



NASA SnowEx 2019 Campaign: Feb 1 - June 1, 2019

A multi-sensor snow remote sensing time-series experiment in multiple snow climates

THP16 SnowEx19 Implementation Planning Team:

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SnowEx19 Leadership Team:

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SnowEx19
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Activities

NASA SnowEx
2017-2021

Leverage
infrastructure &
LiDAR
campaigns

Time Series:
L-band InSAR

Snow Climates

Grand Mesa
IOP

Gaps and
Priorities

Goals and
Campaigns

Timeline of
Aircraft
Experiments

Getting involved

SnowEx19 Time Series Site Leads

- Ned Bair, Lakes Basin, CA
- Roger Bales, American River Basin, CA
- Anne Nolin, Sagehen, CA
- Ernesto Trujillo, Reynolds Creek Exp Watershed (CZO), ID
- Jim McNamara and Chago Rodriguez, Boise River Basin, ID
- McKenzie Skiles, Little Cottonwood Canyon, UT
- Ludo Brucker and Chris Hiemstra, Grand Mesa, CO
- Andy Gleason, Senator Beck Basin, CO
- Jeff Deems, East River, CO
- Dan McGrath, Cameron Pass, CO
- Kelly Elder, Fraser Experimental Forest, CO
- Noah Molotch, Niwot Ridge (CZO), CO
- Ryan Webb, Jemez River (CZO), NM

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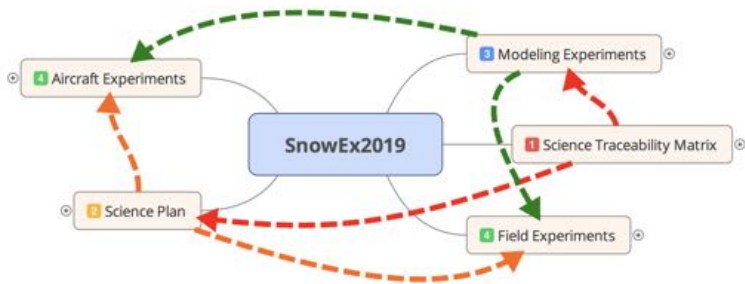
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THP16 SnowEx Planning Activities



Over one sixth of the world's population relies on seasonal snow for water supply, yet monitoring SWE over large regions, especially in the mountains, remains a challenge. NASA SnowEx is a 5-year effort to improve our ability to monitor SWE and albedo from space.

The STM [Deems *et al.*] defined Fundamental Questions and Mission Objectives, which informed the Modeling Experiments [Vuyovich *et al.*] and Science Plan [Durand and Raleigh *et al.*].

The Science Plan and Modeling Experiments are being used to develop the SnowEx19 Aircraft and Field Experiments.

SnowEx 2017: Grand Mesa and Senator Beck Basin, CO

- Large continuous month-long effort
- Focus on training and community building
- Successful intensive ground-based effort, 100+ people
- Very small change in SWE during campaign

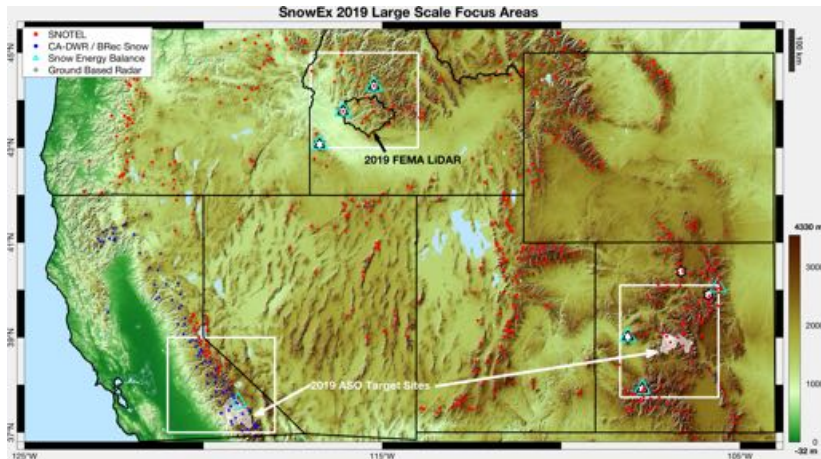
SnowEx 2019: Western U.S.

- More limited funding for airborne and field experiments
- Cover range of snow climates and conditions:
leverage planned campaigns & intensive snow research sites
- Capture accumulation & melt, large Δ SWE:
time series approach, using local experienced field observers
- Focus on low-risk, high TRL instruments for the time series

SnowEx 2020-2021: Alaska

- Tundra and taiga snow, vegetation effects, synergy with ongoing snow studies and ABoVE

Leverage existing infrastructure & airborne LiDAR campaigns



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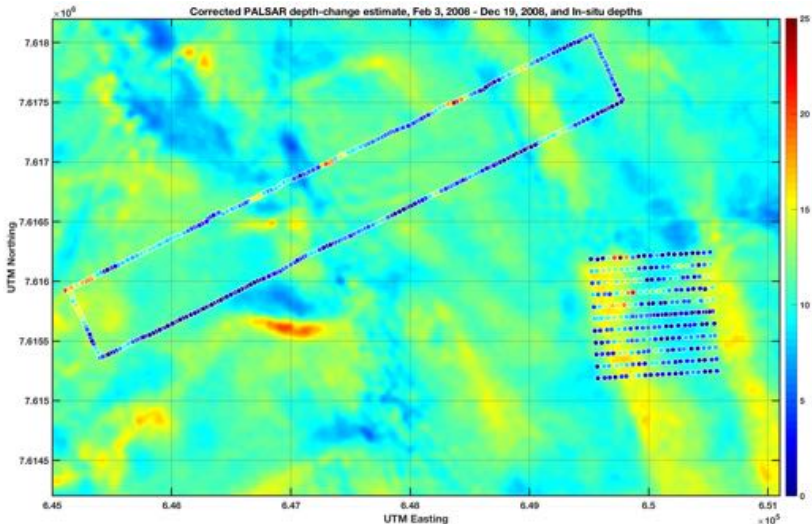
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Areas with existing LiDAR and planned time series during 2019, and good access for field crews. Sites with snow surface energy balance observations, ongoing field experiments, and ground-based radar sites were priorities.

Previous L-band InSAR: North Slope Brooks Range, AK



Based on theoretical inversion [*Gneriussen et al., 2001*] with no tunable parameters, depth change shows reasonable accumulation pattern. In-situ data limited for validation; MagnaProbe from CLPX III (Feb 21, 2008) non-coincident & adjusted based on precip [*Deeb et al., in review*]

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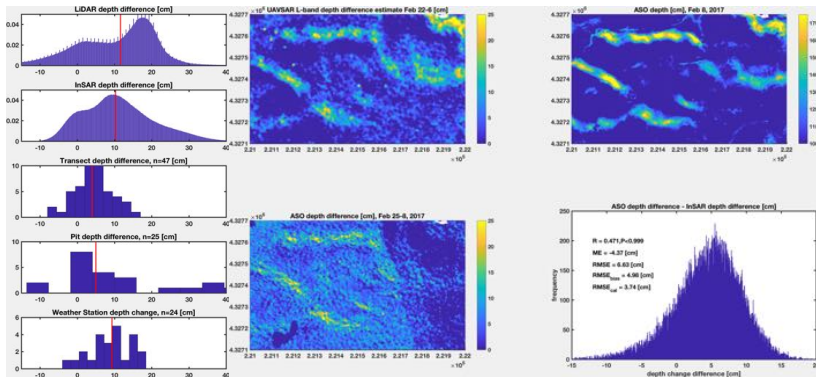
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Previous L-band InSAR: SnowEx17, Grand Mesa



- InSAR depth change - similar pattern to LiDAR depth, Δ depth
- Small depth change SnowEx17
- Time series needed to capture large change in SWE
- Validation needed in a range of snow climates; accumulation & melt
- Observations focused on depth / SWE *change* required

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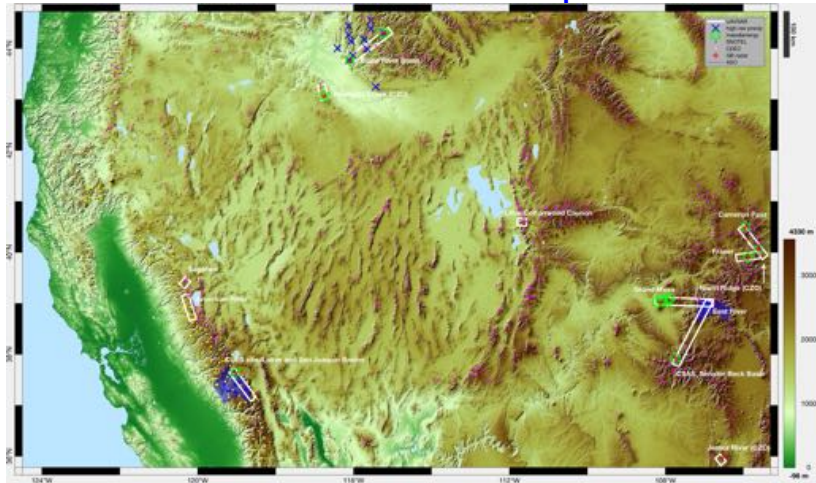
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SnowEx19 Time Series Airborne and Field Experiment



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- UAVSAR (L-band InSAR) biweekly flights over 13 sites
- ASO (LiDAR, Imaging spectrometer) monthly flights over Lakes/San Joaquin, CA and East River, CO
- CRREL Helipod (LiDAR, thermal IR) over Idaho sites
- GLISTIN-A (Ka-band InSAR, 3 flights over Lakes/San Joaquin)

SnowEx19 Grand Mesa Intensive Observation Period, Feb 7-17



- NASA GSFC SWESARR (X-, dual Ku-band radar; X-,K-,Ka-band radiometer)
- UW Thermal IR (3 thermal and 1 optical camera, blackbody, KT-15)
- NASA JPL ASO (LiDAR and Imaging spectrometer)
- UAVSAR (L-band InSAR, additional flights)
- 9 day campaign, with focus on microstructure and surface temperature observations

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SnowEx19 Alignment with THP16 Science Plan

SnowEx19: Addresses the *Gaps*

- Snow climates (Forest, mountain, prairie, maritime)
- Wet snow, accumulation and melt (time series)
- Surface energetics (surface temperature)

SnowEx19: Responds to *Mission Critical* and *Crucial* priorities

- X-band, dual Ku-band SAR (SWESARR)
- L-band InSAR (UAVSAR)
- Ka-band InSAR (GLISTIN-A)
- LiDAR (ASO, CRREL HeliPod)
- Thermal IR (UW, CRREL HeliPod)
- X-, K-, Ka-band Passive microwave (SWESARR)
- Hyperspectral imaging (ASO, CRREL HeliPod)

Modeling/DA priority requires coordination between Modeling, Airborne, and Field Experiments

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SnowEx 2019 Campaigns

Goals for SnowEx 2019 Airborne Experiments

- Quantify accuracy and limitations of L-band InSAR retrievals of change in SWE, in preparation for NISAR
- Test and validate SWE retrieval from Ku-band radar
- Test Ka-band InSAR for snow depth retrieval, quantify bias due to penetration
- Quantify subpixel variability in thermal IR signatures, and effect on coarse resolution spaceborne IR (GOES16)
- Integration of in-situ and airborne data with modeling (THP16 SEUP)

SnowEx 2019 Campaigns

- Time series of L-band InSAR and LiDAR:
leveraging separately funded LiDAR efforts in CA, CO, and ID
- 9-day Intensive Observation Period @ Grand Mesa, CO:
Multi-band radar, passive microwave, thermal IR, L-band InSAR, LiDAR
- Ka-band InSAR, L-band InSAR, LiDAR @ San Joaquin, CA

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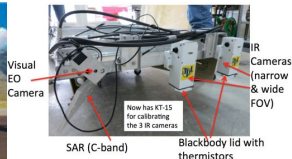
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Timeline of SnowEx19 Aircraft Experiments

SnowEx19



- Green = Lakes and San Joaquin Basins, California
- Orange = Grand Mesa and East River / Gunnison Basins, Colorado
- Brown = Reynolds Creek and Boise River Basin, Idaho
- Blue = Network of 13 sites / flight lines in 5 states

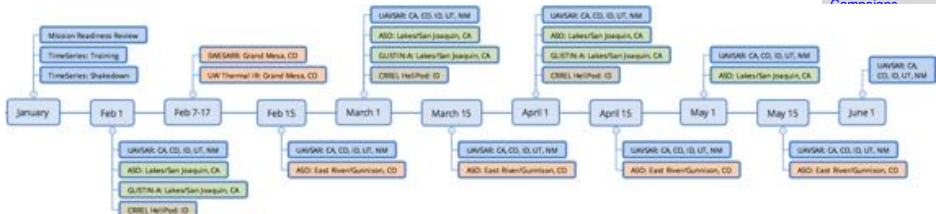
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Want to volunteer / get involved in SnowEx 2019 and beyond?

- Join the International Snow Working Group for Remote sensing (ISWGR)
- Become a SnowEx 2019 Data Early Adopter - field obs will be available online shortly after campaigns
- Participate in monthly telecons during campaign to hear updates and provide feedback
- Modeling / Data assimilation activities in each ISA
- Remote sensing analysis in each ISA
- QC of field / met data
- attend ISWGR SnowSchool
- SnowEx Town Hall, Thursday 12:30, *Marriott Marquis - Independence F-H*

Please email SnowEx19@gmail.com with questions, suggestions, or interest in any of the above.

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Geoscience is a Team Sport



FOR

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Thank you!