Preparing NASA for future Snow Missions:
## Integrating the Spatially explicit SnowModel in LIS

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What is missing in LIS now?

- LIS snow is needed for mission planning and model-data fusion

- The representation of snow in LIS now is one dimensional

- Real snow is extremely heterogenous

- Variability comes from preferential deposition / redistribution

- Occurs on scales of 10-100 m, but has impacts over 10-100 km

- Using LIS as a planning tool for future snow missions thus likely undervalues high spatial resolution and overvalues methods that work well for shallow snowpacks.


Topographic drift accumulations are common in areas where wind, snow, and topography interact.
Matthew Sturm photo

Snow Depth [m]
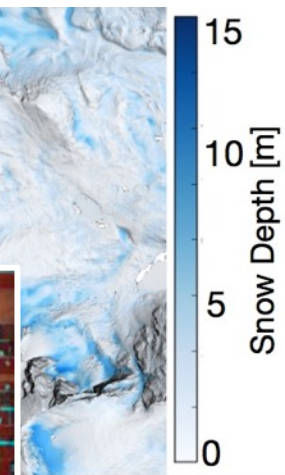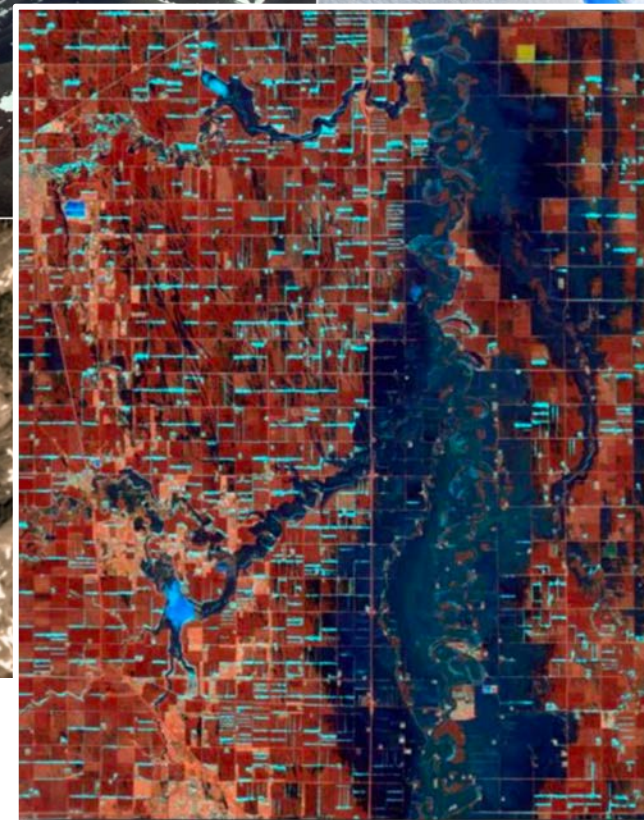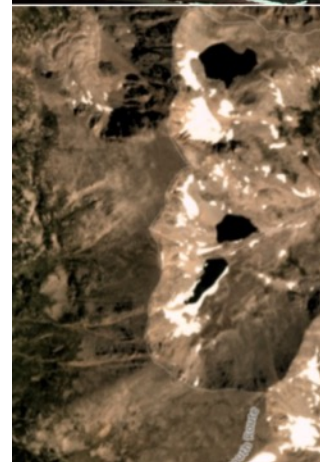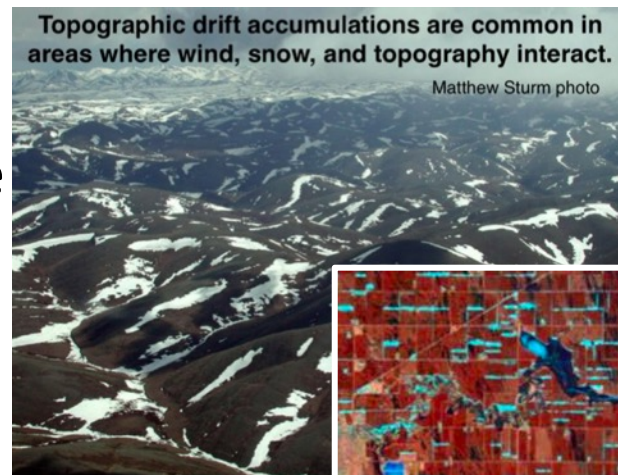
(Chris Hiemstra photo)

Improve LIS Snow modeling capabilities

- Couple SnowModel into LIS
  - Snow redistribution capabilities
  - MicroMet: terrain influenced wind, radiation, temperature,…
  - SnowAssim: SnowModel DA

- Develop test suite

- Provide documentation

- Parallelize SnowModel in LIS

- Couple SnowModel to Noah-MP (or other LSM) in LIS

- Run continental domain Snow OSSE with LIS-SnowModel

Standard LSM Snow

…with redistribution
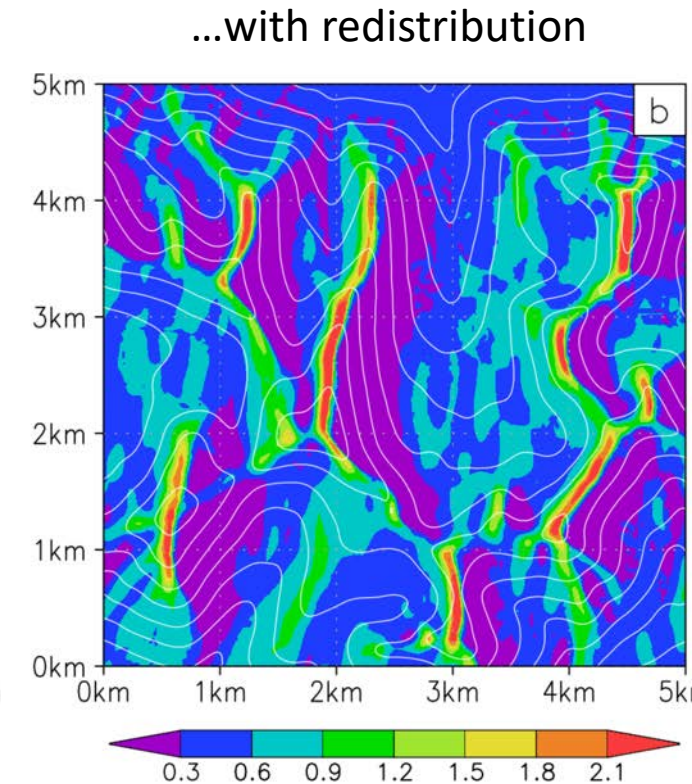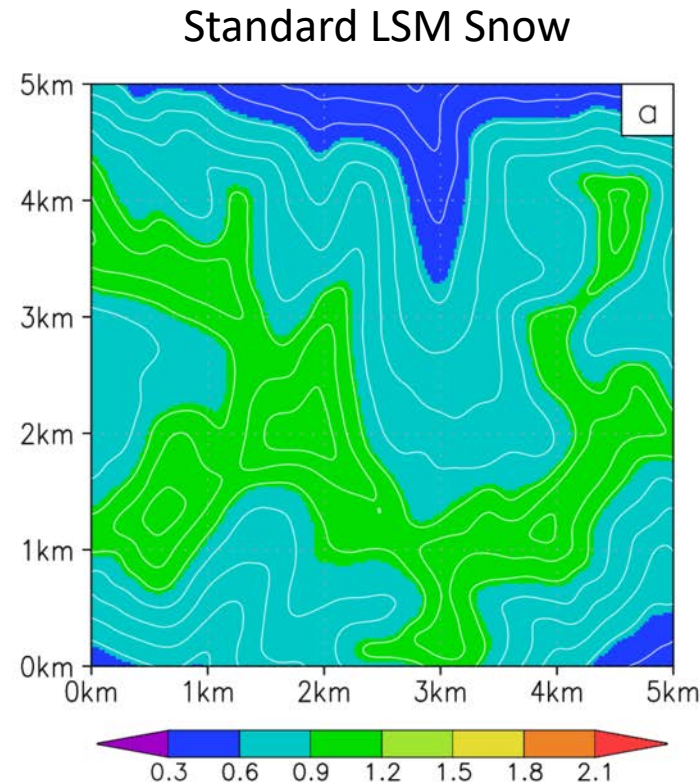
Land Information System (LIS)

- Study **land surface processes** and land-atmosphere interactions
- Integrates satellite- and ground-based **observational data** products with land surface **modeling techniques**

This isn't what LIS Snow looks like!
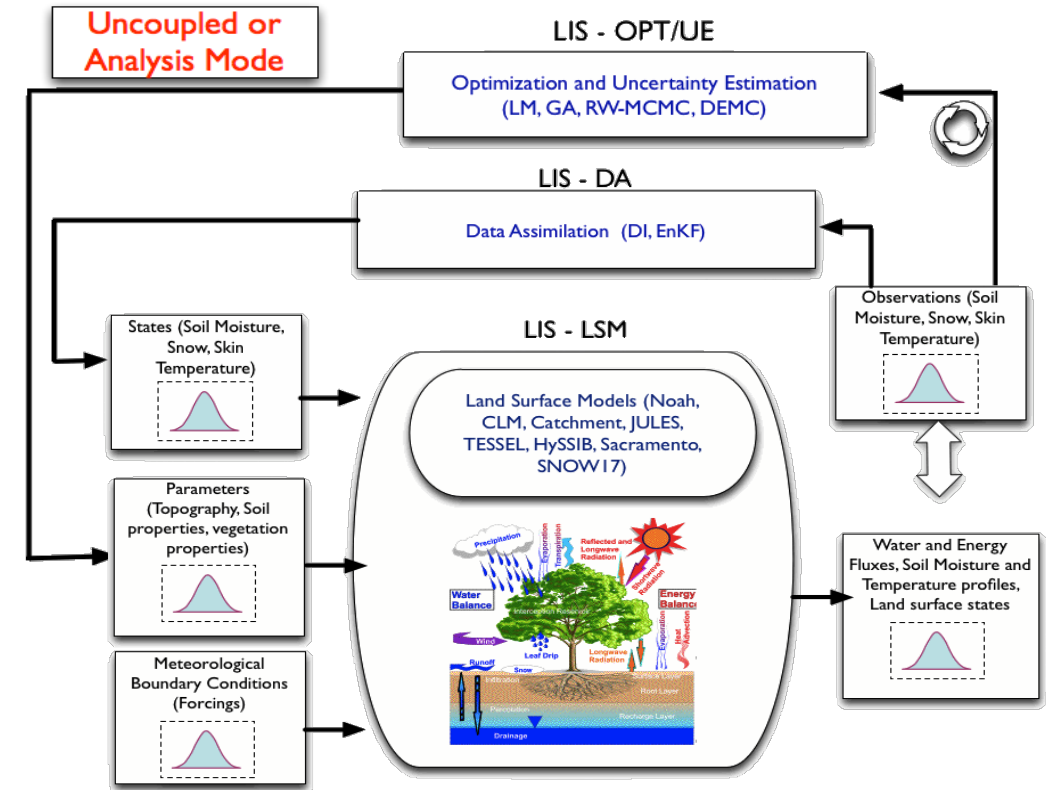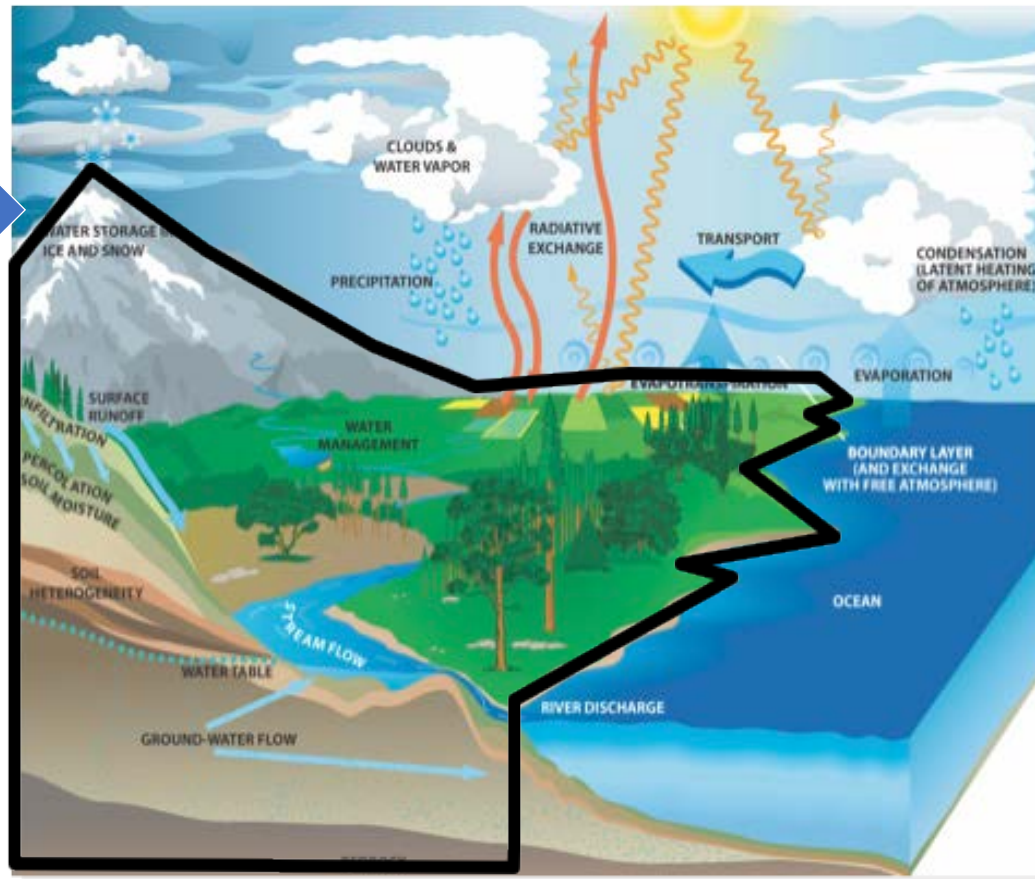
SnowModel

- Detailed snow physics model, includes relevant meteorology

- Used for cryosphere, ecology, hydrology, avalanche studies

- Not parallelized not applicable for continental scales at high resolution

- Not linked to LIS and thus many NASA activities
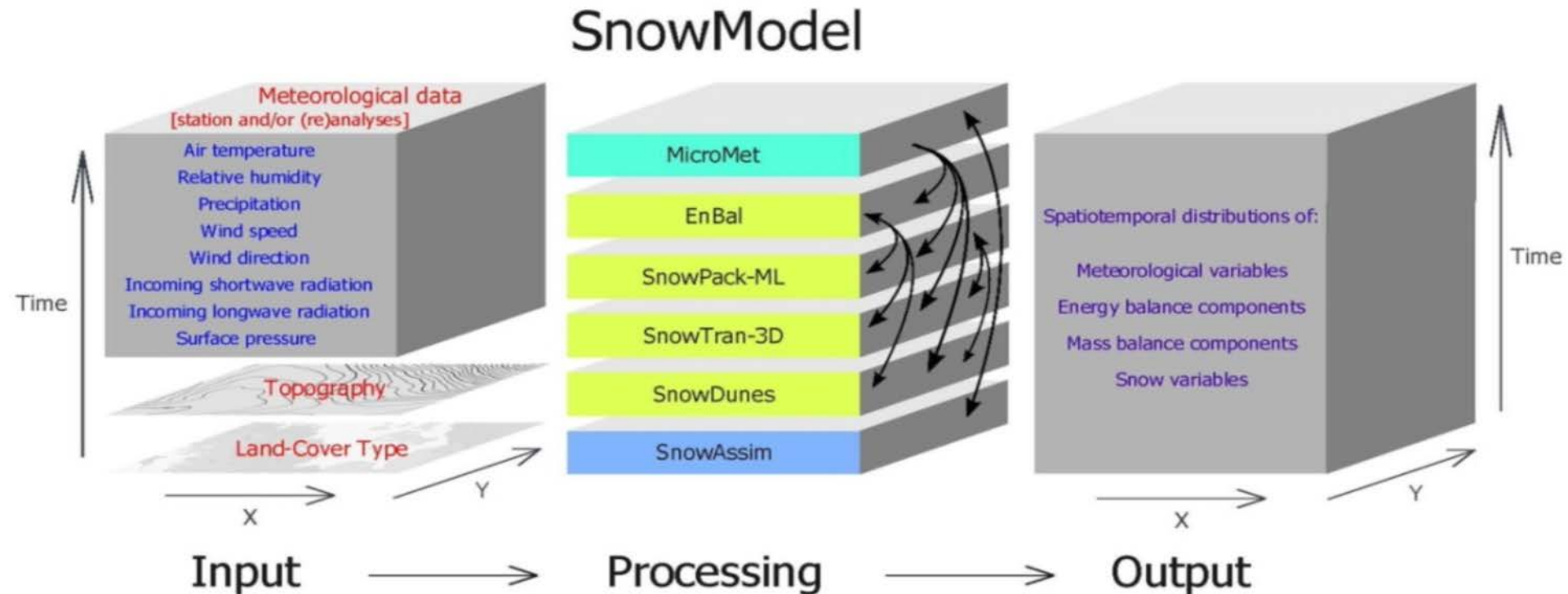
Project Relation to NOS Concept

- Improved planning: better quantify tradeoffs
  - spatial resolution
  - repeat time
  - sensor type
  - and combinations there of…

- Science and forecast:
  - LIS-SnowModel integration to NLDAS, drought monitor, etc.
  - NoahMP coupling links to NOAA's National Water Model
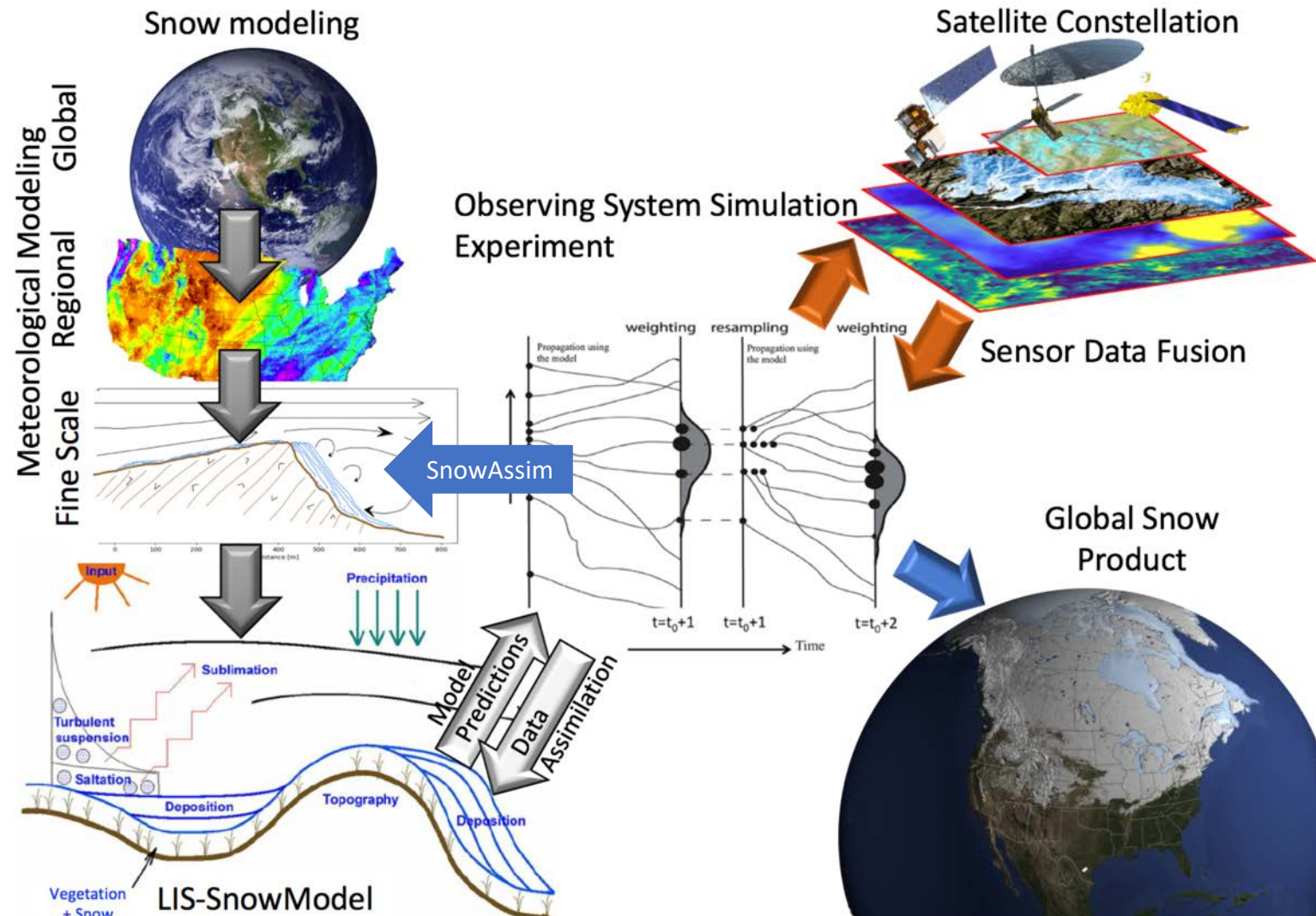
Mission Planning and Model integration

- Provides more realistic scenarios for OSSE
  - Better represent spatial variability
  - Better portray value of e.g. high resolution visible SCA
  - Understand value of lower resolution microwave or SAR technologies
- Future snow missions will likely include multiple sensors and need a snowmodel for DA
- Multi-sensor, model data fusion will be critical
- Potential for connection to operational hydrologic forecasting
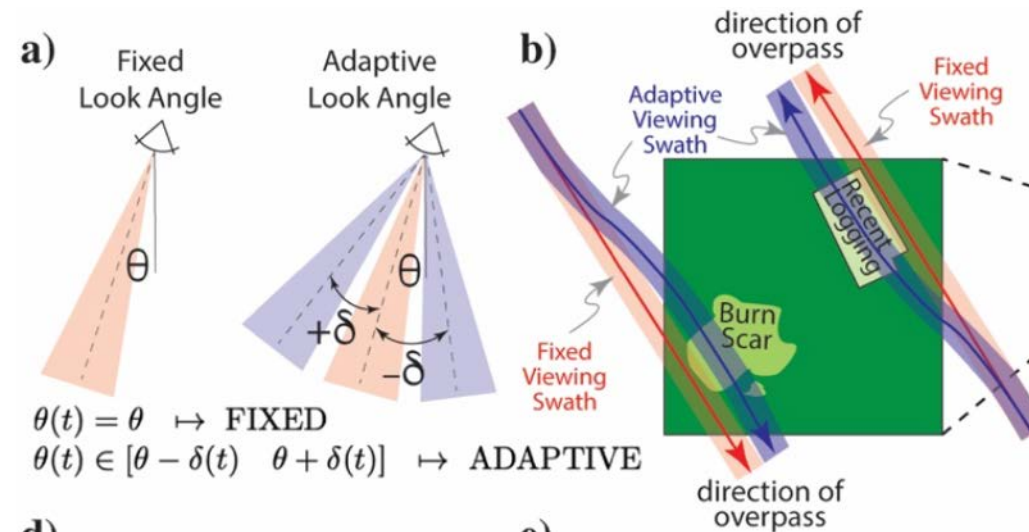
Scientific Relevance Beyond the Mission

- Importance beyond mission activities

- Variability and coverage affect albedo changes
  - Snow albedo feedback and climate

- Coverage affects rain-on-snow flooding

- Distribution affects timing of runoff

- Changes in distribution with climate change may have a greater impact on water resources than enhanced melt rates do.