

Solar Cycle 25 Predictions

Lisa Upton, Doug Biesecker, and the Solar
Cycle 25 Prediction Panel

Space Climate 7

Orford, Québec
July 10th 2019

The Charge to the Panel

Required:

- Predict onset of Cycle 25/solar minimum
- Predict peak intensity and timing of Solar Cycle 25 in V2 of SSN

If possible, also provide:

- Predict north/south hemispheres independently (intensity/timing)
- Predict F10.7/F30
- Predict flare/CME rates

Call for Predictions

- In December 2018, we put out a call for predictions in newsletters across the world.
- Predictions were accepted through February 1, 2019.
- We also conducted a literature review for published predictions.

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6. MEETING: Save the Date: "Scintillating Science: Through the Observations of Radio Scintillation" Wc

THE SOLAR CYCLE 25 PREDICTION PANEL



Douglas Biesecker (NOAA) Co-chair, Lisa Upton (SSRC) Co-chair
Robert Cameron (Max Planck), Frederic Clette (Royal Observatory of Belgium), Rachel Howe (Univ of Birmingham), Haruhisa Iijima (Univ of Nagoya), Bingxian Luo (NSSC), Andres Munoz-Jaramillo (SWRI), Gordon Petrie (NSO), Maria Weber (Univ of Chicago), Peter Wintoft (LUND), Nathan Smith (2nd Weather Squadron)

SSN V1 vs. SSN V2

	T < 1893	T > 1893
SSN V1	1.	0.6
SSN V2	1.666666	1.

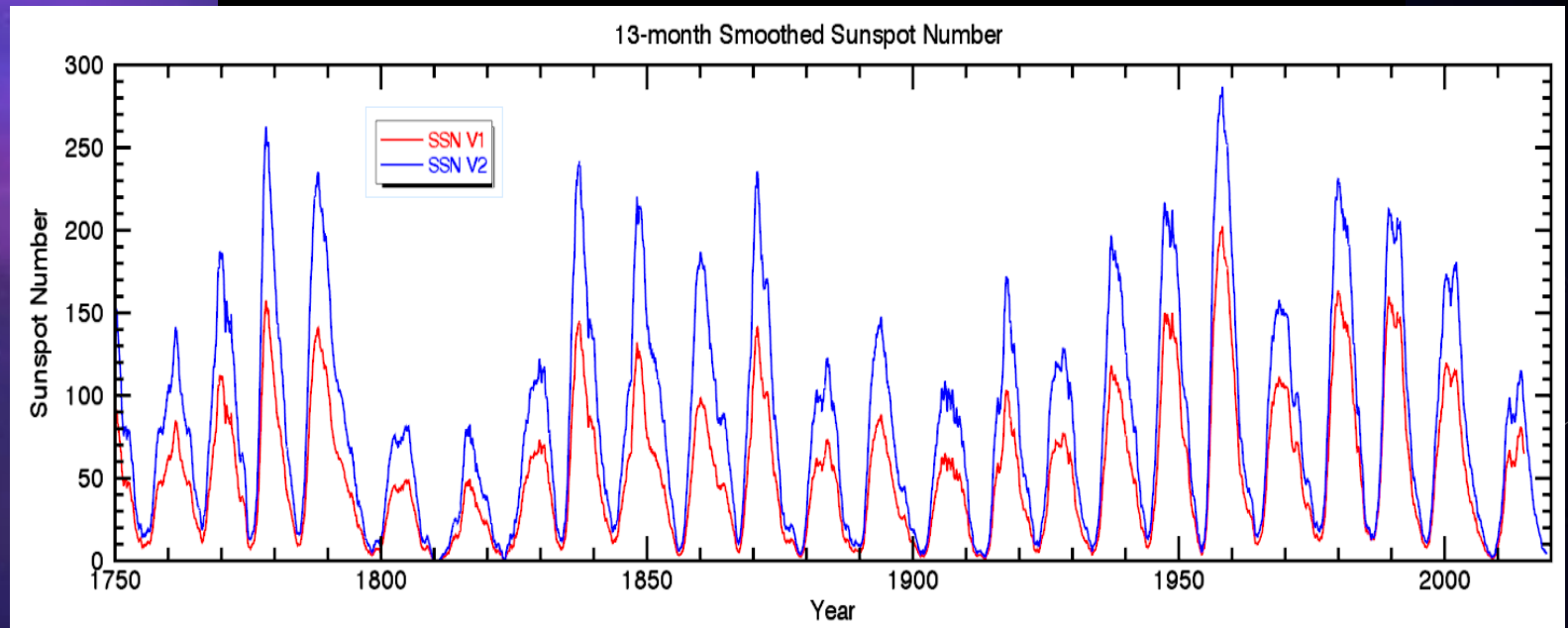
- Rudolph Wolf created the first modern count, stitching together observations from 1749-1893
 - > He tried to mimic early observers by artificially lowering his count
- In 1893, Wolfer took over and determined the a scaling of 0.6 scaling required to keep modern count consistent with Wolf
- There are other conversion factors or inconsistencies that needed to be accounted for, but this **Renormalization** is the primary change in the SSN.
- For the full story see Clette et al. 2014
- The SSN V2 is now Normalized to 1.0, while earlier data is adjusted.
- Based on the Standard 82mm refractor:
 - > All spots are resolved
 - > Equivalent to counts done today
- Consistent with raw numbers from most individual observers
- Keeping the old scale is now pointless:
 - > Now, more than 130 years with the modern scale
 - > Instantaneous conversion on PC
- No other change needed in the future:
 - > Only early numbers adjustments, as part of the recalibration.

The New Solar Cycle

Cycle 24

- Cycle 24 peak was 81.9 in April 2014 (forecasted 90)
- The SSN V2 cycle 24 peak is 116.4 (42% higher)
- The average peak for all cycles was 112.7
- The new average peak is 179.4 (59% larger)
- Cycle 24 4th smallest (Dalton Minimum ~30% smaller)

All 24 Cycles



NOAA changing SSN

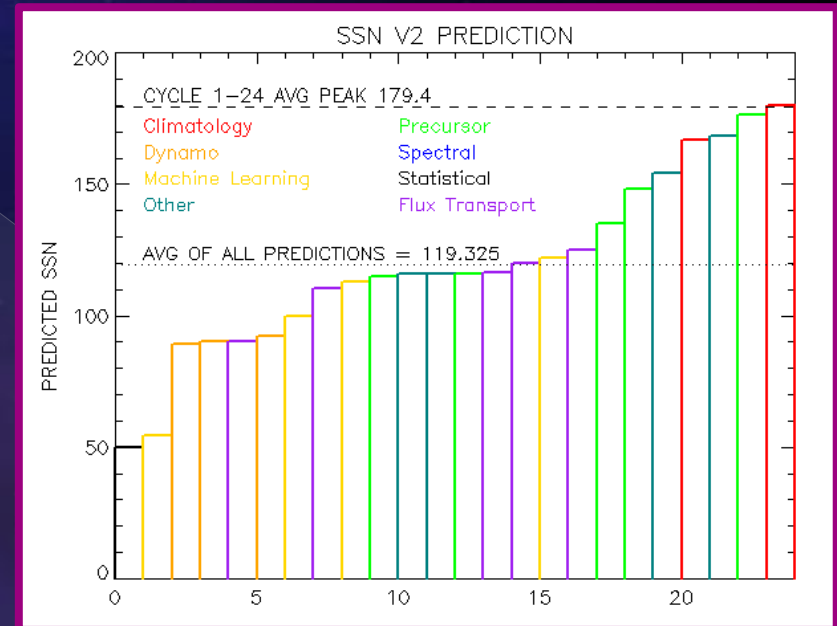
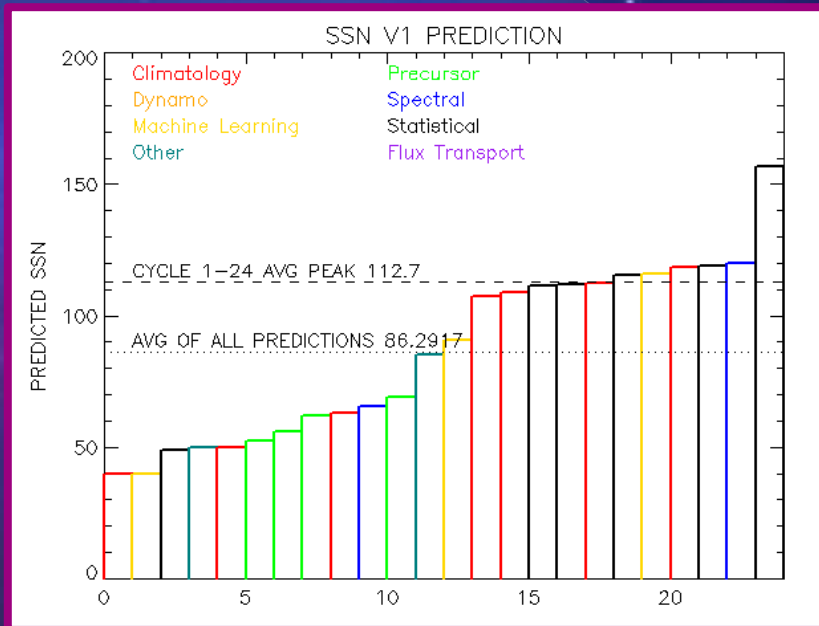
- In July 2015 the Solar Influences Data Center started publishing daily sunspot numbers with Modern scale
- NOAA had already published predictions for the solar cycle – they decided to wait till minimum to switch.
- Users had experience using older numbers
- SWPC continues to correct sunspot number
 - > Their factor is closer to 0.7
 - > Will remove this correction during the next solar minimum
 - > Should be a relatively seamless transition
- Plenty of time to ensure users understand before Cycle 25 gets going

The Predictions

- ◉ We considered ~60 predictions for Cycle 25
- ◉ Different Classes of Predictions
 - > Climatology
 - > Dynamo
 - > Machine Learning / Neural Networks
 - > Precursor
 - > Spectral
 - > Statistical
 - > Surface Flux Transport
 - > Other

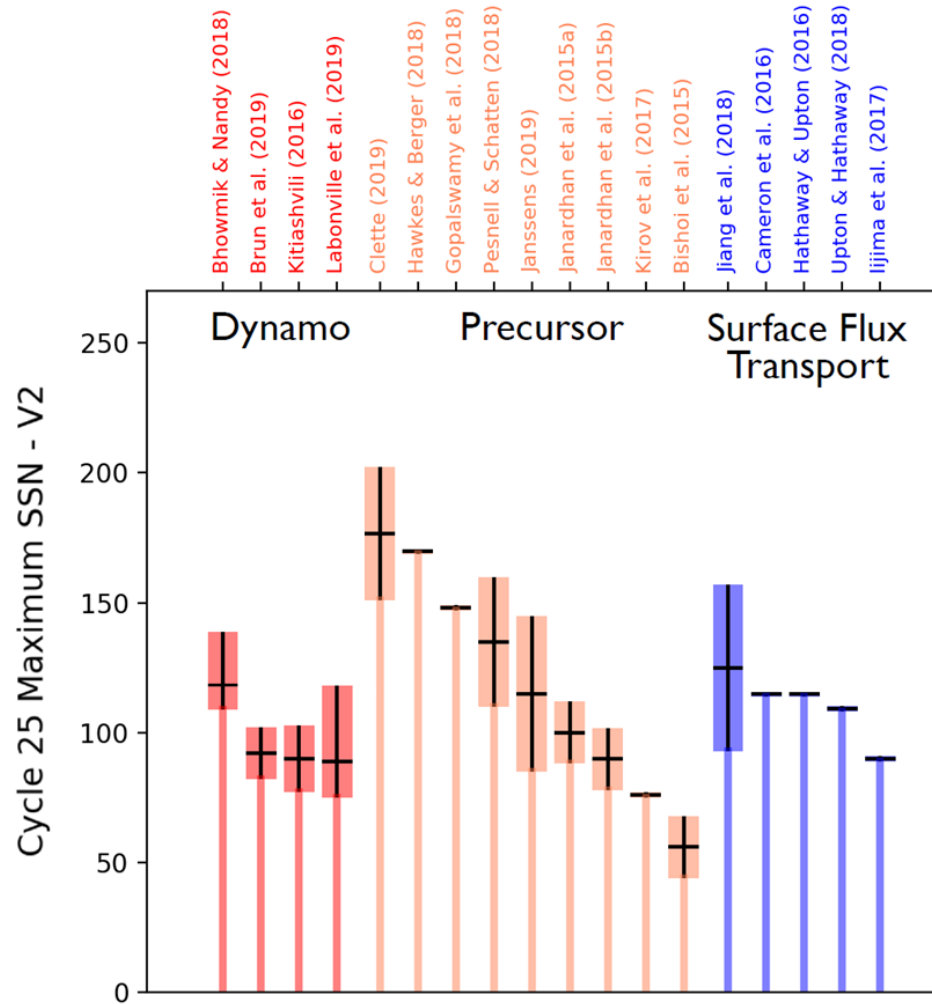
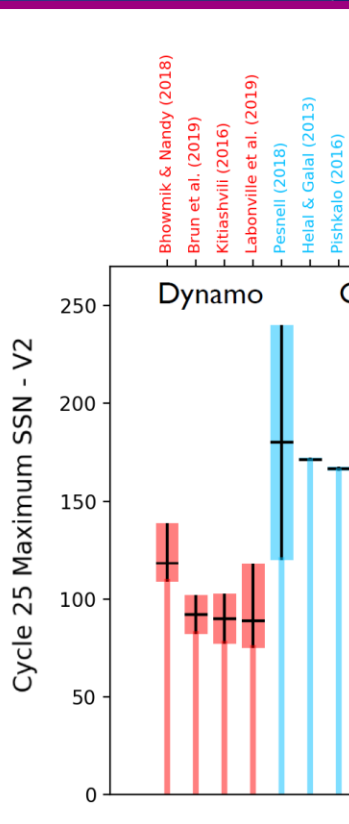
The Predictions

About $\frac{1}{2}$ used the old SSN V1 scaling, and $\frac{1}{2}$ used the new Modern SSN V2 scaling

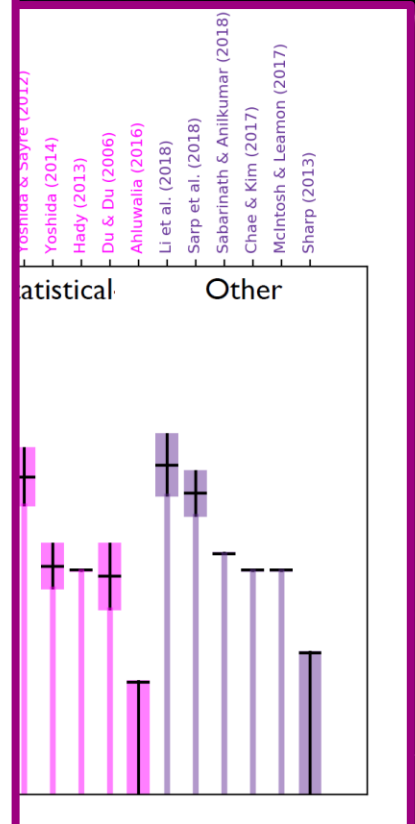


Includes multiple predictions by same author

The Predictions

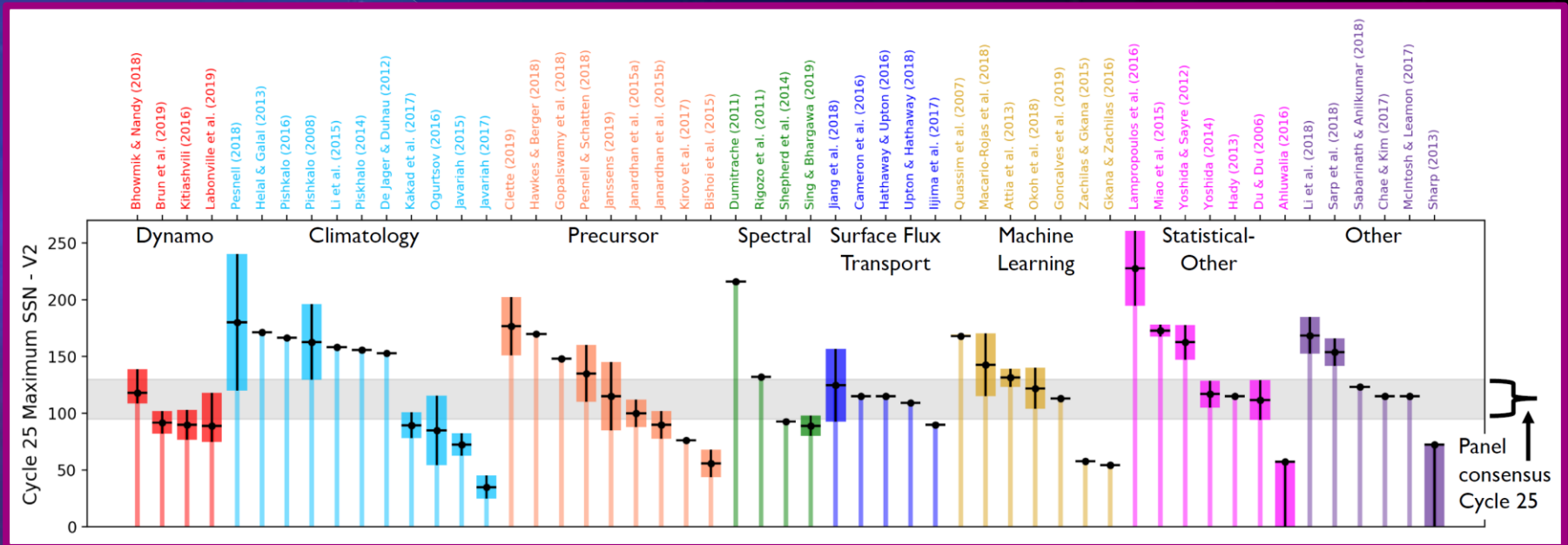


Courtesy of Maria Weber



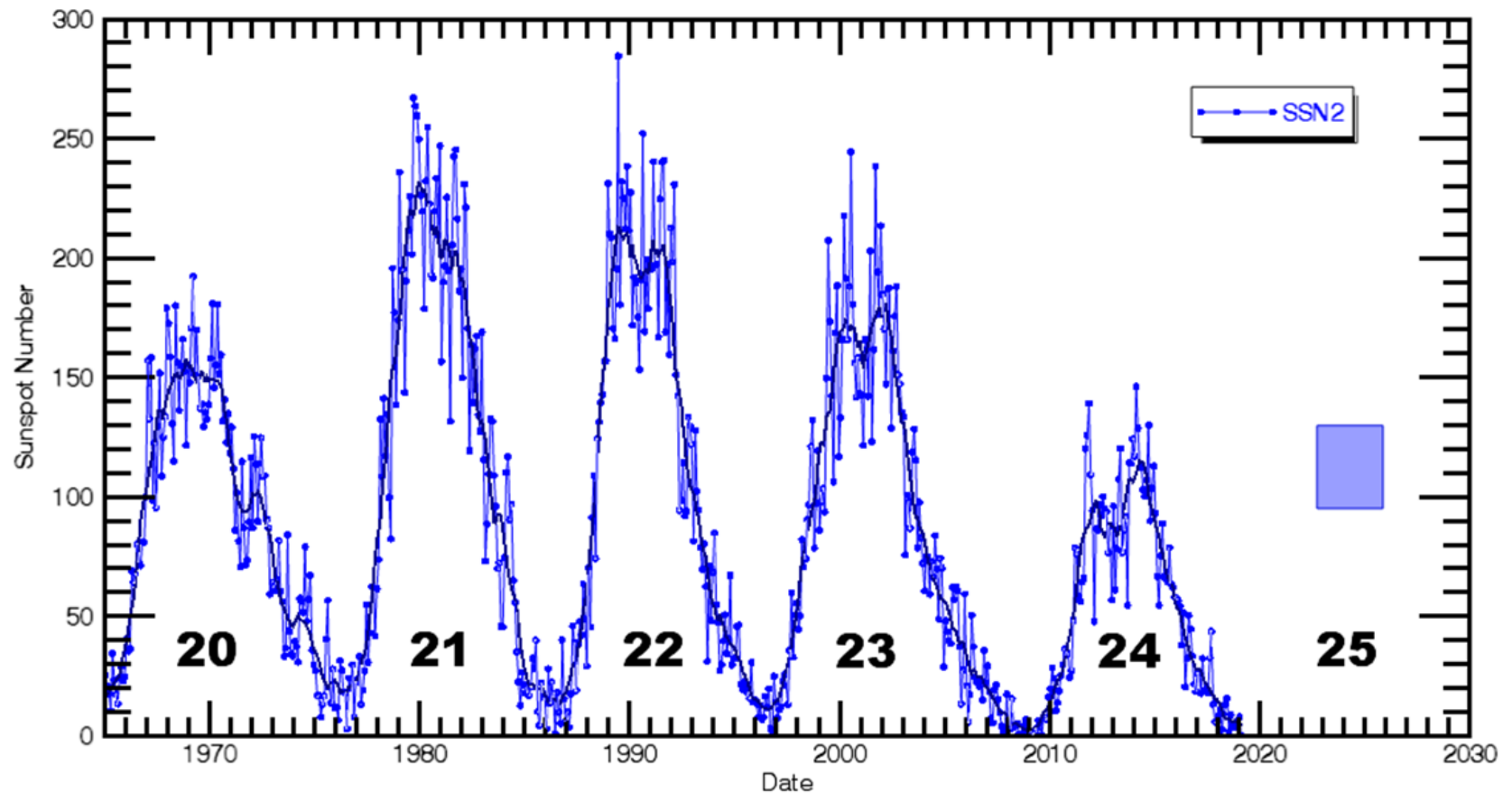
Our Consensus for the Cycle 25 Amplitude

Figure curtesy of Maria Weber



Cycle 25 will be similar in size to cycle 24:
Peak amplitude somewhere between
95 and 130

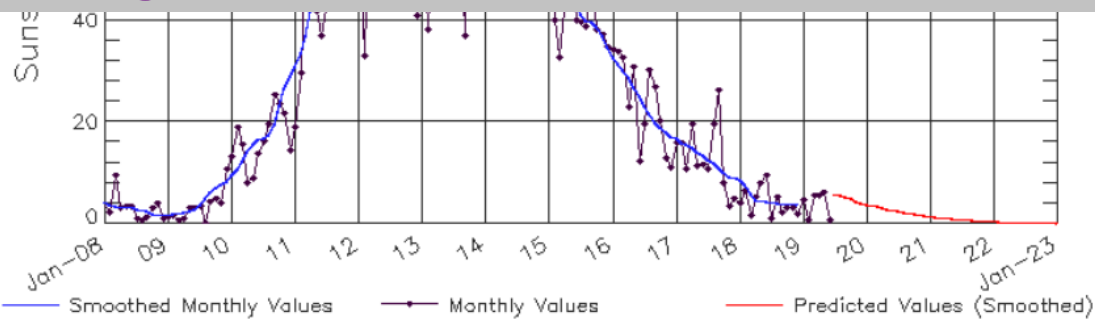
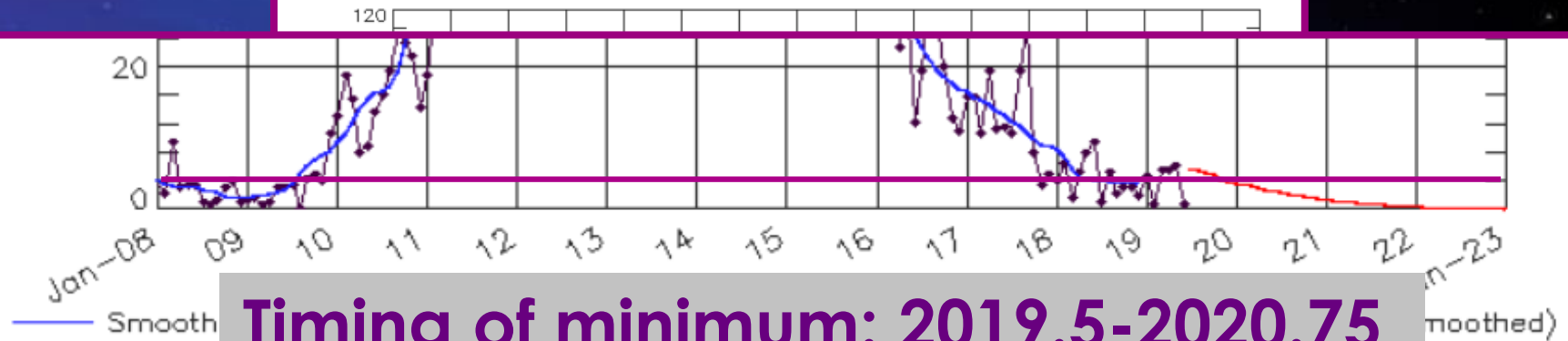
The Downward Trend



Solar Cycle 24/25 Minimum

ISES Solar Cycle Sunspot Number Progression

Observed data through Jun 2019

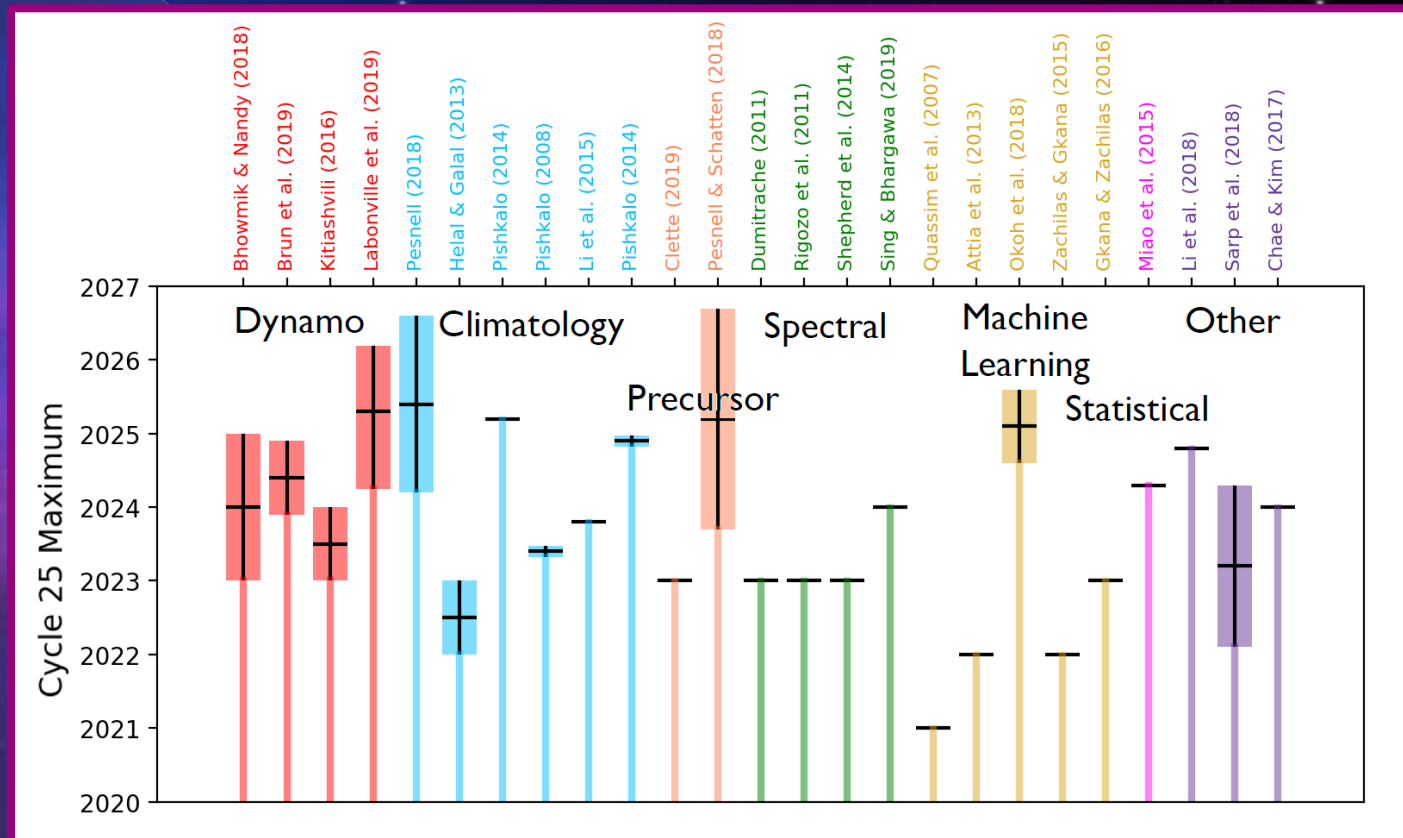


Updated 2019 Jul 8

NOAA/SWPC Boulder, CO USA

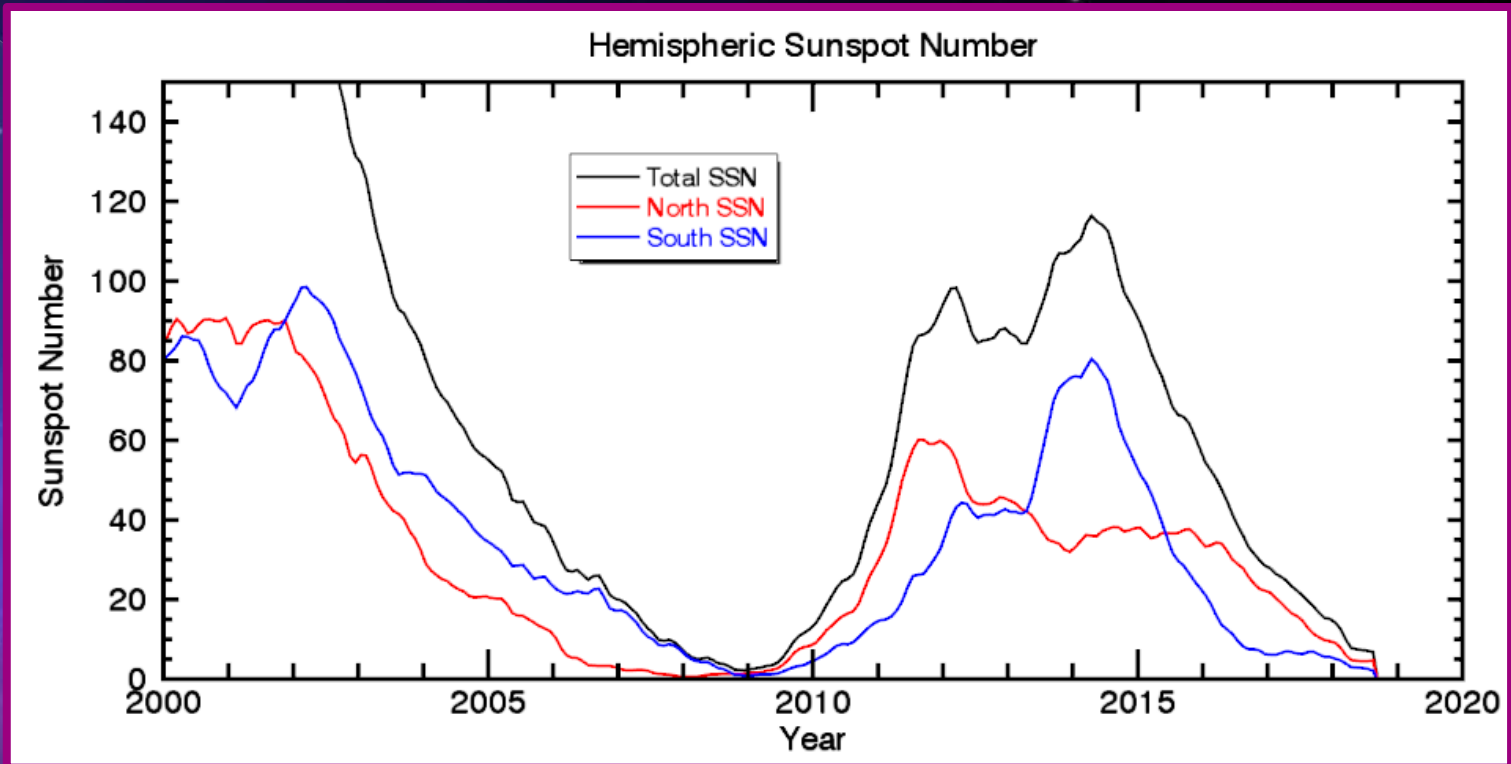
Our Consensus for SC25 Maximum

Figure curtesy of Maria Weber



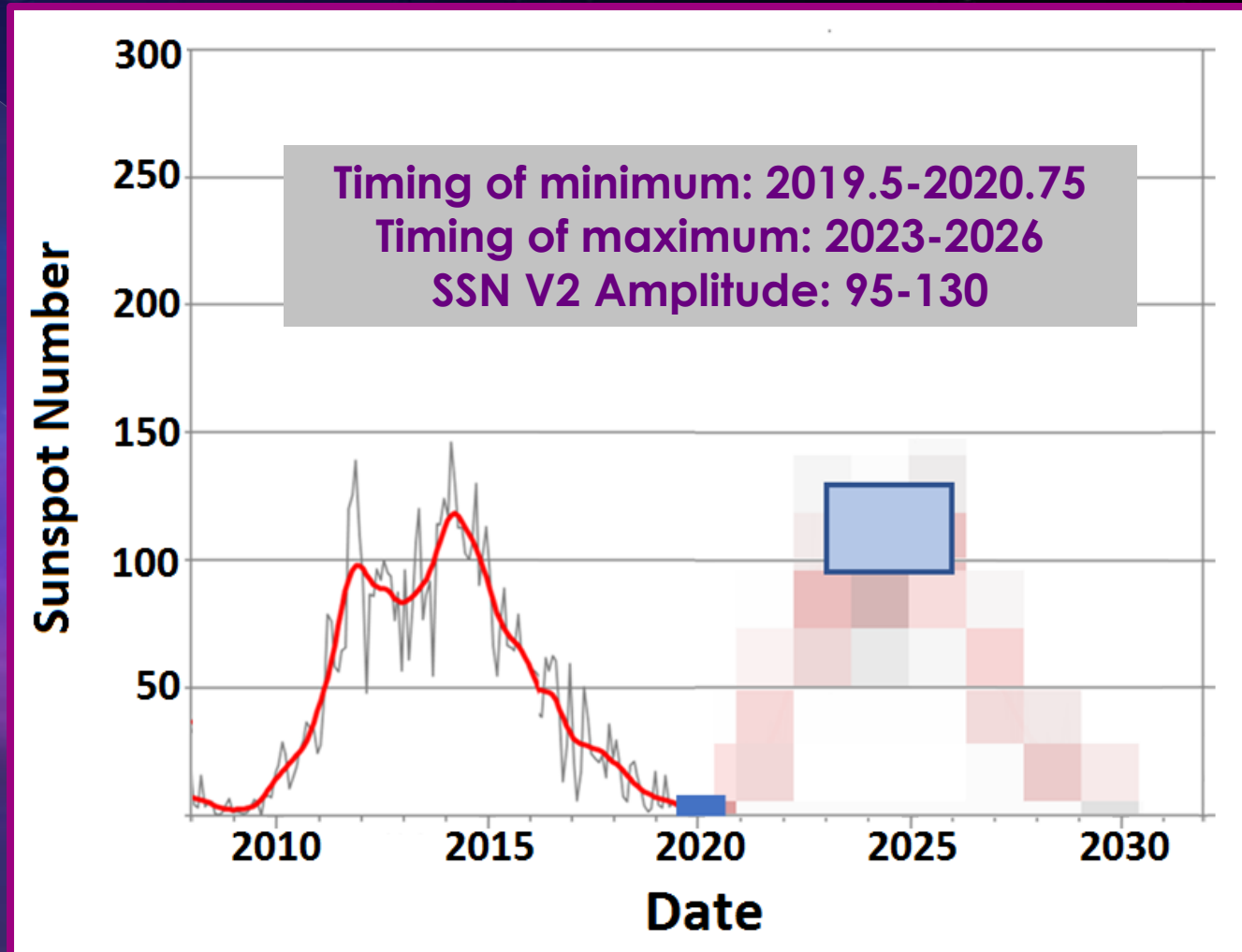
Cycle 25 maximum will occur no earlier than the year 2023 and no later than 2026

HEMISPHERIC ASYMMETRY



- ❖ Panel recognizes that Hemispheric Asymmetry needs further investigation.
- ❖ This may not significantly impact the prediction.
- ❖ We hope to be able to say which hemisphere will lead, relative amplitude, and if there will be a significant delay between the hemispheres.

OUR CONSENSUS FOR CYCLE 25

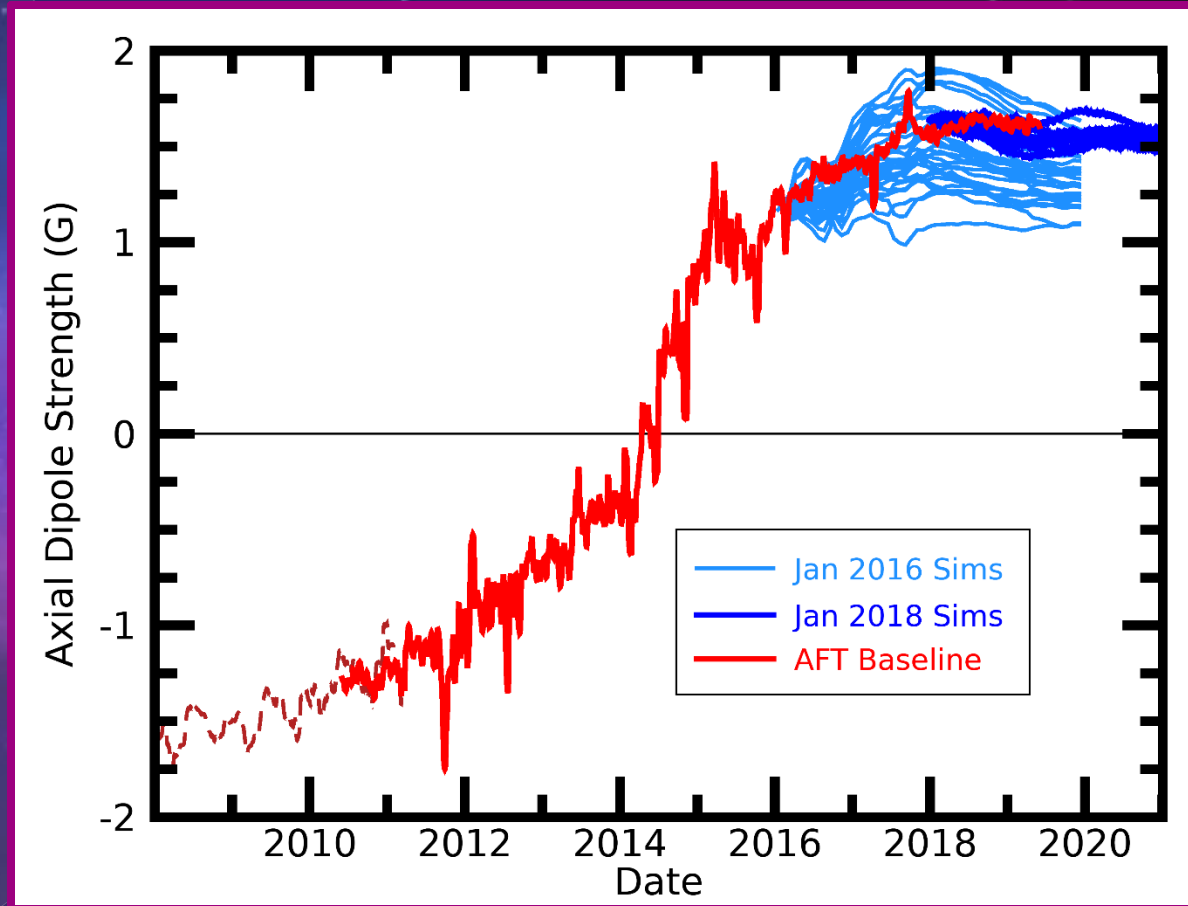


Solar Cycle 25 will be similar to SC24

Still to be done...

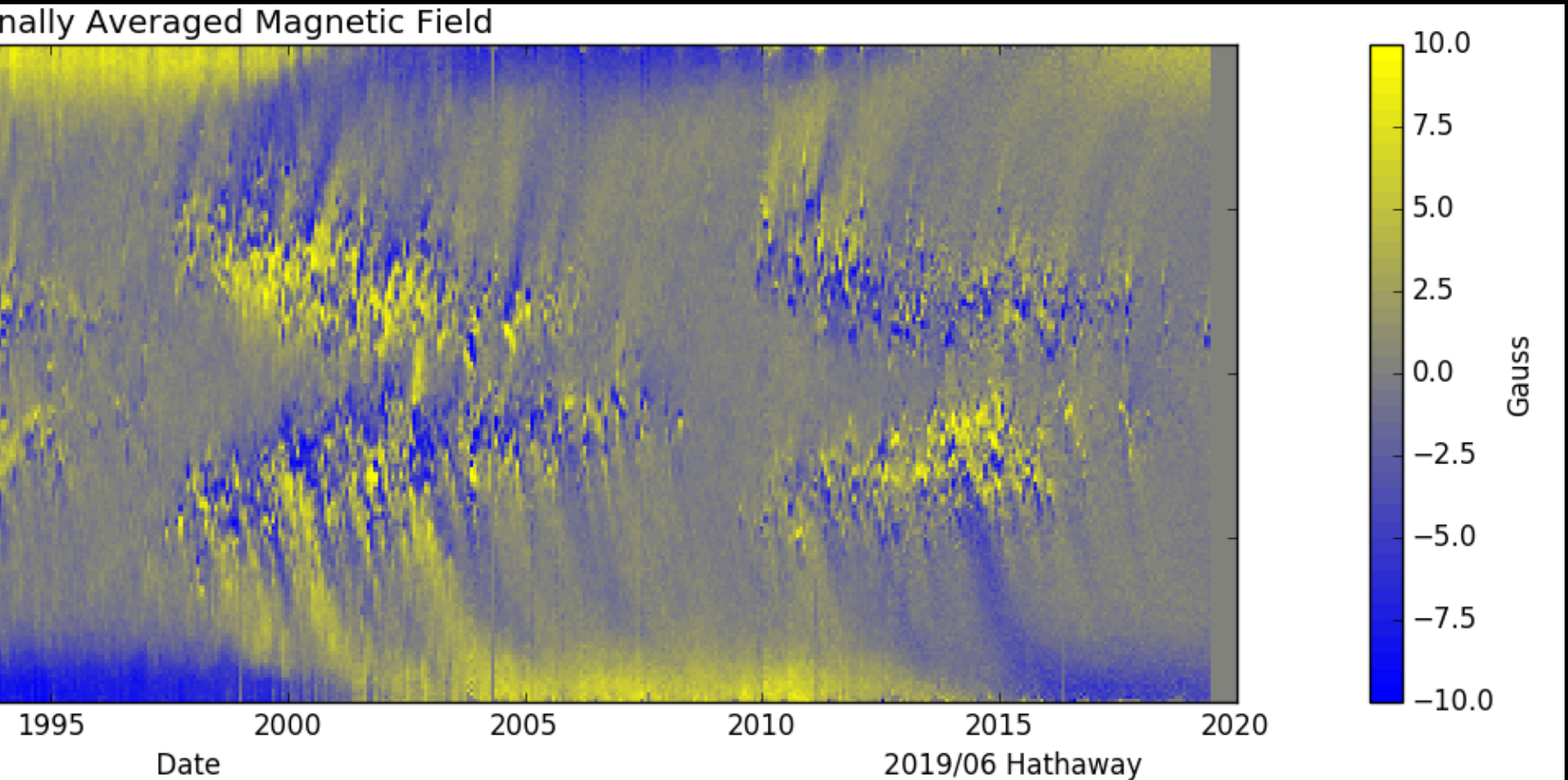
- ◉ Investigate the Hemispheric Asymmetry and Phasing
- ◉ Produce the Official SSN Prediction Curve
- ◉ Provide a statistical estimate of F10.7 Flux
- ◉ Attempt to create a Flare and CME Probability Forecast

My SC25 Prediction



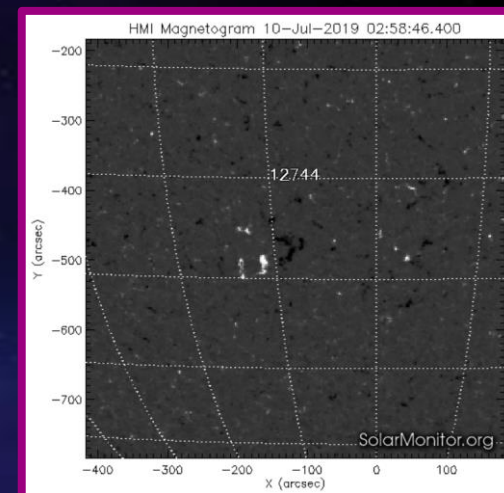
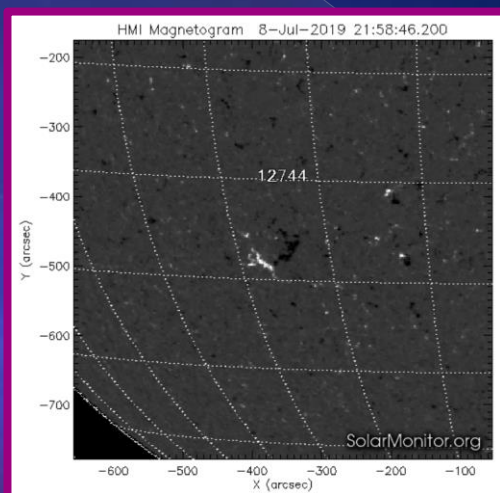
We used the AFT SFT model to predict the polar field evolution: will be ~ 95-97% of SC 24

Timing of minimum: 2019.5-2020.75



We haven't reached solar minimum yet!!

Solar Cycle 25 spots?



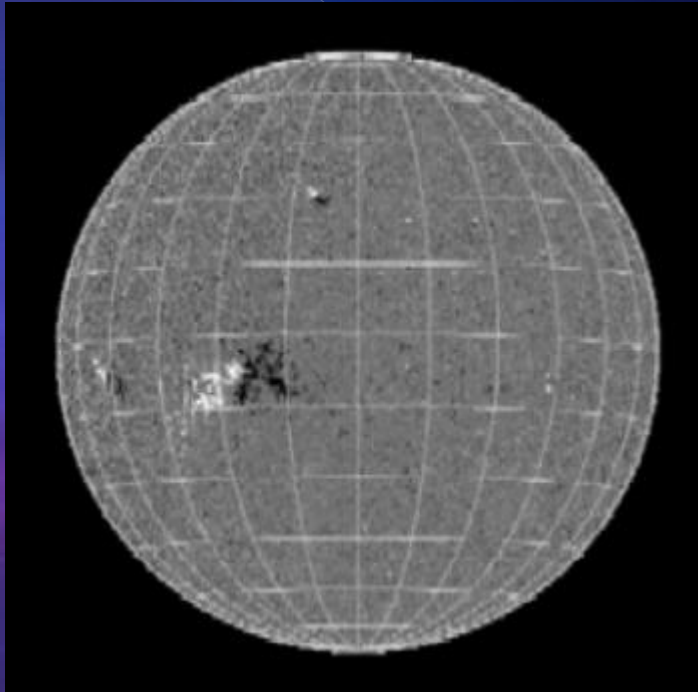
Joint USAF/
SRS Number
Report comp
I. Regions
Nmbr Locat
None
IA. H-alpha
Nmbr Locat
None
II. Regions
Nmbr Lat
2743 N03

Joint USAF/
SRS Number
Report comp
I. Regions
Nmbr Locat
2744 S27E3
IA. H-alpha
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II. Regions
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Joint USAF/
SRS Number
Report comp
I. Regions
Nmbr Locat
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IA. H-alpha
Nmbr Locat
2744 S27E2
II. Regions
Nmbr Lat
2743 N03

Joint USAF/NOAA Solar Region Summary
SRS Number 191 Issued at 0030Z on 10 Jul 2019
Report compiled from data received at SWO on 09 Jul
I. Regions with Sunspots. Locations Valid at 09/2400Z
Nmbr Location Lo Area Z LL NN Mag Type
None
IA. H-alpha Plages without Spots. Locations Valid at 09/2
Nmbr Location Lo
2744 S27E10 211
II. Regions Due to Return 10 Jul to 12 Jul
Nmbr Lat Lo
None

First spot of SC24



Jan, 2008

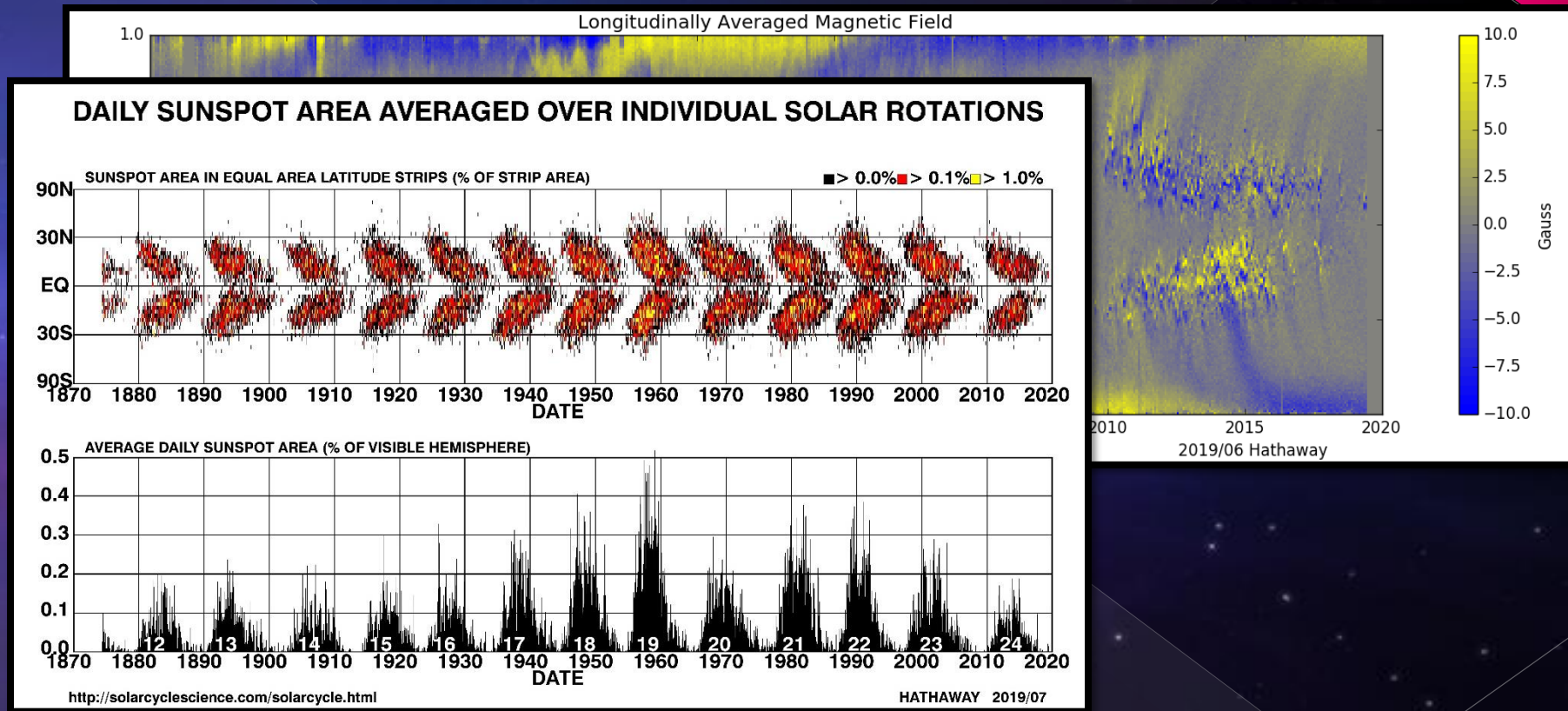
<http://sidc.be/news/x101x/welcome.html>

In fact, the next cycle officially starts when a sunspot minimum is reached, this is at the crossing in time of the sunspot number curves of both cycles. The point is that we can only afterwards determine the starting time.

The appearance of one sunspot isolated in time, even if it has the correct magnetic configuration, can be a false start if this sunspot is not followed by a sequence of sunspots with the correct magnetic configuration. But both the December and January event give a good indication that solar cycle 24 is about to arrive in its full glory.

We haven't reached solar minimum yet!!

Public Service Announcement:



SolarCycleScience.com

Conclusions

- ◉ The Sunspot Number has been revised
 - > NOAA will be adopting these
- ◉ We haven't reached solar minimum
- ◉ Solar Cycle 25 similar to Cycle 24
 - > Amplitude of 95-130
 - > Maximum between 2023-2026
- ◉ We are not in a Maunder Minimum
- ◉ Investigate Hemispheric Asymmetry
- ◉ Predict F10.7/F30 and flare/CME rates
- ◉ My personal prediction (~97% of SC24)
- ◉ SolarCycleScience.com