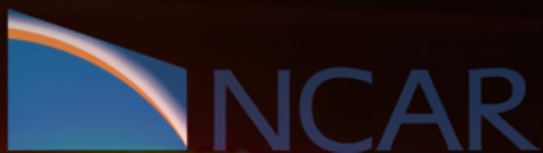


On Final Approach...

...to Solar Maximum

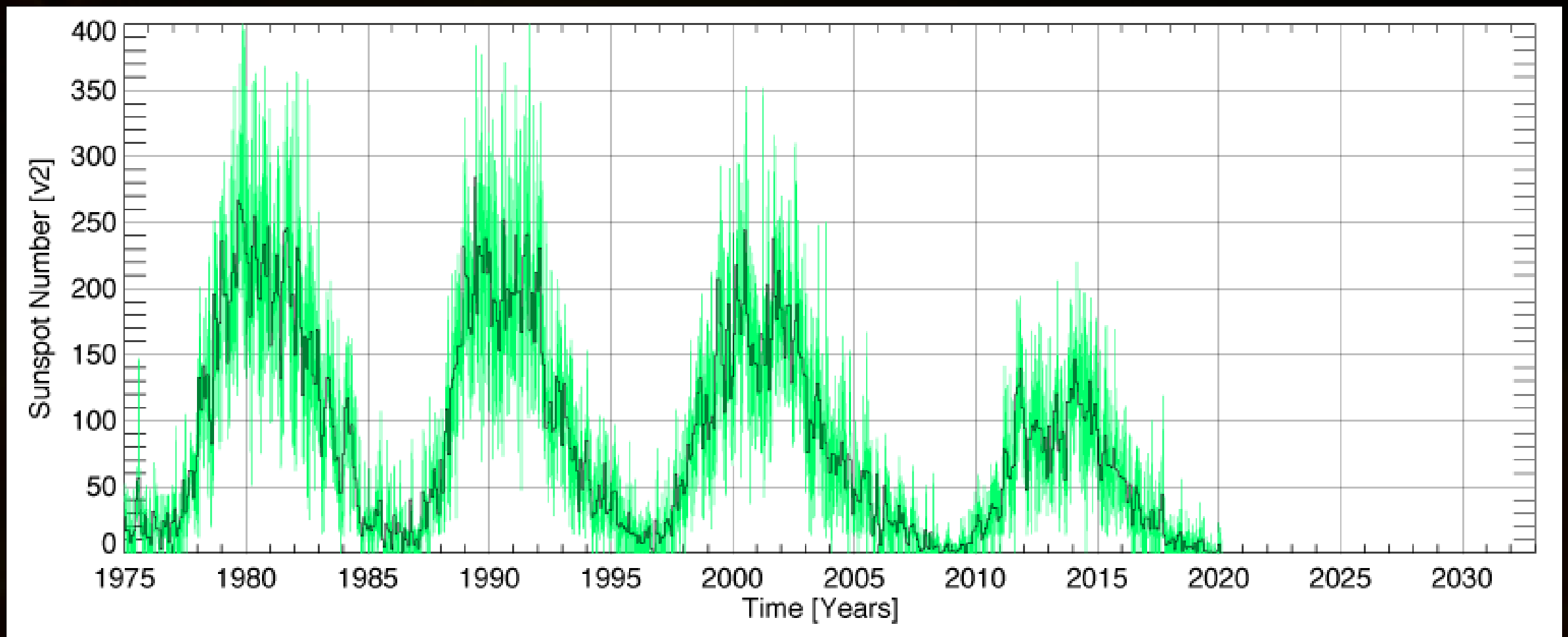
Scott W McIntosh
#SWEF23



This material is based upon work supported by the National Center for Atmospheric Research, which is a major facility sponsored by the National Science Foundation under Cooperative Agreement No. 1852977.

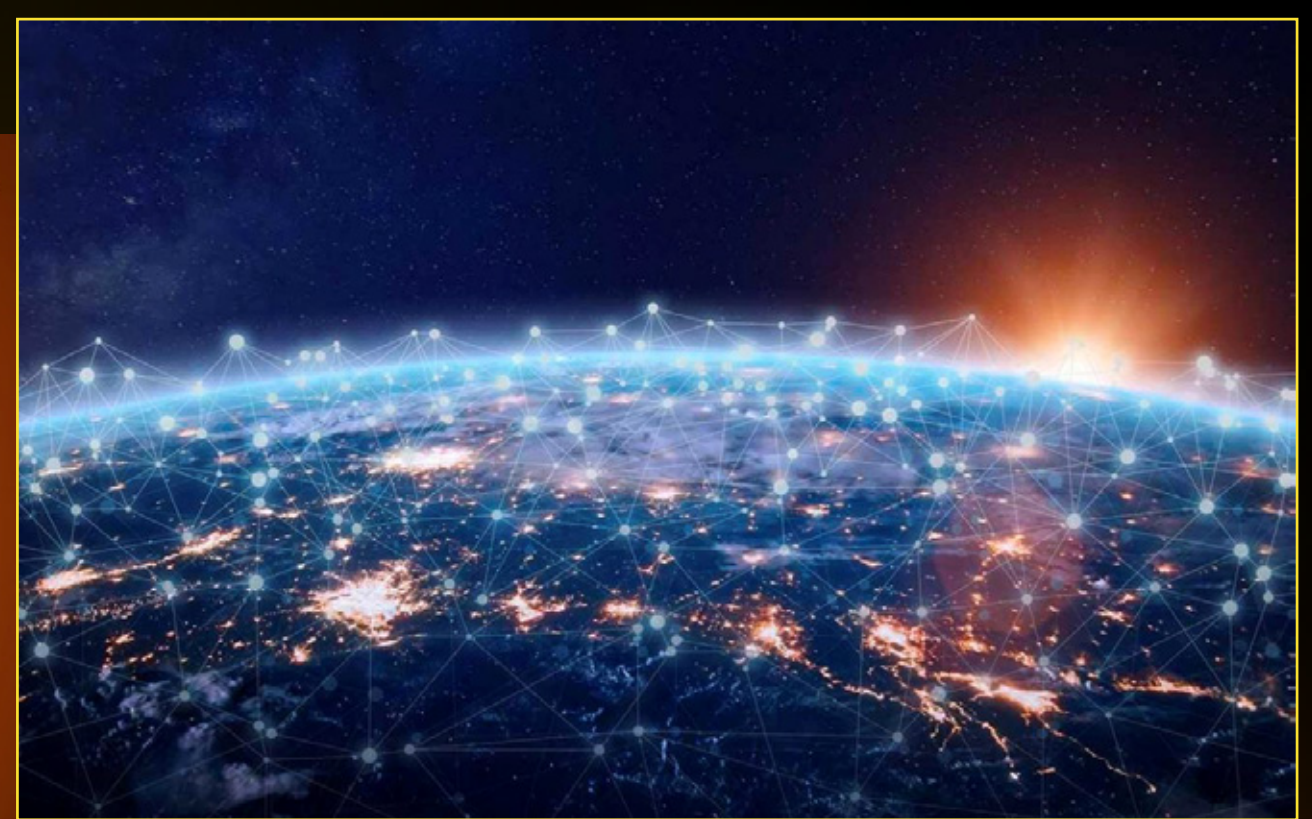


An Impactful Opportunity

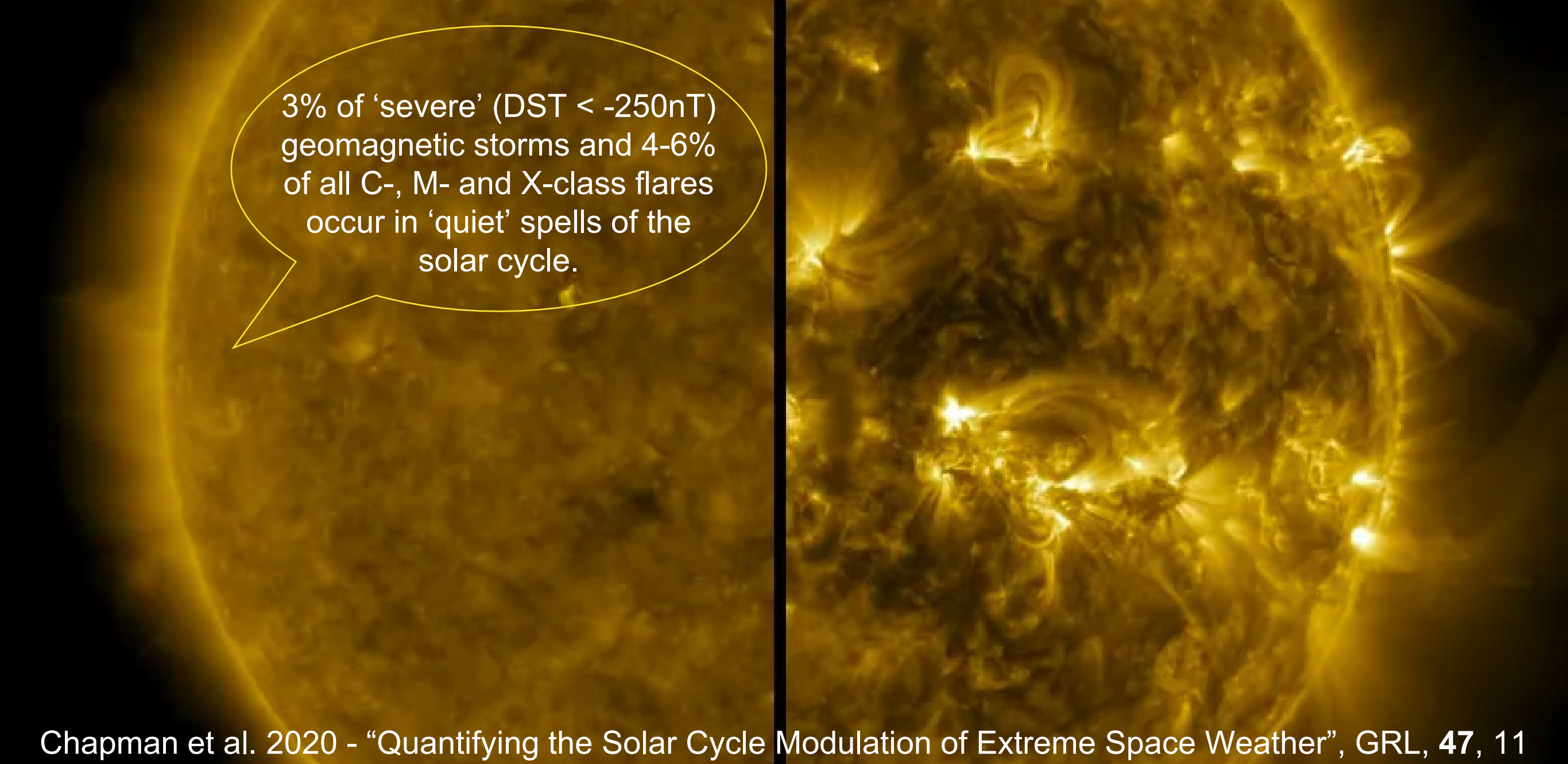


2019 - 2020: Our community convenes to forecast how the Sun would behave over the next decade. Those forecasts would then drive forecasts of solar storms and the LEO geospace environment.

#SunspotCycle25 was about to kick off, but what would it do?



Motivation: Assets across the solar system and in the blooming LEO space economy are increasingly dependent on our understanding of our star.



3% of 'severe' ($\text{DST} < -250\text{nT}$) geomagnetic storms and 4-6% of all C-, M- and X-class flares occur in 'quiet' spells of the solar cycle.

Chapman et al. 2020 - "Quantifying the Solar Cycle Modulation of Extreme Space Weather", GRL, **47**, 11

Note: The differences in the LEO environment between a weak and strong solar cycle are stark.

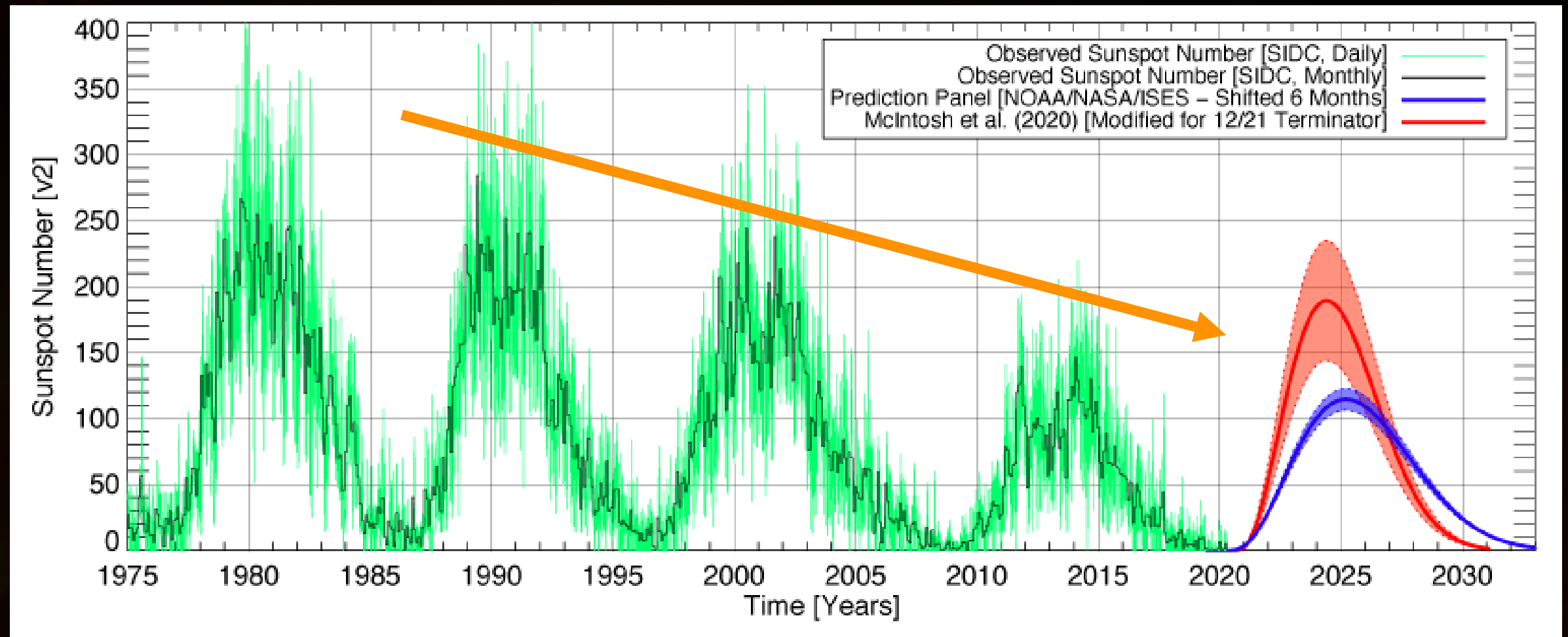
A large satellite dish antenna is positioned on the right side of the frame, pointing towards a bright, colorful aurora in the night sky. The aurora displays vibrant green and purple hues. The background is a dark, starry sky. The dish has several red lights on its structure.

28% chance of at least one
'severe' storm ($DST < -250nT$)
and 4% chance of at least one
'great' ($DST < -500nT$) storm
per year.

Chapman et al. 2020 - "Quantifying the Solar Cycle Modulation of Extreme Space Weather", GRL, 47, 11

Beware: Even in weak sunspot cycles, large geomagnetic events can still strike and cause havoc.

#SunspotCycle25 Will Test Our Understanding



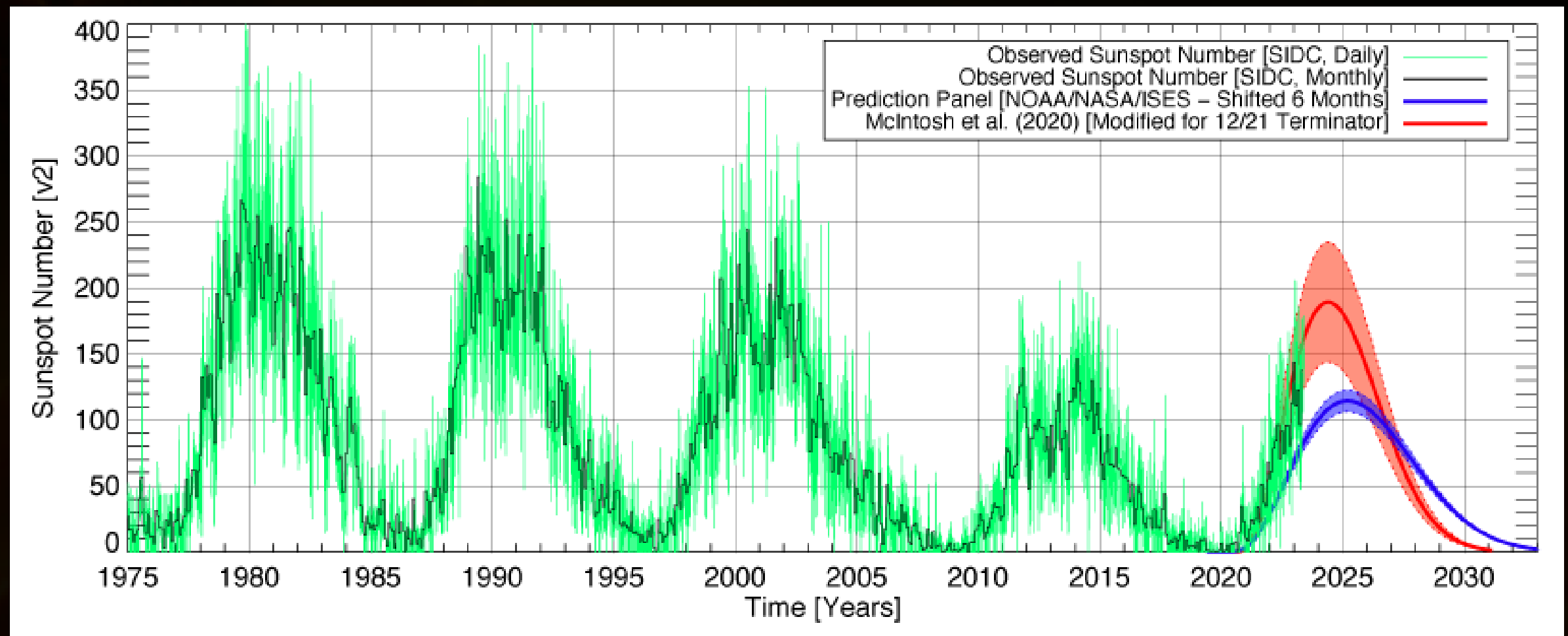
Will the downward trend in solar activity continue?

Compare & Contrast

Community consensus forecast

Outlier forecast based on a new hypothesis

#SunspotCycle25 > #SunspotCycle24

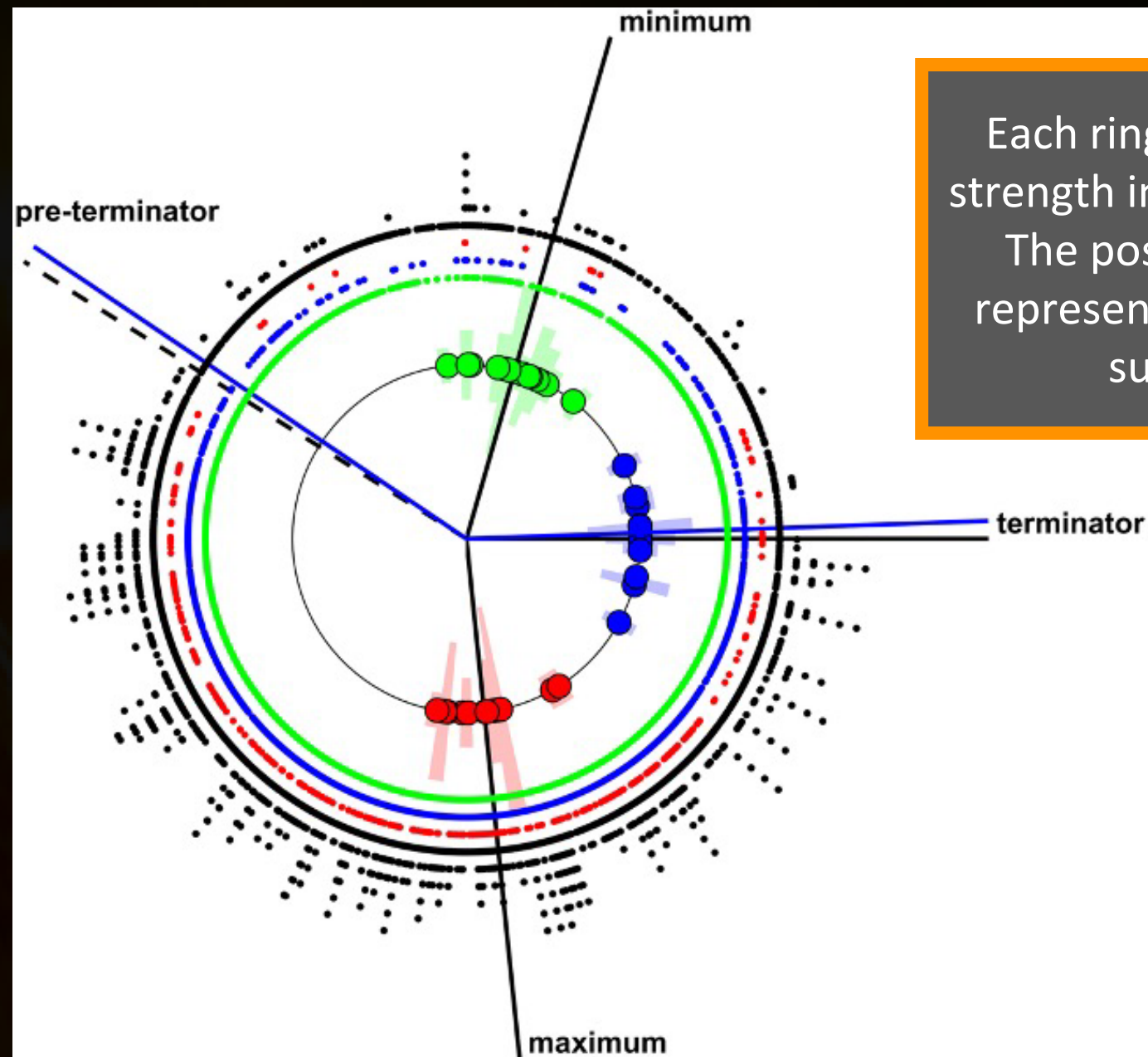


#SunspotCycle25 is on target for maximum about in less than a year from now and an amplitude 50% greater than anticipated.

To date, #SunspotCycle25 has had 17 X-Flares, 40% higher than #SunspotCycle24 at the same stage!

Also, #SunspotCycle25 has had 400+ M-Flares, a staggering 120% higher than #SunspotCycle24 at the same stage!

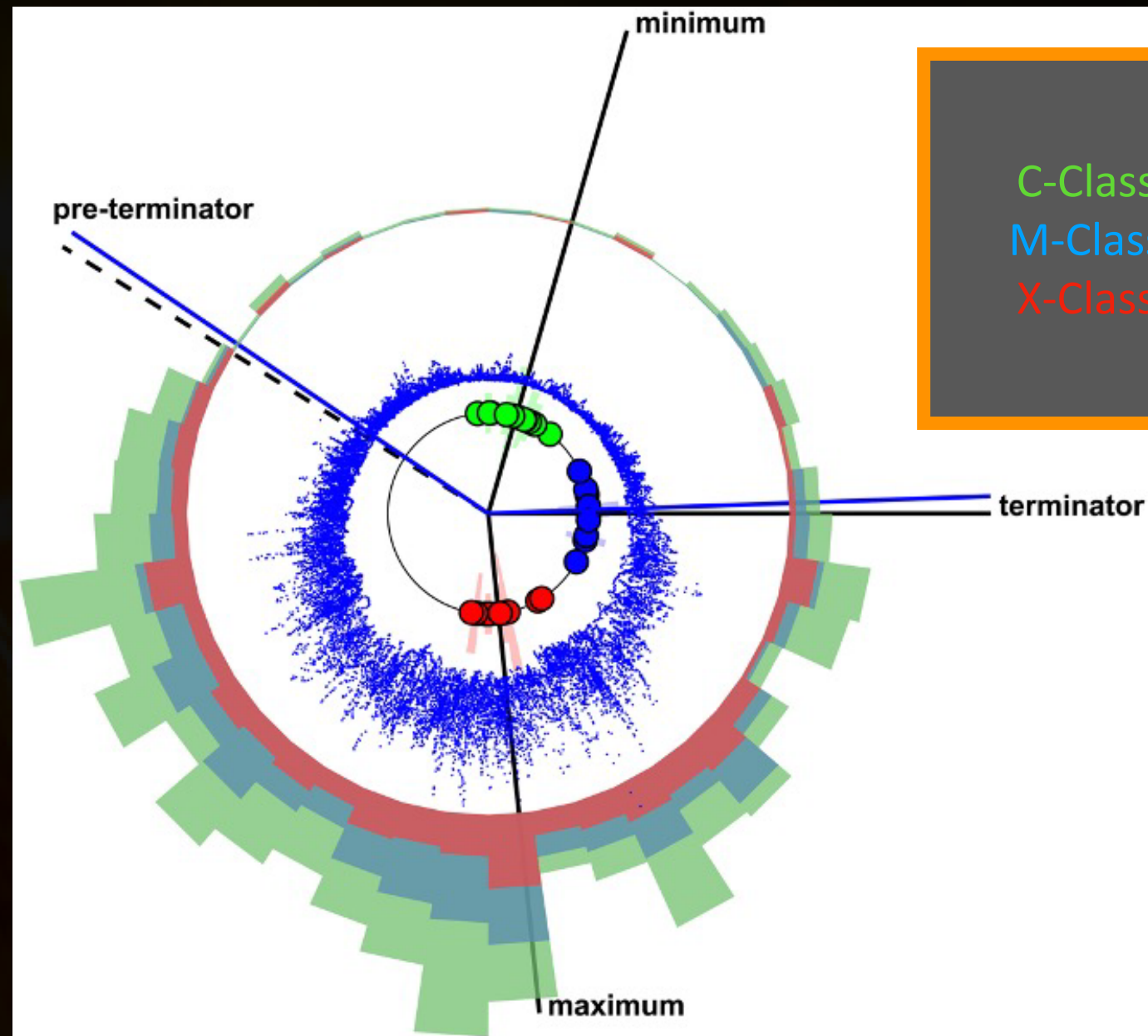
Improving 'Climatologies'



Each ring outward is event strength increasing by -100nT. The position in the circle represents the phase of the sunspot cycle.

Our new methodology, based on the Sun's 22-year magnetic (Hale) cycle, allows us to consistently analyze 14 cycles of geomagnetic data.

Improving 'Climatologies'



...and 4 cycles of GOES solar flare data.
Solar/Geomagnetic activity have 'seasons' of based on the Hale cycle.

#SC25 is on target for a maximum about in less than a year from now and an amplitude 50% greater than anticipated.

#SC25 has had 17 X-flares, 40% higher than #SC24 at the same stage, 120% more M-flares.

The ionosphere and LEO environment are energized at levels above those observed during maximum of #SC24 and we are 25% away from maximum.

Geomagnetic and solar activity generally increase in frequency and severity following solar maximum.

A new approach based on understanding the 22-year 'Hale' cycle is showing great promise in forecasting the helio environment across timescales.

