3rd Machine Learning in Heliophysics
Madrid, 22-26 September 2025

Monday 22nd September

9:30 – 10:00 Welcome (Christophe Arviset) & Introductory Remarks

Session 1 – Chairs: Camporeale & Masson

10:00 – 10:30 *Paul Wright* From Model to Impact: Engineering Machine Learning for Space Weather Forecasting (invited, online)

10:30 – 10:50 *Anant Telikicherla* A New HOPE for Accurate Solar Flare Prediction (online)

10:50 – 11:10 *Youngjae Kim* Interpretable Data-Driven Models for Solar Flare Forecasting through Deep Learning and Symbolic Regression (in-person)

11:10 – 11:40 Coffee break

11:40 – 12:00 *Ekaterina Dineva* Combining Physics-Derived and Machine-Learned Features for Probabilistic Solar Flare Forecasting (in-person)

12:00 – 12:20 *Naoto Nishizuka* Operational Use of Deep Flare Net and AI techniques for Space Weather Forecasting (in-person)

12:20 – 12:40 *Panagiotis Gonidakis* Soft X-ray Flux Prediction for Onboard 24-Hour Solar Flare Forecasting Using CNNs and SDO/AIA Images (in-person)

12:40 – 13:00 *Linn Abraham* Interpretable Deep Learning for Solar Flare Predictions (online)

13:00 – 13:20 *Daniel da Silva* Generative Diffusion Models of the Solar Corona (in-person)

13:30 – 15:00 Lunch

Session 2 – Chairs: Delouille & Consolini

15:00 – 15:30 *George Miloshevich* Data-Driven Closures for Hybrid Plasma Models in Space Plasmas (invited , in-person)

15:30 – 15:50 *Prateek Mayank* Next-Generation MHD Modeling Of Solar Wind Using Neural Operators (in-person)

15:50 – 16:10 *Hiroshi Hasegawa* Reconstruction of two-dimensional MHD and Hall MHD equilibria in space using physics-informed neural networks (in-person)

16:10 – 16:30 *Manuel Lacal* Physics-Informed Neural Networks for Modeling Geomagnetic Storm Dynamics (in-person)

16:30 – 17:00 Coffee break

17:00 – 17:20 *Jithu J Athalathil* Investigating Nonlinear Quenching Effects on Polar Field Buildup Using Physics-Informed Neural Networks (online)

17:20 – 17:40 *Mingyu Jeon* Real-time Reconstruction of Coronal Magnetic Fields using a Physics-informed Neural Operator (in-person)

17:40 – 18:00 *Clinton Groth* Merging Observational Data and Magnetohydrodynamics: A Variational Data Assimilation Approach for the Solar Wind (in-person)

18:00 – 18:30 *Robert Jarolim* The Sun in 3D: Bridging Gaps in Solar Observations with Physics-Informed Machine Learning (invited, in-person)

19:00 – 20:30 Reception (on-site)

Tuesday 23rd September

Session 3 – Chairs: Miloshevich & Camporeale

9:30 – 10:00 *Opal Issan* Bayesian Inference and Global Sensitivity Analysis for Ambient Solar Wind Prediction (invited, in-person)

10:00 – 10:20 *Seungwoo Ahn* Verification of Empirical and Deep Learning Models for Solar Wind Speed Forecasting (in-person)

10:20 – 10:40 *Matthew Billcliff* Extended Lead-Time Geomagnetic Storm Forecasting with Solar Wind Ensembles and Machine Learning (in-person)

10:40 – 11:00 *Francesco Ramunno* Predicting partially observable dynamical systems via diffusion models with a multiscale inference scheme (in-person)

11:00 – 11:30 Coffee break

Session 4 – Chairs: Wing & Consolini

11:30 – 11:50 *Peter Wintoft* Gaussian Process forecast of strong geomagnetic storms using CME-ICME properties (in-person)

11:50 – 12:10 *Hannah Ruedisser* ARCANE: An Operational Framework for Automatic Realtime ICME Detection in Solar Wind In Situ Data (in-person)

12:10 – 12:30 *Jiahui Shan* CAMEL-II: A 3D Coronal Mass Ejection Catalog Based on Coronal Mass Ejection Automatic Detection with Deep Learning (in-person)

12:30 – 12:50 *Julio Hernandez Camero* Bayesian Inference for 3D CME Characterization and Uncertainty Quantification (in-person)

12:50 – 13:10 *Matthew Rutala* Data-driven, Probabilistic Solar Wind Reconstruction Beyond the Earth (online)

13:10 – 13:30 *Sadaf Shahsavani* Kp Prediction from Solar Wind Parameters Using Sparse Library Regression (in-person)

13:30 – 15:00 Lunch

15:00 – 18:30 Poster session 1 (in-person)

Wednesday 24th September

Session 5 – Chairs: Azari & Camporeale

9:30 – 10:30 ESA Datalab tutorial

10:30 – 11:00 *Caitriona Jackman* How to creatively account for the lack of an upstream monitor at planets other than Earth (invited, online)

11:00 – 11:30 *Sabrina Guastavino* Learning the Sun: Machine Learning and Physical Insight for Space Weather Forecasting (invited, in-person)

11:30 – 11:50 Coffee break

Session 6 – Chairs: Masson & Guastavino

11:50 – 12:10 *Abigail Azari* Towards Operational Planetary Space Weather with A Virtual Solar Wind Monitor at Mars (in-person)

12:10 – 12:30 *Daragh Hollman* Classifying MESSENGER Magnetospheric Boundary Crossings Using a Random Forest Model (online)

12:30 – 12:50 *Gautier Nguyen* Auto-encoder based reduced order emulation of the Earth electron radiation belt modeling (in-person)

12:50 – 13:10 *François Ginisty* SPARTAI – an AI-based forecasting pipeline for energetic electrons in the Earth's radiation belts (in-person)

13:10 – 13:30 *Dylan Weston* A threshold-based random forest forecasting model for the Outer Radiation Belt (online)

13:30 – 15:00 Lunch

15:00 – 16:20 Poster Session 2 (virtual: 3 minute flash talks)

16:20 – 16:50 Coffee

Session 7 – Chairs: Leka & Nishizuka

16:50 – 17:10 *Idowu Raji* A Multi-Stage Self Organizing Map-Autoencoder-LSTM Model for Total Solar Irradiance Prediction (in-person)

17:10 – 17:30 *Esraa Elelimy* Long-Horizon Prediction of Solar Wind Events with Reinforcement Learning (online)

17:30 – 17:50 *Bhishek Manek* Cross-Calibrated Video Super-Resolution for Solar Dopplergrams (online)

17:50 – 18:10 *Jacob Bortnik* Using interpretable AI to discover the drivers of acceleration vs depletion events in the radiation belt (online)

18:10 – 18:30 ML-Helio competition launch

Thursday 25th September

Session 8 – Chairs: Delouille & Wing

9:30 – 10:00 *Henrik Eklund* Deep learning across multi-dimensional data (invited, in-person)

10:00 – 10:20 *Daniel Gass* Dataset Creation for ML Applications in Heliophysics - Lessons from ARCAFF (online)

10:20 – 10:40 *Sergio Sánchez Hurtado* Toward Uncertainty-Aware Thermospheric Drag Forecasting via Time Series Foundation Models (in-person)

10:40 – 11:00 *Léa Zuili* MLOps for Reproducible Machine Learning in Space Science: Insights from ESAC (in-person)

11:00 – 11:30 Coffee break

Session 9 – Chairs: Wintoft & Leka

11:30 – 11:50 *Mohamed Nedal* Short-Term Solar Energetic Proton Flux Forecasting using Transformer Architectures (in-person)

11:50 – 12:10 *Paulina Quijia Pilapana* Automatic Identification of Magnetic Reconnection to Assess its Role in Collisionless Turbulent Plasmas Using Unsupervised Machine Learning (in-person)

12:10 – 12:30 *Nikita Balodhi* Bayes in Space: A Bayesian Deep Learning approach for Coronal Temperature estimation (in-person)

12:30 – 12:50 *Junmu Youn* Stereoscopic DEM Analysis Using Solar Orbiter/EUI and AI-Generated Data(in-person)

12:50 – 13:10 *Katherine Keegan* An AI-powered Surface Flux Transport model to measure high-resolution velocity fields and forecast magnetic flux emergence (in-person)

13:10 – 13:30 *Francesco Carella* Transient-Oriented Clustering of Solar Wind Observations at 1 AU (in-person)

13:30 – 15:00 Lunch

15:00 – 18:30 Poster session 3 (in-person)

Friday 26th September

Session10 – Chairs: Camporeale & Masson

9:30 – 10:00	Early career awards
10:00 – 10:30	*Jonathan Citrin* TORAX: A Fast and Differentiable Tokamak Transport Simulator in JAX (invited, online)
10:30 – 10:50	*Joanna Slawinska* Koopman Operator Theory and new Data-Driven Approach to Modeling and Signal Processing of Spatiotemporal Data (online)
10:50 – 11:10	*Andrés Muñoz-Jaramillo* HelioFM a foundation model in heliophysics (in-person)
11:10 – 11:30	*Verena Heidrich-Meisner* Anomaly detection applied to solar wind composition measured by SOHO/CELIAS/CTOF and ACE/SWICS (in-person)
11:30 – 12:00	Coffee break
12:00 -- 13:30	Open discussion
13:30 – 15:00	Farewell lunch

List of posters

Poster session 1 (in-person; posters can be displayed from Mon morning to Tue afternoon)

1) *Simon Wing* Information theory based system level Babcock-Leighton flux transport model-data comparisons (in-person)

2) *Armando Collado-Villaverde* Dst Forecasting with REDst: Pushing the Limits of Real-Time L1 Data (in-person)

3) *Rong Sun* Automatic Detection of Lyman-alpha Solar Flares Based on GOES/EUVS Flux and ASO-S/SDI Images (in-person)

4) *Maria Hasler* Unsupervised analysis of dangerous space weather: Combining ground and space-based measurement (in-person)

5) *Yasmin Machuca* Automatic Identification of CMEs images using synthetically trained neural networks (in-person)

6) *Shi Tao* Automated Detection of Foreshock Transients Using Machine Learning Techniques (in-person)

7) *Emanuel Jess* Discovering heat flux closures using machine learning methods (in-person)

8) *François Ginisty* Augura Space Nowcast Platform: A Research-Focused, Open Demonstrator for Space Weather Data Integration and Visualization (in-person)

9) *Emerick Laborde* Physics-Informed Deep Learning for the characterization of the electron radiation belts dynamics (in-person)

10) *Samuel Burles* Data-Driven Plasma Closure Relation for Landau Damping in One Dimension (in-person)

11) *Ji-Hye Baek* DeepSDO: A Deep Learning-Based Approach for Automated Detection and Visualization of Solar Events (in-person)

12) *Junmu Youn* Aurora Detection in Sequential e-POP/FAI Images Using Deep Learning and Explainable AI (in-person)

13) *KD Leka* SuperSynthia LOS: Learning to Estimate Photospheric Vector Fields from Line-of-Sight Magnetograms (in-person)

14) *Francesco Ramunno* Enhancing image resolution of solar magnetograms: A latent diffusion model approach (in-person)

15) *Raman Mukundan* Towards an Interpretable Model of Localized Geomagnetic Disturbances in Terms of Solar Wind and M-I Processes (in-person)

16) *Brianna Isola* ML-IMEF: A Machine Learning Approach to Global Modeling of the Inner Magnetospheric Electric Field (in-person)

17) *Jihyeon Son* Time-Resolved Causal Analysis of Geomagnetic Storms Using Information Theory (in-person)

18) *Iván Maseda-Zurdo* An Interpretable Approach to SYM-H Geomagnetic Index Forecasting (in-person)

19) *Silvia Kostárová* Opportunities for early detection of CMEs and CIRs by Vigil data and machine learning approach (in-person)

20) *Benjamin Grison* Comparison of automatic and machine-learning detections of EMIC waves (in-person)

21) *Qiushuo Wang* Modeling Ring Current Ion Distribution using MLP, CNN, LSTM, and Transformer Networks (in-person)

22) *Aikaterini Pesini* Solar Radio Burst Tracker: A citizen science initiative to identify Type III solar radio bursts (in-person)

23) *Andrés Muñoz-Jaramillo* Investigating plasma composition with deep learning (in-person)

24) *Veronique Delouille* Mitigating hallucination with non-adversarial strategies for image-to-image translation in solar physics (in-person)

25) *Giuseppe Consolini* On timescale of geomagnetic storm recovery phase (in-person)

Poster session 2 (virtual: posters will be uploaded online and authors will have a 3-minute flash talk with 2 slides)

1) *Stefan Lotz* Solar wind - geomagnetic disturbance coupling predicted and interpreted with KnowIt (online)

2) *Nathaniel Laurent* World Coordinate System Framework to enhance AI applications in PyTorch (online)

3) *Jakub Juranek* Self-improving solar events prediction system: exploring potential of Darwin Gödel Machine agentic AI framework for cosmic weather forecasting (online)

4) *Carl Shneider* Proxy Sensing of Space Weather Events Using Solar Panel Telemetry (online)

5) *Herman le Roux* Automated Detection of Solar Radio Bursts Using Detectron (online)

6) *Liam Smith* Using TEC to Enhance 3D Electron Density Models (online)

7) *Raphael Attie* CHESS: Coronal Hole Extraction with Semantic Segmentation (online)

8) *Xiangning Chu* Unraveling Near-Earth Space Dynamics with Machine Learning (online)

9) *Simon Joyce* Revealing the Martian ionosphere using AI and 20 years of Mars Express data (online)

10) *Daniele Telloni* Transition to a Critical State of Active Regions: Identifying Solar Flare Precursors (online)

11) *Dibya Mishra* Neural Network-Based Detection of Plages in Historical Solar Drawings (online)

12) *Mariano Sanchez Toledo* Automatic GCS reconstruction of CMEs using synthetically-trained neural networks (online)

13) *Paloma Jol* Flare forecasting using Fully Convolutional Network to gain insight into active regions (online)

14) *Andy Smith* Self Supervised Encoding to Find Similar Observations (online)

15) *Atuel Villegas* High resolution TEC forecasting using transformers models (online)

16) *Subhamoy Chatterjee* Deep Generative model that uses physical quantities to generate and retrieve solar magnetic active regions (online)

17) *Jan Raath* Machine Learning in Galactic Cosmic Ray Propagation (online)

18) *Stefan Lotz* TEC and Transfer Learning (online)

19) *Nina Bonaventura* Estimated high-resolution photospheric flows using an AI surface flux transport model (online)

Poster session 3 (in-person; posters can be displayed from Wed morning to Thu afternoon)

1) *Francesco Ramunno* AIA2STIX: Bridging the gap between UV and X-ray in solar imaging (in-person)

2) *Hiroshi Hasegawa* Revisiting the cold-dense plasma sheet formation mechanism using causal inference and information-theoretic analysis (in-person)

3) *Daeil Kim* Solar EUV Channel Selection with Magnetogram via Multi-domain image Translation (in-person)

4) *Poshan Belbase* Reconstructing Historical Solar Activity Indices to Model Past Space Weather Events (in-person)

5) *Edoardo Legnaro* Solar Active Region Classification with Deep Learning (in-person)

6) *João Felipe Pereira* Comparing Machine and Deep Learning Techniques for Solar Flare Prediction (in-person)

7) *Simon Mackovjak* Deep Learning Classification of Low-latitude Ionospheric Structures in Airglow Images (in-person)

8) *Stephen Tete* Bayesian and Machine Learning for Geomagnetic Activity forecast: Where Causality augments Explainability (in-person)

9) *Jose Espinoza Acosta* CCA-Informed Neural Networks for Predicting Plasma Sheet Conditions from Solar Wind Drivers (in-person)

10) *Dominique Stumbaugh* Reconstructing Equatorial Electron Flux Measurements from LEO (in-person)

11) *Daniel da Silva* Data-Mining Similar Scenarios for Uncertainty Quantification of Solar Wind Predictions at L1 (in-person)

12) *Robert Jarolim* 3D Tomographic Reconstruction of Coronal Plasma Density and Temperature Using Neural Radiance Fields (in-person)

13) *Sanjali Vuriti* Data Analysis for Multi-Hazard Risk Science: Risk and Resilience of Societal Critical Infrastructure to Space Weather and Compounding Natural Hazards (in-person)

14) *Sandor Kruk* ESA Datalabs: Digital Innovation in Space Science (in-person)

15) *David O'Ryan* AnomalyMatch: A Detection Method of Astrophysical Anomalies in Imaging Data (in-person)

16) *Jan Reerink* The Heliophysics Extended Survey Environment (in-person)

17) *Griffin T. Goodwin* An EUV Extension to the SWAN-SF Flare Forecasting Dataset (in-person)

18) *Alexandre Suteau* DeepHelio - Predicting Solar Wind Speed at L1 Using Solar Imagery and Deep Learning (in-person)

19) *Emanuel Jess* Bridging Kinetic and Fluid Scales: Addressing the Plasma Closure Problem with ML (in-person)

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