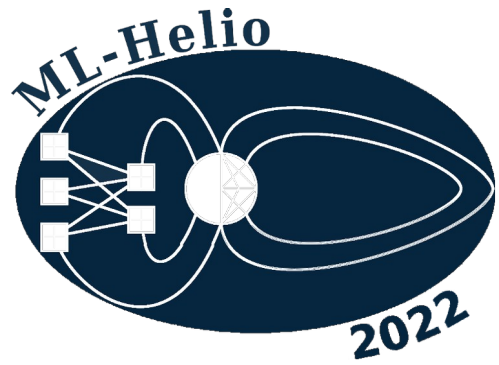


**2<sup>nd</sup> Machine Learning in Heliophysics  
Boulder, 21 – 25 March 2022**



**Monday 21<sup>st</sup> March**

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

**Session 1 – Chairs:**

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*

11:00 – 11:20      **Cedric Huwyler** (University of Applied Sciences and Arts Northwestern, CH)  
*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** (Haute Ecole d'Ingénierie et d'Architecture Fribourg, CH)  
*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:**

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

## Tuesday 22<sup>nd</sup> March

8:00 – 9:30	(demo) <b>Hannah Marlowe</b> (Amazon AWS)
9:30 – 10:00	Coffee break
10:00 – 11:30	<b>Wendy Carande</b> (LASP, University of Colorado) <i>Tutorial on ML, part 1</i>
11:30 – 12:30	Poster Session A ( <i>mostly virtual</i> )
12:30 – 14:00	Lunch

### Session 3 – Chairs:

14:00 – 14:30	(Invited) <b>Katariina Nykyri</b> (Embry-Riddle Aeronautical University) <i>Information Theory and Machine Learning Applications to Solar Wind Magnetosphere Interactions</i>
14:30 – 14:50	<b>Sahib Julka</b> (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	<b>Simon Wing</b> (Johns Hopkins Applied Physics Lab) <i>Modeling radiation belt electrons with information theory informed neural networks</i>
15:10 – 15:30	<b>Georgios Balasis</b> (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)  
*The Center for HelioAnalytics*
- 15:50 – 18:00      Poster Session A (*mostly in-person*) – including coffee and refreshments

### **Wednesday 23<sup>rd</sup> March**

- 8:30 – 10:30      **Enrico Camporeale** *Tutorial on ML, part 2:*
- *Gaussian Process Regression*

- 10:30 – 11:00      Coffee Break

#### **Session 4 – Chairs:**

- 11:00 – 11:20      **Ramiz A. Qudsi** (Boston University)  
*Algorithm Development for Magnetic Field topology Reconstruction in a 3-D Simulation Box Using Machine Learning*
- 11:20 – 11:40      **Brecht Laperre** (KU Leuven)  
*Identification of closure terms from fully kinetic plasma simulations using machine learning*
- 11:40 – 12:00      **Mikhail Sitnov** (Johns Hopkins Applied Physics Lab)  
*Resolving the geomagnetic tail current sheet structure with data mining*
- 12:00 – 12:20      **Sigiava Aminimalragia-Giamini** (SPARC)  
*Radiation belt model including semi-annual variation and Solar driving (SENTINEL)*
- 12:20 – 12:40      **Sergio Vidal-Luengo** (University of Colorado)  
*Whistler-mode Waves and Relativistic Precipitation Event Detection by Employing Self-Organizing-Maps*
- 12:40 – 14:00      Lunch

#### **Session 5 – Chairs:**

- 14:00 – 14:30      (invited) **Jay Johnson** (Andrews University)  
*Information Horizon of Flares and Magnetic Active Regions*
- 14:30 – 14:50      **Marius Giger** (University of Applied Sciences and Arts Northwestern, CH)  
*Unsupervised event detection in heliophysics*
- 14:50 – 15:10      **Sophie Teichmann** (Georg-August-Universität Göttingen)  
*Influence of solar wind parameters on unsupervised solar wind classification*
- 15:10 – 15:30      **Talwinder Singh** (University of Alabama)  
*Improving the Arrival Time Prediction of Coronal Mass Ejections using*

*Magnetohydrodynamic Ensemble Modeling, Heliospheric Imager data and Machine Learning*

- 15:30 – 16:00 (invited) **Gary Doran** (JPL)  
*Responsive Onboard Science for Europa Clipper*
- 16:00 – 16:30 Coffee
- 16:30 – 17:00 (invited) **Maria Elena Innocenti** (Ruhr University Bochum)  
*A versatile technique for unsupervised classification and preliminary analysis of simulation results*
- 17:00 – 17:20 **Hannah Marlowe** (Amazon)  
*An unsupervised learning approach to superstorm signature identification in precipitating particle data*
- 17:20 – 17:40 **Andong Hu** (University of Colorado)  
*Innovative Dst predictions using neural networks*
- 17:40 – 18:00 **Kiley Yeakel** (Johns Hopkins Applied Physics Lab)  
*Automated algorithm for the detection of dispersionless electron injection events in Earth's magnetotail*

## Thursday 24<sup>th</sup> March

### *Session 6 – Chairs:*

- 8:30 – 9:00 (invited) **Maziar Raissi** (University of Colorado)  
*Data-Efficient Deep Learning using Physics-Informed Neural Networks*
- 9:00 – 9:20 **Xiaoyue Li** (Zhejiang University)  
*Transfer-Solar-GAN: Generation of Input Sources for Solar Wind Models with Deep Learning*
- 9:20 – 9:40 **Panagiotis Tigas** (Oxford University)  
*Global geomagnetic perturbation forecasting using deep learning*
- 9:40 – 10:00 **Mohamed Nedal** (Bulgarian Academy of Sciences)  
*Forecasting the Solar Energetic Protons Integral Flux using the Bi-Directional Long Short-Term Memory Neural Network*
- 10:00 – 10:20 **Andrew Smith** (University College London)  
*Producing ML-driven Real-Time Forecasts of the Probability of Large Rates of Change of the Surface Magnetic Field in the UK*
- 10:20 – 11:00 Coffee Break
- 11:00 – 11:30 (invited) **Alan Kaptanoglu** (University of Washington)

*Machine Learning for discovering sparse models of fluids, plasmas, and much more*

11:30 – 12:30	Poster Session B (mostly virtual)
12:30 – 14:00	Lunch
14:00 – 14:20	<b>Sai Gowtam Valluri</b> (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	<b>Vivian Otugo</b> (Rivers State University) <i>Estimation of ionospheric critical plasma frequencies from GNSS-TEC measurements using artificial neural networks</i>
14:40 – 15:00	<b>Jhassmin A Aricoché</b> (Universidad Nacional del Callao) Modeling ionograms with deep neural networks: Contrasting models
15:00 – 15:30	<b>Brianna Maze</b> and <b>Alec Engell</b> (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

## Friday 25<sup>th</sup> March

### **Session 7 – Chairs:**

8:30 – 9:00	Early career awards
9:00 – 9:30	(invited) <b>Maria J. Molina</b> (NCAR, Boulder, Colorado) <i>Machine Learning for the Geosciences</i>
9:30 – 9:50	<b>Simon Mackovjak</b> (Slovak Academy of Sciences) <i>Towards explanation of airglow variation by ML techniques</i>
9:50 – 10:10	<b>Shanshan Bao</b> (Rice University) <i>A gray-box approach in modeling atmospheric precipitation in global geospace models</i>
10:10 – 10:30	<b>Daniel I Okoh</b> (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	<b>Delores J Knipp</b> (University of Colorado) <i>Geophysical interpretations from machine learning superstorm signature identification in satellite precipitating particle data</i>
11:20 – 11:40	<b>Ekaterina Verner</b> (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

*(Poster sessions will be assigned once we have numbers on virtual and in-person attendees)*

Carlos J Diaz Baso	<i>Bayesian Stokes inversion with Normalizing flows</i>
Spiridon Kasapis	<i>Machine Learning-Based Forecasting of SEP Events Using the Recently Published MDI Data</i>
Linnea Wolniewicz	<i>SEARCH: SEgmentation of Active Regions and Coronal Holes</i>
Pete Riley	<i>What Machine Learning Algorithms Teach us about Which Explanatory Variables Matter Most in Predicting Bz within Coronal Mass Ejections</i>
Yong Ji	<i>Composite model for predicting sym-H index</i>
Egor Illarionov	<i>Machine learning for digitization of historical records of solar activity</i>
Zeyu Sun	<i>Predicting Solar Flares Using CNN and LSTM on Two Solar Cycles of Active Region Data</i>
Shan Jiahui	<i>Transfer learning for the three-dimensional reconstruction of CMEs</i>
Xiukuan Zhao	<i>Ionospheric scintillation prediction using gradient boosting algorithm</i>
Matthew G Lennard	<i>Machine Learning in Heliophysics</i>
Anna L Morozova	<i>Comparison of the performance of PCA-NN models for daily mean TEC over the Iberian Peninsula: performance of different neural networks configuration</i>
Kevin D Smith	<i>Machine Learning Classification of Mercury Magnetospheric Boundary Crossings</i>
Daniel T S Wrench	<i>Exploring the potential of neural networks to predict statistics of solar wind turbulence</i>

Rukundo Wellen	<i>Forecasting of ionospheric electron content (TEC) using a time series neural network</i>
Emmanuel De Leon	<i>Automatic detection of the electron density from the WHISPER instrument onboard CLUSTER</i>
Drew L Turner	<i>Unsupervised clustering employed to identify different drivers of relativistic electron enhancement events in Earth's magnetotail</i>
Xiangning Chu	<i>Relativistic Electron Model in the Outer Radiation Belt Using a Neural Network Approach</i>
Kimberly D Moreland	<i>A machine-learning oriented remote and in-situ database for forecasting SEP occurrence and properties</i>
Amy Keese	<i>Methods to improve magnitude accuracy for machine learning predictions of ground magnetic field perturbations</i>
Hannah T Rüdisser	<i>Automatic Detection of Interplanetary Coronal Mass Ejections</i>
Luisa Capannolo	<i>Investigating the Relativistic Electron Precipitation using Deep Learning Techniques</i>
Raman Mukundan	<i>Optimizing a Neural Network for Regional Forecasting of Ground Magnetic Perturbations Using Spherical Elementary Current Systems</i>
Alexander Boyd	<i>SHELLS Model: Specifying High-altitude Electrons using Low-altitude LEO Systems</i>
Michael K Coughlan	<i>Using a Convolutional Neural Network with Uncertainty to Forecast GIC Risk of Occurrence at Mid-Latitudes.</i>
Victor A Pinto	<i>Developing near real-time ground magnetic field perturbations predictions with machine learning models</i>
Xudong Sun	<i>SpIn4D: Spectropolarimetric Inversion in Four Dimensions with Deep Learning</i>
Rong Lin	<i>Predicting Ambient Solar Wind Speed at L1-point based on Convolutional Neural Network and PFSS Magnetogram</i>
Stefan Lotz	<i>Solar flare forecast and feature attribution with simple deep neural networks</i>
Mario Cobos Maestre	<i>Stability of loss functions for solar wind forecasting using Deep Learning</i>
Armando Collado-Villaverde	<i>Deep Neural Networks With Convolutional and LSTM Layers for SYM-H and ASY-H Forecasting.</i>
Suvadip Sinha	<i>A comparative study of supervised machine learning algorithms to forecast solar flares</i>
Tommaso Alberty	<i>Chaos and spontaneous stochasticity: two sides of (un)predictability</i>
Luiz F Guedes dos Santos	<i>Exploring the ability of Convolutional Neural Networks to predict Solar wind quantities at 1 AU</i>
Seray Sahin	<i>Spatial and Temporal Analysis of Quiescent Coronal Rain over an Active Region</i>

Luiz F Guedes dos Santos	<i>Forecasting flux rope's orientation using CNNs</i>
Peter Wintoft	<i>Solar wind to ground magnetic field proxies studied with GRU networks: predictability with respect to physical phenomena</i>
Kamen Kozarev	<i>Towards Lucky Imaging for Quiet-Time Low-Frequency Radio Solar Observations</i>
Verena Heidrich-Meisner	<i>Neural network reconstruction of in-situ solar wind parameters</i>
Ute V Amerstorfer	<i>Machine Learning Solutions for Data Analysis and Exploitation in Planetary Science - A Work Package in Europlanet 2024 Research Infrastructure</i>
Ajay Kumar Tiwari	<i>CME-learn: An interactive playground to benchmark CME databases for the time of arrival (ToA) prediction for using machine learning methods</i>
Elizabeth P O'Dwyer	<i>Machine Learning for the Classification of Low Frequency Extensions of Saturn Kilometric Radiation</i>
Harry Arnold	<i>Using Effective Resistivity Maps Derived From Data Mining for Global MHD Simulations of the Magnetosphere</i>
Ajay Kumar Tiwari	<i>Predicting Arrival Time and Arrival Speed for CMEs: Machine Learning and Ensemble Methods</i>
Laura Simms	<i>A comparison of ARMAX (autoregressive moving average transfer function) and RNN (recurrent neural network) models to predict geostationary keV electrons</i>
Luigi Palladino	<i>Application of diverse explainable DL architectures for sunspot groups detection and classification</i>
Dogacan S Ozturk	<i>A predictive model for the high-latitude ionospheric convection</i>
Aliaa A. M. Afify	<i>Development of a forecasting technique for ionospheric plasma irregularities by applying a supervised machine learning regression technique to spaceborne GPS measurements</i>
Matthew Blandin	<i>Predicting Geomagnetically Induced Currents across Alaska utilizing Multi-Variate LSTM models</i>
Chris Green	<i>Solar flare predictions with mixed data neural network</i>
Reynaldo O Rojas Zelaya	<i>Forecasting Spread F at Jicamarca</i>
Adam T Michael	<i>Radiation Belt Variability due to Wave-Particle Interactions: A Multiscale Modeling Approach</i>
Kendra Bergstedt	<i>Machine Learning Algorithms for the Detection of Plasmoids in Multiple-X-Line Collisionless Reconnection Regions</i>
Yigit Aytac	<i>A Computer Vision Approach for Real-time Solar Event Detection</i>
Andong Hu	<i>A Multi-Hour-Ahead global geospace model using Gated Recurrent Unit (GRU) networks and SuperMAG data</i>
Sevag Derghazarian	<i>Neural Network Based ISR Estimates</i>



Jasmine R Kobayashi	<i>Machine Learning Models as an Alternative to Standard Interpolation Techniques for Estimating Gaps in OMNI Data</i>
Robert Jarolim	<i>ITI for the Sun: Improved intercalibration of multi-instrument heliophysics data series with Instrument-To-Instrument translation</i>
Paul J Wright	<i>SDOVIS: A Vision Transformer Model for Solar Dynamics Observatory (SDO) Data</i>
Laura Simms	<i>The use of differencing to remove spurious correlations in models of geostationary 2 MeV electron flux</i>
Naoto Nishizuka	<i>Reliable Probability Forecast of Solar Flares using Deep Neural Networks</i>
Juliana Vievering	<i>Real-Time Solar Flare Predictions using Machine Learning</i>
Constantinos Papadimitriou	<i>Application of information theoretical measures for improved machine learning modelling of the electron radiation belt</i>
Hemapriya Raju	<i>Deep learning analysis on CMEs associated with flares and filaments</i>
Ryan McGranaghan	<i>A Next Generation Space Weather Particle Precipitation Model: Mature machine learning approaches, multiscale mesoscale prediction, and an open science framework for machine learning</i>
Dattaraj B Dhuri	<i>A deep learning model of proton auroras on Mars</i>
Henrik Eklund	<i>Image refinement and estimation of intensity contrast degradation at small scales events of Solar observations.</i>
Sumanth A.T. Rotti	<i>Machine Learning Dataset of SEP Events from Solar Cycles 22, 23 and 24.</i>
Yana Shtyk	<i>Solar flare prediction using a multi-channel model</i>
Pavithra G Srinivas	<i>Development Of An Onboard Space Weather Module For Satellite Operations</i>
Grant K Stephens	<i>Global structure of magnetotail reconnection unveiled by mining spaceborne magnetometer data</i>
Gonzalo A Cucho-Padin	<i>A machine learning framework for the reconstruction of the 3-D ion density distributions and energetic fluxes in the Earth's cusp</i>
Andrea Diercke	<i>Automatic Extraction of Solar Filaments Using Machine Learning Techniques</i>
Vanessa M Mercea	<i>Detection of sunquakes in Egression Power Maps using Deep Autoencoders</i>
Anthony Sciola	<i>Ring current plasma pressure reconstructed from empirical magnetic field distributions embedded within a global MHD model</i>
Varad Deshmukh	<i>Decreasing False Alarm Rates in ML-based Solar Flare Prediction using SDO/HMI Data</i>
Talha Siddique	<i>A Bayesian Ensemble Machine Learning Approach For Prediction of Geomagnetically Induced Currents (GICs) With Uncertainty Quantification</i>

Victor M Velasco Herrera	<i>Are Ground Level Enhancement events really the result of a random process?</i>
Sachin A Reddy	<i>Predicting Equatorial Plasma Bubbles with Machine Learning and CubeSats</i>
Edward J E Brown	<i>Attention-based machine vision models and techniques for solar wind speed forecasting using solar EUV images</i>
Stefano Bianco	<i>A neural network model of the plasmasphere dynamics</i>
Michele Piana	<i>The STIX imaging problem</i>
Denny Oliveira	<i>Perspectives on the use of data assimilation for improving thermospheric empirical models: Focus on extreme magnetic storms</i>
Ravindra T Desai	<i>Using a neural network to model ultra-relativistic charged particles and exploit sparse datasets</i>
Harim Lee	<i>Generation of Modern Satellite Data from Galileo Sunspot Drawings by Deep Learning</i>
Charles Topliff	<i>A domain transfer approach to forecasting the Solar Wind at L1</i>
Shah Mohammad Bahauddin	<i>Unboxing the Black Box: Learning to identify acoustic wave sources on the Sun from Deep Learning</i>
Daniel E da Silva	<i>Semi-Empirical Data Compression for Heliophysics Space Mission Data</i>
Subhamoy Chatterjee	<i>Utilizing a Convolutional Neural Network to Efficiently Label a Solar Flux Emergence Video Dataset</i>
Subhamoy Chatterjee	<i>Forecasting the Occurrence Probability and Properties of Solar Energetic Particle Events using a Multivariate Ensemble of Convolutional Neural Networks</i>
Dominique L Stumbaugh	<i>Predicting Equatorial Electron Flux Measurements from Low Earth Orbit</i>
Donglai Ma	<i>Automatic discovery of the equations governing radiation belt dynamics</i>
Adeline T M Paiement	<i>Cloud removal from ground-based images of the Sun</i>
Simon Bouriat	<i>Forecasting low-energy particle flux in LEO using DMSP satellites: data analysis and first results</i>
Saida Milena Diaz Castillo	<i>Dense segmentation of solar granulation structures using deep learning</i>

James Lende	<i>Statistical Investigation of the Erosion and Refilling of the Plasmasphere - Neural Network Model Approach</i>
John C Dorelli	<i>Vlasov Informed Super Resolution (VISR): A Deep Learning Approach for De-Aliasing Particle Data</i>
Brian Swiger	<i>Energetic Electron Flux Predictions in the near-Earth Plasma Sheet from Solar Driving</i>
Donglai Ma	<i>Machine learning based reconstruction and prediction of radiation belt flux</i>
Xin Cao	<i>Investigation of the response of equivalent ionospheric current to upstream solar wind and magnetospheric activity: a neural network approach</i>
Enrico Camporeale	<i>Space Weather with Quantified Uncertainty: Optimizing Ensembles for Probabilistic Predictions</i>
Enrico Camporeale	<i>The PRAISE Initiative: Promoting Research in Artificial Intelligence for the Space Economy</i>

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