HALE

Integrated space and earth weather intelligence

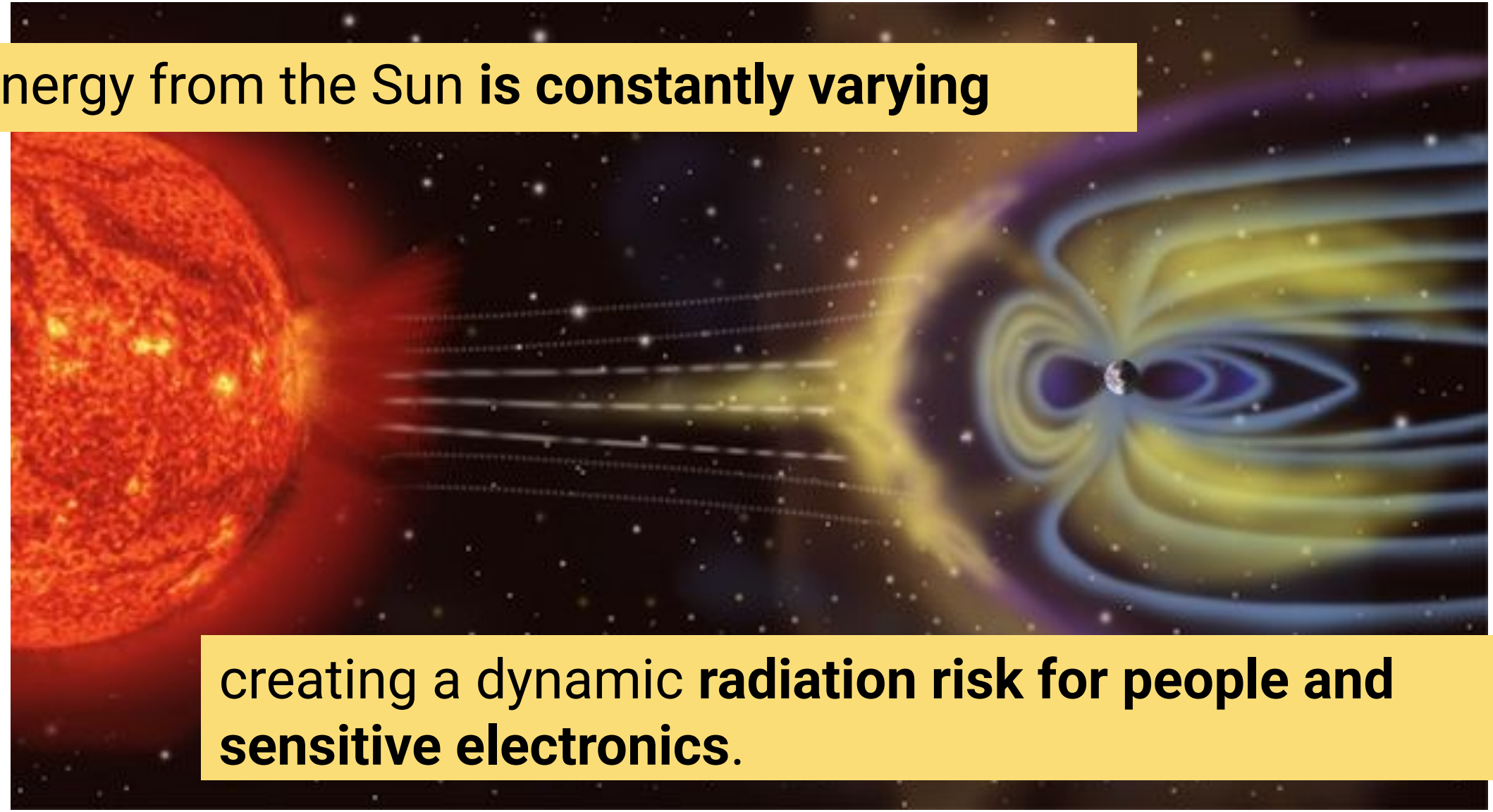
Hale Aviation Radiation Dosage Calculator (HARDC):
A Real-Time Tool for Assessing and Mitigating Flight Crew Radiation Exposure

Presenters: Scott W. McIntosh & Katherine D. Monson, Hale SWx

Goal: To present the Hale Aviation Radiation Dosage Calculator (HARDC)—a bespoke software solution for **regulatory compliance** and **proactive risk management** of cosmic radiation exposure for aircrew.

NASEM Context: HARDC directly supports the committee's mandate by providing validated, quantitative data on exposure, health outcomes (lifetime dose), and mitigation strategies (rerouting)

Energy from the Sun **is constantly varying**



creating a dynamic **radiation risk for people and sensitive electronics**.

The Problem: **Occupational Exposure at Altitude**

Aircrew exposure to ionizing radiation is a subtle, significant health risk that must be quantified

Galactic Cosmic Rays (GCR)
Originate from supernovae; consist primarily of high-energy protons (87%) and helium nuclei (12%). These particles create secondary cascades (neutrons, muons, etc.) that contribute **80–90%** of the effective dose at cruising altitudes.

Solar Energetic Particles (SEP)
Arise from solar flares and CMEs, delivering bursts of lower-energy protons. They can temporarily amplify radiation levels by factors of **10 to 500** during ground-level events (GLEs), particularly at high latitudes.

Health Impact
Aircrew receive annual effective doses of **1–6 mSv**—up to 20 times higher than the general public—potentially elevating cancer risks over a lifetime. ICRP recommends limits of **20 mSv per year** (averaged over five years).

Hale Aviation Radiation Dosage Calculator (HARDC)

The Hale Aviation Radiation Dosage Calculator (HARDC) is a bespoke software tool designed to estimate, monitor, and mitigate radiation dosages for both **human crew** and **aircraft components.**

Data Inputs
HARDC processes user-submitted flight plans (using departure and arrival airports, dates, and aircraft types)

Outputs – Human
Calculates effective doses in Sv, providing **lifetime accumulations** over careers

Outputs – Hardware
Computes Total Ionizing Dose (TID) in Grays (Gy) for sensitive electronics and components

HARDC – Flight Crew

Forward-looking Forecast

- Empowers decision-making for **flight crew**
- Provides estimated cumulative radiation dosage
- **Track individual crew exposure rates** based on anticipated flight plans
- Enables planning horizon of 1-20+ years

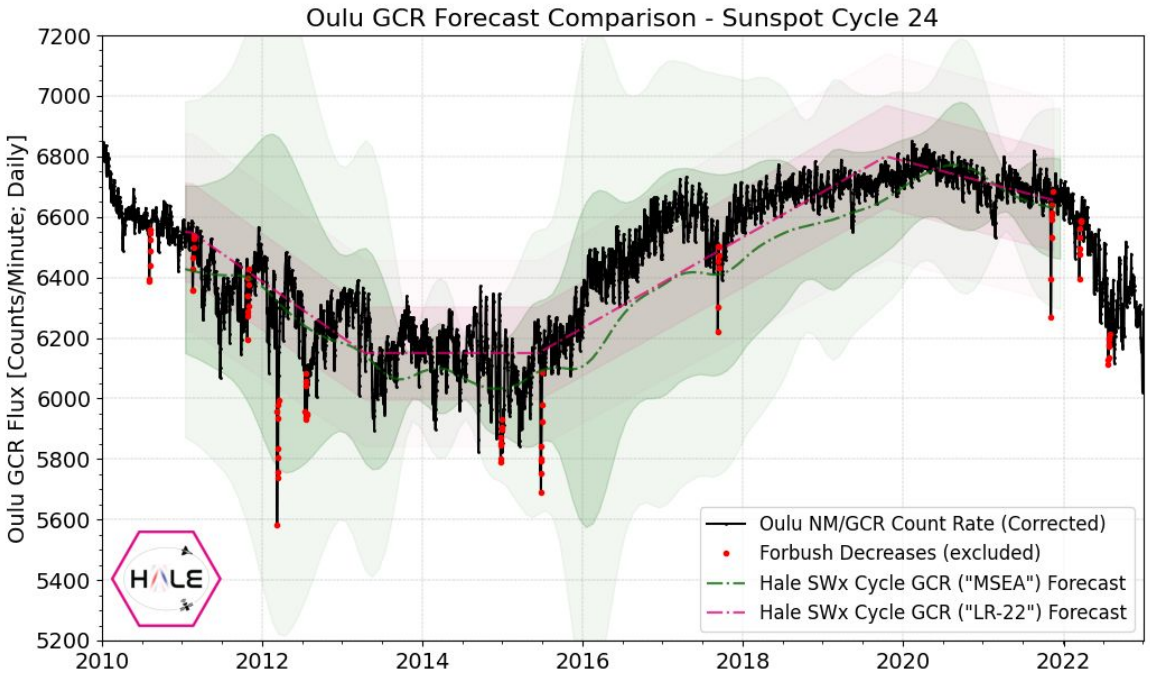
HARDC – Avionics

Forward-looking Forecast

- Empowers decision-making for **airlines**
- Provides estimated cumulative radiation dosage
- **Track individual avionics boards** based on aircraft flight plans
- Enables scheduling of proactive maintenance for sensitive electronics based on radiation exposure

Technical Core: **Hale Galactic Cosmic Ray (GCR) Forecast**

Unprecedented forecasting **accuracy** (80-85% within 1-sigma)



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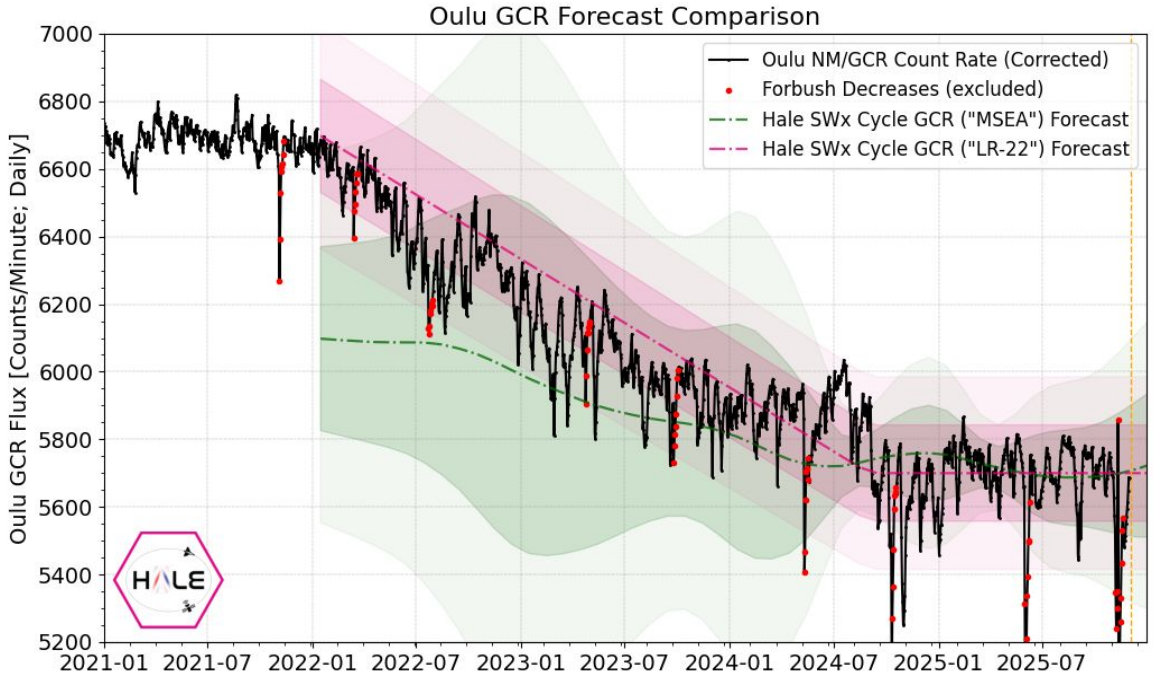

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Conclusions & Recommendation

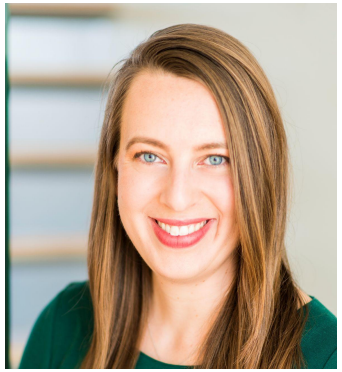
The Hale Aviation Radiation Dosage Calculator (HARDC) is a bespoke software tool designed to estimate, monitor, and mitigate radiation dosages for both **human crew** and **aircraft components.**

NASEM Focus Areas

- ✅ Assess available data and literature on radiation exposure to flight crews.
- ✅ Evaluate existing computational models that analyze and estimate radiation exposure and health risks.
- ✅ Identify potential harmful radiation sources at aviation altitudes and select a flight path or paths that would provide a bound or bounds on understanding plausible worst-case radiation exposure, considering the routes of transpolar flights at high altitudes while receptive to considering other routes.
- ✅ Determine availability and types of individual exposure information and health data as well as knowledge gaps and limitations for potential epidemiological studies.
- ✅ Consider potential mitigation measures that could reduce radiation exposure to flight crews.

HARDC is responsive to all focus areas

Founders



KATHERINE MONSON

Co-Founder & CEO

Aerospace / deeptech startup executive.

- Former CEO of KSAT Inc: US head of the largest satellite ground communications company, managing industry-wide aerospace & defense contracts.
- Former COO at Hedron, a space optical technology company
- CEO advisory to Auterion, Tetrix, & Starcloud
- Former management consultant specializing in supply-chain management and high-stakes negotiations.

Dr. SCOTT McINTOSH

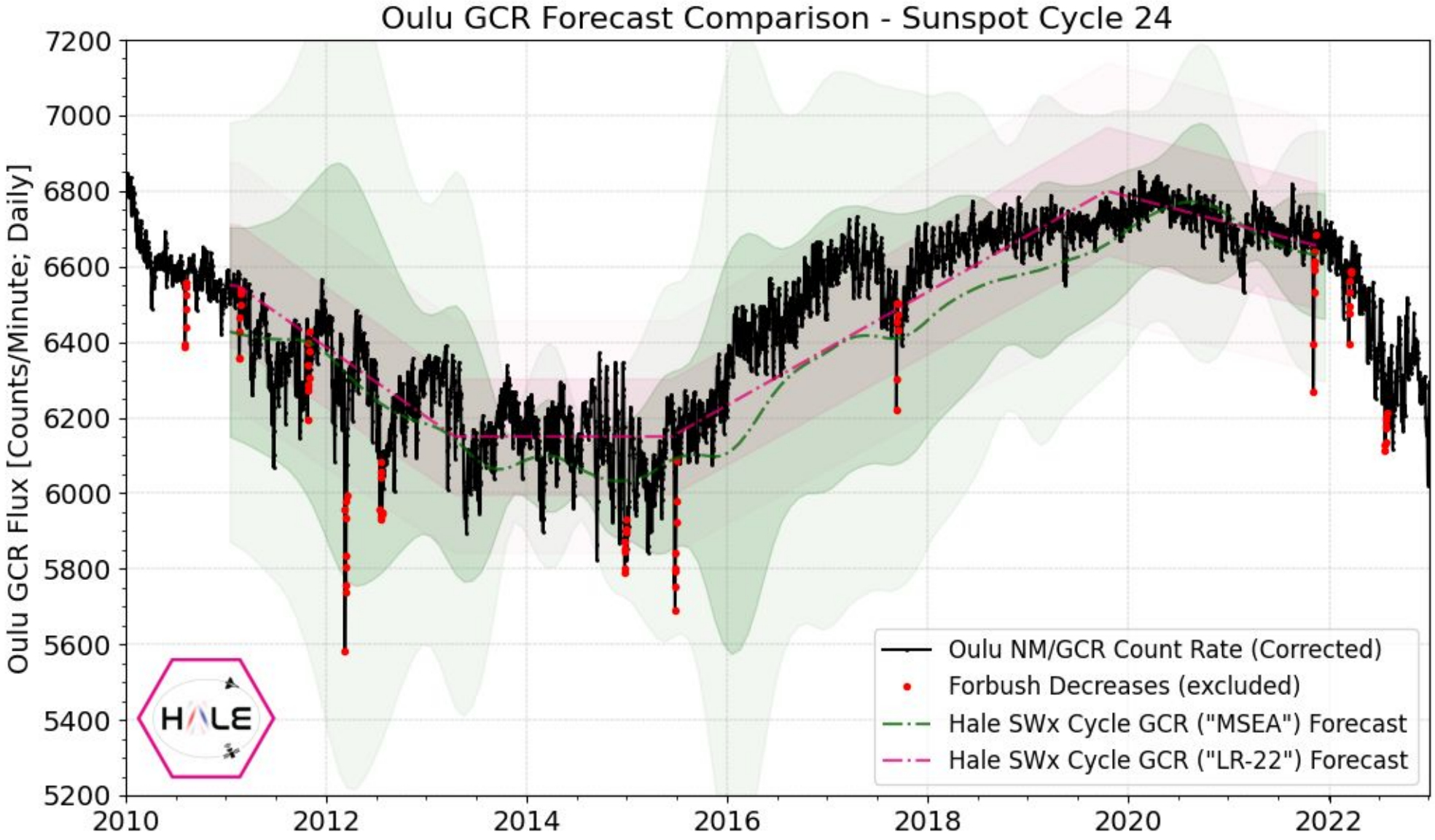
Co-Founder & Chief Science & Technology Officer

World-renowned solar and astrophysics expert.

- Former Deputy Director of the National Center for Atmospheric Research (NCAR)
- Research Lead for White House Office of Science and Technology Policy (OSTP) Space Weather Group
- Chair of the American Meteorological Society's Scientific and Technological Activities Commission for Space Weather.
- 25+ years of research, over 11k citations.
- Published in Nature and Science.

APPENDIX

Last cycle – **Forecast accuracy: unprecedented** (85% within 1-sigma)



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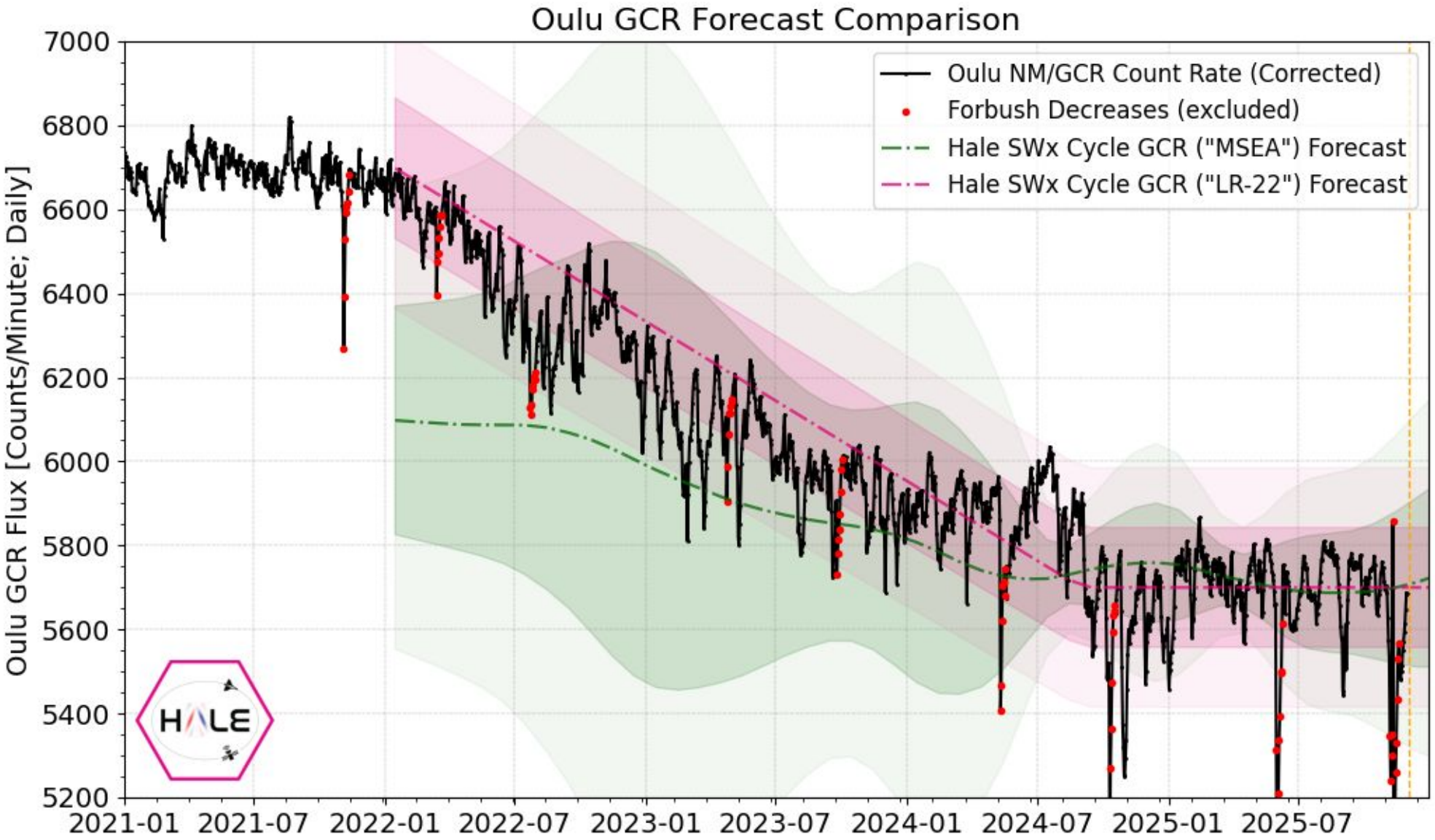
This cycle – **Forecast accuracy: unprecedented** (80% within 1-sigma)



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