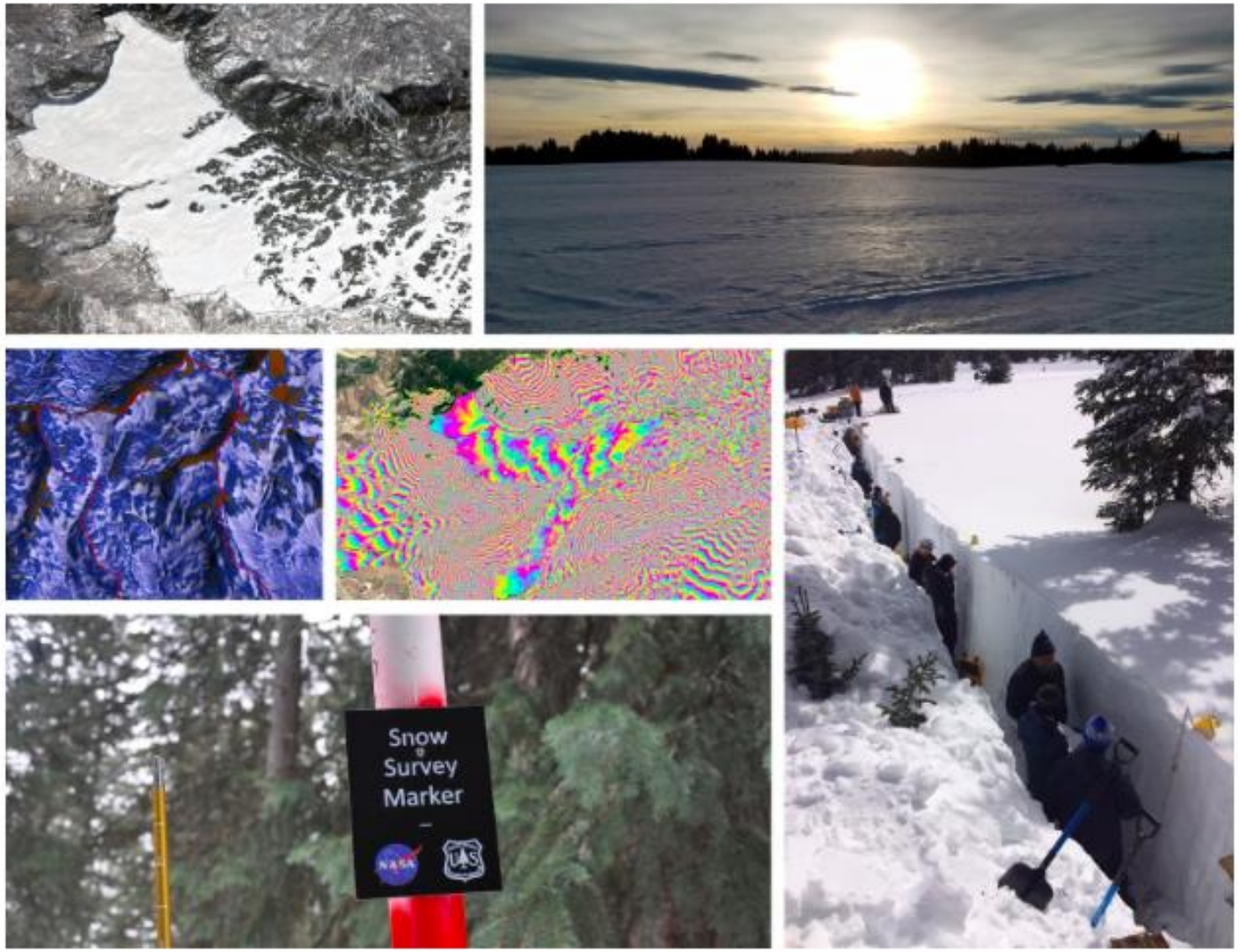
NASA SnowEx Science Plan:

Assessing Approaches for Measuring Water in Earth's Seasonal Snow



Mark Raleigh and Mike Durand

On behalf of the Science Plan Working Group: Charles Gatebe, Ed Kim, Noah Molotch, Thomas H. Painter, Melody Sandells, and Carrie Vuyovich

AGU100 ADVANCING EARTH AND SPACE SCIENCE

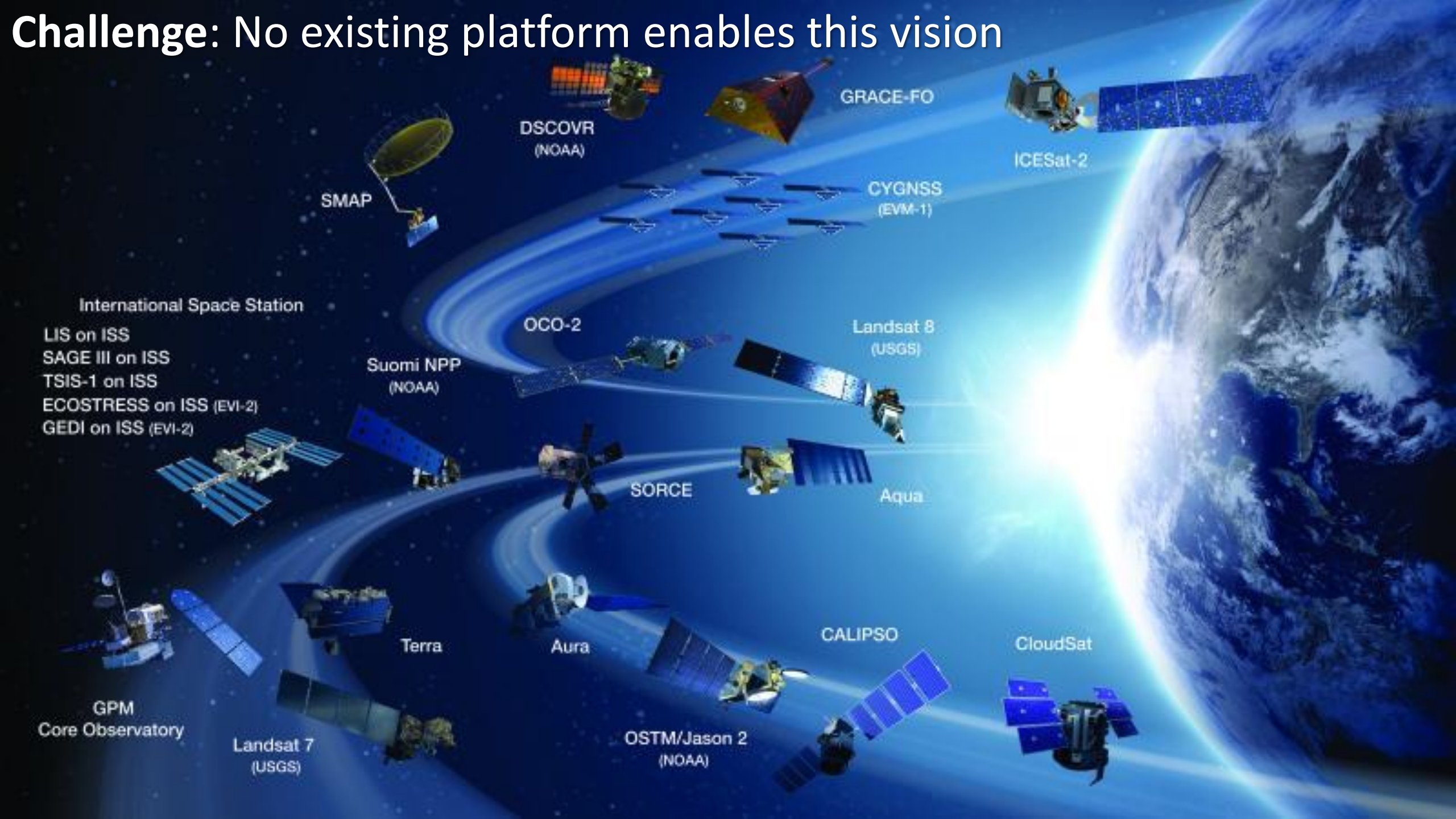
FALL MEETING

Washington, D.C. | 10–14 Dec 2018

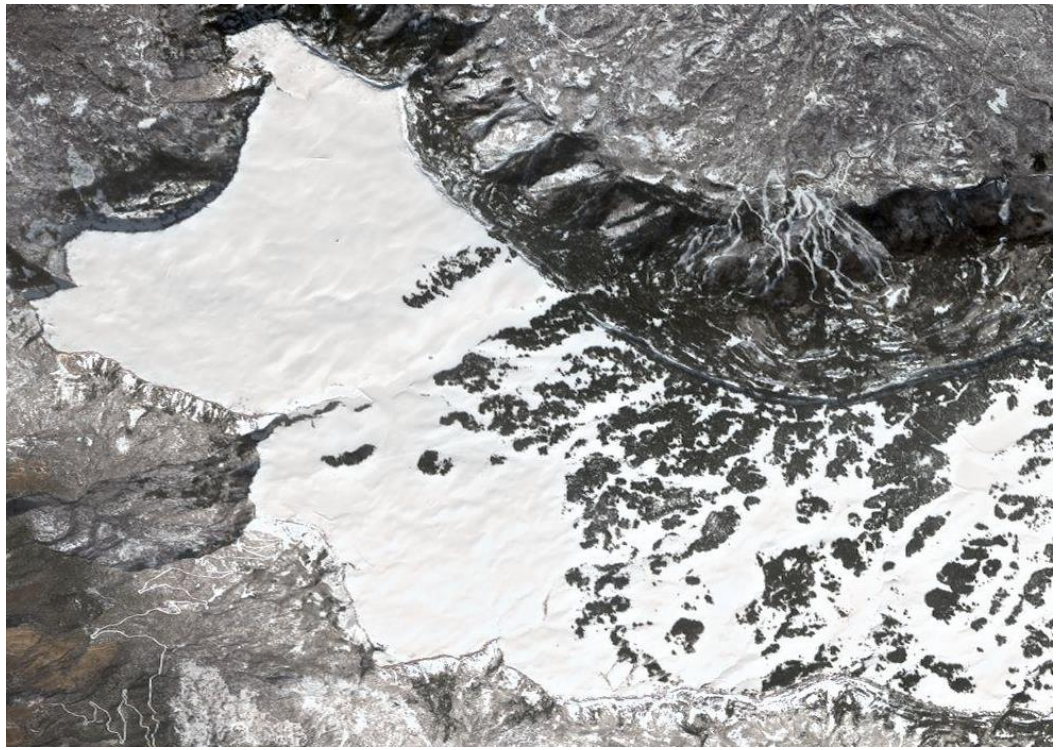
Vision: A comprehensive satellite-based approach for mapping of global snow water equivalent (SWE) across Earth's diverse cold regions

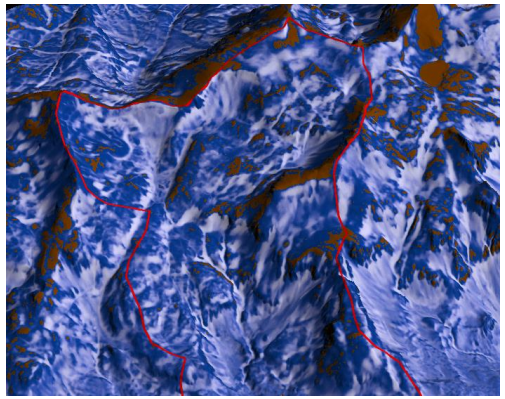
Photo courtesy: Chris Hiemstra

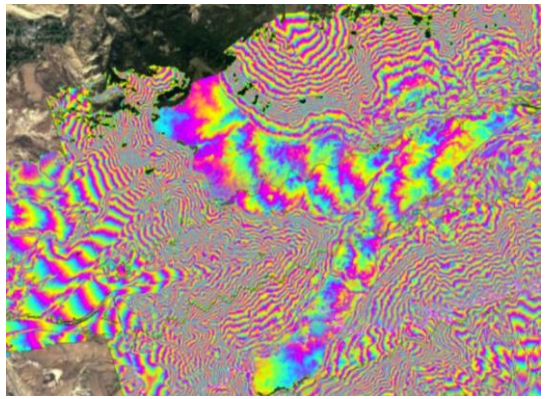
Challenge: No existing platform enables this vision



Opportunity: New measurements and new missions







Above: Worldview Stereo image
Below Left: ASO snow depth
Below Right: Ka-band GLISTIN-A (courtesy Delwyn Moller and the ASO team)

How do we get there?

The optimal approach and combination of sensors/models is unknown for mapping SWE globally.

Need: A community effort to compare and combine emerging and existing remote sensing, modeling, and assimilation to identify optimal strategies for mapping SWE and related snow properties.

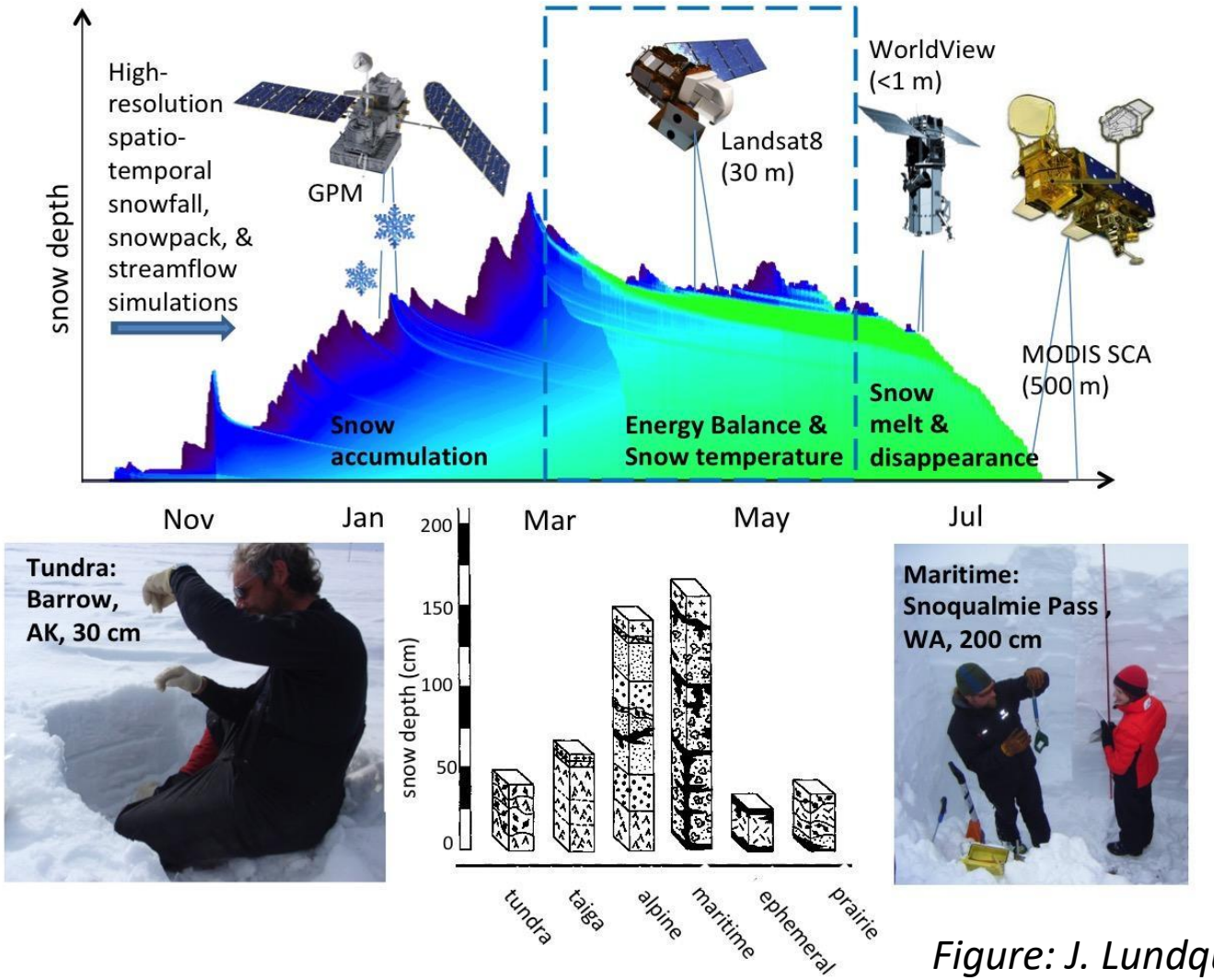


Figure: J. Lundquist

Enter NASA SnowEx

- Five year program funded by NASA THP to address the most important gaps (technology, science) in snow remote sensing

- **Goal**: Lay the groundwork for a future satellite mission (e.g., decadal survey) with capabilities to measure snow globally (with focus on SWE)

- **Approach**: Coordinated airborne and ground field campaigns with a variety of measurement techniques and different environments

SnowEx Science Plan

- **Focus**: Where are there opportunities to solve problems, better understand capabilities/limitations of our measurements, models, algorithms etc., and push things forward?
- **Purpose**: Support decision making for future SnowEx campaigns. Provide guidance to implementation teams
- **Scope**: Set priorities; implementation left to implementation team
- **Format**: Structured around articulating several “gaps”.
- **Audience**: everyone interested in SnowEx activities. Jared Entin, Jack Kaye, iSWGR, THP16, larger scientific community
- **Status:** This is a living document that seeks community input.

Identifying SWE techniques

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SNOWEX NASA

Tables were populated by consulting quad charts informed by community workshops, the literature, and discussions with experts.

Some subjectivity is admittedly present.

Table 1. Summary of snow depth/SWE and snow melt estimation techniques

		Snow Characteristic			Gap Capabilities							Space Potential		
Type	**Snow sensing/ estimation Technique**	**Snow Depth**	**SWE**	**Melt**	**High-Res**	**Wet snow**	**Deep Snow**	**Forests**	**Complex Terrain**	**Shallow Snow**	**Clouds**	**Path to Space**	**Global coverage**	**Mature Algorithm**
SWE via snow depth	Lidar													
	Ka-band InSAR													
	Dual band Ku/Ka													
	Stereo Photogrammetry													
	Wideband Radiometer													
volume scattering	Ku-band SAR													
	Passive Microwave													
signal interferom.	L-Band InSAR													
	Signals of Opportunity													
airborne / ground only	FMCW Radar													
	Gamma													

Green – Demonstrated capability. May not work in all areas, but uncertainty is understood. May still benefit from additional research and algorithm development. TRL > 5?

Yellow – Potential capability identified and validated in multiple studies. Research needed to better quantify uncertainty. TRL 3-5?

Orange – Potential capability identified, but uncertainty not quantified. High risk. TRL 1-2?

Red – No Capability

Identified Gaps

- Forest Snow
- Maritime Snow
- Mountain Snow
- Prairie Snow
- Snow Surface Energetics
- Tundra Snow
- Wet Snow

Images: NASA “Got Snow?” document

Recommended Campaigns

Organize annual campaigns to address one or more gaps:

2017: Forests
2019: Forests, mountains, wet snow ….

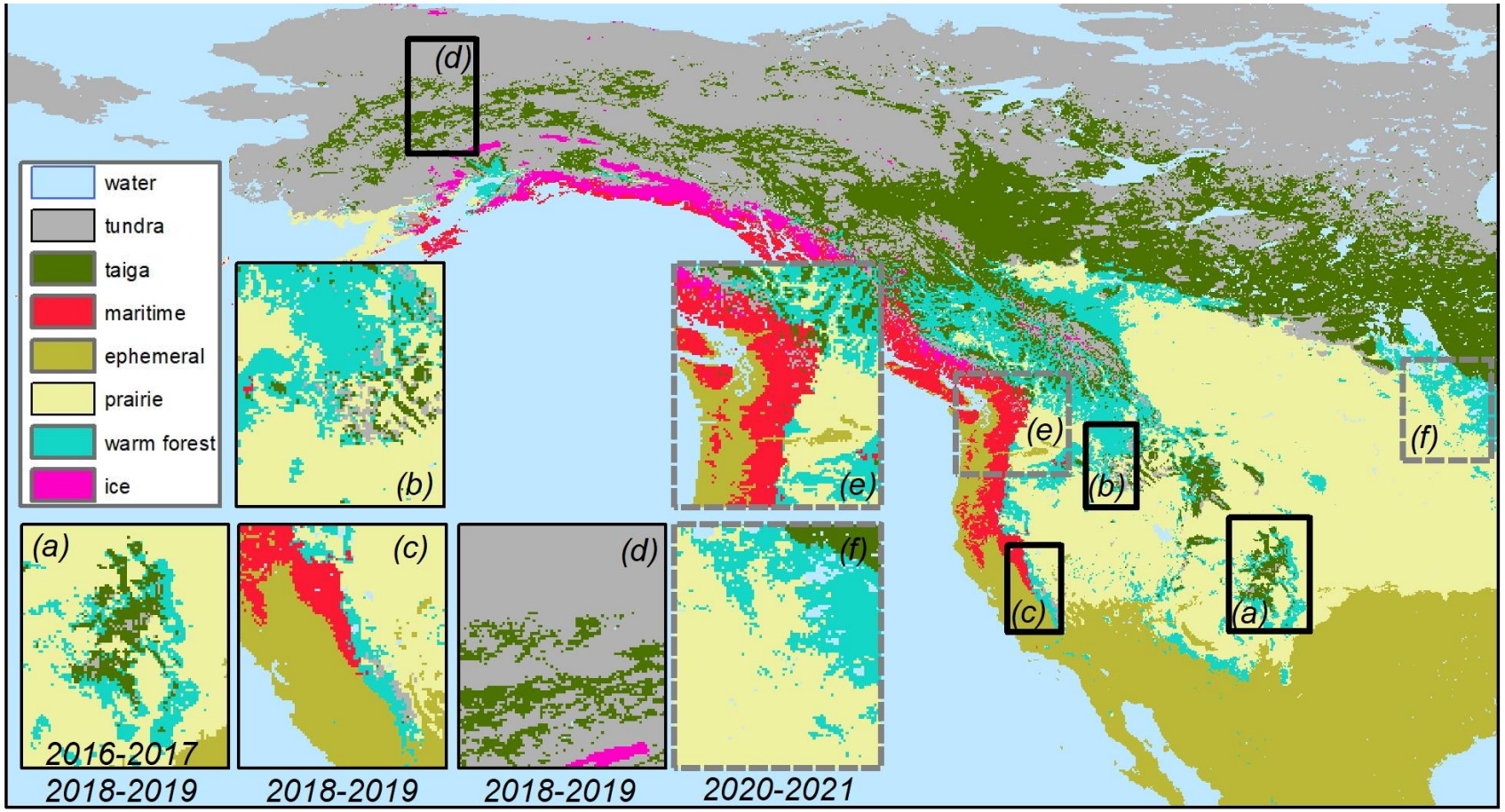
2020*: tundra, boreal
2021*: prairie and/or maritime

**proposed, not yet approved by NASA*

Leverage other community activities, for example:

- ASO in 2017, 2019
- ABoVE in 2020

Notional study domains and snow climates (Liston/Sturm classification)



Status and Next Steps

- Current draft available (v 1.6):
  - https://tinyurl.com/ybshd54d

- In progress:
  - Summary report of the October 2018 community survey
  - Version 1.7 of the science plan - anticipated in January 2019

- Questions/comments? Please contact:
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  - **Mark Raleigh** (mark.raleigh@colorado.edu)