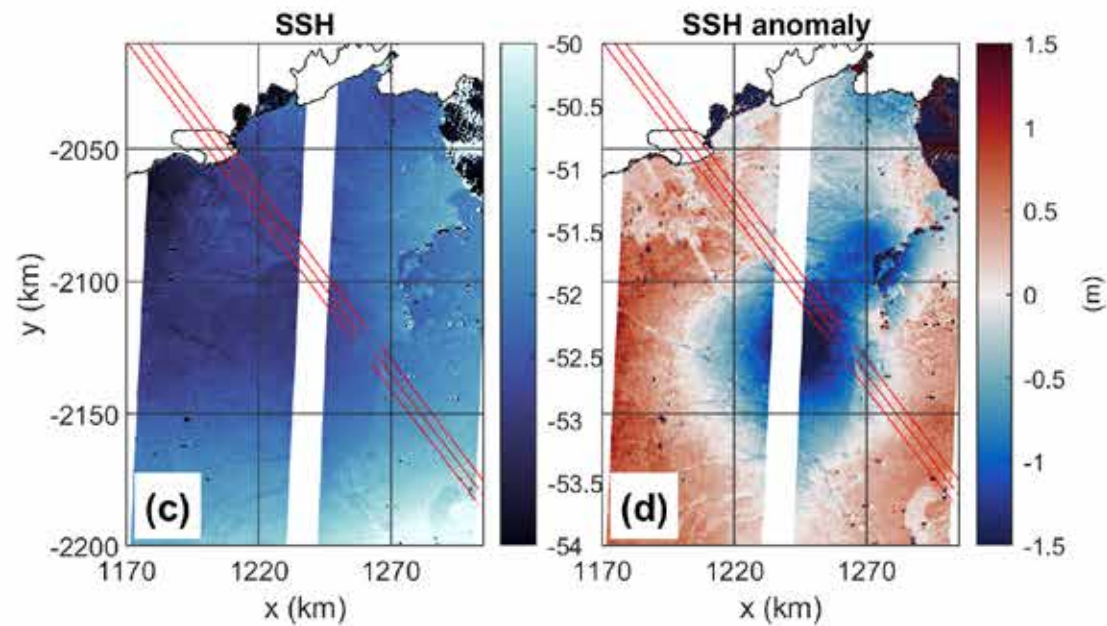
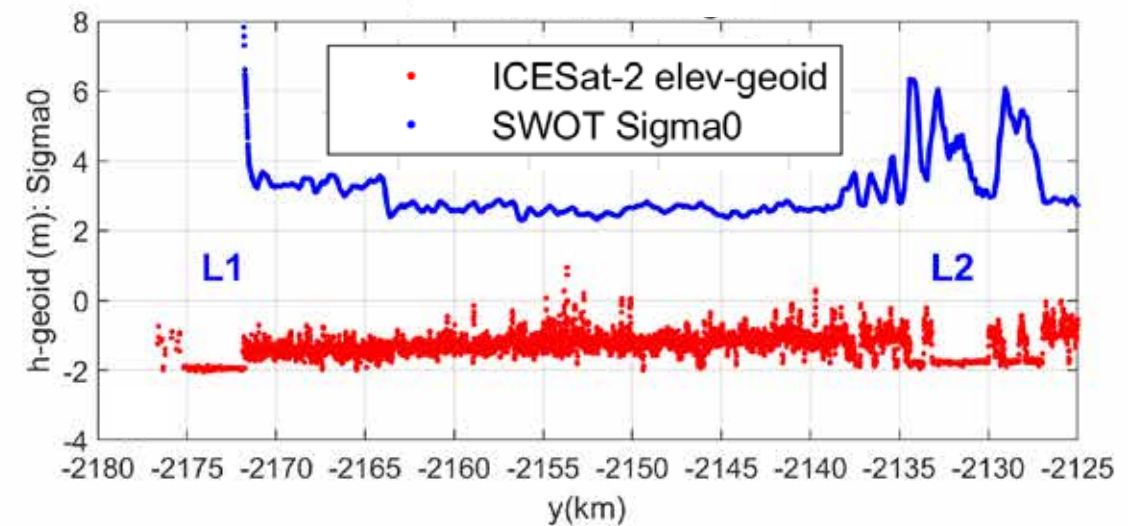
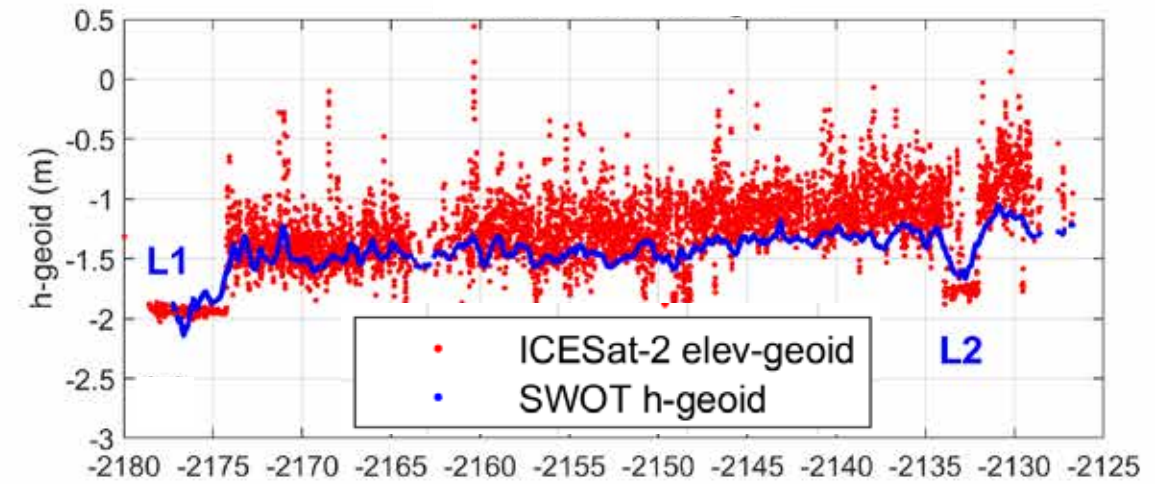
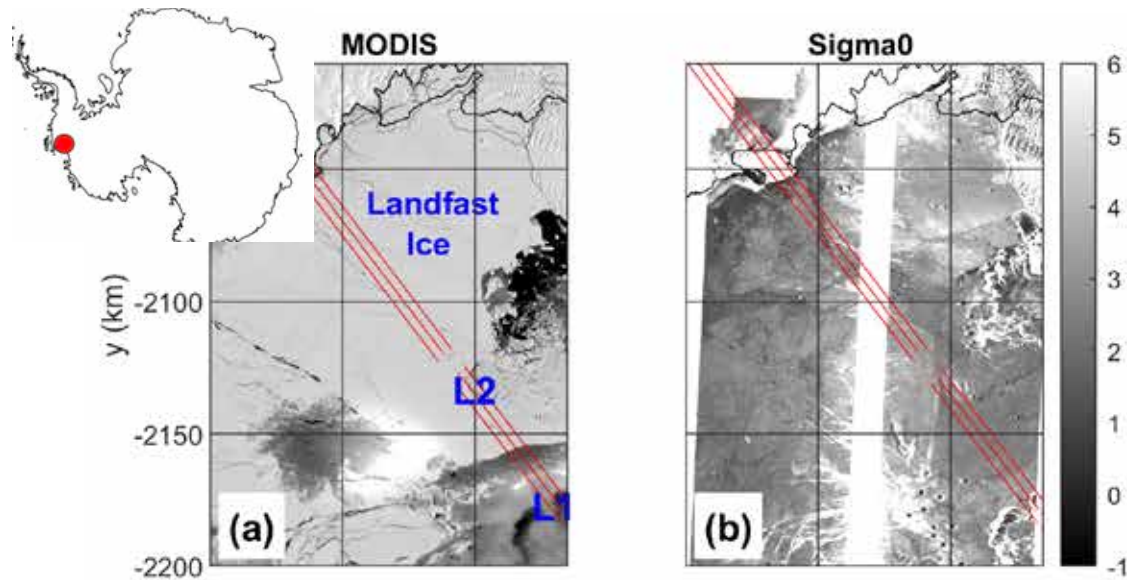
# Strong SWOT coherence found over mountain glaciers (Tibet)



(figure by Cassie Stuurman)



# Assess uncertainty of SWOT surface heights, create time-dependent maps of SSH, and validate SSH geophysical corrections (Tasha Snow, ESSIC/GSFC)

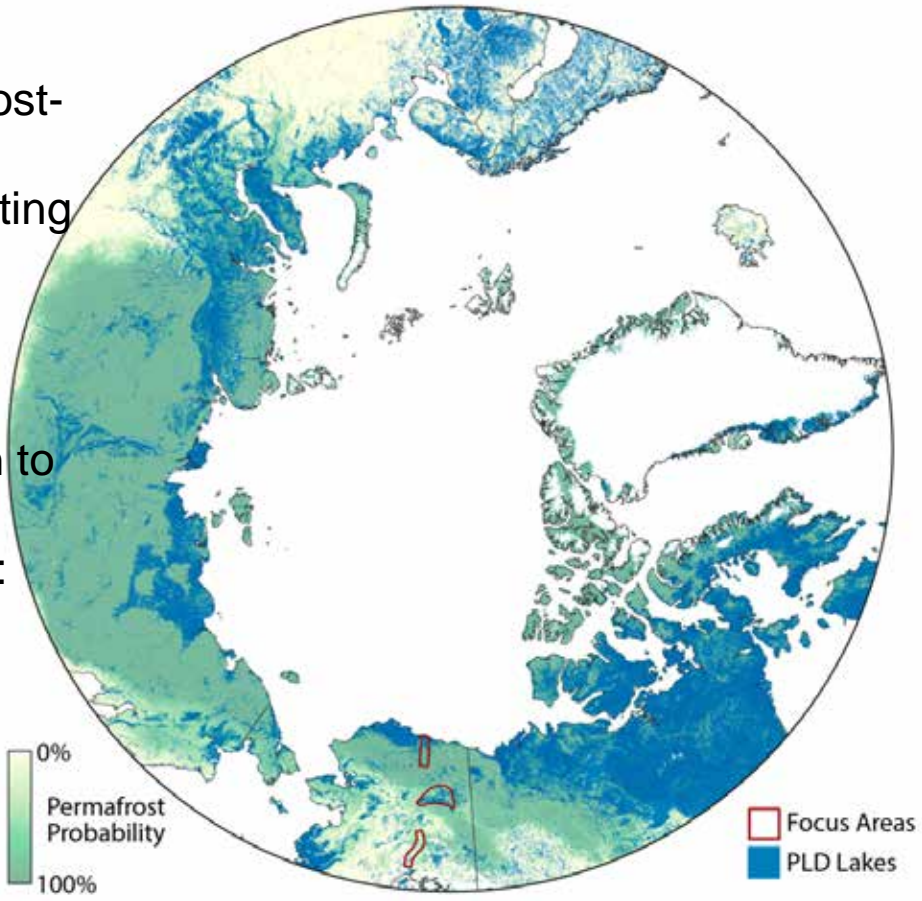




# Leveraging SWOT observations to understand permafrost-surface water feedbacks

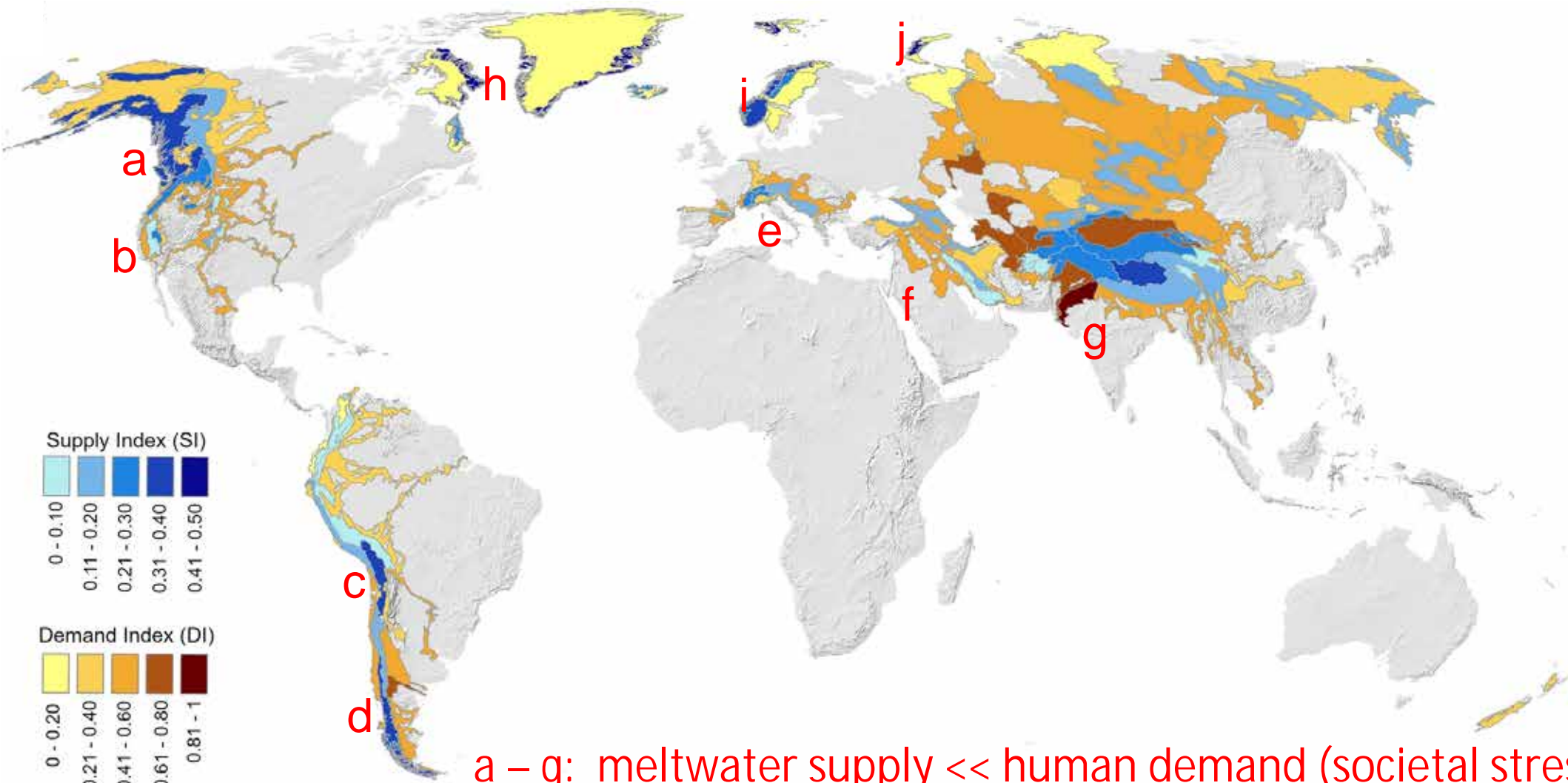
Around half of all water bodies observed by SWOT are located in permafrost-impacted environments. Research into how permafrost influences surface water variability has found evidence of both drying and wetting trends, limiting our understanding of Arctic surface water will change as permafrost continues to thaw.

By fusing SWOT observations of surface water area and WSE with optical satellite observations of both inundation and vegetation presence, we plan to investigate key outstanding questions in Arctic surface water variability to help better resolve permafrost-surface water dynamics. Questions include:



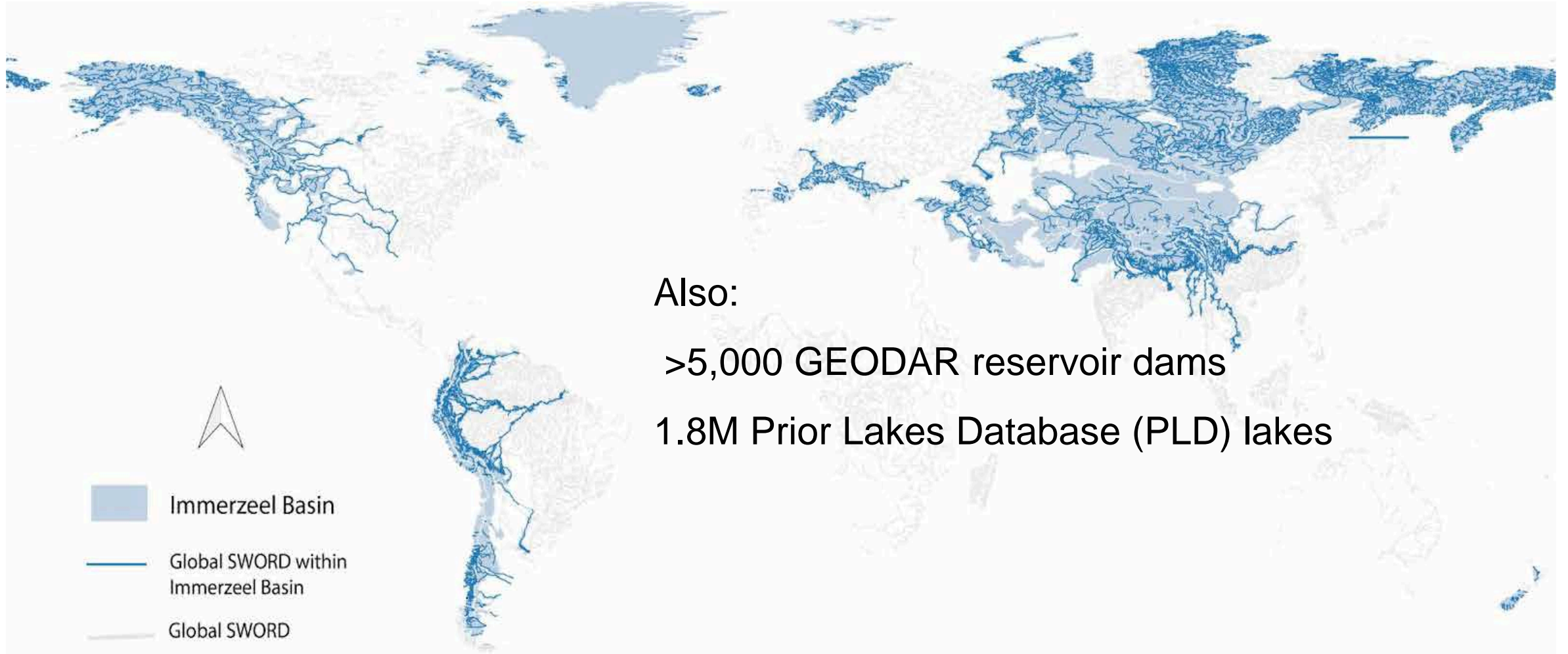
# The world's 78 most impactful ice/snow "water tower units" (WTUs)

(Immeerzel et al., Nature, 2020)



a – g: meltwater supply << human demand (societal stress)  
h – j: meltwater supply >> human demand (sea level rise)

>86,000 SWORD reaches lie within these 78 WTUs...



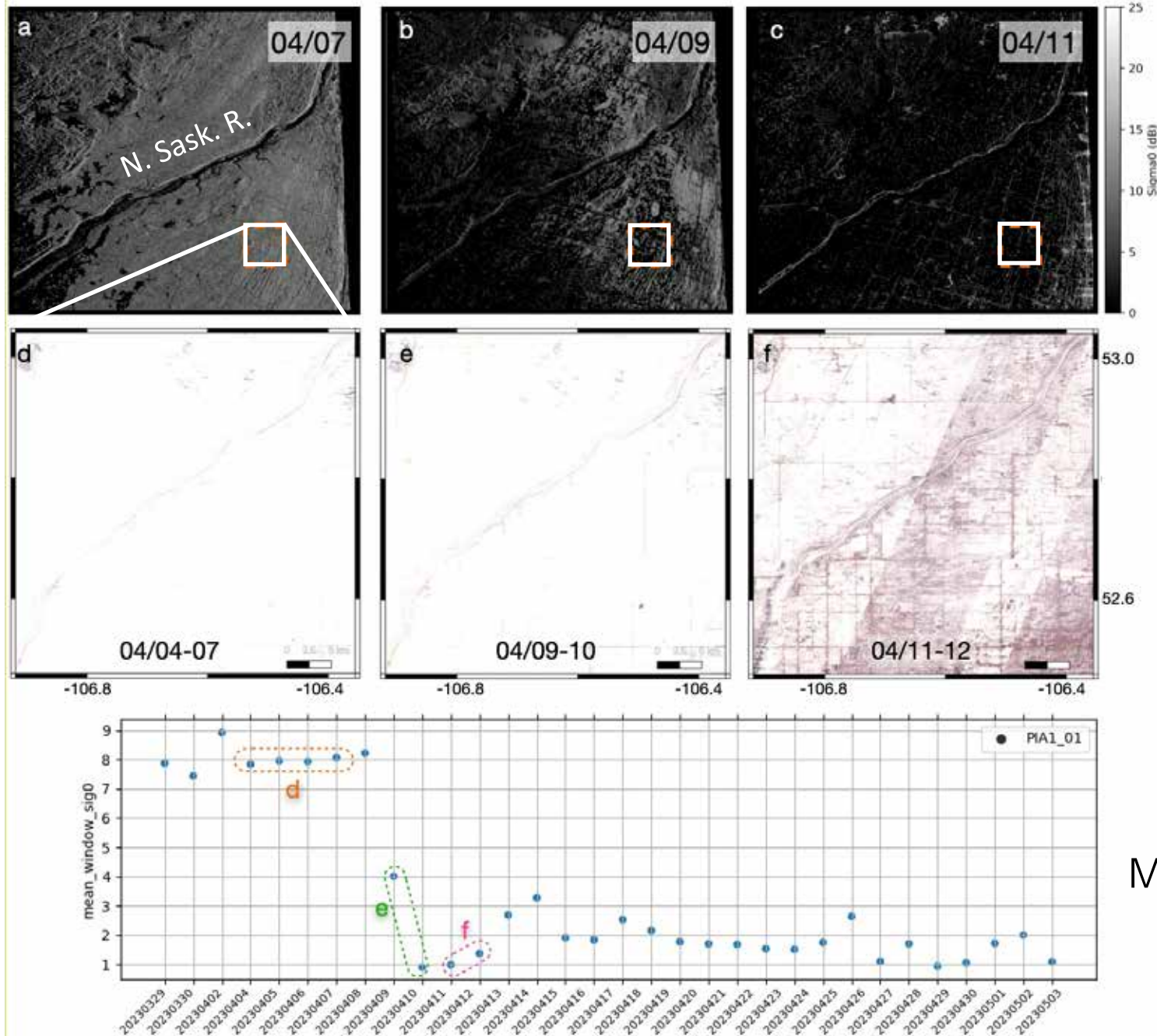
Also:

>5,000 GEODAR reservoir dams

1.8M Prior Lakes Database (PLD) lakes

# SWOT backscatter is sensitive to snow

Daily SWOT fast-sampling backscatter detects snow, and snowmelt onset (brief darkening)



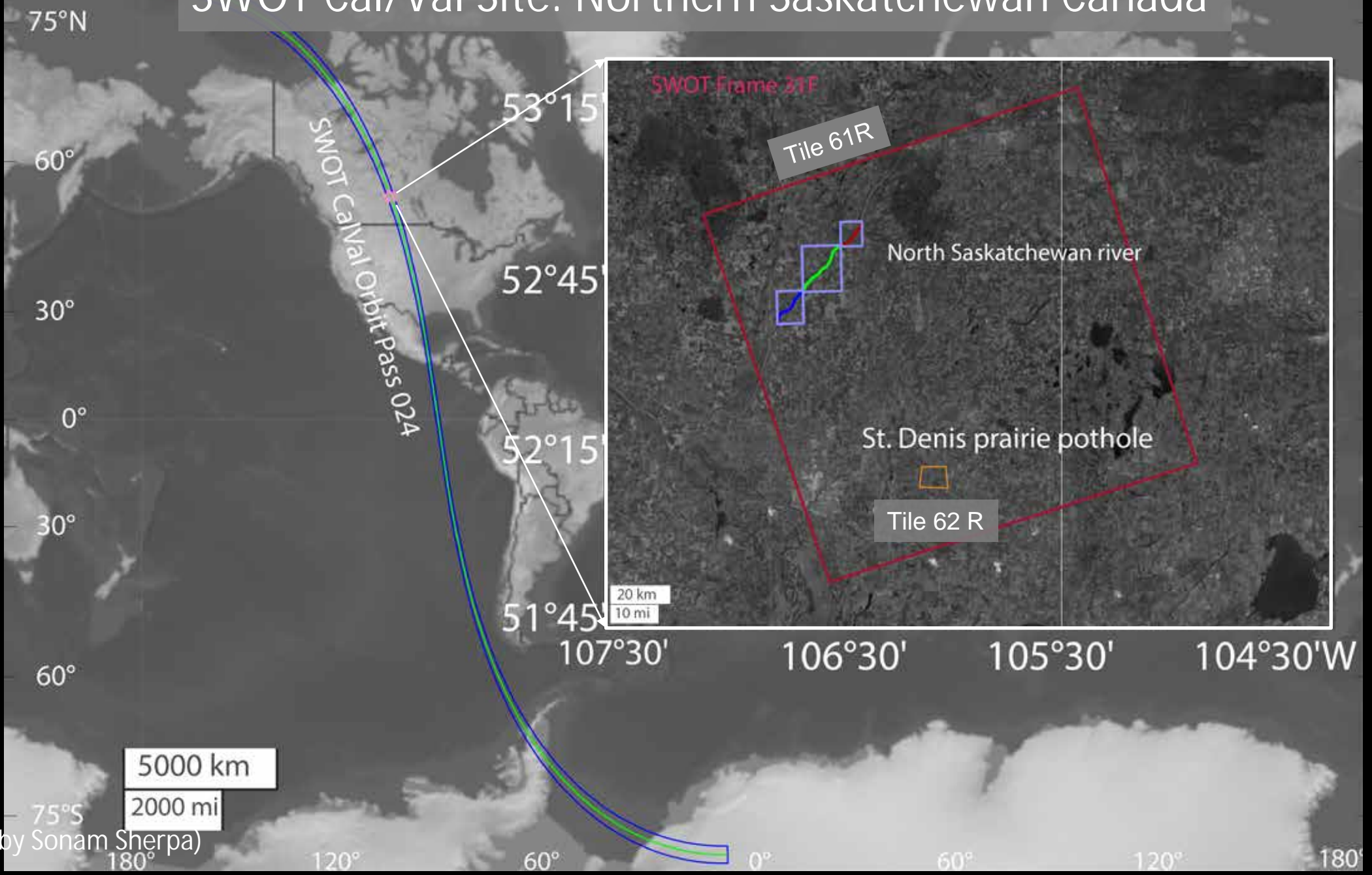
SWOT

Planet

March 29-May 3

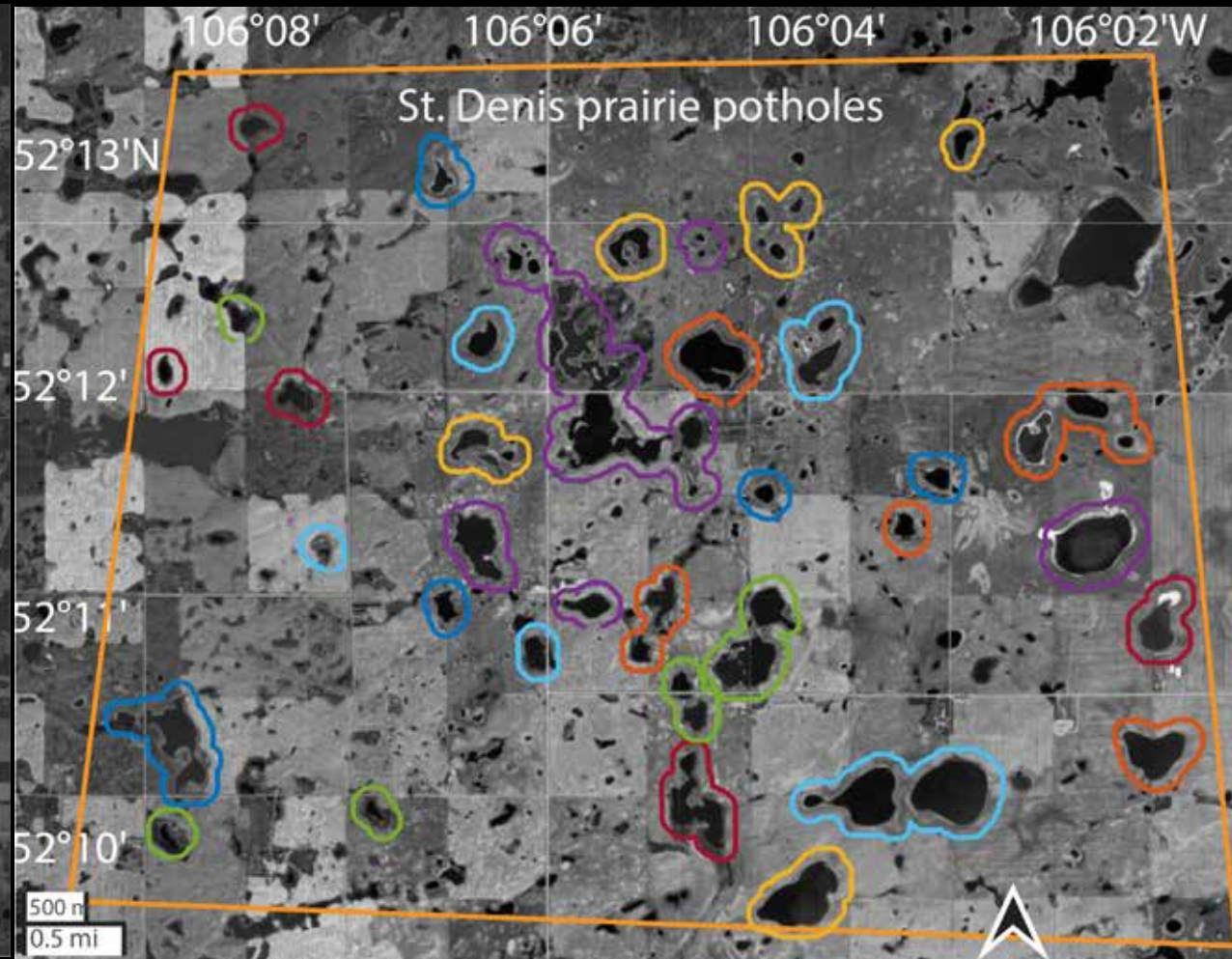
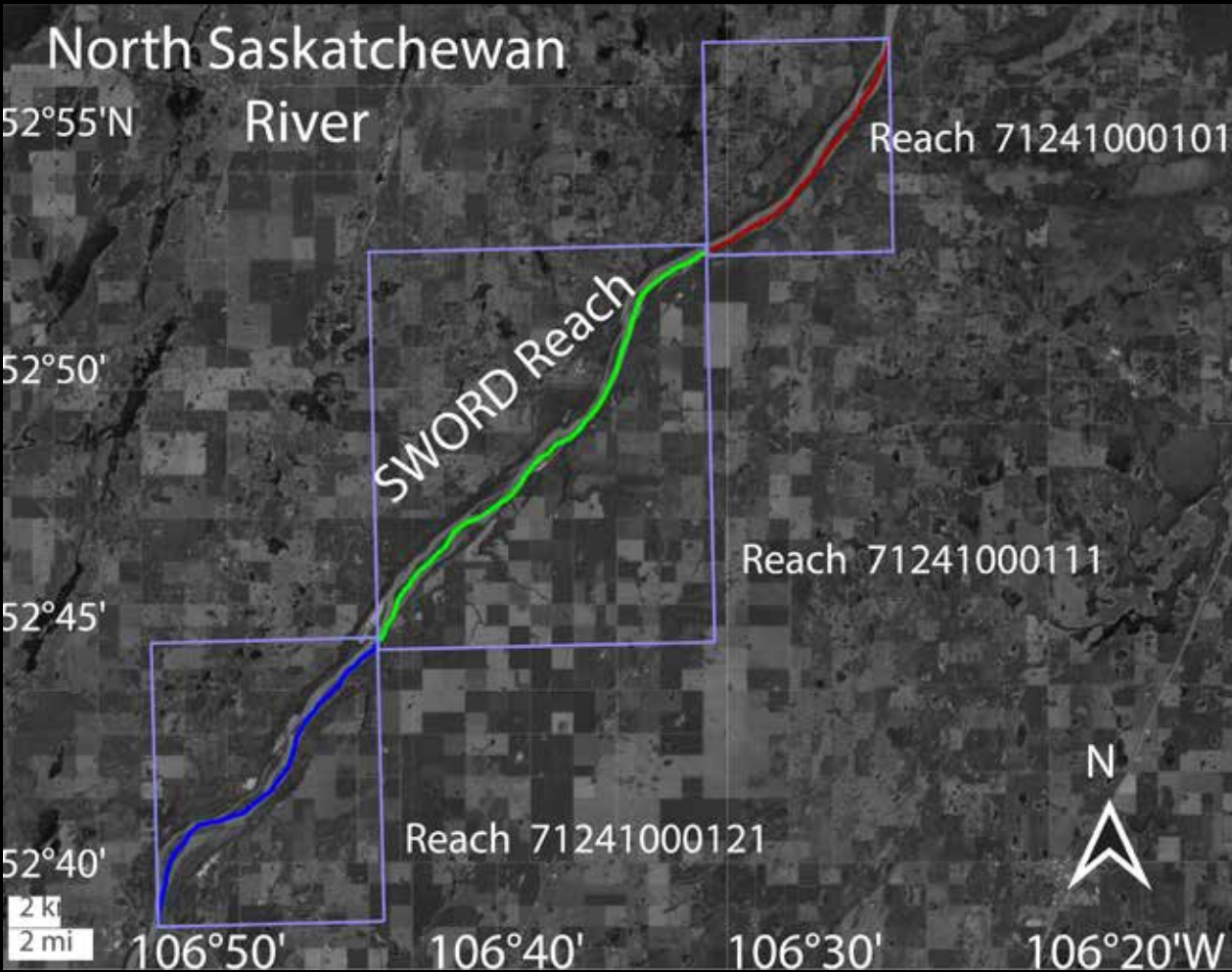
(figure by Cassie Stuurman)

# SWOT Cal/Val Site: Northern Saskatchewan Canada



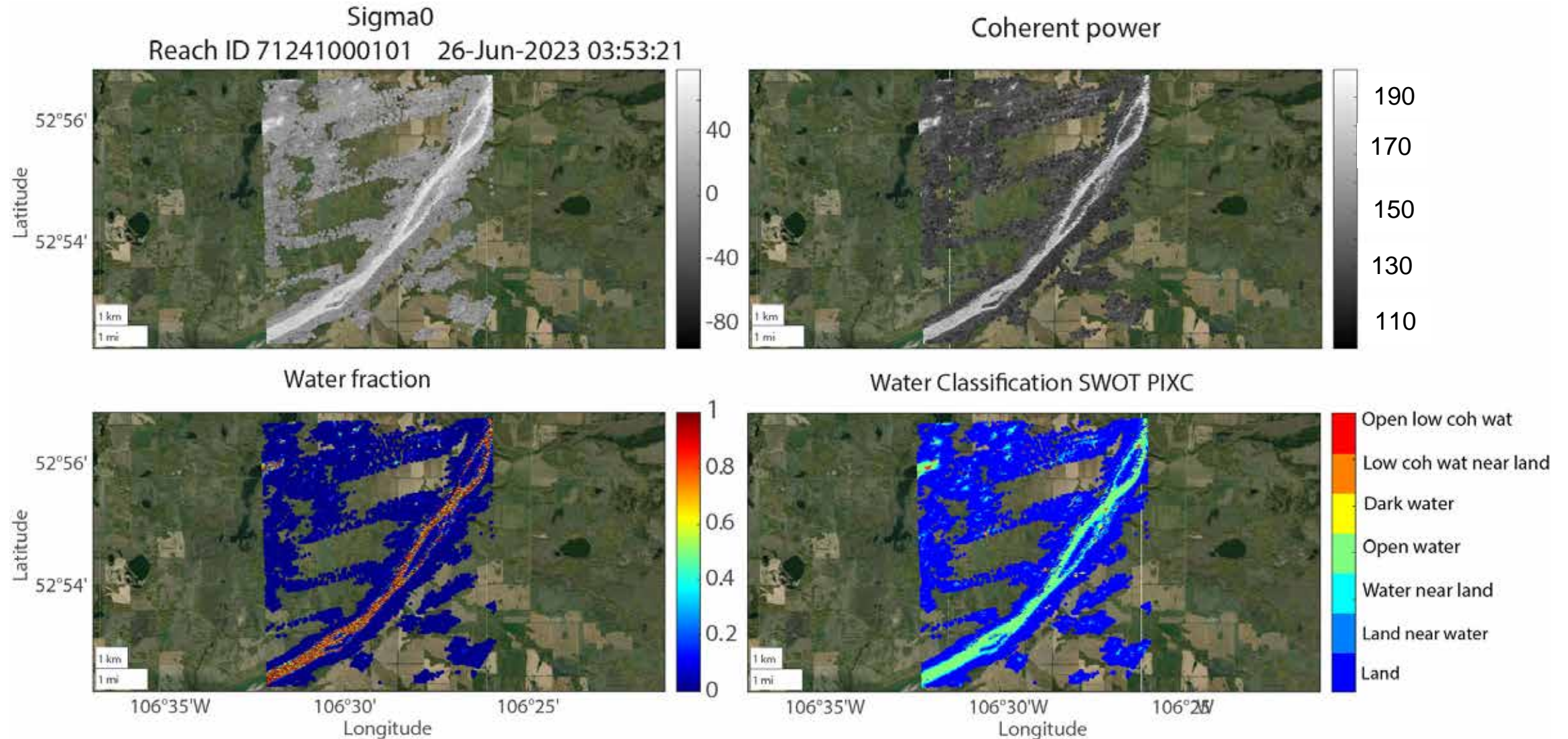
(figures by Sonam Sherpa)

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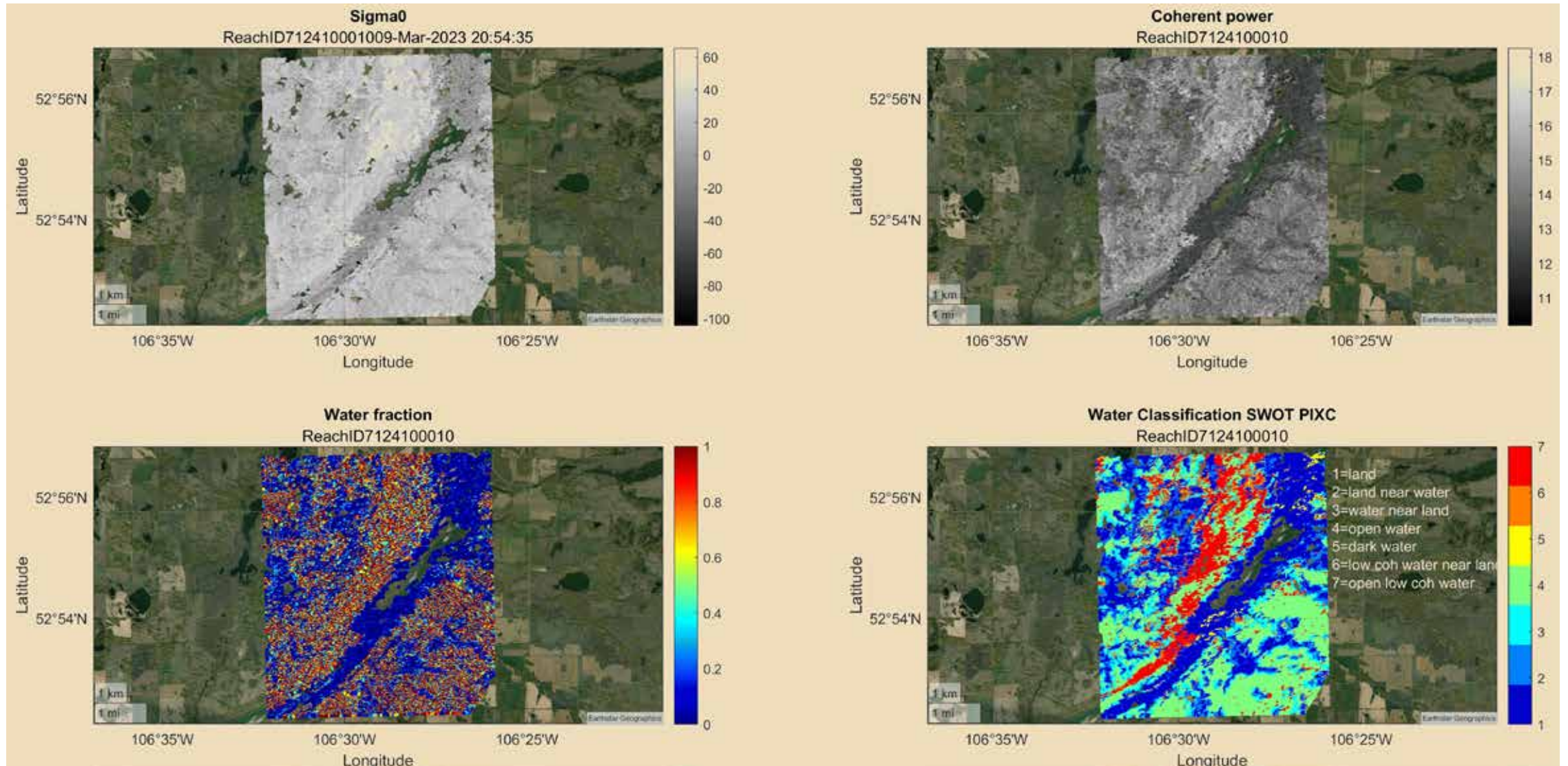
(figures by Sonam Sherpa)

# SWOT backscatter and classification products for N. Saskatchewan R.



(figures by Sonam Sherpa)

# Snow/ice and spring melt strongly impacts river detection



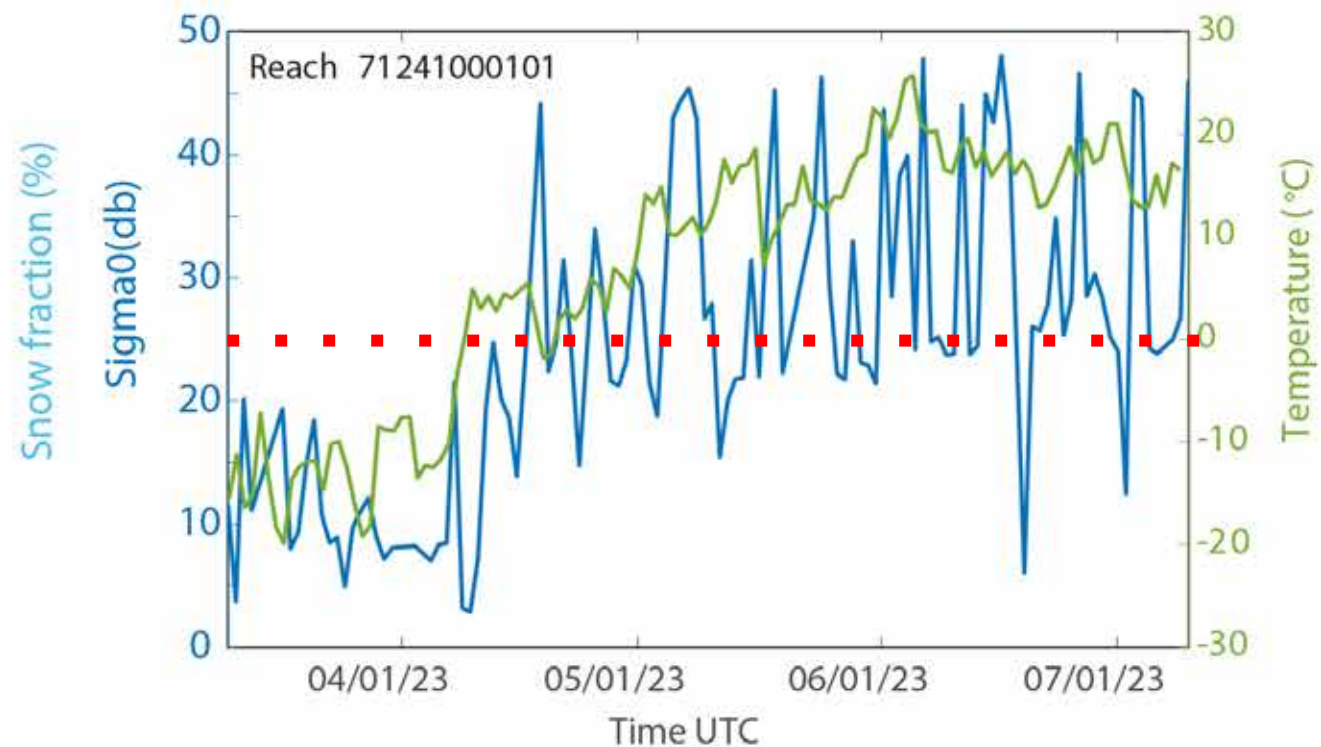
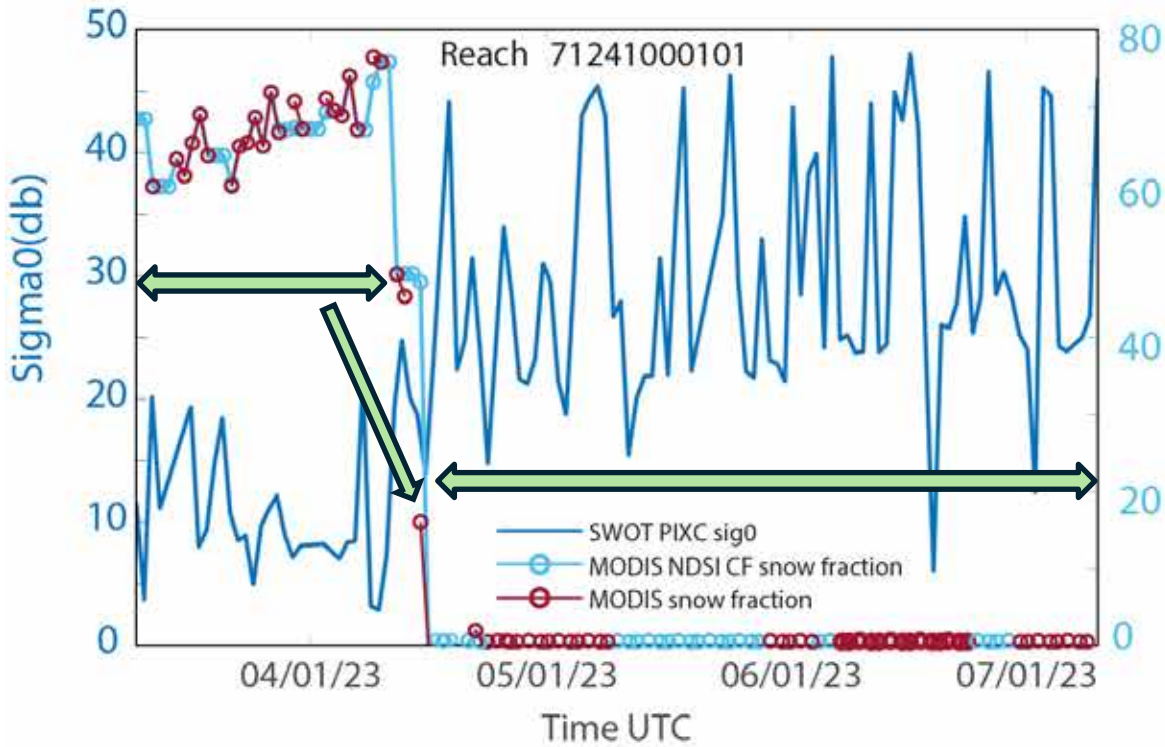
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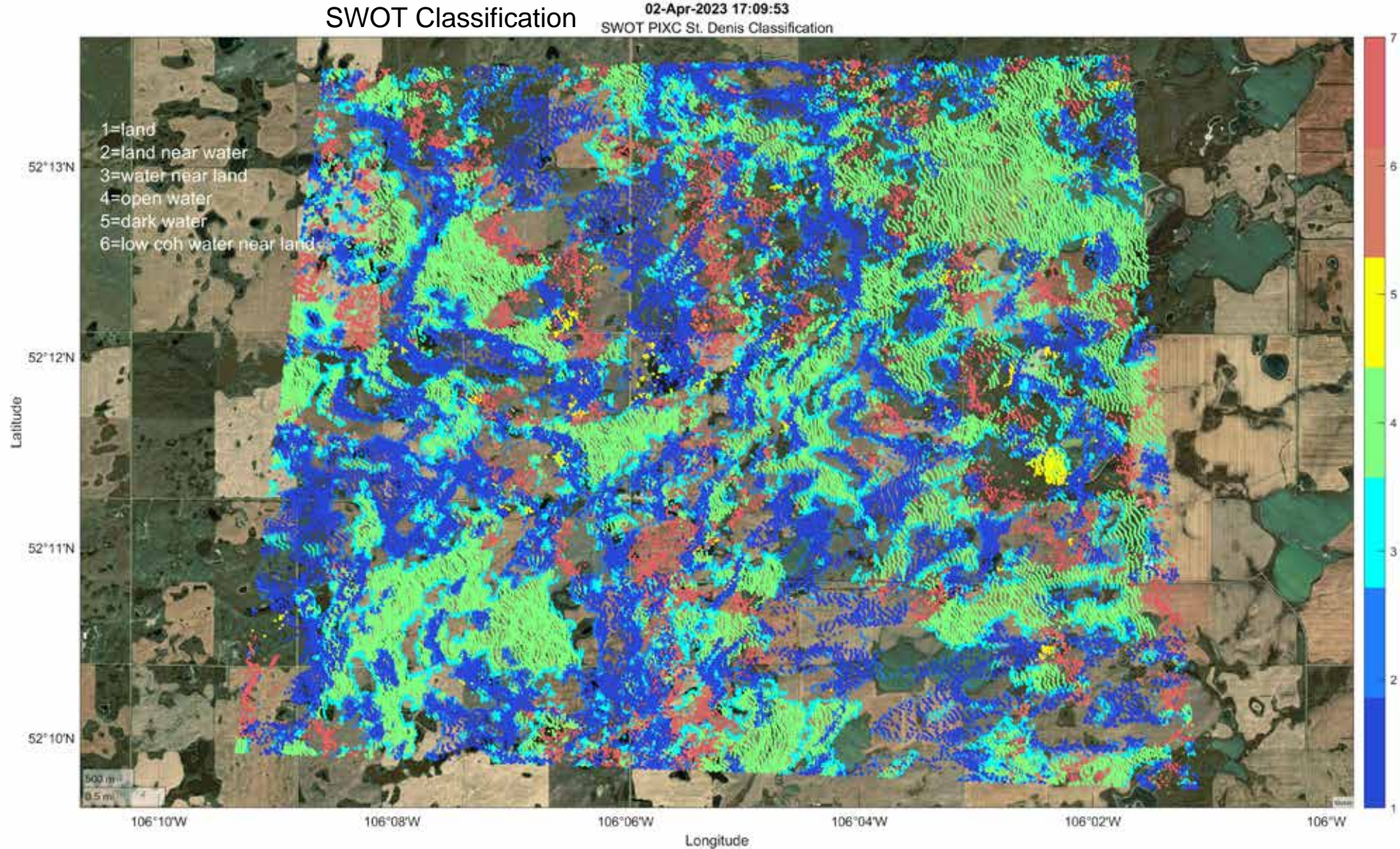
# Snow cover suppresses backscatter: N. Saskatchewan River

SWOT sig0 and MODIS NDSI snow cover (%)

SWOT sig0 and MODIS Mean daily temp.

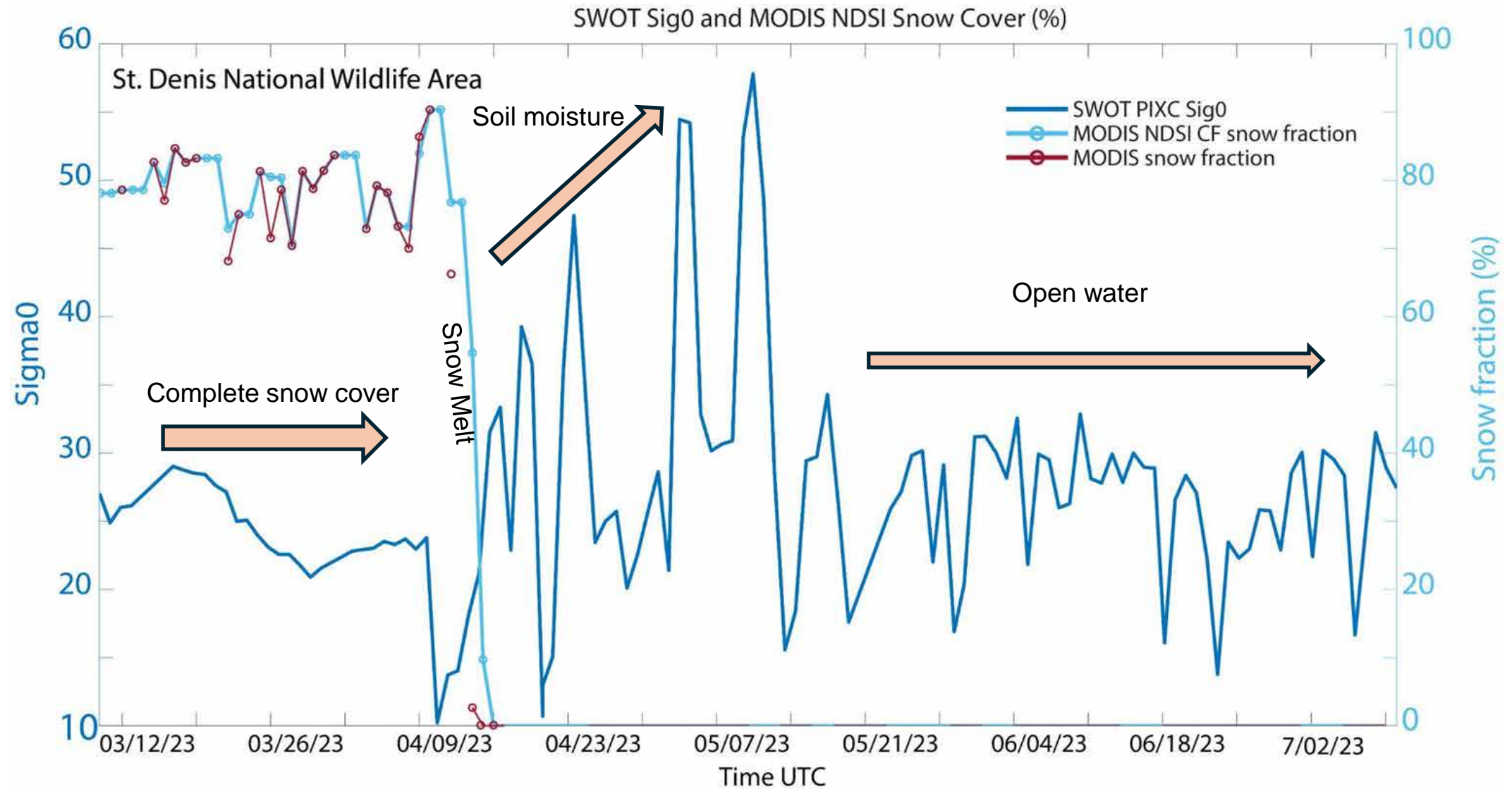


# Snow/ice and spring melt strongly impacts lake detection

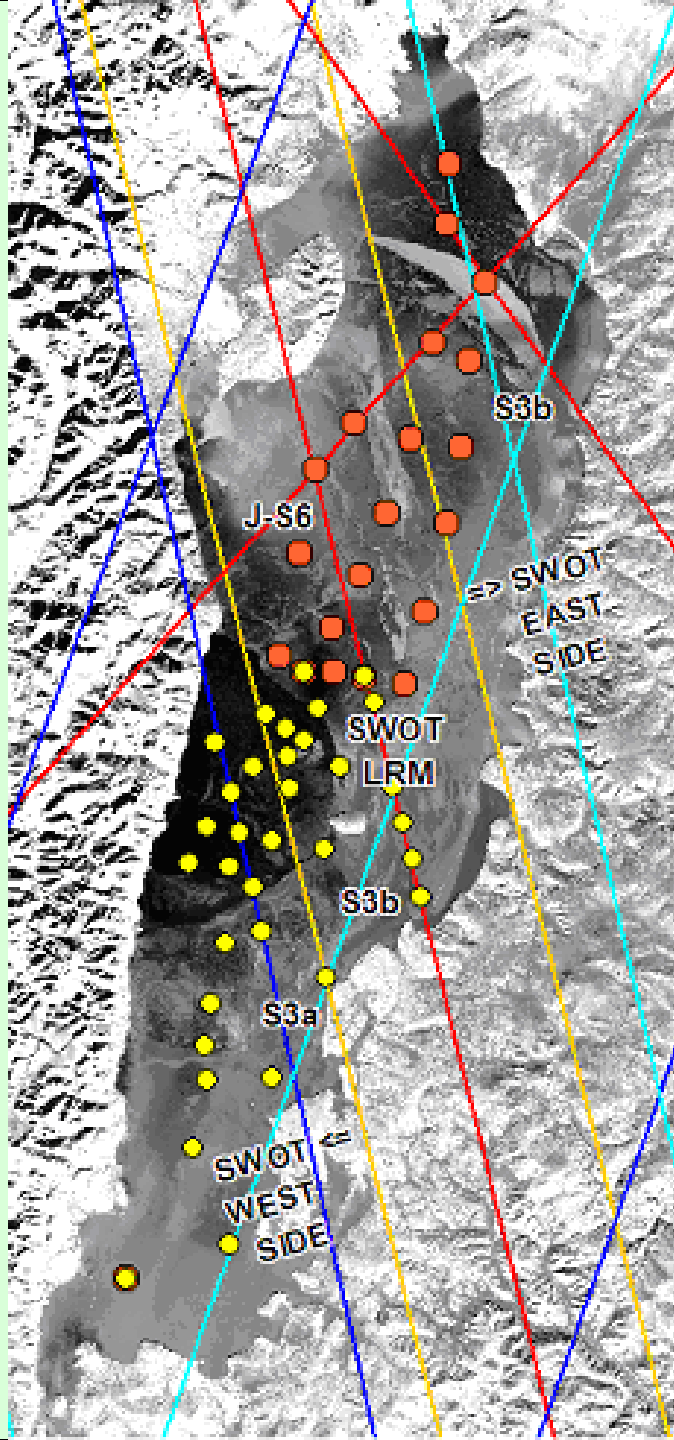


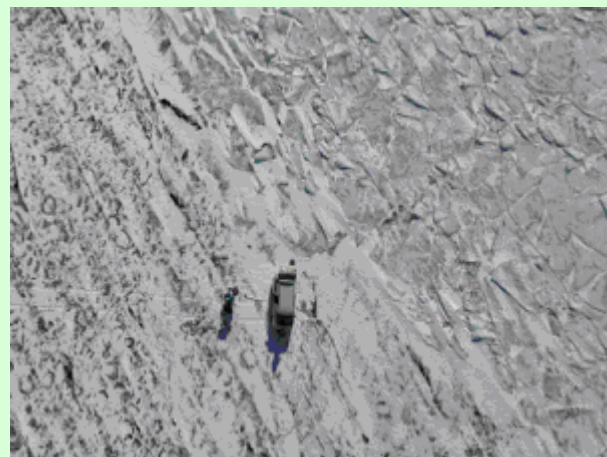
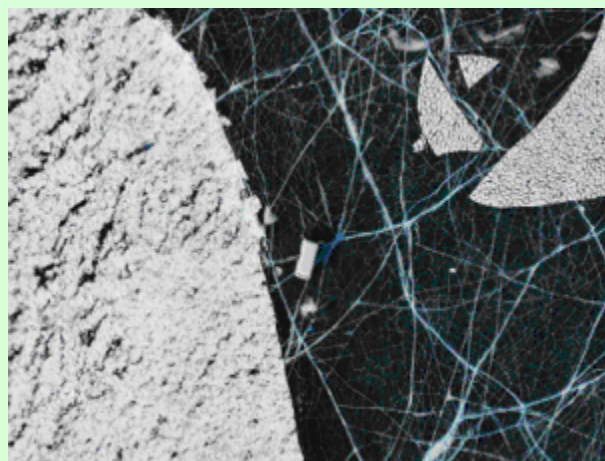
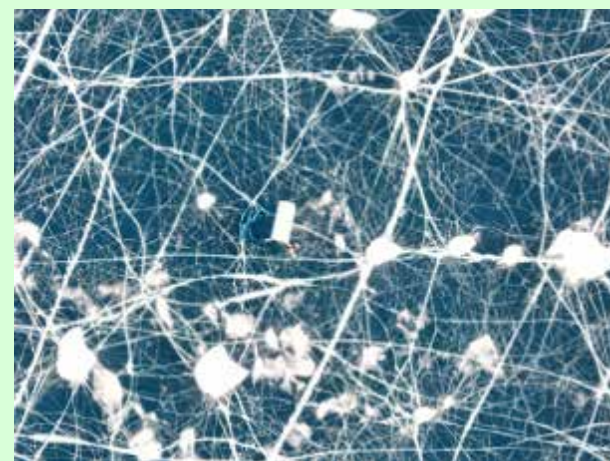
(figures by Sonam Sherpa)

# Snow cover suppresses backscatter: St. Denis prairie pothole lakes

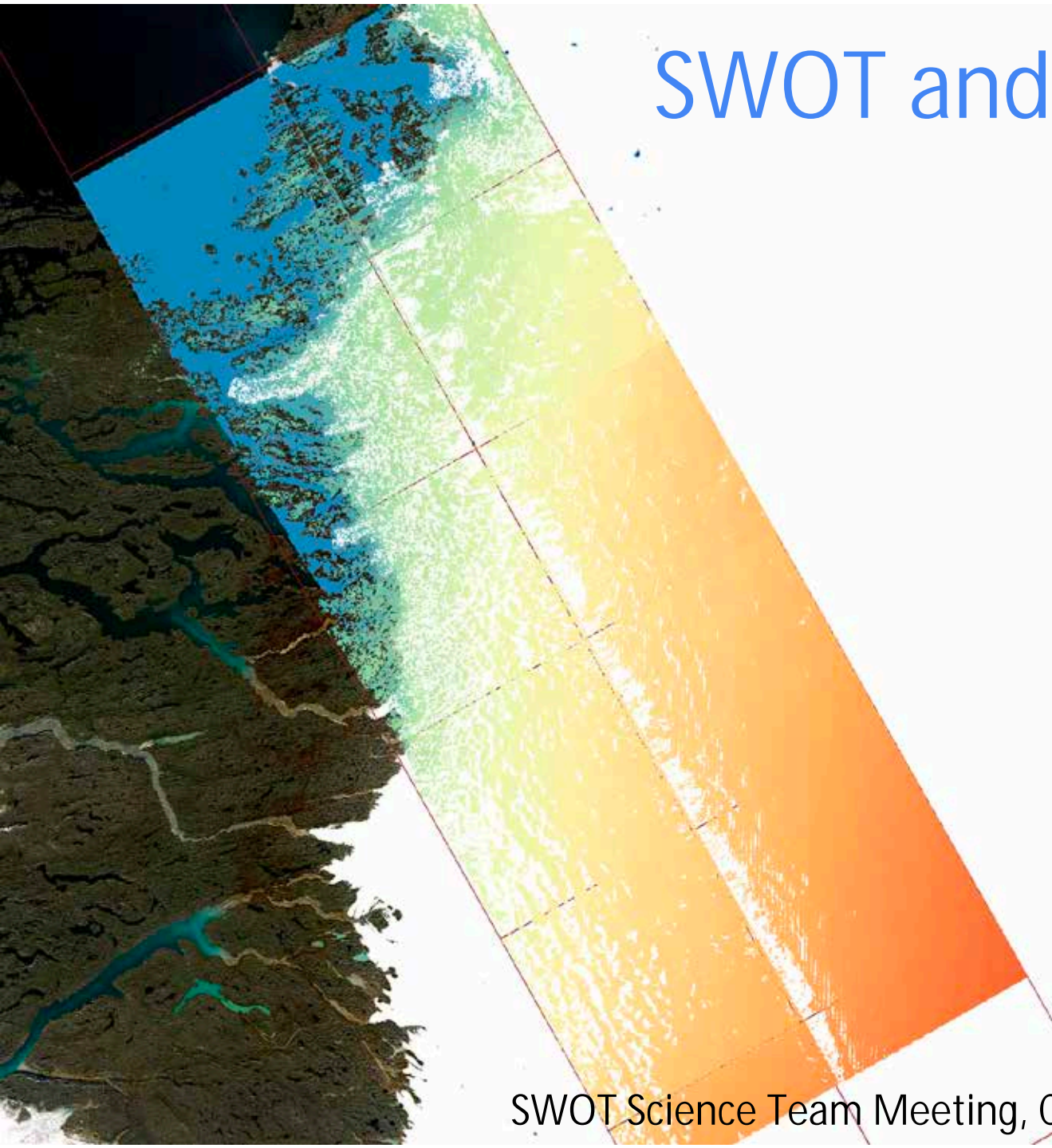


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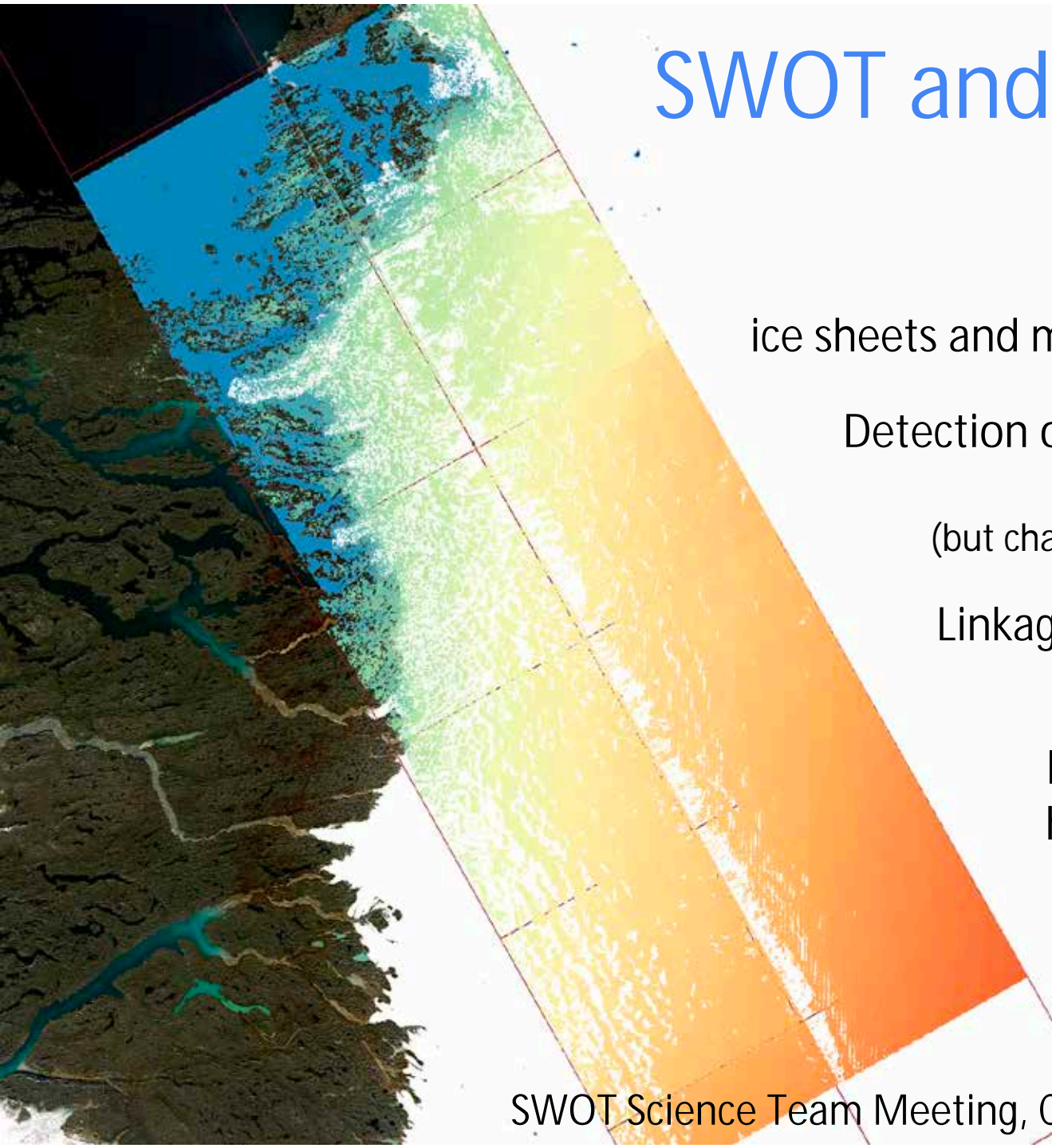




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ice sheets and mountain glaciers of

Detection of

(but challenging due to penetration)

Linkages

Improved hydrology products for SWOT