The PRAISE Initiative:
Promoting Artificial Intelligence for the Space Economy

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https://ml-space-weather.github.io

## What is in the future of the Space Economy?

The Space Economy, defined as:
• Space Weather, and
• Space Traffic Management

will be dominated and driven by
Artificial Intelligence

Artificial Intelligence in Space Weather

There are a number of applications where AI is already outperforming traditional (human) forecasting: Geomagnetic indices prediction, solar wind forecast, etc.
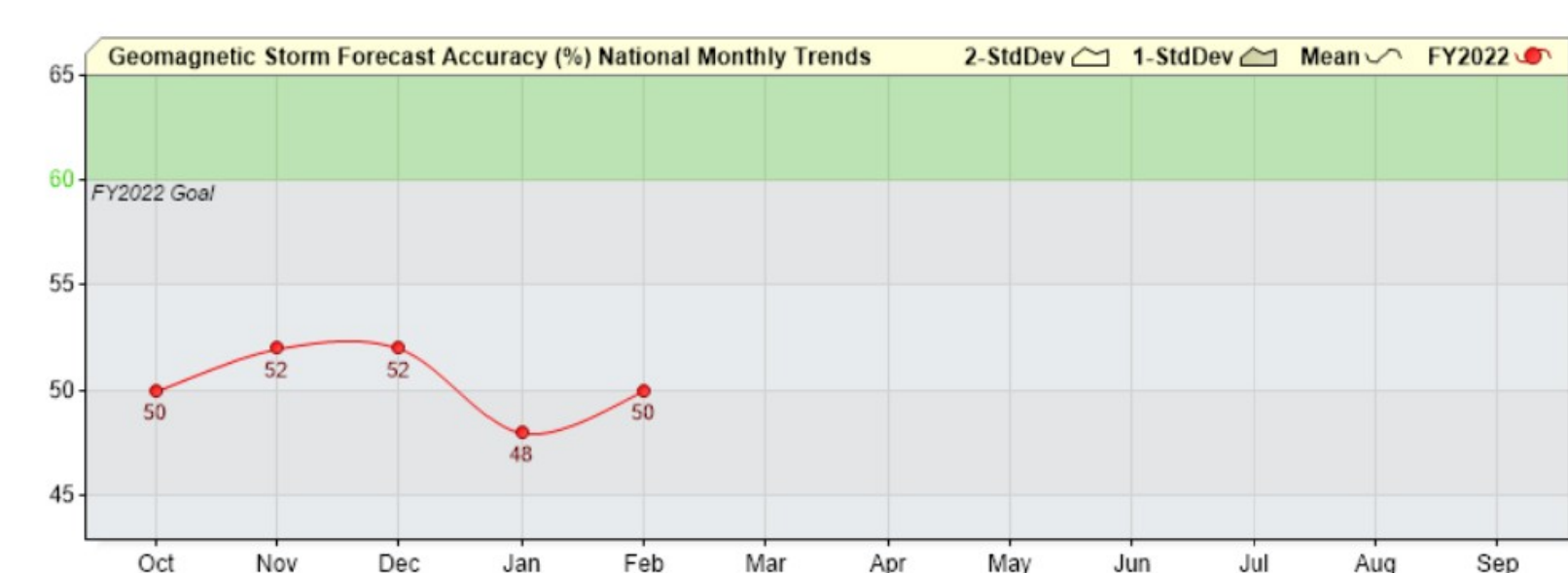
SWPC 2022 performance on Geomagnetic storm prediction
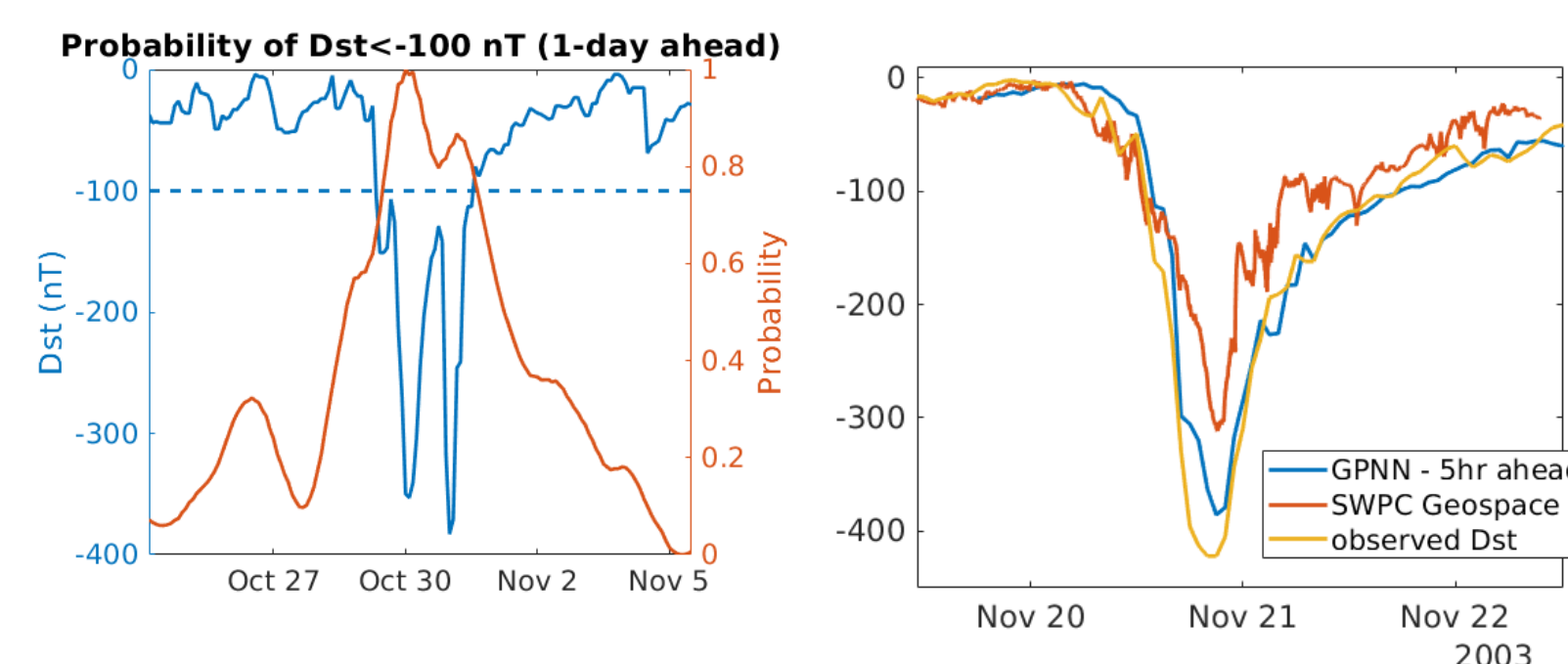
Probabilistic (left) and deterministic (right) predictions for Dst.

See Andong Hu's talk *Innovative Dst predictions using neural netwoks*

Space Situational Awareness

Space Situational Awareness (SSA) is defined as the ability to model and predict the near-Earth space environment and its impact on the dynamics of orbital objects (satellites and debris), in order to detect and prevent collisions between these objects. SSA is an interdisciplinary topic that combines the fields of Space Weather prediction with astrodynamics and space systems engineering to tackle phenomena that bear enormous societal implications. An advancement in our understanding and prediction capability of SSA is absolutely necessary to match the explosive growth we are currently witnessing in Low Earth Orbit (LEO), with **57,000 new satellite launches planned through 2029**, and the consequential growth of the space industry, expected to reach **the 1 trillion dollars milestone by 2040**.
Without fundamental advances in SSA models and decision systems, we risk catastrophic chain-reaction collisions that could create debris clouds that would render near-Earth space unsafe for decades or even centuries to come, and the collapse of the space economy.

How can we make AI for the Space Economy reliable and usable in the everyday decision making process?

We have identified 3 areas where advancement in AI is needed in order to meet the needs of the New Space Economy:

• Robustness against Adversarial Attack
• Out-of-distribution generalization
• Uncertainty-aware and interpretable ML

The PRAISE initiative

PRAISE is a multi-institute initiative that stems from the realization that applications of Artificial Intelligence in the Space Science domain are about to reach a tipping point, with an inevitable shift from proof-of-principle concepts, championed by a small number of early-adopters, to well-established applications adopted widely by the whole sector. As our world expands technologically and physically into space and we recognize the interconnections between society and the space environment, our prosperity is inextricable from the need to better understand and ultimately predict the space environment. The **entire space economy** will soon become reliant on the ability to make robust, data- driven, autonomous, and justifiable decisions, and will only thrive when AI becomes fully integrated in the decision-making process. However, our knowledge infrastructure and models have not kept pace with the increasing pace of space technology development. Hence, in order for those forward-looking applications to become mainstream and initiate a cascade of innovations spanning across the entire near-Earth space domain to eventually impact society, a number of technical challenges need to be overcome.

On the other hand, the ML-Helio community has reached a **critical mass** that enables us to tackle and solve these difficult and important problems.

What to do?

We can act individually (with low chances of success), or we can **act as a community**! We call upon the entire ML-Helio community to initiate a bottom-up approach, where every idea and every individual can contribute.
At this stage, it is not clear what funding mechanism would be the most appropriate to support PRAISE, and we'd like to hear your opinion.
If you are interested to be involved, or just to be kept informed, please reach me at:
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