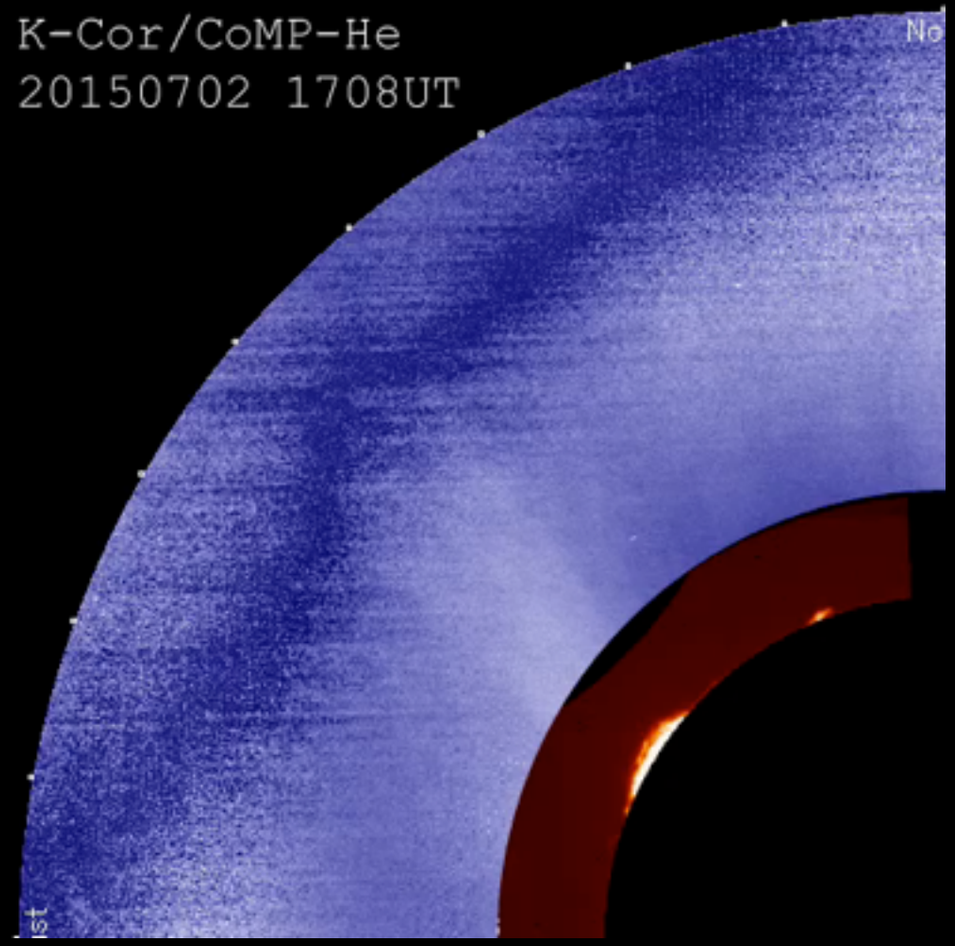
HAO Perspective

- Focal point on Space Weather and visible improvement of SWx enterprise.
  - Fundamental observationally-driven research can help.
  - Rare convergence of political “will.”
- New Strategic and Implementation Plan Roll-Out - July 2016
  - Emphasis on observationally-driven science and innovation.
  - Internal/External Scientific Working Groups
  - Enabling CSAC
    - ChromoInversion
    - “Forward” Coronal Spectropolarimetry and beyond.
- Current Instrumentation
  - KCor
  - CoMP
  - [PSPT]
- Instrumentation in Development
  - ChroMag Prototype [Alfred]
  - “UCoMP”
- Desired Instrumentation
  - COSMO
    - [KCor, ChroMag, “LC”]
  - Community Spar
- Opportunities Possible in GEO/AGS/GS
  - SWAP/SWORM
  - “Quo Vadis”

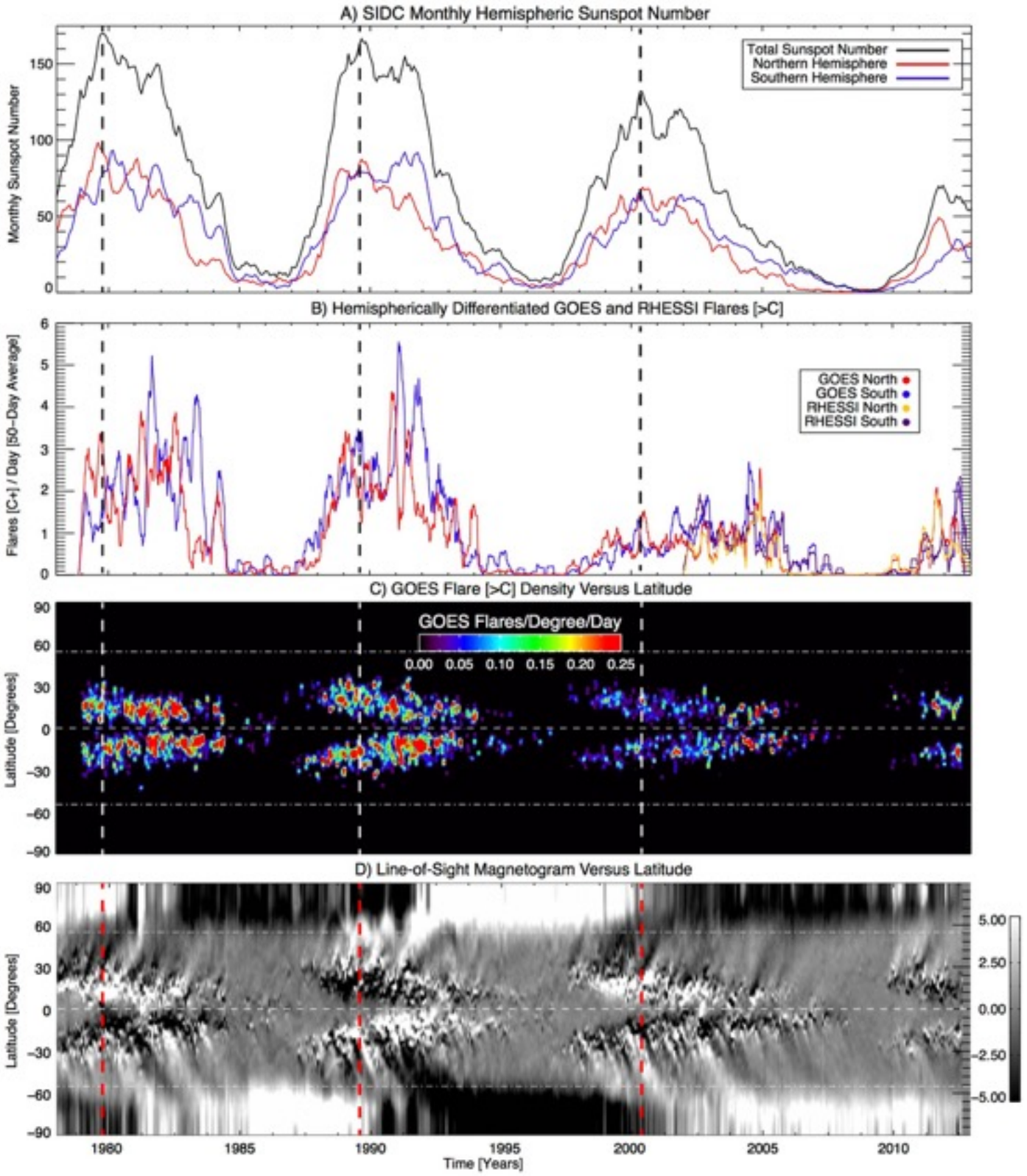


“Synoptic” Science Perspective

- Focal point should be Space Weather and visible improvement of SWx enterprise
  - Space Weather is ALL the time, **not** just events, not just extreme events.
  - Enable magneto-thermal modeling of outer atmosphere/inner heliosphere
    - improve knowledge of conditions before/after/during

- SSI: Understanding B -> λ
  - Complimentary resolution of same instrument - understand signals across scale and how the [magnetic] scales couple.
  - “Seasonal” impulses in flux emergence.
    - 95%+ DRIVER of space weather.
    - beyond “horse has bolted” paradigm.
  - Multi-line “comparative” helioseismology.
    - Capability to push helioseismology forward.
    - Lorentz force pressure impact identified?
  - “Extended Cycle”
    - Feature Tracking NOT just averaging.
    - What “is” differential rotation?
    - High latitudes are key.
      - Possible “home” of dynamo
    - Rosetta stone for stellar activity observations.

Observing Seasons



Overall Decline in Flaring

$Flare_{MAX}$ later than SSN_{MAX}

Follows by >1year

The “Gnevyshev Gap”

Hemispheric Phase Variance

Quite independent

Clear Flare Clustering

In Latitude AND Time

Flare “Surges”!

Rapid quasi-periodic increase in flare rate.

decadal and “annual” timescale evolution are present!

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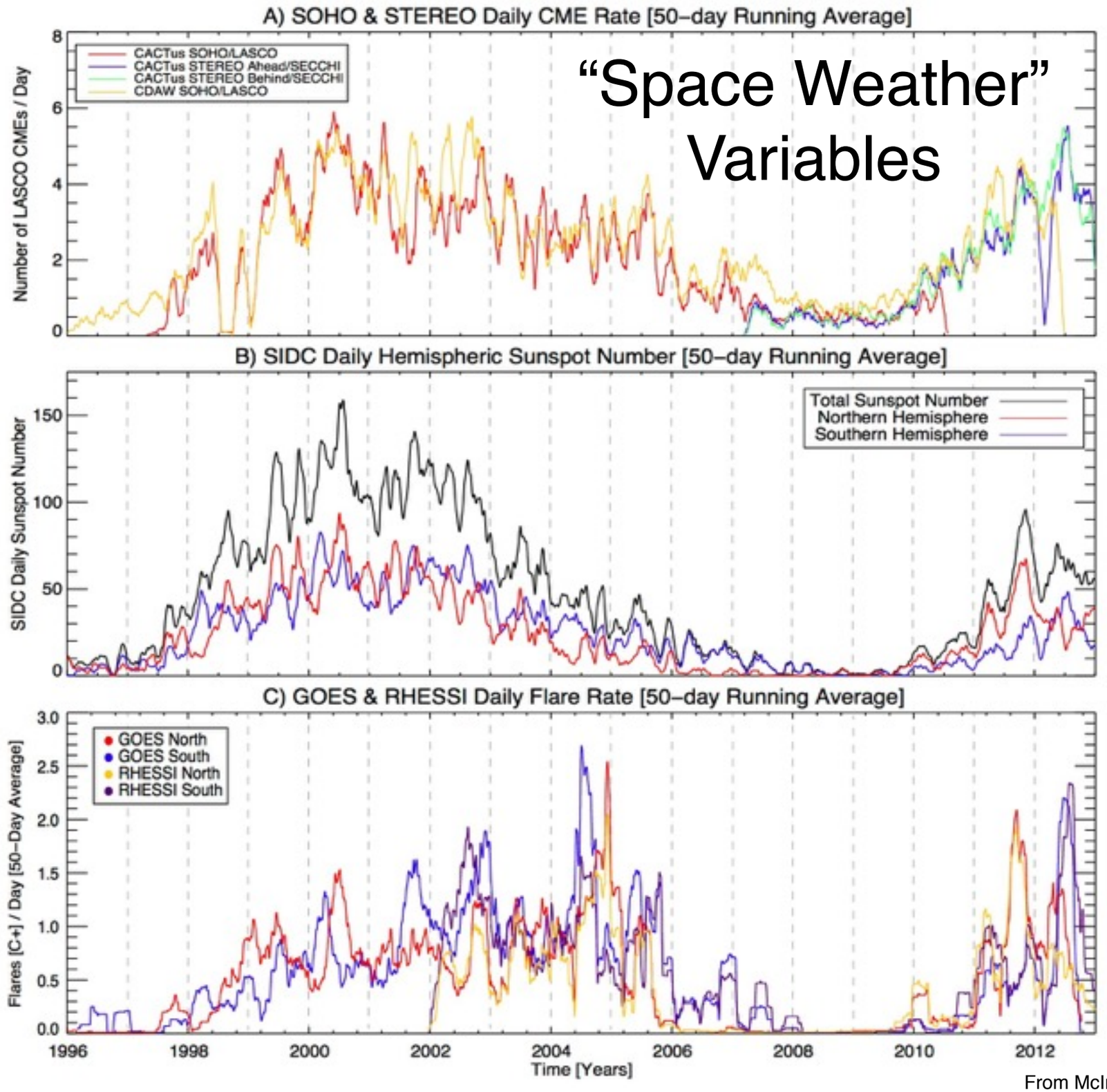
Observing Seasons



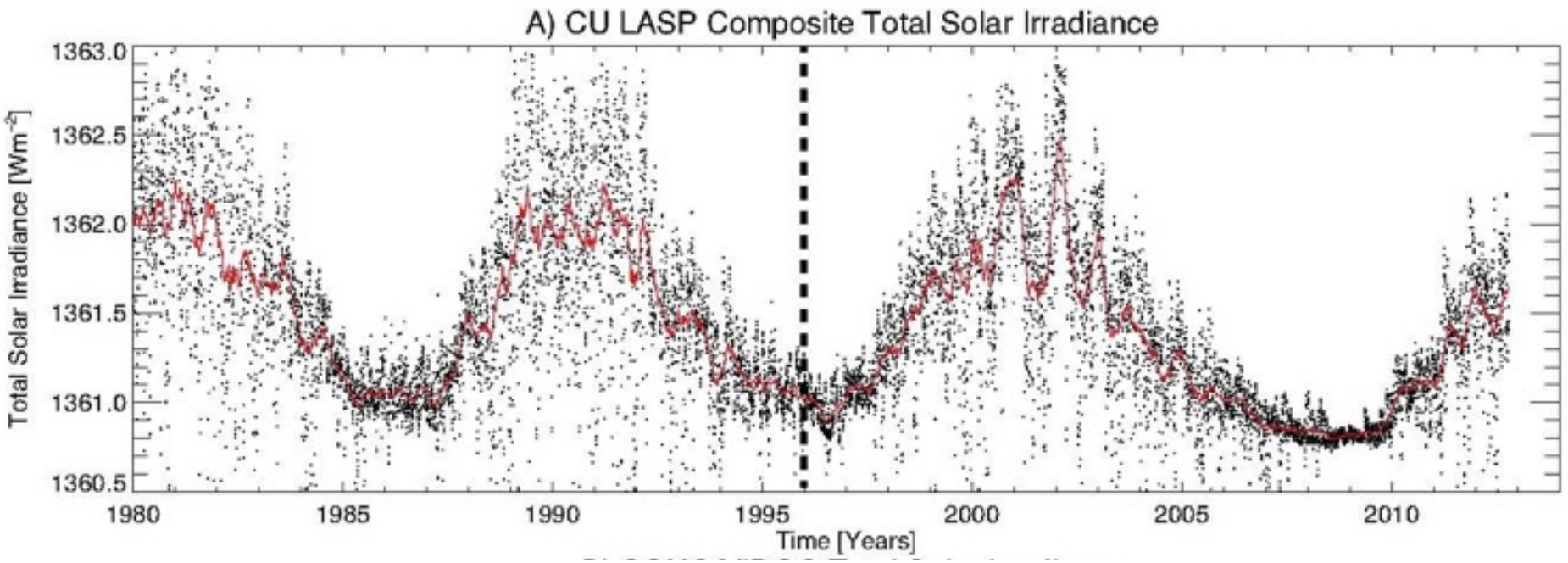
Coronal Mass Ejection
"CMEs"
Rate ~100% Increase

(h)SSN
Rate ~50-100% Increase

Flares
Rate >100% Increase

From McIntosh et al. (2014b) "On The Quasi-Periodic Forcing of The Sun's Eruptive, Radiative, and Particulate Output"

Observing Seasons



"Radiation"

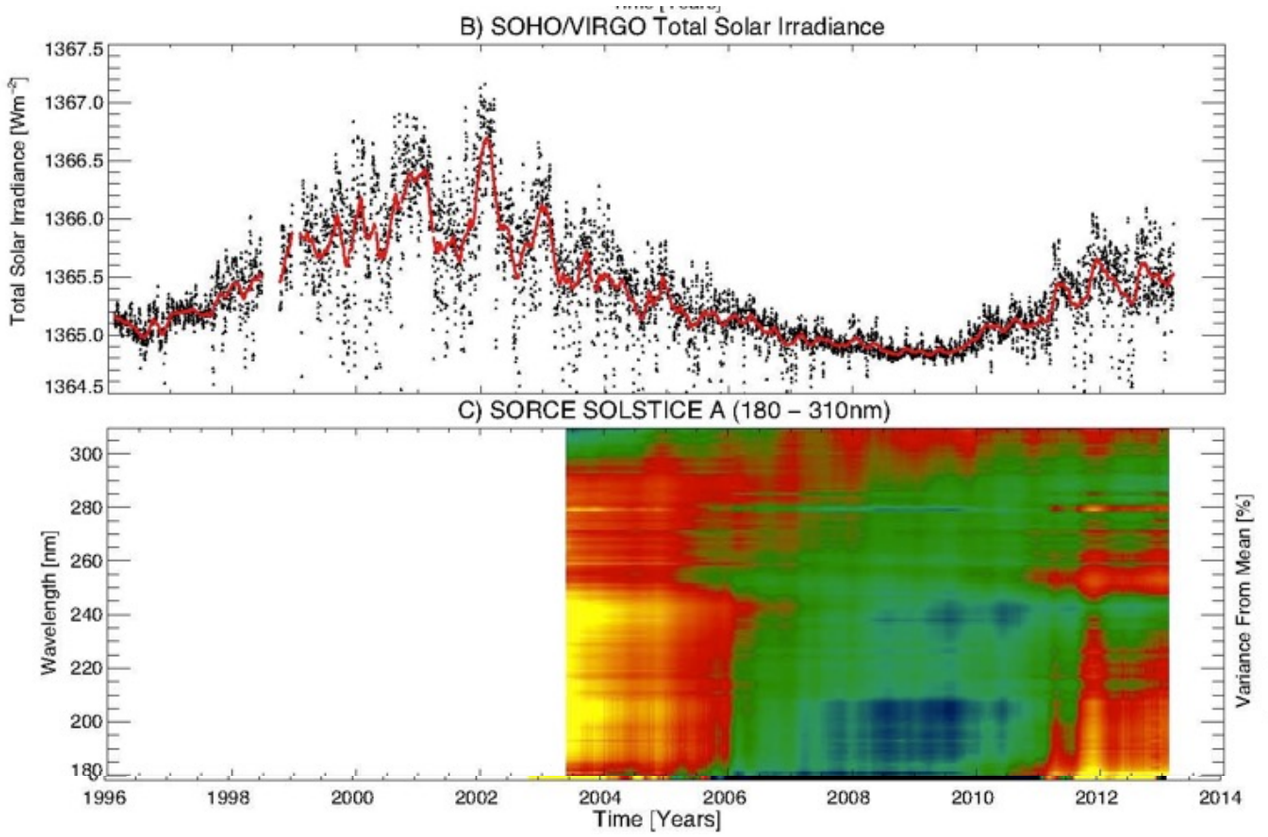
TSI ~1Wm^{-2}yr^{-1}

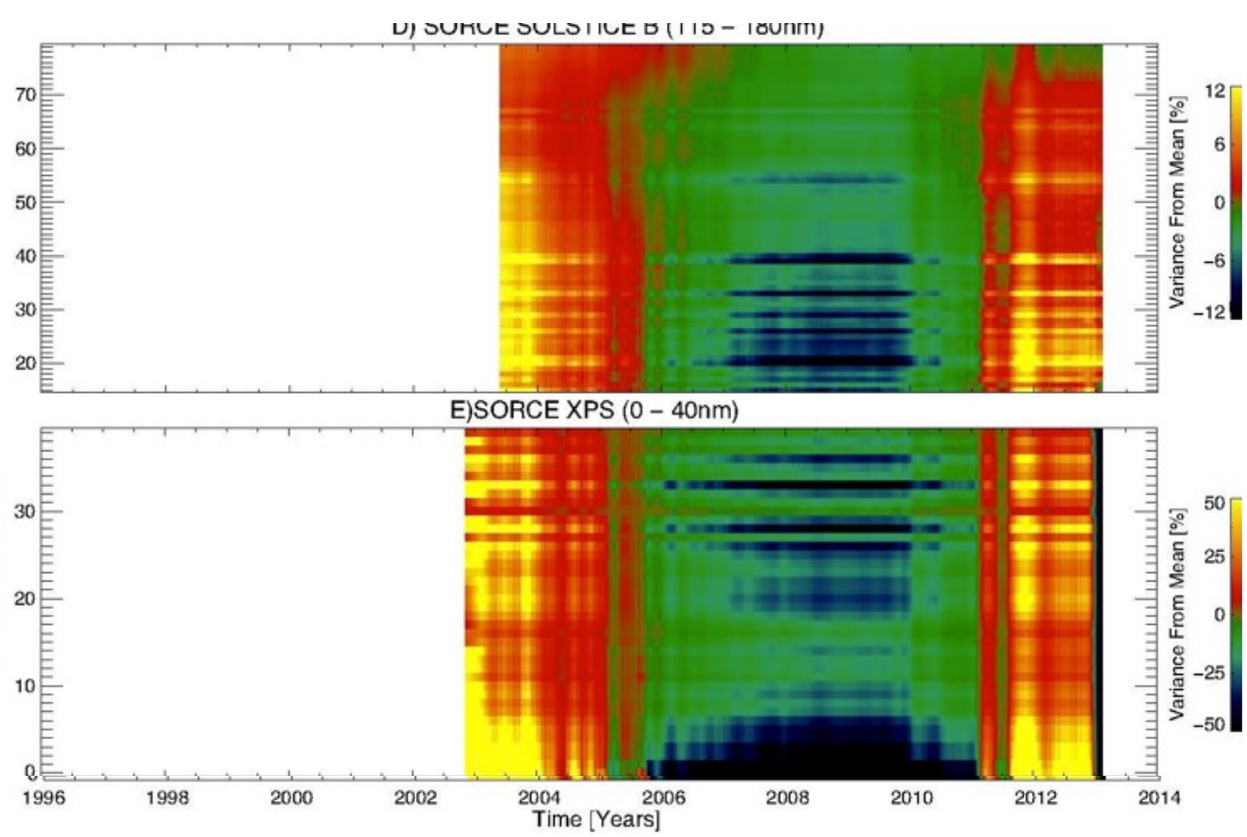
SSI_{UV} ±5%

SSI_{EUV} ±15%

SSI_{XR} ±75%

$SSI_{Opt/IR}$ ±?





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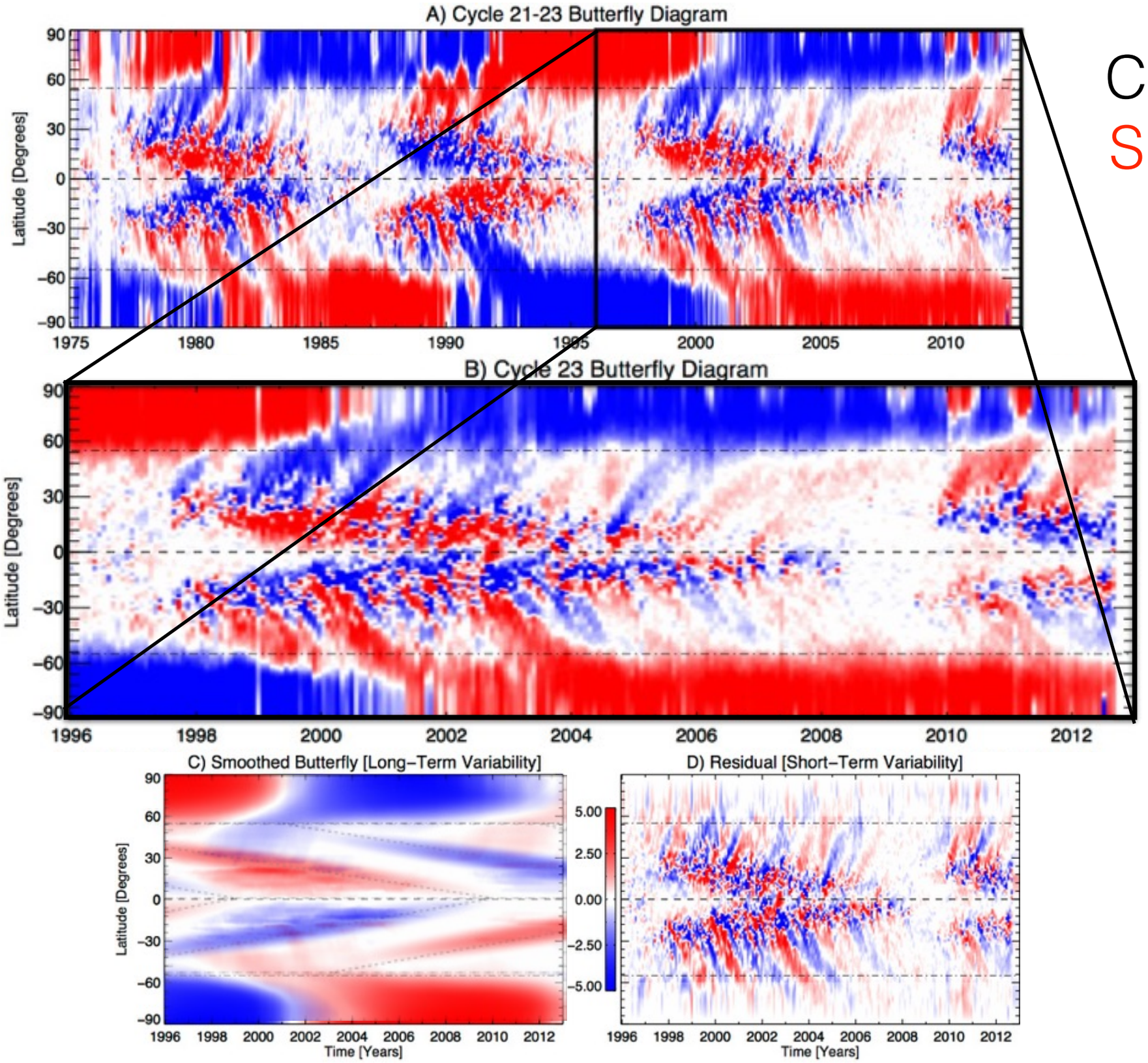
Observing Seasons



Cause?:

Surges of Surface Magnetism

….apparent poleward motion of magnetic flux from the activity bands….

….apparent poleward motion is likely what happens when you feed the Sun's surface meridional circulation…..only a result of flux surge?

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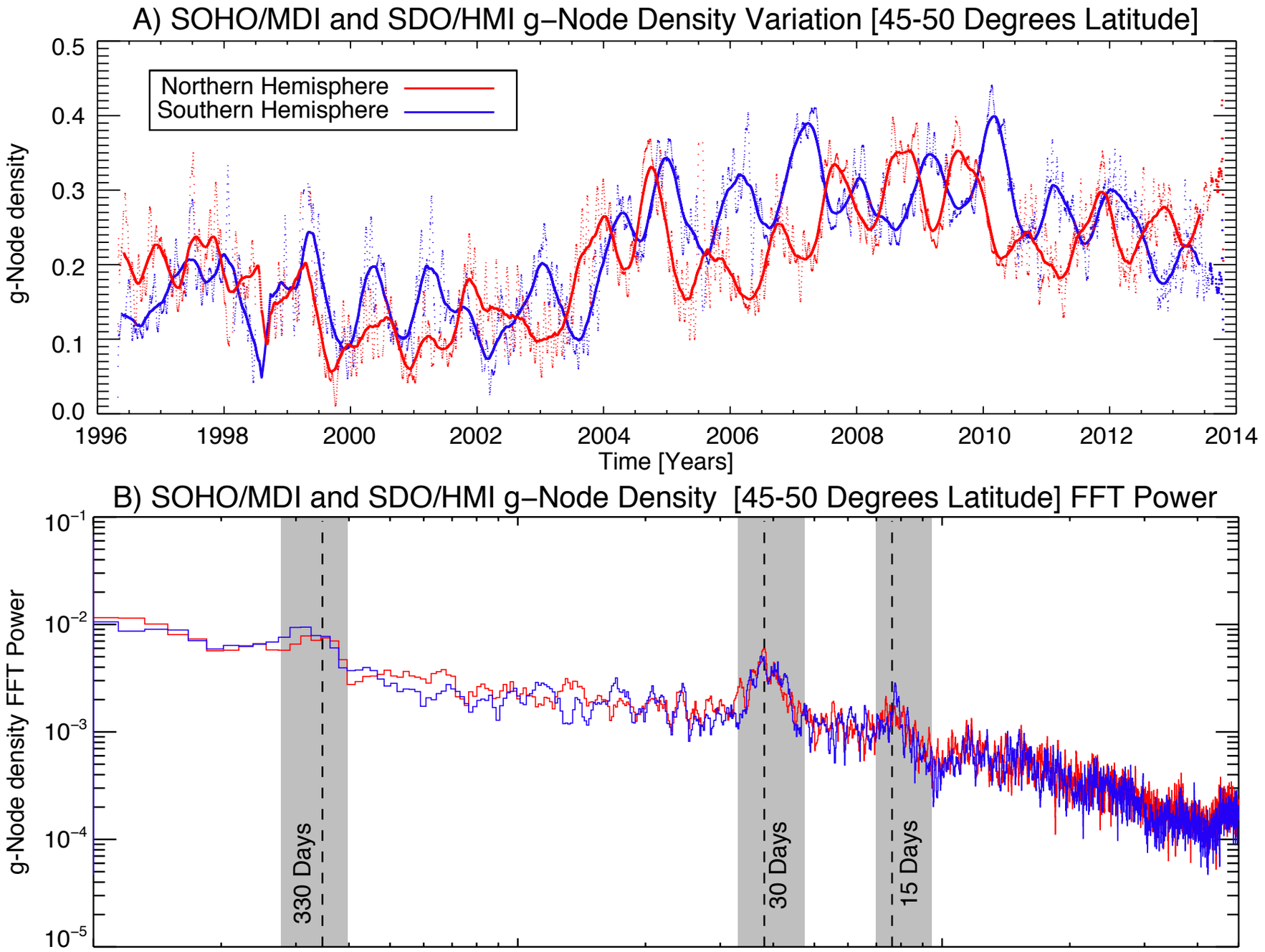
Observing Seasons

Observations reveal (very) strong surges in solar magnetism
Effect storm production, radiative, and particulate output.



g-node/BP monitoring (in each hemisphere) permit assessment of surge phase…..

Understanding: Are there eruptive energy/momentum transport phenomena on the Earth's "activity bands" that we can learn from?

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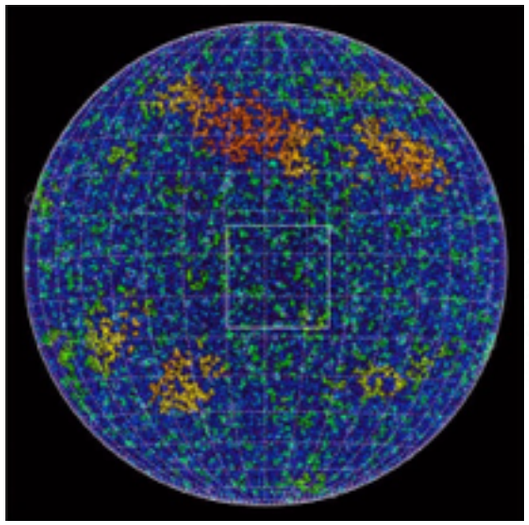
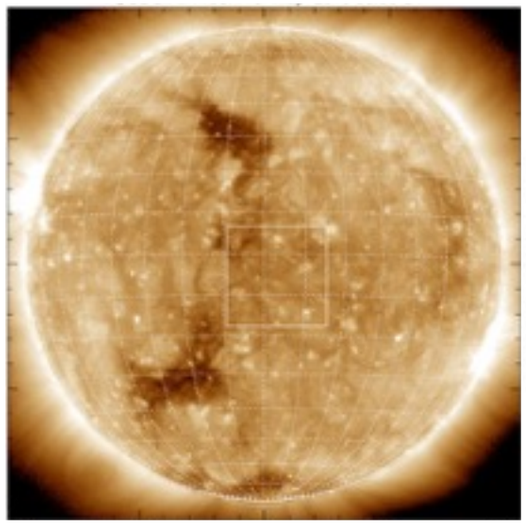
Out of the Depths

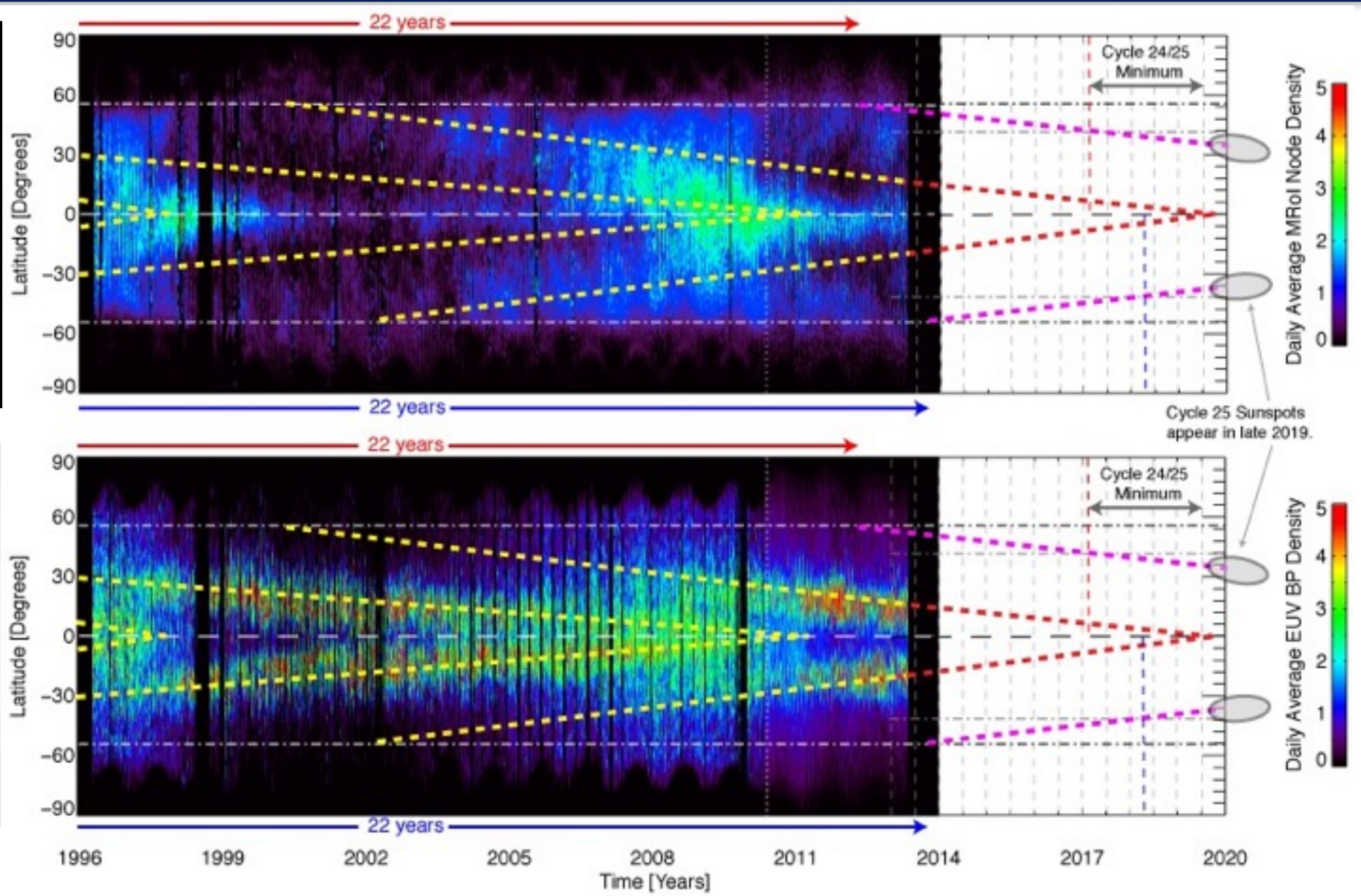
Is Solar Cycle 25 Showing Itself?

McIntosh et al. (2014)





August 2013



Observational diagnostics reveal the "Extended Solar Cycle" (ESC). The ESC appears (~10) years before and at much higher latitudes (~30°) than traditional diagnostics (cf. sunspots) of the solar cycle. Tracking the EAC provides new forecast capability for the progression of the solar cycle and challenges convention on the solar dynamo.

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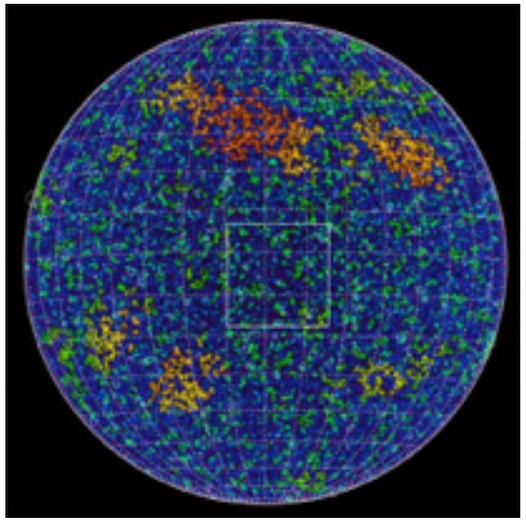
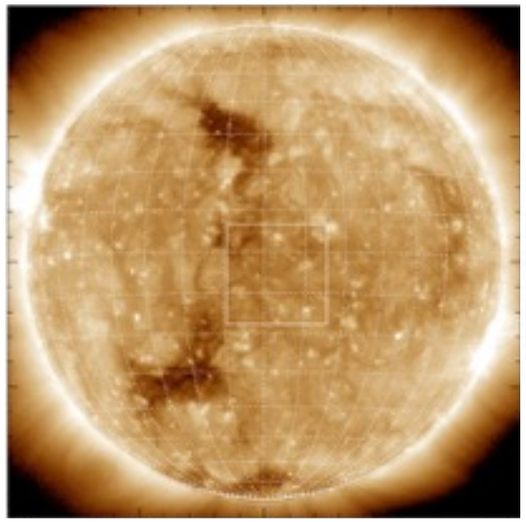
Out of the Depths

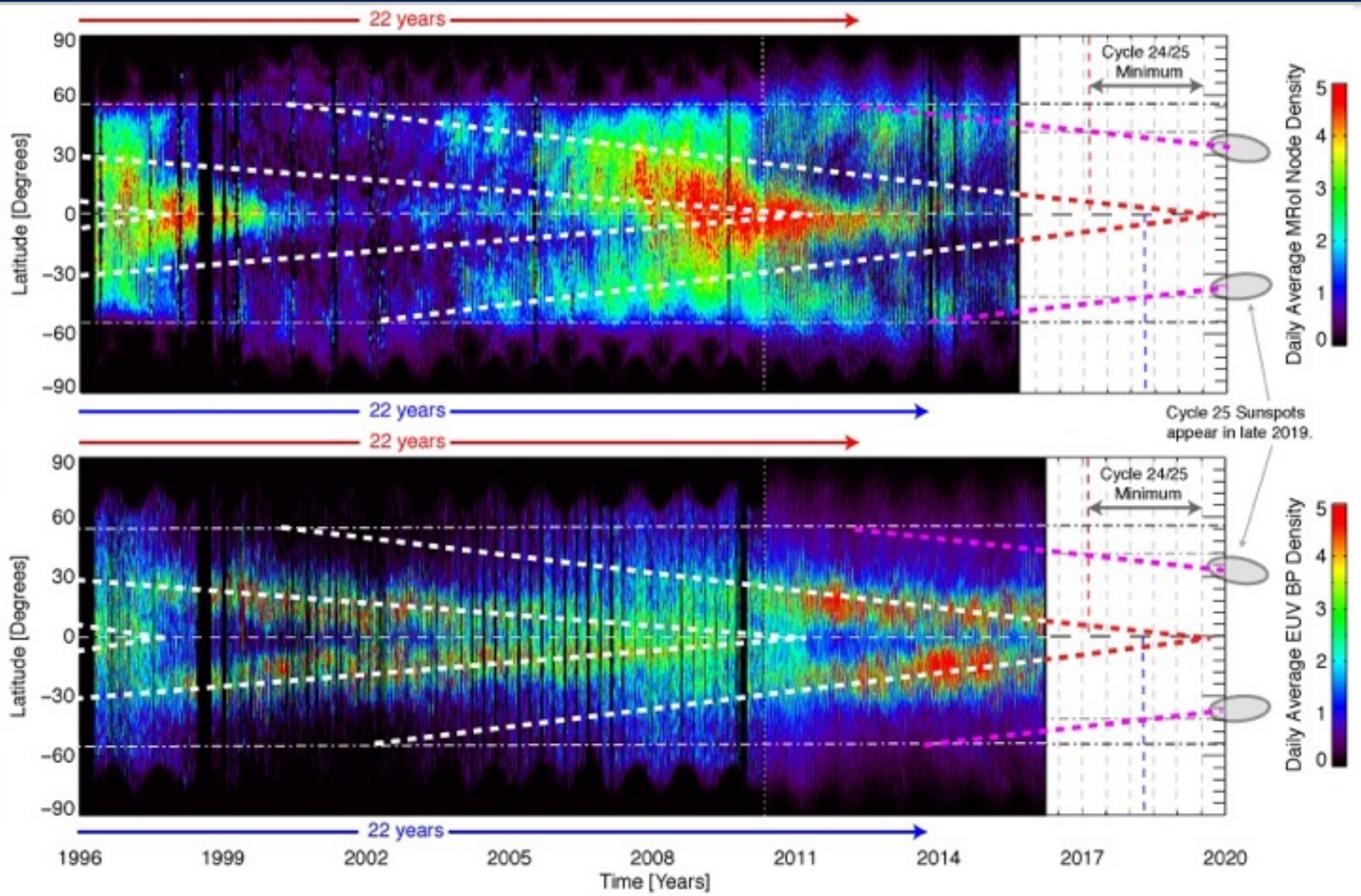
Is Solar Cycle 25 Showing Itself?

McIntosh et al. (2016 in prep)





April 2016



- Solar Cycle 25 (SC25) is visible at higher latitudes in BOTH solar hemispheres.
- SC25 progressing as anticipated with solar minimum conditions onset in 2017.
- Anticipate that C25 will be much weaker then SC24 (which was 25% weather than its predecessor). Implications for host of atmospheric inputs!

NCAR NSF

Out of the Depths

Is Solar Cycle 25 Showing Itself?

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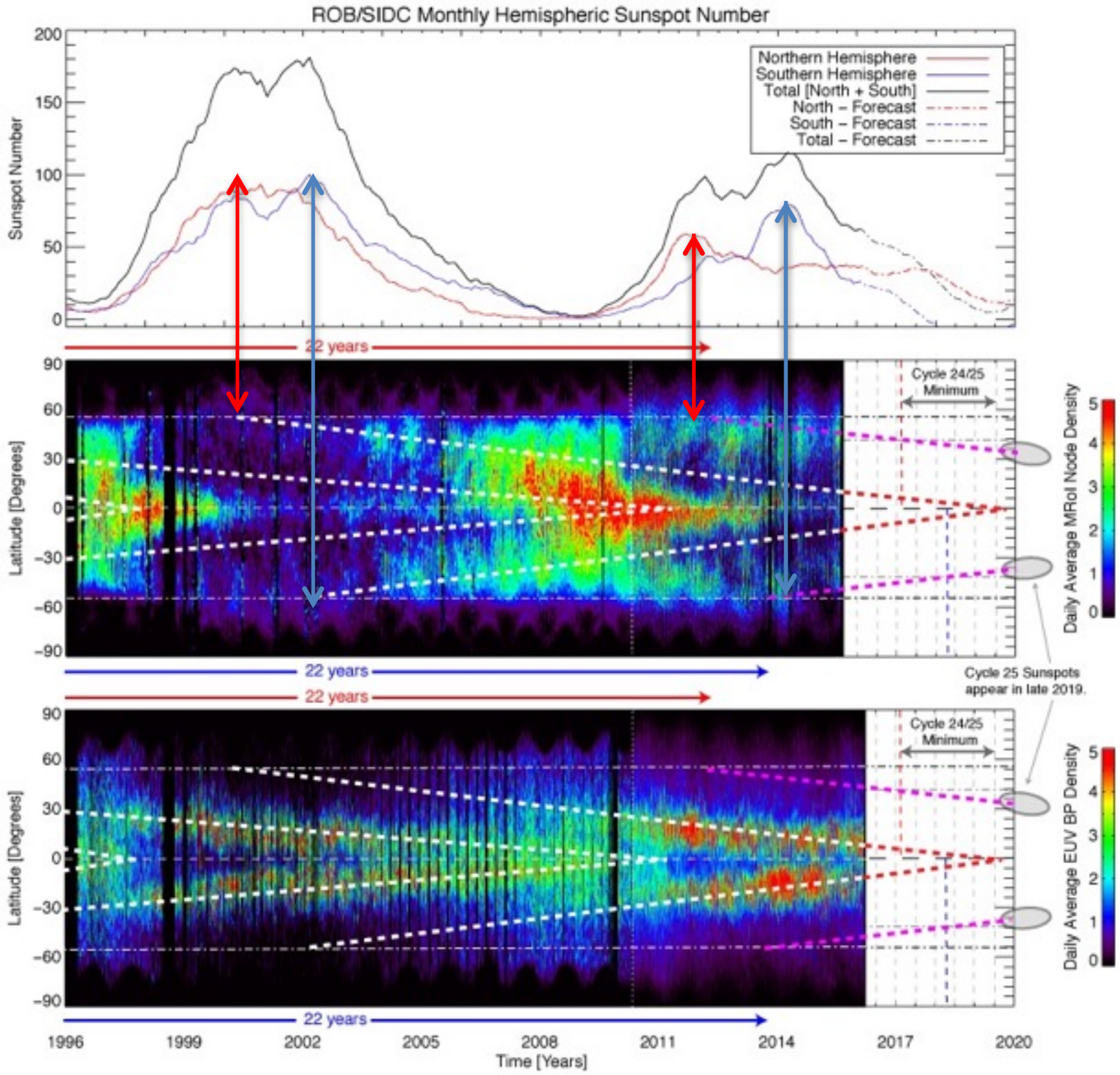

- Hemispheric Sunspot Number (Solar Max) peaks WHEN expected from ESC analysis.
- SC25 sunspots will appear in late 2019, but SC 24/25 minimum could be LONG and DEEP.
- With a 25% per cycle decay over the past three cycles are we looking at the descent in to a new minimum of solar activity?