# SH006-06 Oscillations in Secondary to Primary Polar Crown Polarity Inversion Lines (PILs) around Solar Maximum (Smax) over Five Solar Cycles (SCs)

NH=Northern Hemisphere
SH=Southern Hemisphere


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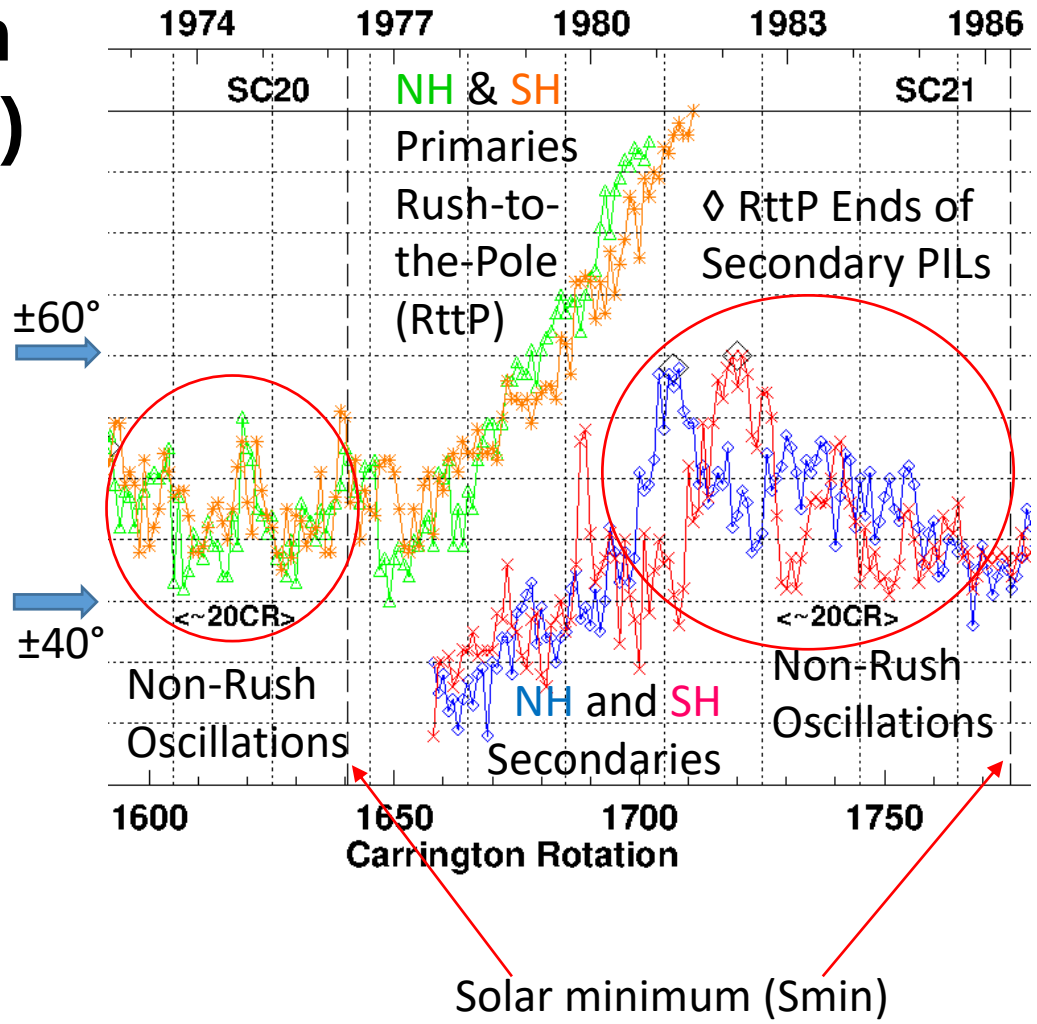
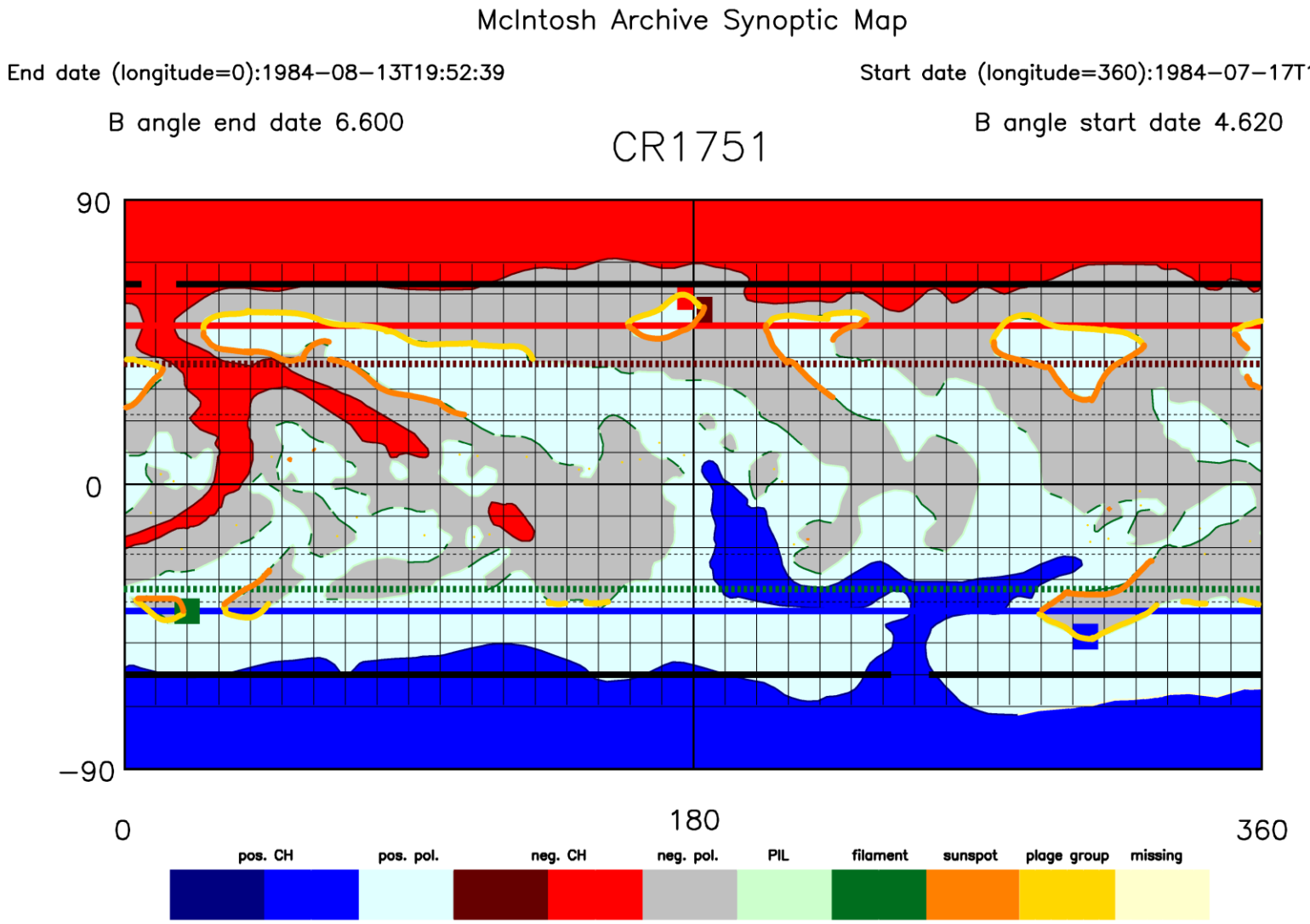


# McIntosh Archive of 55 years of PILs (Dec'54-Aug'09, SC 19-23) and 35 years of Coronal Holes (CHs, Apr'74-Aug'09)



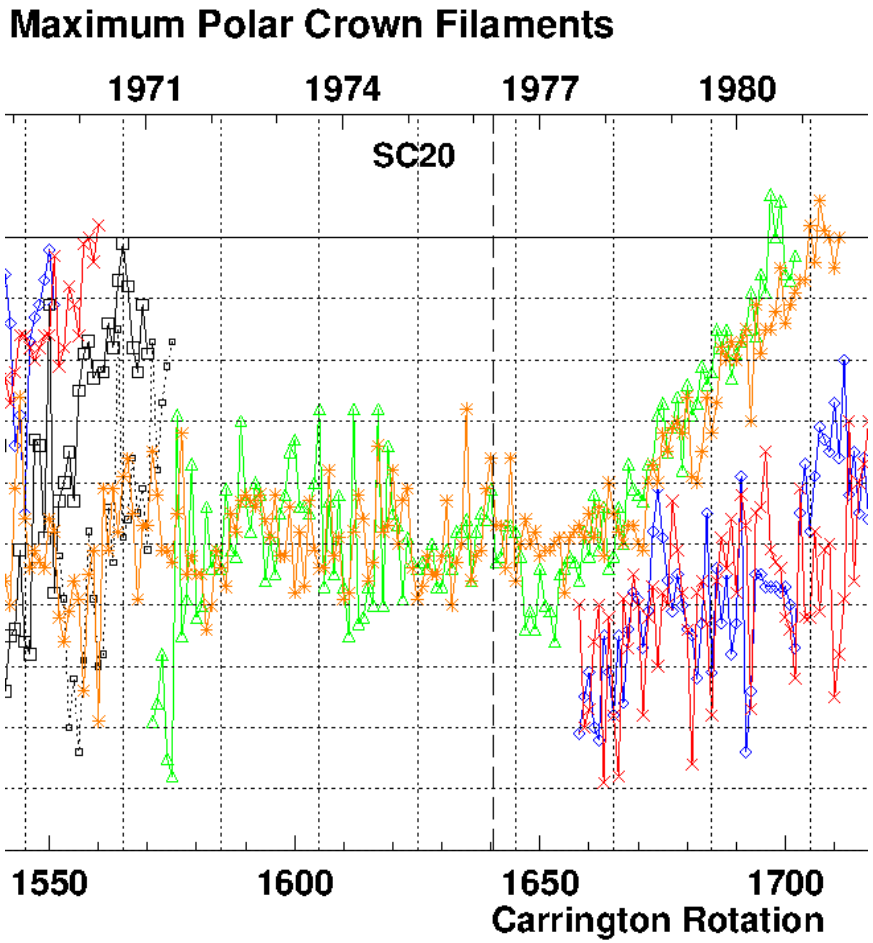

Solar minimum Jul-Aug 1984

Polar coronal hole (CH) latitudinal extent ~28-30°, with low-latitude extensions

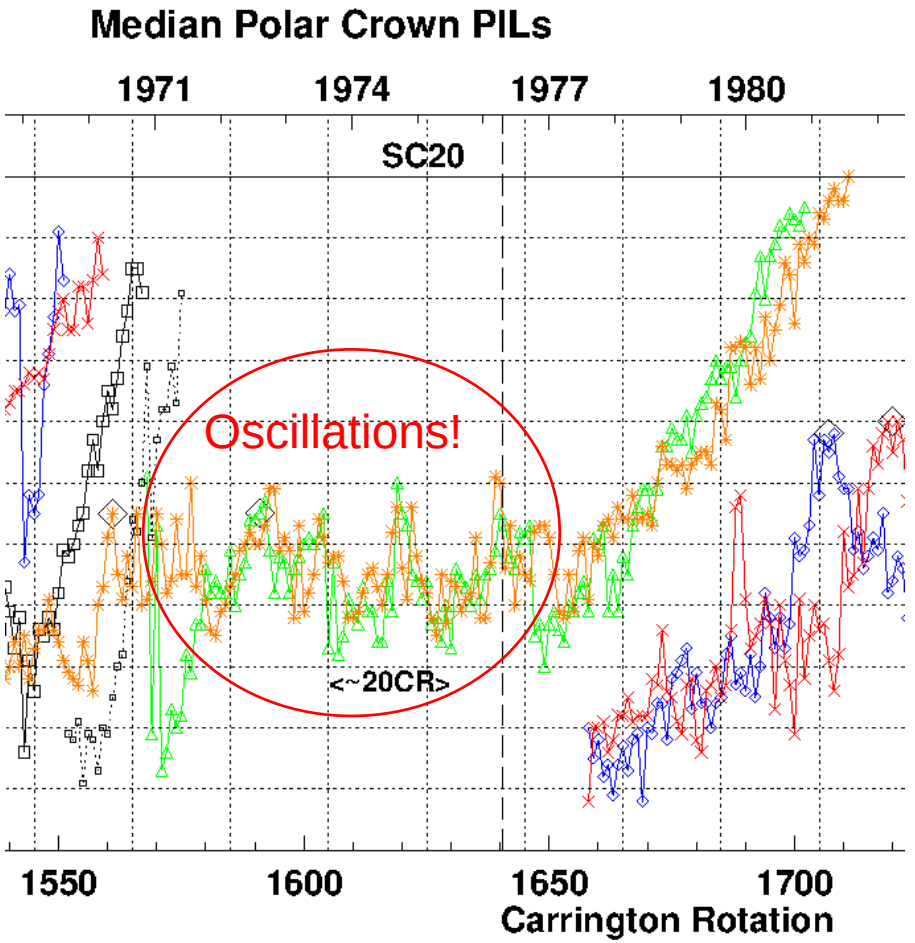
Primary PIL (polarity inversion line) 50.0°N, 40.5°S

Secondary PIL (polarity inversion line) 38.5°N, 33.5°S

# Median PILs (Polarity Inversion Lines) Cleaner, Better Story than Filaments

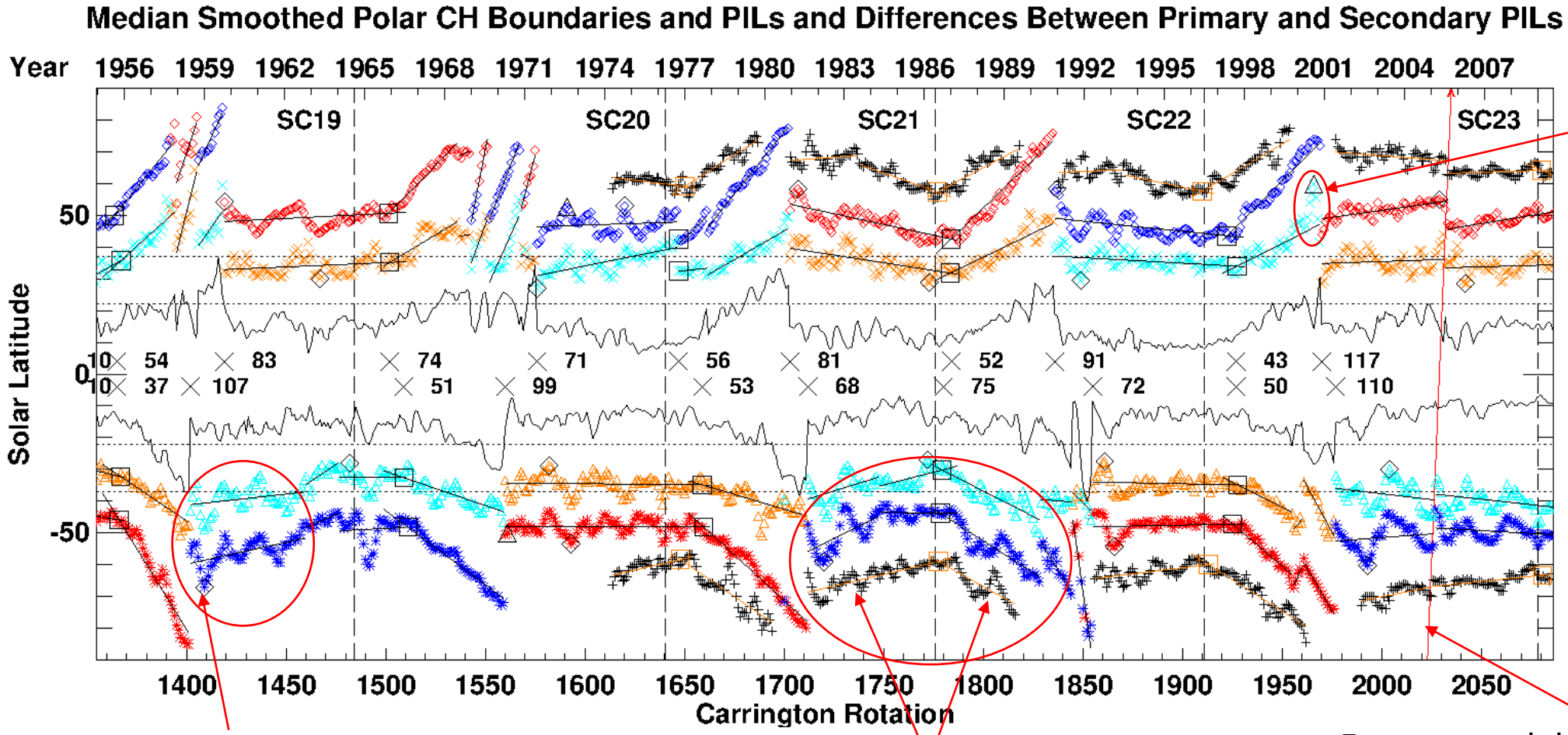



±55°



# SC 19-23 Oscillations after Secondary PIL Rush-to-the-Pole End Peaks

The end of the Rush-to-the-Pole (RttP) of the secondary PIL (diamonds or triangles) is usually later than the RttP end of the primary PIL marking the polarity change at the pole at Solar maximum (Smax), where red=negative and blue=positive




Early end ~60°N in the Rush-to-the-Pole (RttP) Secondary PIL

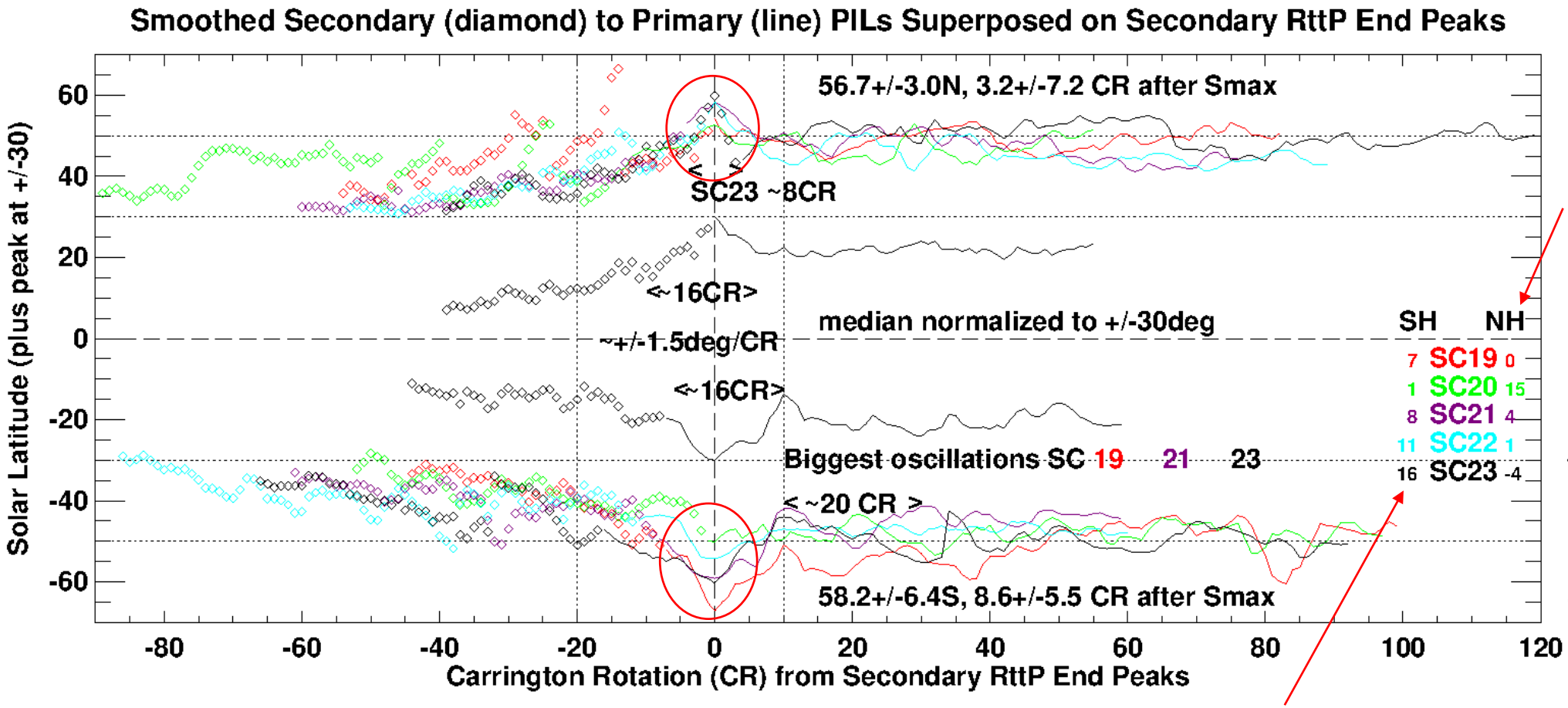
Smax Secondary Rush-to-the Pole (RttP) PIL ends in Primary non-Rush PIL ~67°S

Oscillations also in CH boundary

Equatorward drop in latitude from South to North ~15°/CR (CR=Carrington Rotation)

# Secondary PIL Ends Its Rush-to-the-Pole (RttP) ~57°N (~58°S) in the Primary non-Rush PIL ~3 CR (~9 CR) after Solar Maximum Polarity Change

Superposed Epoch Plot with the end of the Secondary PIL's RttP at Zero



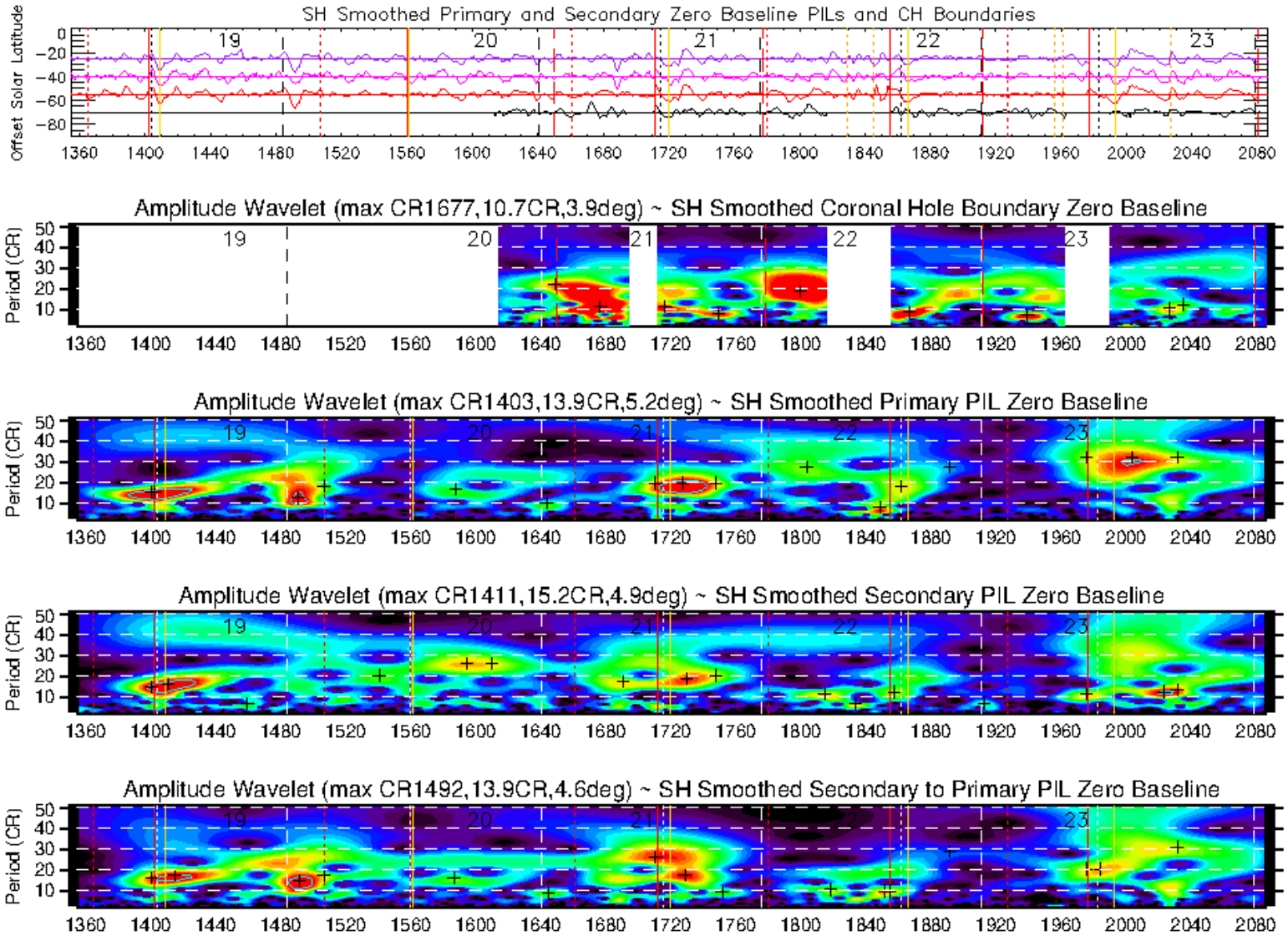

Northern Hemisphere (NH) secondary PIL RttP end is ~3 CR (1 CR median) after the Solar maximum (Smax) polarity change

Southern Hemisphere (SH) secondary PIL RttP end is ~9 CR (8 CR median) after the solar maximum polarity change

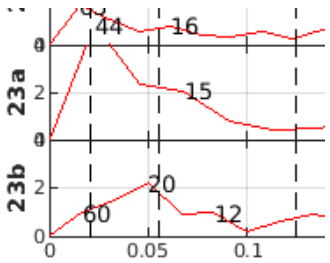
# ~16 CR Oscillations from Solar Maximum Transition Peaks

Red lines Smax polarity change.

Gold lines transition peaks.




Fast Fourier Transform (FFT) Amplitudes (°Lat) and Periods (CR)
SC 23a ~5° ~35 CR
SC 23b ~2° ~20-25 CR

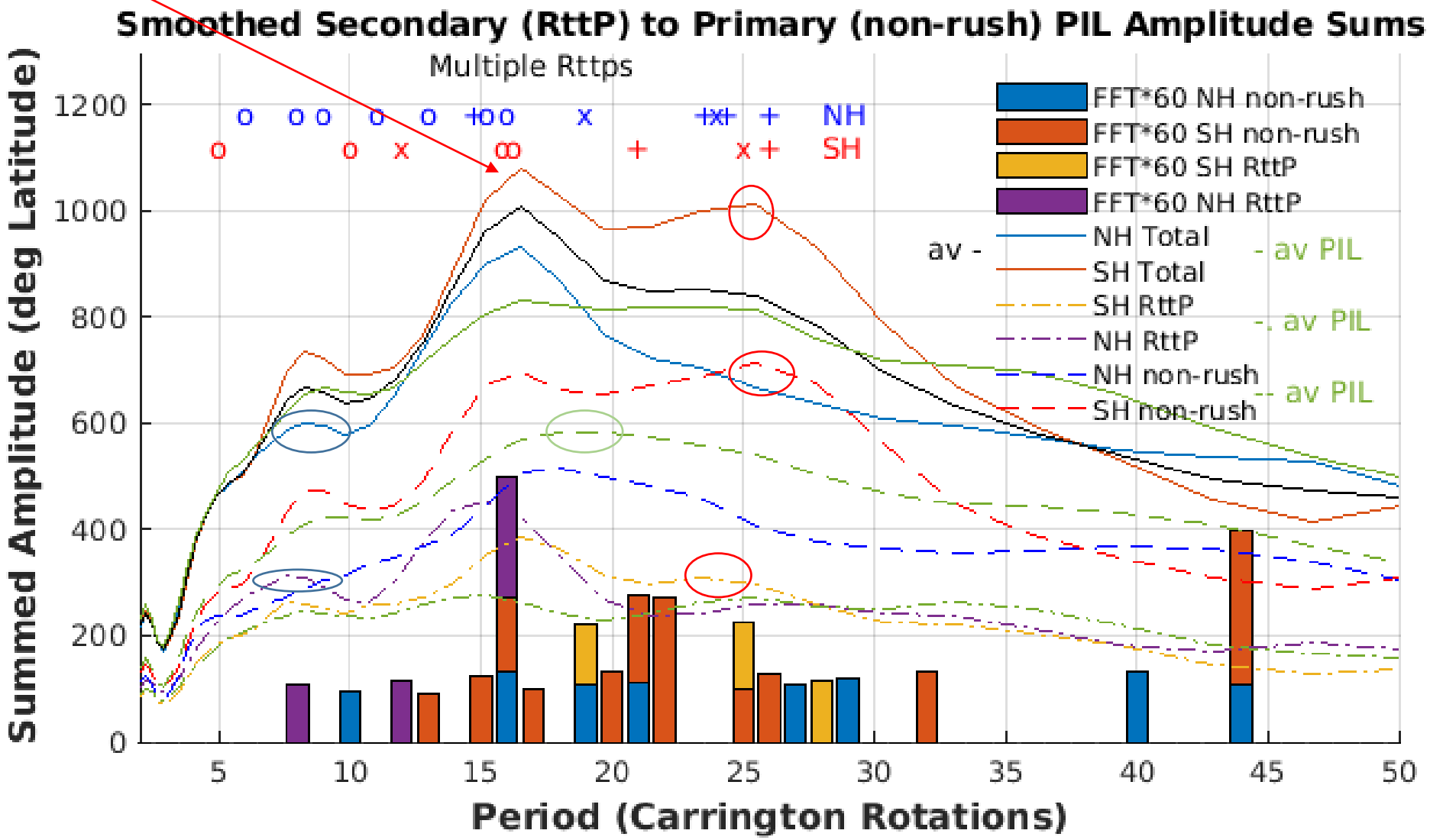



~10-35 CR period of oscillations

Largest SH (Southern Hemisphere) oscillations in odd SCs 19, 21, 23

Oscillations ~16 CR at Smax Transition Peaks

# ~16 CR PIL Peak Period from FFT Bars and Wavelet Amplitude Sums




Av PIL=primary + secondary PIL (av NH + SH)

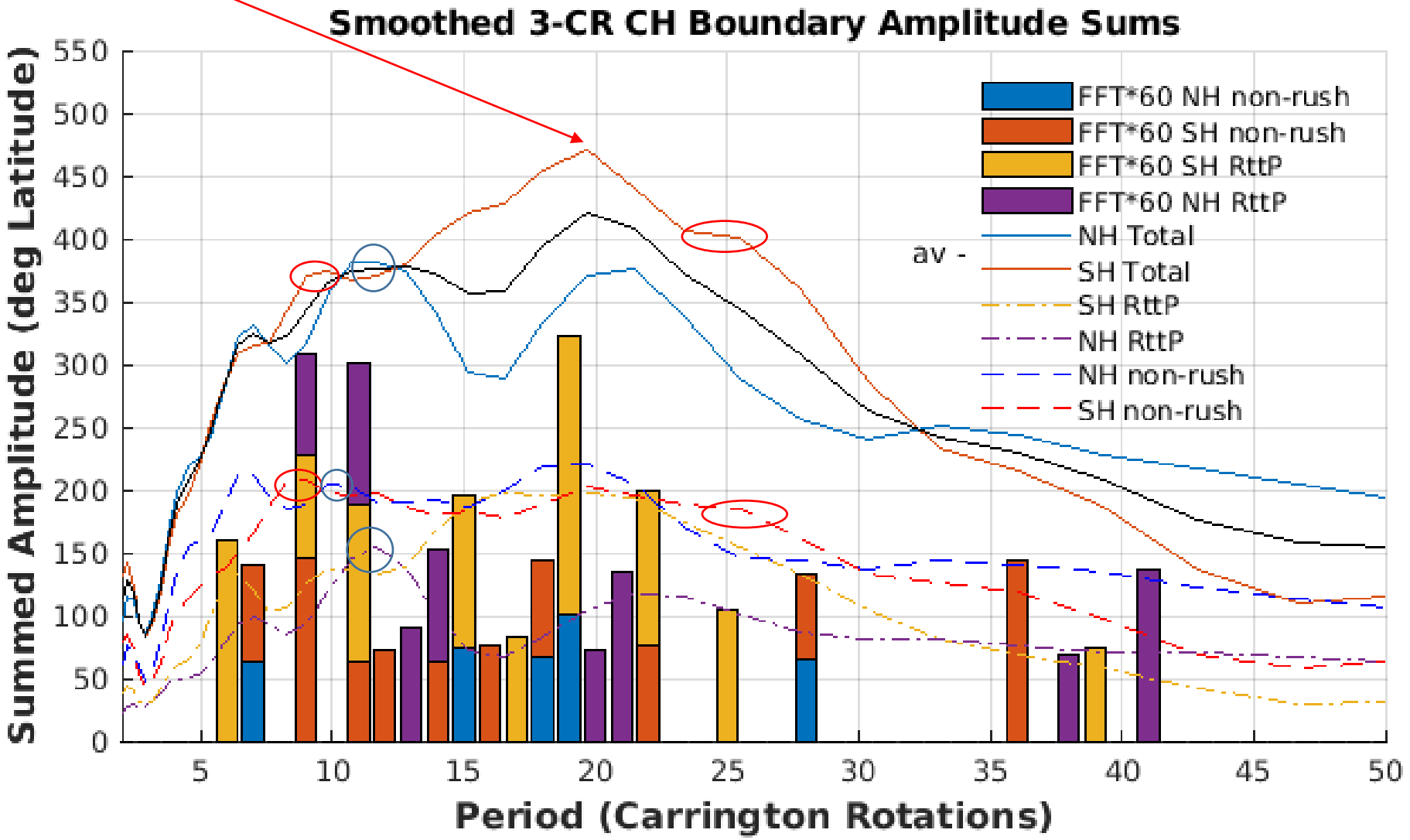
SH peak ~25 CR, non-Rush

NH peak ~8 CR, Rush-to-the-Pole=RttP

Av PIL non-Rush peak ~20 CR

# ~20, ~10 CR Periods for CH Boundary from FFT Bars and Wavelet Sums

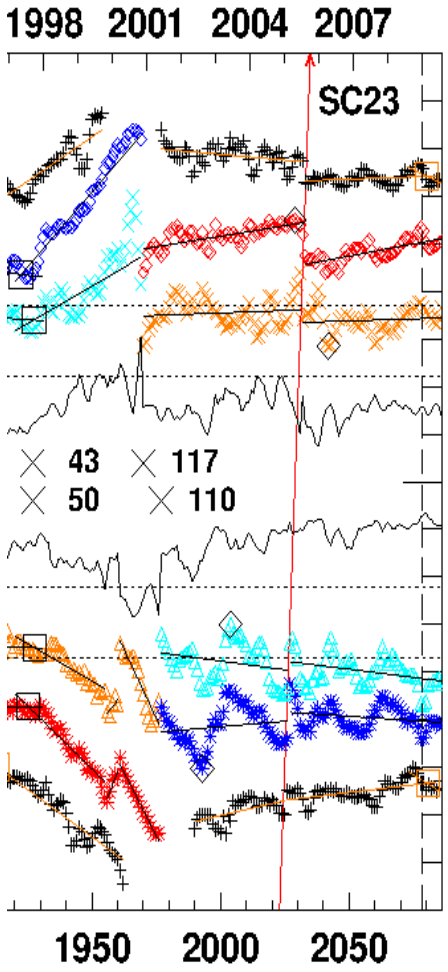
No major ~16 CR period because have only one CH Boundary




SH peak
~25, ~9 CR
- Similar to PIL

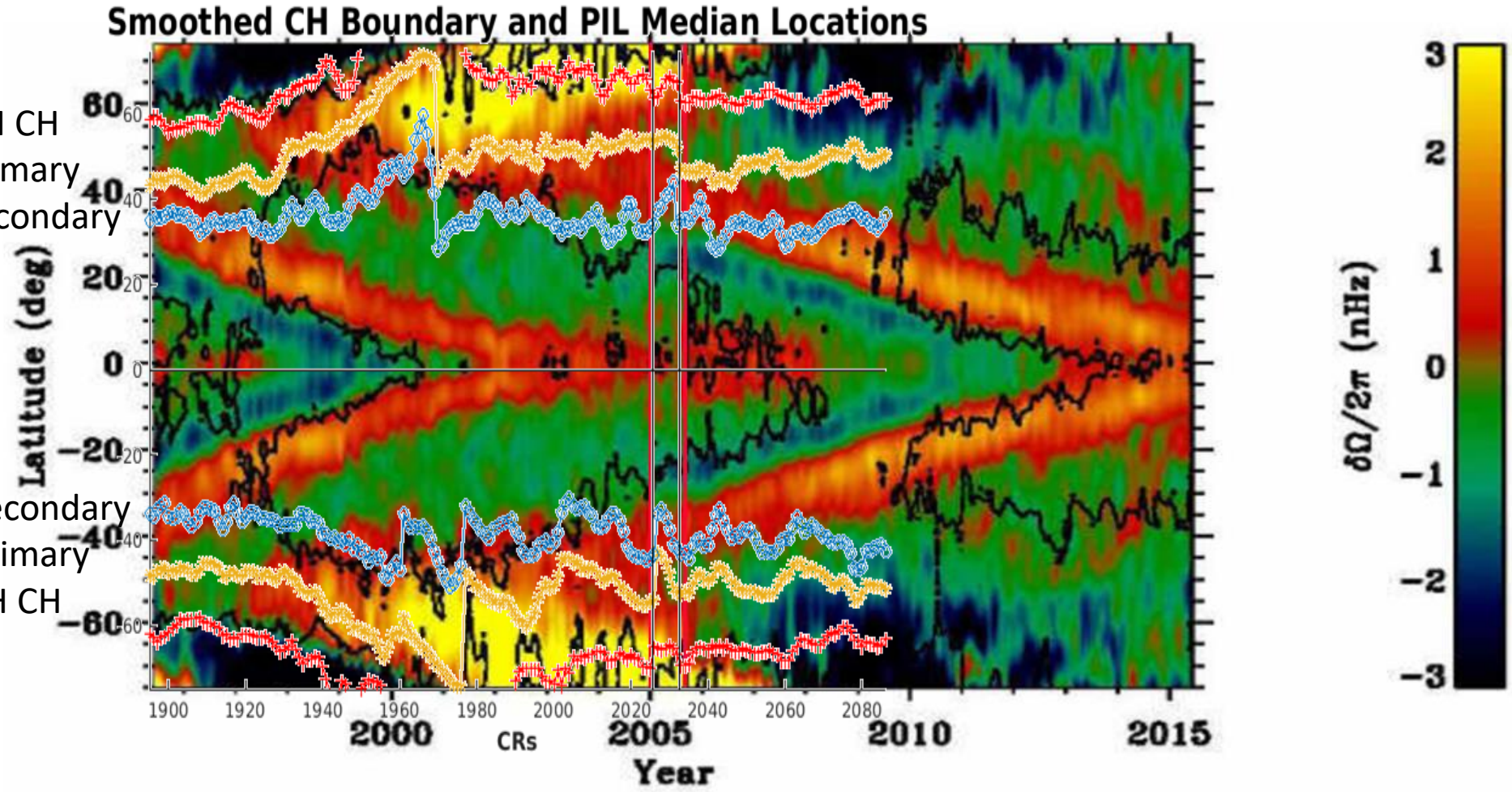
NH peak
~11, ~7 CR
- Similar to PIL

# ~15°/CR Disturbance Expands Polar Coronal Holes ~50% from South to North in 2005 CR2023-35




NH CH
Primary
Secondary

Secondary
Primary
SH CH

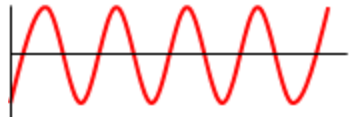



Southern PIL wavelets ~30 CR before, ~22 CR after and smaller amplitudes

*From Howe (2016) meridional flows and 5 G unsigned magnetic flux.*
Overplot SC 23 PILs and Coronal Hole boundaries.

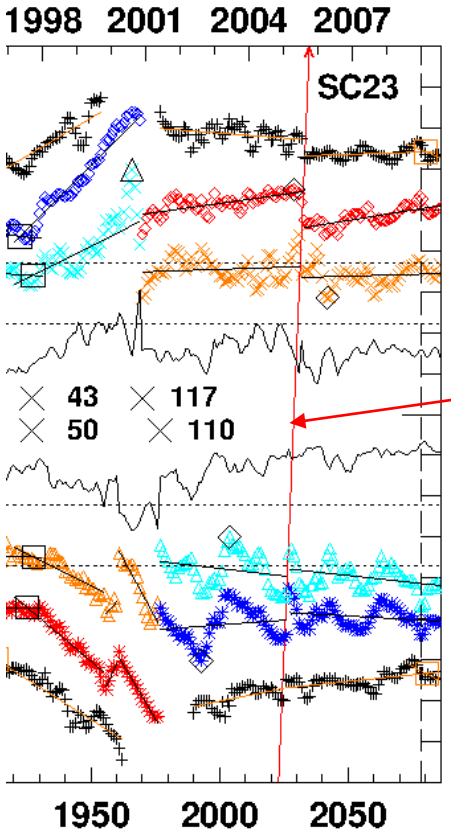
~±57° Latitude

# CONCLUSIONS



The RttP End of the Secondary PIL in the Transition to the non-rush Primary PIL

~16 CR Oscillations in Solar Latitude!




CH (NH)
Primary
Secondary

Secondary
Primary
CH (SH)

*Other periods shared with Coronal Hole (CH) boundaries of ~25 (SH), ~20 (non-rush), ~7-11 CR (mostly NH)*

AWESOME ~15°/CR Disturbance from Southern Hemisphere (SH) to Northern Hemisphere (NH) in 2005 SC 23 solar minimum!

*What do modelers think happened here?*

https://www2.hao.ucar.edu/mcintosh-archive/four-cycles-solar-synoptic-maps

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