Circumpolar Albedo of Northern Lands from Landsat-8 and Sentinel-2

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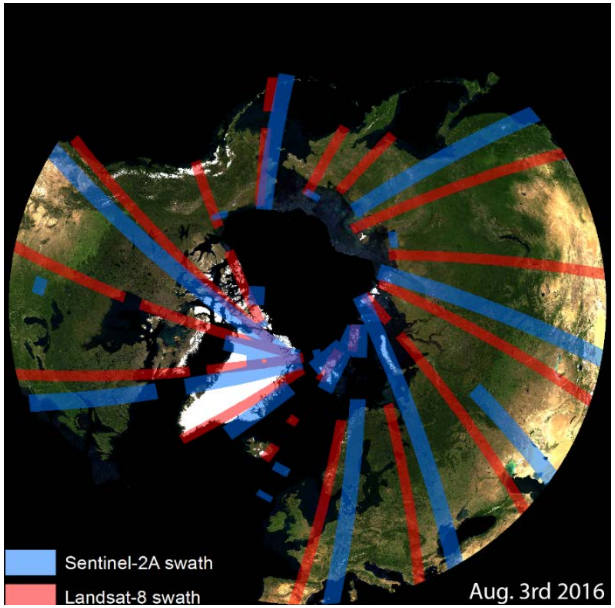
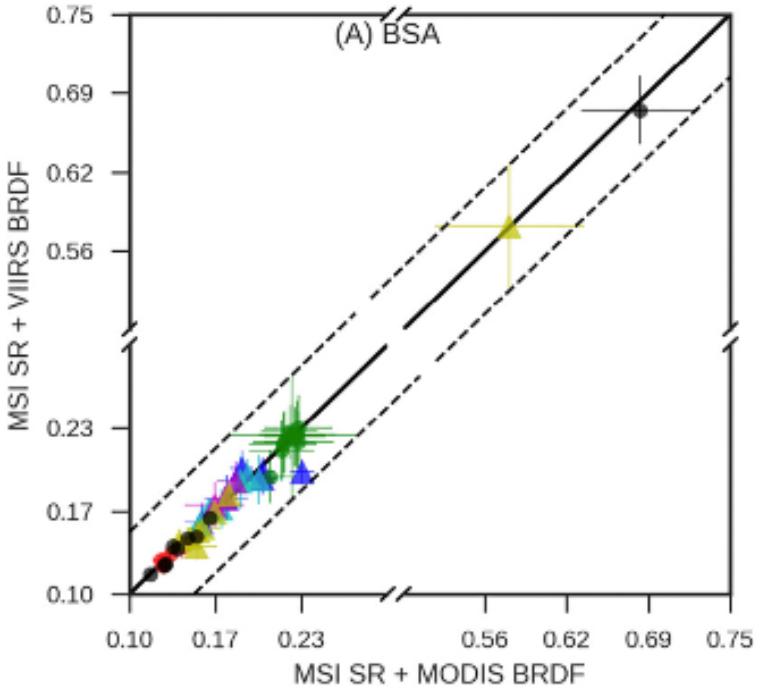
Goals:

- *Adapt Landsat-8 Land Surface Albedo methodology into a coupled Landsat-8 and Sentinel-2 Land Surface Albedo product of circumpolar northern lands (*40°N to 84°N) *for snow-free and snow-covered conditions.*
- *Investigate the temporal and spatial variation of albedo in the higher latitudes due to land use change, shrubification, species shift, and forest disturbance from fire and insect infestation. Explore impacts on surface energy budgets, and radiative forcing*

Data Utilized for L-8 and S-2 WSA and BSA Albedos

- *Landsat-8 and Sentinel-2 Surface Reflectances*
- *MODIS MCD43A1 BRDF Product and MCD43A2 QA*
- *VIIRS VNP43MA1 BRDF Product and VNP43MA2 QA*
- *Harmonized Landsat-8 and Sentinel-2 SR (HLS)*





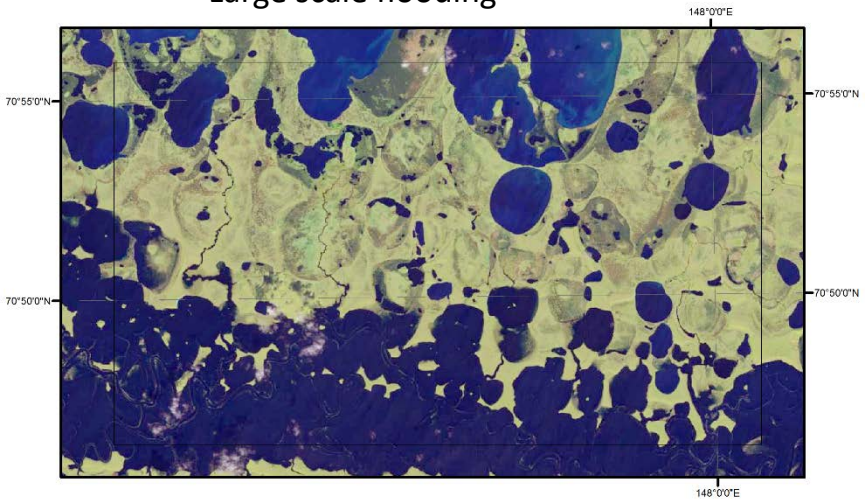
Sentinel-2A BSA with MODIS BRDF vs BSA with VIIRS BRDF at SurfRad sites, Li et al., 2018, Wang et al, 2016

Albedo complexity in high latitudes

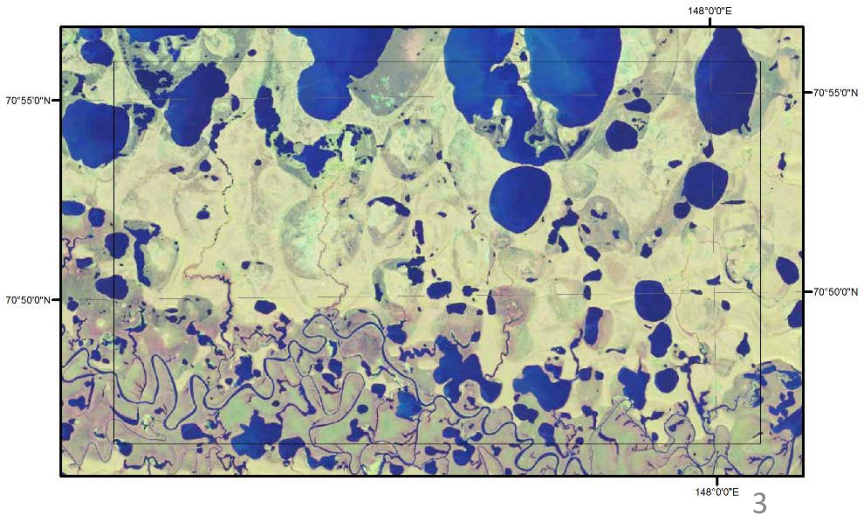
Changes in snow melt, open water and vegetation type impact the surface energy budget across high latitudes

- Albedo is a driver of landscape wide effective radiative forcing, especially in the presence of snow cover in the winter and spring
- Tundra albedo is strongly influenced by the fractional cover of water surfaces (Juszack,2017).
- Northeastern Siberia

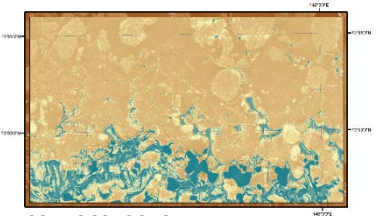
Landsat 8 True Color Composite 7-25-2017
Large scale flooding



Landsat 8 True Color Composite 8-04-2018



Shoulder season shortwave WSA, Sentinel-2A, Sentinel-2B, and Landsat-8 Northeastern Siberia, June 2018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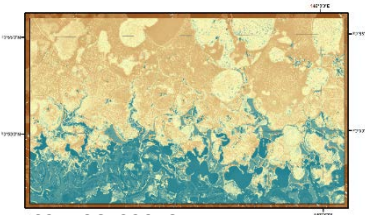
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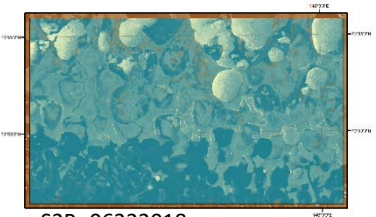
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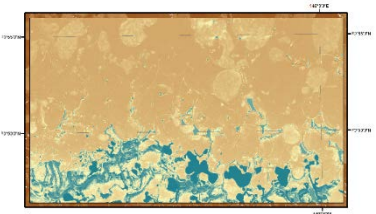
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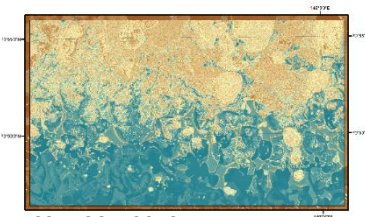
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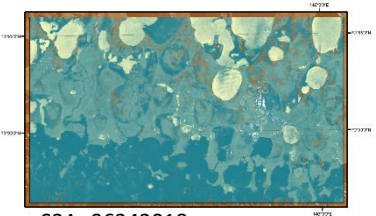
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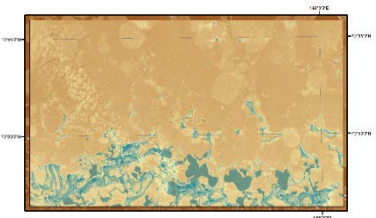
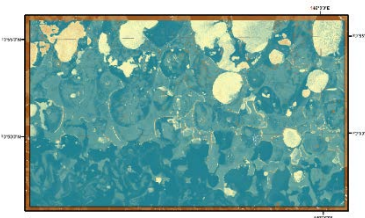

LC8- 06102018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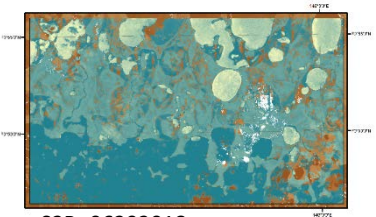
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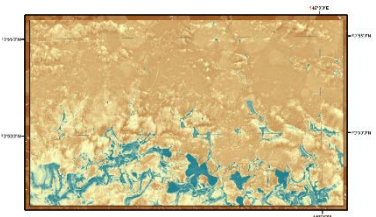
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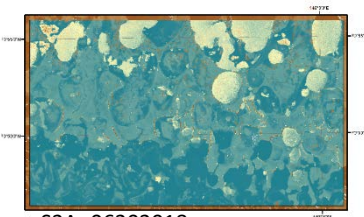
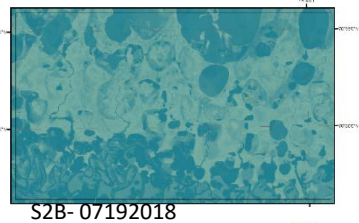

S2A- 06202018

July-Aug 2018
Sentinel-2B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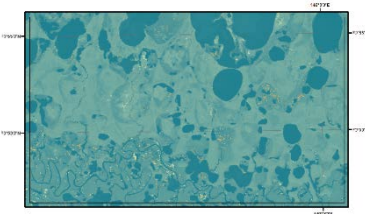
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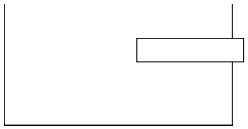
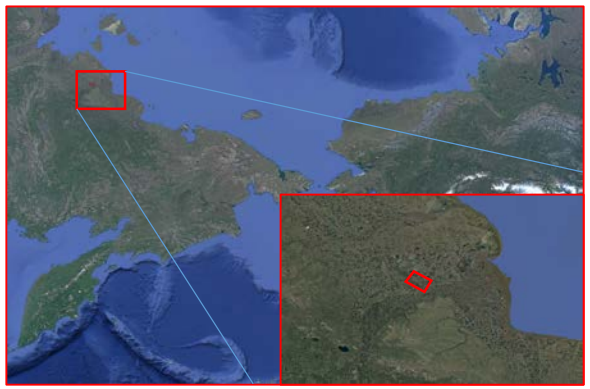
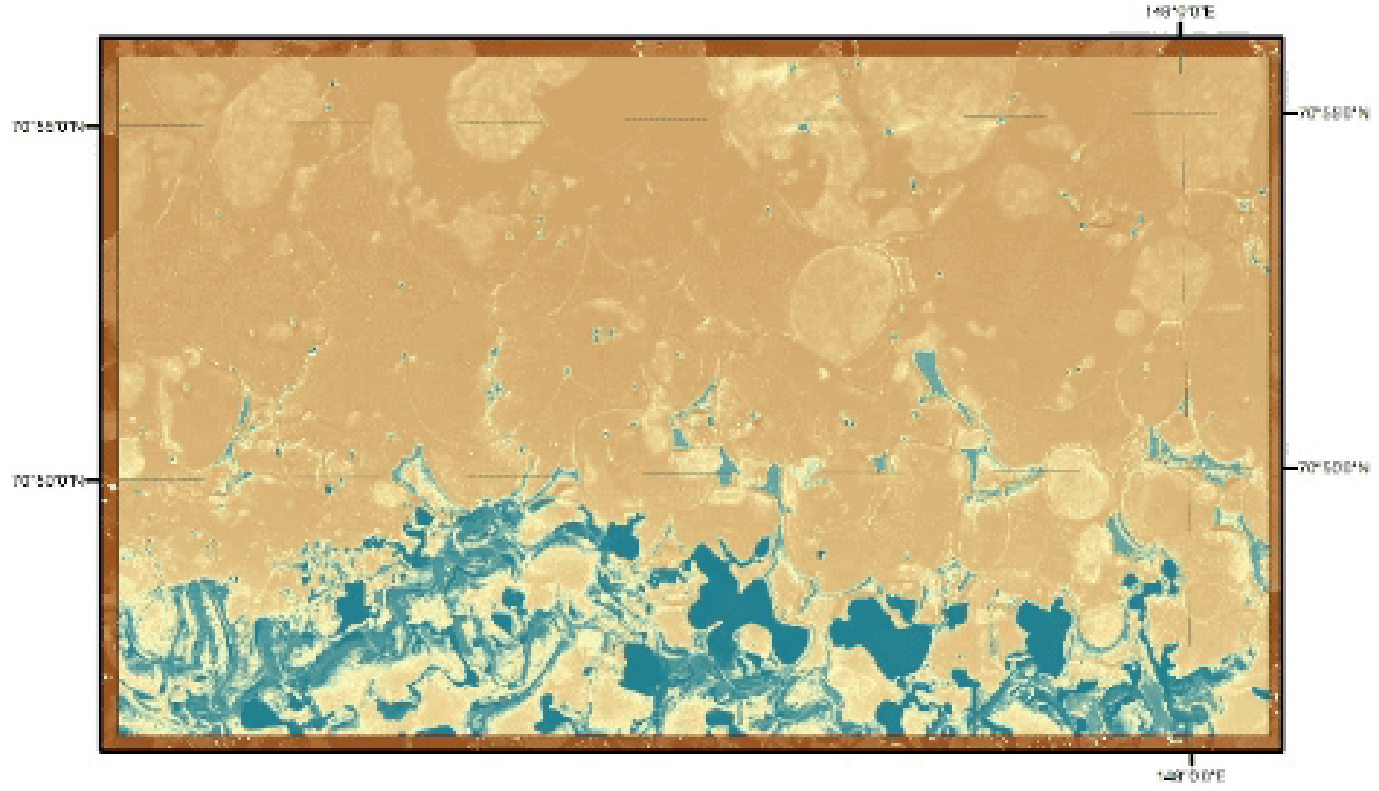


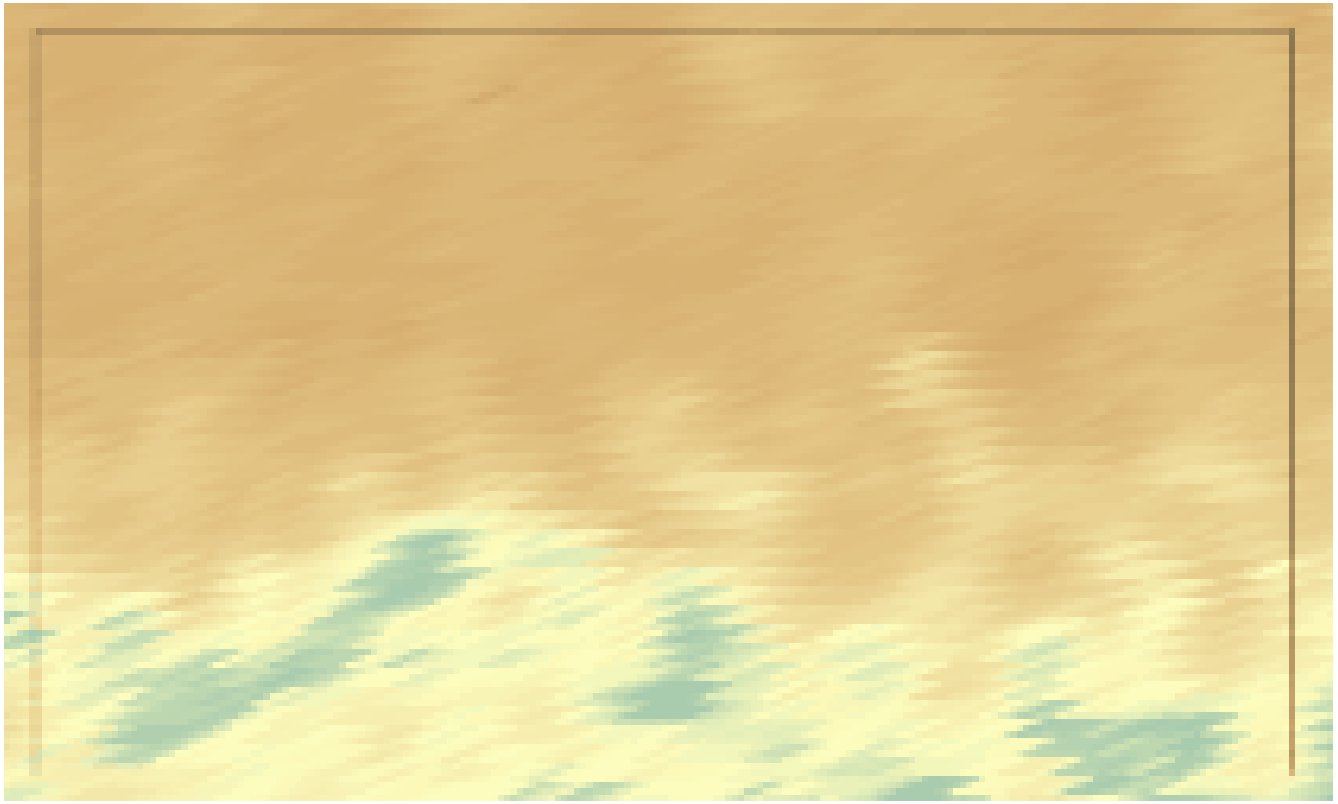


We can now capture phenological changes in high latitudes, including snow melt progression: 2018 – first sensing year at full capacity

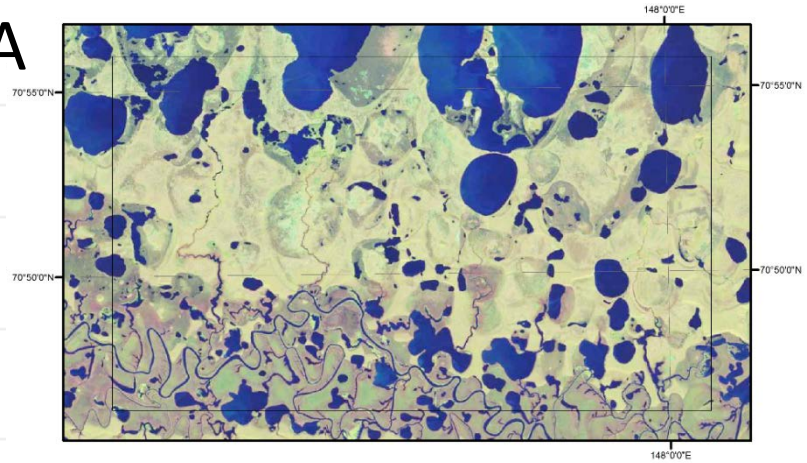
Growing Season White Sky Albedo derived form Landsat8 and Sentinel 2A/2B over northeastern Siberia 2018

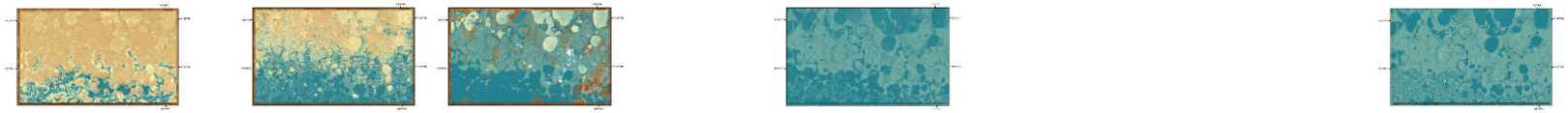


Growing season: MODIS MCD43A3 shortwave WSA 2018

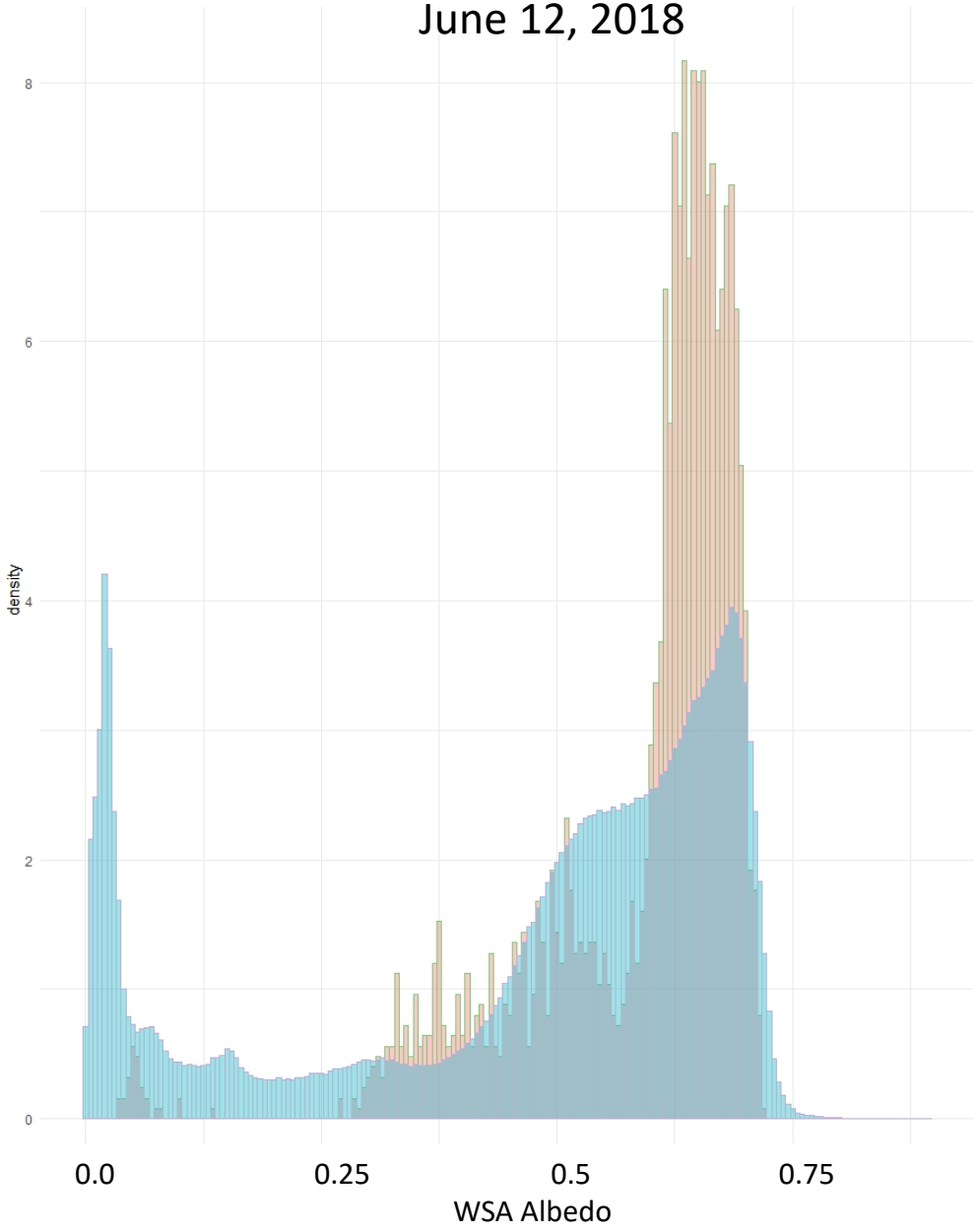


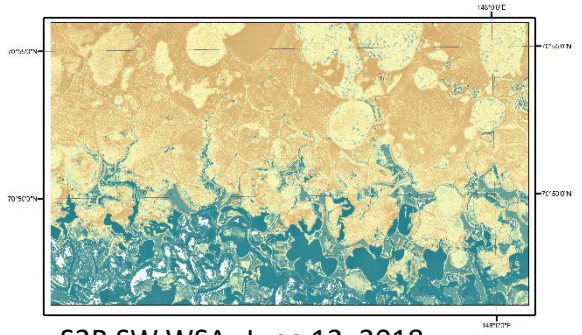
Shoulder season shortwave WSA



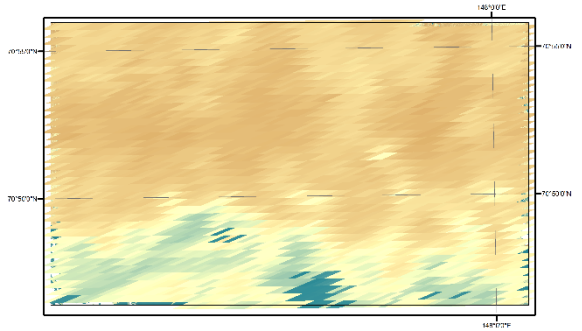


Density WSA albedo values of MODIS/Sentinel2
June 12, 2018

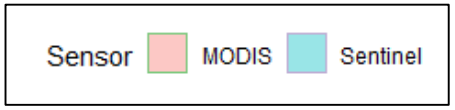




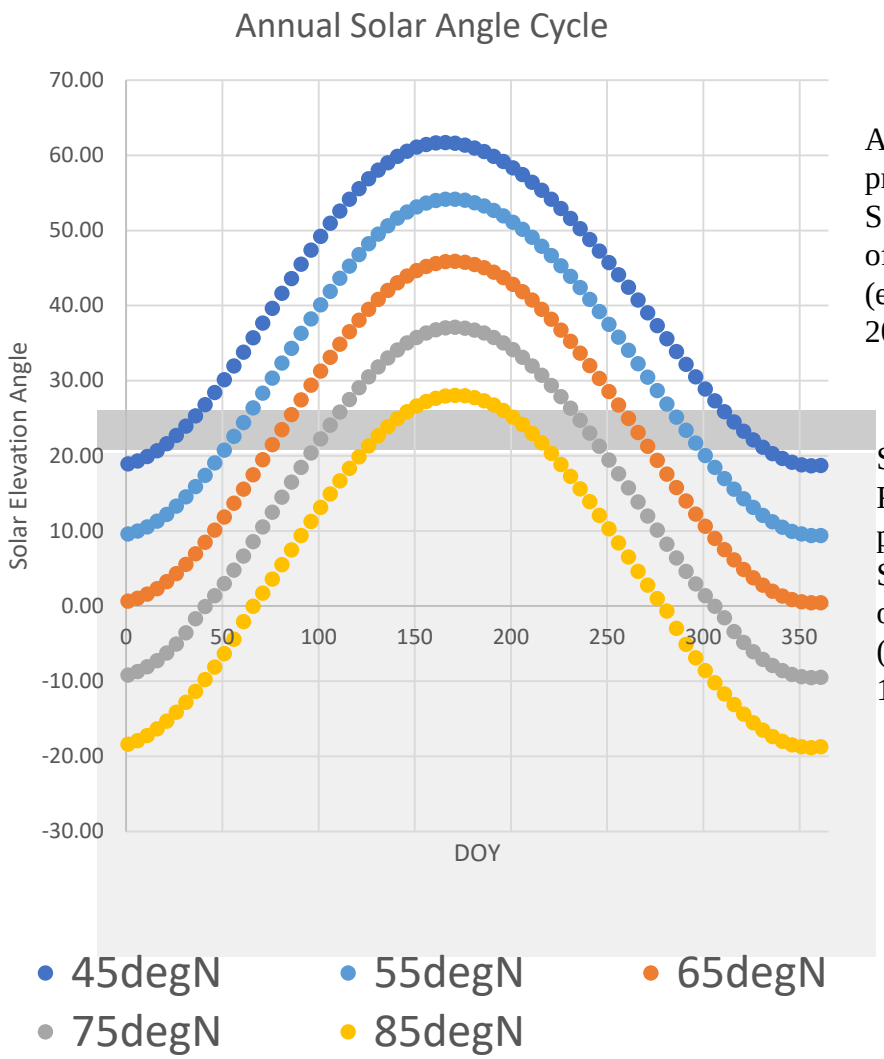
S2B SW WSA- June 12, 2018



MODIS SW WSA - June 12, 2018



Harmonized Landsat Sentinel-2 (HLS)



Albedo processing SZA Threshold of 70° (elevation of 20°)

Surface Reflectance processing SZA Threshold of 76° (elevation of 14°)

Spatial correction S-2 ->30m

Spectral correction S-2 -> Landsat-8

View angle correction (small bulk correction (reversible) , Roy et al., 2016)

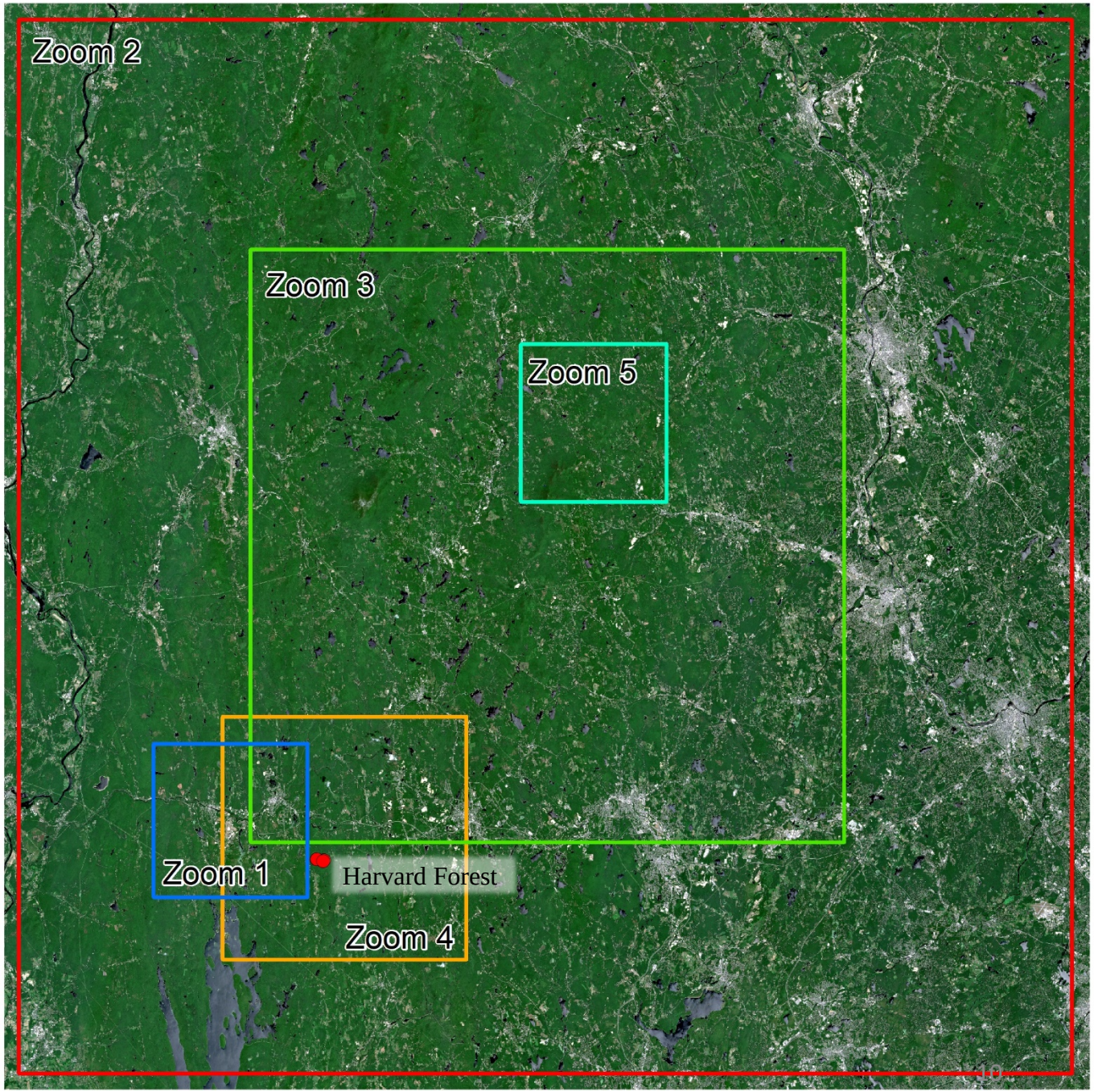
Szn correction (currently incorrectly applied and in any case not recommended (latitude, landcover impacts)

Updates being implemented

T18TYN, 7/7/2018
Central Massachusetts,
Harvard Forest

SR Composite

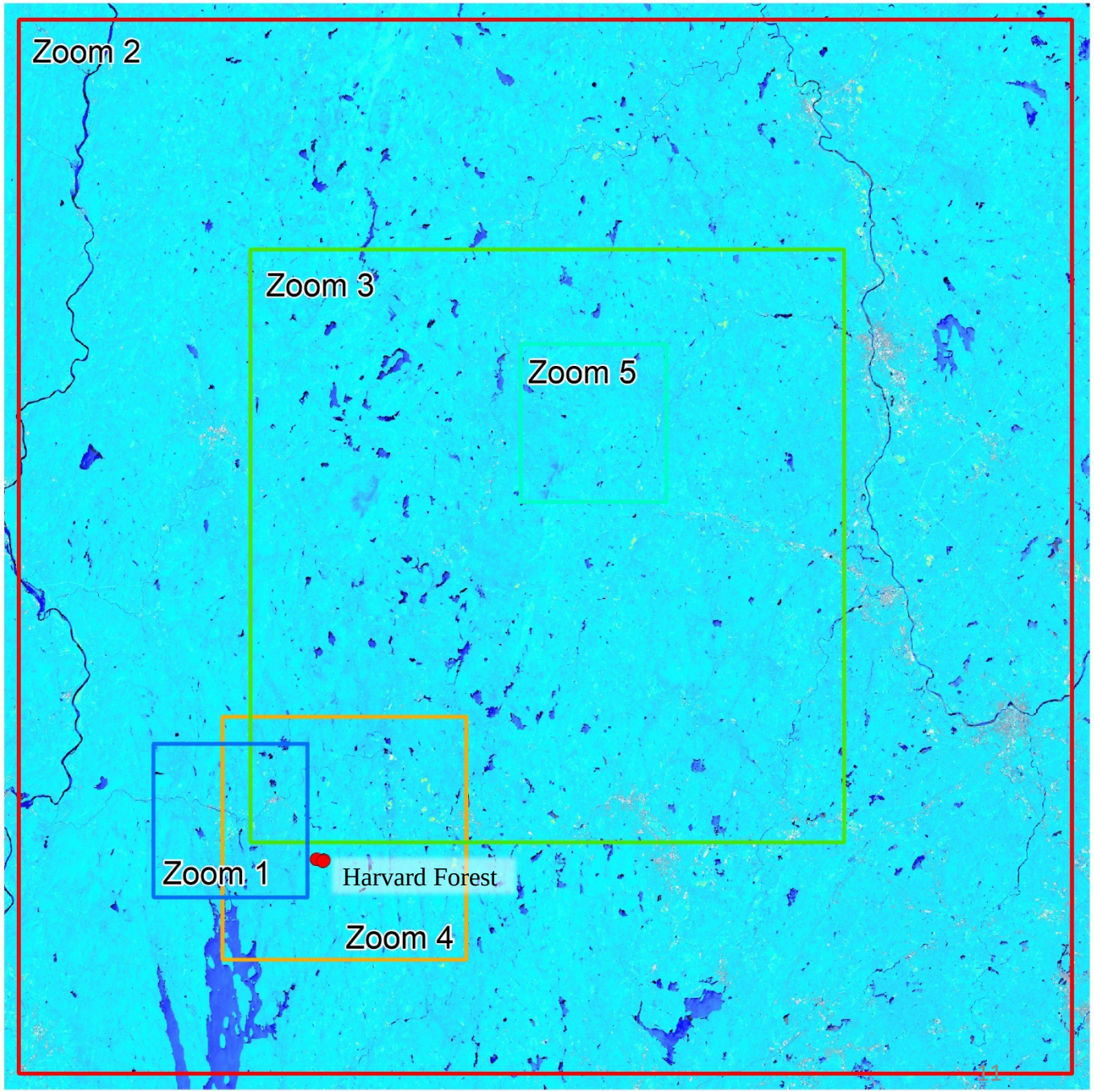
Various Zooms
Illustrated



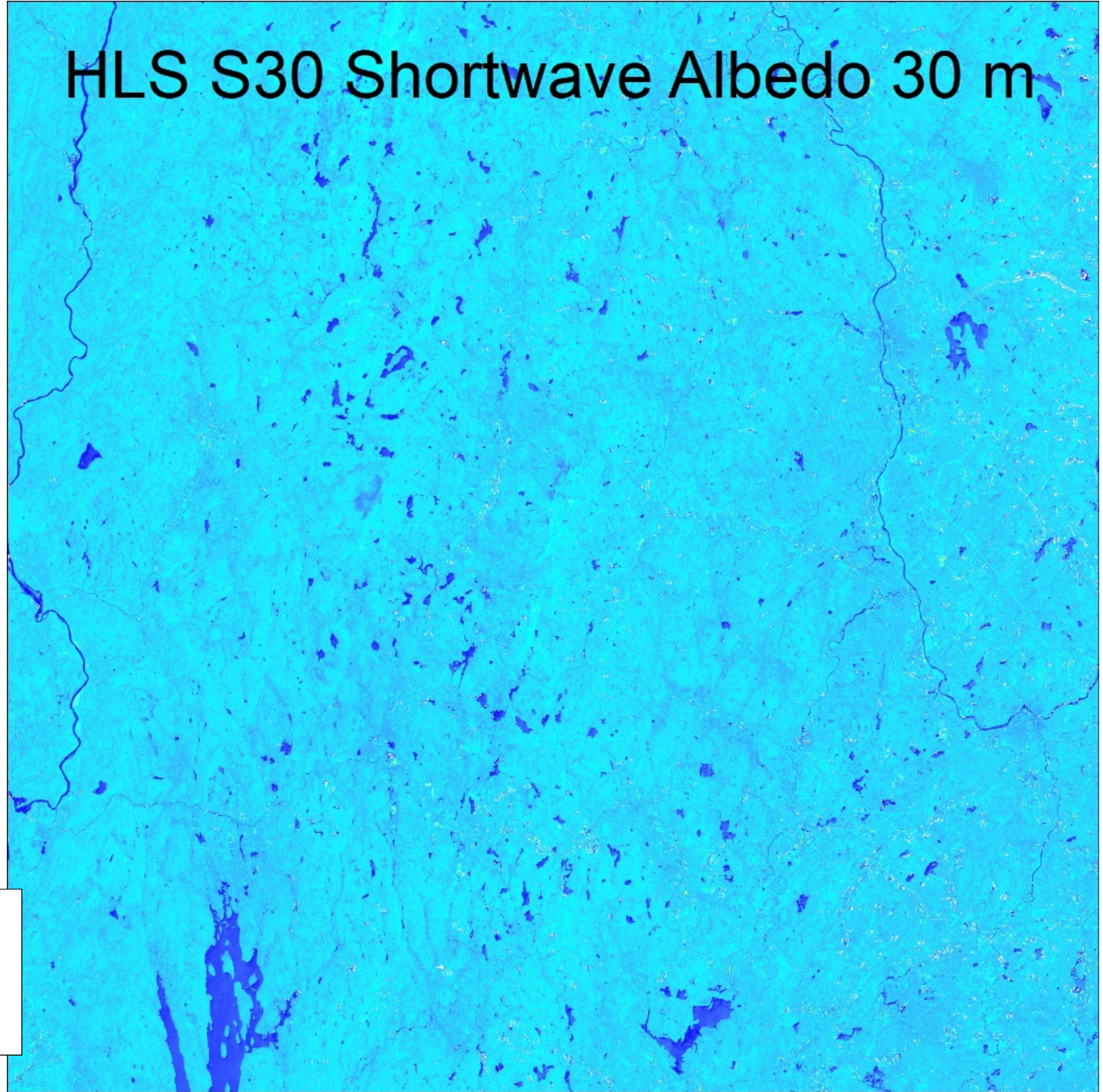
T18TYN, 7/7/2018
Central Massachusetts

Shortwave WSA

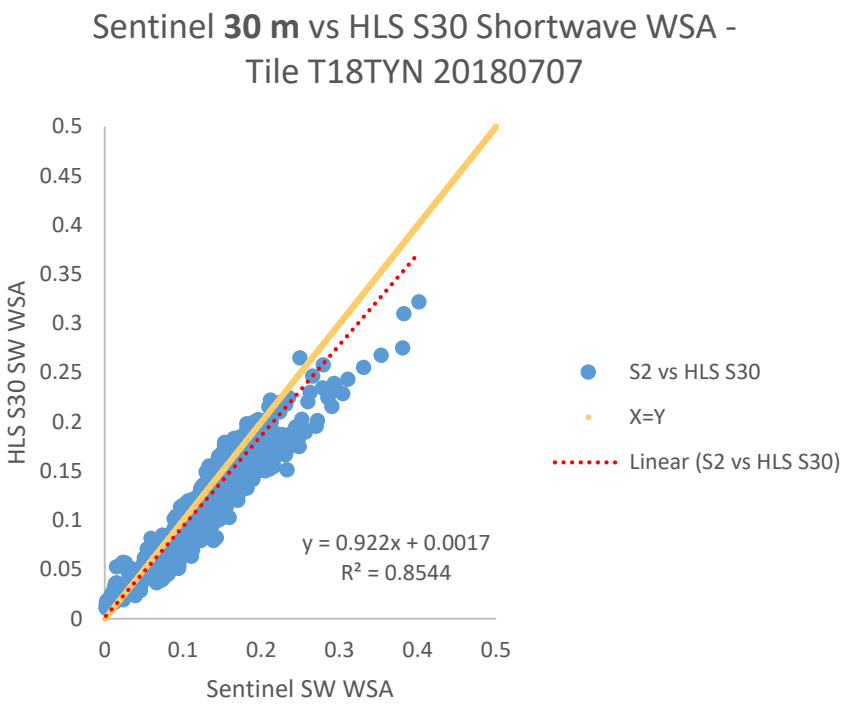
Various Zooms
Illustrated



Zoom
Location 2
Entire tile

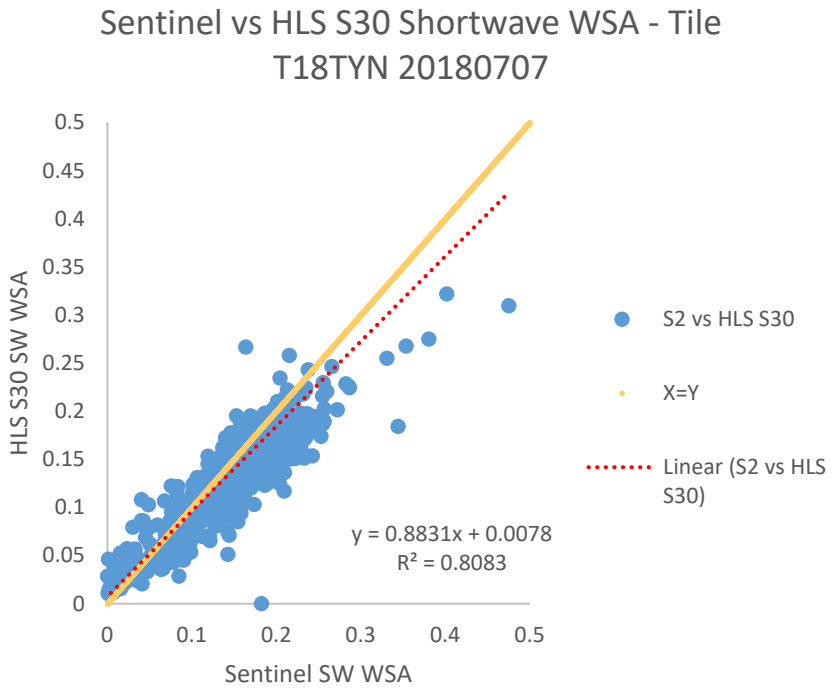


Scene-Wide Comparison of T18TYN 7/7/2018, Shortwave Albedo



RMSE	0.014482
Bias	0.010464

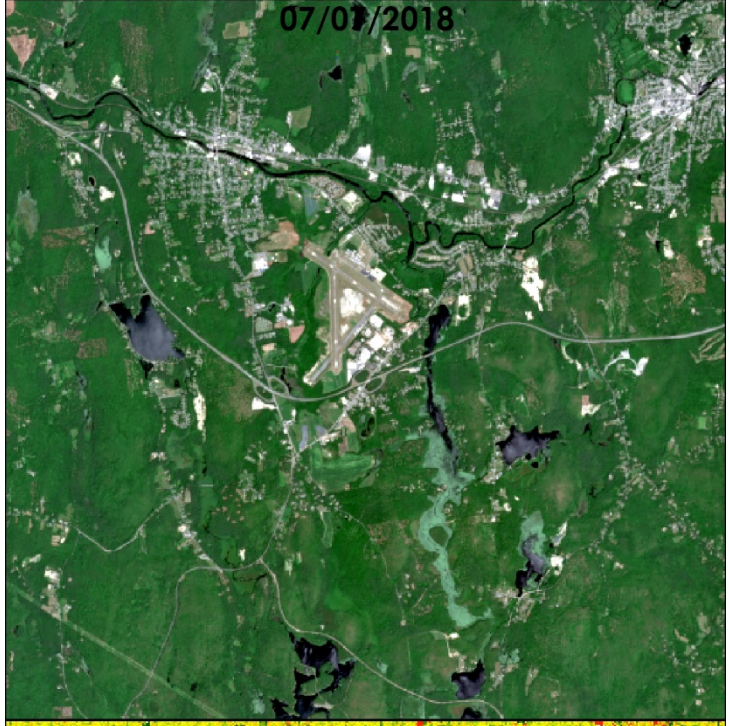
S2 Resampled to exact 30 m grid of HLS



RMSE	0.015656
Bias	0.01034

S2 in original 20 m

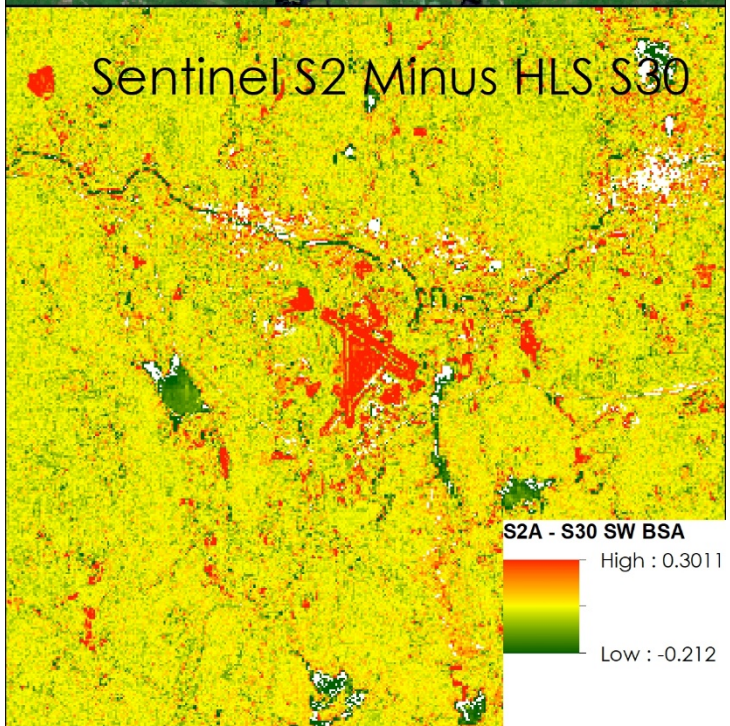
Zoom Location 1



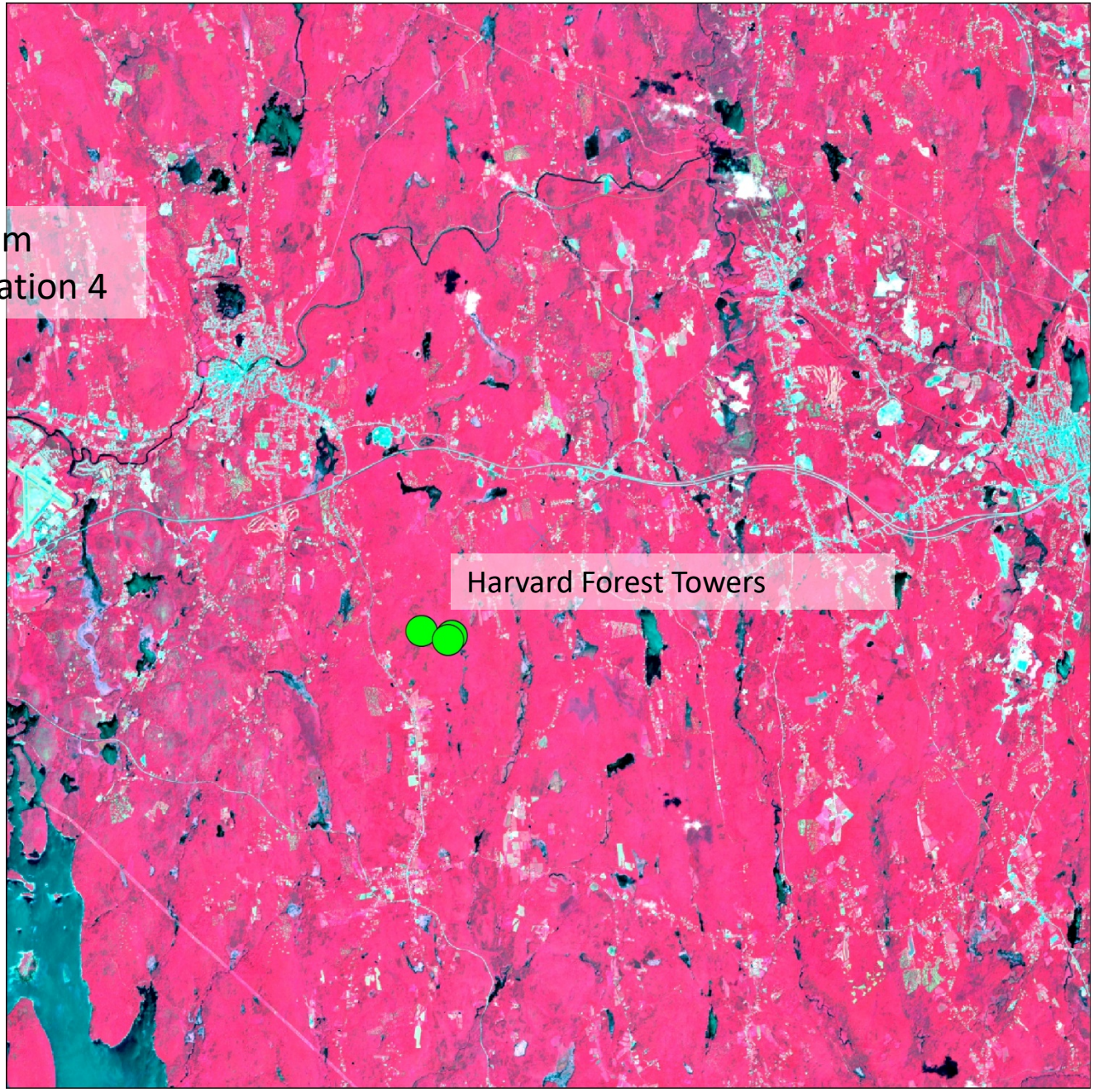
Zoom in of difference image (bottom) and true color composite (top).

Airfield-adjacent bare ground/low grass is considerably higher in Sentinel 2 than HLS S30. QA issues.

Cause of large differences is being investigated….



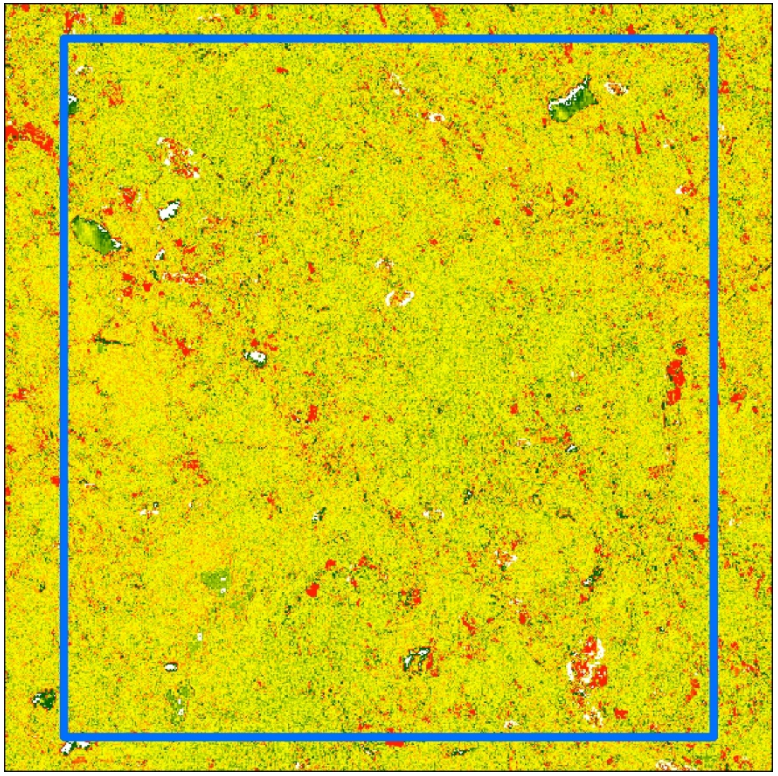
Zoom
Location 4

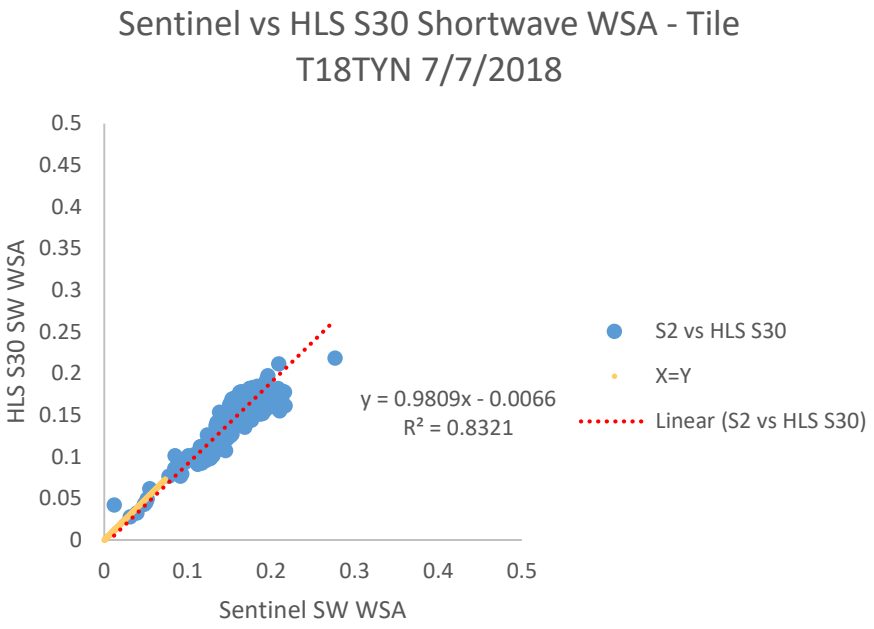


S2 NIR image

Different Location, Subset with Minimal Streams, Power Lines, Roads

Zoom Location 5





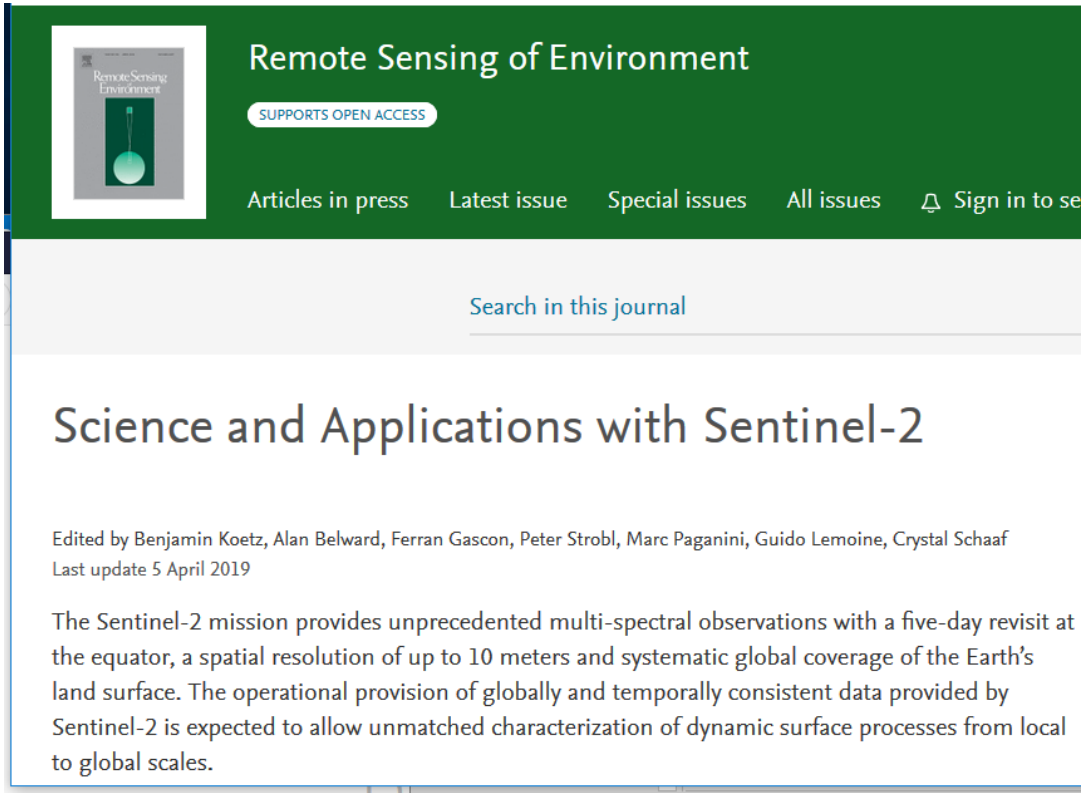
RMSE	0.013
Bias	0.009531

Small spatial subset with limited linear features (waterways/power lines/etc), to limit resampling-based differences.

Sentinel is resampled to HLS 30 m resolution.

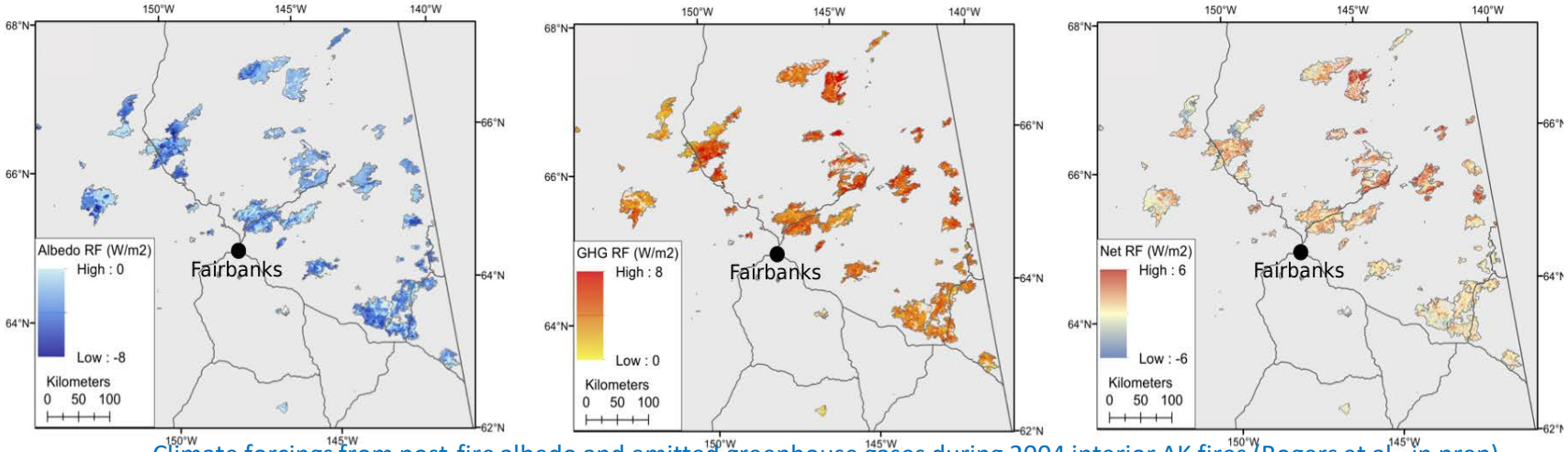
- Sample albedo data have been delivered to CoIs Rogers (WHRC) and Hall (ESSIC/UMd).
- CoI Healy (USFS) has put FIA Memorandum in place for evaluation sites.
- Collaborator Schaepman-Strub (UZurich) will be evaluating our albedo results at High Latitude Drone Ecology Network (HiLDEN) sites. https://arcticdrones.org/

- Note: Sentinel-2 Special Issue has finally been completed!



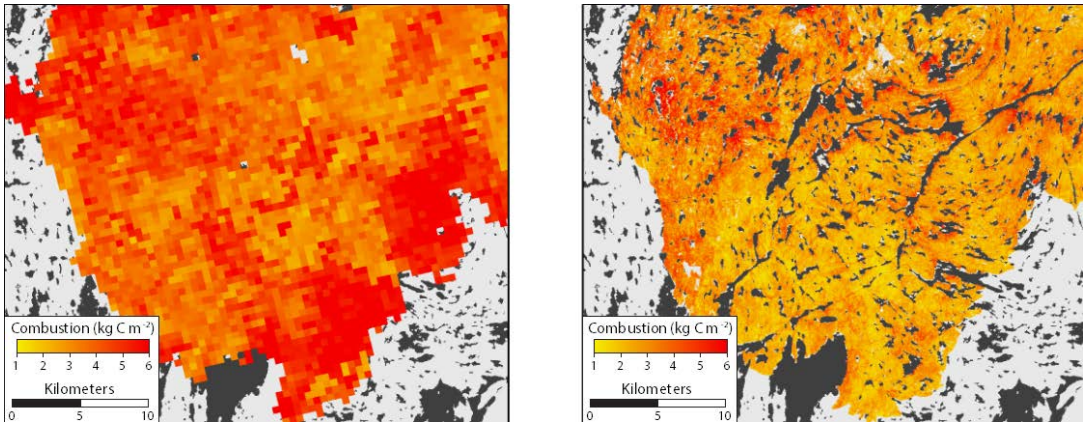
Li, Z., Erb, A., Sun, Q., Liu, Y., Shuai, Y., Wang, Z., Boucher, P., Schaaf, C., 2018. Preliminary assessment of 20-m surface albedo retrievals from sentinel-2A surface reflectance and MODIS/VIIRS surface anisotropy measures. Remote Sens of Environ, 217, 352–365. https://doi.org/10.1016/j.rse.2018.08.025

Post-fire albedo and climate forcings in Alaska and Canada (Co-I Rogers)



Climate forcings from post-fire albedo and emitted greenhouse gases during 2004 interior AK fires (Rogers et al., in prep).

- Building on Rogers ABoVE.
- Derived statistical models of climate forcings from (i) post-fire albedo trajectories and (ii) greenhouse gas emissions at MODIS 500 m.
- For this project, merged Landsat-Sentinel data used to quantify spatial scaling issues.



Combustion from 2014 Northwest Territories fires using MODIS (Veraverbeke et al., 2017; trained in AK) and Landsat (Walker et al., 2018; regionally calibrated).

Landsat, Sentinel, HLS on Amazon Web Services (AWS)

- AWS provides a scalable high performance computing environment, with several available Linux distributions
- Schaaf Lab currently working with AWS team to deploy albedo codes for Landsat, Sentinel-2, and the Harmonized Landsat Sentinel-2 (HLS) products
- Specifically, cfncluster module provides functionality to create large compute cluster for parallel processing with minimal programmatic difficulty
  - Up to hundreds of compute clusters
  - Master node specs: Memory optimized, SSD local storage, up to 64 virtual CPU, 488 Gb memory
  - S3 Storage access to Landsat, Sentinel-2, HLS data repositories
- Currently optimizing compute cluster EC2 images
- Albedo codes currently implemented for limited-scale processing on AWS