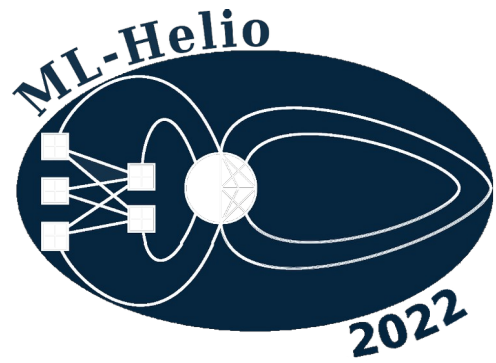


**2nd Machine Learning in Heliophysics
Boulder, 21 – 25 March 2022**



Monday 21st March

8:30 – 9:30 Registration and Coffee
9:30 – 10:00 Introductory Remarks

Session 1 – Chairs: Tom Berger (in-person), Naoto Nishizuka (virtual)

10:00 – 10:30 (Invited) **Rafal Angryk**
Making Stuff Up: Ameliorating Data Scarcity in Flare Forecasting through Synthetic Multivariate Time Series Generation with Deep Learning

10:30 – 11:00 Coffee break

11:00 – 11:20 **Cedric Huwyler** (FHNW, Switzerland)
Using Multiple Instance Learning for Explainable Flare Prediction

11:20 – 11:40 **Kiera van der Sande** (University of Colorado)
Comparing Solar Flare Irradiance in GOES X-ray and SDO/AIA EUV Data via Machine Learning Regression

11:40 – 12:00 **Jonathan Donzallaz** (iCoSys, HES-SO, Switzerland)
SolarNet: Solar Flares Prediction with Self-Supervised Learning

12:00 – 12:20 **Dattaraj B Dhuri** (NYU Abu Dhabi)
Deep learning reconstruction of sunspot vector magnetic fields for forecasting solar storms

12:20 – 14:00 Lunch

Session 2 – Chairs: Tom Berger (in-person), Enrico Camporeale (in-person)

14:00 – 14:30 (Invited) **Eunsu Park**
Application of image translation methods based on deep learning to solar data

14:30 – 14:50 **Elena G Broock** (Instituto Astrofísico de Canarias)
Farnet-II: application of Convolutional LSTM and attention mechanisms to solar far-side activity detection

14:50 – 15:10 **Allison Liu** (University of Colorado)
Data Augmentation of Magnetograms for Solar Flare Prediction using GANs

15:10 – 16:00 Coffee Break

16:00 – 16:30	(Invited) Andres Munoz-Jaramillo <i>Using Neural Network Ensembles to Estimate Uncertainty in Heliophysics Applications</i>
16:30 – 16:50	Robert Jarolim (Graz University) <i>Probing the coronal magnetic field with physics informed neural networks</i>
16:50 – 17:10	Oleg Stepanyuk (Bulgarian Academy of Sciences) <i>Advanced Image Preprocessing and Feature Tracking for Remote CME Characterization with Deep Learning</i>
17:10 – 17:30	Benoit Tremblay (University of Colorado) <i>Emulation of MHD simulations to Infer Flows in Granulation, Sunspots, and Active Regions</i>
18:30 – 20:00	Reception <i>Embassy Suites by Hilton, 2601 Canyon Blvd, Boulder</i>

Tuesday 22nd March

8:00 – 9:30	(Hands-on tutorial) Hannah Marlowe (Amazon AWS) <i>Introduction to computer vision object detection for solar flare identification.</i>
9:30 – 10:00	Coffee break
10:00 – 11:30	Wendy Carande (LASP, University of Colorado) <i>Tutorial on ML, part 1</i> <ul style="list-style-type: none"> • <i>Data exploration</i> • <i>Supervised and unsupervised learning</i> • <i>Parameter searches</i>
11:30 – 12:30	Poster Session A (mostly virtual)
12:30 – 14:00	Lunch

Session 3 – Chairs: **Pete Riley (virtual), Enrico Camporeale (in-person)**

14:00 – 14:30	(Invited) Katariina Nykyri (Embry-Riddle Aeronautical University) <i>Information Theory and Machine Learning Applications to Solar Wind Magnetosphere Interactions</i>
14:30 – 14:50	Sahib Julka (University of Passau) <i>An active learning approach for automatic detection of bow shock and magnetopause crossing signatures in Mercury's magnetosphere using MESSENGER magnetometer observations.</i>

14:50 – 15:10	Simon Wing (Johns Hopkins Applied Physics Lab) <i>Modeling radiation belt electrons with information theory informed neural networks</i>
15:10 – 15:30	Georgios Balasis (National Observatory of Athens) <i>Machine Learning Techniques for Automated ULF Wave Recognition in Swarm Time Series</i>
15:30 – 15:50	Michael S. Kirk (ASTRA) <i>The Center for HelioAnalytics</i>
15:50 – 18:00	Poster Session A (mostly in-person) – including coffee and refreshments

Wednesday 23rd March

8:30 – 10:30	Enrico Camporeale (University of Colorado) <i>Tutorial on ML, part 2</i> <i>Gaussian Process Regression</i>
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10:30 – 11:00	Coffee Break
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Session 4 – Chairs: Jacob Bortnik (virtual), Amy Keesee (in-person)

11:00 – 11:20	Ramiz A. Qudsi (Boston University) <i>Algorithm Development for Magnetic Field topology Reconstruction in a 3-D Simulation Box Using Machine Learning</i>
11:20 – 11:40	Brian Swiger (University of Michigan) <i>Energetic Electron Flux Predictions in the near-Earth Plasma Sheet from Solar Driving</i>
11:40 – 12:00	Mikhail Sitnov (Johns Hopkins Applied Physics Lab) <i>Resolving the geomagnetic tail current sheet structure with data mining</i>
12:00 – 12:20	Sigiava Aminimalragia-Giamini (SPARC) <i>Radiation belt model including semi-annual variation and Solar driving (SENTINEL)</i>
12:20 – 12:40	Sergio Vidal-Luengo (University of Colorado) <i>Whistler-mode Waves and Relativistic Precipitation Event Detection by Employing Self-Organizing-Maps</i>
12:40 – 14:00	Lunch

Session 5 – Chairs: Simon Wing (in-person), Pete Riley (virtual)

14:00 – 14:30	(invited) Jay Johnson (Andrews University) <i>Information Horizon of Flares and Magnetic Active Regions</i>
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14:30 – 14:50	Marius Giger (FHNW, Switzerland) <i>Unsupervised event detection in heliophysics</i>
14:50 – 15:10	Sophie Teichmann (Georg-August-Universität Göttingen) <i>Influence of solar wind parameters on unsupervised solar wind classification</i>
15:10 – 15:30	Talwinder Singh (University of Alabama) <i>Improving the Arrival Time Prediction of Coronal Mass Ejections using Magnetohydrodynamic Ensemble Modeling, Heliospheric Imager data and Machine Learning</i>
15:30 – 16:00	(invited) Gary Doran (JPL) <i>Responsive Onboard Science for Europa Clipper</i>
16:00 – 16:30	Coffee
16:30 – 17:00	(invited) Maria Elena Innocenti (Ruhr University Bochum) <i>A versatile technique for unsupervised classification and preliminary analysis of simulation results</i>
17:00 – 17:20	Hannah Marlowe (Amazon) <i>An unsupervised learning approach to superstorm signature identification in precipitating particle data</i>
17:20 – 17:40	Andong Hu (University of Colorado) <i>Innovative Dst predictions using neural networks</i>
17:40 – 18:00	Kiley Yeakel (Johns Hopkins Applied Physics Lab) <i>Automated algorithm for the detection of dispersionless electron injection events in Earth's magnetotail</i>

Thursday 24th March

Session 6 – Chairs: Michael Kirk (virtual), Amy Keesee (in-person)

8:30 – 9:00	(invited) Maziar Raissi (University of Colorado) <i>Data-Efficient Deep Learning using Physics-Informed Neural Networks</i>
9:00 – 9:20	Xiaoyue Li (Zhejiang University) <i>Transfer-Solar-GAN: Generation of Input Sources for Solar Wind Models with Deep Learning</i>
9:20 – 9:40	Panagiotis Tigas (Oxford University) <i>Global geomagnetic perturbation forecasting using deep learning</i>
9:40 – 10:00	Mohamed Nedal (Bulgarian Academy of Sciences) <i>Forecasting the Solar Energetic Protons Integral Flux using the Bi-Directional Long Short-Term Memory Neural Network</i>

10:00 – 10:20	Andrew Smith (University College London) <i>Producing ML-driven Real-Time Forecasts of the Probability of Large Rates of Change of the Surface Magnetic Field in the UK</i>
10:20 – 11:00	Coffee Break
11:00 – 11:30	(invited) Alan Kaptanoglu (University of Washington) <i>Machine Learning for discovering sparse models of fluids, plasmas, and much more</i>
11:30 – 12:30	Poster Session B (mostly virtual)
12:30 – 14:00	Lunch

Session 7: - Chairs: Pete Riley (virtual), Delores Knipp (in-person)

14:00 – 14:20	Sai Gowtam Valluri (University of Alaska) <i>An Artificial Neural Network-based global three-dimensional ionospheric electron density model: present state, challenges, and future directions</i>
14:20 – 14:40	Vivian Otugo (Rivers State University) <i>Estimation of ionospheric critical plasma frequencies from GNSS-TEC measurements using artificial neural networks</i>
14:40 – 15:00	Jhassmin A Aricoché (Universidad Nacional del Callao) Modeling ionograms with deep neural networks: Contrasting models
15:00 – 15:30	Brianna Maze and Alec Engell (NextGen) <i>The Weather Machine Learning Platform and the Space Radiation Intelligence System</i>
15:30 – 17:30	Poster Session B (mostly in-person) – including coffee and refreshments
19:30	Social Dinner <i>Champions Center – Rooftop Terrace Club, 2150 Stadium Dr, Boulder, 80302</i>

Friday 25th March

Session 8 – Chairs: Enrico Camporeale (in-person), Tom Berger (in-person)

8:30 – 9:00	Early career awards
9:00 – 9:30	(invited) Maria J. Molina (NCAR, Boulder, Colorado) <i>Machine Learning for the Geosciences</i>
9:30 – 9:50	Simon Mackovjak (Slovak Academy of Sciences) <i>Towards explanation of airglow variation by ML techniques</i>

9:50 – 10:10	Shanshan Bao (Rice University) <i>A gray-box approach in modeling atmospheric precipitation in global geospace models</i>
10:10 – 10:30	Daniel I Okoh (Centre for Atmospheric Research) <i>Results from a 3-D electron density model developed from COSMIC radio occultation data using artificial neural networks</i>
10:30 – 11:00	Coffee
11:00 – 11:20	Delores J Knipp (University of Colorado) <i>Geophysical interpretations from machine learning superstorm signature identification in satellite precipitating particle data</i>
11:20 – 11:40	Ekaterina Verner (NASA) <i>Heliophysics AI/ML focused program, AWS case study and crowdsourcing result</i>
11:40 – 13:00	Open discussion
13:00	Farewell lunch (bag lunch available)

List of posters (v=virtual; p=in person)

Session A (Tuesday 22)

- 1) Amy Keesee (p) *Methods to improve magnitude accuracy for machine learning predictions of ground magnetic field perturbations*
- 2) Jasmine R Kobayashi (v) *Machine Learning Models as an Alternative to Standard Interpolation Techniques for Estimating Gaps in OMNI Data*
- 3) Dattaraj B Dhuri (v) *A deep learning model of proton auroras on Mars*
- 4) Charles Topliff (p) *A domain transfer approach to forecasting the Solar Wind at L1*
- 5) Talha Siddique (v) *A Bayesian Ensemble Machine Learning Approach For Prediction of Geomagnetically Induced Currents (GICs) With Uncertainty Quantification*
- 6) Adam T Michael (v) *Radiation Belt Variability due to Wave-Particle Interactions: A Multiscale Modeling Approach*
- 7) Spiridon Kasapis (p) *Machine Learning-Based Forecasting of SEP Events Using the Recently Published MDI Data*
- 8) Pete Riley (v) *What Machine Learning Algorithms Teach us about Which Explanatory Variables Matter Most in Predicting Bz within Coronal Mass Ejections*
- 9) Rainer Arlt (v) *Machine learning for digitization of historical records of solar activity*

- 10) Gonzalo A Cucho-Padin (p) *A machine learning framework for the reconstruction of the 3-D ion density distributions and energetic fluxes in the Earth's cusp*
- 11) Jiahui Shan (v) *Transfer learning for the three-dimensional reconstruction of CMEs*
- 12) Xiukuan Zhao (v) *Ionospheric scintillation prediction using gradient boosting algorithm*
- 13) Kimberly D Moreland (p) *A machine-learning oriented remote and in-situ database for forecasting SEP occurrence and properties*
- 14) Anna L Morozova (v) *Comparison of the performance of PCA-NN models for daily mean TEC over the Iberian Peninsula: performance of different neural networks configuration*
- 15) Daniel T S Wrench (v) *Exploring the potential of neural networks to predict statistics of solar wind turbulence*
- 16) Raman Mukundan (p) *Optimizing a Neural Network for Regional Forecasting of Ground Magnetic Perturbations Using Spherical Elementary Current Systems*
- 17) Rukundo Wellen (v) *Forecasting of ionospheric electron content (TEC) using a time series neural network*
- 18) Xiangning Chu (v) *Relativistic Electron Model in the Outer Radiation Belt Using a Neural Network Approach*
- 19) Luiz F Guedes dos Santos(p) *Exploring the ability of Convolutional Neural Networks to predict Solar wind quantities at 1 AU*
- 20) Hannah T Rüdisser (v) *Automatic Detection of Interplanetary Coronal Mass Ejections*
- 21) Luisa Capannolo (v) *Investigating the Relativistic Electron Precipitation using Deep Learning Techniques*
- 22) Alexander Boyd (v) *SHELLS Model: Specifying High-altitude Electrons using Low-altitude LEO Systems*
- 23) Kamen Kozarev (p) *Towards Lucky Imaging for Quiet-Time Low-Frequency Radio Solar Observations*
- 24) Michael K Coughlan (v) *Using a Convolutional Neural Network with Uncertainty to Forecast GIC Risk of Occurrence at Mid-Latitudes.*
- 25) Victor A Pinto (v) *Developing near real-time ground magnetic field perturbations predictions with machine learning models*
- 26) Xudong Sun (v) *SpIn4D: Spectropolarimetric Inversion in Four Dimensions with Deep Learning*
- 27) Kendra Bergstedt (p) *Machine Learning Algorithms for the Detection of Plasmoids in Multiple-X-Line Collisionless Reconnection Regions*
- 28) Rong Lin (v) *Predicting Ambient Solar Wind Speed at L1-point based on Convolutional Neural Network and PFSS Magnetogram*
- 29) Mario Cobos Maestre (v) *Stability of loss functions for solar wind forecasting using Deep Learning*
- 30) Armando Collado-Villaverde(v) *Deep Neural Networks With Convolutional and LSTM Layers for SYM-H and ASY-H Forecasting.*

- 31) Andong Hu (p) *A Multi-Hour-Ahead global geospace model using Gated Recurrent Unit (GRU) networks and SuperMAG data*
- 32) Suvadip Sinha (v) *A comparative study of supervised machine learning algorithms to forecast solar flares*
- 33) Tommaso Alberti (v) *Chaos and spontaneous stochasticity: two sides of (un)predictability*
- 34) Juliana Vievering (p) *Real-Time Solar Flare Predictions using Machine Learning*
- 35) Verena Heidrich-Meisner (v) *Neural network reconstruction of in-situ solar wind parameters*
- 36) Ute V Amerstorfer (v) *Machine Learning Solutions for Data Analysis and Exploitation in Planetary Science - A Work Package in Europlanet 2024 Research Infrastructure*
- 37) Ajay Kumar Tiwari (v) *CME-learn: An interactive playground to benchmark CME databases for the time of arrival (ToA) prediction for using machine learning methods*
- 38) Subhamoy Chatterjee (p) *Forecasting the Occurrence Probability and Properties of Solar Energetic Particle Events using a Multivariate Ensemble of Convolutional Neural Networks*
- 39) Donglai Ma (v) *Machine learning based reconstruction and prediction of radiation belt flux*
- 40) Enrico Camporeale (p) *Space Weather with Quantified Uncertainty: Optimizing Ensembles for Probabilistic Predictions*
- 41) Liam Smith (v) *Machine Learning for Ionospheric Extrapolation and Forecasting in a Data-Model Fusion Approach*
- 42) Kyle Domico (v) *A Machine Learning and Computer Vision Approach to Geomagnetic Storm Forecasting*
- 43) Dominique L Stumbaugh (p) *Predicting Equatorial Electron Flux Measurements from Low Earth Orbit*
- 44) Yong Ji (v) *Composite model for predicting sym-H index*
- 45) Matthew G Lennard (v) *Machine Learning in Heliophysics*
- 46) Simon Bouriat (p) *Forecasting low-energy particle flux in LEO using DMSP satellites: data analysis and first results*

Session B (Thursday 24)

- 48) Luiz F Guedes dos Santos (p) *Forecasting flux rope's orientation using CNNs*
- 49) Henrik Eklund (v) *Image refinement and estimation of intensity contrast degradation at small scales events of Solar observations.*
- 50) Adeline T M Paiement (v) *Cloud removal from ground-based images of the Sun*
- 51) Elizabeth P O'Dwyer (v) *Machine Learning for the Classification of Low Frequency Extensions of Saturn Kilometric Radiation*
- 52) Carlos J Diaz Baso (p) *Bayesian Stokes inversion with Normalizing flows*
- 53) Harry Arnold (v) *Using Effective Resistivity Maps Derived From Data Mining for Global MHD Simulations of the Magnetosphere*
- 54) Ajay Kumar Tiwari (v) *Predicting Arrival Time and Arrival Speed for CMEs: Machine Learning and Ensemble Methods*
- 55) Laura Simms (v) *A comparison of ARMAX (autoregressive moving average transfer function) and RNN (recurrent neural network) models to predict geostationary keV electrons*
- 56) Yigit Aytac (p) *A Computer Vision Approach for Real-time Solar Event Detection*
- 57) Dogacan S Ozturk (v) *A predictive model for the high-latitude ionospheric convection*
- 58) Aliaa A. M. Afify (v) *Development of a forecasting technique for ionospheric plasma irregularities by applying a supervised machine learning regression technique to spaceborne GPS measurements*
- 59) Matthew Blandin (v) *Predicting Geomagnetically Induced Currents across Alaska utilizing Multi-Variate LSTM models*
- 60) Robert Jarolim (p) *ITI for the Sun: Improved intercalibration of multi-instrument heliophysics data series with Instrument-To-Instrument translation*
- 61) Reynaldo O Rojas Zelaya (v) *Forecasting Spread F at Jicamarca*
- 62) Laura Simms (v) *The use of differencing to remove spurious correlations in models of geostationary 2 MeV electron flux*
- 63) Naoto Nishizuka (v) *Reliable Probability Forecast of Solar Flares using Deep Neural Networks*
- 64) Paul J Wright (p) *SDOVIS: A Vision Transformer Model for Solar Dynamics Observatory (SDO) Data*
- 65) Constantinos Papadimitriou (v) *Application of information theoretical measures for improved machine learning modelling of the electron radiation belt*
- 66) Hemapriya Raju (v) *Deep learning analysis on CMEs associated with flares and filaments*
- 67) Ryan McGranaghan (v) *A Next Generation Space Weather Particle Precipitation Model: Mature machine learning approaches, multiscale mesoscale prediction, and an open science framework for machine learning*

- 68) Andrea Diercke (p) *Automatic Extraction of Solar Filaments Using Machine Learning Techniques*
- 69) Sumanth A.T. Rotti (v) *Machine Learning Dataset of SEP Events from Solar Cycles 22, 23 and 24.*
- 70) Yana Shtyk (v) *Solar flare prediction using a multi-channel model*
- 71) Pavithra G Srinivas (v) *Development Of An Onboard Space Weather Module For Satellite Operations*
- 72) Denny Oliveira (p) *Perspectives on the use of data assimilation for improving thermospheric empirical models: Focus on extreme magnetic storms*
- 73) Grant K Stephens (v) *Global structure of magnetotail reconnection unveiled by mining spaceborne magnetometer data*
- 74) Vanessa M Mercea (v) *Detection of sunquakes in Egression Power Maps using Deep Autoencoders*
- 75) Anthony Sciola (v) *Ring current plasma pressure reconstructed from empirical magnetic field distributions embedded within a global MHD model*
- 76) Ravindra T Desai (p) *Using a neural network to model ultra-relativistic charged particles and exploit sparse datasets*
- 77) Sachin A Reddy (v) *Predicting Equatorial Plasma Bubbles with Machine Learning and CubeSats*
- 78) Edward J E Brown (v) *Attention-based machine vision models and techniques for solar wind speed forecasting using solar EUV images*
- 79) Stefano Bianco (v) *A modification of the PINE model for real-time plasmaspheric forecasts*
- 80) Thomas Berger (p) *Decreasing False Alarm Rates in ML-based Solar Flare Prediction using SDO/HMI Data*
- 81) Shah Mohammad Bahauddin(v) *Unboxing the Black Box: Learning to identify acoustic wave sources on the Sun from Deep Learning*
- 82) Donglai Ma (v) *Automatic discovery of the equations governing radiation belt dynamics*
- 83) Saida Milena Diaz Castillo (v) *Dense segmentation of solar granulation structures using deep learning*
- 84) Harim Lee (p) *Generation of Modern Satellite Data from Galileo Sunspot Drawings by Deep Learning*
- 85) James Lende (v) *Statistical Investigation of the Erosion and Refilling of the Plasmasphere - Neural Network Model Approach*
- 86) John C Dorelli (v) *Vlasov Informed Super Resolution (VISR): A Deep Learning Approach for De-Aliasing Particle Data*

- 87) Xin Cao (v) *Investigation of the response of equivalent ionospheric current to upstream solar wind and magnetospheric activity: a neural network approach*
- 88) Subhamoy Chatterjee (p) *Utilizing a Convolutional Neural Network to Efficiently Label a Solar Flux Emergence Video Dataset*
- 89) Zeyu Sun(v) *Predicting Solar Flares Using CNN and LSTM on Two Solar Cycles of Active Region Data*
- 90) Linnea Wolniewicz (v) *SEARCH: SEgmentation of Active Regions and Coronal Holes*
- 91) Enrico Camporeale (p) *The PRAISE Initiative: Promoting Research in Artificial Intelligence for the Space Economy*
- 92) Kevin D Smith (v) *Machine Learning Classification of Mercury Magnetospheric Boundary Crossings*
- 93) Daniel E da Silva (p) *Semi-Empirical Data Compression for Heliophysics Space Mission Data*

Sponsors



Time difference calculator

(Note: on this week USA is on Daylight Saving time, while Europe and Australia are still on winter time)

Boulder	Rome	New Delhi	Tokyo	Sydney
MDT (UTC -6)	CE T (UTC+1)	IST (UTC +5:30)	JST (UTC +9)	AEDT (UTC +11)
8:00 am	3:00 pm	7:30 pm	11:00 pm	1:00 am
12:00 pm	7:00 pm	11:30 pm	3:00 am	5:00 am
3:00 pm	10:00 pm	2:30 am	6:00 am	8:00 am
5:00 pm	12:00 am	4:30 am	8:00 am	10:00 am