

# Zachary Langford

*Curriculum Vitae*

## Personal details

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*Citizenship* U.S. Citizen

## Education

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### Ph.D. Energy Science & Engineering 2017

*University of Tennessee – Knoxville*

Dissertation: *Spatiotemporal Characterization of Arctic Ecosystems Using Geospatial Analytics*

Concentration: Remote Sensing, Environmental Modeling, and Data Analytics

### MSc. Civil Engineering 2013

*Pennsylvania State University – University Park*

Concentration: Environmental Remote Sensing and Hydrology

### BSc. Earth System Science 2011

*University of Alabama in Huntsville*

Concentration: GIS, Remote Sensing, and Hydrology

## Research Interests

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Image Processing; Anomaly Detection; Spatial Modeling; High Performance Computing; Machine Learning; Environmental Modeling

## Work Experience

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### Research Technologist 2016-present

*Boeing Research & Technology*

- Designing machine learning applications applied on multi-dimensional multi/hyperspectral datasets.
- Lead projects related to geospatial intelligence (GEOINT), focusing on analytics on aerial platforms.
- Synthetic data creation of multi/hyperspectral sensors for machine learning applications.
- Developing geospatial frameworks for mapping airport environments for autonomous applications.

### Graduate Research Assistant 2014-2016

*Oak Ridge National Laboratory & University of Tennessee*

- PhD research with Oak Ridge National Laboratory (ORNL) working on data analytics applied to environmental datasets.
- Designed efficient algorithms for parallelization on CPUs and GPUs.
- Provided geospatial datasets of Arctic ecosystems for parameterizing land surface models.
- Developed multi-sensor fusion frameworks for retrieving surface parameters.

- Developed automated algorithms for identifying and understanding disturbance threats (e.g., wildfires) using spatiotemporal datasets.

### Research Internship

2014-2014

*Oak Ridge National Laboratory*

- Utilized WorldView-2 and LiDAR datasets to create plant functional type (PFT) maps for driving land surface models.
- Developing machine learning algorithms on high-resolution satellite imagery.

### Graduate Research Assistant

2011-2013

*Pennsylvania State University*

- Utilized high-resolution, 50 cm – 2 m, panchromatic & multispectral satellite imagery (QuickBird, WorldView-2, and GeoEye) to characterize soil moisture profiles in the McMurdo Dry Valleys, Antarctica using an object-based classification scheme and artificial neural networks (ANNs).

### Research Assistant

2010-2011

*University of Alabama in Huntsville*

- Collaborated with NASAs Regional Visualization and Monitoring System (SERVIR) and Smithsonian Tropical Research Institute (STRI) to integrate satellite and geospatial data to support environmental monitoring in Central America.

## Skills

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<i>Languages</i>	Python, R, MATLAB, C/C++, SQL, JavaScript
<i>API (Learning)</i>	CUDA, OpenMP
<i>Software</i>	L <sup>A</sup> T <sub>E</sub> X, MySQL, Blender, Unity
<i>Image Processing/GIS</i>	ENVI/IDL, GDAL, GRASS GIS, QGIS, DIRSIG
<i>Deep Learning</i>	TensorFlow, Keras, Theano, PyTorch
<i>Operating System</i>	UNIX, Linux, Windows

## Awards

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**2015, University of Alaska:** Travel Grant for Environmental Modeling Workshop

**2014, ORNL/UTK:** Energy Science and Engineering Fellowship

**2011, UAH:** Travel Grant for International Astronautical Congress, South Africa

**2010, UAH:** Travel Grant for Sustainable Development in Latin America

## Academic Service

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### Journal Article Reviewer:

Remote Sensing (2015–2018)

Computers and Geosciences (2018)

Progress in Artificial Intelligence (2018)

Remote Sensing of Environment (2017)

International Journal of Remote Sensing (2015, 2016, 2018)

## Publications

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- [1] Z. L. Langford, J. Kumar, and F. M. Hoffman, “Wildfire Mapping in Interior Alaska Using Deep Neural Networks on Imbalanced Datasets,” in *Proceedings of the 2018*

*IEEE International Conference on Data Mining Workshops (ICDMW 2018)*, Institute of Electrical and Electronics Engineers (IEEE).

- [2] Z. L. Langford, J. Kumar, and F. M. Hoffman, "Convolutional neural network approach for mapping arctic vegetation using multi-sensor remote sensing fusion," in *Proceedings of the 2017 IEEE International Conference on Data Mining Workshops (ICDMW 2017)*, Institute of Electrical and Electronics Engineers (IEEE), Conference Publishing Services (CPS), Nov. 2017.
- [3] Z. L. Langford, J. Kumar, F. M. Hoffman, R. J. Norby, S. D. Wulschleger, V. L. Sloan, and C. M. Iversen, "Mapping Arctic plant functional type distributions in the Barrow Environmental Observatory using WorldView-2 and LiDAR datasets," *Remote Sensing*, vol. 8, p. 733, Sept. 2016.
- [4] Z. L. Langford, M. N. Gooseff, and D. J. Lampkin, "Spatiotemporal Dynamics of Wetted Soils across a Polar Desert Landscape, McMurdo Dry Valleys Antarctica," *Antarctic Science*, vol. 27, pp. 197–209, April 2015.
- [5] Z. L. Langford, R. Griffin, S. Christopher, and C. Calamaio, "Protecting the Panama Canal Watershed through the Exchange of Geospatial Data," in *62nd International Astronautical Congress*, (IAF), 2011.
- [6] Z. L. Langford, R. Griffin, S. Christopher, C. Calamaio, and T. Keeton, "Socio-Environmental Impacts of Land Cover Change in the Panama Canal Watershed," in *62nd International Astronautical Congress*, (IAF), 2011.

## **Under Review and In Preparation**

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- [1] Z. L. Langford, J. Kumar, F. M. Hoffman, A. Breen, and C. M. Iversen, "Field-Scale Arctic Vegetation Mapping Using Multisensor Fusion and Convolutional Neural Networks," *Remote Sensing*, In Revision.

## **Theses and Dissertations**

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- [1] Z. L. Langford, *Spatio-Temporal Characterization of Arctic Ecosystems Using Geospatial Analytics*. PhD thesis, University of Tennessee - Knoxville, Bredesen Center for Interdisciplinary Research and Graduate Education, Knoxville, Tennessee, USA, Dec. 2017.
- [2] Z. L. Langford, "Are the Dry Valleys Getting Wetter? A Preliminary Assessment of Wetness Across the McMurdo Dry Valleys Landscape," Master's thesis, Pennsylvania State University, Department of Civil and Environmental Engineering, University Park, Tennessee, USA, May 2013.

## **Conference Talks and Posters**

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- [1] F. M. Hoffman, Z. L. Langford, J. Kumar, S. Norman, , and W. W. Hargrove, "Applying Google Earth Engine to Wildfire Disturbance Detection in the State of Alaska." U.S. International Association for Landscape Ecology (US-IALE) Annual Meeting, April 11, 2018, Chicago, Illinois, USA.
- [2] Z. L. Langford, J. Kumar, and F. M. Hoffman, "Convolutional Neural Network Approach for Mapping Arctic Vegetation using Multi-Sensor Remote Sensing." Seventh

Workshop on Data Mining in Earth System Science (DMESS 2017), November 18, 2017, New Orleans, Louisiana, USA.

- [3] Z. L. Langford, J. Kumar, F. M. Hoffman, S. D. Wulschleger, C. M. Iversen, and R. J. Norby, "Mapping Vegetation Distributions in Arctic Ecosystems for Parameterizing Models using Satellite-derived Phenology." U.S. International Association for Landscape Ecology (US-IALE) Annual Meeting, April 5, 2016, Asheville, North Carolina, USA.
- [4] F. M. Hoffman, J. Kumar, Z. L. Langford, W. W. Hargrove, J. T. Randerson, W. J. Riley, D. M. Lawrence, and G. Keppel-Aleks, "Computational Approaches for Model, Experiment, and Data Integration Supporting Site Characterization and Model Evaluation." 2016 Workshop on An Integrated Network for Terrestrial Ecosystem Research on Feedbacks to the Atmosphere and Climate (INTERFACE): Linking Experimentalists, Ecosystem Modelers, and Earth System Modelers, January 1-February 3, 2016, St. Pete Beach, Florida, USA.
- [5] Z. L. Langford, J. Kumar, and F. M. Hoffman, "Landscape characterization of Arctic ecosystems using data mining algorithms and large geospatial datasets." American Geophysical Union (AGU) Fall Meeting (December 14–18, 2015), December 17, 2015, San Francisco, California, USA.
- [6] J. Kumar, Z. L. Langford, and F. M. Hoffman, "Characterizing biotic and abiotic properties of landscape and their implications for ecohydrological processes across scales." American Geophysical Union (AGU) Fall Meeting (December 14–18, 2015), San Francisco, California, USA.
- [7] F. M. Hoffman, J. Kumar, Z. Langford, R. T. Mills, and W. W. Hargrove, "Representativeness-Based Sampling Network Design and Scaling Strategies for Measurements in Arctic Ecosystems." Next Generation Ecosystem Experiments (NGEE) Arctic All Hands Meeting (December 12–13, 2015), December 12–13, 2015, San Francisco, California, USA.
- [8] F. M. Hoffman, J. Kumar, D. M. Maddalena, Z. L. Langford, W. W. Hargrove, and J. T. Randerson, "Characterizing Tropical Forest Representativeness for Optimizing Sampling Network Coverage." 1<sup>st</sup> Annual Next Generation Ecosystem Experiments (NGEE) Tropics Meeting (August 9, 2015), August 9, 2015, Linthicum Heights, Maryland, USA.
- [9] F. M. Hoffman, J. Kumar, D. M. Maddalena, Z. L. Langford, W. W. Hargrove, and J. T. Randerson, "Characterizing Tropical Forest Representativeness for Optimizing Sampling Network Coverage ." 52<sup>nd</sup> Annual Meeting of the Association for Tropical Biology and Conservation (ATBC) (July 12–16, 2015), July 14, 2015, Honolulu, Hawaii, USA.
- [10] F. M. Hoffman, W. W. Hargrove, J. Kumar, Z. L. Langford, , and D. M. Maddalena, "High Performance Computational Landscape Ecology and Using Clustering to Define Climate Regimes." International Association for Landscape Ecology (IALE) World Congress (July 5–10, 2015), July 6, 2015, Portland, Oregon, USA.
- [11] F. M. Hoffman, J. Kumar, Z. Langford, S. D. Wulschleger, D. Maddalena, W. W. Hargrove, M. Mu, W. J. Riley, and J. T. Randerson, "Computational Approaches for Model, Experiment, and Data Integration Supporting Site Characterization and Model Evaluation." Community Surface Dynamics Modeling System (CSDMS) 2015 Annual Meeting (May 26–28, 2015), May 28, 2015, Boulder, Colorado, USA.

- [12] F. M. Hoffman, J. Kumar, D. Maddalena, Z. Langford, and W. W. Hargrove, "Multi-variate Spatio-Temporal Clustering: A Framework for Integrating Disparate Data to Understand Network Representativeness and Scaling Up Sparse Ecosystem Measurements." 2014 American Geophysical Union (AGU) Fall Meeting (December 15–19, 2014), December 18, 2014, San Francisco, California, USA.
- [13] Z. L. Langford, J. Kumar, F. M. Hoffman, V. Sloan, R. Norby, and S. Wullschleger, "Mapping Plant Functional Type Distributions in Arctic Ecosystems Using WorldView-2 Satellite Imagery and Unsupervised Clustering." 2014 American Geophysical Union (AGU) Fall Meeting (December 15–19, 2014), December 18, 2014, San Francisco, California, USA.
- [14] J. Kumar, Z. L. Langford, F. Yuan, and F. M. Hoffman, "Remote Sensing to Inform Plant Functional Type (PFT) Distributions in the Community Land Model." 2014 American Geophysical Union (AGU) Fall Meeting (December 15–19, 2014), December 19, 2014, San Francisco, California, USA.
- [15] F. M. Hoffman, J. Kumar, W. W. Hargrove, Z. Langford, D. Maddalena, W. J. Riley, and J. T. Randerson, "Integrating Earth Science Research through Model, Experiment, and Data Synthesis." U.S. Department of Energy Green Ocean Amazon (GOAmazon) Joint Principal Investigators Meeting, Woodrow Wilson International Center for Scholars, October 29, 2014, Washington, DC, USA.
- [16] F. M. Hoffman, J. Kumar, Z. Langford, D. Maddalena, N. Collier, V. Sloan, R. T. Mills, and W. W. Hargrove, "Representativeness-Based Sampling Network Design and Scaling Strategies for Measurements in Arctic and Tropical Ecosystems." U.S. Department of Energy Joint Terrestrial Ecosystem Science and Subsurface Biogeochemistry Research Principal Investigator Meeting (May 6–7, 2014), May 6, 2014, Potomac, Maryland, USA.
- [17] Z. L. Langford, M. N. Gooseff, and D. J. Lampkin, "Characterizing spatiotemporal dynamics of wetted soils across a polar desert landscape, McMurdo Dry Valleys, Antarctica." 2012 American Geophysical Union (AGU) Fall Meeting, December 2012, San Francisco, CA, USA.
- [18] Z. L. Langford, M. N. Gooseff, and D. J. Lampkin, "Characterizing spatiotemporal dynamics of wetted soils across a polar desert landscape, McMurdo Dry Valleys, Antarctica." LTER All Scientists Meeting, September 2012, Estes Park, CO, USA.
- [19] Z. L. Langford, M. N. Gooseff, and D. J. Lampkin, "Characterizing spatiotemporal dynamics of wetted soils across a polar desert landscape, McMurdo Dry Valleys, Antarctica." XXXII SCAR and Open Science Conference, July 2012, Portland, OR, USA.

## **Datasets**

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1. Langford, Z., F. Hoffman, and J. Kumar. 2014. Remote sensing-based characterization, 2-m, Plant Functional Type Distributions, Barrow Environmental Observatory, 2010. Next Generation Ecosystem Experiments Arctic Data Collection, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee, USA. doi:10.5440/1123668.
2. Langford, Z., F. Hoffman, and J. Kumar. 2018. Remote Sensing-Based, 5-m, Vegetation Distributions, Kougatok Road Mile Marker 64, Seward Peninsula, Alaska,

ca. 2000–2016. Next Generation Ecosystem Experiments Arctic Data Collection, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee, USA. doi:10.5440/1418854.

## **References**

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Available upon request