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Observatior Types

Objectives

OSSE

TAT-C Hyperplanes Eulerian Grid Single Platform Constellation Trade-off Space

Machine Learning Emulators Variability Experiments

Conclusions

Towards the Development of a Global, Satellite-based, Terrestrial Snow Mission Planning Tool

Co-authors: Sujay Kumar<sup>1</sup>, Jacqueline Le Moigne<sup>2</sup>, and Sreeja Nag<sup>2,3</sup>

### Bart Forman

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June 7<sup>th</sup>, 2017



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- What observational records are needed (in space and time) to maximize terrestrial snow experimental utility?
- How might observations be coordinated (in space and time) to maximize this utility?
- What is the additional utility associated with an additional observation?
- ④ How can future mission costs be minimized while ensuring Science requirements are fulfilled?



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## **Observing System Simulation Experiment**







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## **TAT-C** Orbital Simulator

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Eulerian Grid

#### Experiments



# "Comb" Viewing $\mapsto$ Single Platform

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Single Platform



## "Comb" Viewing $\mapsto$ Constellation

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## Trade-off Space: Coverage vs. Resolution

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- Explore trade-off between engineering and science
  - Field-of-View (FOV)?
  - Platform altitude?
  - Repeat cycle?
  - Single platform vs. constellation?
  - Orbital configuration(s)?
- How do we get the most scientific bang for our buck?



## Machine Learning "Emulators"

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Physically-based Land Surface Model(s)



Xue and Forman, 2015 Remote Sensing of Environ.

Observation Operator (Forman et al., 2013; Forman and Reichle, 2014; Forman and Xue, 2016)

### brightness temperature 36 GHz, V-pol 36 GHz, H-pol 18 GHz, V-pol 18 GHz, H-pol 10 GHz, V-pol 10 GHz, H-pol

Multi-frequency, Multi-polarization Training Targets



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Physically-based Land Surface Model(s)



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### spectral difference 18V - 36V 18H - 36H 10V - 36V 10H - 36H

Multi-frequency, Multi-polarization Training Targets



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## **Spatiotemporal Variability**



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## **Spatiotemporal Variability**



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### **Relevancy Scenarios**

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Experiments

- Scenario 1: Benchmark Analysis
  - Passive MW Assimilation only
- Scenario 2: Comparative Analysis
  - Passive MW vs. Active MW vs. LIDAR
- Scenario 3: Multi-sensor Analysis
  - single-sensor platform
  - multi-sensor platform
  - constellation of sensors



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- Global snow mission planning will require evidence of achievable science via OSSE
- Land Information System (LIS) provides "nature run" plus assimilation framework
- TAT-C provides spatiotemporal sub-sampling of observations, including cost estimates and risk assessments
- Machine learning maps model state(s) into observation space (i.e.,  $T_b$  and  $\sigma_0$ )
  - Enables integration of  $T_b$ ,  $\sigma_0$ , and  $\delta h$  in geophysical realm (i.e., SWE and snow depth)
  - Multiple frequencies/polarizations/observations allow for flexibility and modularity in DA framework
- Snow OSSE is on-going  $\longrightarrow$  open to suggestions!



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# Thank You. Questions and/or Comments?

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