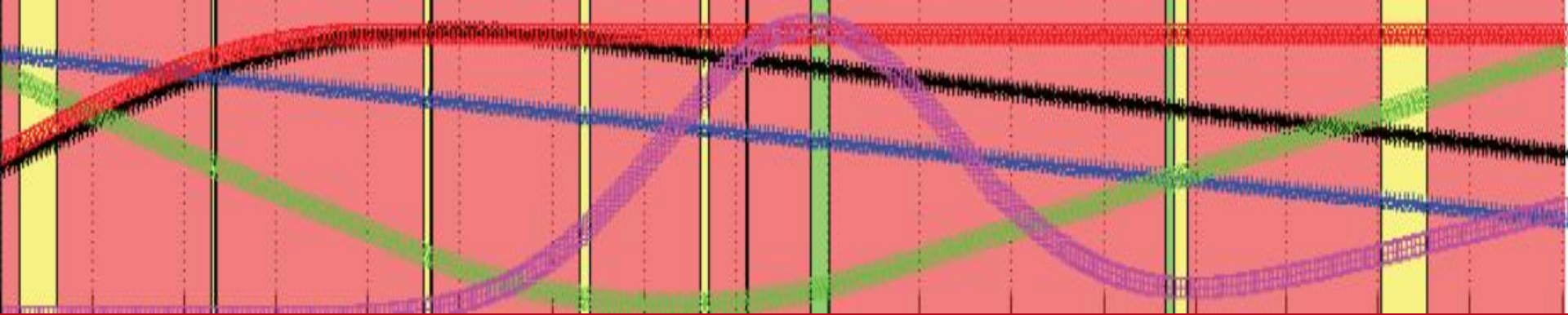




Facilitating Novel Modalities for Spectrum Sharing between Earth-Observing Microwave Radiometers and Commercial Users

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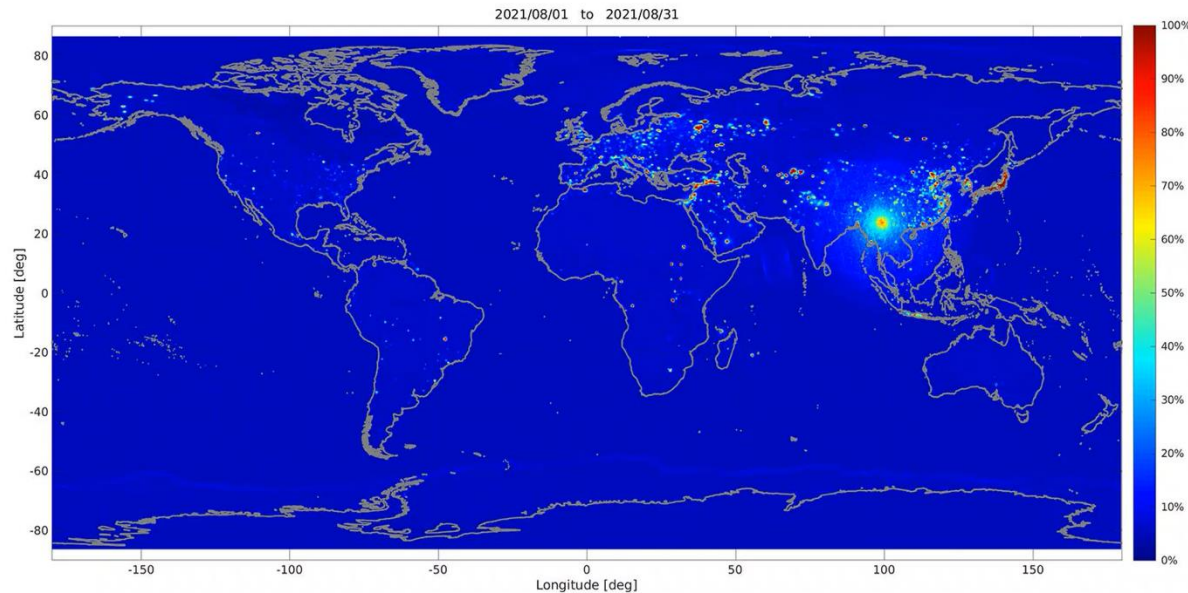
September 11, 2025

ElectroScience
LABORATORY



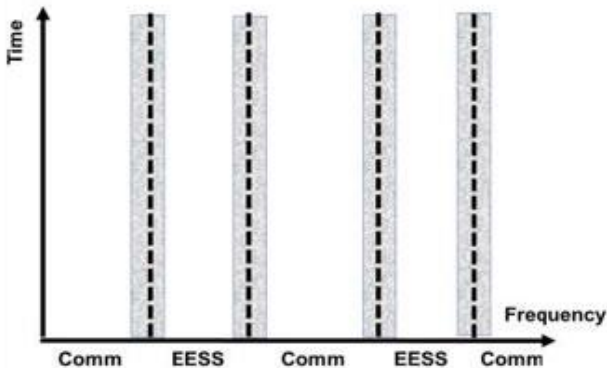
Project objectives

- Promote future spectrum coexistence between Earth observing microwave radiometers and communication users
- Research areas:
 - First principles model development relating geophysical sensing performance to radiometer spectrum use
 - Economic analyses to facilitate design of robust commercial market for shared spectrum
- Collaborative project combines expertise in microwave remote sensing and economic modeling

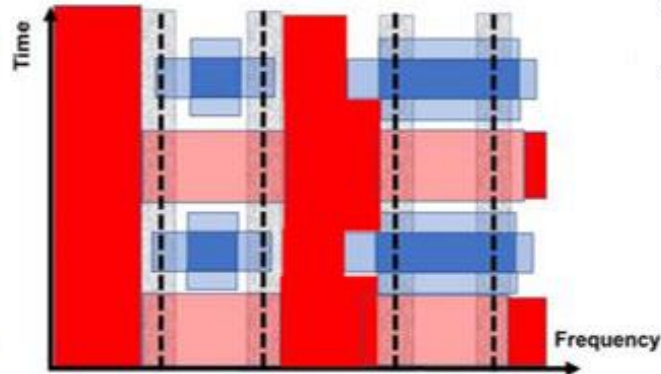


Progress to date

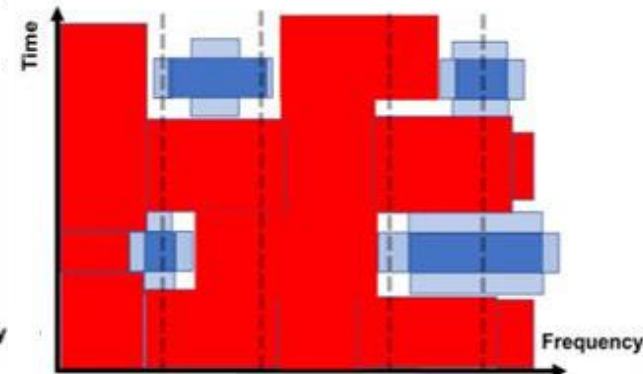
Current allocation approach



Infrequent access can allow sharing?



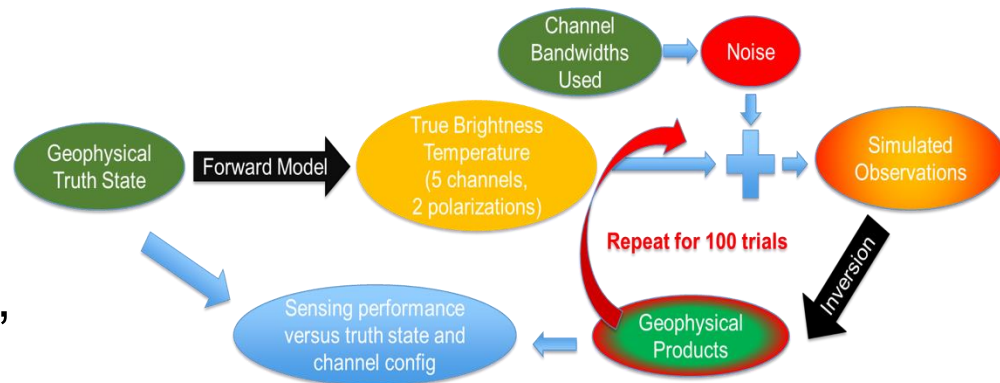
Future: More flexible frequency use



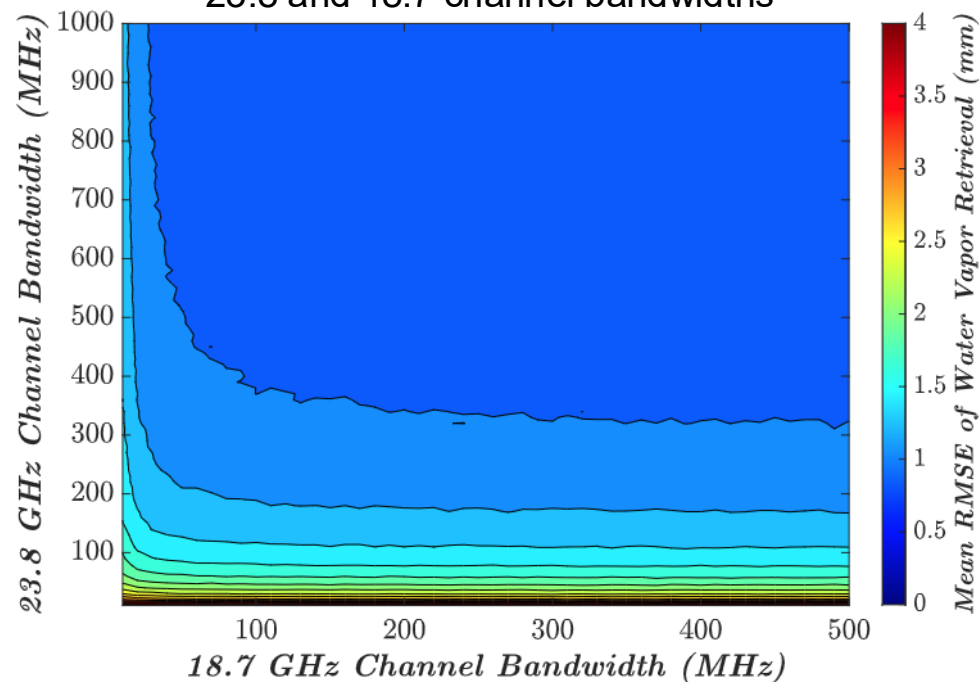
- Vision: Flexible use of the spectrum achievable through shared access between active and passive users.
- We developed a statistical (as opposed to deterministic) model of radiometer spectrum access using 'traces' of overpasses from 15 space-based microwave radiometers
- We used this information in an economic model to study viability of commercial user market
- We developed efficient models that map radiometer spectrum access to geophysical sensing performance

Geophysical Sensing Performance Model

- First-principles physics-based model used to map radiometer center frequency, bandwidth, and integration time to errors in sensing ocean wind speed (WS), sea surface temperature (SST), atmospheric water vapor (IWV), and cloud liquid water (CLW)
- Relationships simplified using both linear and quadratic regressions as well as machine learning approach
- Results show potential for future flexible and adaptive sharing while maintaining sensing performance



Water vapor retrieval error (mm) vs
23.8 and 18.7 channel bandwidths



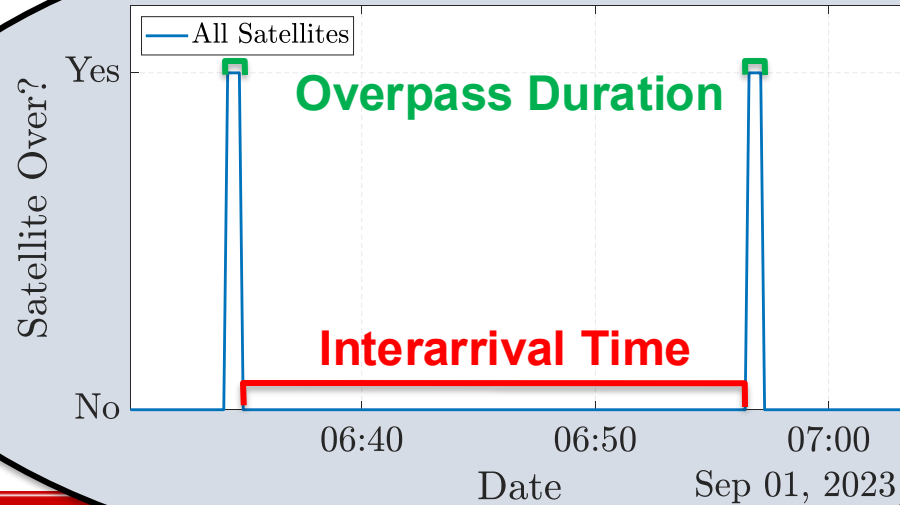
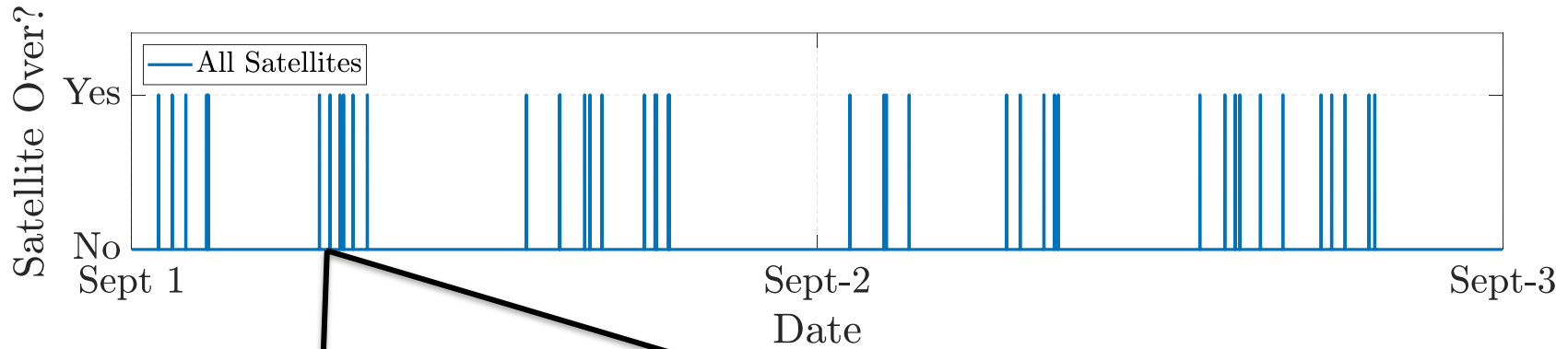
Radiometer Access Studies

- Data from the 23.8 GHz channel of 15 microwave radiometers is used to produce CCDFs of interarrival times and the duration of overpasses at 15 locations.

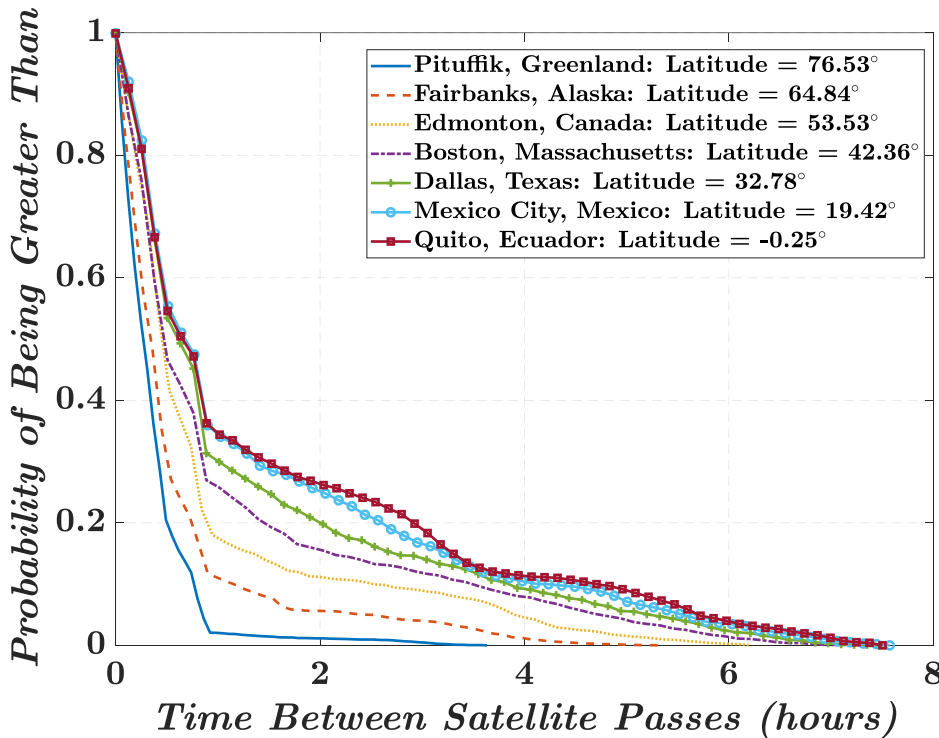


Data Formatting

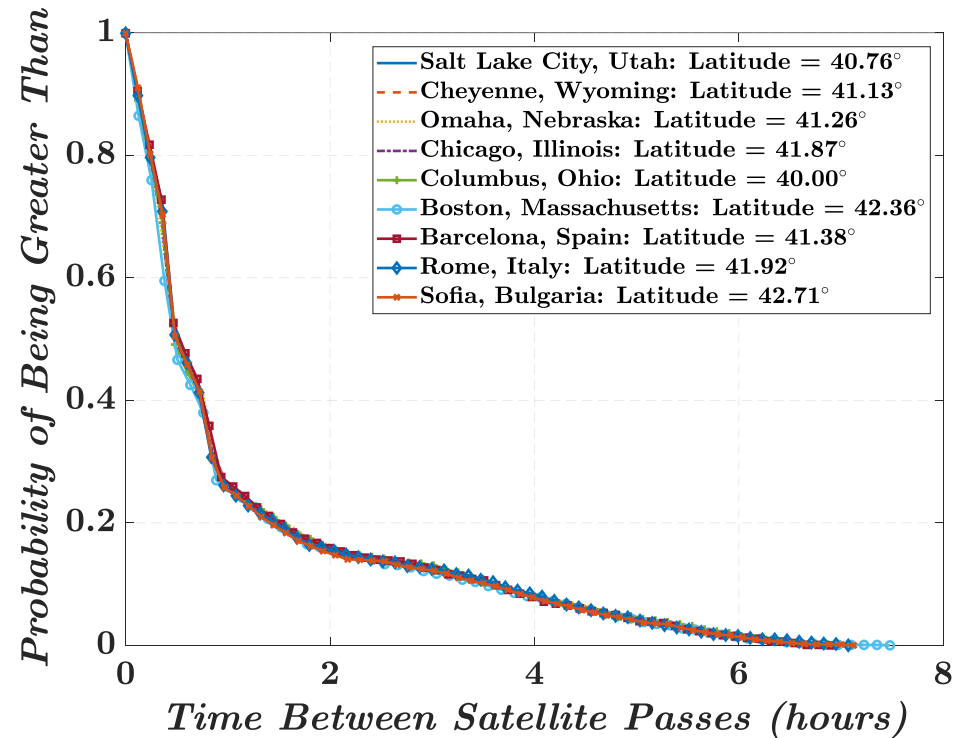
- Now for the last 11 ...



Interarrival Analysis



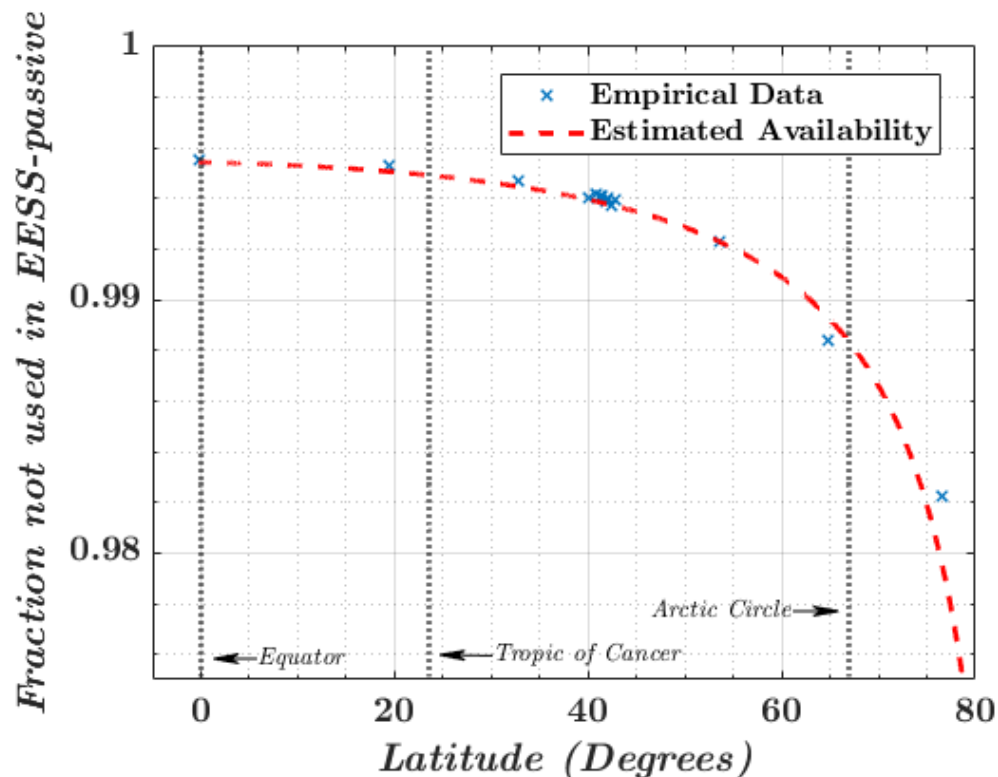
Different Latitude



Same Latitude

Economic Insight

- Availability > 99% for latitudes with 60 degrees of equator
- Expect to see high incentive for sharing as a result, save for applications which may be particularly preemption sensitive.
- Overpass statistics applied to develop an economic model for spectrum sharing



Broader Impacts

- Publications

- J. Chamberlain, D. Starobinski and J. T. Johnson, "Facilitating Spectrum Sharing With Passive Satellite Incumbents," *IEEE Journal on Selected Areas in Communications*, vol. 42, no. 12, pp. 3719-3733, Dec. 2024
- N. Brendle, J. T. Johnson, D. Starobinski and J. Chamberlain, "Estimating the Retrieval Performance of Passive Remote Sensing Under Alternate Spectrum Sharing Scenarios," *IGARSS 2024*, pp. 753-755.
- J. Chamberlain, J. T. Johnson and D. Starobinski, "Spectrum Sharing between Earth Exploration Satellite and Commercial Services: An Economic Feasibility Analysis," *DySPAN*, 2024, pp. 197-206.
- N. Brendle, J. Chamberlain, J. T. Johnson, D. Starobinski, "Advancing Spectrum Sharing through Statistical Analysis of EESS-Passive Satellite Overpasses," *DySPAN*, UK 2025, to be published.
- R. García, N. Brendle, P. de Matthaeis, J. T. Johnson, B. Backus, "Challenges and Opportunities of Spectrum Coexistence for Passive Remote Sensing," *EuCAP 2025*.
- N. Brendle, A. Islam, J. Johnson, "Power Conservation In Rough Surface Emission Modeling," *IGARSS 2025*.
- 2025 BU Ph.D. graduate Dr. Jonathan Chamberlain received the BU ECE Doctoral Achievement Award
- Data of radiometer 'traces' available at: <https://github.com/nislab/passive-radiometer-trace-data>