TERMINATORS:

The Death of Solar Cycles and La Niña

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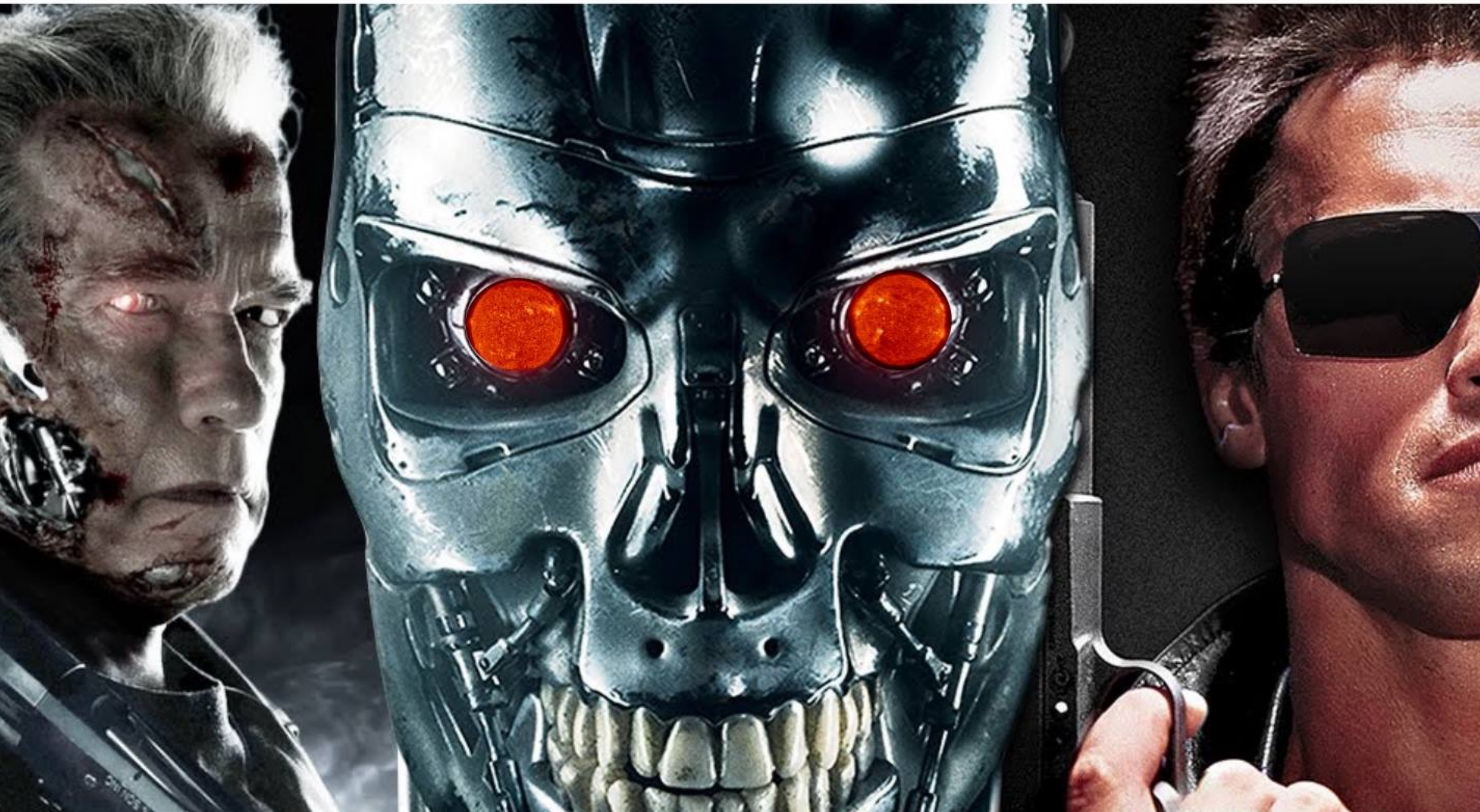


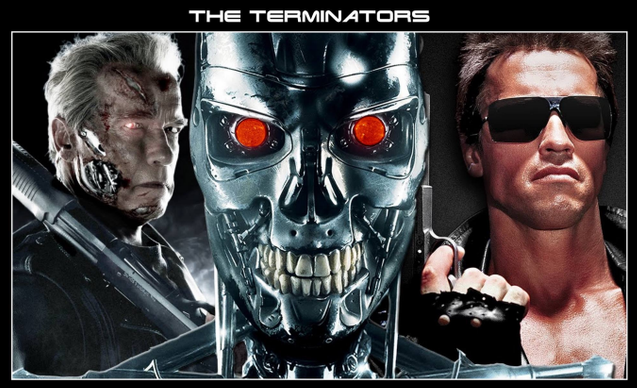
TERMINATORS:

The Death of Solar Cycles and La Niña

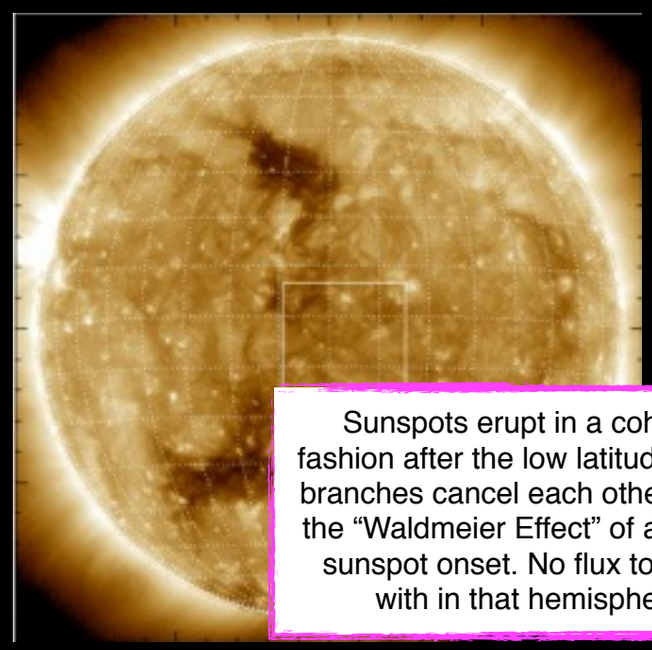
OVERVIEW:

- 22 Year Band Model
- Terminators & Canonical Indices
- Termination & Irradiance
- Terminators & La Niña
- Terminators & The Future

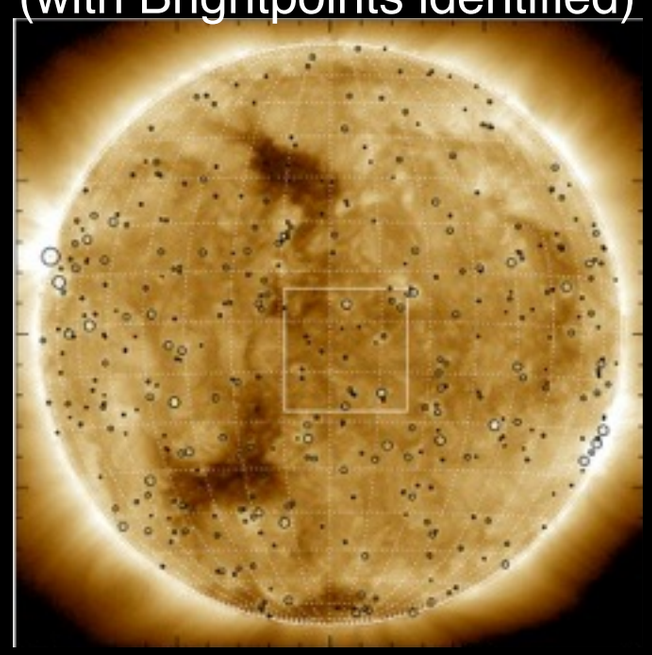
SOHO/SDO observations point to the origin of the 11-year waxing and waning of sunspots

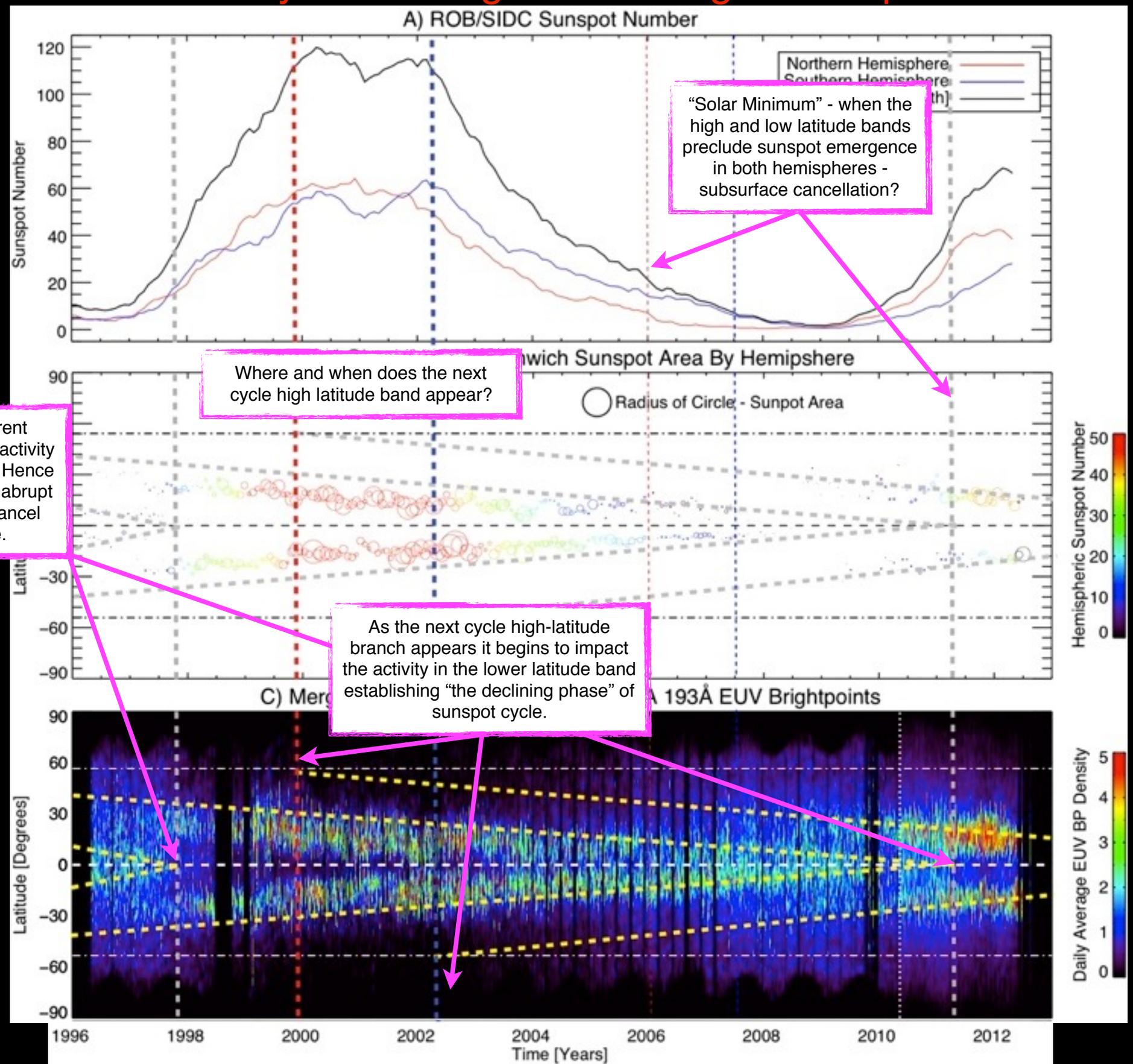


SDO/AIA 193Å



SDO/AIA 193Å
(with Brightpoints identified)





"Solar Minimum" - when the high and low latitude bands preclude sunspot emergence in both hemispheres - subsurface cancellation?

Where and when does the next cycle high latitude band appear?

Sunspots erupt in a coherent fashion after the low latitude activity branches cancel each other. Hence the "Waldmeier Effect" of an abrupt sunspot onset. No flux to cancel with in that hemisphere.

As the next cycle high-latitude branch appears it begins to impact the activity in the lower latitude band establishing "the declining phase" of sunspot cycle.

Green Line Background

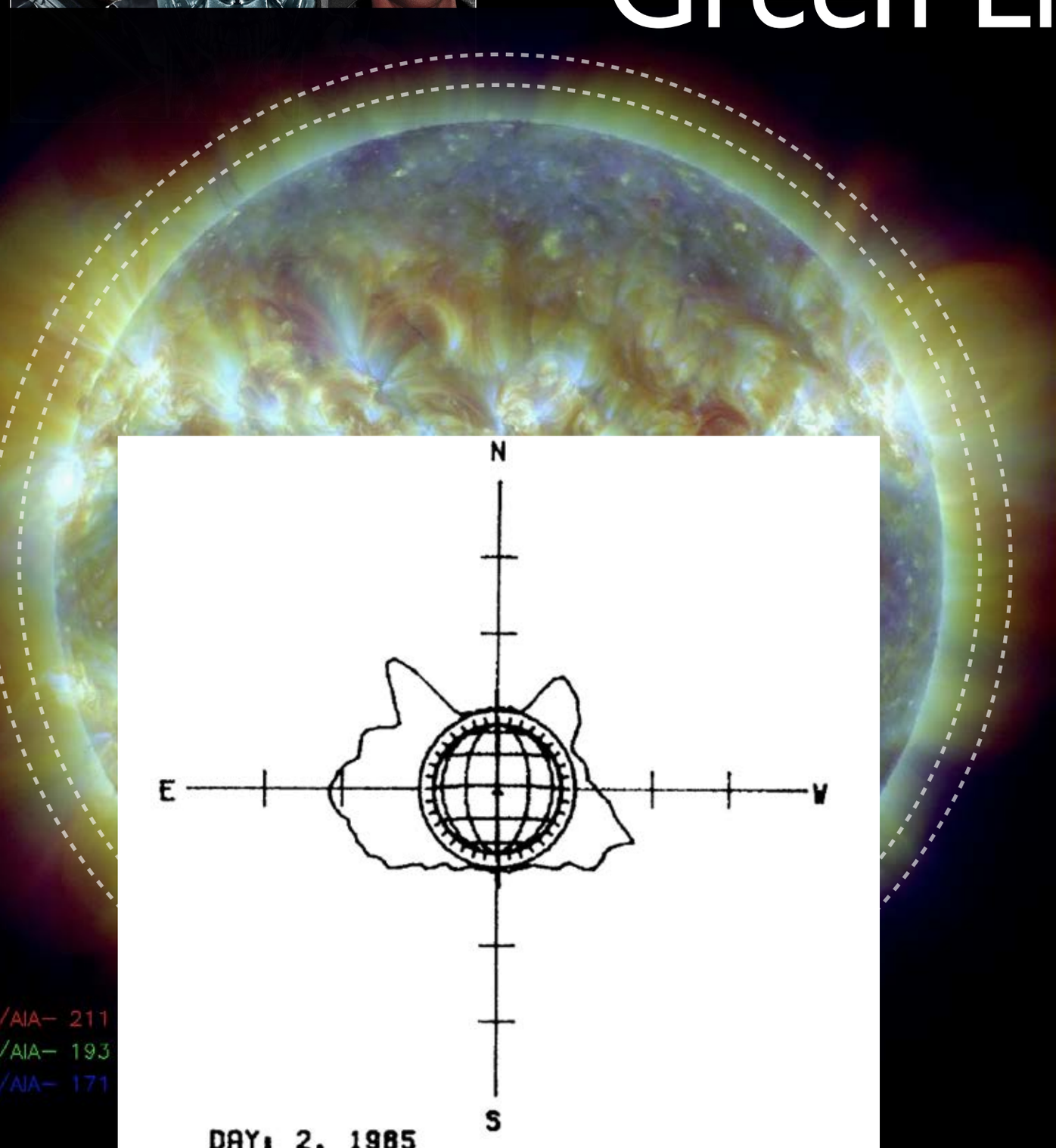
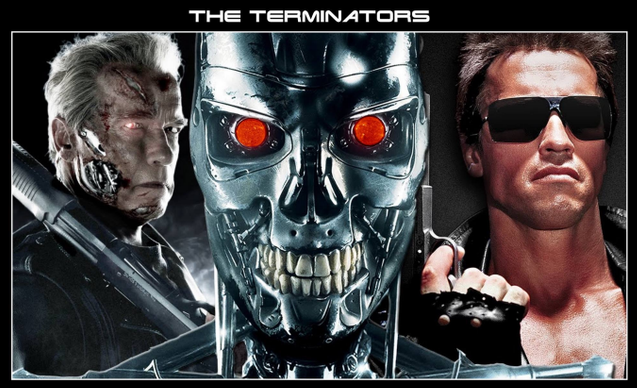
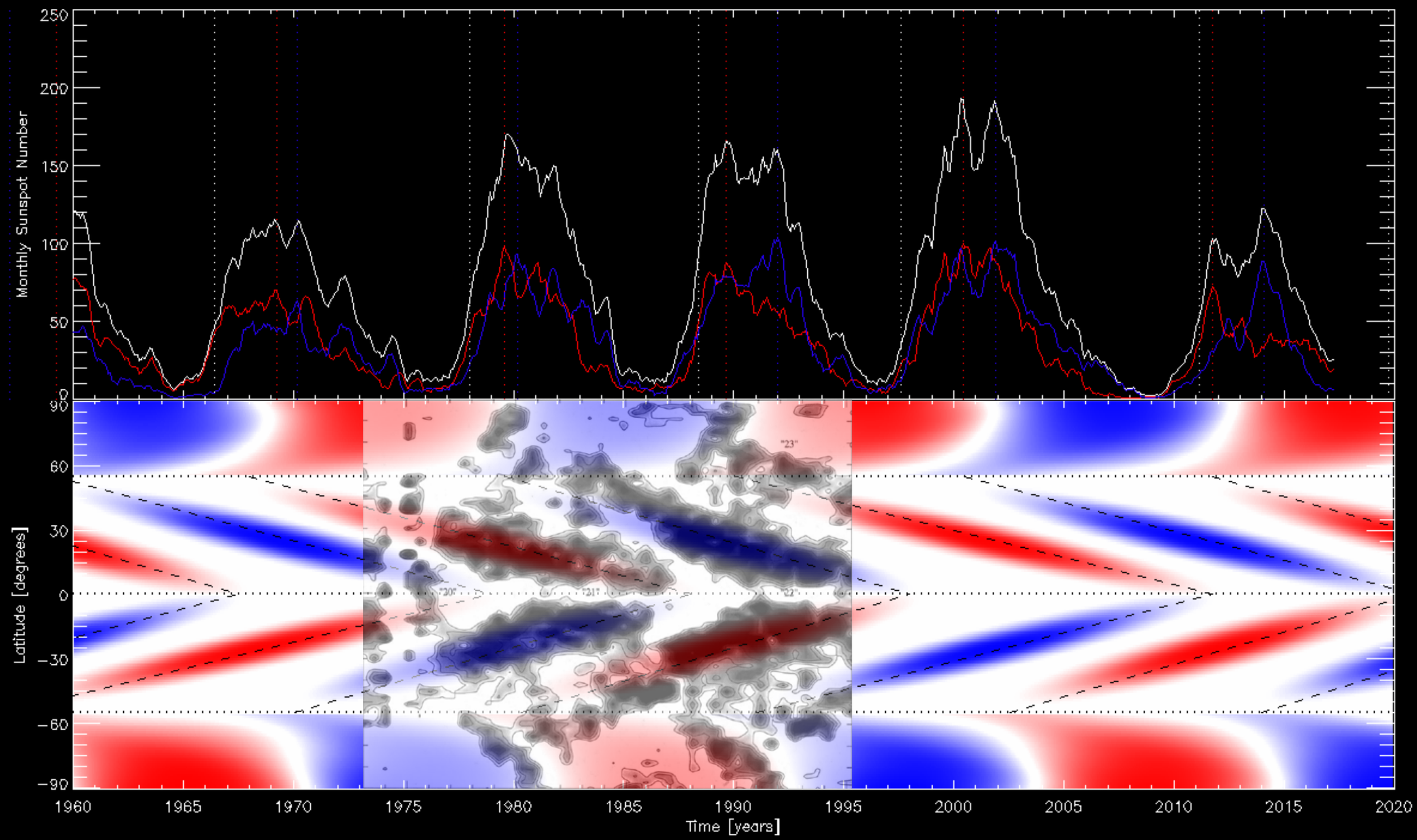


Figure 1. Sample coronal scan in Fe XIV 530.3 nm at 1.15 $R_\odot$ obtained at the National Solar Observatory facility at Sacramento Peak on January 2, 1985, with the 40-cm-aperture coronagraph and the emission-line coronal photometer. This is a polar plot of intensity with zero intensity at the unit circle of radius 5 millionths of the brightness of the disk. Note the high-latitude coronal emission regions in the northern hemisphere.

- Starting with the advent of the coronagraph in the late 1930s, Lyot and his group made routine measurements of the 5303Å "green line" of the corona — before they knew that it was emission from highly ionized iron.
- They couldn't photograph/image, so they did the next best thing and took an annular scan around the limb—at a height 15% above the limb—of the 5303Å brightness. These measurements were picked up in the US [first at HAO and then NSO in the 1960s], Slovakia and by the Wehrmacht at the dawn of realizing the impact of the Sun on radio communications.
- The annular profile of coronal brightness identically maps the morphological shape of the corona. Bulges [see left] in the scan overlie magnetically complex regions—like active regions and filaments… and there's the connection.
- ***LONG*** duration archival record.



Band Model: Comparison to Altrock



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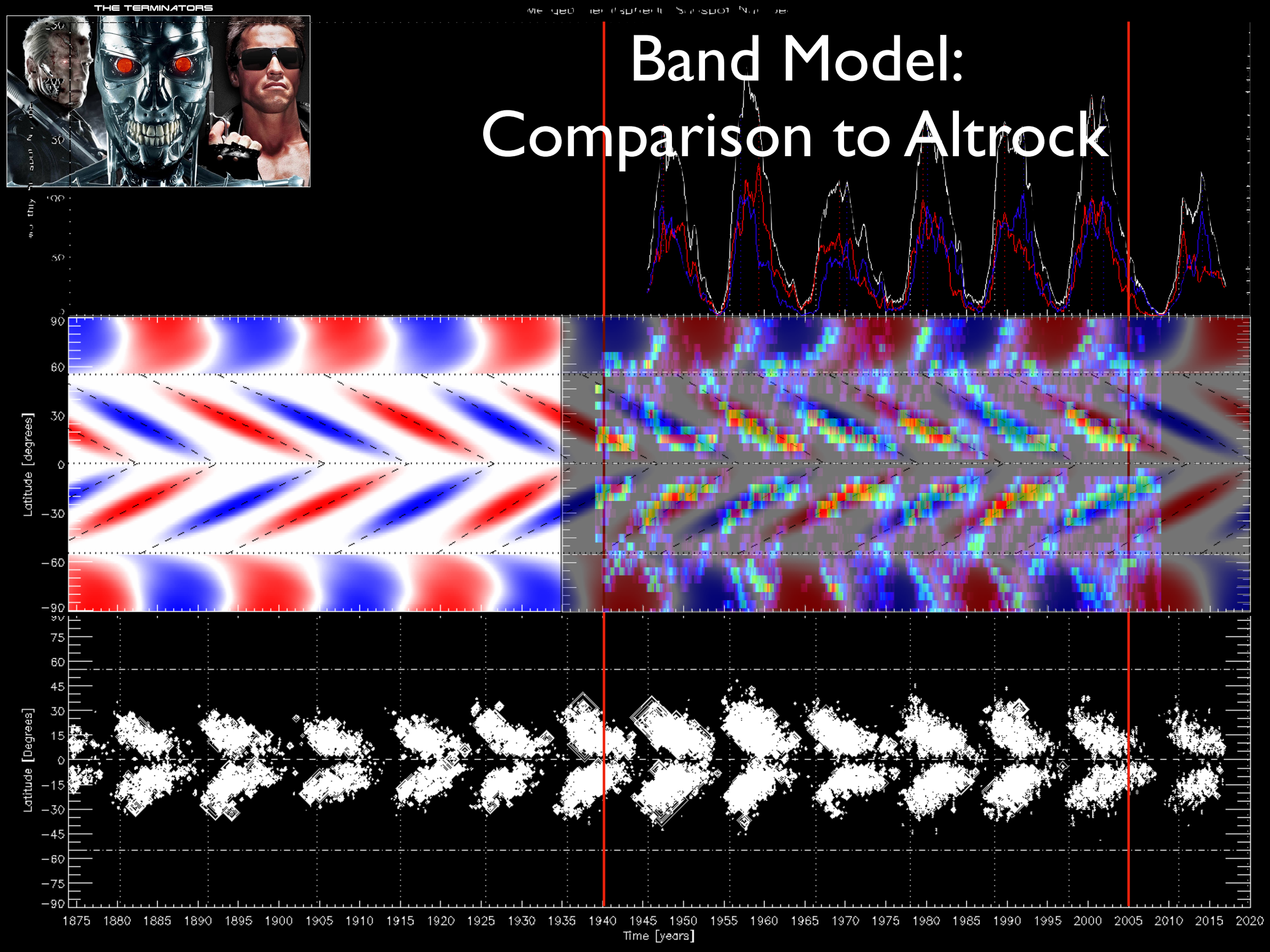
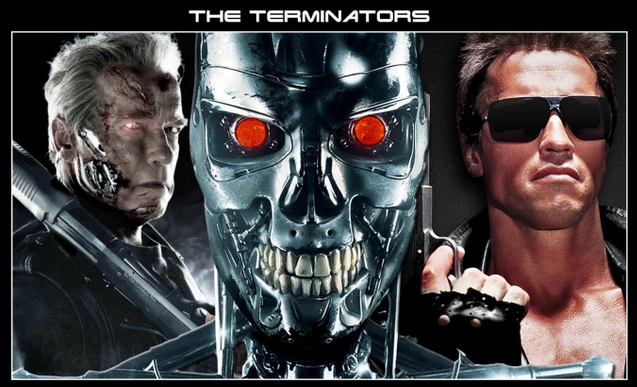
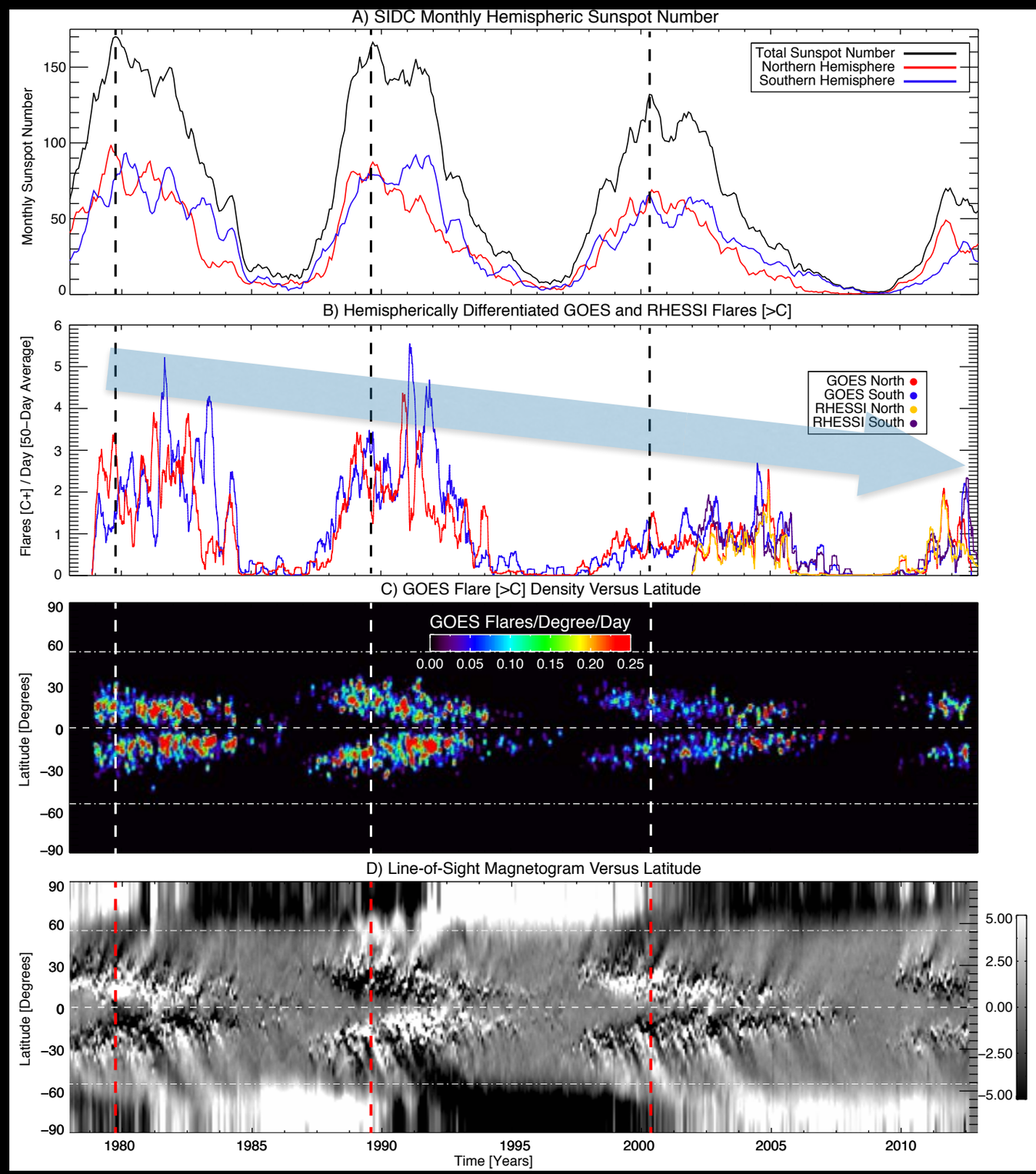
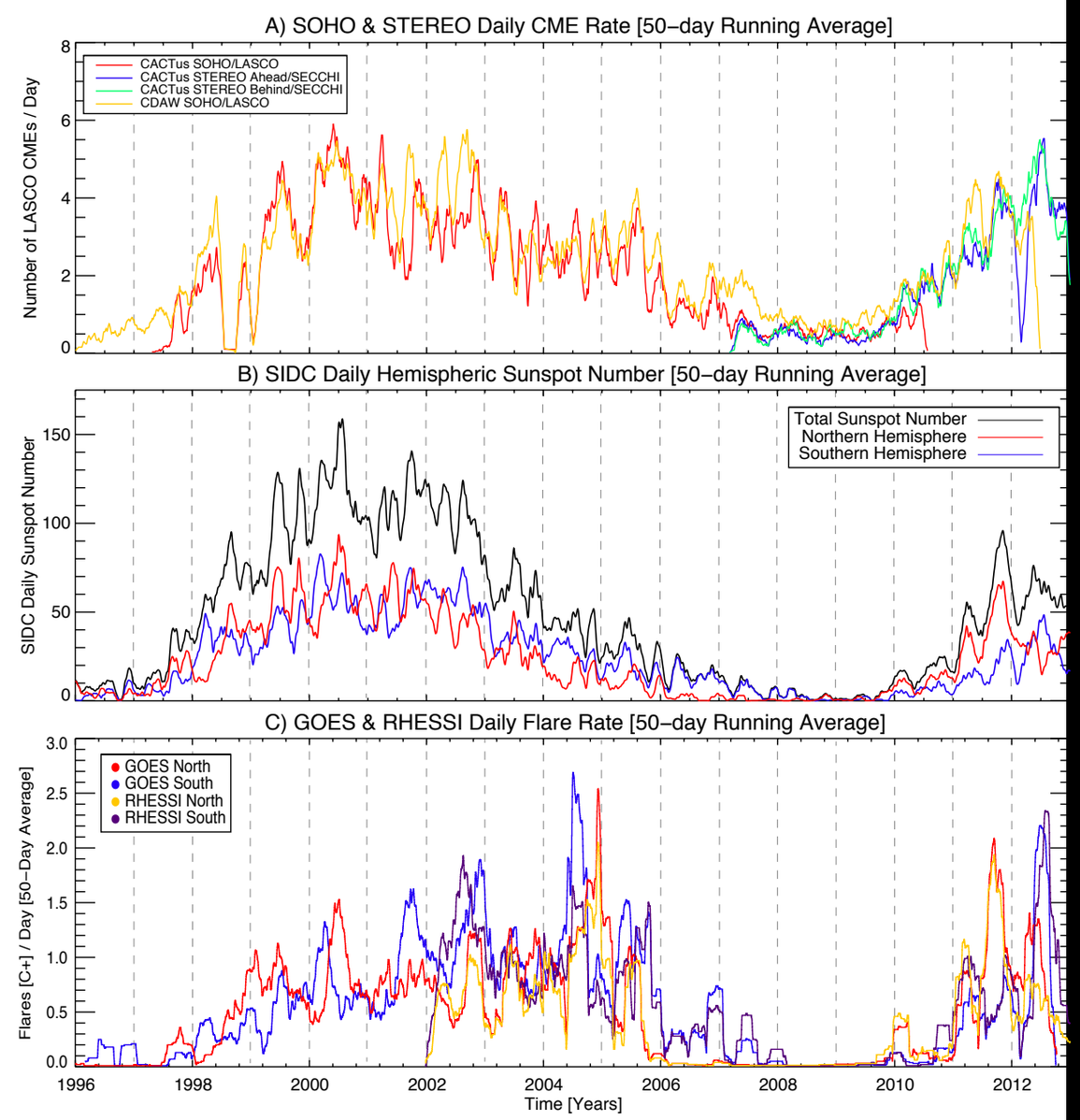


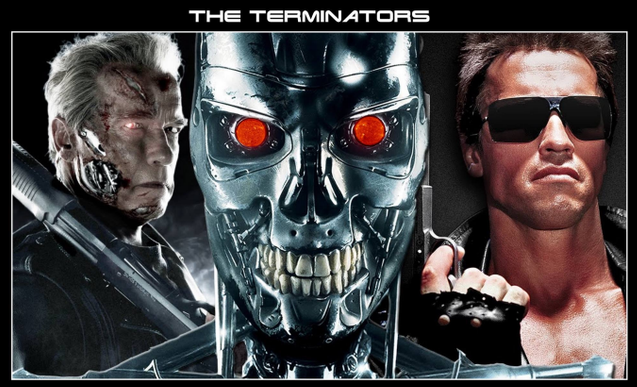


Seasons: Observations reveal (very) strong surges in solar magnetism that effect storm production, radiative, and particulate output.





Cycle 23



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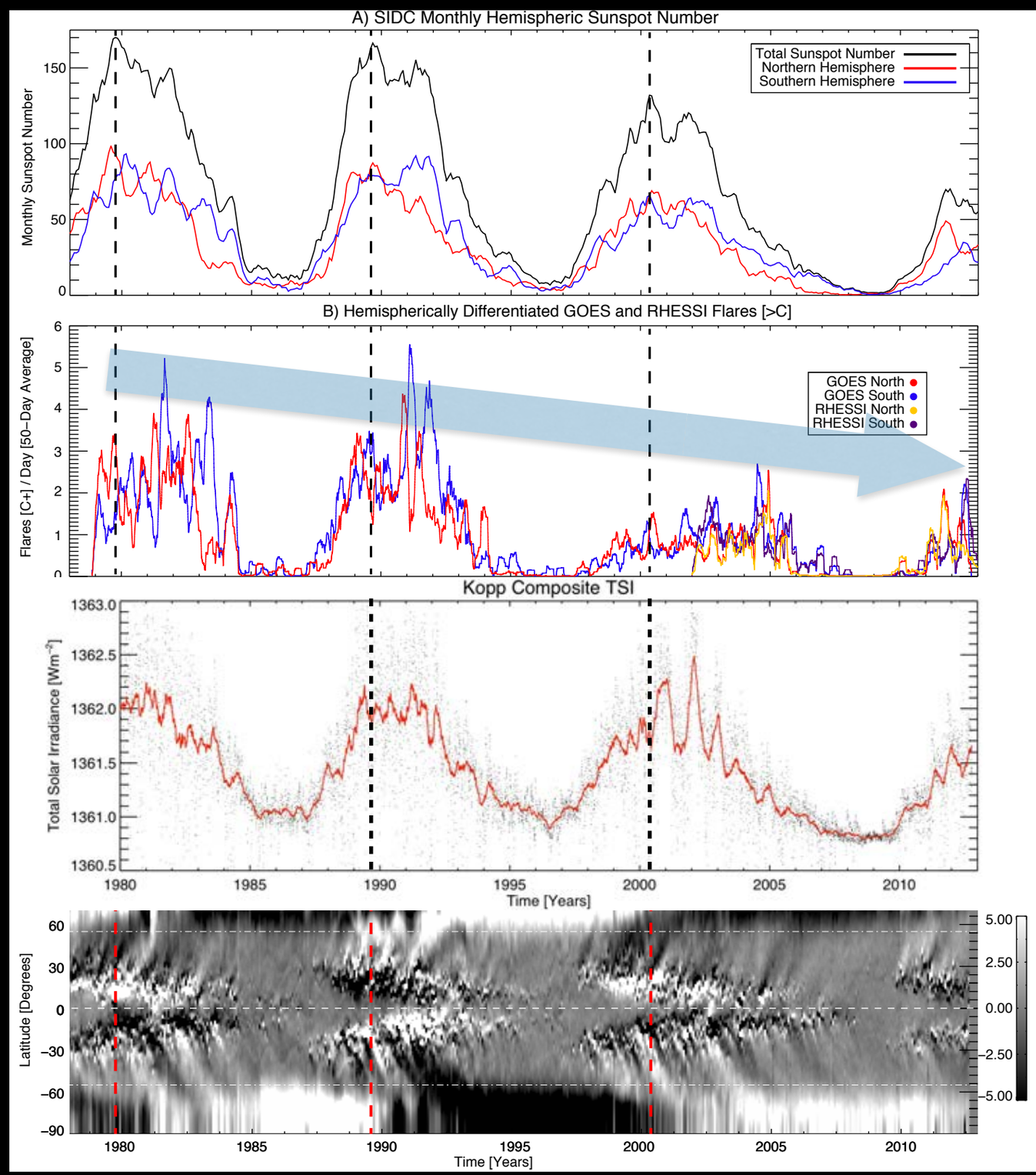

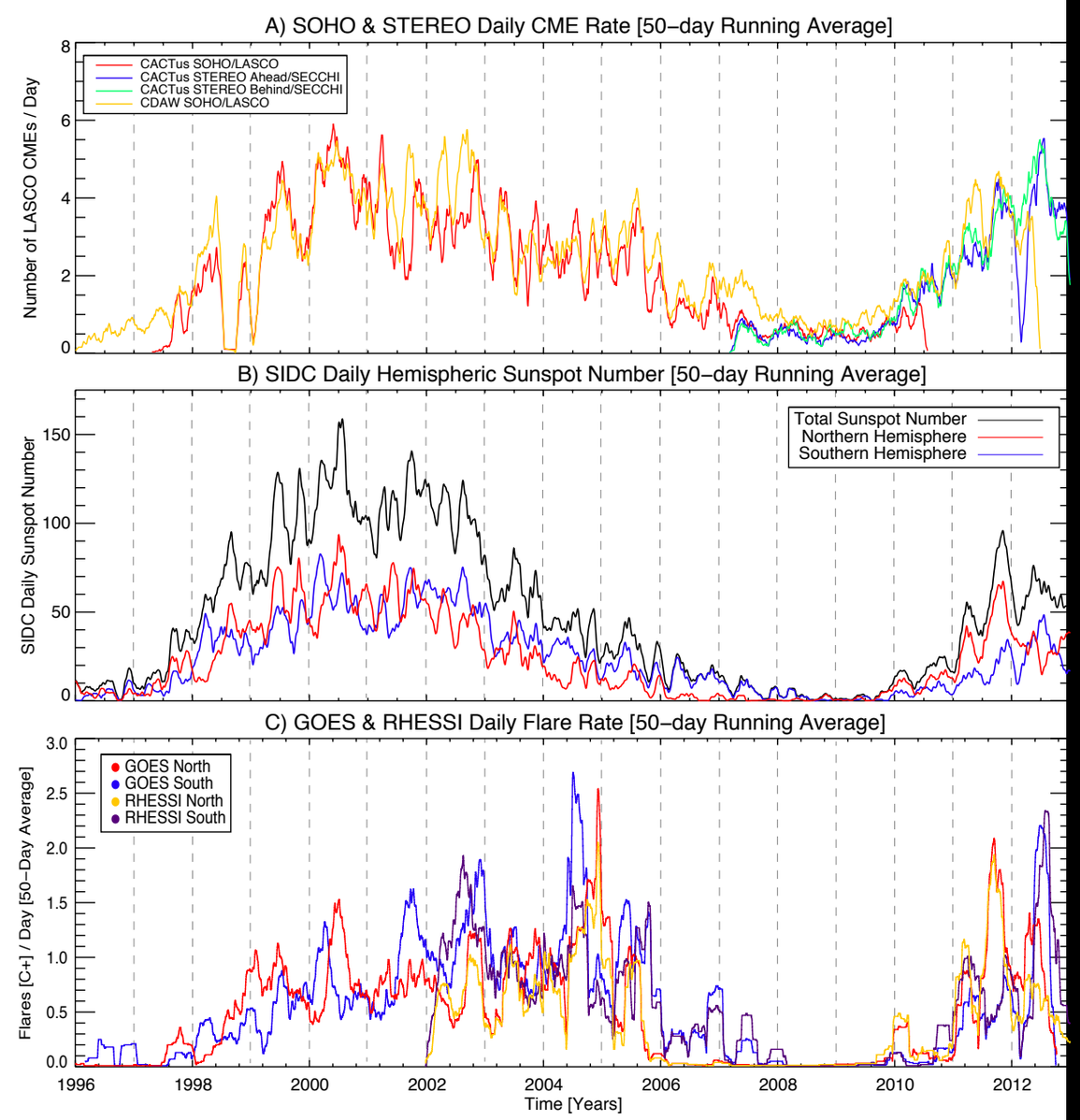

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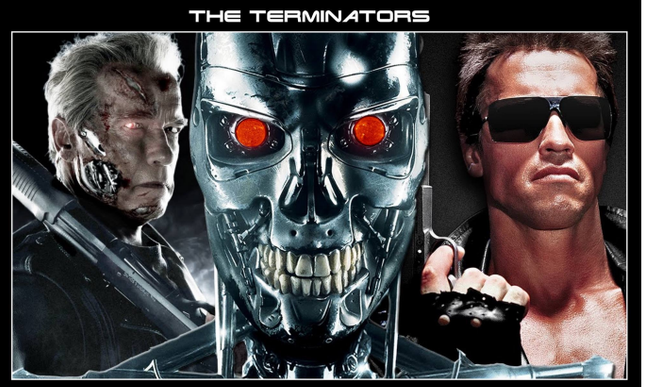
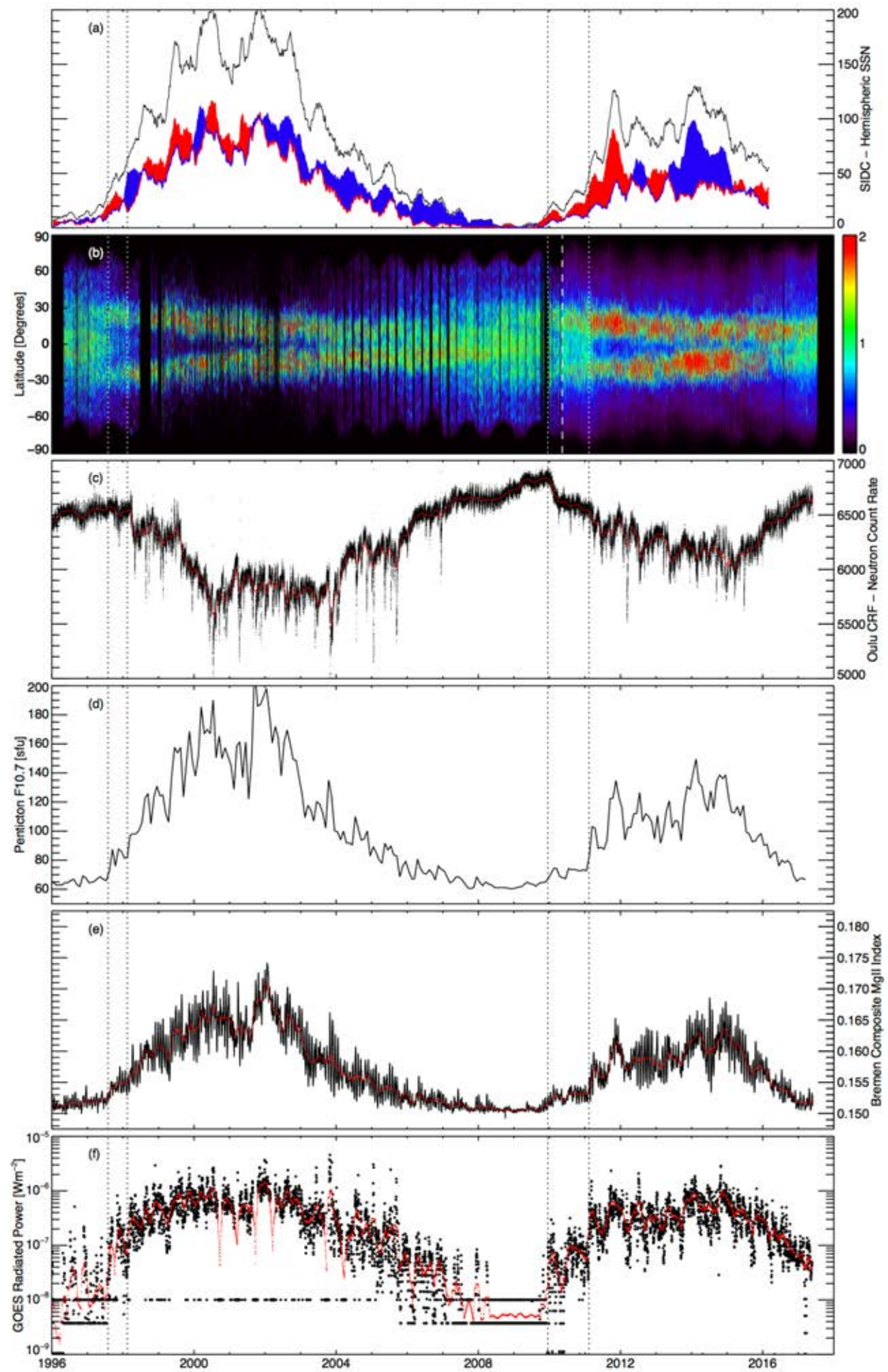
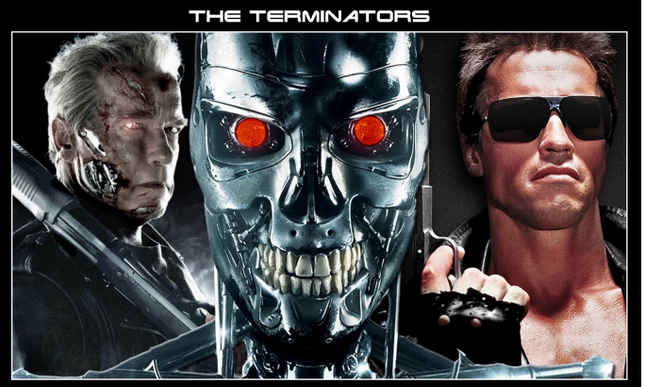


- hSSN
- EIT/AIA BPs
- Oulu CRF
- F10.7
- Mg ii (chrom)
- GOES X-ray



- Correlated variability in all forms of solar radiative and particulate output



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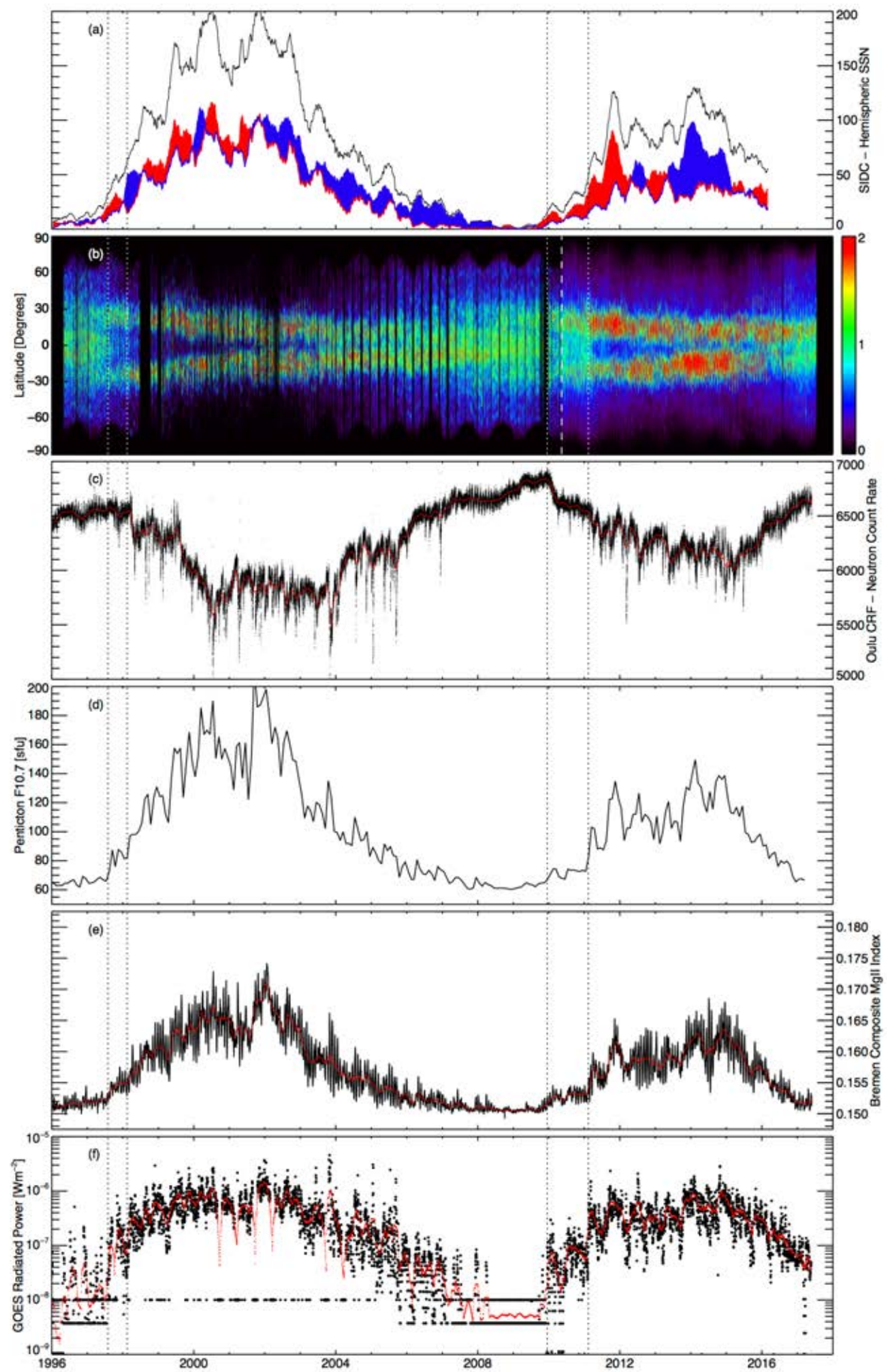

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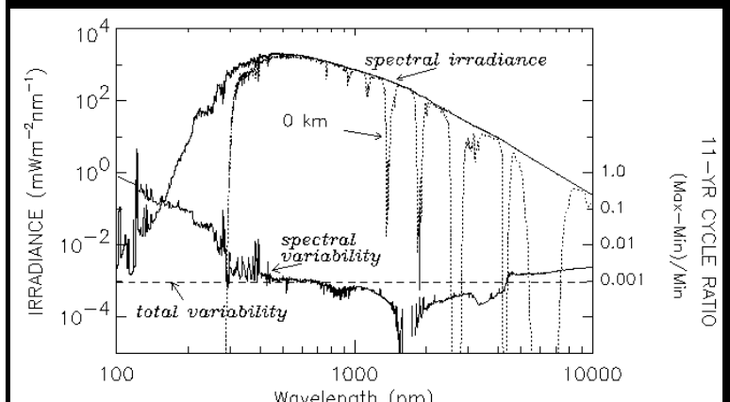
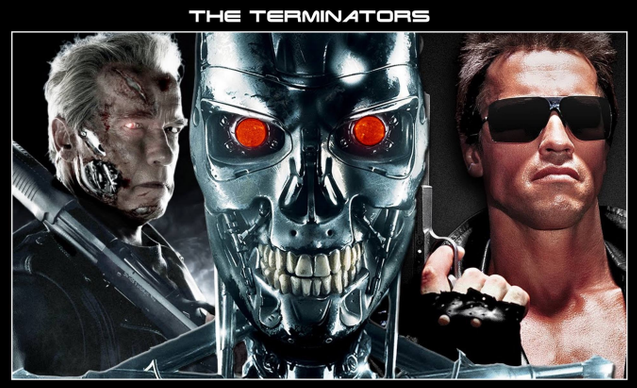
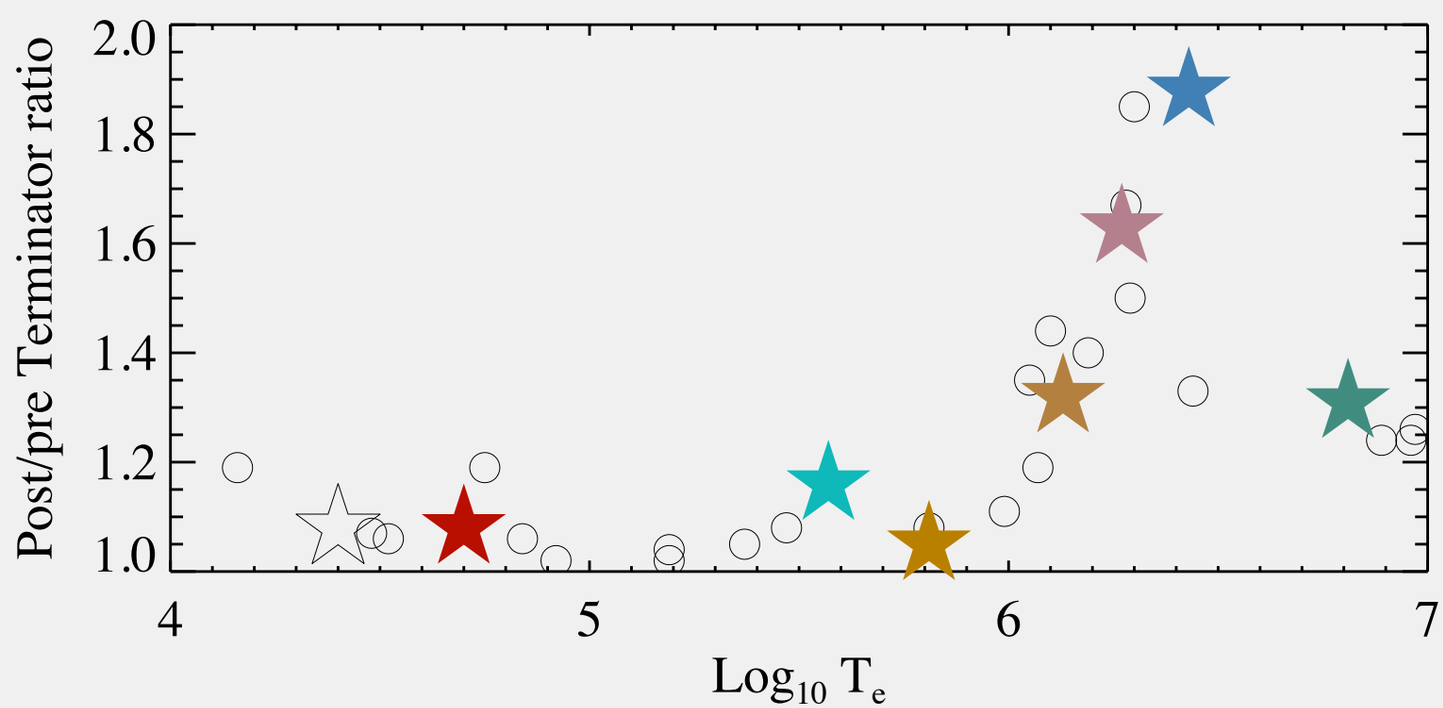
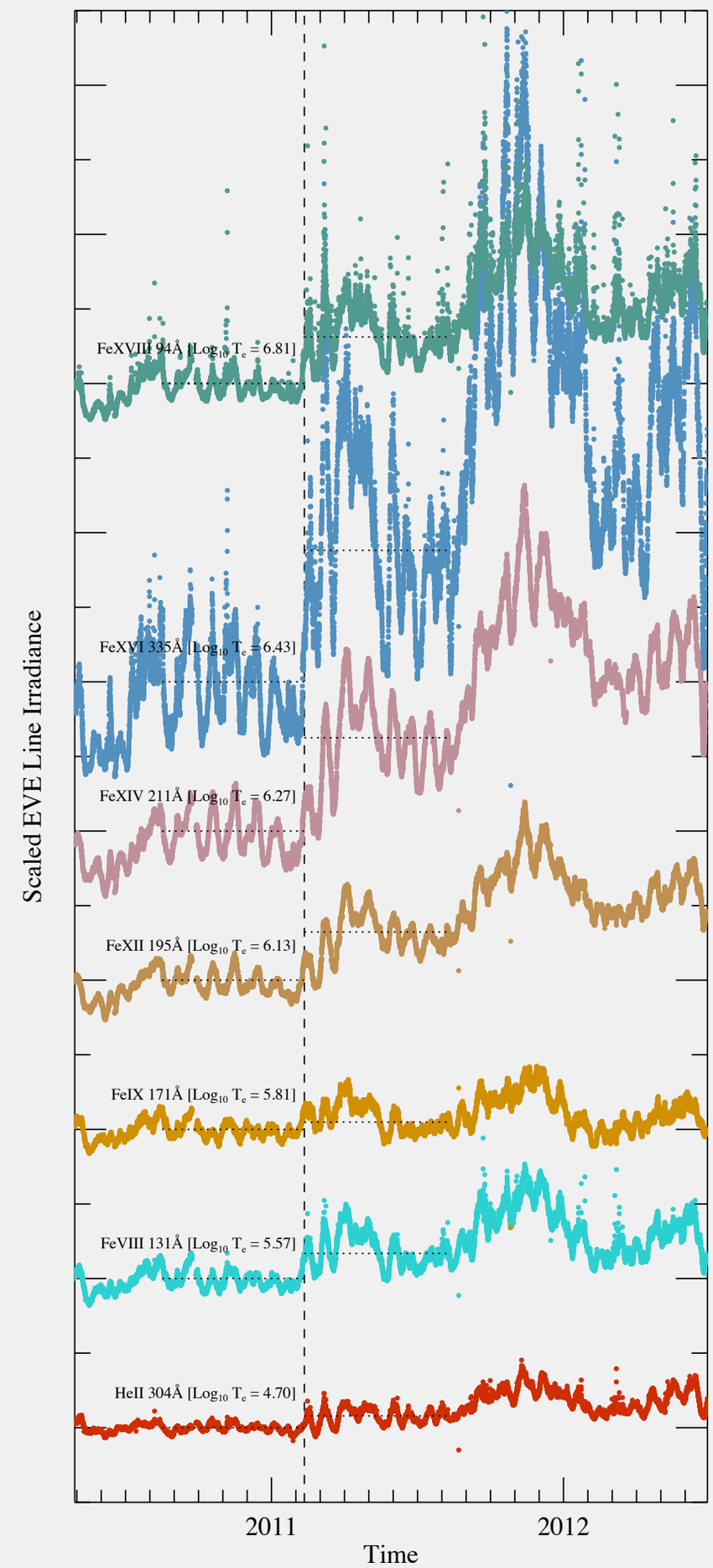


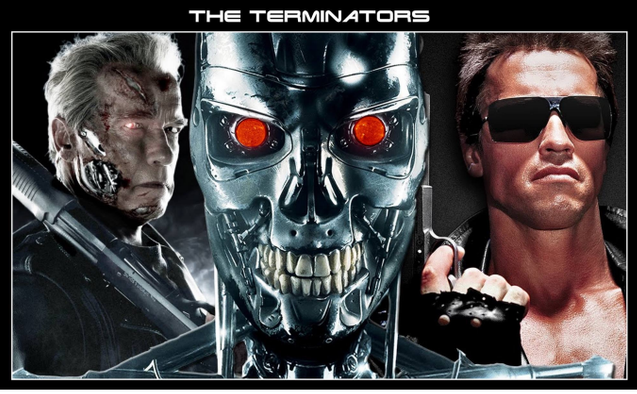


EVE

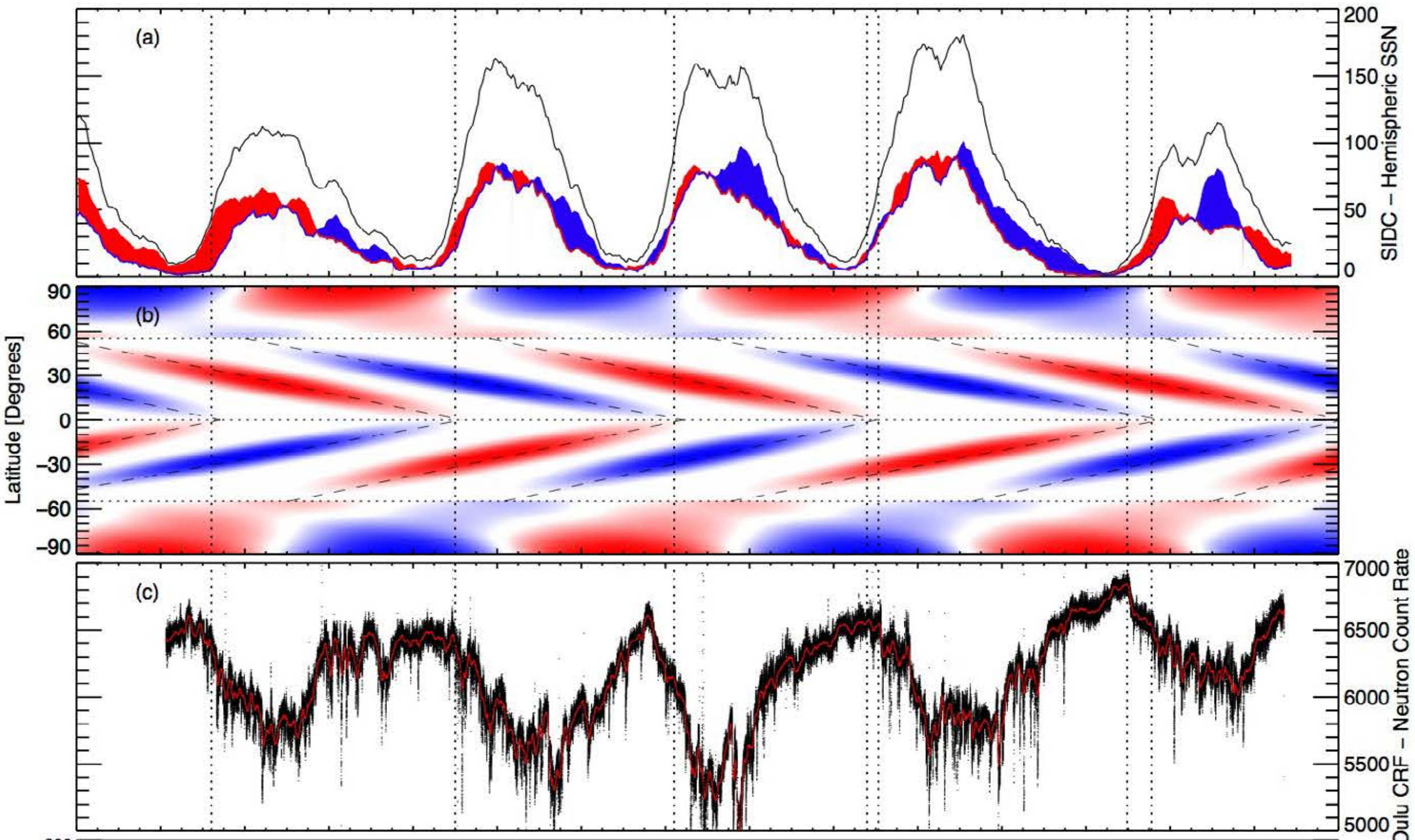
- Increase in EVE irradiance immediate and simultaneous across all spectral lines
- Biggest change for relatively hot corona (but not hottest)
  - some implication for heating mechanism
- White star = Lyman alpha. Even +5% large implication for ozone

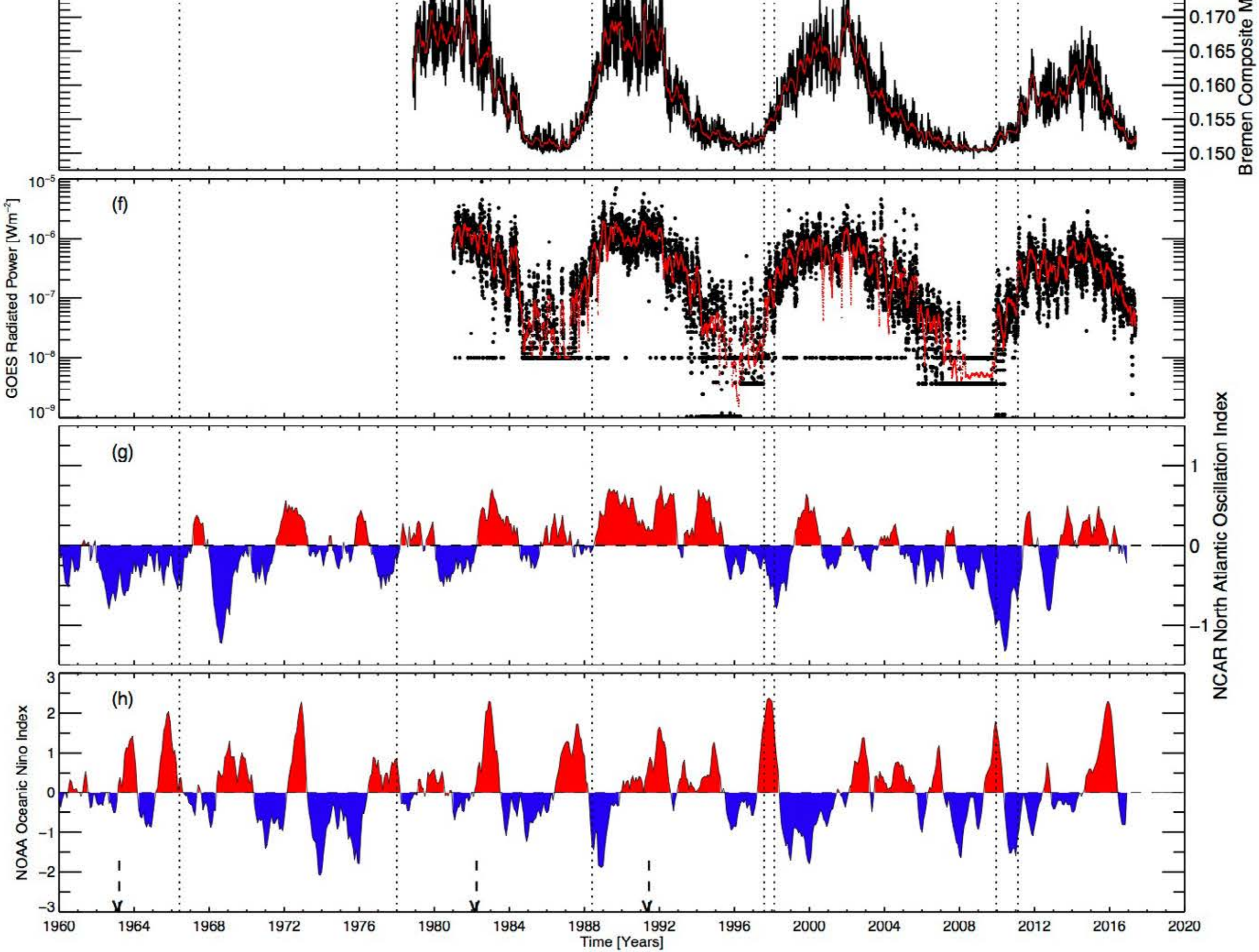


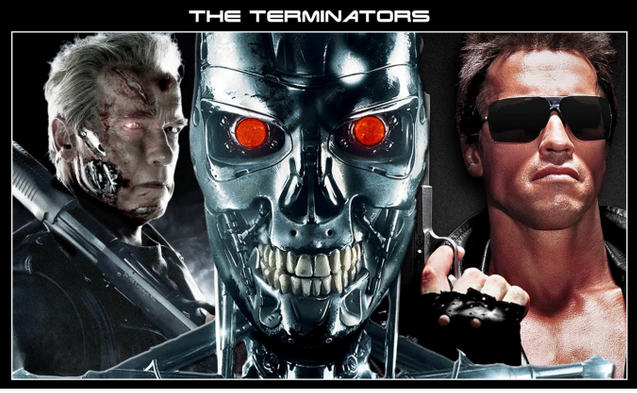




El Niño & La Niña




Bremen Composite M
0.170
0.165
0.160
0.155
0.150
(f)
GOES Radiated Power [Wm^{-2}]
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
(g)
NCAR North Atlantic Oscillation Index
1
0
−1
(h)
NOAA Oceanic Nino Index
3
2
1
0
−1
−2
−3
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000
2004
2008
2012
2016
2020
Time [Years]



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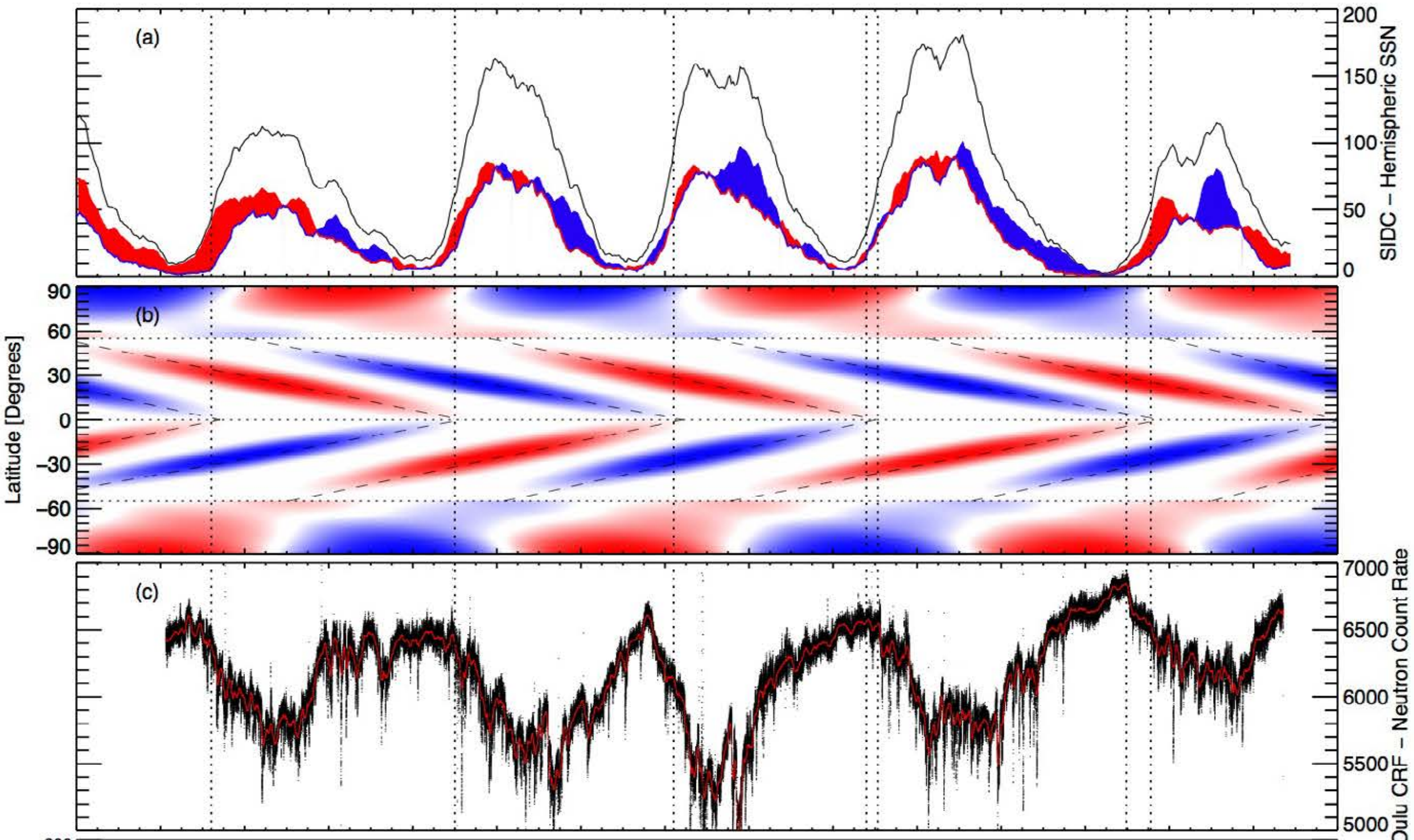
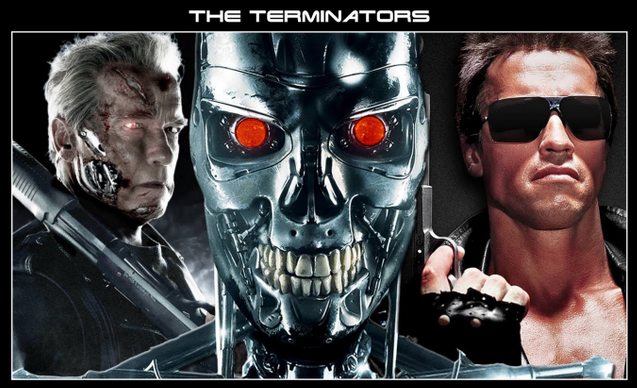
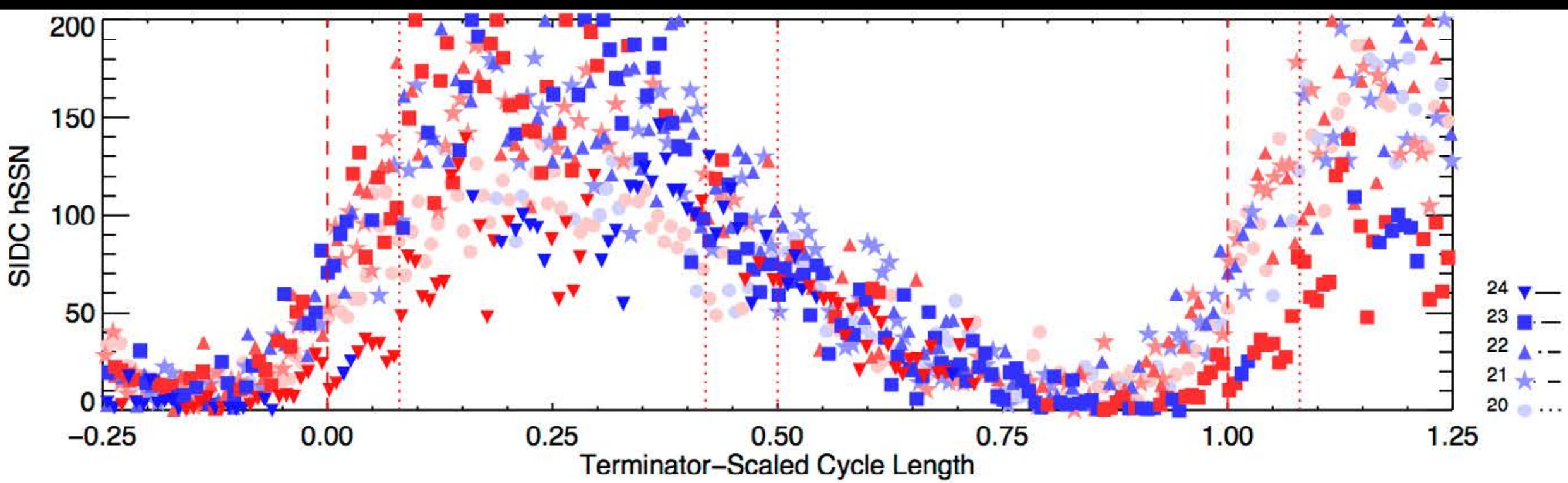
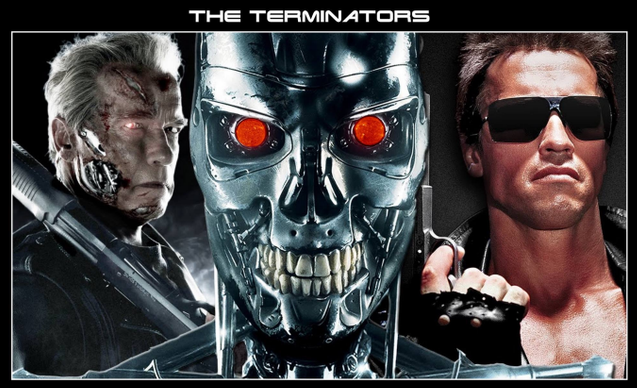




Superposed Epochs





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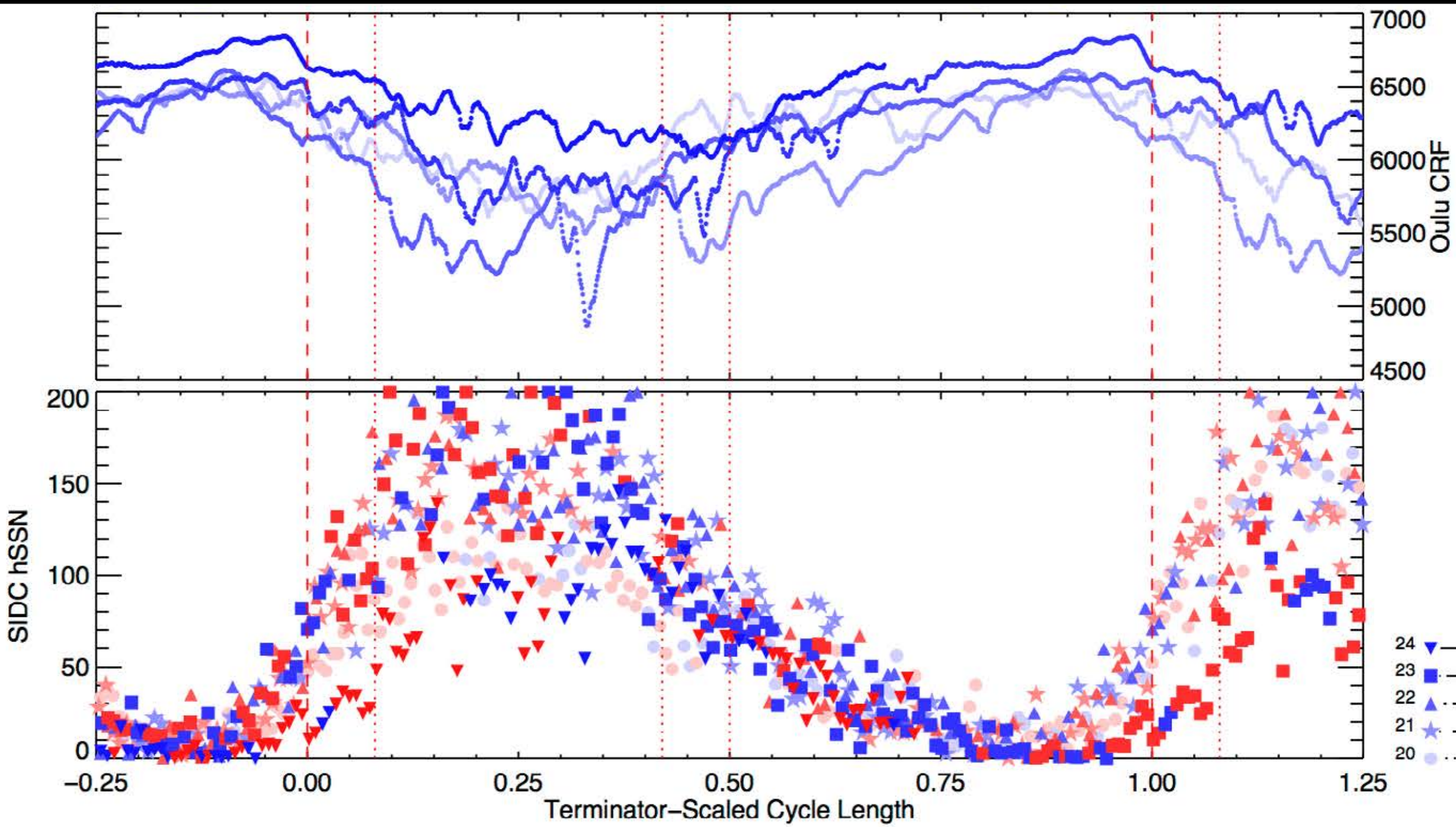
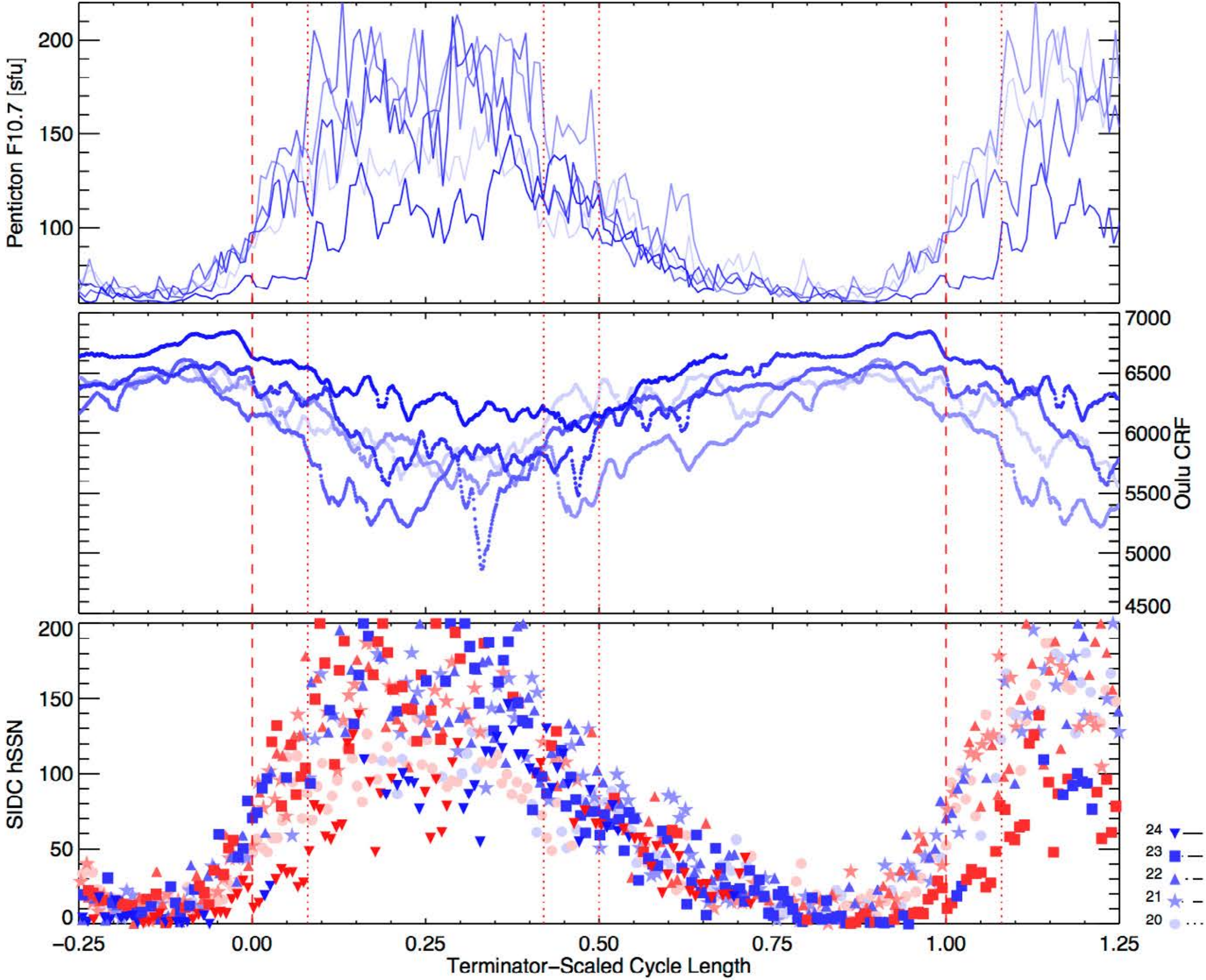
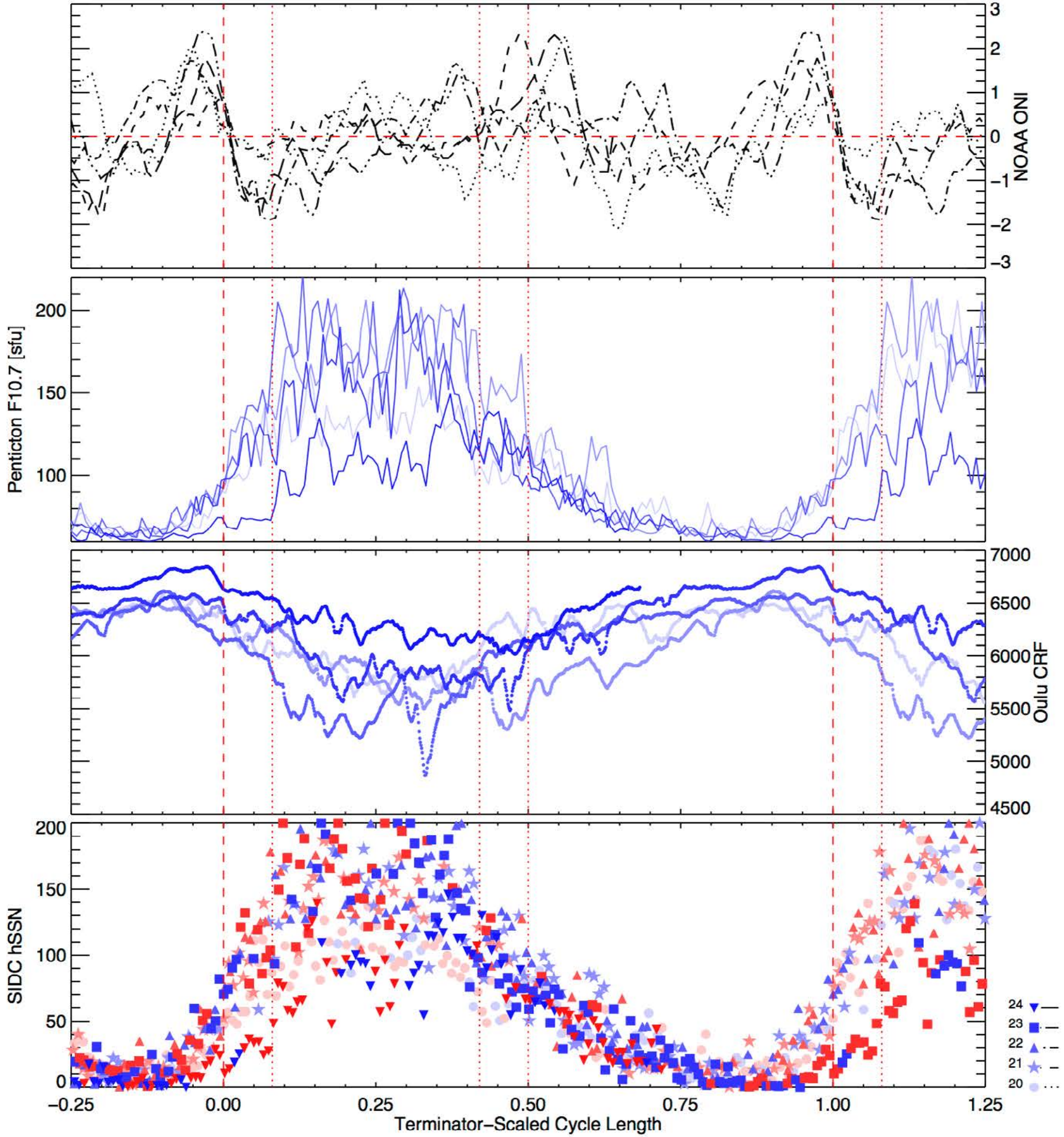



Penticton F10.7 [sfu]
200
150
100
Oulu CRF
7000
6500
6000
5500
5000
4500
SIDC hSSN
200
150
100
50
0
24
23
22
21
20
−0.25
0.00
0.25
0.50
0.75
1.00
1.25
Terminator−Scaled Cycle Length

THE TERMINATORS


NOAA ONI
3
2
1
0
−1
−2
−3
Penticton F10.7 [sfu]
200
150
100
Oulu CRF
7000
6500
6000
5500
5000
4500
SIDC hSSN
200
150
100
50
0
24
23
22
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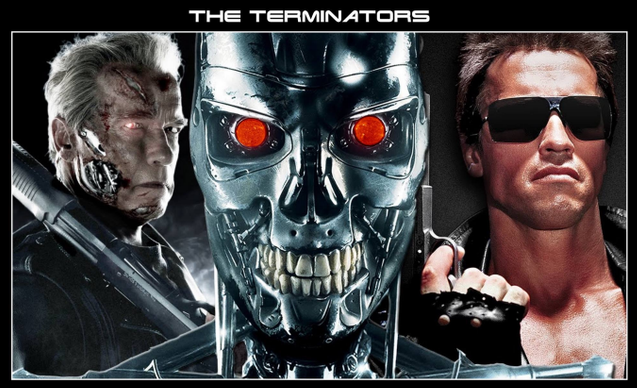
20
−0.25
0.00
0.25
0.50
0.75
1.00
1.25
Terminator−Scaled Cycle Length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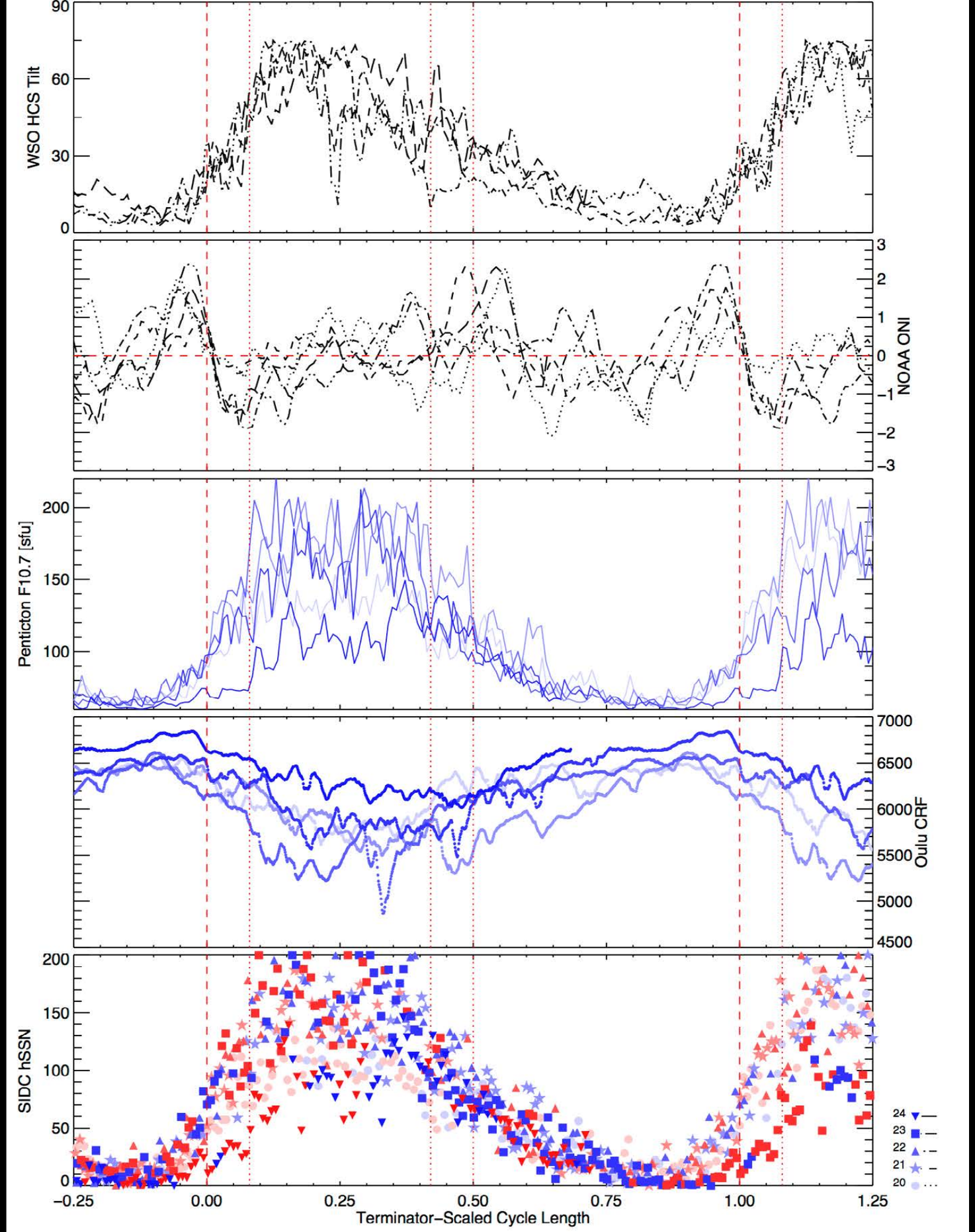
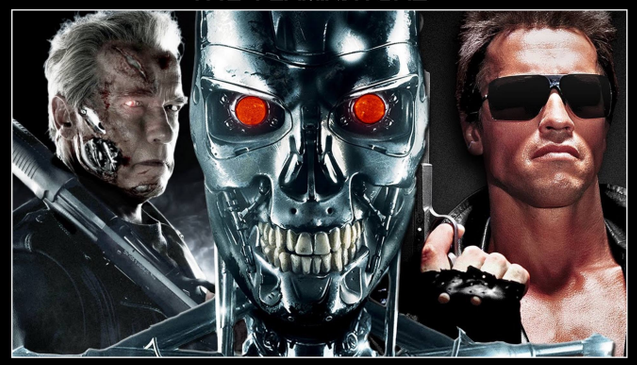
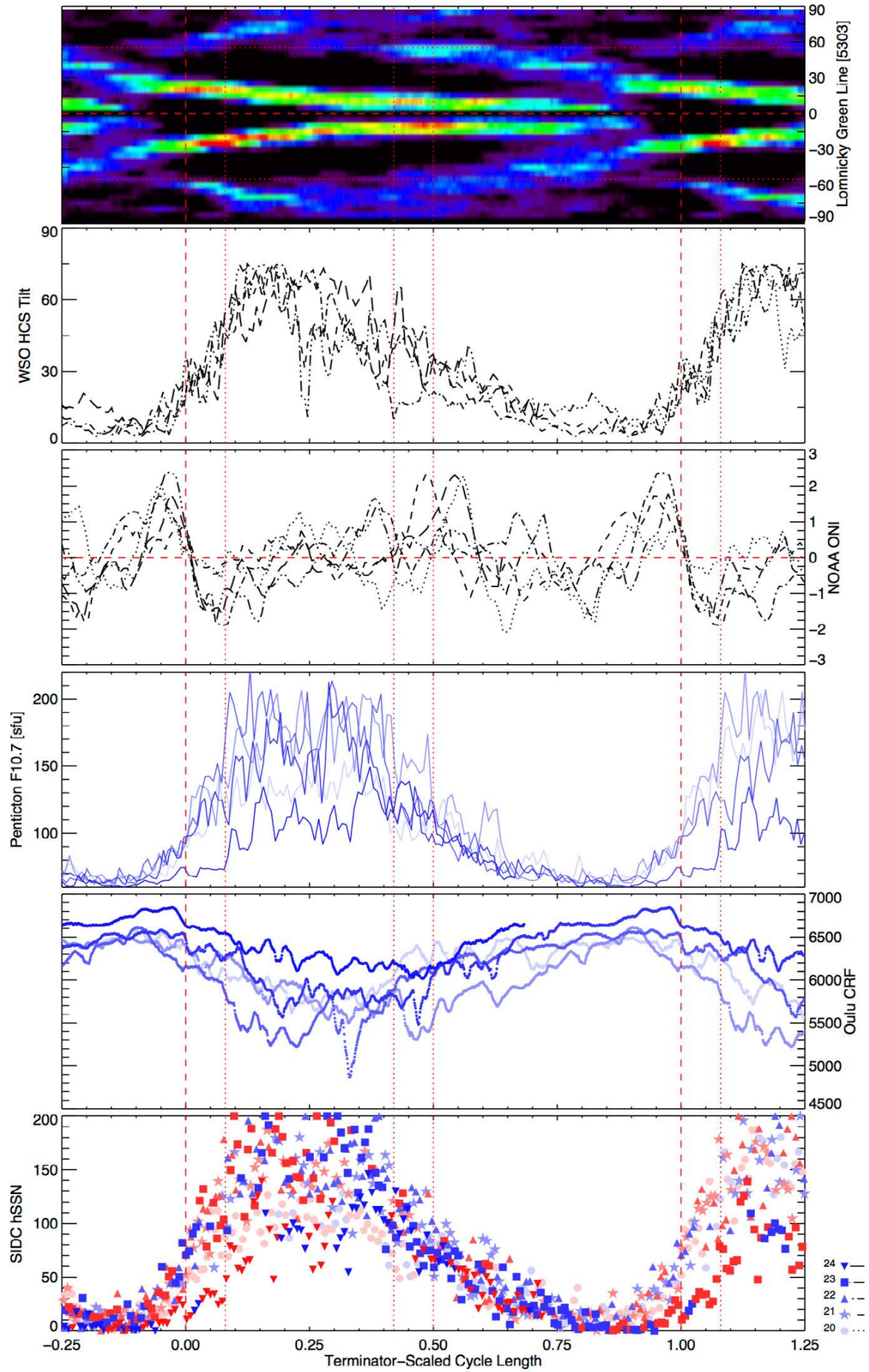
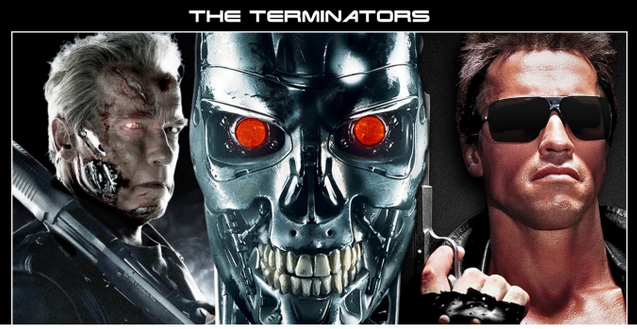

WSO HCS Tilt
NOAA ONI
Penticton F10.7 [sfu]
Oulu CRF
SIDC hSSN
Terminator−Scaled Cycle Length
24
23
22
21
20

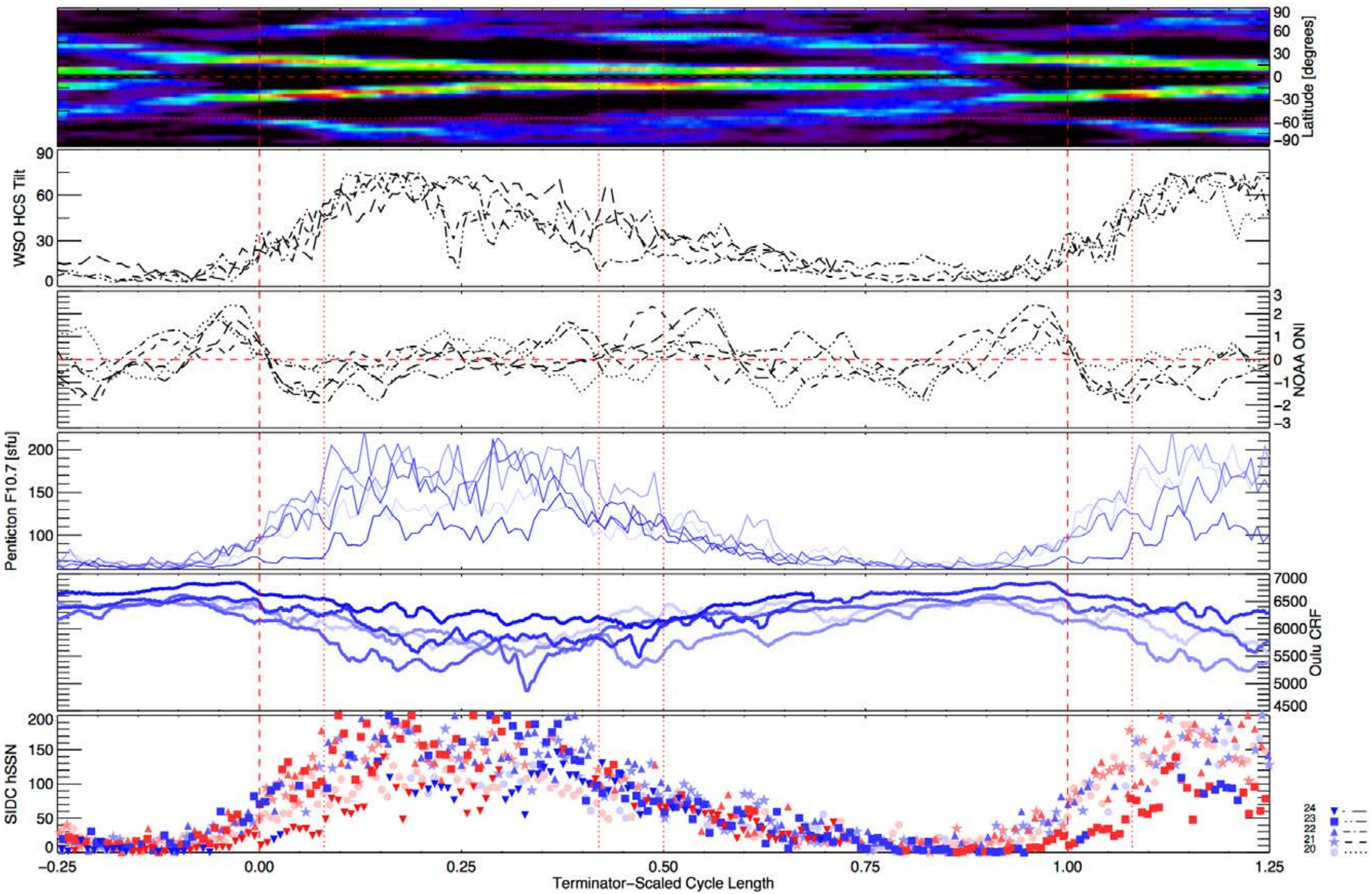
THE TERMINATORS

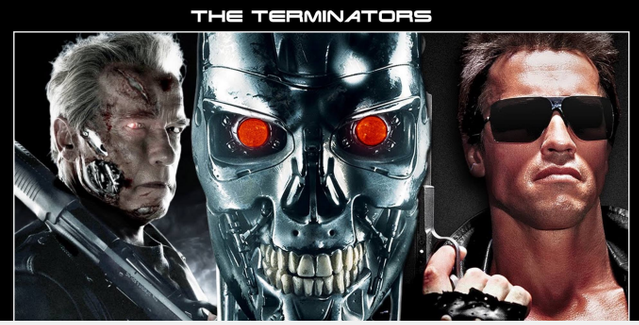




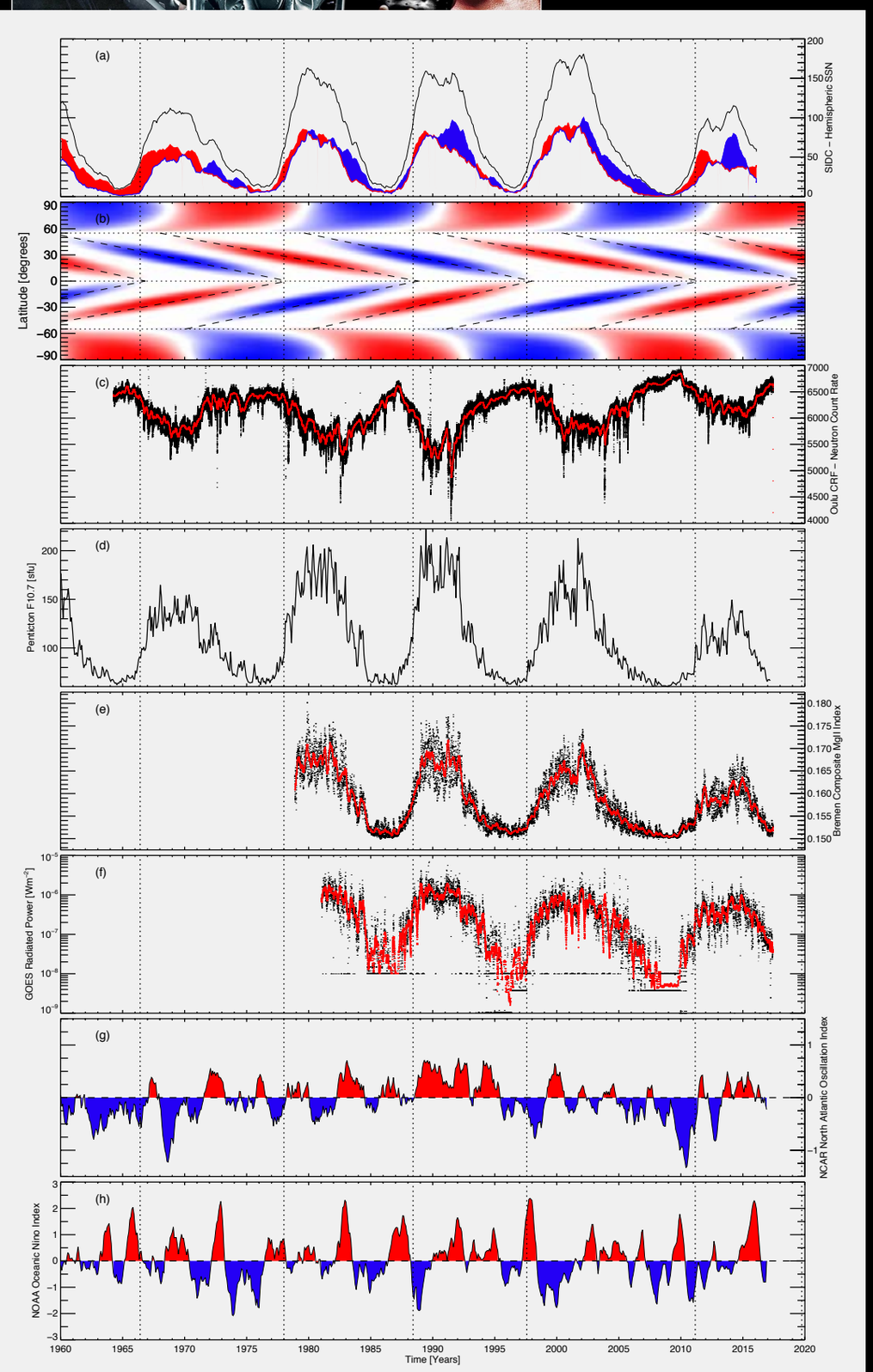


Superposed Epochs



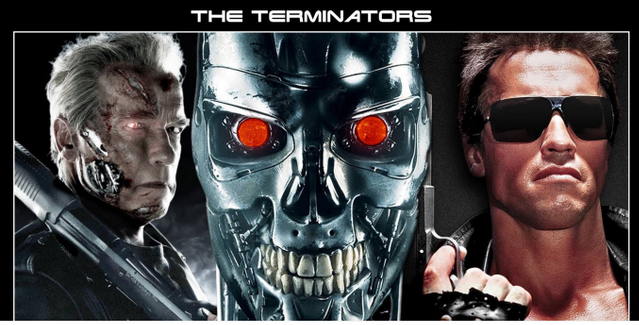


El Niño & La Niña

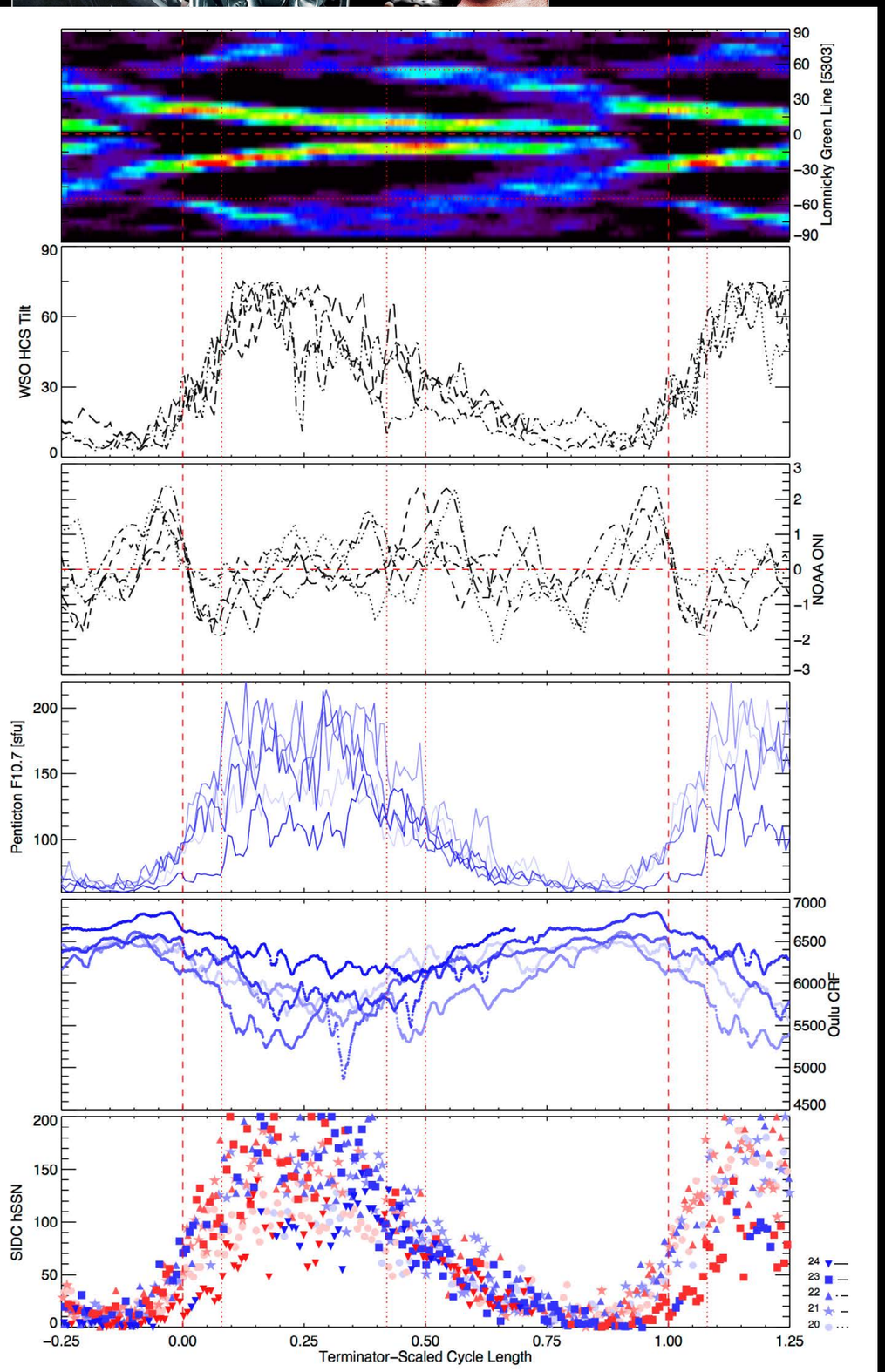


- Correlation of La Niña and Terminators is coherent for at least the last **SIX** solar cycles
  - Only having RGO SS data and ENSO but eyeball believable 1870-1920
  - 1930s, 1940s anomalous temps (cf. Hockey Stick graph)

- NOT random. Only $200/10^6$ Monte Carlo trials (piecemeal shuffle ENSO) better than observed Terminator correlation



El Niño & La Niña



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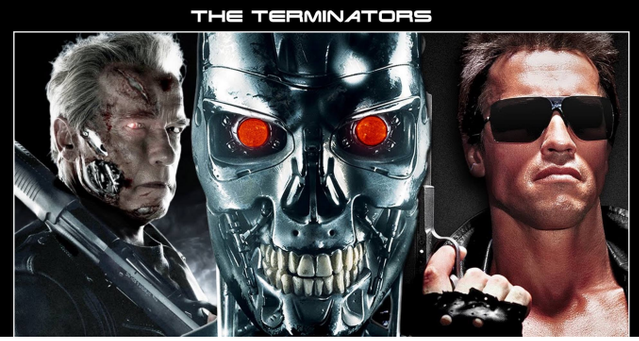
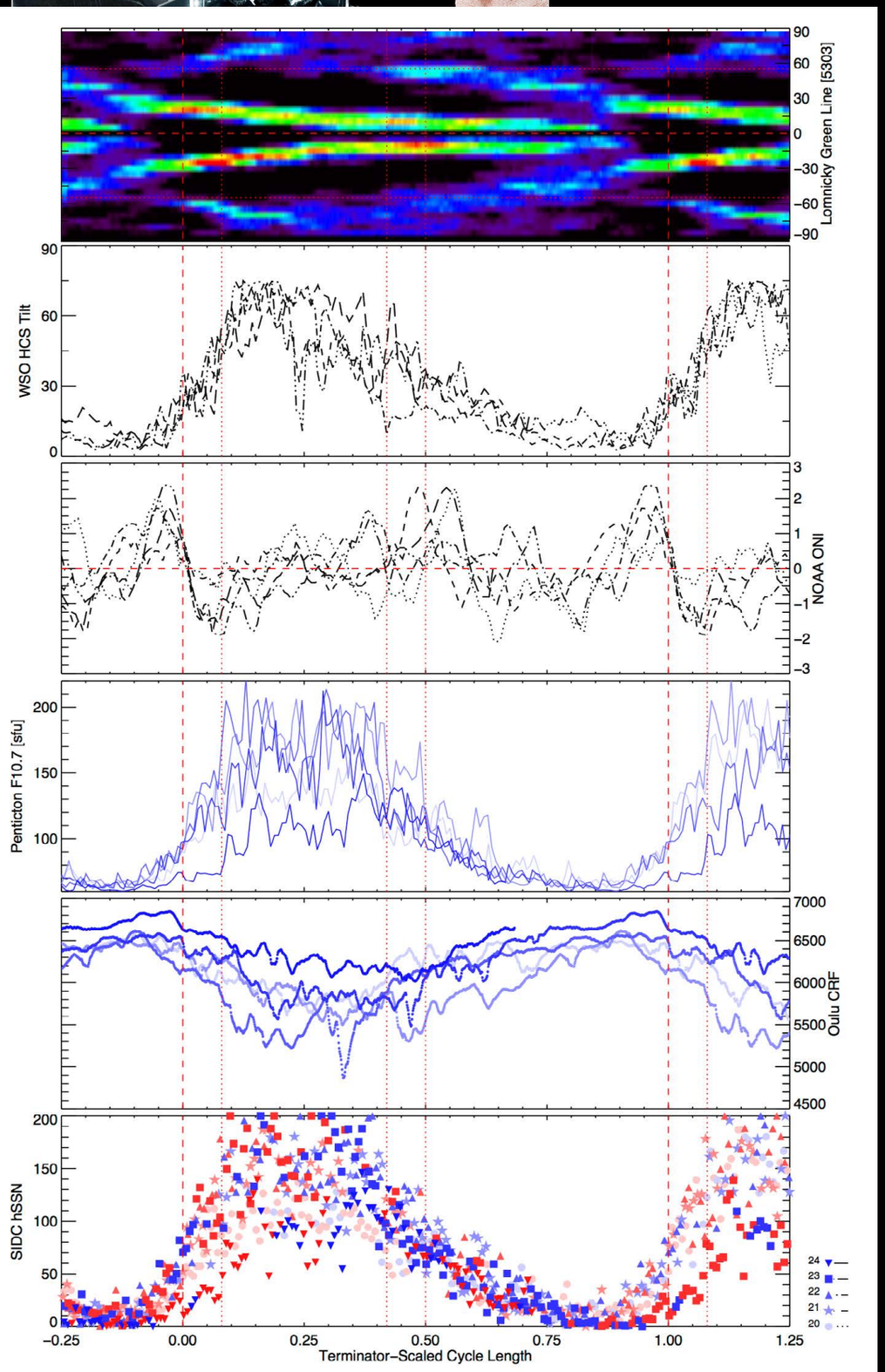
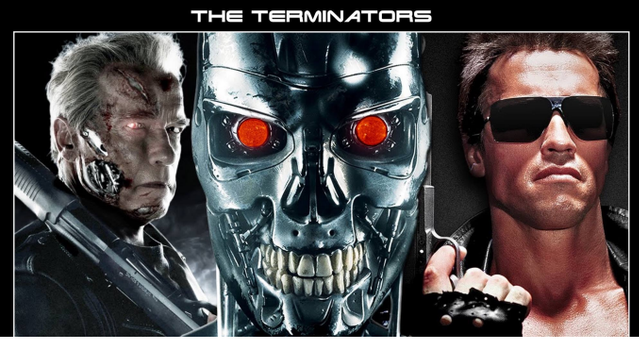
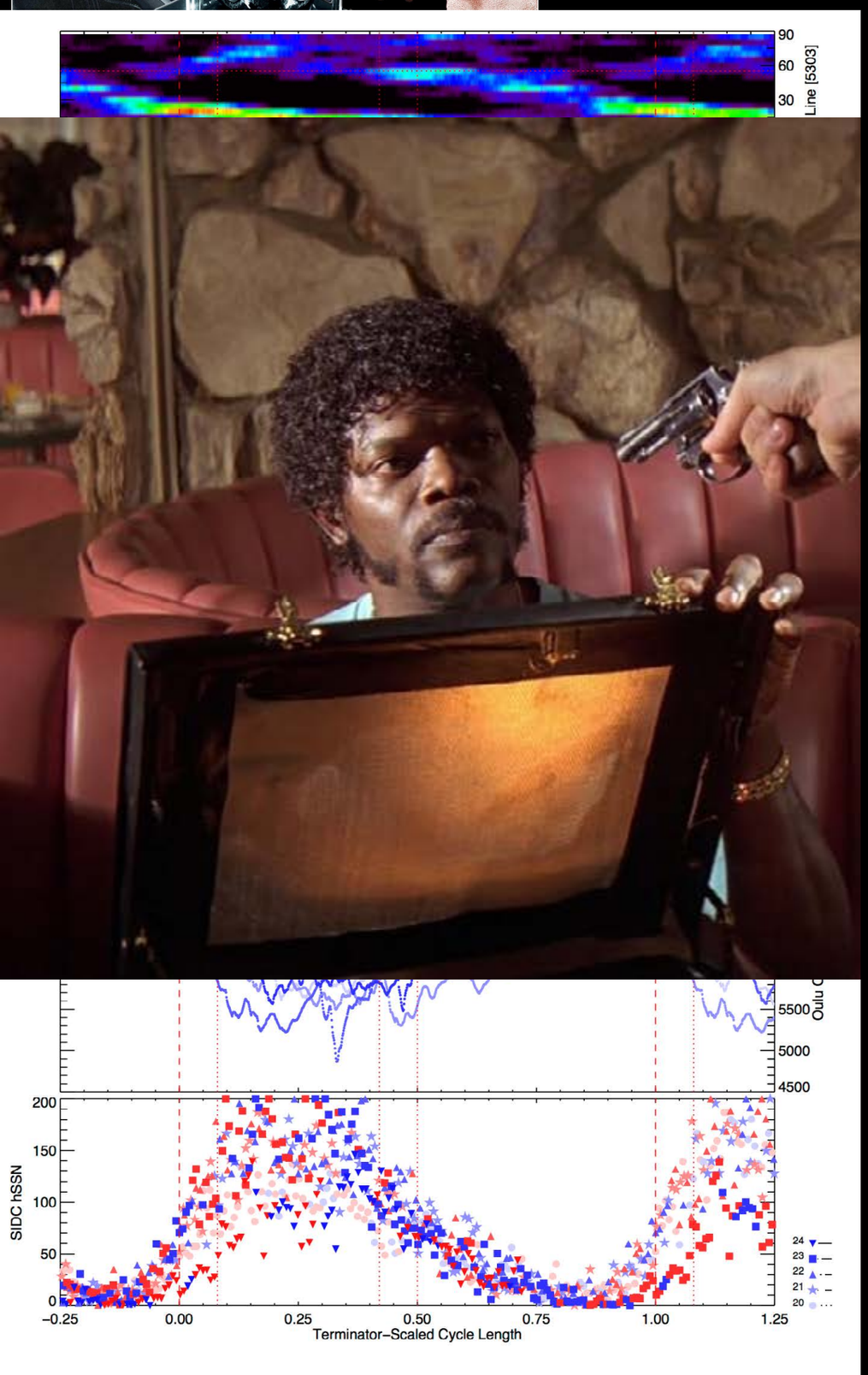




Summary

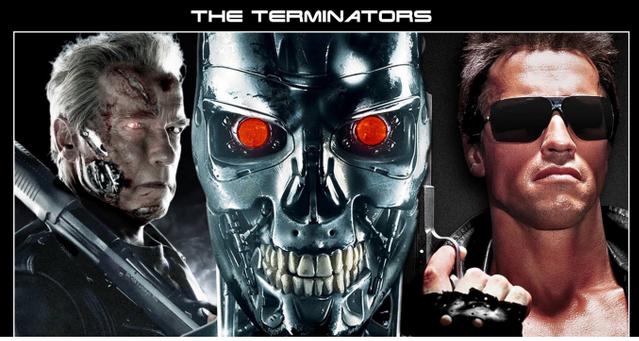
- Terminator is the fiducial time constant of the solar cycle – max and min are artificial constructs.
- "Extended cycle" ***IS THE CYCLE.***
- Coherent pattern emerges in Superposed Epoch Analysis.
- Correlation of La Niña and Terminators primarily driven by changes – ~4% step decrease – in Cosmic Rays.

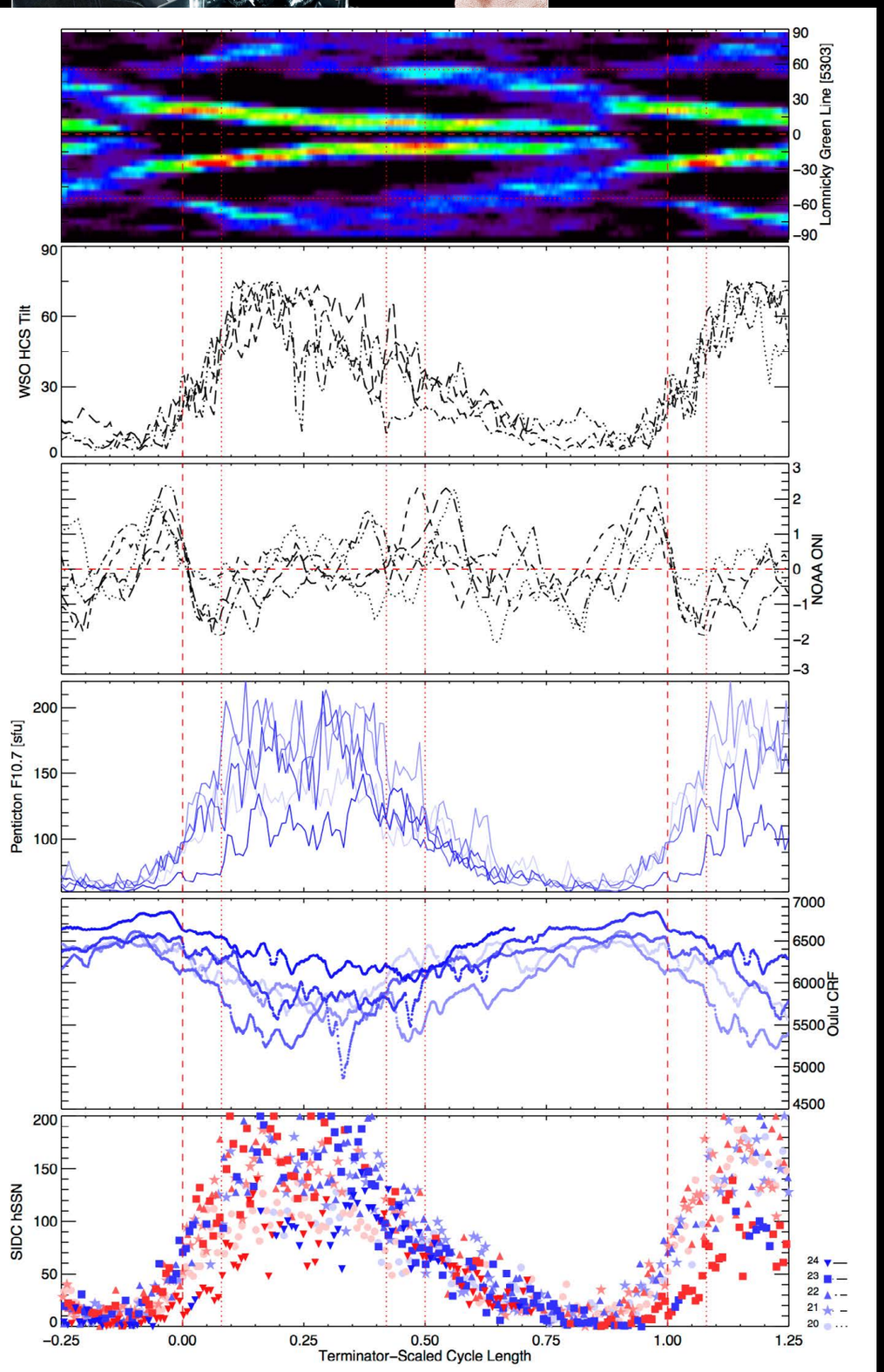




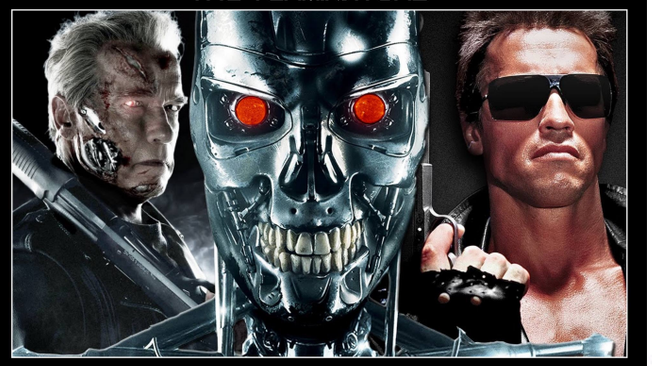
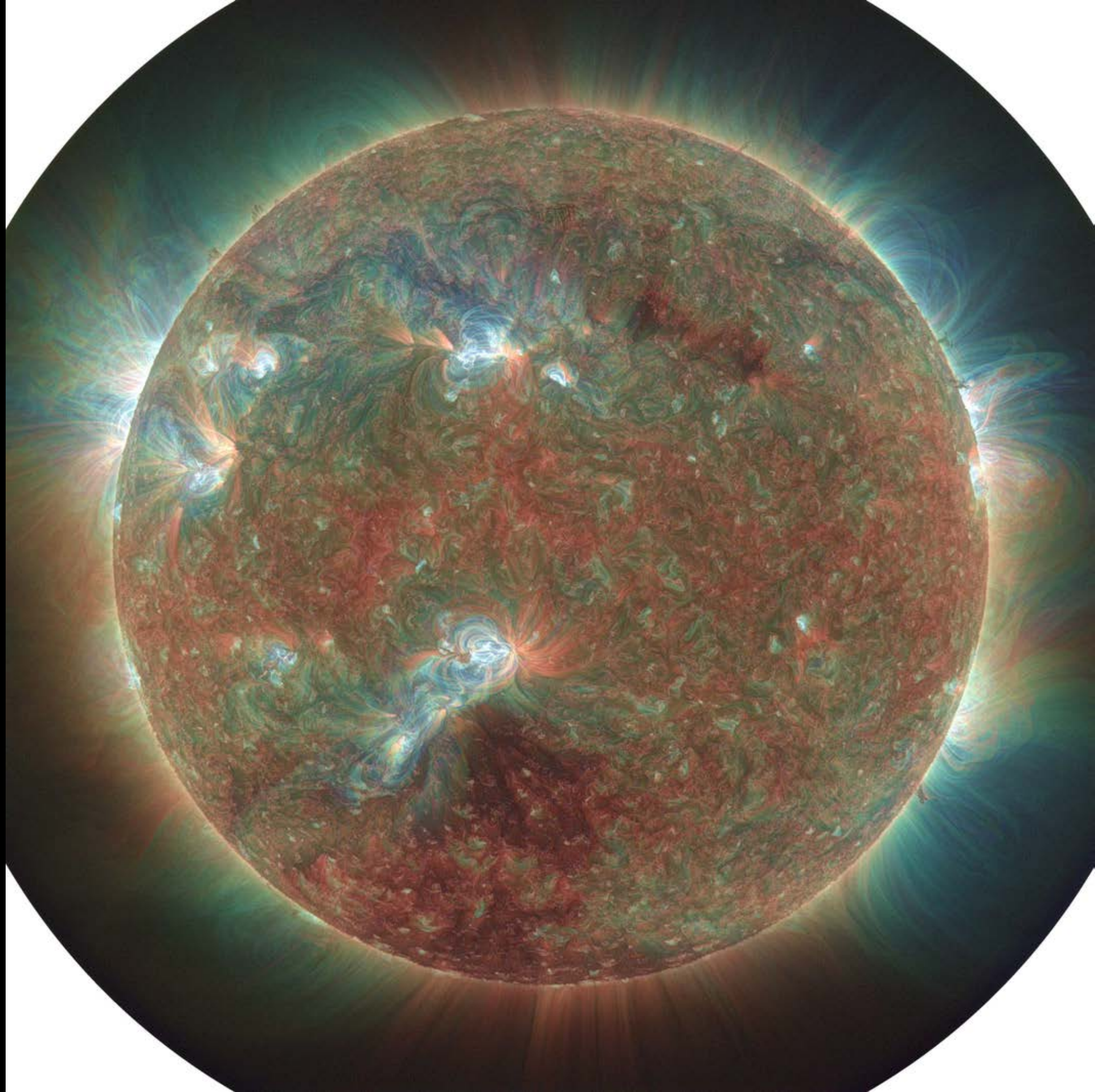
Summary

- Are photons the MacGuffin? SSN is **certainly** a MacGuffin!
- Need capability to really assess GCRs and <27day effects in coupled atmospheric models… — Don't smooth the data!
- Next Terminator estimated from BP bands to be 2020 April… (Say it with me now…!)





Summary

- Are photons the MacGuffin? SSN is **certainly** a MacGuffin!
- Need capability to really assess GCRs and <27day effects in coupled atmospheric models… — Don't smooth the data!
- Next Terminator estimated from BP bands to be 2020 April… (Say it with me now…!)

THE TERMINATORS