Towards the Next Generation of Land Surface Remote Sensing: A Comparative Analysis of Passive Optical, Passive Microwave, Active Microwave, and LiDAR Retrievals

Presenter & PI: Prof. Bart Forman[1]

Team Members: Sujay Kumar[2], Paul Grogan[3], Rhae Sung Kim[2], Melissa Wrzesien[2], Lizhao Wang[1], Jongmin Park[1], Jawairia Ahmad[1]

[1]University of Maryland, College Park, MD
[2]Stevens Institute of Technology, Hoboken, NJ
[3]NASA Goddard Space Flight Center, Greenbelt, MD

Program: AIST-18

Question: How to optimally view coupled snow-soil moisture-vegetation system from space?

THE PROBLEM: signal from one variable (e.g., vegetation) is noise to another variable (e.g., snow or soil moisture) → **requires cohesive, coordinated framework**

Explore the coupled snow-soil moisture-vegetation system
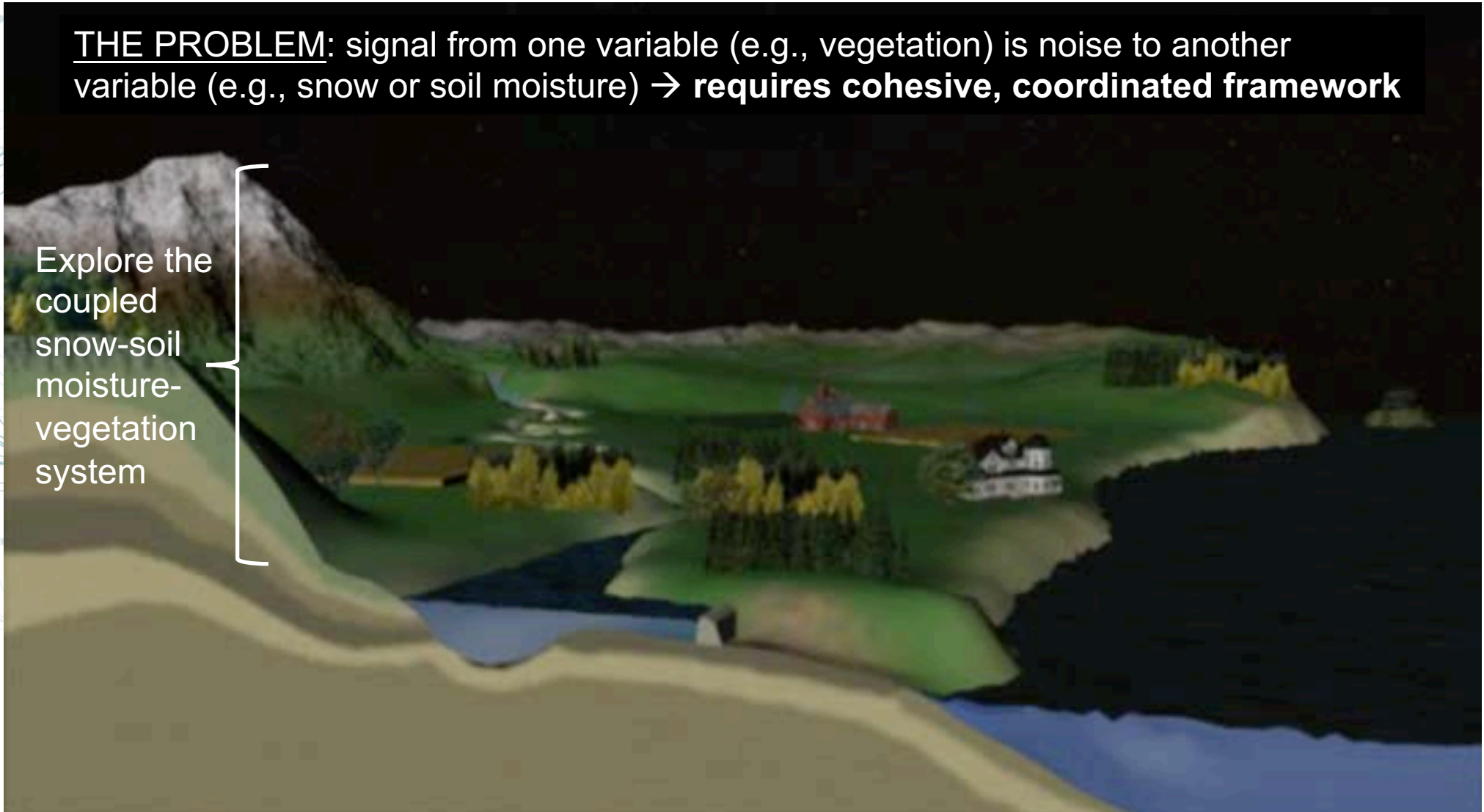
Remote Sensing Questions

- "One size fits all" solution does not exist
  - Requires a **suite of different sensors** with different strengths / weaknesses
  - **LiDAR, SAR, PMW radiometry, and VIS/NIR** imagery
- How best to **coordinate suite of sensors**?
- Explore **trade-off** between engineering and science
  - Sensor **type**?
  - Configuration of **orbit**? **Altitude**? **Inclination** angle?
  - Sensor **field-of-view** (FOV) and **swath width**?
  - Sensor **error characteristics**?
  - **Single** sensor? **Multi-sensor** constellation?
  - Associated **costs and risks**?
- How do we get the most **scientific bang** for our buck?

Observing System Simulation Experiment (OSSE)
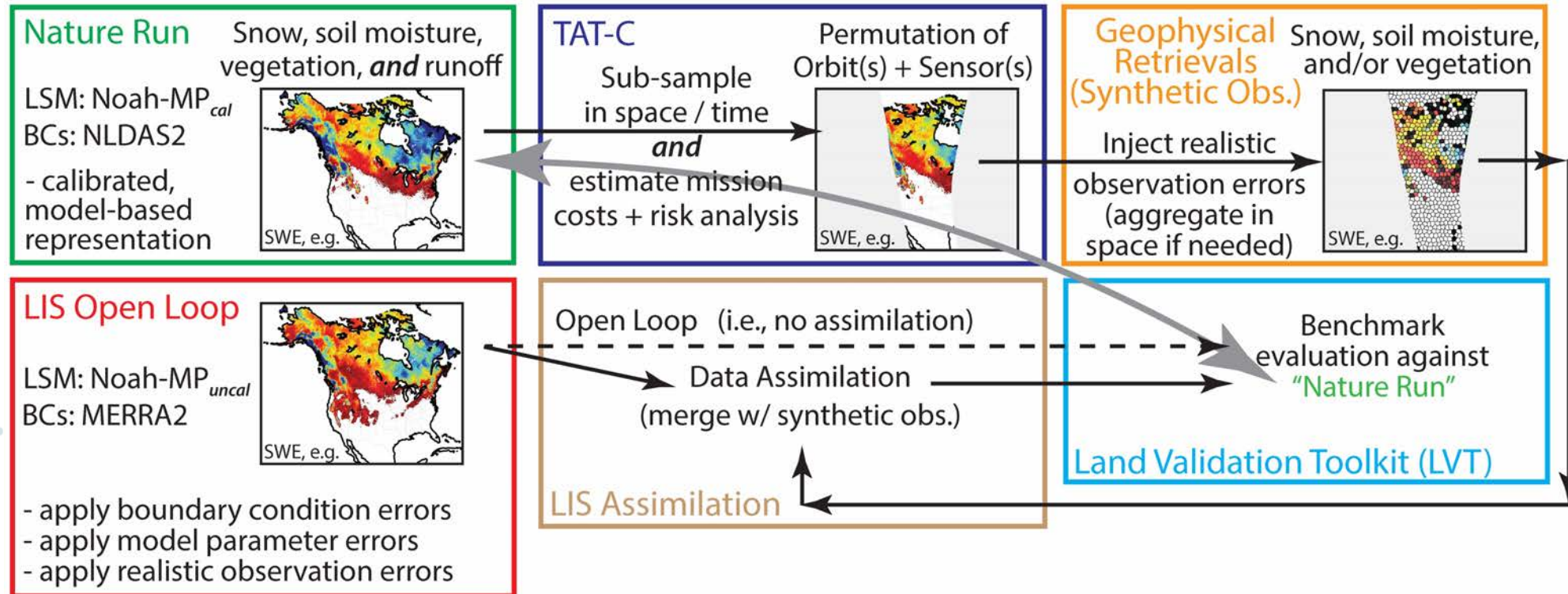
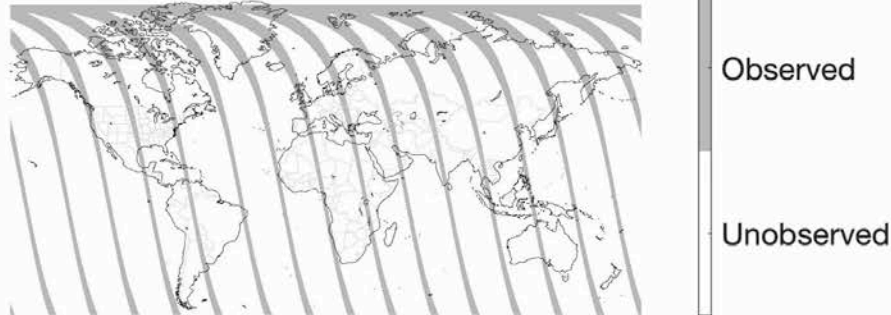# Space-time subsampler for LiDAR, SAR, and PMW
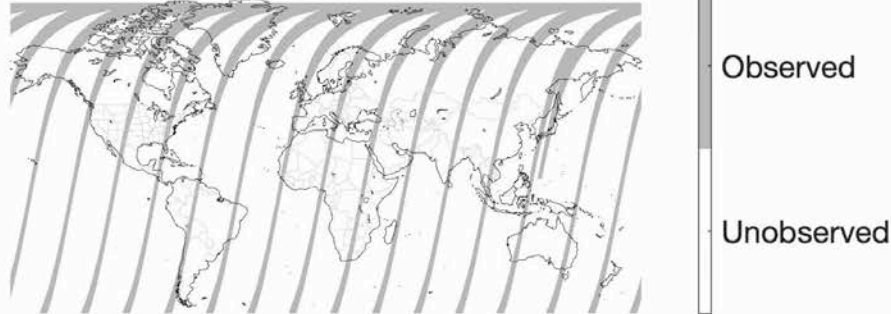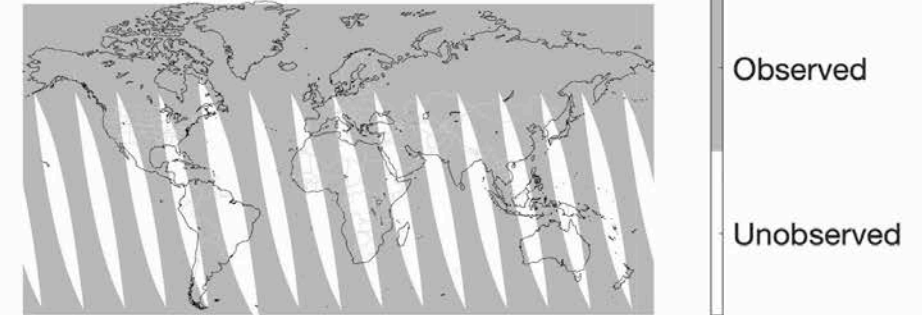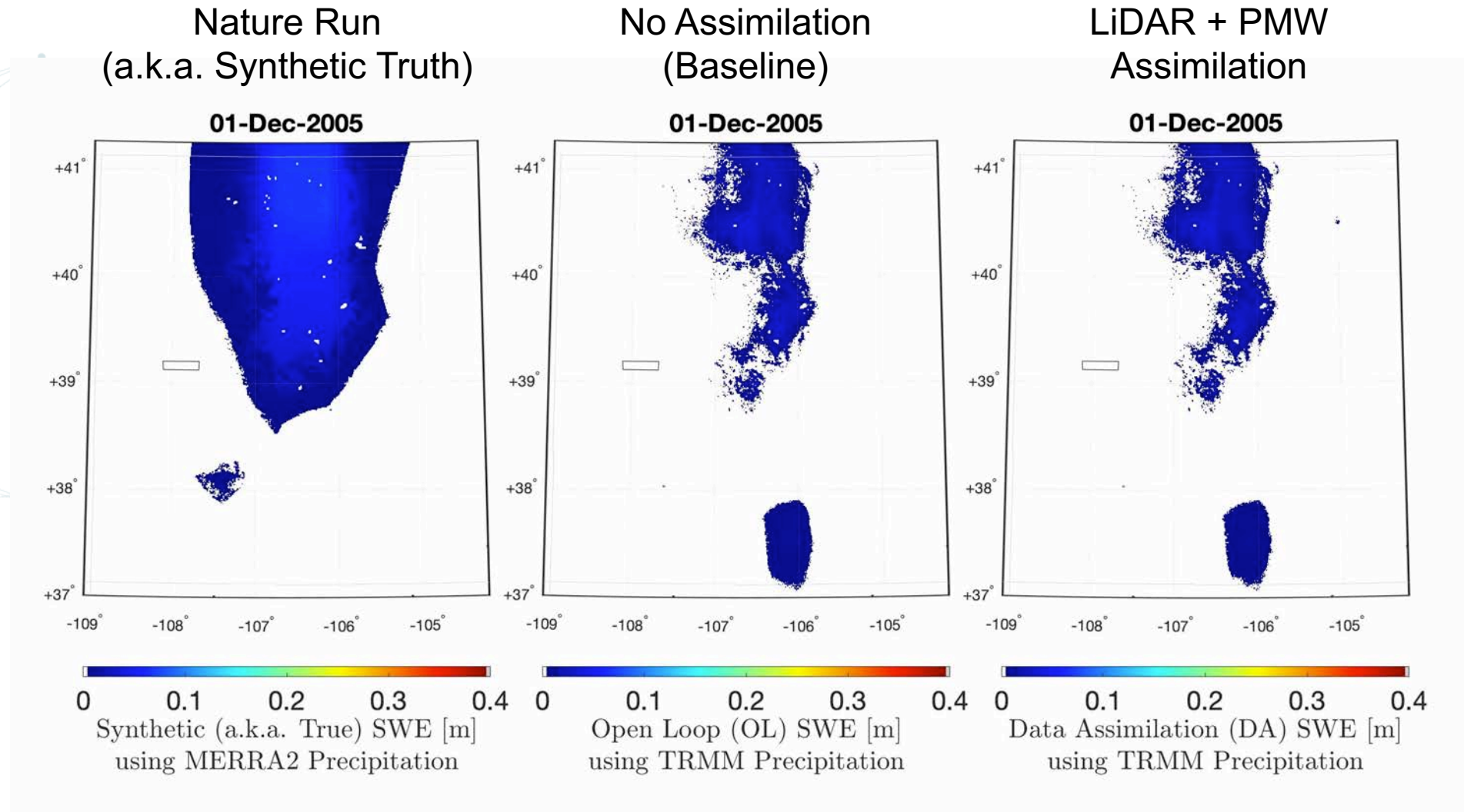
Suite of Synthetic Retrievals to Mix and Match
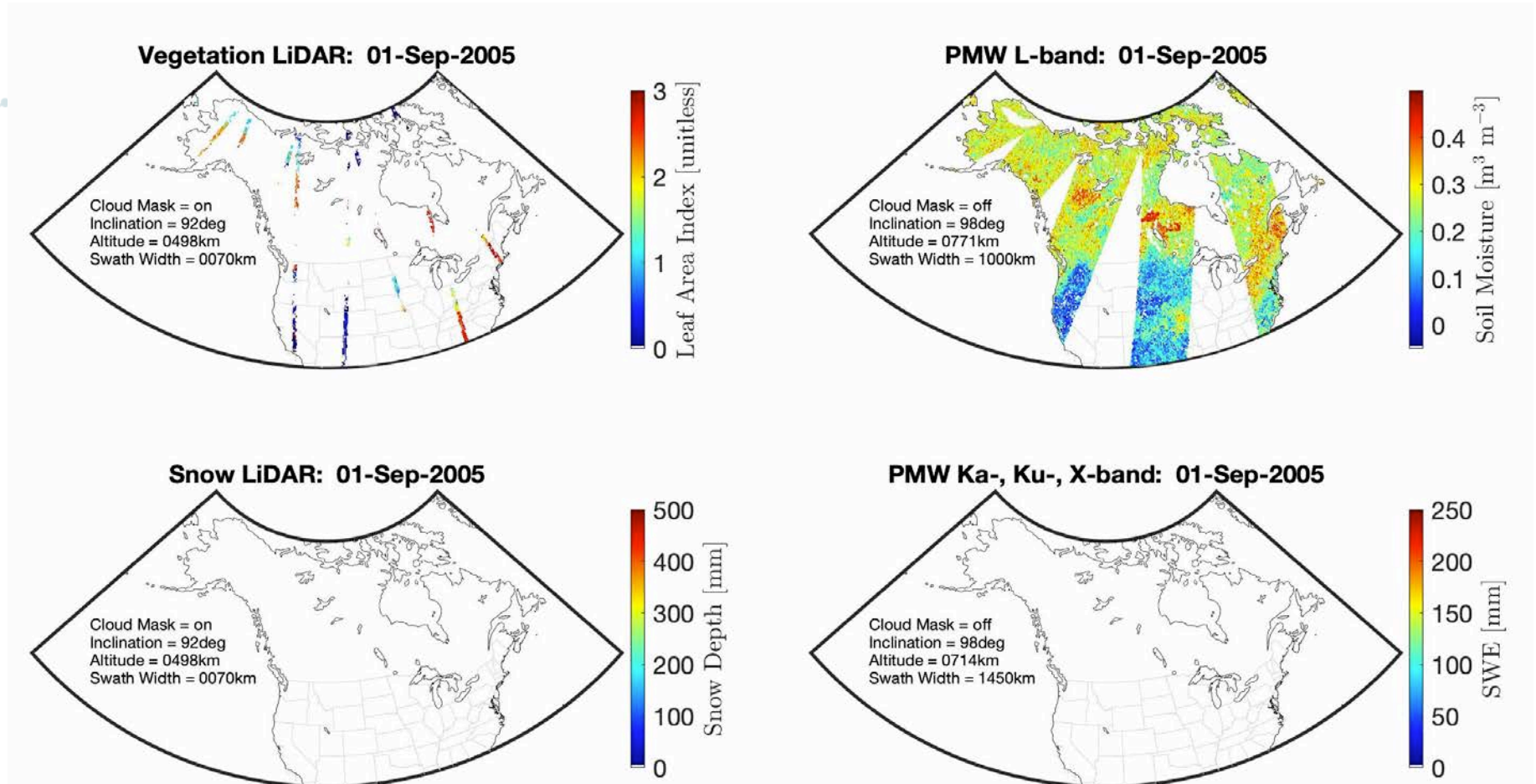
NOTE: incorporates realistic **cloud mask** (LiDAR) and ***frozen soil mask*** (PMW L-band)

Example of LiDAR+PMW Experiment for Snow

Nature Run (a.k.a. Synthetic Truth) — Synthetic (a.k.a. True) SWE [m] using MERRA2 Precipitation

No Assimilation (Baseline) — Open Loop (OL) SWE [m] using TRMM Precipitation

LiDAR + PMW Assimilation — Data Assimilation (DA) SWE [m] using TRMM Precipitation

Conclusions and Next Steps

- OSSE provides **systematic and cohesive framework** to assess an **optimal strategy** for remote sensing of coupled snow-soil moisture-vegetation system

- On-going **data assimilation (DA) experiments**
  - Marginal gain via **single-sensor** experiments
  - Complementary gain via **multi-sensor** experiments

- **Cost and risk** estimates

- Added utility from **adaptive viewing** relative to static viewing (not discussed in this talk)

- Thank you to **NASA AIST** program for financial support and **MARCC** for supercomputing resources