

# SRIJA CHAKRABORTY

Associate Scientist

Earth from Space Institute, Universities Space Research Association  
schakraborty@usra.edu

## RESEARCH SUMMARY

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My research interest lies in developing algorithms based on *applied machine learning* principles to analyze remotely sensed Earth and Space observations for enhancing the interpretation of these datasets in close collaboration with domain scientists. The objective is to maximize information extraction from large multidimensional Earth and Space Science datasets using advances in machine learning. At present, my research is centered around utilizing Earth Observation datasets for both near-real time detection and tracking of changes and anomalies as well as understanding and forecasting long-term trends using advances in machine learning for tackling large, multidimensional datasets with spatio-temporal variations.

## EDUCATION

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### **Ph.D. Computer Engineering, August 2014 - December 2019**

Arizona State University

*Thesis: Advanced Processing of Multispectral Satellite Data for Detecting and Learning Knowledge-based Features of Planetary Surface Anomalies*

### **B.Tech Computer Science and Engineering, August 2010 - June 2014**

West Bengal University of Technology

## EXPERIENCE

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*Earth from Space Institute, Universities Space Research Association*

January 2022 - Present

### **Associate Scientist**

*Understanding the Earth at night and global environmental change using NASA's Black Marble Product Suite and machine learning*

- Supervisor: Dr. Eleanor C. Stokes, Black Marble Science Team
- Unsupervised learning of multispectral nighttime images for thermal anomaly detection
- Exploring unsupervised and self-supervised methods for machine learning-enabled training data generation
- Detection and benchmarking of machine learning methods for monitoring nighttime thermal anomalies
- Time-series analysis of nighttime images (anomaly detection, forecasting) for nightlight-derived estimates of urban changes such as power outages, electrification, urbanization, conflicts
- Improving nighttime cloud detection with machine learning

*NASA Goddard Space Flight Center*

February 2020 - January 2022

### **NASA Postdoctoral Program Fellow**

*Monitoring the Earth at night using NASA's Black Marble Product Suite and machine learning*

- Advisers: Dr. Virginia Kalb, Black Marble Science Team
- Unsupervised thermal anomaly detection from multispectral nighttime images for extracting fires and gas flaring signals
- Improving nighttime cloud detection with machine learning
- Time-series analysis of BRDF-corrected nighttime images for tracking nightlight-derived estimates of global socio-economic change and power outages

*Arizona State University*

August 2014 - December 2019

### **Graduate Research Assistant, Signal Processing & Adaptive Sensing Laboratory, Mars Space Flight Facility**

*Anomaly and novelty detection in multispectral time-series for Earth and Planetary Science applications*

- Co-Advisers: Prof. Philip Christensen, Prof. Antonia Papandreou-Suppappola
- Adaptive modeling of satellite image time-series (MODIS) and sequential Monte Carlo estimation of time-varying model parameters
- Time-frequency estimation of satellite image-time series to analyze land surface reflectance change rate and post-change dynamics
- Unsupervised change detection from multitemporal satellite observations to monitor post-change trends

- Multispectral analysis of land cover model parameters during land cover change and its unsupervised categorization
- Rule-based representations of planetary landforms and expert-guided prioritization of multispectral THEMIS images to retrieve novel instances
- Designed region of interest-aware data compression algorithms for THEMIS images

*Jet Propulsion Laboratory*

May 2018 - July 2018

**Research Intern, Machine Learning and Instrument Autonomy Group**

*Spectral Anomaly Detection for Europa Clipper Onboard Science*

- Mentors: Dr. Gary Doran, Dr. Kiri Wagstaff
- Spectral anomaly simulation framework for Galileo NIMS data, and generated preliminary synthetic MISE datasets
- Anomaly and target detectors to detect simulated spectral anomalies in Galileo NIMS data
- Investigated an unusual trend in novelty rank observed while detecting artificially injected spectra using anomaly detectors

*Los Alamos National Laboratory*

June 2017 - August 2017

**Research Intern, Applied Machine Learning Summer School**

*Unsupervised Seismic Anomaly Detection*

- Mentors: Dr. James Theiler, Dr. Diane Oyen
- Unsupervised algorithms for detecting anomalies using spectrogram representation of seismic time-series

*Arizona State University*

Spring 2015 - Spring 2019

**Graduate Teaching Assistant**

- Software Design, Data Structures and Algorithms, Object Oriented Programming and Data Structures

## AWARDS

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NASA SMD AI/ML Working Group, Training Dataset and Benchmarking Study, Earth Science: March - October 2022  
 Oxford Machine Learning Summer School, Participant: July - August 2021  
 NASA Postdoctoral Program Fellowship: February 2020 - January 2022  
 Ferdinand A. Stanchi Fellowship, ASU : Spring 2019  
 JPL Graduate Fellowship : May - July 2018  
 Engineering Graduate Fellowship, ASU : Spring 2018  
 Travel Grants: ICLR (2020), ICML (WiML) 2020, IEEE IGARSS Student Travel Grant, July 2017  
 ASU Graduate College and Graduate School Travel Grant : March 2018, December 2018, January 2019, December 2019  
 ASU Grace Hopper Scholarship : 2017  
 NASA JPL Center for Climate Sciences Summer School, Participant : August 2016  
 University Graduate Fellowship, ASU : Fall 2014 - Summer 2015, Spring 2016, Spring 2017

## FUNDING

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PI - *Benchmarking NASA's Black Marble Product Suite for Near-Real Time Monitoring: A Case Study with Thermal Anomalies*, NASA SMD AI/ML Working Group, Training Dataset and Benchmarking Study, Earth Science: March - October 2022, \$92,479  
 Co-I, (PI: Dr. Eleanor Stokes) - *Nightlights-Based Assessment of Global Electricity Infrastructure and Future Emissions to Meet Growing Demand*, NASA, 2021-2024  
 Co-I, (PI: Dr. Zhuosen Wang) - *Maintenance and Continuation of NASA's Black Marble Nighttime Lights Using Suomi NPP and NOAA-20 VIIRS*, NASA, 2021-2024

## REFEREED JOURNAL AND CONFERENCE PUBLICATIONS

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- R1. **S. Chakraborty**, T. Oda, V.L. Kalb, Z. Wang, M.O. Román, *Potentially Underestimated Gas Flaring Activities - A New Approach to Detect Combustion Using Machine Learning and NASA's Black Marble Product Suite*, Environmental Research Letters, 2023, In Press, <https://doi.org/10.1088/1748-9326/acb6a7>.  
 R2. D. Hills, J. Damerow, B. Ahmmed, N. Catolico, **S. Chakraborty**, C. Coward, R. Crystal-Ornelas, W. Duncan, L. Goparaju, C. Lin, Z. Liu, M. Mudunuru, Y. Rao, R. Rovetto, Z. Sun, B. Whitehead, L. Wyborn, T. Yao, *Earth and Space Science Informatics Perspectives on Integrated, Coordinated, Open, Networked (ICON) Science*, Earth and Space Science, 2022, <https://doi.org/10.1029/2021EA002108>.

- R3. T. Oda, M.O. Román, Z. Wang, E.C. Stokes, Q. Sun, R.M. Shrestha, S. Feng, T. Lauvaux, R. Bun, S. Maksyutov and **S. Chakraborty**, *US Cities in the Dark: Mapping ManMade Carbon Dioxide Emissions Over the Contiguous US Using NASAs Black Marble Nighttime Lights Product*. *Urban Remote Sensing: Monitoring, Synthesis, and Modeling in the Urban Environment*, 2021, pp.337-367.
- R4. K. Wagstaff, G. Doran, A. Davies, S. Anwar, **S. Chakraborty**, M. Cameron, I. Daubar, C. Phillips, *Enabling Onboard Detection of Events of Scientific Interest for the Europa Clipper Spacecraft*, Proceedings of the Twenty-Fifth ACM SIGKDD Conference On Knowledge Discovery And Data Mining, 2019.
- R5. **S. Chakraborty**, S. Das, A. Banerjee, S.K.S. Gupta, P. R. Christensen, *Expert Guided Rule Based Prioritization of Scientifically Relevant Images for Downlinking over Limited Bandwidth from Planetary Orbiters*, Proceedings of the Thirty-First Annual Conference on Innovative Applications of Artificial Intelligence, 2019.
- R6. **S. Chakraborty**, A. Banerjee, S. Gupta, P. R. Christensen, A. Papandreou-Suppappola, *Time-Varying Modeling of Land Cover Change Dynamics Due to Forest Fires*, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 11, no. 6, pp. 1769–1776, 2018.
- R7. **S. Chakraborty**, A. Banerjee, S. Gupta, P. Christensen, *Region of Interest Aware Compressive Sensing of THEMIS Images and Its Reconstruction Quality*, IEEE Aerospace Conference, 2018.
- R8. **S. Chakraborty**, A. Banerjee, S. Gupta, A. Papandreou-Suppappola, P. Christensen, *Estimation of Dynamic Parameters of MODIS NDVI Time Series Nonlinear Model Using Particle Filtering*, IEEE International Geoscience and Remote Sensing Symposium (IGARSS), pp. 1091–1094, 2017.
- R9. **S. Chakraborty**, S. Das, P. Chatterjee, *Prediction of domain boundaries in protein sequences using predicted secondary structure and physicochemical properties of amino acids*, IEEE International Conference on Circuit, Power and Computing Technologies, March 2014.

#### Submitted Articles and Planned Submissions

1. **S. Chakraborty**, P.R. Christensen, A. Papandreou-Suppappola, *On the Class Separability of Land Surface Reflectance Time-Series Change Using Explainable Change Representations*, Submitted.
2. **S. Chakraborty**, E.C. Stokes, *Adaptive Modeling of Satellite-Derived Nighttime Lights Time-Series for Tracking Urban Change Processes Using Machine Learning*, In preparation.
3. E. C. Stokes, **S. Chakraborty**, O. Alexander, *Global Urban Activity Changes from COVID-19 Physical Distancing Restrictions*, In preparation.

#### CONFERENCE ABSTRACTS AND POSTERS

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- A1. **S Chakraborty**, T Oda, VL Kalb, Z Wang, EC Stokes, RM Shrestha, *Benchmarking NASAs Black Marble Product Suite for Near-Real Time Monitoring of Nighttime Combustion*, AGU Fall Meeting, 2022.
- A2. **S Chakraborty**, EC Stokes, *Adaptive Modeling of Satellite-Derived Nighttime Lights for Monitoring Urban Change Processes Using Time-Series Forecasting*, AGU Fall Meeting, 2022.
- A3. RM Shrestha, EC Stokes, Z Wang, VL Kalb, **S Chakraborty**, A Molthan, JR Bell, LA Schultz *Disaster Monitoring through NASAs Black Marble Nighttime Lights Product Suite*, AGU Fall Meeting, 2022.
- A4. **S. Chakraborty**, T. Oda, V.L. Kalb, Z. Wang, M.O. Román, *Satellite-Derived Combustion Activity Estimation Using Machine Learning and NASA’s Black Marble Product Suite for Evaluation of Greenhouse Gas Emission Inventories*, Metrology for Climate Action, 2022.
- A5. **S. Chakraborty**, *Explaining Unsupervised Detections of Natural Hazards from Multispectral Satellite Image Time-Series*, AI for Earth and Space Science, ICLR, 2022.
- A6. **S. Chakraborty**, T. Oda, V.L. Kalb, M.O. Román, Z. Wang, *Towards Improved Monitoring of Combustion Emissions: An Enhanced Combustion Detection Approach Using Machine Learning and NASAs Black Marble Nighttime Lights Product Suite*, AGU Fall Meeting, 2021.
- A7. M. Ansdell, **S. Chakraborty**, M. Guhathakurta, M.M. Little, *Growing Opportunities for Multiparty Collaborations in Artificial Intelligence and Machine Learning for Science Research*, AGU Fall Meeting, 2021.
- A8. **S. Chakraborty**, *Multispectral Analysis of Land Surface Reflectance Time-Series for Clustering Change Events*, NASA Second AI and Data Science Workshop, February 2021.

- A9. **S. Chakraborty**, V.L. Kalb, M.O. Román, Z. Wang, E.C. Stokes, R.M. Shrestha, I.L. Paynter, T. Oda, *Modeling VIIRS Brightness Temperature for Improving Nighttime Cloud Detection*, AGU Fall Meeting Abstract, December 2020.
- A10. E. C. Stokes, M. O. Román, R.M. Shrestha, Z. Wang, V. L. Kalb, I. L. Paynter, **S. Chakraborty**, T. Oda, *Battling COVID-19 from Space: Cross-Scale Changes in Urban Activity Captured by NASA’s Black Marble Product Suite*, AGU Fall Meeting Abstract, December 2020.
- A11. M. O. Román, E.C. Stokes, R.M. Shrestha, Z. Wang, V.L. Kalb, I.L. Paynter, **S. Chakraborty**, T. Oda, *Tracking Responses to the COVID-19 Pandemic using NASA’s Black Marble Product Suite*, AGU Fall Meeting Abstract, December 2020.
- A12. **S. Chakraborty**, *Analysis of Multispectral Land Surface Reflectance Time-Series for Detecting and Classifying Land Cover Change*, 2nd NOAA Workshop on Leveraging AI in Environmental Sciences, November 2020.
- A13. **S. Chakraborty**, *Towards Data-Informed Climate Sciences - Leveraging Machine Learning Inferences of Satellite Observations*, Workshop in Data Science in Climate and Climate Impact Research, August 2020.
- A14. **S. Chakraborty**, *Unsupervised Land Cover Change Detection and Interpretation from Multispectral Satellite Image Time-Series*, Women In Machine Learning Workshop, ICML, 2020.
- A15. **S. Chakraborty**, *Time-Varying Semantic Representations of Planetary Observations for Discovering Novelties*, AI for Earth Workshop, ICLR, 2020.
- A16. **S. Chakraborty**, A. Papandreou-Suppappola, P.R. Christensen, *Class Separability of Land Cover Change Events from Multispectral Satellite Image Time-Series*, AGU Fall Meeting Abstract, December 2019.
- A17. K. L. Wagstaff, G. Doran, A. Davies, S. Anwar, **S. Chakraborty**, M. Cameron, J. Bapst, S. Chien, C. Cochrane, I. Daubar, S. Diniega, C. Phillips, S. Piqueux, *Responsive Onboard Science for the Europa Clipper Mission*, JPL Data Science Showcase, April 2019.
- A18. K. L. Wagstaff, D. L. Blaney, **S. Chakraborty**, S. A. Chien, A. G. Davies, S. Diniega, and G. Doran, *Spectral Anomaly Detection for the Mapping Imaging Spectrometer for Europa (MISE)*, 50th Lunar and Planetary Science Conference, Abstract #1604, March 2019.
- A19. **S. Chakraborty**, A. Banerjee, S. K. S Gupta, P. R. Christensen, A. Papandreou-Suppappola, *Multitemporal Analysis of Image Time-Series for Land Cover Change Detection and Unsupervised Classification of Change Event Using Spectral Analysis*, AGU Fall Meeting Abstract, 2018.
- A20. K. L. Wagstaff, A. Davies, G. Doran, **S. Chakraborty**, S. Anwar, D. L. Blaney, S. Chien, P. R. Christensen, and S. Diniega, *Responsive Onboard Science for Europa Clipper*, Outer Planets Assessment Group Meeting, Sept 2018.
- A21. **S. Chakraborty**, A. Banerjee, S. Gupta, P. Christensen, A. Papandreou-Suppappola, *Automated Land Cover Change Detection and Mapping from Hidden Parameter Estimates of Normalized Difference Vegetation Index (NDVI) Time-Series*, AGU Fall Meeting Abstract, 2017.

## TECHNICAL PRESENTATIONS

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1. *Monitoring the Earth at Night with a Machine Learning Lens*, NASA Goddard Scientific Colloquium, February 2023. [*Invited*]
2. *Benchmarking NASA’s Black Marble Product Suite for Near-Real Time Monitoring of Nighttime Combustion*, AGU Fall Meeting, 2022.
3. *Adaptive Modeling of Satellite-Derived Nighttime Lights for Monitoring Urban Change Processes Using Time-Series Forecasting*, AGU Fall Meeting, 2022.
4. *Feature Extraction from Visible Infrared Imaging Radiometer Suite (VIIRS) Observations for Monitoring the Earth at Night*, International Virtual School on Application of Machine Learning and IoT in Remote Sensing, Chapnet-2020, IEEE Geoscience and Remote Sensing Society, Kolkata Chapter, December 2020. [*Invited*]
5. *Latent Space Representations of VIIRS Multispectral Observations for Monitoring the Earth at Night*, Early Career Scientist Forum, November 2020.
6. *Analysis of Multispectral Land Surface Reflectance Time-Series for Detecting and Classifying Land Cover Change*, 2nd NOAA Workshop on Leveraging AI in Environmental Sciences, November 2020.
7. *Extracting Features from VIIRS Observations for Monitoring the Earth at Night*, NASA SED Director’s Seminar (Earth Science Division), November 2020.

8. *Towards Data-Informed Climate Sciences - Leveraging Machine Learning Inferences of Satellite Observations*, Workshop in Data Science in Climate and Climate Impact Research, Weather and Climate Risks Group, ETH Zurich, August 2020.
9. *Time-Varying Semantic Representations of Planetary Observations for Discovering Novelties*, AI for Earth Workshop, ICLR, April 2020.
10. *Class Separability of Land Cover Change Events from Multispectral Satellite Image Time-Series*, AGU Fall Meeting, December 2019.
11. *Adaptive Representations of Multispectral Satellite Images for Change and Novelty Detection*, Carnegie Institute for Science, October 2019. [*Invited*]
12. *Tracking Dynamic Changes in Land Surface Using Statistical Processing and Bayesian Modeling of Satellite Time-Series Data*, Department of Earth and Environment, Boston University, October 2019. [*Invited*]
13. *Expert Guided Rule Based Prioritization of Scientifically Relevant Images for Downlinking over Limited Bandwidth from Planetary Orbiters*, IAAI/AAAI, January 2019.
14. *Spectral Anomaly Detection for Europa Clipper*, Machine Learning and Instrument Autonomy Group, Jet Propulsion Laboratory, July 2018.
15. *Region of Interest Aware Compressive Sensing of THEMIS Images and Its Reconstruction Quality*, IEEE Aerospace Conference, March 2018.
16. *Unsupervised Seismic Anomaly Detection*, Los Alamos National Laboratory, August 2017.
17. *Estimation of Dynamic Parameters of MODIS NDVI Time Series Nonlinear Model Using Particle Filtering*, IEEE IGARSS, July 2017.
18. *Multitemporal Analysis of Satellite Image Time-Series for Land Cover Change Detection*, NASA JPL Climate Sciences Summer School, August 2016.

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## EXPERIENCE AND SKILLS

**Machine Learning and Statistical Signal Processing:** Unsupervised learning, feature extraction and selection, parameter estimation, time-series analysis, particle filters, extended Kalman filters, clustering, anomaly detection, neural networks, autoencoders, variational autoencoders, generative modeling, convolutional neural networks, long short term memory networks (LSTM), LSTM-variants, dimensionality reduction, multispectral and hyperspectral image analysis, few-shot learning, explainable AI/ML

**Programming and Analysis:**

Proficient: Python (numpy, scipy, scikit-learn, pymc3), MATLAB, C

Intermediate: R, Shell Scripting (Bash)

**Deep Learning Frameworks:** Keras, TensorFlow

**High Performance Computing:** Use of Docker and Kubernetes

**Remote Sensing Interfaces and Tools:** Davinci, preliminary JMARS and Google Earth Engine

**Remote Sensing Datasets:** VIIRS, MODIS, Landsat, THEMIS (Visible and Infrared), Galileo NIMS

**Version Control:** Git

**Typesetting:** L<sup>A</sup>T<sub>E</sub>X

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## PROFESSIONAL SERVICE & MEMBERSHIP

**Reviewer:**

NASA ROSES (Executive Secretary, Panelist) : 2020 - Present

NASA EpSCOR : 2020-Present

IEEE Transactions on Geoscience and Remote Sensing: 2022 - Present

ICLR AI for Earth Sciences Workshop : 2022

Climate Change AI Innovation Grants: 2021

Environmental Science and Policy: 2021

NeurIPS AI for Earth Sciences Workshop : 2020

Sub Reviewer: Challenges in Deploying and Monitoring Machine Learning Systems: ICML-2020

**Invited Participant:**

Artificial Intelligence for Earth System Predictability (AI4ESP): November 2021

Explainable/ Interpretable/ Trustworthy AI Session

**Volunteer:**

**NASA SMD AI/ML Working Group:** August 2020 - Present

Conducted NASA Cross Divisional ML Applications Landscape Survey: 2021

Conducted NASA AI/ML Workshop (Focus Area Host): May 2021

Session Co-Convener Cross Divisional Applications of AI/ML in NASA Science, AGU 2021, 2022

**IEEE GRSS Image Analysis and Data Fusion Technical Committee (Co-Lead):** September 2021 - Present

Working Group on Remote Sensing Benchmarking Datasets

Co-Organized IEEE IADF School on Machine Learning for Remote Sensing, October 2022

Social Media Lead

AGU ICON/ FAIR Principles, Open Collaboration Across Geosciences, Writing Group: April - August, 2021

Machine Learning for Science and Engineering, Earth and Environmental Sciences Track: 2020

USA Science and Engineering Festival: 2020.

**Membership:**

IEEE Geoscience and Remote Sensing Society, American Geophysical Union

**Media Coverage :** New Voices in AI, AIHub, January, 2023