SnowEx: a NASA airborne campaign

leading to a snow satellite mission

SnowEx update: December 22, 2016

SnowEx Team/contributors to this report: Edward Kim, Charles Gatebe, Amy Misakonis, Dorothy Hall, HP Marshall, Ludovic Brucker, Kelly Elder, Chris Hiemstra, Amanda Leon, Rani Gran, Matt Beckley, Mark Raleigh

Sponsored by NASA Headquarters/Terrestrial Hydrology Program Manager: Jared Entin

Agenda Outline

- Welcome – Ed/Gatebe
- Upcoming Meetings – Dorothy Hall
  - IGARSS Fort Worth, Texas, USA, 23-28 July 2017
  - SnowEx Workshop, Boulder, CO, August 2017
- Winter Ground Logistics Updates – C. Hiemstra/HP Marshall
  - AGU Town Hall
  - Selection of Snow Pits Locations
- Data Management Updates - Amanda Leon
  - CPLX Data Metrics
- Aircraft Logistics Updates – Ed Kim
  - P-3 (AESMIR, CAR, IR Sensors, SnowSAR)
  - King Air/ASO (Lidar & Spectrometer)
  - G-3/UAVSAR & GLISTIN-A
- Weather Products/Plans – Matt Beckley
- Public Outreach – Rani Gran
- Schedule & General Logistics Upadtes – Amy Misakonis
- Topical presentation: Time lapse Cameras – Mark Raleigh
- Q&A

UPCOMING MEETINGS & EVENTS

Dorothy Hall

UPCOMING MEETINGS

IGARSS 2017 MEETING, Fort Worth, Texas, USA, 23-28 July, 2017

http://www.igarss2017.org/default.asp

Paper submission deadline is January 9th, 2017

Invited Session: NASA's SnowEx Campaign: Preliminary Results

SnowEx Workshop,

Boulder, CO, August 2017 (dates TBD)

WINTER GROUND LOGISTICS UPDATES

K.Elder/L. Brucker/HP Marshall/C.Hiemstra

WINTER GROUND LOGISTICS

NSIDC National Snow & Ice Data Center | DATA | RESEARCH | NEWS | ABOUT | SEARCH | Web pages

NASA Distributed Active Archive Center (DAAC) at NSIDC

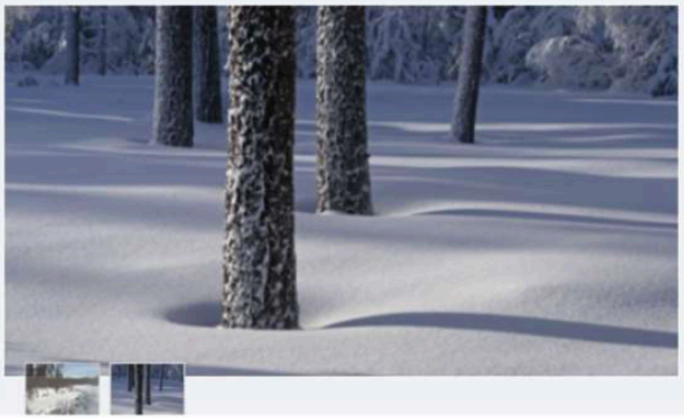
NASA SnowEx

New Approaches for Mapping Snow Water Equivalent

- Overview
- Campaign Resources

Overview

NSIDC DAAC will archive and distribute data products from the **NASA SnowEx** campaigns focusing on collecting snow data in forested regions with airborne multi-sensor and in situ validation observations.



SWE and Snow Energy Balance

Distribution of snow-water equivalent and snow energy balance. Photo credit: Randi Hausken

Read more ...

- Overview
- Campaign Resources

Campaign Resources

Year 1: Colorado

Shapefiles of the campaign study areas including transects, Terrestrial Laser Scan (TLS) areas, met towers, and raster data imagery with some tree classification/density layers. Also including flight-line boxes.

Photographs taken with SnowEx cameras during the Fall 2016 campaign. Photos depict terrain and environment for the upcoming February 2017 campaign.

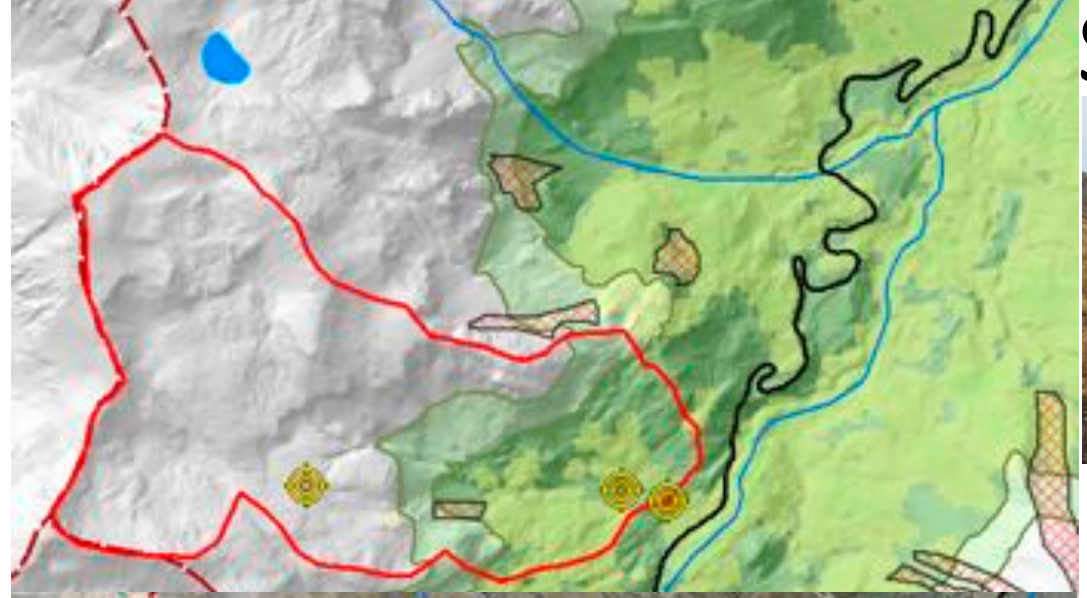
SnowEx team

Senator Beck Basin

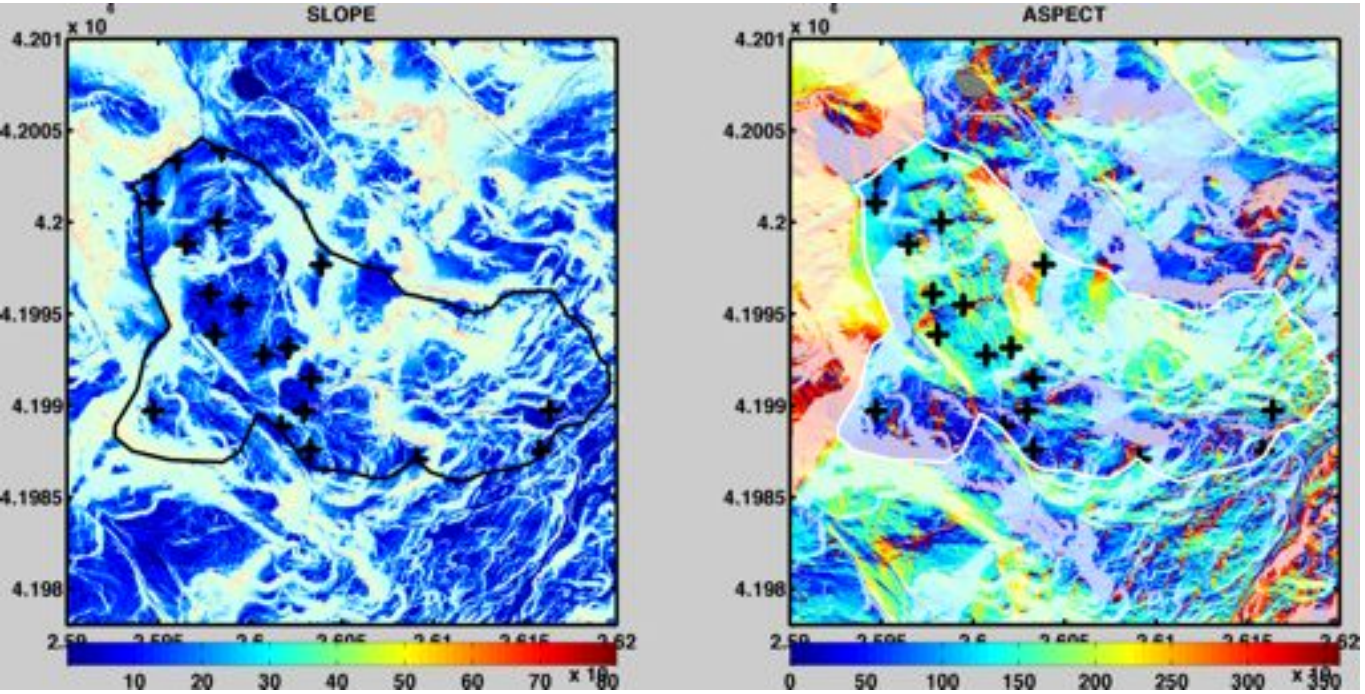
Instrumentation, Spatial surveys

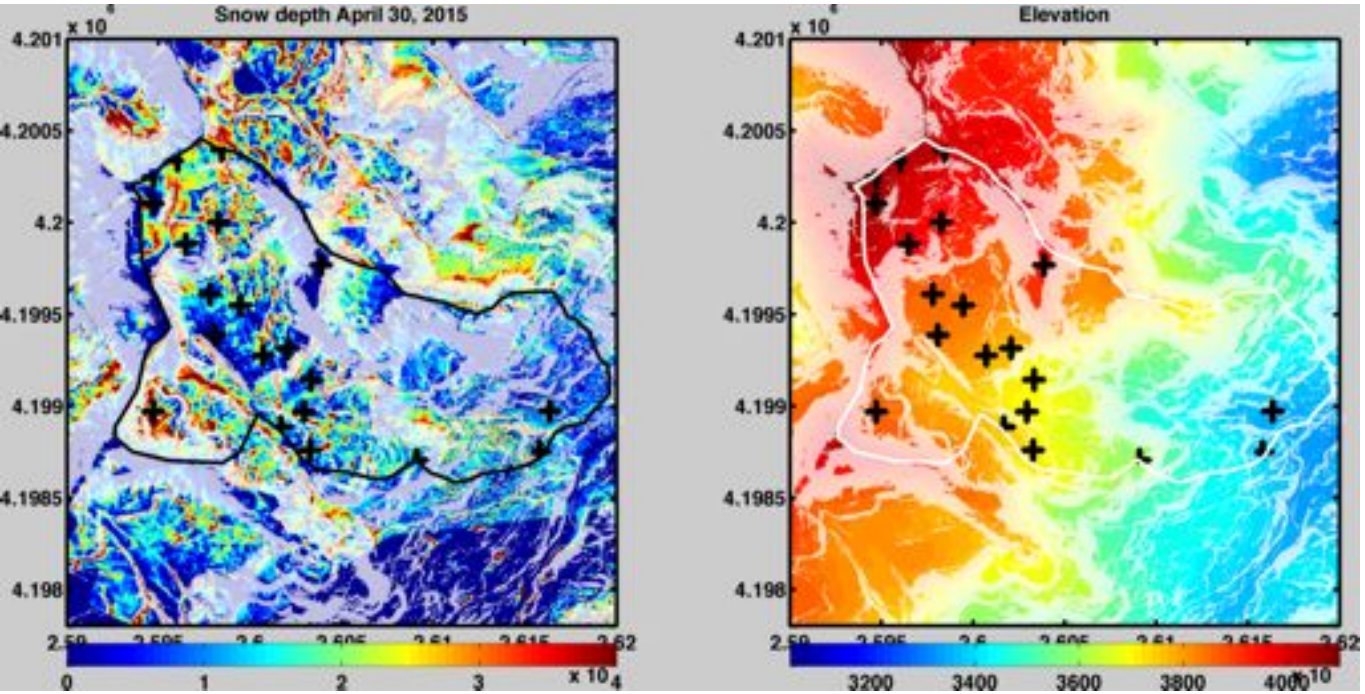
- **2 Full-energy balance Met stations** ***[Center for Snow and Avalanche Studies]***
- **Time lapse cameras, Tree accelerometers** ***[Univ. CO]***
- **NetR9/NetRS GPS** ***[Univ. CO, NSIDC, UNAVCO]***
- **Sun photometer** ***[Aeronet]***
- **1-6 GHz impulse, 24-26 GHz FMCW tower-based microwave radars [BSU]**
- ***Stream gauge [Center for Snow and Avalanche Studies]***
- ***TLS Surveys [NSIDC, CRREL]***
- ***GB radar surveys [BSU]***
- ***Historical ASO overflights [NASA JPL]***

Senator Beck Basin



- Alpine
- Treeline
- Below Treeline





- ***DRAFT Sampling plan***
- Sampling in safe areas 1st priority
- Focus on high snow variability, complex terrain
- 100m N/S, E/W depth transects, central snowpits
- TLS surveys
- Radar surveys
- Spectrometer
- NIR photography
- SnowMicroPen
- Snow Casting

A Note on "Extra" Ground Activities

- Jared & the SnowEx project leadership fully understand the desire to leverage SnowEx infrastructure (instrumentation, survey lines, etc.) for "extra" ground activities before/during/after the official 3-week campaign in February.
- As much as we'd all like to accommodate requests for "extra" activities, we cannot, and we ask all of you to understand why:
  - Safety: a major goal of SnowEx is wide community participation, and we've been able to select 70 (!) participants. This was only possible through an *enormous* amount of behind-the-scenes work to select sites, routes, measurements, schedule, consider search & rescue scenarios, etc. Any "extra" activity that would be perceived as part of SnowEx—whether technically true or not---puts all that at risk, for the entire snow community; not only for year 1, but for future years as well.
  - Logistics: there are no extra snowmobiles, safety equipment, time, etc. for unplanned activities. That snowmobile that appears to be "unused" may be on standby for search and rescue. All resources are being tightly managed in order to make SnowEx affordable, manageable, and safe for the group.
- Feb 2017 is still only the first year, not the last year. There will be heaps and gobs of awesome unique data to keep us all busy for years to come. Let's not put that at risk to gain a small "extra" something. There will be future opportunities to do things that weren't done in year 1.

DATA MANAGEMENT UPDATES

Amanda Leon

Instrument Data POCs

- SnowEx Leadership has been identifying instrument POCs to be the data contact for the DAAC
- This role is not necessarily the instrument Science Lead, PI, person planning the campaign activates, operating the instrument, etc.
- It is someone who can:
  - Complete the instrument/product survey
  - Be the primary POC with DAAC on data management implementation (e.g. data formats, data transfers)
  - Represent the data from similar instruments and coordinate data management practice across those instrument teams

GBRS Data POCs

Instrument	Name
GPS antenna on weather stations	Eric Small
Microwave radiometers	Alexandre Langlois
Microwave radiometers	Roger De Roo
Pluvio, and Parsivel disdrometer	Ana Barros
Pluvio, and Parsivel disdrometer	Matt Wingo, Walt Peterson
PIP	Larry Bliven
Radar*	HP Marshall
Scatterometer	Richard Kelly
Spectroradiometer*	Karl Rittger
Sun photometer	Jon Rodriguez
Time-lapse camera*	Mark Raleigh
Tree accelerometers	Mark Raleigh
TLS	Jeff Deems

* Represents multiple instruments

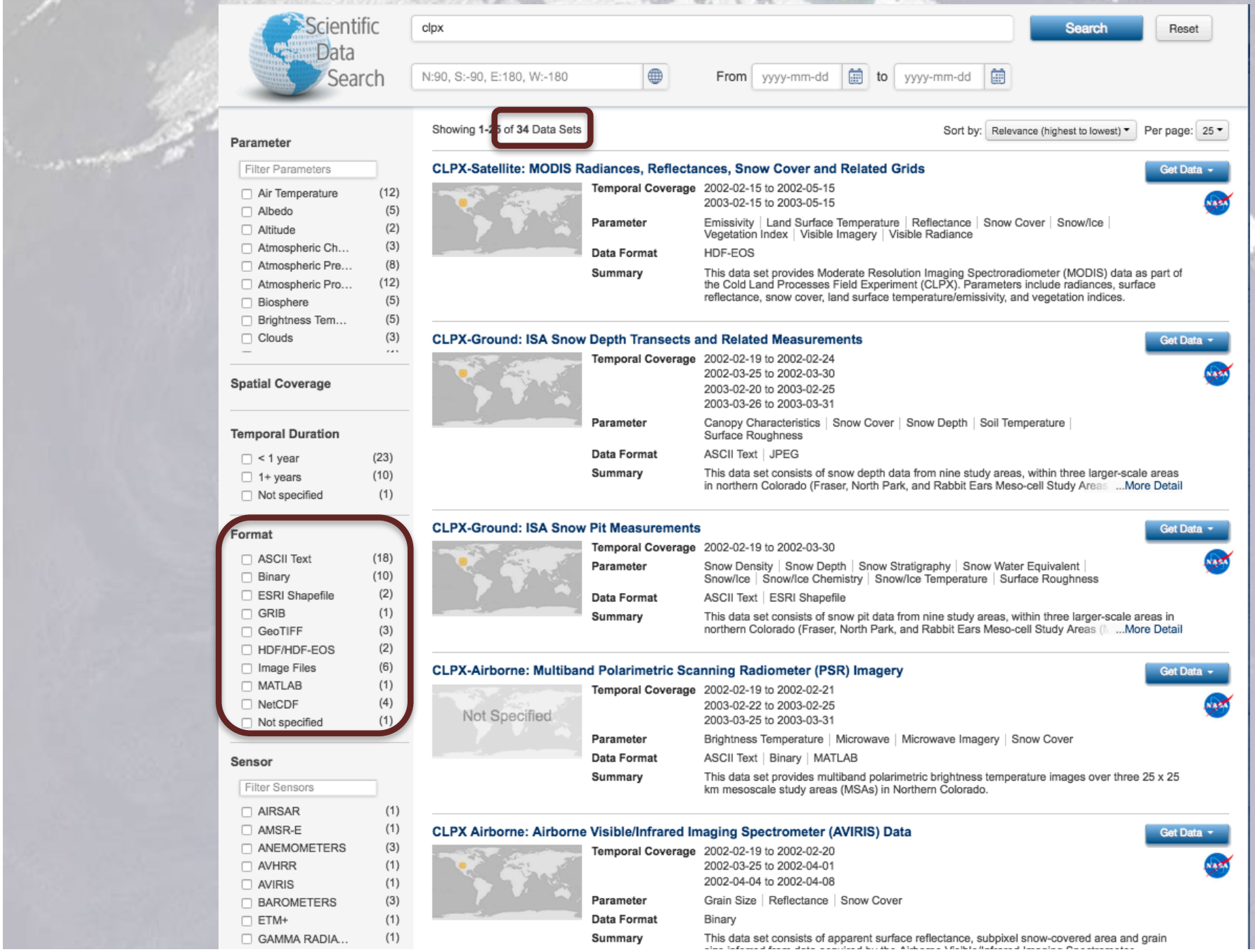
Airborne Data POCs

Instrument	Name
AESMIR (The Airborne Earth Science Microwave Imaging Radiometer)	Ed Kim
ASO (Airborne Snow Observatory)	Jeff Deems
CAR (Cloud Absorption Radiometer)	Charles Gatebe
SnowSAR	Alex Coccia
GLISTIN-A	Delwyn Moller
Thermal IR	Dorothy Hall
KT.15 thermal IR sensor (non-imager)	Chris Chicadel
UAVSAR	TBD – Elias Deeb is determining

Field Data POCs

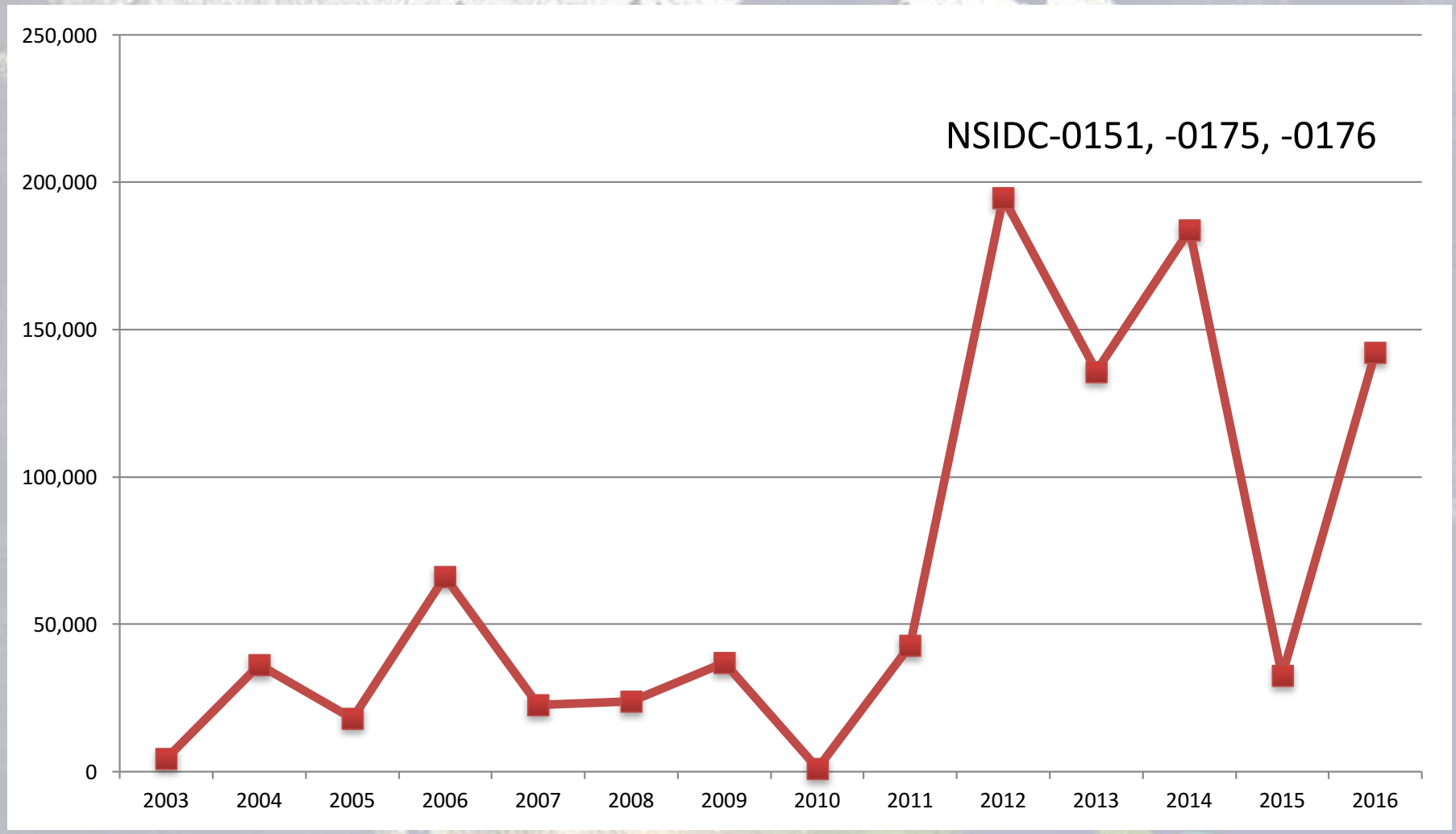
Instrument/Collection Type	Name
Snow Pit	Kelly Elder
Snow Depth Transects	Kelly Elder
Meteorology	Paul Houser
IceCube	Nick Rutter
Magnaprobe	Chris Hiemstra

CLPX User Metrics



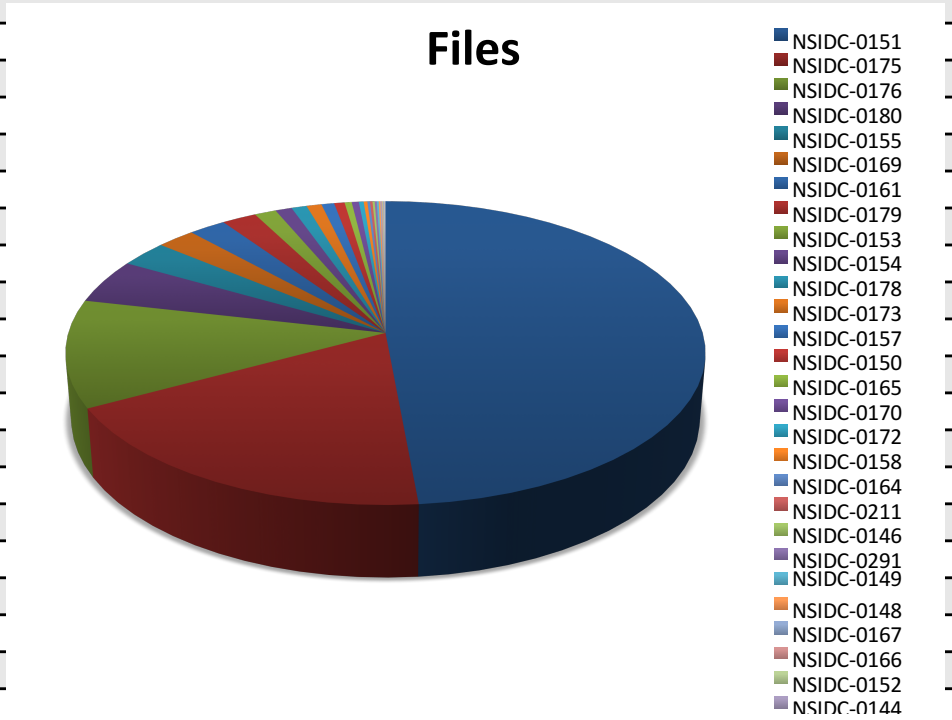
Distribution per Year: 2003-2016

- Files



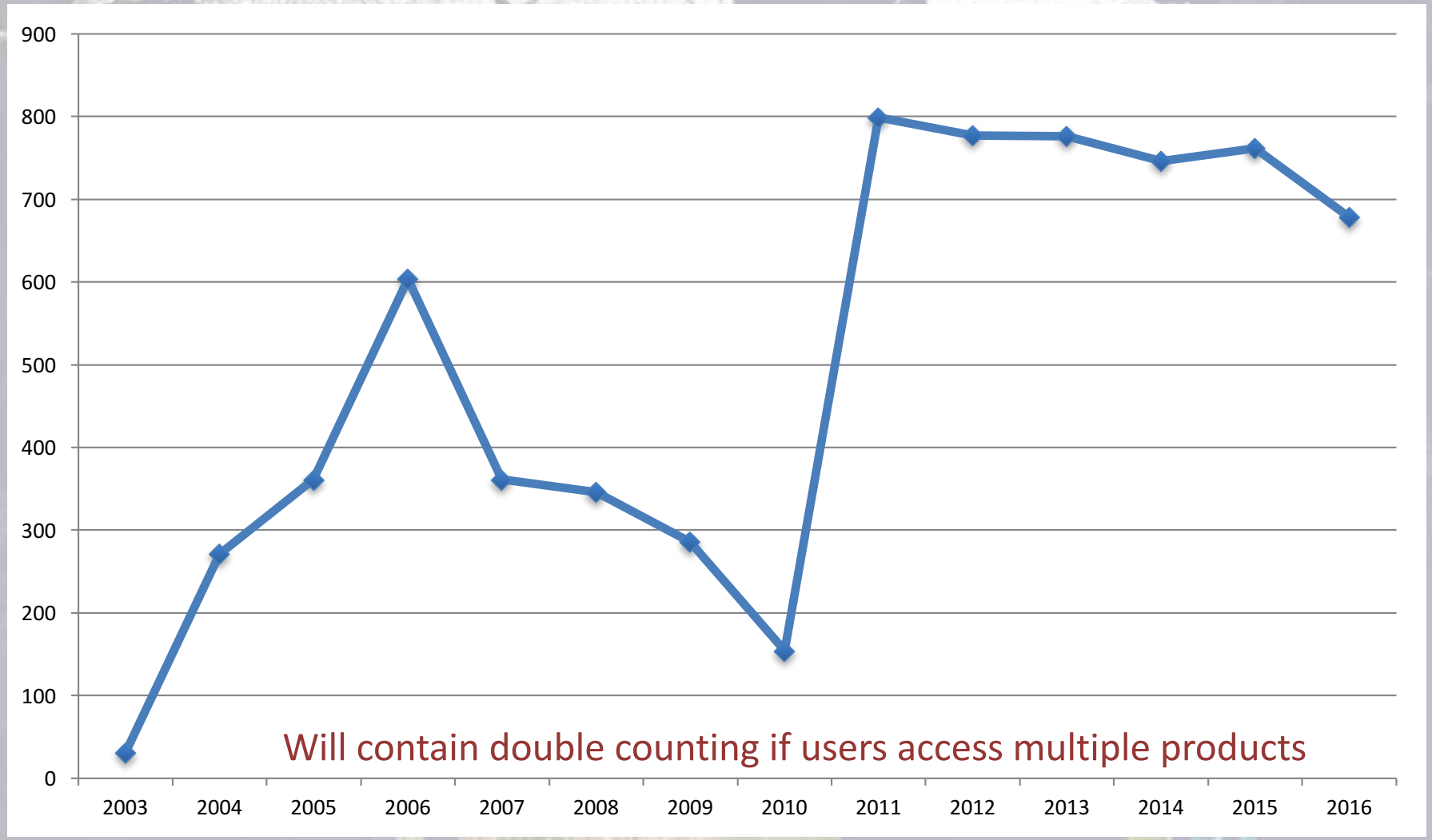
Distribution by Product: 2003-2016

Product ID	Files	Product
NSIDC-0151	457,118	CLPX-Satellite: MODIS Radiances, Reflectances, Snow Cover and Related Grids
NSIDC-0175	174,913	CLPX-Ground: ISA Snow Depth Transects and Related Measurements
NSIDC-0176	107,697	CLPX-Ground: ISA Snow Pit Measurements
NSIDC-0180	44,261	CLPX NOAA FSL Rapid Update Cycle 20 km (RUC-20) Dataset
NSIDC-0155	26,142	CLPX-Airborne: Multiband Polarimetric Scanning Radiometer (PSR) Imagery
NSIDC-0169	20,844	
NSIDC-0161	20,151	
NSIDC-0179	18,756	
NSIDC-0153	11,725	
NSIDC-0154	8,983	
NSIDC-0178	8,275	
NSIDC-0173	8,146	
NSIDC-0157	6,882	
NSIDC-0150	5,650	
NSIDC-0165	3,852	
NSIDC-0170	3,827	
NSIDC-0172	2,603	
NSIDC-0158	1,957	
NSIDC-0164	1,438	
NSIDC-0211	1,353	
NSIDC-0146	1,161	
NSIDC-0291	1,118	
NSIDC-0149	1,034	
NSIDC-0148	898	
NSIDC-0167	531	
NSIDC-0166	515	
NSIDC-0152	456	
NSIDC-0144	347	
NSIDC-0145	345	
NSIDC-0159	301	
NSIDC-0168	275	
Grand Total	941,554	



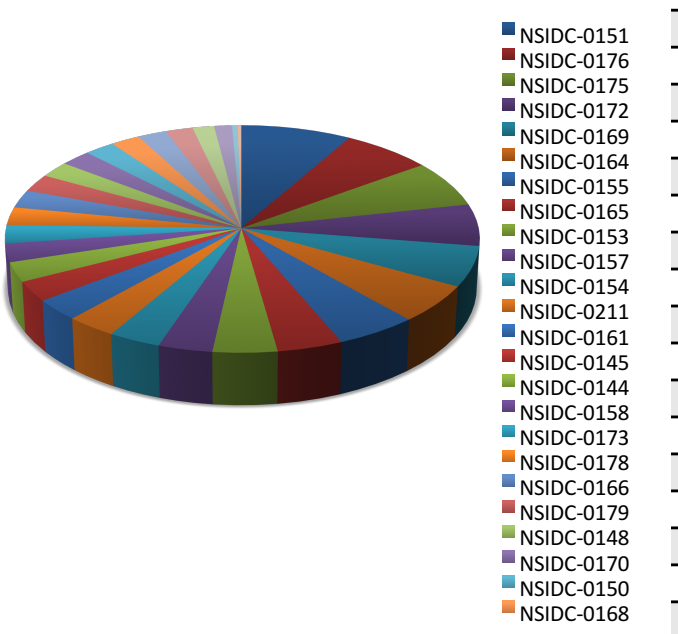
Distribution per Year: 2003-2016

- Unique Hosts (proxy for users)



Distribution by Product: 2003-2006

Product ID	Hosts	Product
NSIDC-0151	515	CLPX-Satellite: MODIS Radiances, Reflectances, Snow Cover and Related Grids
NSIDC-0176	439	CLPX-Ground: ISA Snow Pit Measurements
NSIDC-0175	434	CLPX-Ground: ISA Snow Depth Transects and Related Measurements
NSIDC-0172	394	CLPX-Ground: ISA Main Meteorological Data
NSIDC-0169	379	CLPX-Ground: Snow Measurements at the Local Scale Observation Site (LSOS)
NSIDC-0164	349	
NSIDC-0155	318	
NSIDC-0153	270	
NSIDC-0165	267	
NSIDC-0157	222	
NSIDC-0154	214	
NSIDC-0211	203	
NSIDC-0161	192	
NSIDC-0144	188	
NSIDC-0145	188	
NSIDC-0173	174	
NSIDC-0158	168	
NSIDC-0166	168	
NSIDC-0178	167	
NSIDC-0179	158	
NSIDC-0148	154	
NSIDC-0170	153	
NSIDC-0168	146	
NSIDC-0159	143	
NSIDC-0150	139	
NSIDC-0152	139	
NSIDC-0167	111	
NSIDC-0149	88	
NSIDC-0180	30	
NSIDC-0291	14	
NSIDC-0146	4	



Support requests made to User Services since May 2011

CLPX 12/21/2016

User Services Support Summary: CLPX

29	306	155
# Questions Resolved	# Public Comments	# Solved Tickets

Key Support Metrics

CLPX Support Provided

Support Type	
NSIDC Ops Support	8
Documentation Support	7
Reference DAAC	7
USO NSIDC Product Selection Support	3
USO Science Support	3
NSIDC Web/Writer Support	1
Reference Non-DAAC	1
Citation Support	0
ECS Order Failure	0
NSIDC Programmer Support	0
NSIDC Science Support	0
Other	0
PI/External Support	0
USO GIS Support	0
USO Programming Support	0
USO System Support	0
USO Tools Support	0

Ops Support = Support with data download/access
Documentation Support = Point users to documented info
Reference DAAC = Point users to info located elsewhere
Product Selection Support = Point user to appropriate product
Science Support = Science support provided beyond what is documented

Support by CLPX Product

Product	# Registrations	# Questic
nsidc-0154	9	10
nsidc-0176	9	9
nsidc-0153	8	8
nsidc-0178	0	7
nsidc-0148	2	6
nsidc-0175	3	6
nsidc-0169	4	5
nsidc-0149	0	4
nsidc-0173	0	4
nsidc-0157	7	4
nsidc-0144	0	3
nsidc-0179	0	3
nsidc-0155	1	3
nsidc-0166	1	3
nsidc-0172	3	3
nsidc-0161	0	2
nsidc-0167	0	2
nsidc-0181	0	2
nsidc-0145	2	2
nsidc-0152	2	2
nsidc-0159	3	2
nsidc-0165	4	2
nsidc-0180	4	2
nsdic-0148	0	1
nsidc-0164	0	1
nsidc-0158	2	1
nsidc-0150	1	0
nsidc-0168	1	0
nsidc-0211	2	0

CLPX Data Topic Tag

Data Topics	
Algorithm/Processing/Science	1
Access	0
Coverage	0
Format	0
Geolocation/Projection	0
Import/Read	0
Other	0
Resolution	0
Subset	0
Visualization/Browse	0

Sample User Question

CLPX-Satellite: EO-1 Hyperion Surface Reflectance, Snow-Covered Area, and Grain Size

I used the Hyperion and AVIRIS image snow grain sizes and snow sub-pixels products, i find some questions.

- (1) your Hyperion or AVIRIS image are .hdr format, but your products such as snow grain sizes is .pic
- format, why you do it?
- (2) How to open .pic format files, pic format is not equal to .pict format.
- (3) i want to compare our algorithm with your products, but i try to open these .pic fil3, and l lost,
- please give me some help, why the .pic formart file are not converted into single band .hdr format file, if you do it , it might save many time.

Handling the User Question

- Product contains different files for different measurements

File	Grid size	Spatial Coverage
Snow cover	Not documented (256 x 512)	Not documented
Snow grain size	Not documented (256 x 512)	Not documented
Surface reflectance	Documented (256 x 3127)	Documented

- Had no way of knowing where the smaller grid files were spatially located

User Request Takeaways

- Include geolocation information in files
- DAAC does not have the resources to inspect and verify every data file across such a large, heterogeneous set of products. We prioritize:
  - Geolocation (risen in priority since CLPX)
  - Grid
  - Data structure: data fields, units
- Documentation and metadata not captured during the project is very challenging to fill in later

AIRCRAFT LOGISTICS UPDATES

Edward Kim

Airborne Sensors

CONFIRMED CORE SENSORS

- SnowSAR: X & Ku-band radar
- CAR (BRDF)
- AESMIR (passive microwave) 18 & 36 GHz
- Thermal IR/video suite
  - Imager
  - High-accuracy non-imaging (KT.15)
  - Video camera
- ASO suite
  - Lidar
  - Hyperspectral imager

CONFIRMED EXPERIMENTAL SENSORS

- UAVSAR: L-band radar
- GLISTIN-A: Ka-band radar

POTENTIAL SENSORS

- WISM: X, Ku, & Ku-band radar
- ~~UAV w/lidar~~ (insufficient time for NASA approval; try in future years)
- NRL ice suite

Aircraft

List as of Dec 21

Confirmed

- NRL P-3
- King Air with ASO (same as fall)
- NASA G-III with GLISTIN-A (same as fall)
- NASA G-III with UAVSAR

Potential

- Twin Otter with WISM
- Another Twin Otter with NRL ice suite

WEATHER PRODUCTS/PLANS

Matt Beckley

Weather Updates

- Julie Malingowski will be our main forecaster at NWS. I have sent her a "wish list" of information we would need. She had a few questions that we should discuss:

- Daily Phone calls – Do we want to set times for these, or call at your convenience? Will the morning briefings be regularly scheduled, or will those vary as well?

- Reports/Maps – Julie will show us a couple different options for text and/or graphical PDFs before the mission begins so we can see what would help SnowEx the best.

- Flight altitudes – Are we looking for these relative to the surface of the Grand Mesa and/or Senator Beck (AGL)? We do have our 00z and 12z soundings from KGJT that will be quite representative of the Grand Mesa, and ~80 miles north of Senator Beck.

PUBLIC OUTREACH

Rani Gran

SnowEx Communications Campaign

Rani Gran,
NASA Goddard
Office of
Communications

Snow Ex Communications

- **Host a media** day at the airport in Colorado Springs on a hard down day – offering a tour of the plane, a press briefing about the purpose of the mission, and interview time with scientists and crew members. This model has been used successfully for many airborne campaigns (OLYMPEX, KORUS-AQ, ACT-America, GRIP, HS-3, etc.)
- Date: Mid February

Snow Ex Communications

Written Products

- Technology Feature
- Media Advisory
- Overview Feature
- Social Media posts during before and during campaign

- Video Products
  - Video of planes, instruments, ground stations
  - Short produced video for Social Media
  - Overview video feature
  - Content will be posted to a Scientific Visualization Studio Page, http://svs.gsfc.nasa.gov/

Snow Ex Campaign

- We will reach out to selected media and suggested they visit Grand Mesa. Jon Hare, Forest Service agreed to help with escorts.
- Jon Hare is planning to talk about Snow Ex at local Grand Mesa schools

Snow Ex Communications

Mid January

- Media Advisory about the media day and Snow Ex campaign
- Technology feature on Snow Ex Campaign
- Short video will go out on social media
- Capture video and picture of instruments be loaded into P-3 at Patuxent Naval Air Station

- Early February
  - Videographer/producer from the Forest Service will capture video of ground station in Grand Mesa, CO. He will also collect some interviews. We want to make this video available to the media that cover Snow Ex campaign

Snow Ex Communications

- Mid February
  - NASA Videographer/producer hopefully get a chance to fly on one of the P-3 flights
  - Overview feature on Snow Ex Campaign will be published
  - Video feature

Snow Ex Communications

- Help Needed
  - Send us pictures and written captions or descriptions of your work out in the field. We would like to use these in written products.

Snow Ex Communications Team

Ellen Gray
Senior Writer/
communcation specialist

Joy Ng
Video
Producer/Social
Media Specialist

Patrick Lynch
Communications
Manager

Rani Gran, Public
Affairs Specialist

SCHEDULE AND GENERAL LOGISTICS

Amy Misakonis

Schedule

- NRL CDR – Complete
- Instrument Readiness Review – Complete
- WFF Airworthiness TIM – Complete
- Instruments are making their way to PAX river
  - CAR Integration – 1/3
  - AESMIR Integration – 1/5
  - SnowSar Integration – 1/9
  - IR Suite Integration – 1/11
- Test Flights – 1/12 and 1/13
- A/C and GT Early Arrival – 2/1
- Week 1 personnel arrive 2/5

General Logistics

- Finishing collecting contact info for all participants
- All personnel will arrive on Sundays with the intent of group transport from the airport (unless arriving in a POV or rental)
- Personnel will be requested to arrive in Grand Junction at or before 12:30 local time
- More info to follow via email on actions required to book travel
- Lodging and Food at Grand Mesa is included in the campaign, Lodging is provided at SBB with food on per diem
- Please respond to emails quickly as a lot will need to happen in the next 1-2 weeks to execute a successful February campaign
- We will send out a list of personal items to bring
-

TOPICAL PRESENTATION: TIME LAPSE CAMERAS

Mark Raleigh

SnowEx Time-lapse Camera Network

Mark Raleigh, Ryan Currier,
Jessica Lundquist, Chris Hiemstra,
Paul Houser, Ludo Brucker, Kelly Elder

Overview

- 30 cameras installed in fall 2016
  - 29 at Grand Mesa
  - 1 at Senator Beck
- Typical program
  - Wake: 8 AM
  - Sleep: 5 PM
  - 2 hour frequency
  - Modified in select cases

Wingscapes TimelapseCam
8 megapixel
24 cameras

Wingscapes TimelapseCam Pro
20 megapixel
6 cameras

A sampling of snow studies w/ cameras

Allamano, P., A. Croci, and F. Laio (2015), Toward the camera rain gauge, *Water Resour. Res.*, *51*, doi:10.1002/2014WR016298.

Dickerson-Lange, S. E., J. A. Lutz, K. A. Martin, M. S. Raleigh, R. Gersonde, and J. D. Lundquist (2015), Evaluating observational methods to quantify snow duration under diverse forest canopies, *Water Resour. Res.*, *51*, doi:10.1002/2014WR015744.

Farinotti, D., J. Magnusson, M. Huss, and A. Bauder (2010), Snow accumulation distribution inferred from time-lapse photography and simple modelling, *Hydrol. Process.*, *24*, 2087–2097, doi:10.1002/hyp.7629.

Floyd, W., and M. Weiler (2008), Measuring snow accumulation and ablation dynamics during rain-on-snow events: innovative measurement techniques, *Hydrol. Process.*, *22*(24), 4805–4812, doi:10.1002/hyp.7142.

Garvelmann, J., S. Pohl, and M. Weiler (2013), From observation to the quantification of snow processes with a time-lapse camera network, *Hydrol. Earth Syst. Sci.*, *17*(4), 1415–1429, doi:10.5194/hess-17-1415-2013.

Hinkler, J., S. B. Pedersen, M. Rasch, and B. U. Hansen (2002), Automatic snow cover monitoring at high temporal and spatial resolution, using images taken by a standard digital camera, *Int. J. Remote Sens.*, *23*(21), 4669–4682, doi:10.1080/01431160110113881.

Parajka, J., P. Haas, R. Kirnbauer, J. Jansa, and G. Blöschl (2012), Potential of time-lapse photography of snow for hydrological purposes at the small catchment scale, *Hydrol. Process.*, doi:10.1002/hyp.8389.

Sugiura, K., S. Nagai, T. Nakai, and R. Suzuki (2013), Application of time-lapse digital imagery for ground-truth verification of satellite indices in the boreal forests of Alaska, *Polar Sci.*, *7*(2), 149–161, doi:10.1016/j.polar.2013.02.003.

Variables for SnowEx

- Snow covered area (on ground)
- Snow presence in canopy
- Snow depth (select sites)
- Timing/duration of snow storms
- Sky conditions (select sites)

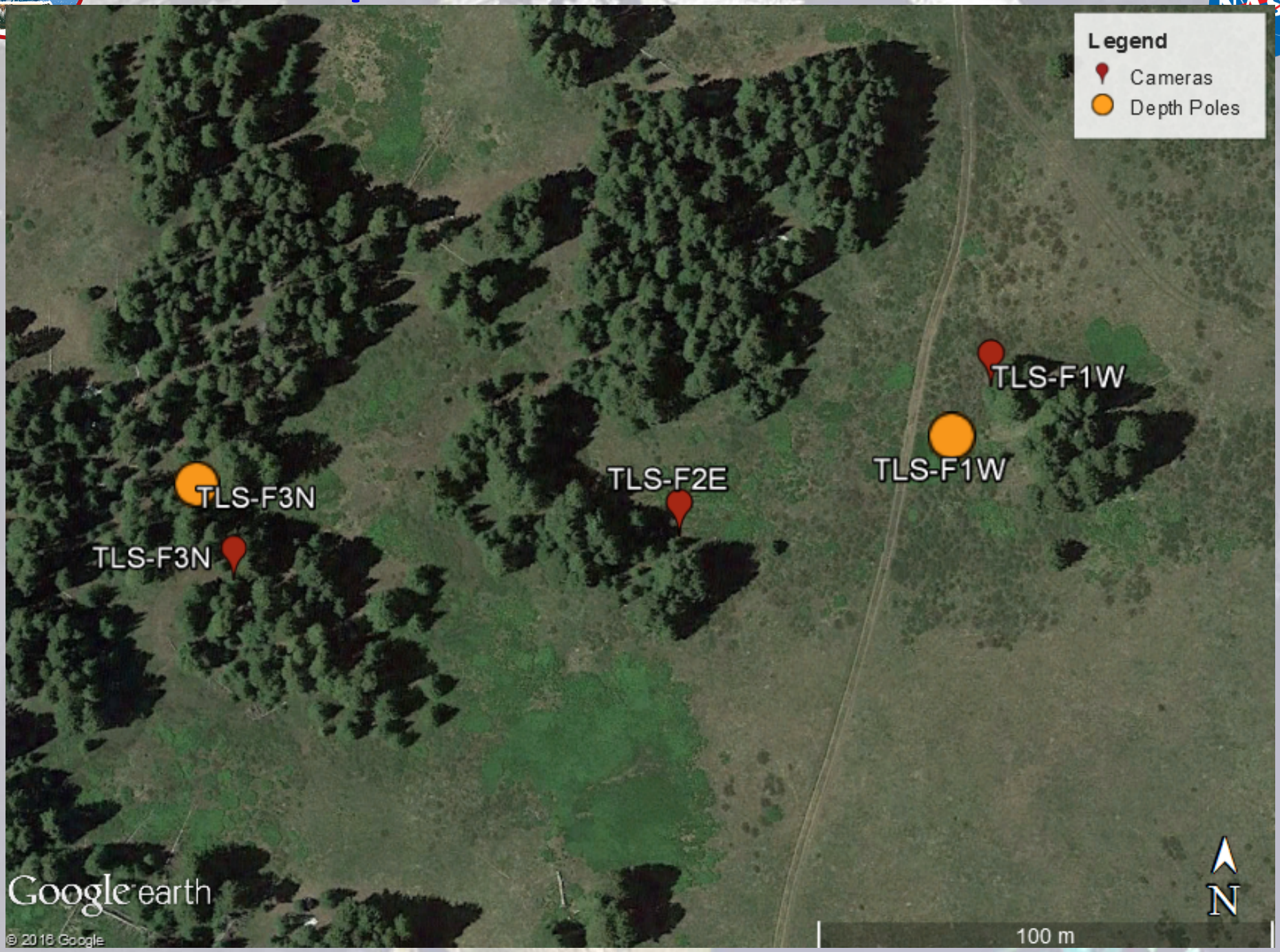
General strategy

- Multiple cameras at same site
- Multiple angles
- One in forest, one in clearing

Grand Mesa Deployment

TLS Sites	A, D, F, J, K, L, N
Other	Jumbo Campground, Ranger Station LSOS

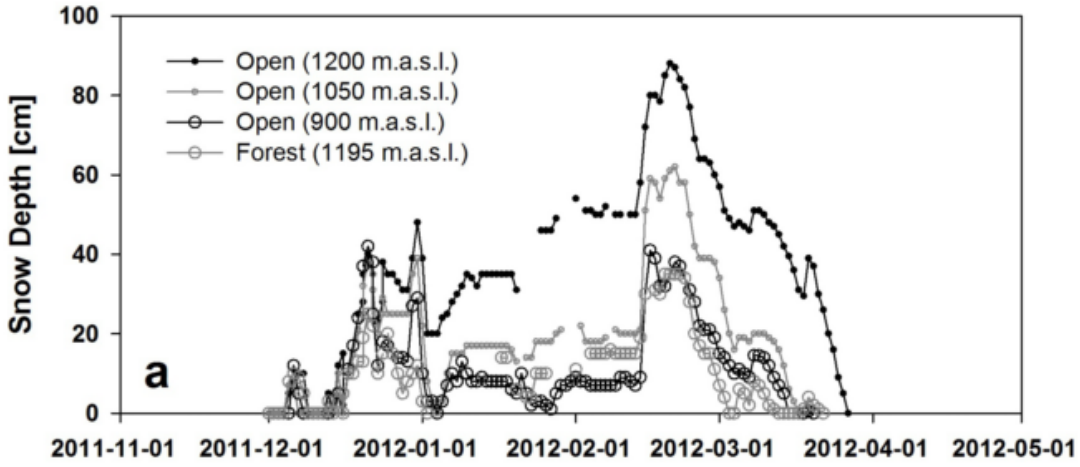
Example: TLS Site F

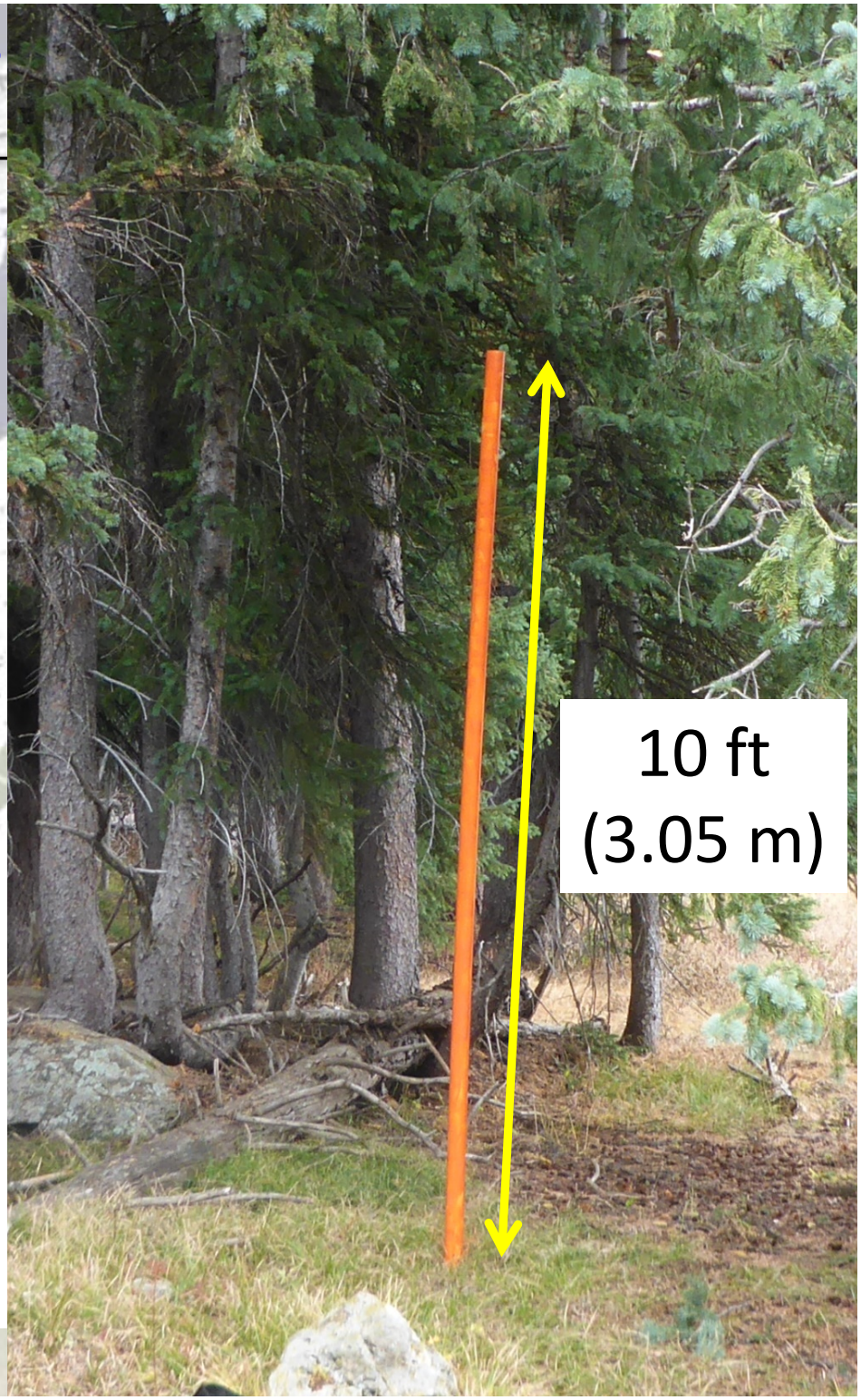


Example: TLS Site F

Snow Depth Sampling

- 10 ft. PVC pole
- Painted orange (image processing)
- 15 locations (GM)
- Example data from Garvelmann et al. (2013):



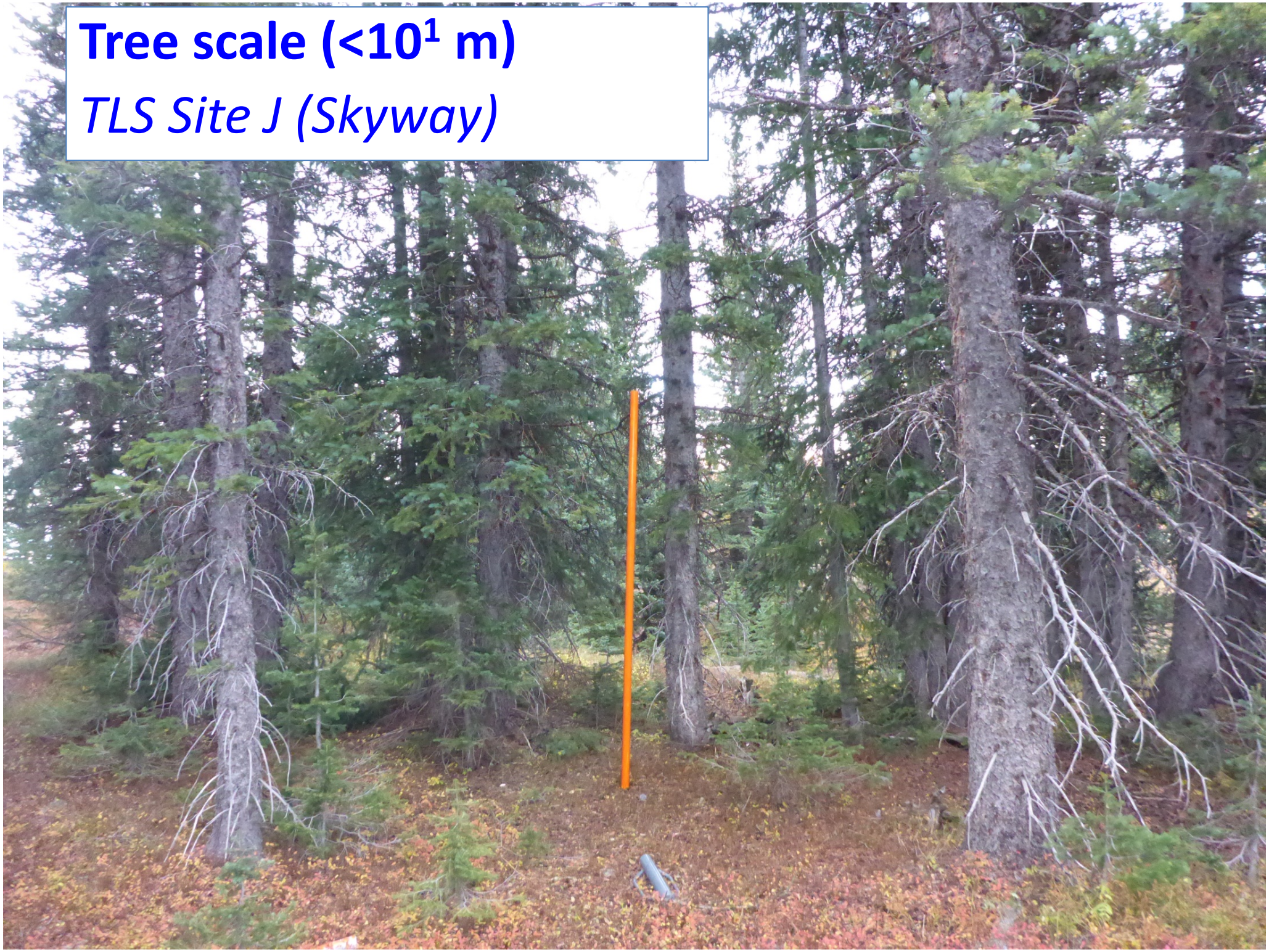


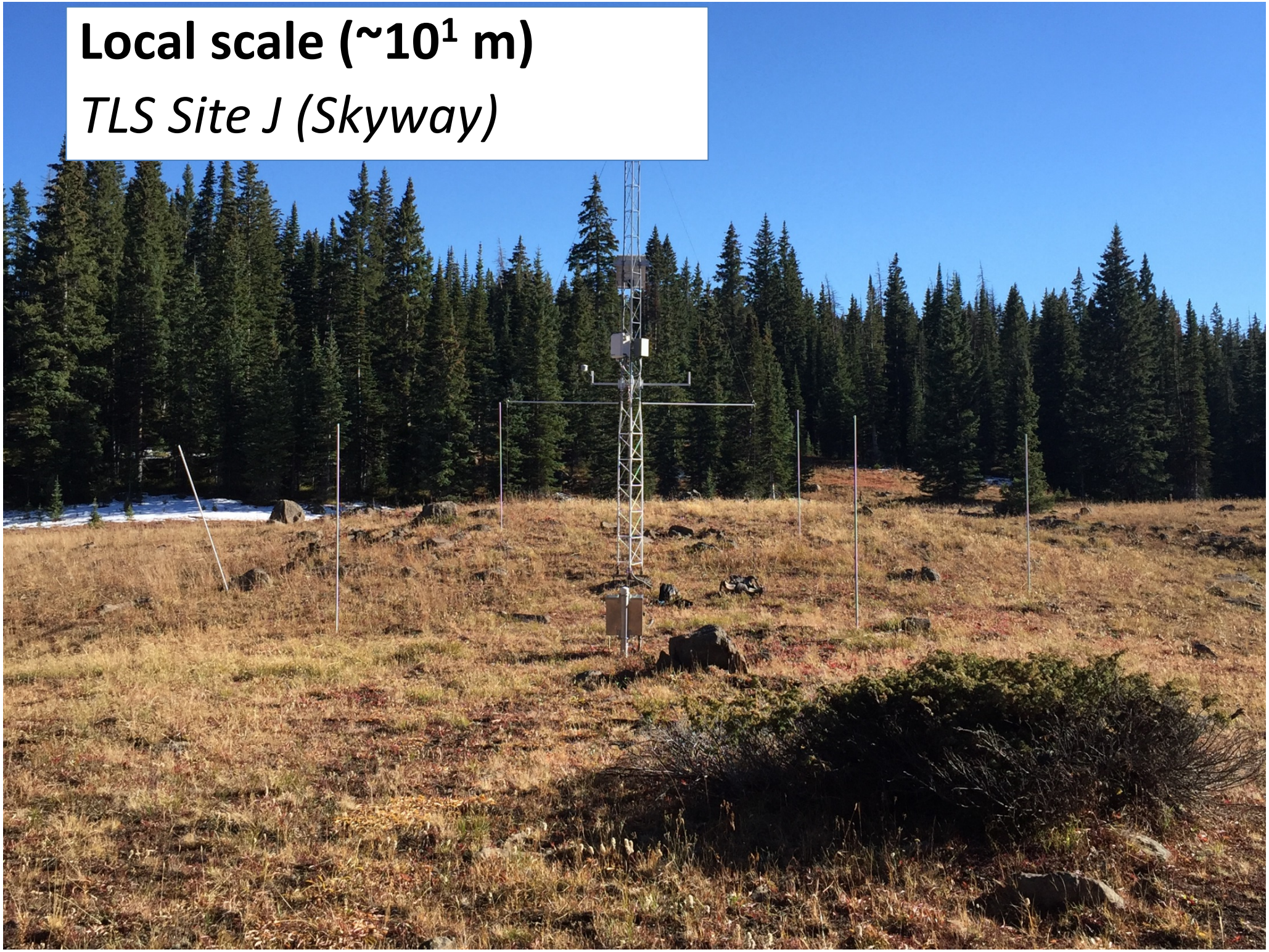
Paired T/RH Monitoring

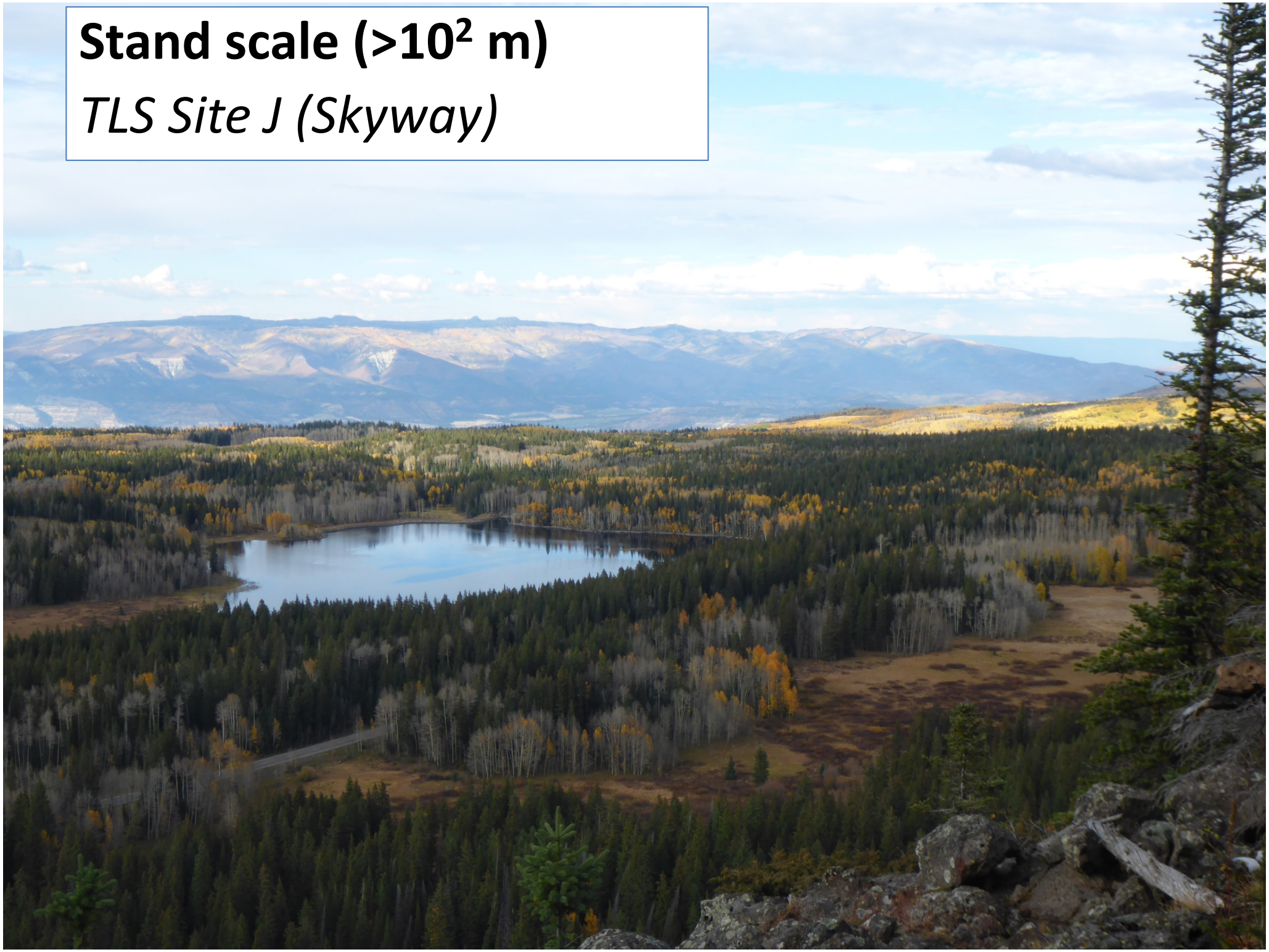
- HOBO T/RH sensor
- Typically >3m
- 10 locations (GM)

Tree scale (<10^1 m)

TLS Site J (Skyway)




Local scale (~10¹ m)
TLS Site J (Skyway)


Stand scale (>10² m)
TLS Site J (Skyway)

Spatial Locations

TLS-K2N

Camera Name
TLS-K2N

Instrument
Time-lapse camera

Study Area
Grand Mesa

Site Type
TLS

Site Description
TLS-K

Latitude
39.0342

- Google Maps Interface (w/ photos, metadata)
- Shapefiles
- Google Earth .kml

Contact me (mark.raleigh@colorado.edu) if interested in these.

Q & A