Prediction of Adverse effects of Geomagnetic storms and Energetic Radiation (PAGER)

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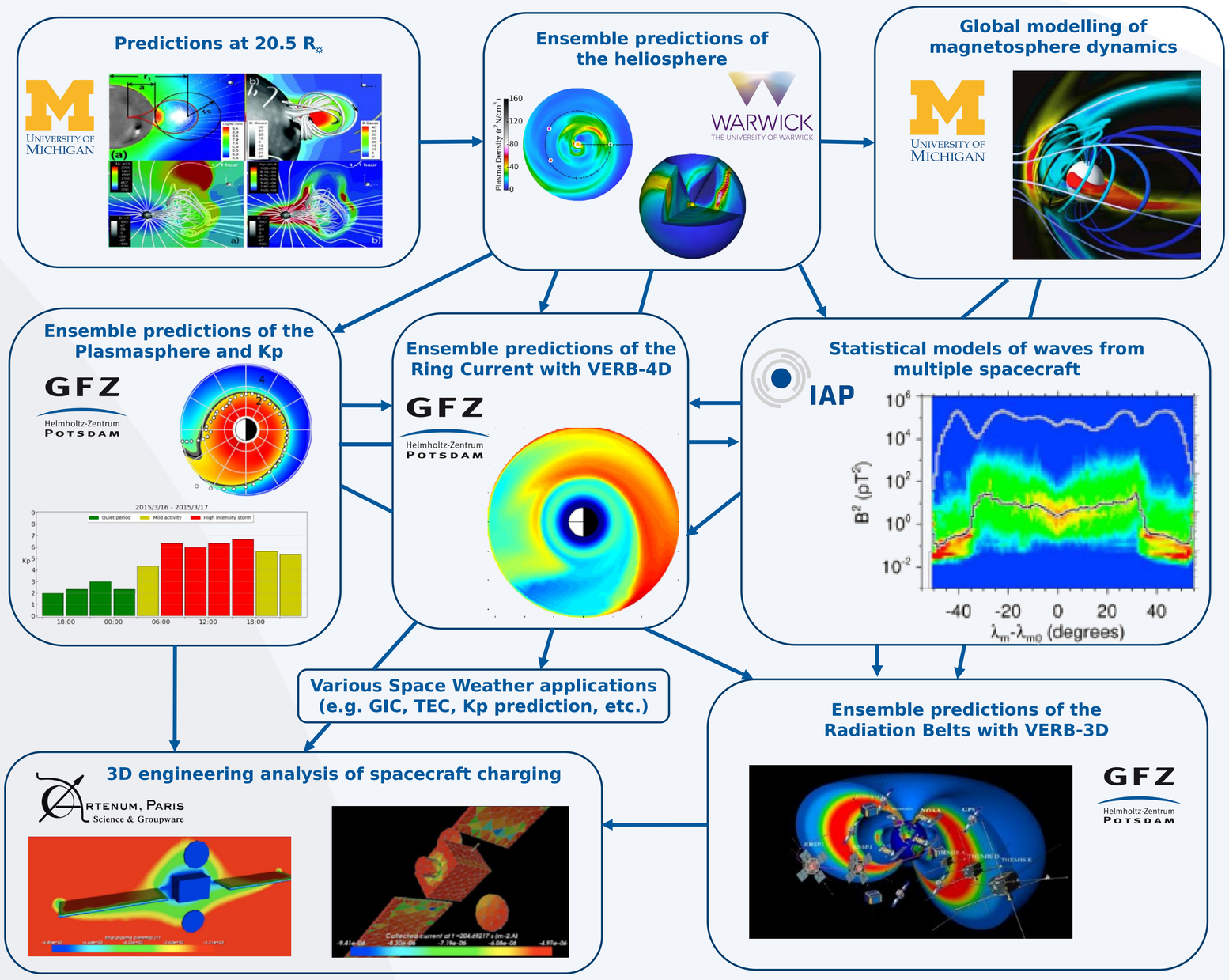
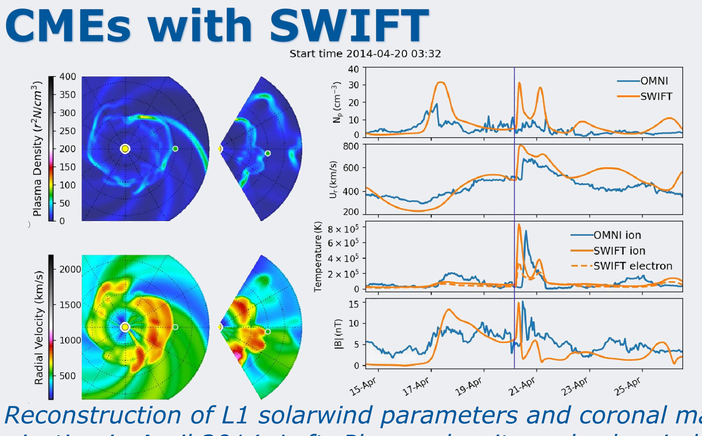
Objectives

- Predictions with sufficient lead-time for stakeholders to respond
- Reliable predictions utilizing all available data
- Predictions with confidence levels so stakeholders can estimate risks and economic benefits
- Clear forecasts with easy to understand variables that are usable for stakeholders

Coupling of state-of-the-art models

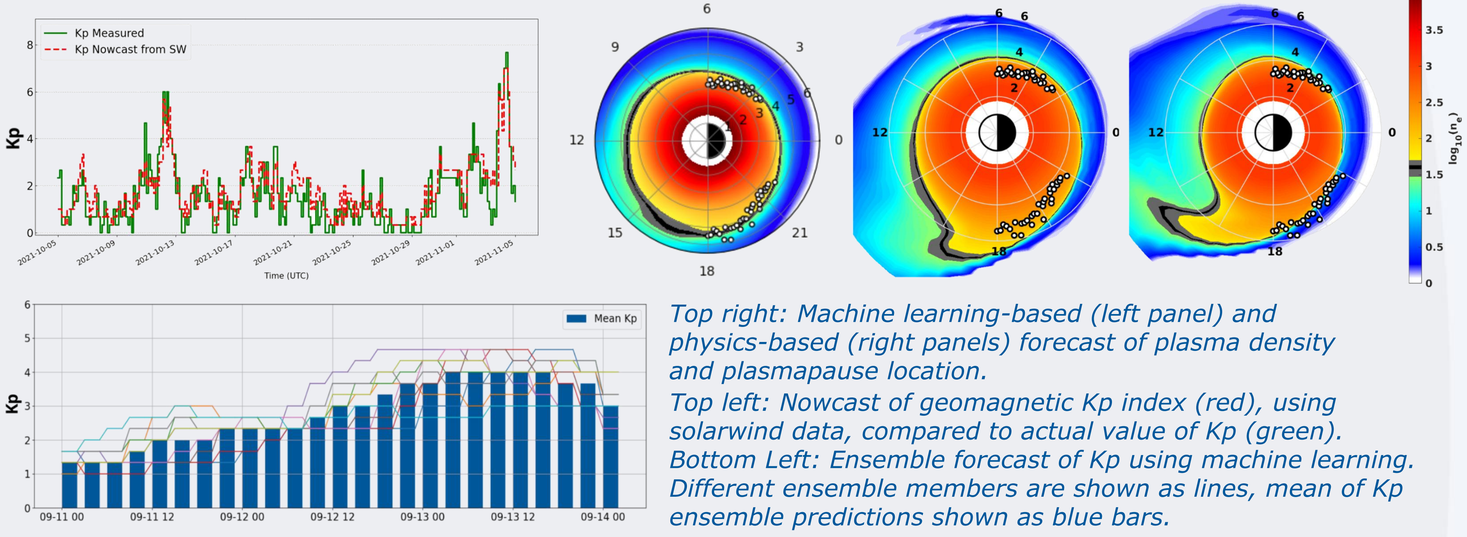


Solarwind ensembles and CMEs with SWIFT



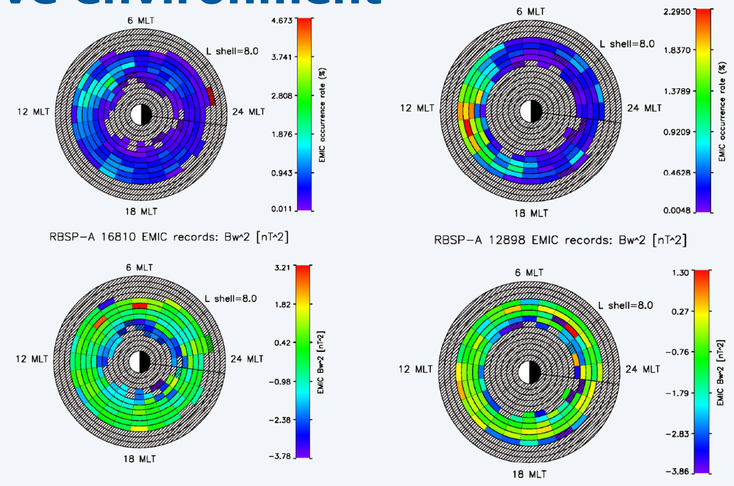
Reconstruction of L1 solarwind parameters and coronal mass ejection in April 2014. Left: Plasma density and solarwind velocity between the sun (yellow) and Earth (green).

Machine learning-based forecasts of Kp and the plasmasphere



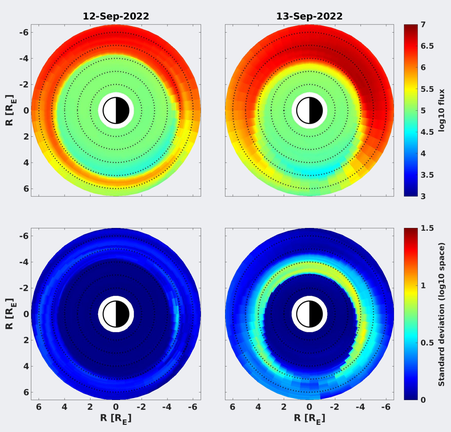
Top right: Machine learning-based (left panel) and physics-based (right panels) forecast of plasma density and plasmapause location.
Top left: Nowcast of geomagnetic Kp index (red), using solarwind data, compared to actual value of Kp (green). Bottom Left: Ensemble forecast of Kp using machine learning. Different ensemble members are shown as lines, mean of Kp ensemble predictions shown as blue bars.

Empirical models of electromagnetic wave environment

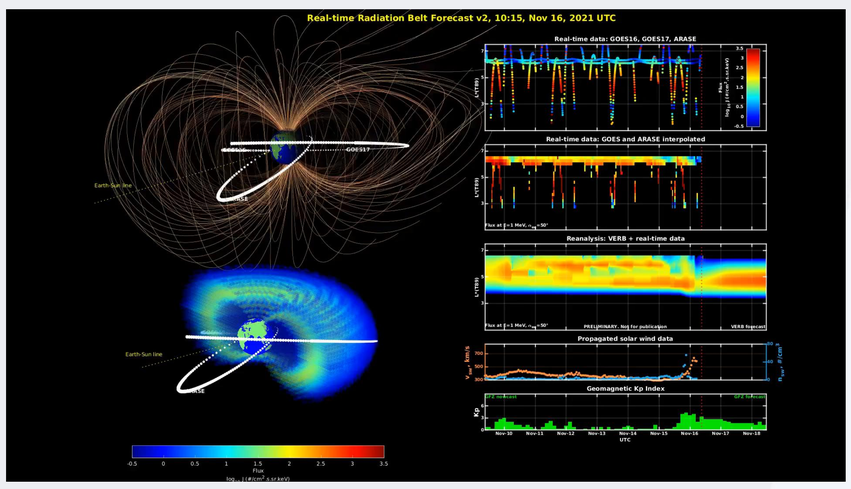


Model for EMIC waves. Top row shows wave occurance rates, bottom row wave magnetic field amplitude. Left: Helium ions, Right: Protons.

Data-assimilative modelling of radiation belts and ring current



Mean and standard deviation of ensemble forecast for ring current electron flux using VERB-4D.



Data-assimilative radiation belt electron flux nowcast and forecast using VERB-3D with realtime GOES and Arase measurements.

Summary

- Responding to stakeholder requirements
- Coupling models all the way from the sun to Earth to predict space weather effects
- Making use of data assimilation and modern machine learning tools
- Performing ensemble forecasts to quantify uncertainties of predictions
- Visit us at **www.spacepager.eu**

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