Fraser King, PhD

MACHINE LEARNING AND REMOTE SENSING SCIENTIST

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Education

University of Waterloo   *Waterloo, Ontario, Canada*
PHD, GEOGRAPHY   *2019 - 2022*
- Advisor: Dr. Christopher Fletcher
- Thesis: Developing a radar-based machine learning snowfall retrieval algorithm
- Finalist for the Waterloo 2023 Governor General's Gold Academic Medal (doctoral)

University of Waterloo   *Waterloo, Ontario, Canada*
MASTER OF SCIENCE   *2017 - 2019*
- Advisor: Dr. Christopher Fletcher
- Thesis: Validating CloudSat-CPR retrievals for the estimation of snow accumulation in the Canadian Arctic

University of Waterloo   *Waterloo, Ontario, Canada*
BACHELOR OF COMPUTER SCIENCE (HONOURS)   *2012 - 2017*
- Graduated with distinction on the Dean's honour list
- Participated in the honours co-op program with outstanding performance reviews

Professional Experience

2023	**Postdoctoral Research Fellow**, University of Michigan
2022	**Artificial Intelligence Research Intern**, Aquanty Inc.
2019	**Machine Learning Research Intern**, Aquanty Inc.
2016-2017	**Software Engineer**, TD Bank

Publications

King, F., Pettersen, C., Dolan, B., Shales, J., Posselt, D., (2024). Primary Modes of Northern Hemisphere Snowfall Particle Size Distributions. *Journal of Atmospheric Science*, in review.

King, F., Pettersen, C., Bliven, L., Cerrai, D., Chibisov, A., Cooper, S.J., L'Ecuyer, T., Kulie, M.S., Leskinen, M., Mateling, M., McMurdie, L., Moisseev, D., Nesbitt, S.W., Petersen, W.A., Rodriguez, P., Schirtzinger, C., Stuefer, M., von Lerber, A., Wingo, M.T., Wolff, D.B., Wong, T., Wood, N., (2024). A Comprehensive Northern Hemisphere Particle Microphysics Dataset from the Precipitation Imaging Package. *Earth and Space Science*, in review.

King, F., Pettersen, C. & Fletcher, C. G., Geiss, A. (2024). Development of a deep full-scale connected U-Net for reflectivity inpainting in spaceborne radar clutter zones. *Artificial Intelligence for the Earth Systems*. https://doi.org/10.1175/AIES-D-23-0063.1.

King, F., Kelly, R., & Fletcher, C. G. (2023). New opportunities for low-cost LiDAR-derived snow depth estimates from a consumer drone-mounted smartphone. *Cold Regions Science and Technology*, 207, 103757. https://doi.org/10.1016/j.coldregions.2022.103757

King, F., Duffy, G., Milani, L., Fletcher, C. G., Pettersen, C., & Ebell, K. (2022). DeepPrecip: A deep neural network for precipitation retrievals. *Atmospheric Measurement Techniques*, 15, 6035–6050. https://doi.org/10.5194/amt-15-6035-2022

King, F., Duffy, G., & Fletcher, C. G. (2022). A Centimeter Wavelength Snowfall Retrieval Algorithm Using Machine Learning. *Journal of Applied Meteorology and Climatology*, https://doi.org/10.1175/JAMC-D-22-0036.1

King, F., Kelly, R., & Fletcher, C. G. (2022). Evaluation of LiDAR-Derived Snow Depth Estimates From the iPhone 12 Pro. *IEEE Geoscience and Remote Sensing Letters*, https://doi.org/10.1029/2021MS002836

Fletcher, C. G., McNally, W., Virgin, G., & **King, F.** (2022). Toward efficient calibration of higher resolution Earth System Models. *Journal of Advances in Modeling Earth Systems*, 19, 1–5. https://doi.org/10.1109/LGRS.2022.3166665

King, F., & Fletcher, C. G. (2021). Using CloudSat-derived snow accumulation estimates to constrain gridded snow water equivalent products. *Earth and Space Science*, e2021EA001835. https://doi.org/10.1029/2021EA001835

Duffy, G., **King, F.**, Bennartz, R., and Fletcher, C. G. (2021). Seasonal Estimates and Uncertainties of Snow Accumulation from CloudSat Precipitation Retrievals. *Atmosphere*, 12(3), 363. https://doi.org/10.3390/atmos12030363

King, F., Erler, A. R., Frey, S. K., and Fletcher, C. G. (2020). Application of machine learning techniques for regional bias correction of snow water equivalent estimates in Ontario, Canada, *Hydrol. Earth Syst. Sci.*, 24, 4887–4902, https://doi.org/10.5194/hess-24-4887-2020

King, F., & Fletcher, C. G. (2020). Using CloudSat-CPR Retrievals to Estimate Snow Accumulation in the Canadian Arctic. *Earth and Space Science*, 7(2), e2019EA000776. https://doi.org/10.1029/2019EA000776

Awards, Fellowships, & Grants

2023	**Governor General's Gold Academic Medal (Finalist)**, University of Waterloo	–
2023	**Postdoctoral Fellowship**, Natural Sciences and Engineering Research Council (NSERC)	*$ 90,000*
2022	**Early Career Scientist Award (2nd)**, International Precipitation Working Group	*$ 50*
2021	**Campbell Scientific Canada Award**, Eastern Snow Conference	*$ 500*
2020	**Doctoral Scholarship**, Natural Sciences and Engineering Research Council (NSERC)	*$ 63,000*
2019	**Exceptional Doctoral Student Scholarship**, University of Waterloo	*$ 10,000*
2019	**ESRI Canada GIS Centres of Excellence National Hackathon (1st)**, ESRI Canada	*$ 500*
2019	**Jack Rosen Memorial Award for Environmental Innovation (1st)**, University of Waterloo	*$ 2,000*
2019	**GRADflix Research Communication Video Winner (1st)**, University of Waterloo	*$ 1,000*
2019	**ESM-SnowMIP EGU Travel Grant**, Snow Models Intercomparison Project	*$ 1,000*
2012	**Governor General's Bronze Academic Medal**, Central Huron Secondary School	–

Presentations

Invited Talks

Spring 2024. *Towards Interpretable Artificial Intelligence in the Atmospheric Sciences* Invited Speaker, NASA Jet Propulsion Laboratory. In Person.

Spring 2024. *Let it Snow! Let it Snow! Let it Snow! Climate Series Talks.* Invited Speaker, Maitland Valley Conservation Authority. Online.

Winter 2024. *A Comprehensive Northern Hemisphere Particle Microphysics Dataset from the Precipitation Imaging Package* Invited Speaker, PSD Working Group. Online.

Fall 2023. *Development of a deep full-scale connected U-Net for reflectivity inpainting in spaceborne radar clutter zones* Invited Speaker, AGU 2023. In person.

Fall 2022. *Do neural networks dream of falling snow?* Invited Speaker, Intact Financial Corporation. Online.

Summer 2022. *DeepPrecip: A deep neural network for precipitation retrievals*. Invited Speaker, PMM Land Surface Working Group. Online.

Fall 2021. *Enhancing the accuracy of current snow water equivalent products using remote sensing and machine learning*. Guest Lecture, Machine Learning Research Group, University of Guelph. Online.

Winter 2019. *Bias correcting snow water equivalent data using machine learning*. Guest Lecture, Aquanty Inc. In person.

Contributed Presentations

King, F., Pettersen, C., & Fletcher, C. G., (2023). Development of a full-scale connected U-Net for reflectivity inpainting in spaceborne radar blind zones. Invited oral presentation: American Geophysical Union 2023. In Person.

King, F., Pettersen, C., & Fletcher, C. G., (2023). Development of a full-scale connected U-Net for reflectivity inpainting in spaceborne radar blind zones. Oral presentation: American Meteorological Society's 40th Conference on Radar Meteorology. In Person.

King, F., Pettersen, C., & Fletcher, C. G., (2023). Development of a deep full-scale connected U-Net for reflectivity inpainting in spaceborne radar clutter zones. Oral presentation: Eastern Snow Conference 2023. In Person.

King, F., Pettersen, C., & Fletcher, C. G., (2023). Development of a deep full-scale connected U-Net for reflectivity inpainting in spaceborne radar clutter zones. Oral presentation: Vanderbilt University Machine Learning and Snowfall Workshop. In Person.

King, F., Duffy, G., Milani, L., Fletcher, C. G., Pettersen, C., & Ebell, K. (2022). DeepPrecip: A deep neural network for precipitation retrievals. Oral presentation: University of Waterloo Graduate Student Conference. In Person.

King, F., Duffy, G., Milani, L., Fletcher, C. G., Pettersen, C., & Ebell, K. (2022). DeepPrecip: A deep neural network for precipitation retrievals. Oral presentation: AGU Collective Madison Meeting (SatMET). Online.

King, F., Duffy, G., Milani, L., Fletcher, C. G., Pettersen, C., & Ebell, K. (2022). DeepPrecip: A deep neural network for precipitation retrievals. Oral presentation: AGU Frontiers in Hydrology Meeting. Online.

King, F., Duffy, G., Milani, L., Fletcher, C. G., Pettersen, C., & Ebell, K. (2022). DeepPrecip: A deep neural network for precipitation retrievals. Oral presentation: International Precipitation Working Group. In person.

King, F., Duffy, G., Milani, L., Fletcher, C. G., Pettersen, C., & Ebell, K. (2022). DeepPrecip: A deep neural network for precipitation retrievals. Oral presentation: Eastern Snow Conference. Online.

King, F., Kelly, R., & Fletcher, C. G. (2022). What if you put a phone on a drone?. Oral presentation: Canadian Meteorological and Oceanographic Society. Online.

King, F, Duffy, G., Fletcher, C. G. (2021). A Centimeter Wavelength Snowfall Retrieval Algorithm Using Machine Learning. Poster: International Summer Snowfall Workshop. Online.

King, F, Fletcher, C. G. (2021). Using CloudSat-CPR derived snow accumulation estimates to constrain gridded snow water equivalent products. Oral presentation: Canadian Meteorological and Oceanographic Society. Online.

King, F, Kelly, R., Fletcher, C. G. (2021). Evaluation of LiDAR snow depth estimates from portable consumer devices and their application for citizen science. Oral presentation: Eastern Snow Conference. Online.

King, F, Fletcher, C. G. (2021). Using CloudSat-CPR derived snow accumulation estimates to constrain gridded snow water equivalent products. Oral presentation: IEEE Geoscience and Remote Sensing Society (IGARSS). Online.

King, F, Fletcher, C. G. (2020). Bias-correction of gridded SWE products using CloudSat-CPR snowfall estimates. Oral presentation: Canadian Meteorological and Oceanographic Society. Online.

King, F, Erler, A., Frey, S., Fletcher, C. G. (2020). Application of Machine Learning Techniques for Regional Bias Correction of SWE Estimates in Ontario, Canada. Oral presentation: Climate Informatics (CI). Online.

King, F, Fletcher, C. G. (2020). Evaluation of Gridded Snow Products Using CloudSat Snowfall Estimates. Poster: Canadian Space Agency (CSA) Workshop. CSA, Montreal, Canada.

King, F, Fletcher, C. G. (2019). Evaluation of Gridded Snow Products Using CloudSat Snowfall Estimates. Oral presentation: European Geosciences Union (EGU). Vienna, Austria.

King, F, Fletcher, C. G. (2019). Using CloudSat-CPR Retrievals to Estimate Snow Accumulation in the Canadian Arctic. Oral presentation: Canadian Meteorological and Oceanographic Society. Halifax, Nova Scotia.

Research Projects

Radar Blindzone Inpainting using Artificial Intelligence 2023 - Present

I am the primary investigator on a research project which uses deep learning to predict near surface reflectivity profiles in spaceborne radar. As the project lead, I am responsible for sourcing and processing the training data, designing and tuning the convolutional neural network, assigning tasks to other co-authors, and presenting the results at conferences and workshops. My 2-year Postdoctoral Fellowship proposal on this topic was approved and funded by NSERC, beginning in 2023.

Deep Learning Snowfall Retrieval (DeepPrecip) 2021 - 2022

I was the primary investigator on a deep learning snowfall retrieval project where my responsibilities included algorithm design, model implementation, and performance evaluation. As the leader of a team of 5 other researchers, I was also responsible for delegating project tasks and adhering to tight deadlines. I facilitated an ongoing collaborative effort with

various international partners and data providers, and our work resulted in multiple conference presentations and a journal article publication.

Canadian Space Agency (CSA) Snowfall Project 2017 - 2020

As a highly qualified person on a CSA-funded snowfall project, I was responsible for analysing the output from several space-borne remote sensing instruments and presenting my results twice a year at bi-annual meetings. This project group consisted of members from various Universities and Government agencies, with a joint interest in improving next-generation space-based snowfall estimates. My participation resulted in various international conference presentations and several scientific publications related to the validation and application of CloudSat-CPR measurements.

Teaching Experience

2024	**Master's of Science Defense Committee Member**, External Examiner	*University of Waterloo*
2022	**Machine learning applications for land cover classification using Sentinel-2**, Instructor	*Aggregate Intellect*
2017-2019	**ENVS 278**, Teaching Assistant	*University of Waterloo*

Mentoring

2023-Present	**Research Mentor**, Department of Climate and Space Sciences and Engineering	*University of Michigan*
2017-2019	**Statistics Tutor**, Undergraduate Students in Math, Computer Science and Geography	*University of Waterloo*

Technical Skills

- **Languages**: Python, C/C++, Objective-C, R, Rust, Go, Swift, Javascript, Bash
- **Software**: Tensorflow, scikit-learn, SciPy, Keras, PyTorch, Zarr, Xarray, Pandas, Git, SQL, HDF, netCDF, Slurm, CUDA
- **Hardware**: Azure, Graphcore, Google Compute, Great Lakes, Mist GPU Cluster, Google Colab, Paperspace

Outreach & Professional Development

SERVICE AND OUTREACH

2023	**AMS Radars**, Machine Learning Session Abstract Reviewer	*AMS*
2023	**Google Quantum AI**, Design Consultant	*Google*
2023	**International Precipitation Conference 14**, Session Moderator	*University of Oklahoma*
2022	**AGU Precipitation Technical Committee**, Executive Member (ongoing)	*American Geophysical Union*
2022	**Eastern Snow Conference**, Executive Council Member (ongoing)	*ESC*
2022	**Canadian Meteorological and Oceanographic Society (CMOS) Bulletin**, Author	*CMOS*
2022	**NSERC Science Exposed**, Lead Designer	*NSERC*
2021	**Environment Building Mural Project (Canada Map)**, Creator, Designer and Project Lead	*University of Waterloo*
2021	**Environment Graduate Student Recruitment**, PhD Student Panelist	*University of Waterloo*
2018	**Let's Talk Science**, Student Volunteer	*University of Waterloo*

DEVELOPMENT

GraphCore AI Training: Completed an online training course to use deep learning libraries like Tensorflow and Keras with big data on the Graphcore Intelligence Processing Unit pods.

Compute Canada - High Performance Computing Course: A two day in-person course provided in-depth detail into using the Niagara super-computing cluster (ie. submitting and parallelizing compute tasks).

3 Minute Thesis Competition: As a participant in this competition, I learned valuable techniques for communicating my research in a clear and concise manner to a wide audience.