

Solar Cycle 25 Predictions

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

Key Take Away Messages

- ◉ We haven't reached solar minimum yet!
- ◉ Solar Cycle 25 will be similar to SC24!
- ◉ We are not in a Maunder Minimum!

The Charge to the Panel

Required:

- Predict Cycle 24/25 solar minimum
- Predict peak intensity and phasing of Solar Cycle 25 in V2 of SSN

If possible, also provide:

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

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.

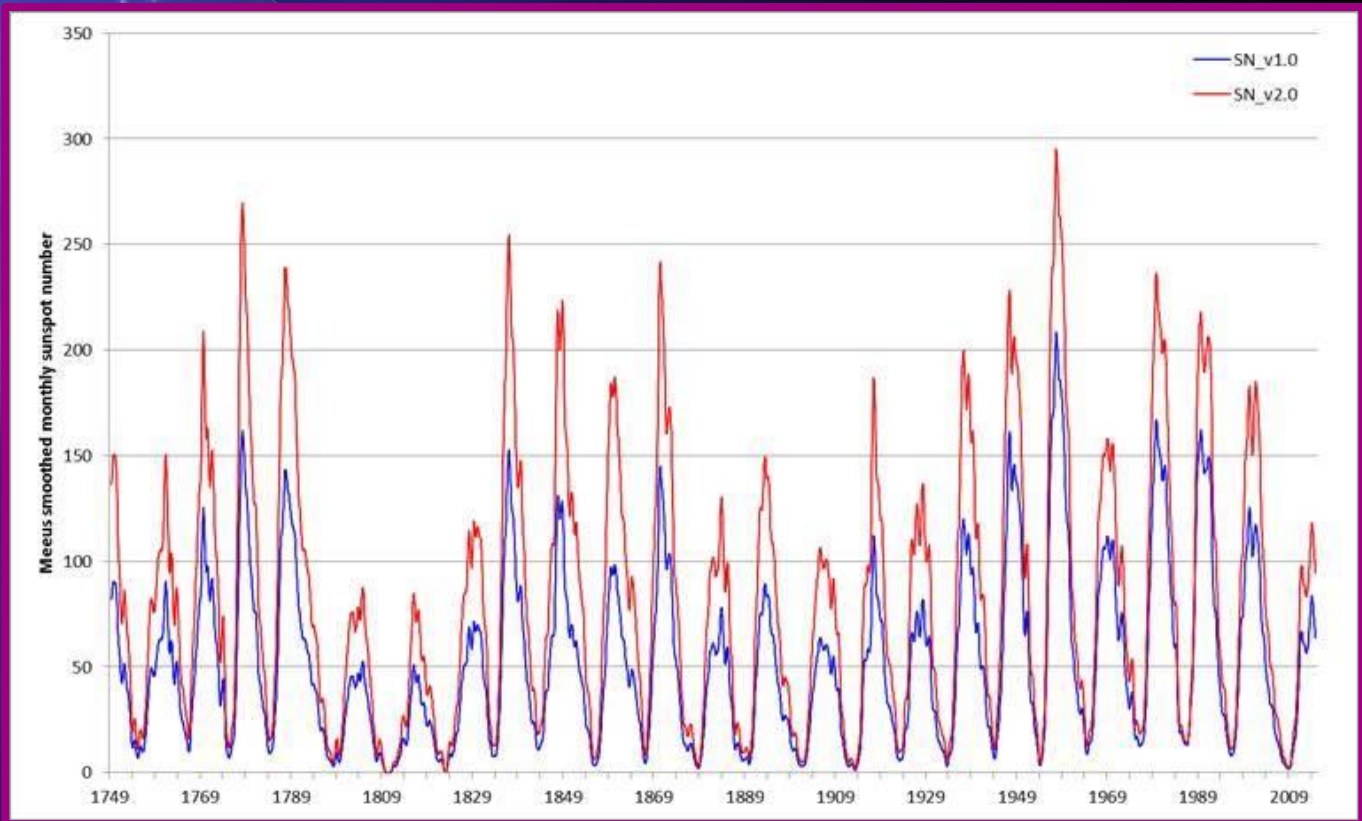
- Rudolph Wolf created the first modern count, stitching together observations from 1749-1893
 - > He tried to mimic early observers by artificially lowering his count
- In 1893, Wolfer took over and determined the a scaling of 0.6 scaling required to keep modern count consistent with Wolf
- There are 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)
- Actually, the cycle 24 peak was 116.4 (42% larger)
- The average peak for SSN V1 was 112.7
- The new average peak is 179.4 (59% larger)
- Cycle 24 is 4th smallest (Dalton Minimum ~30% smaller)

All 24 Cycles



NOAA changing SSN

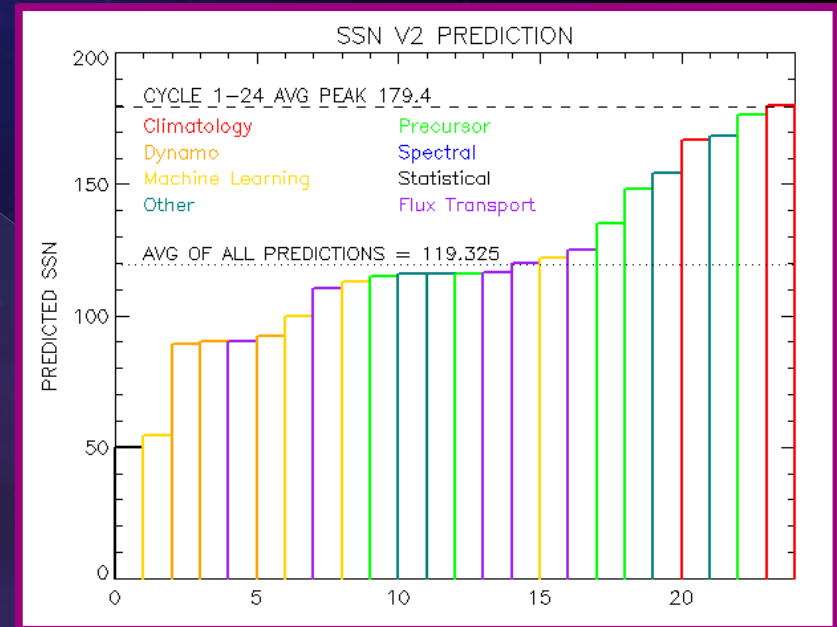
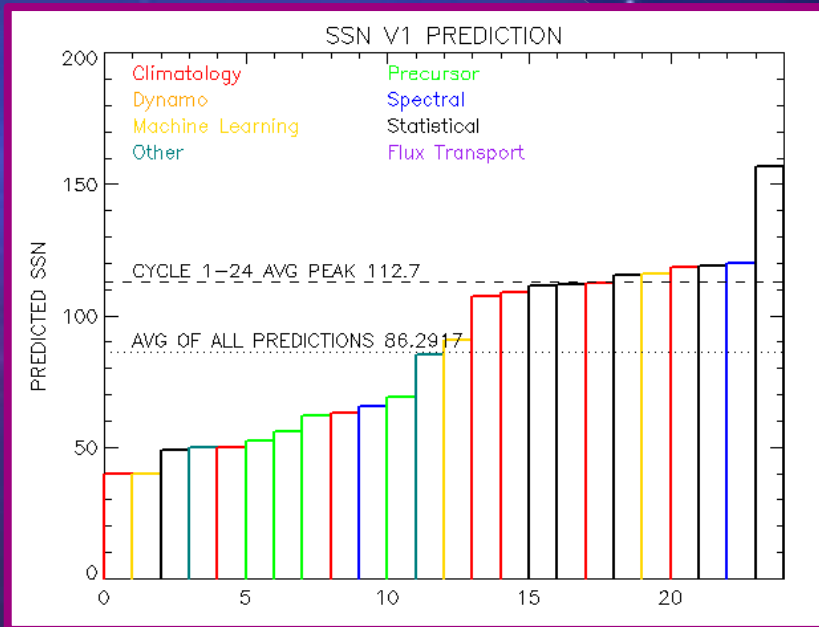
- In July 2015 the Solar Influences Data Center started publishing daily sunspot numbers with Modern scale
- NOAA had already published predictions for the solar cycle – they decided to wait till minimum to switch.
- Users had experience using older numbers
 - > May 2015 was 58.8 using the old scale
 - > With the Modern scale, it was 88.8
- SWPC continues to reduce the sunspot number
 - > Their factor is closer to 0.7
 - > Will remove this reduction 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 ~61 predictions for Cycle 25
- ◉ Different Classes of Predictions
 - > Climatology (~12)
 - > Dynamo (~4)
 - > Machine Learning / Neural Networks (~6)
 - > Precursor (~12)
 - > Spectral/Statistical (~12)
 - > Surface Flux Transport (~5)
 - > Other (~10)

The Predictions

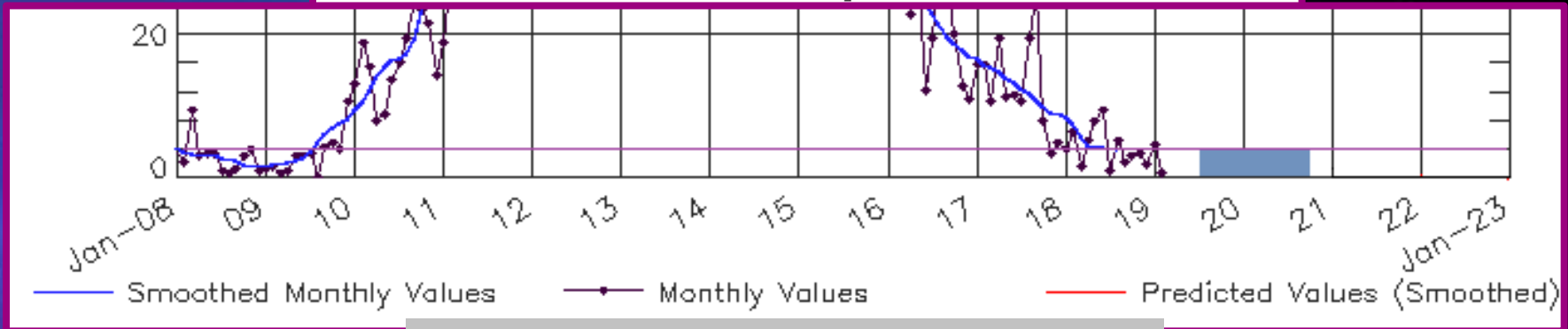
About ½ used the old SSN V1 scaling, and ½ used the new Modern SSN V2 scaling



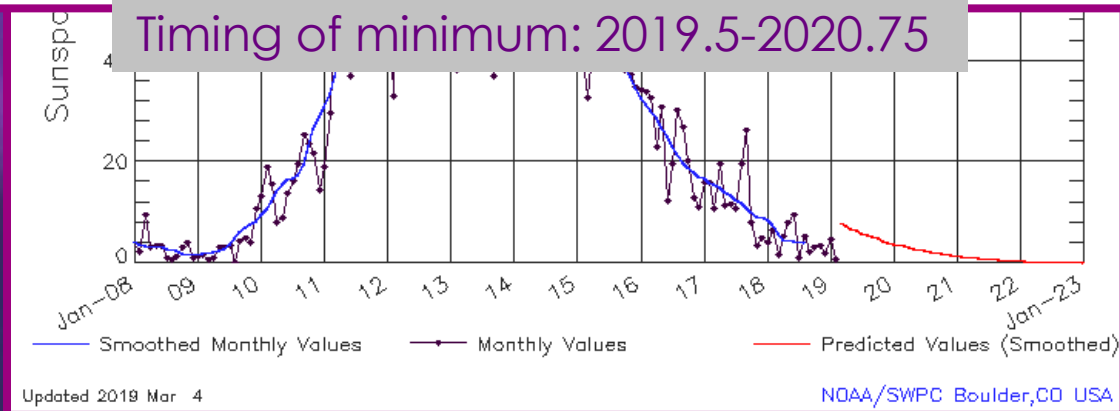
Includes multiple predictions by same author

Solar Cycle 24/25 Minimum

ISES Solar Cycle Sunspot Number Progression
Observed data through Feb 2019



Timing of minimum: 2019.5-2020.75



Updated 2019 Mar 4

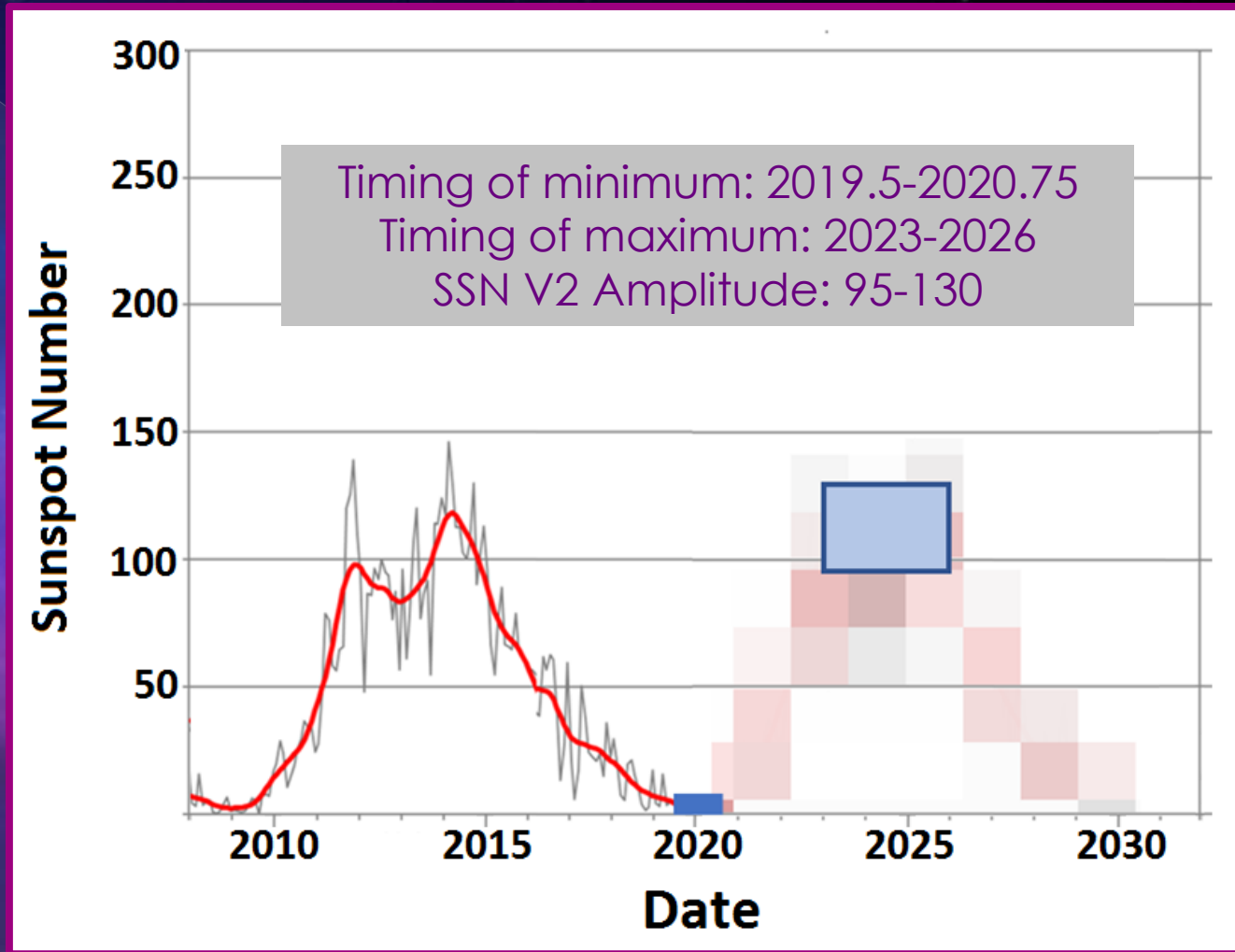
NOAA/SWPC Boulder, CO USA

We haven't reached solar minimum yet!!

Extreme Solar Storms

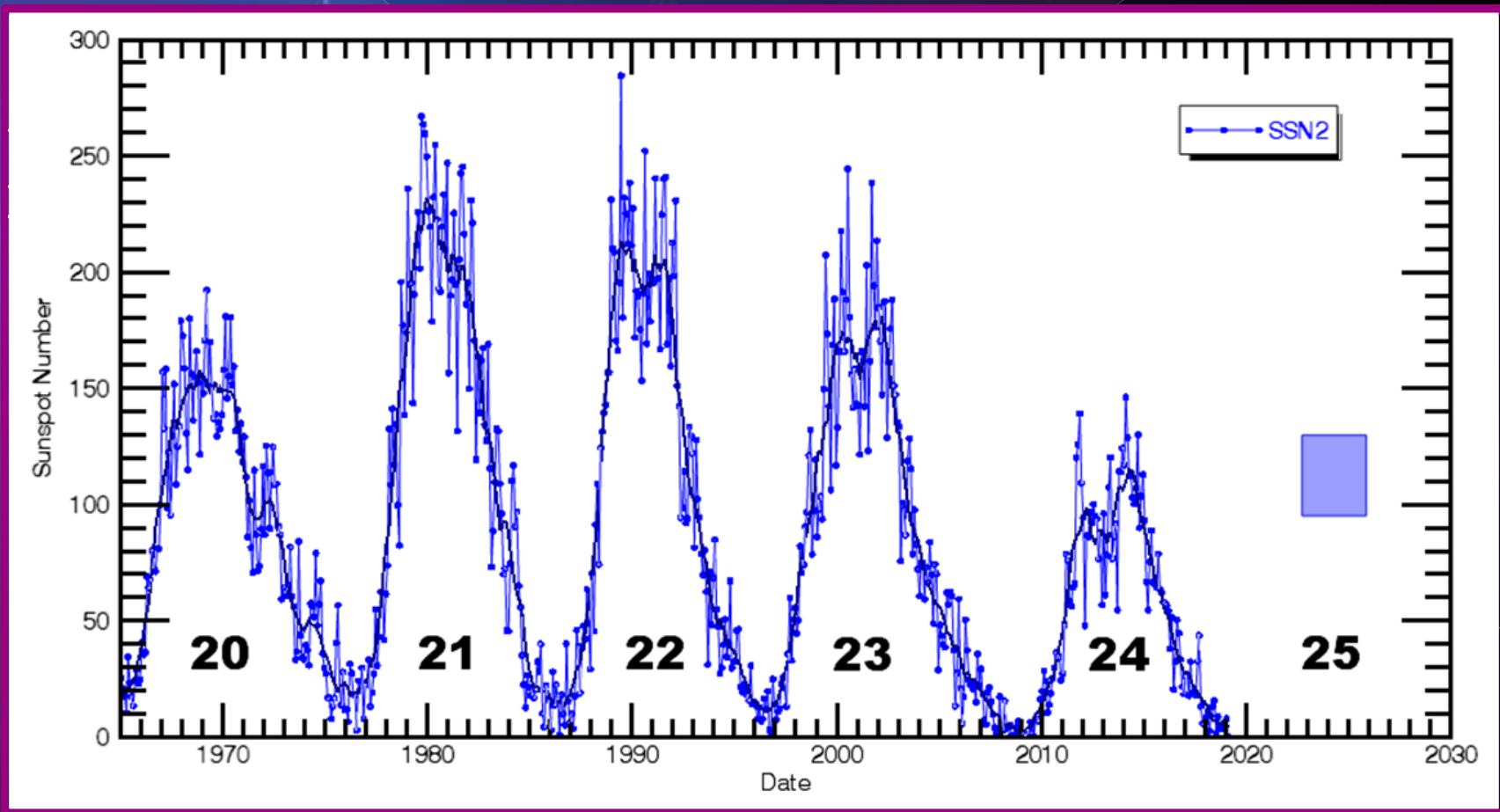
- ◉ Extreme Space Weather events can happen near solar minimum.
- ◉ March 1989 geomagnetic storm
 - > Knocked out the power grid of Quebec
 - > One of the most extreme storms of the Space Age
- ◉ Solar Storm of 2012
 - > Ultrafast CME directed away from Earth with properties that some suggest may have been akin to a Carrington-class storm

OUR CONSENSUS FOR CYCLE 25

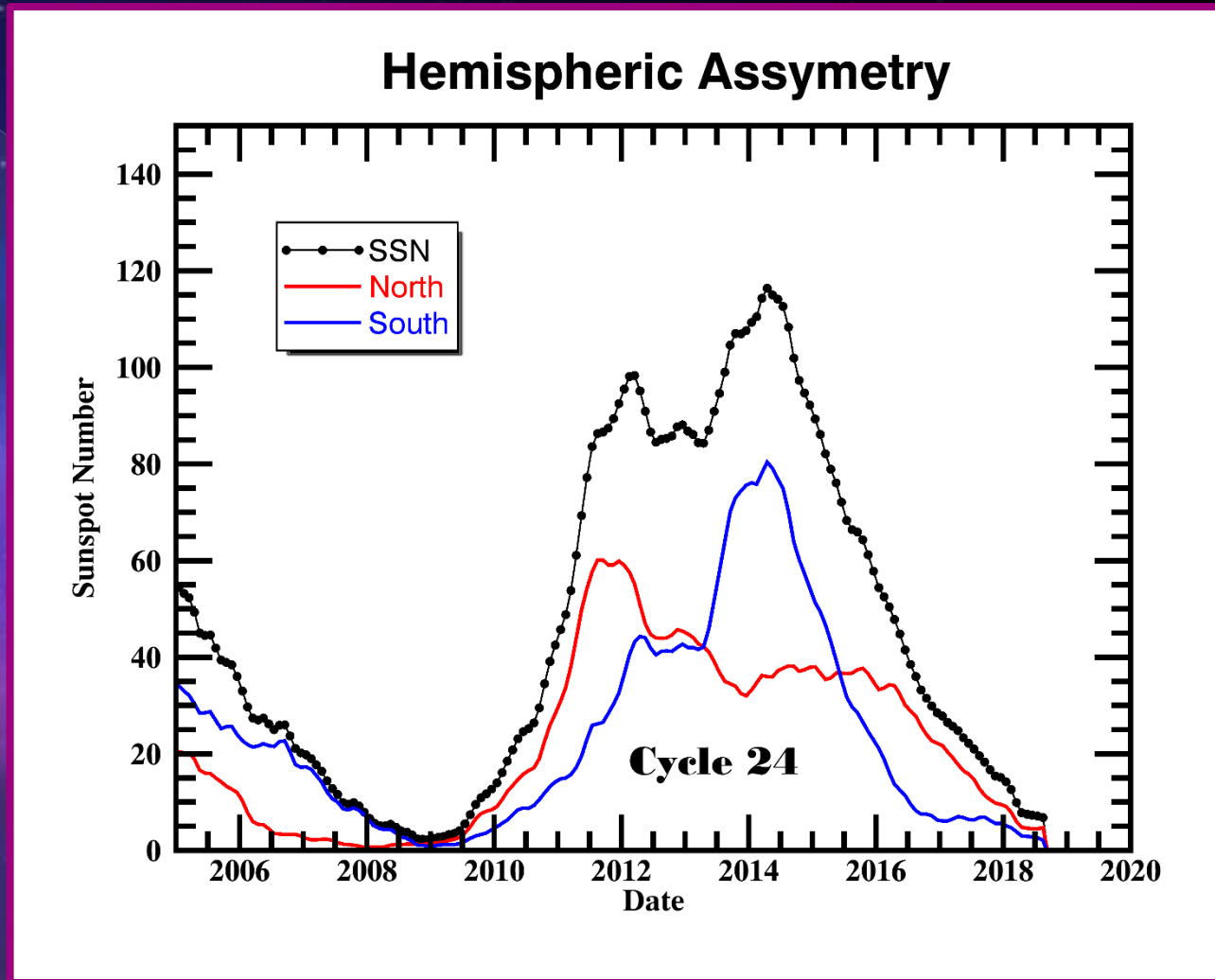


Solar Cycle 25 will be similar to SC24

The Downward Trend



HEMISPHERIC ASYMMETRY



Panel recognizes that Hemispheric Asymmetry needs further investigation.

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
- ◉ We hope to have this done by the end of the year

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