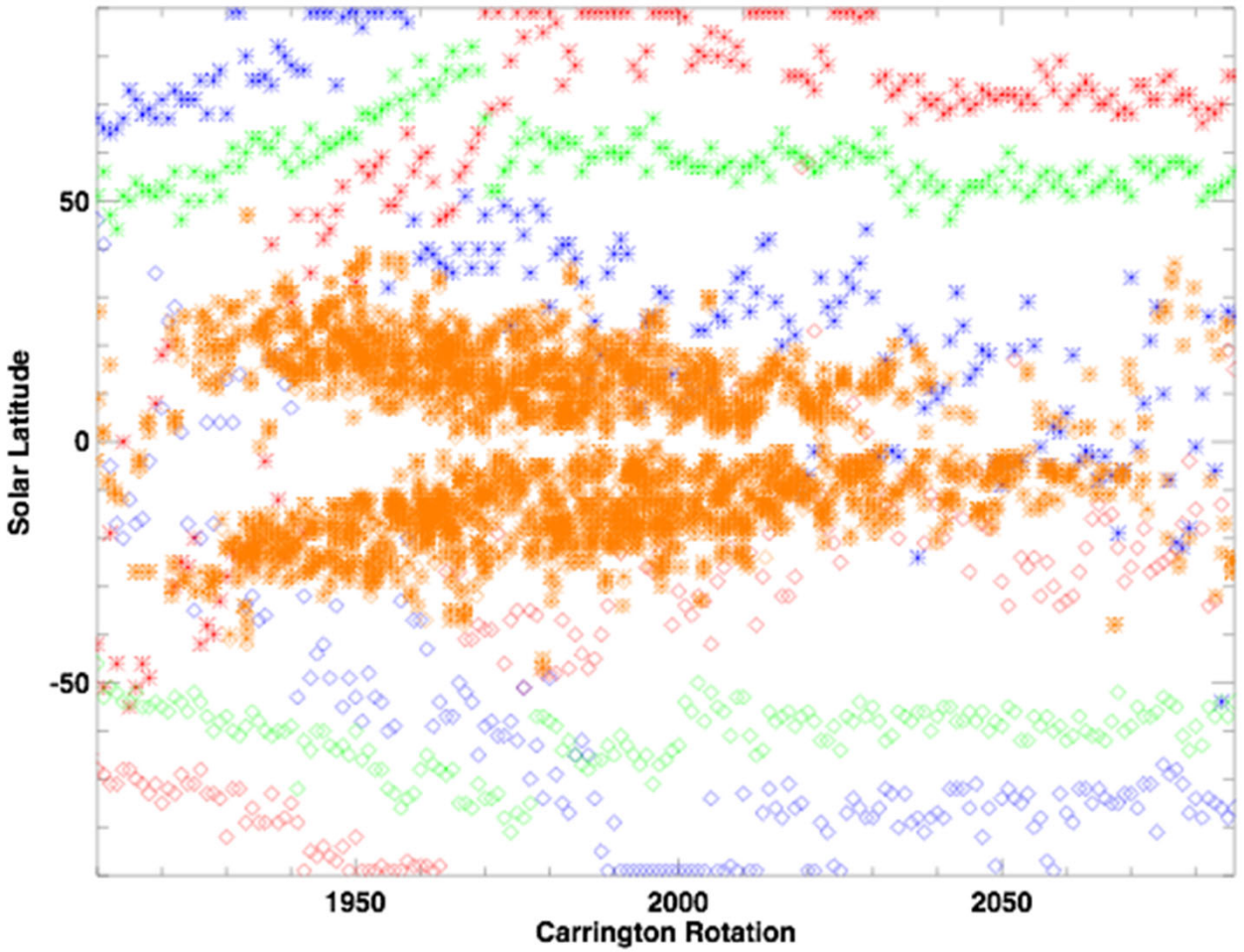
Studies of Global Solar Magnetic Field Patterns Using a Newly Digitized Archive



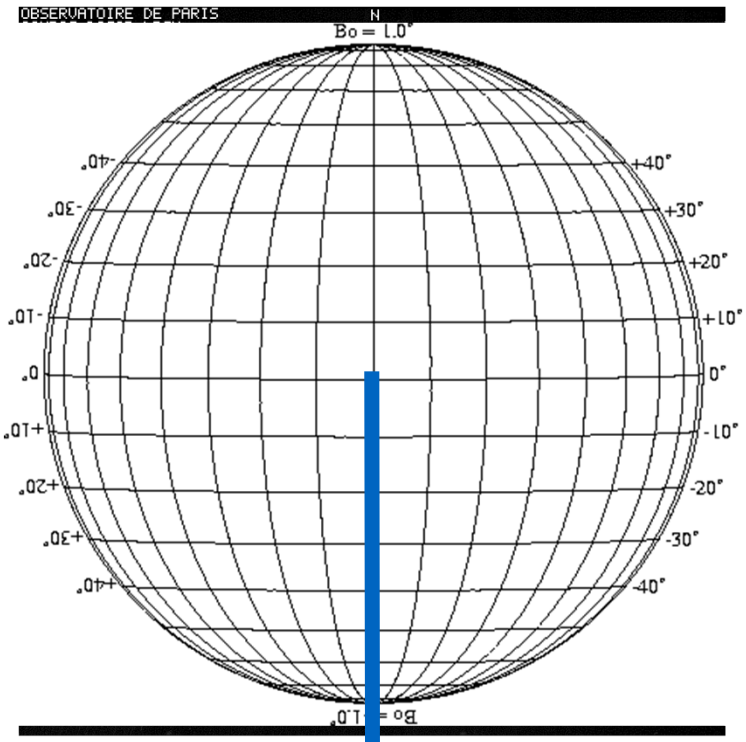
David F Webb, Ian Hewins, Sarah E Gibson, Robert McFadden, Barbara A Emery and Anna V Malanushenko

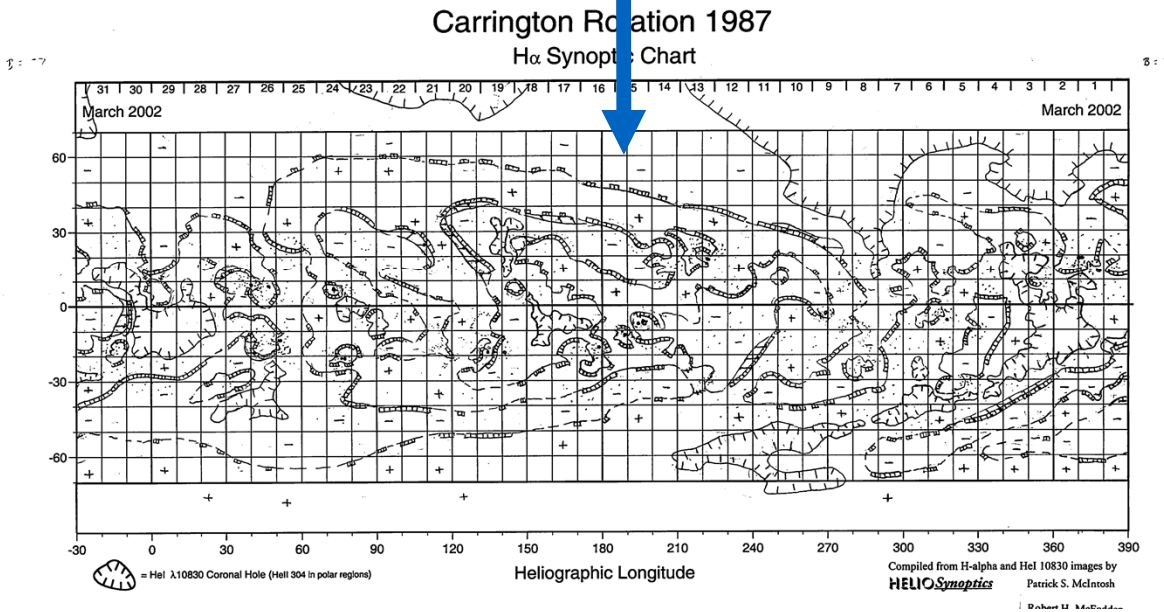
McIntosh Archive: 44 years of solar observations

Unique and consistent set of solar Carrington maps drawn by Pat McIntosh

Based on H-alpha, He 10830, and photospheric magnetic observations

Mapping large-scale coronal features over four solar cycles

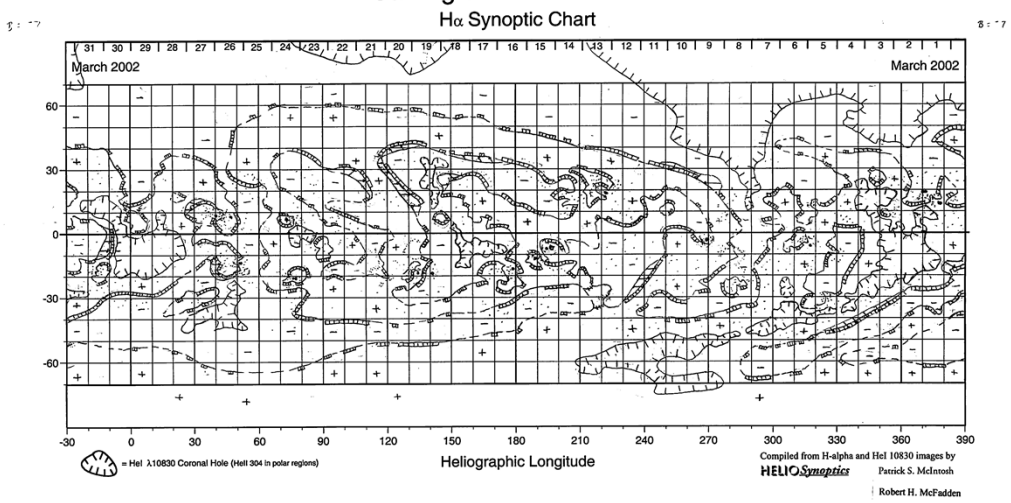




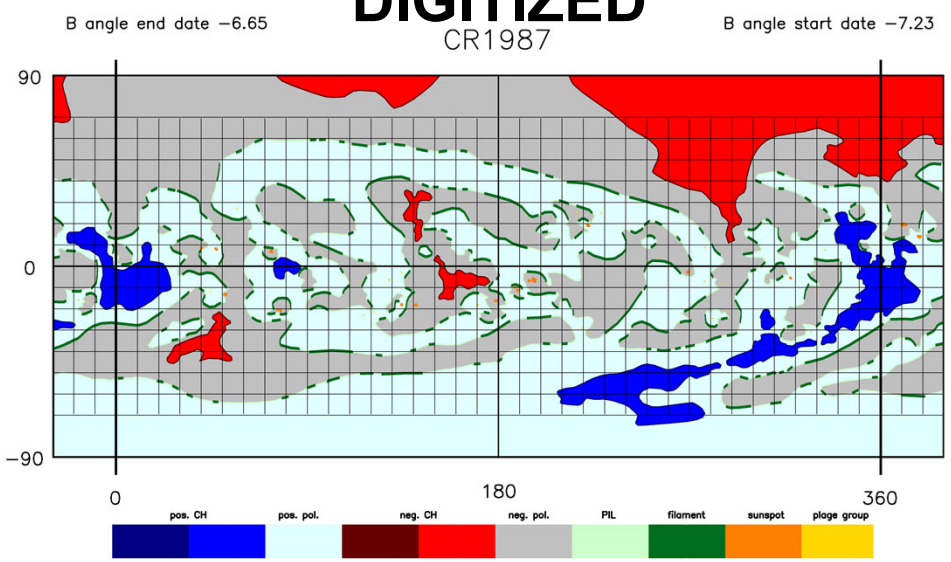
McIntosh Archive: Searchable Digitized Database

- Scan all original maps (Level 0)
- Convert to uniform size, orientation, scaled to a latitude-longitude grid (Level 1)
- Use Photoshop to assign unique color to each type of solar feature (Levels 2-3)

ORIGINAL

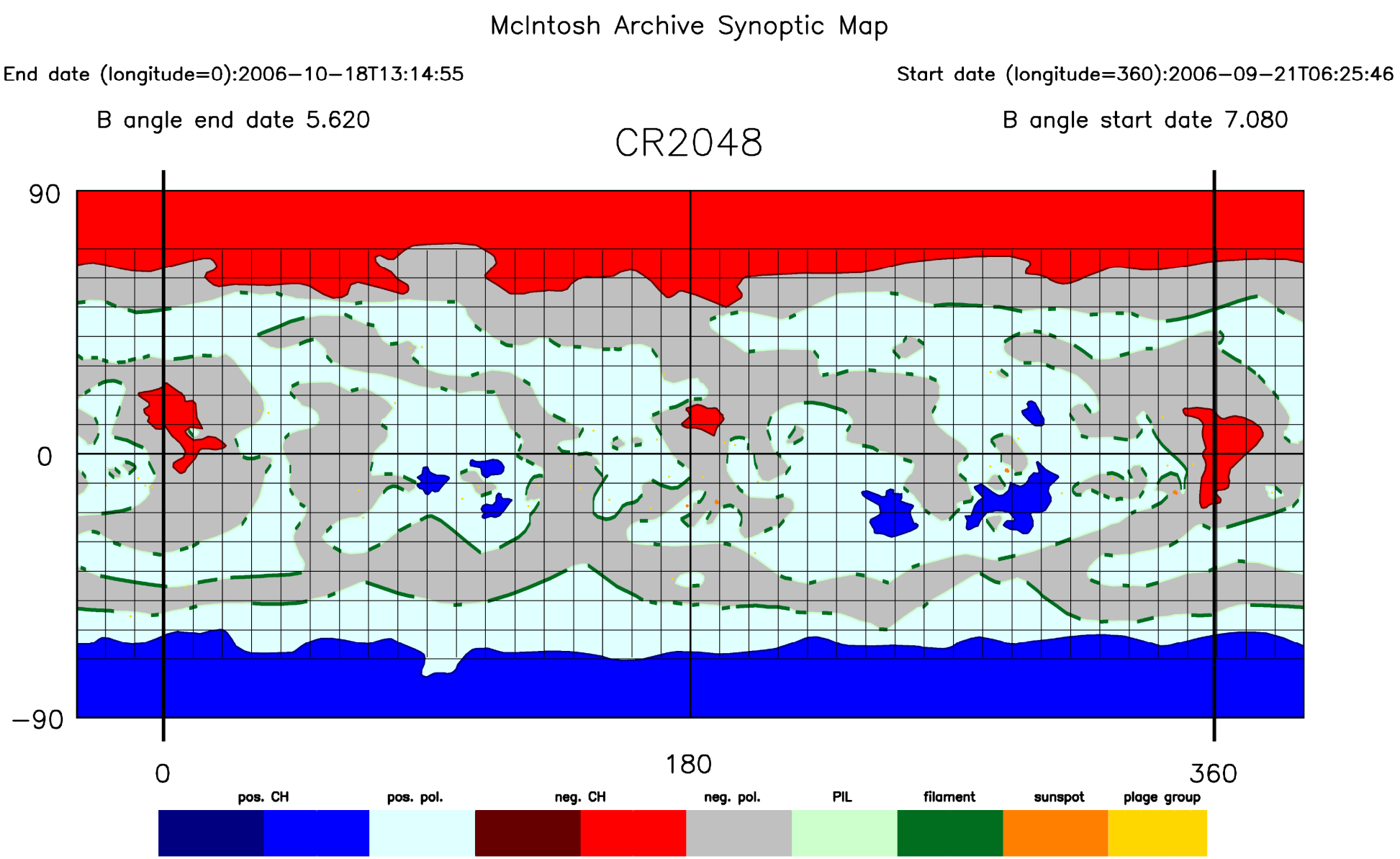


DIGITIZED

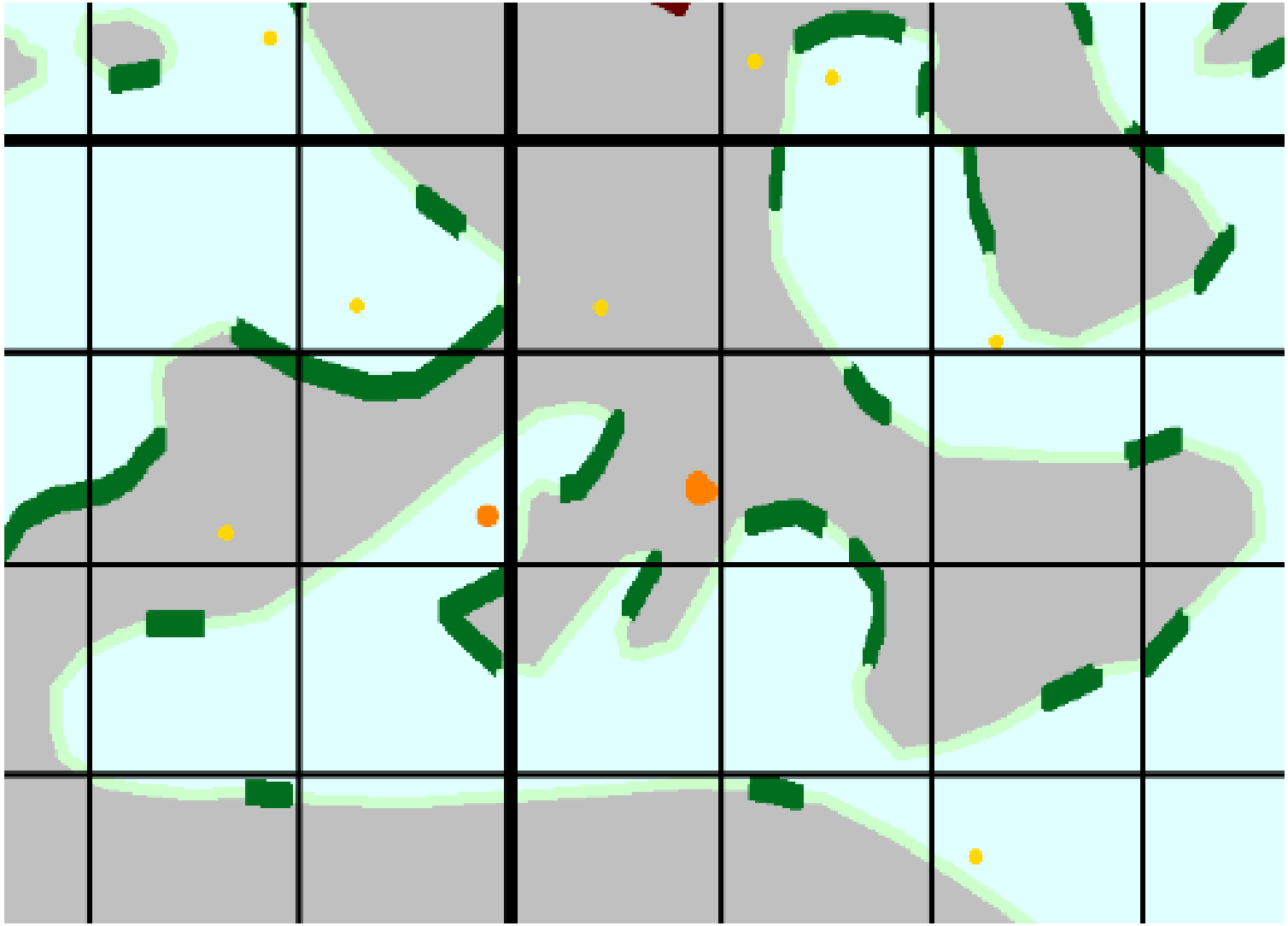


End product: GIF images and FITS files that are **searchable** by solar feature, longitude, latitude, date, etc.

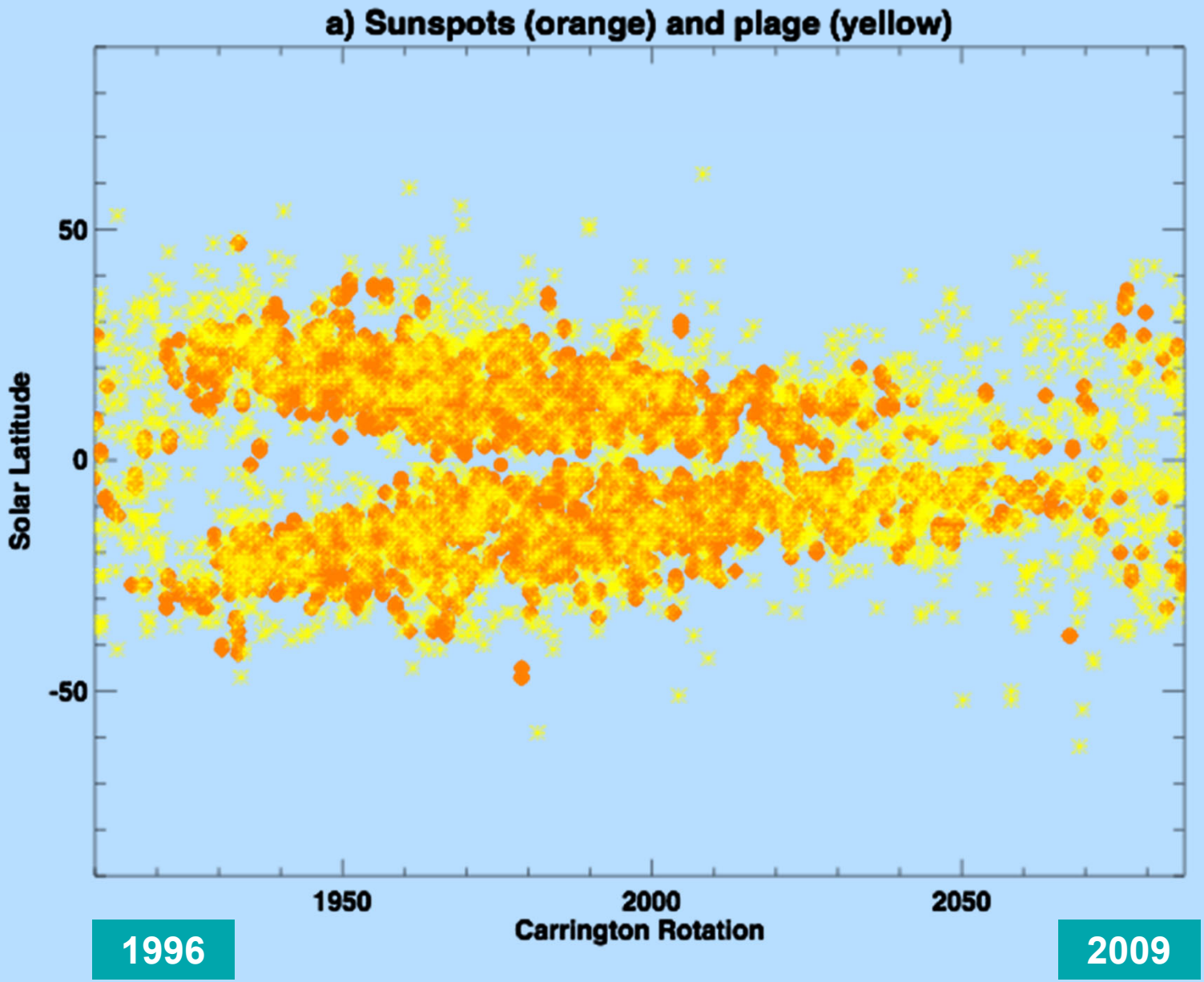
Sunspots, plage, coronal holes, filaments



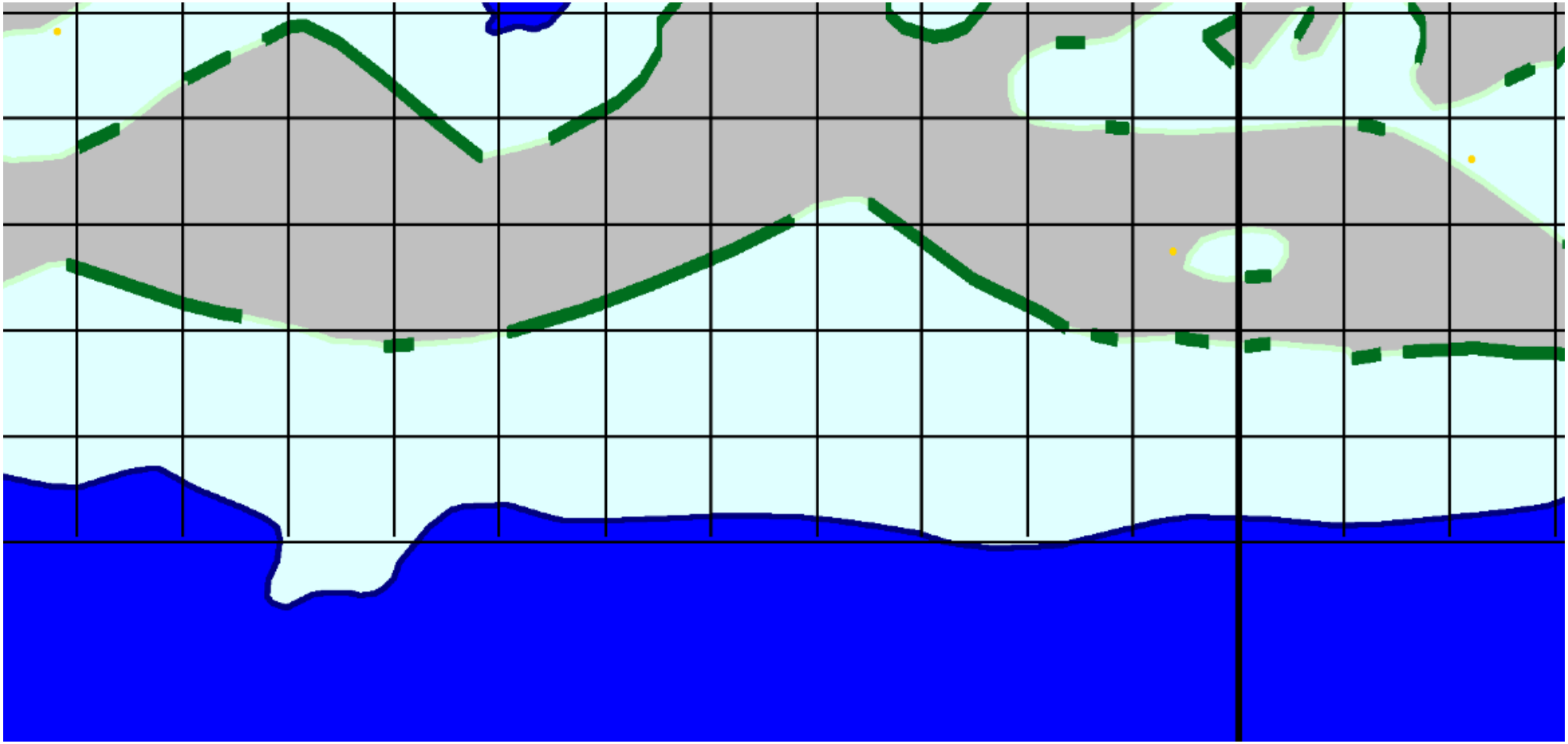
Sunspots, plage, coronal holes, filaments



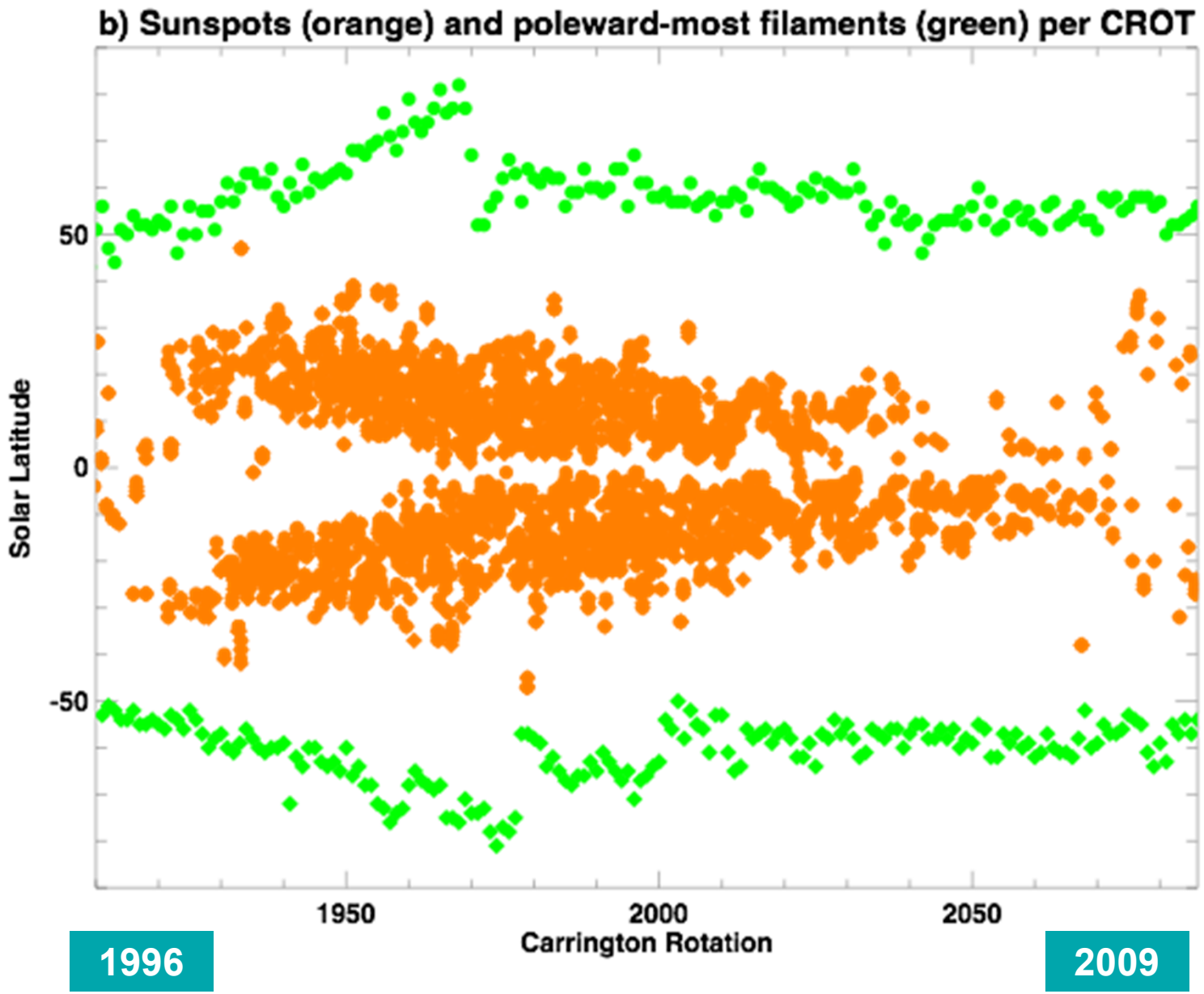
Sunspots, plage



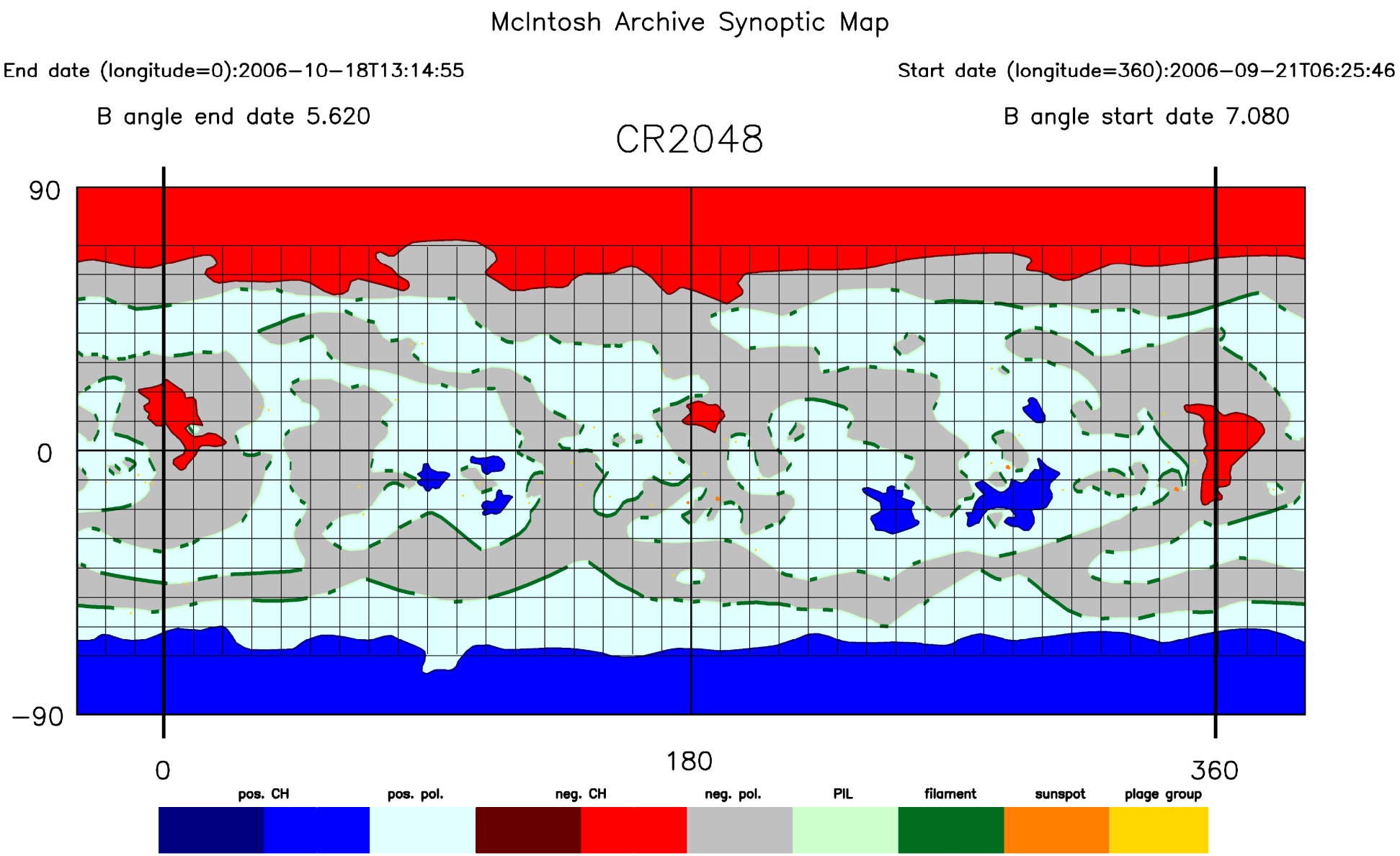
Sunspots, plage, coronal holes, filaments



Filaments: rush to the poles

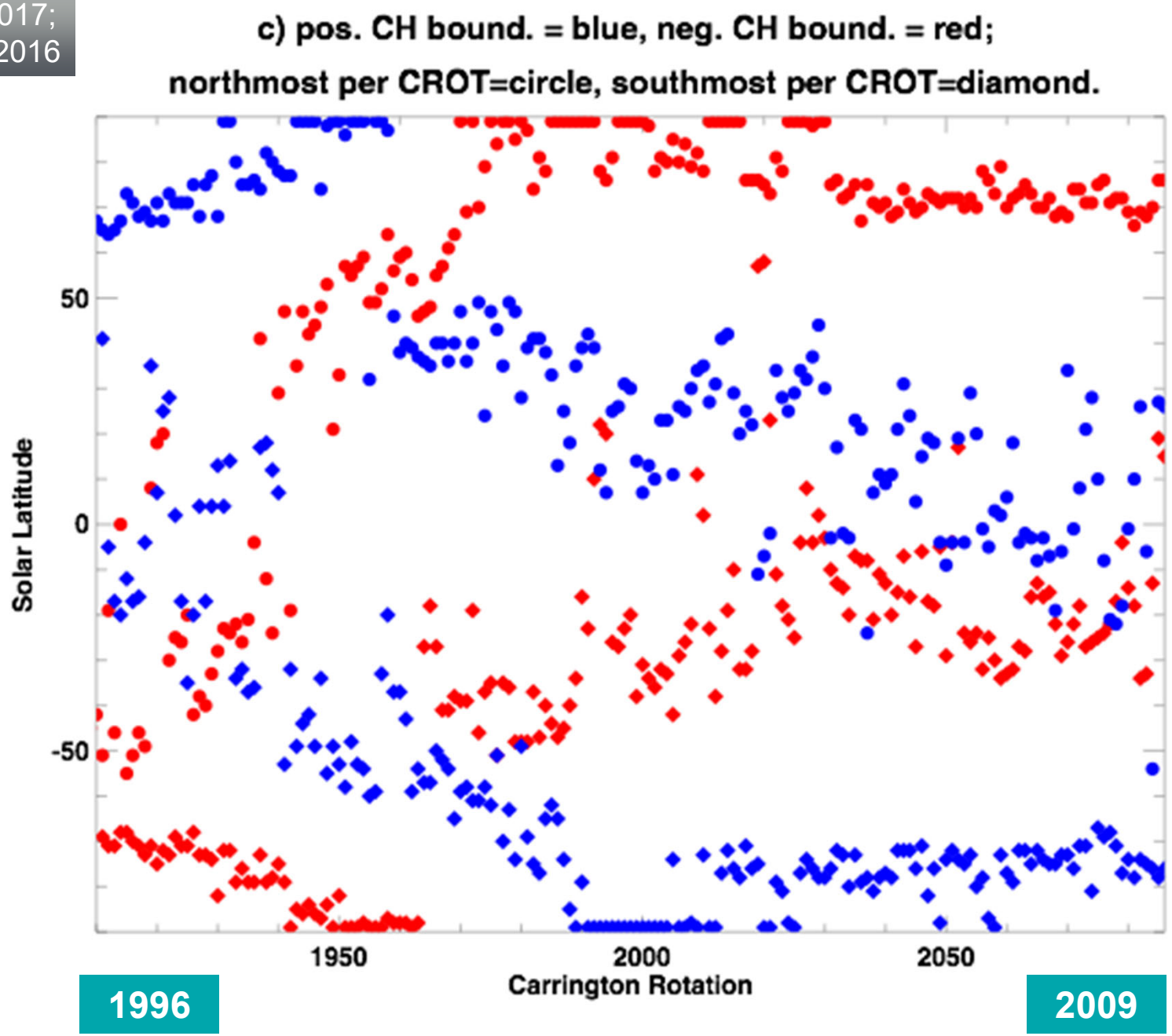


Sunspots, plage, coronal holes, filaments



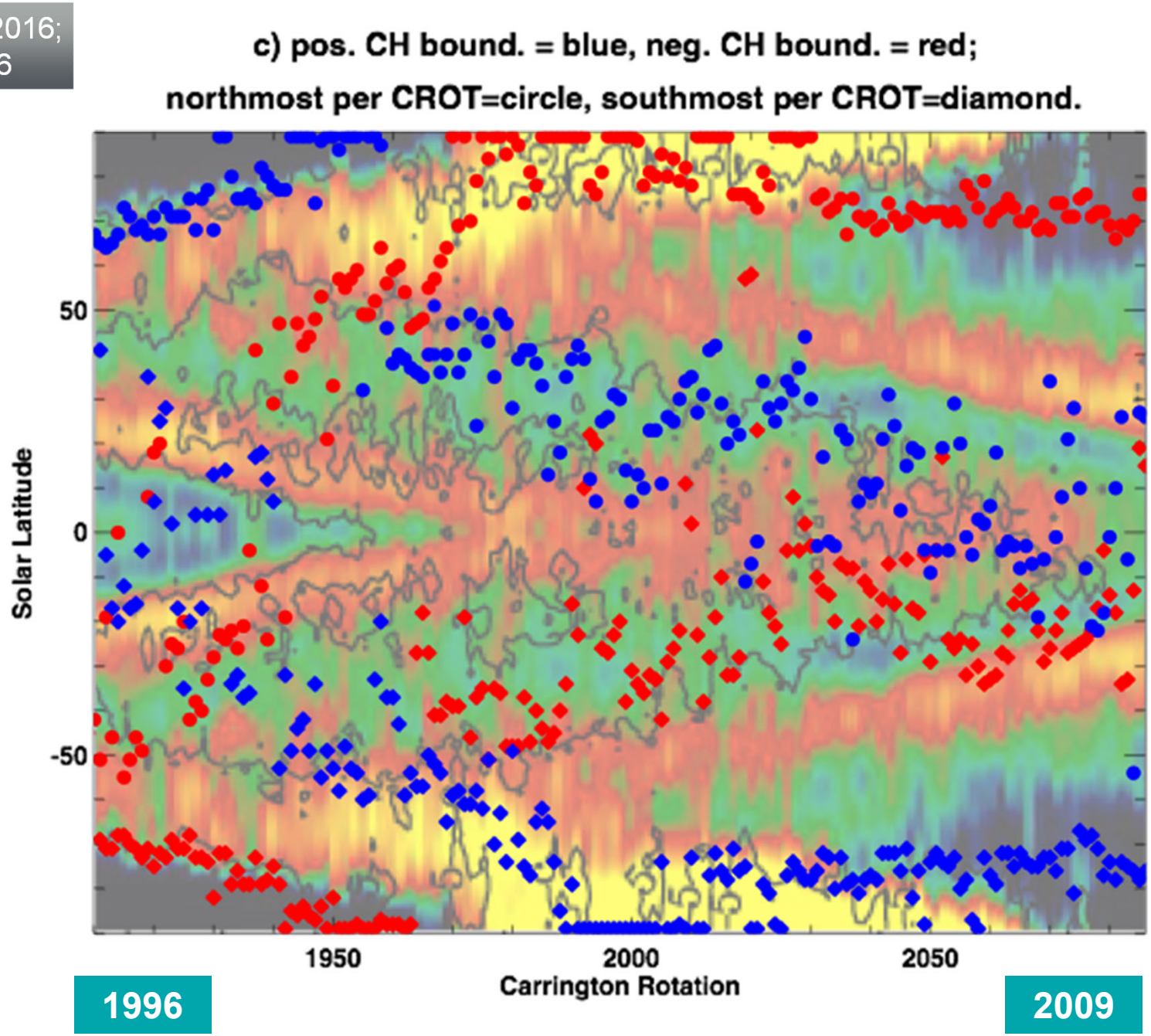
Coronal holes (polar and low-lat)

Webb et al., 2017;
Gibson et al., 2016



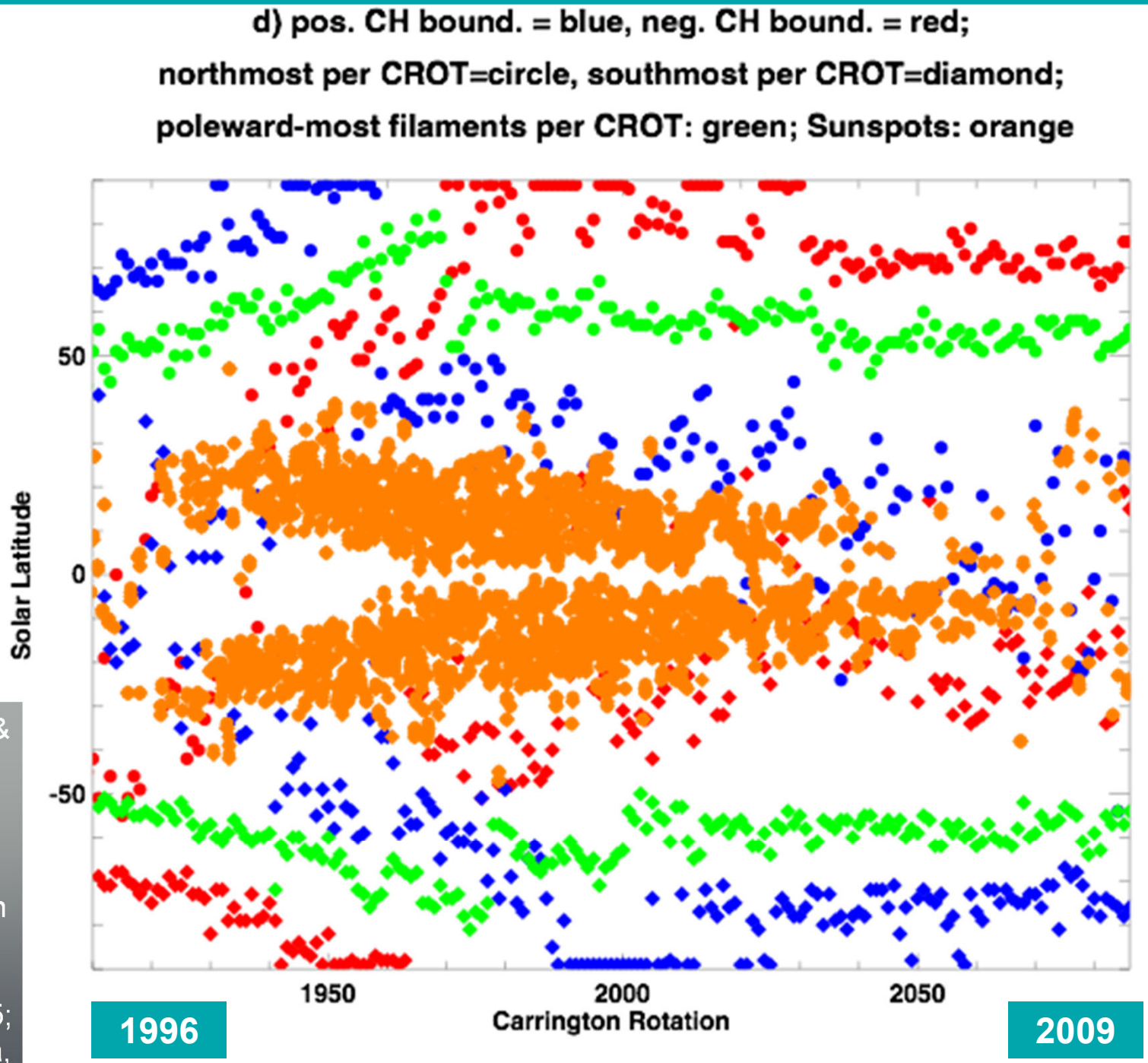
Coronal holes (polar and low-lat); Torsional oscillations

Gibson et al., 2016; Howe, 2016



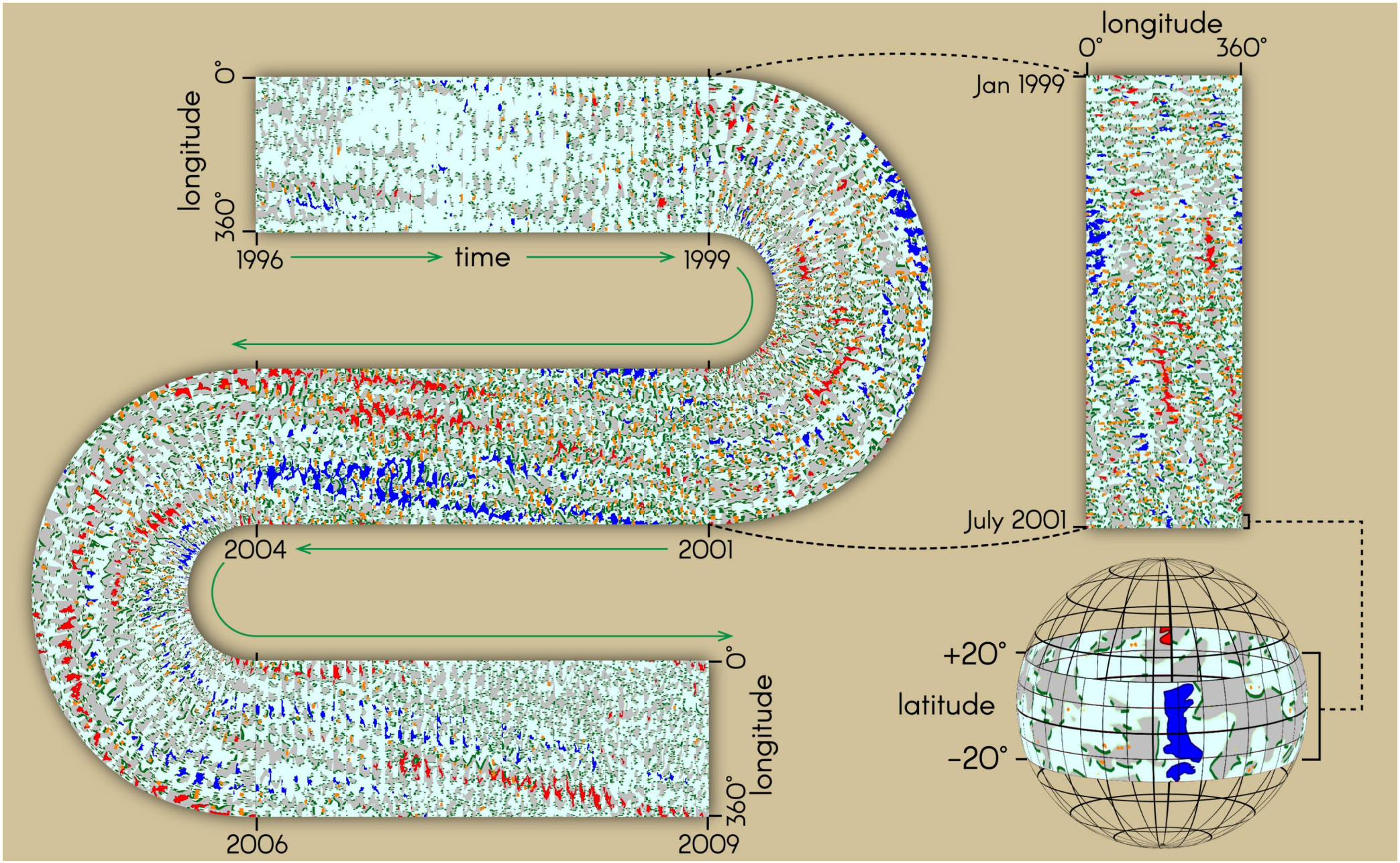
Coronal holes, filaments, sunspots: open vs closed fields

Webb et al., 2017; Gibson et al., 2016



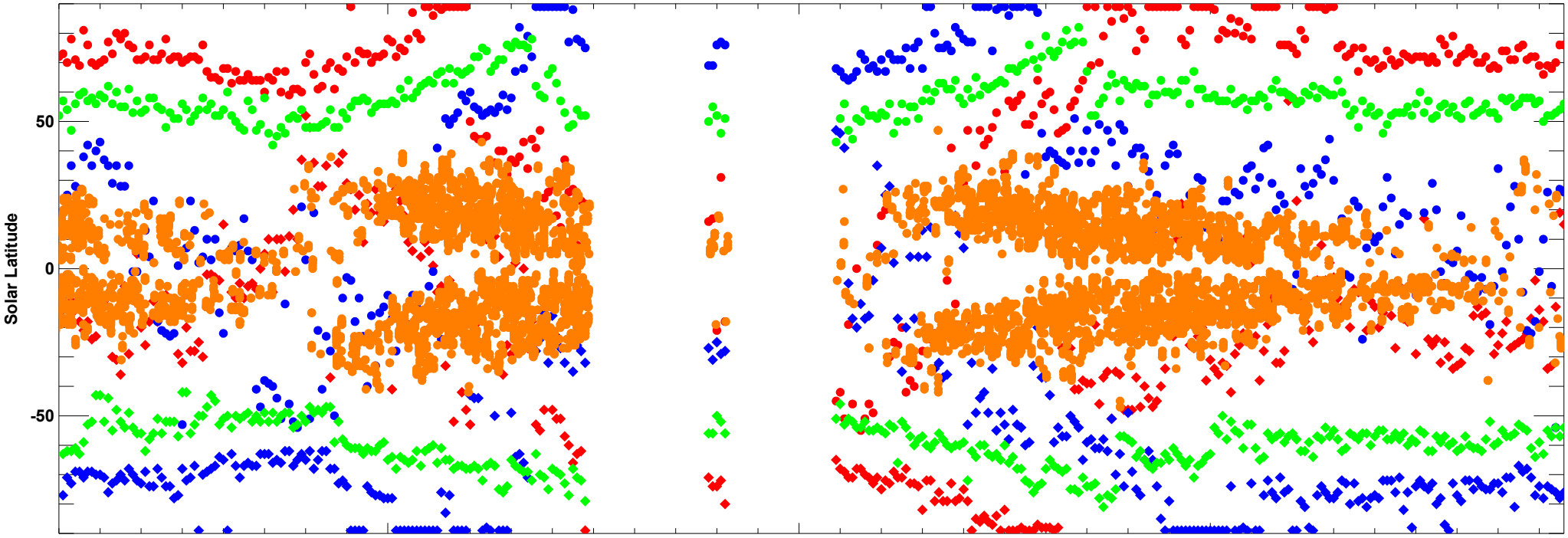
See also Webb, Davis & McIntosh, 1983; McIntosh & Wilson, 1985; Wilson et al., 1988; Harvey and Recely, 2002; Luhmann et al. 2002; McIntosh, 2003; McIntosh et al 2014; Karna et al., 2015; Bilenko & Tavastsherna, 2016

Stack plots


longitude
0°
360°
1996
time
1999
2004
2001
2006
2009
0°
360°
longitude
longitude
0°
360°
Jan 1999
July 2001
+20°
latitude
-20°

Variation over solar cycles

d) pos. CH bound. = blue, neg. CH bound. = red;
northmost per CROT=circle, southmost per CROT=diamond;
poleward-most filaments per CROT: green; Sunspots: orange



1982

2009

Variation over solar cycles

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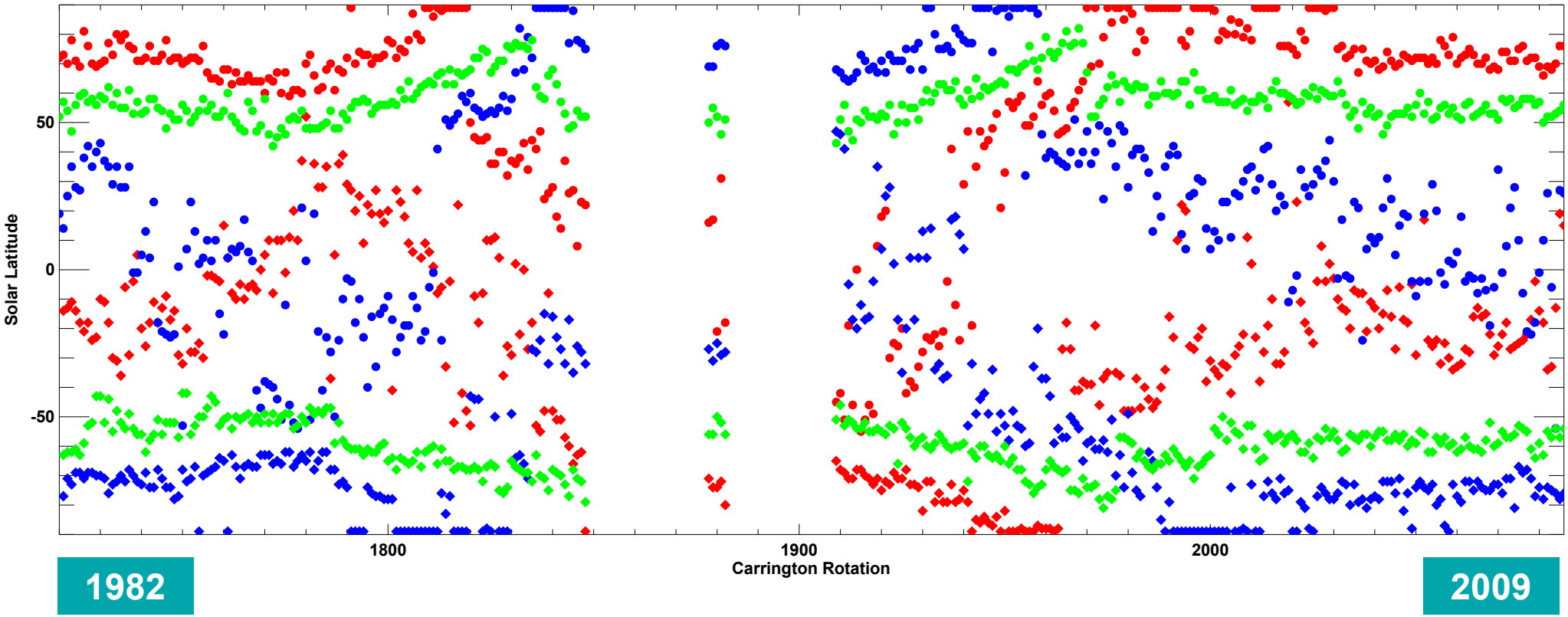

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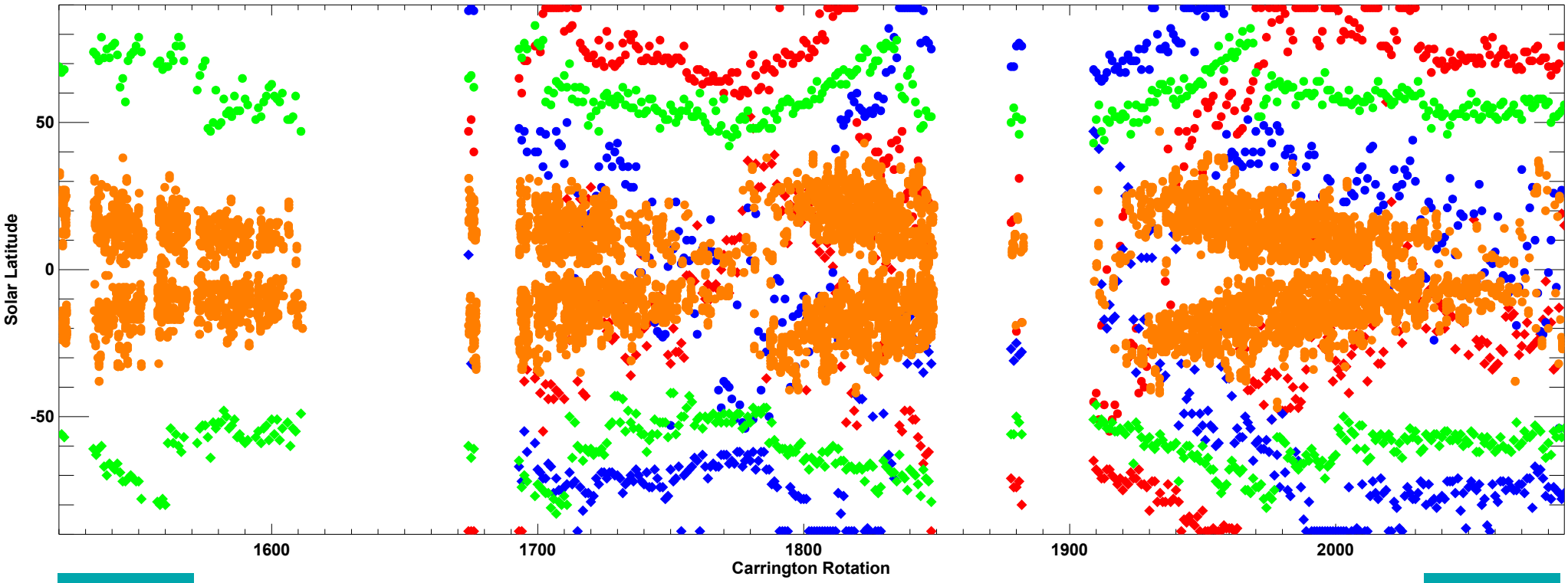
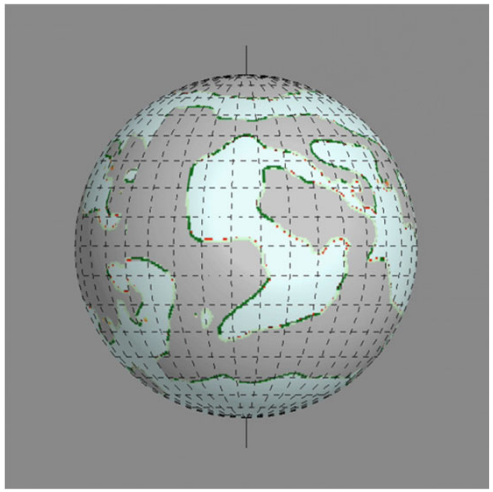


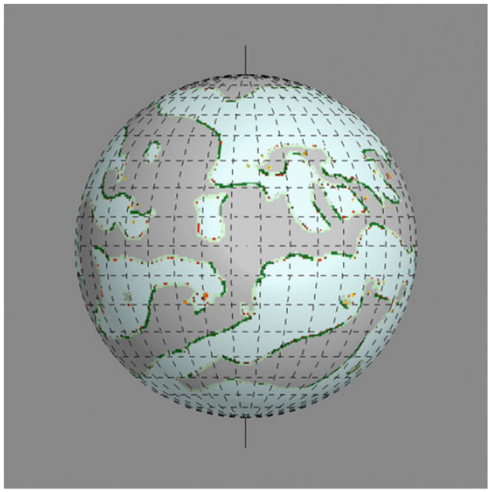
1967

2009

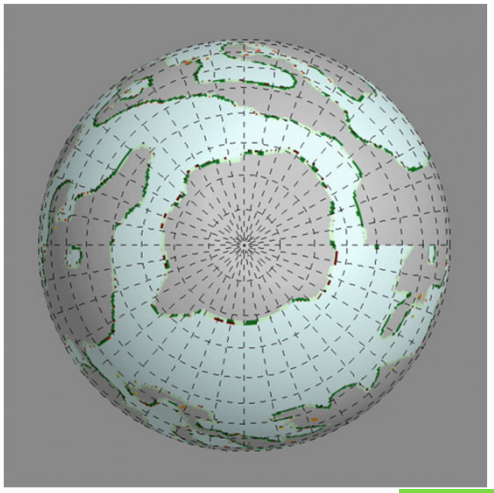
Conclusions



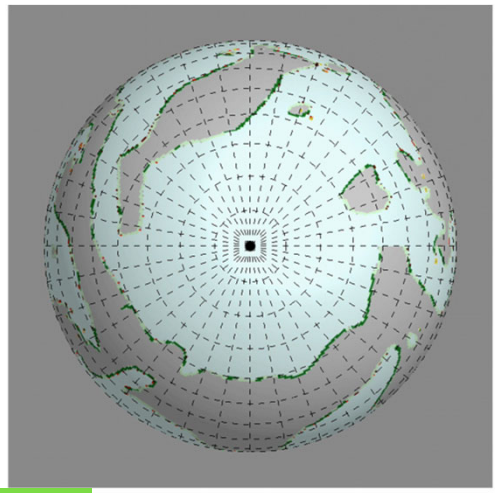
The McIntosh archive is a unique observational community resource enabling studies of global solar magnetic patterns (open & closed)



Potential science applications include analysis of the origins of solar features, correlation studies between solar features and connections to solar wind features, and context for historical event studies.

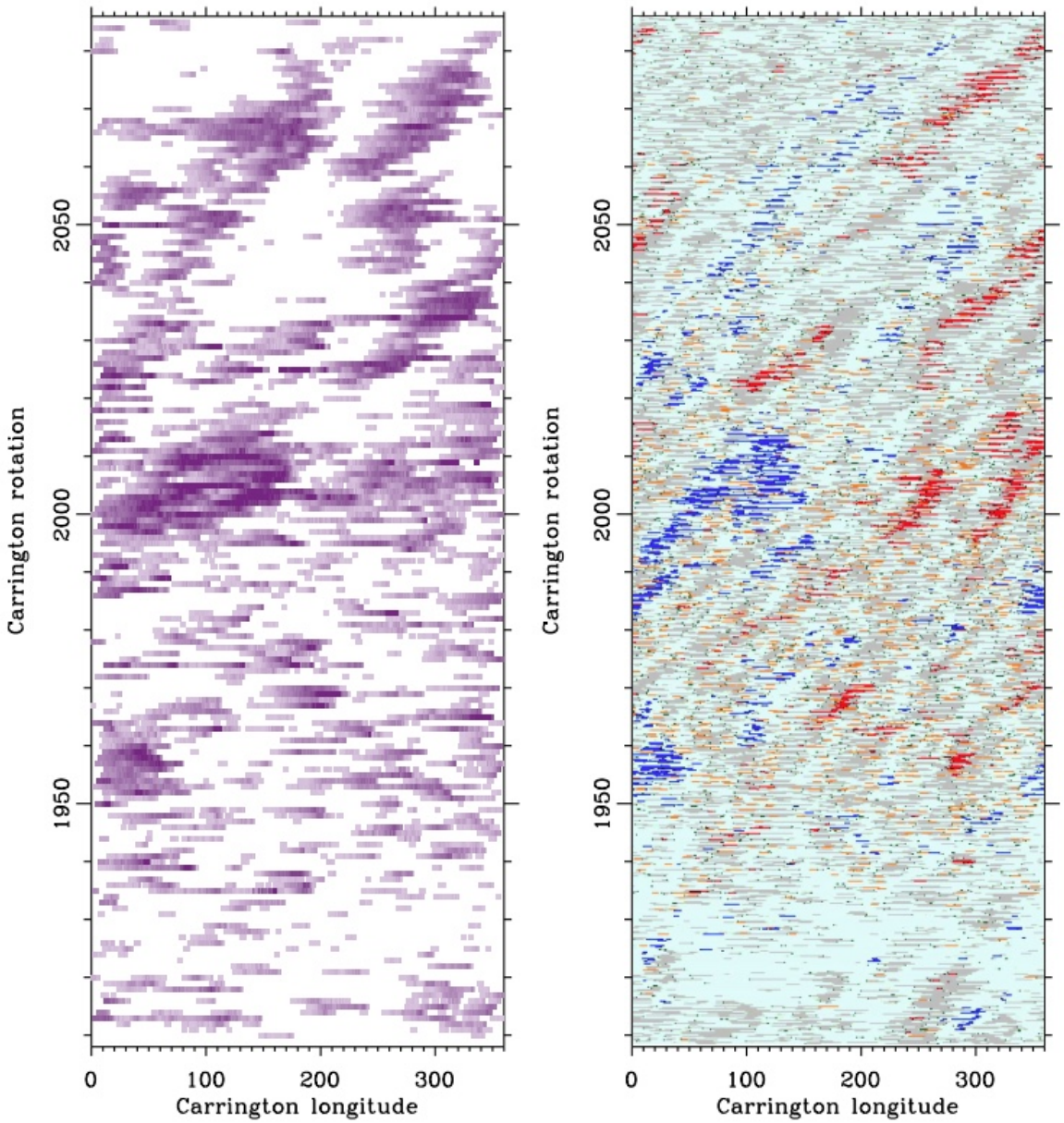


https://www2.hao.ucar.edu/mcintosh-archive/four-cycles-solar-synoptic-maps



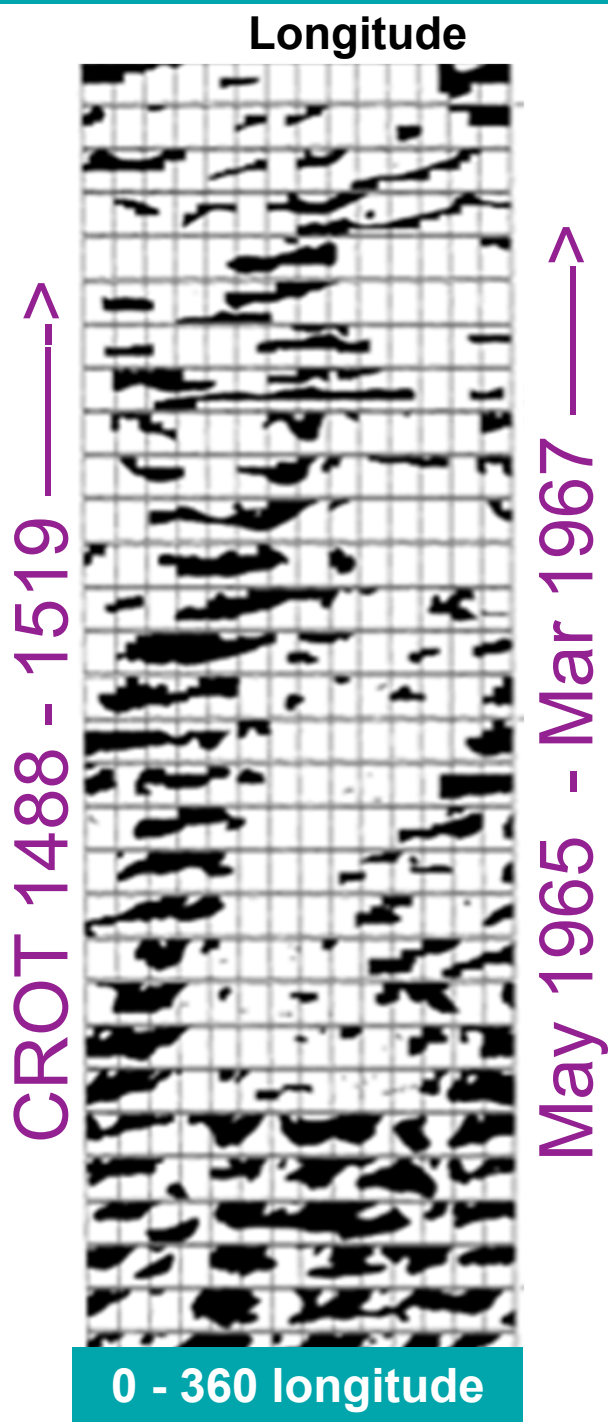
Search "McIntosh archive NOAA HAO"

Stack plots patterns: coronal holes → high-speed solar-wind streams

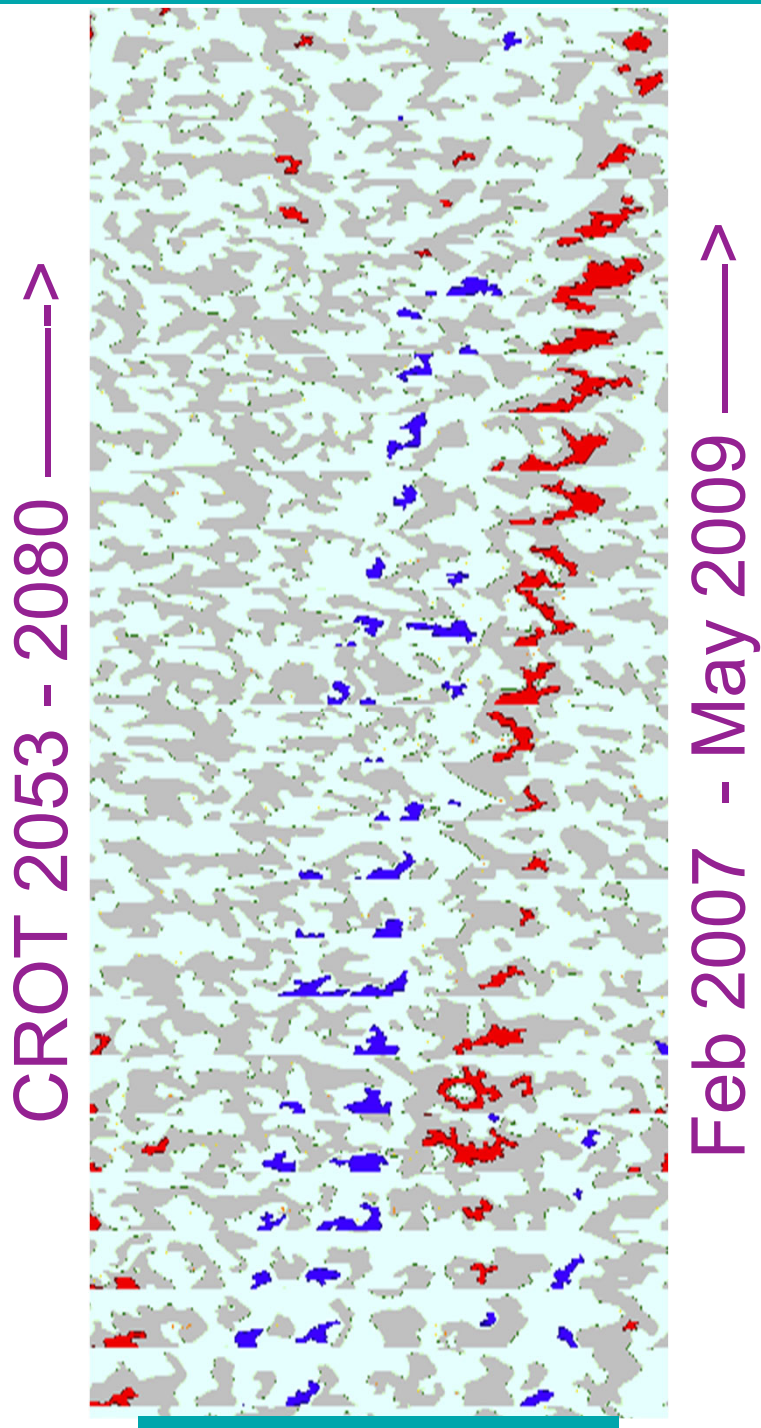


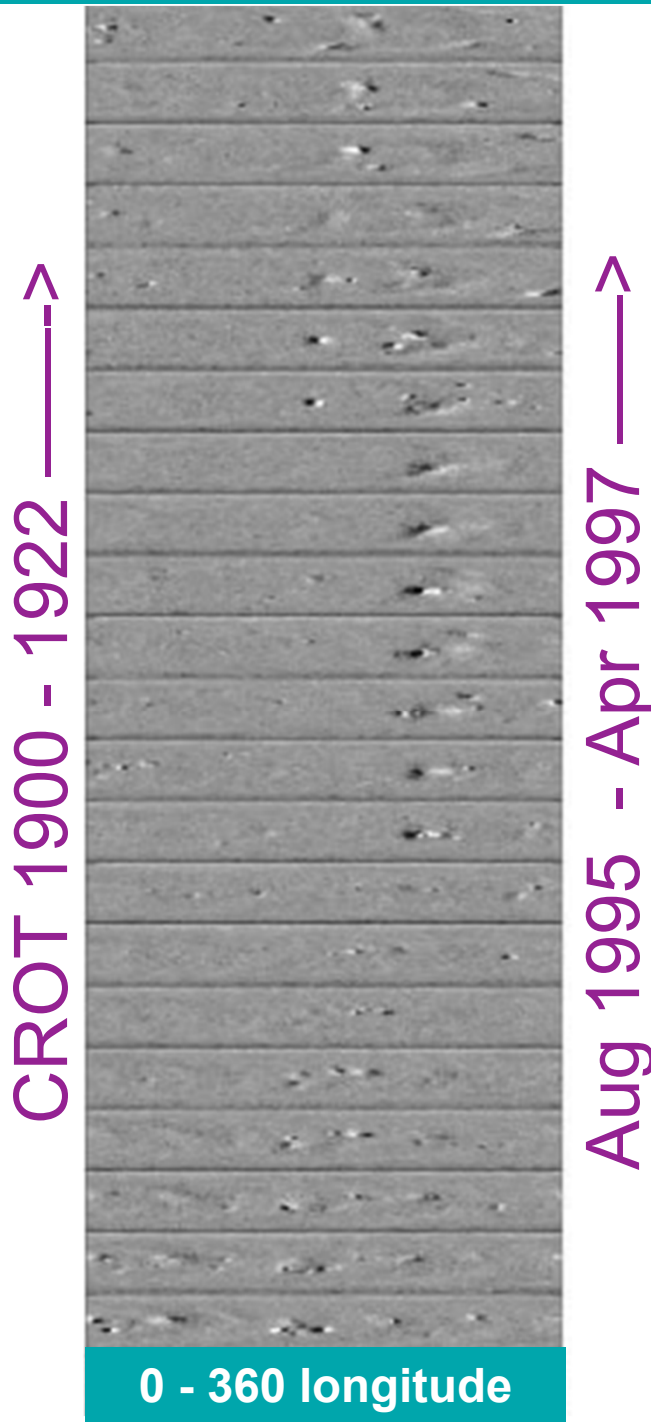
Cranmer et al. 2017

Stack plots: magnetic fields, coronal holes

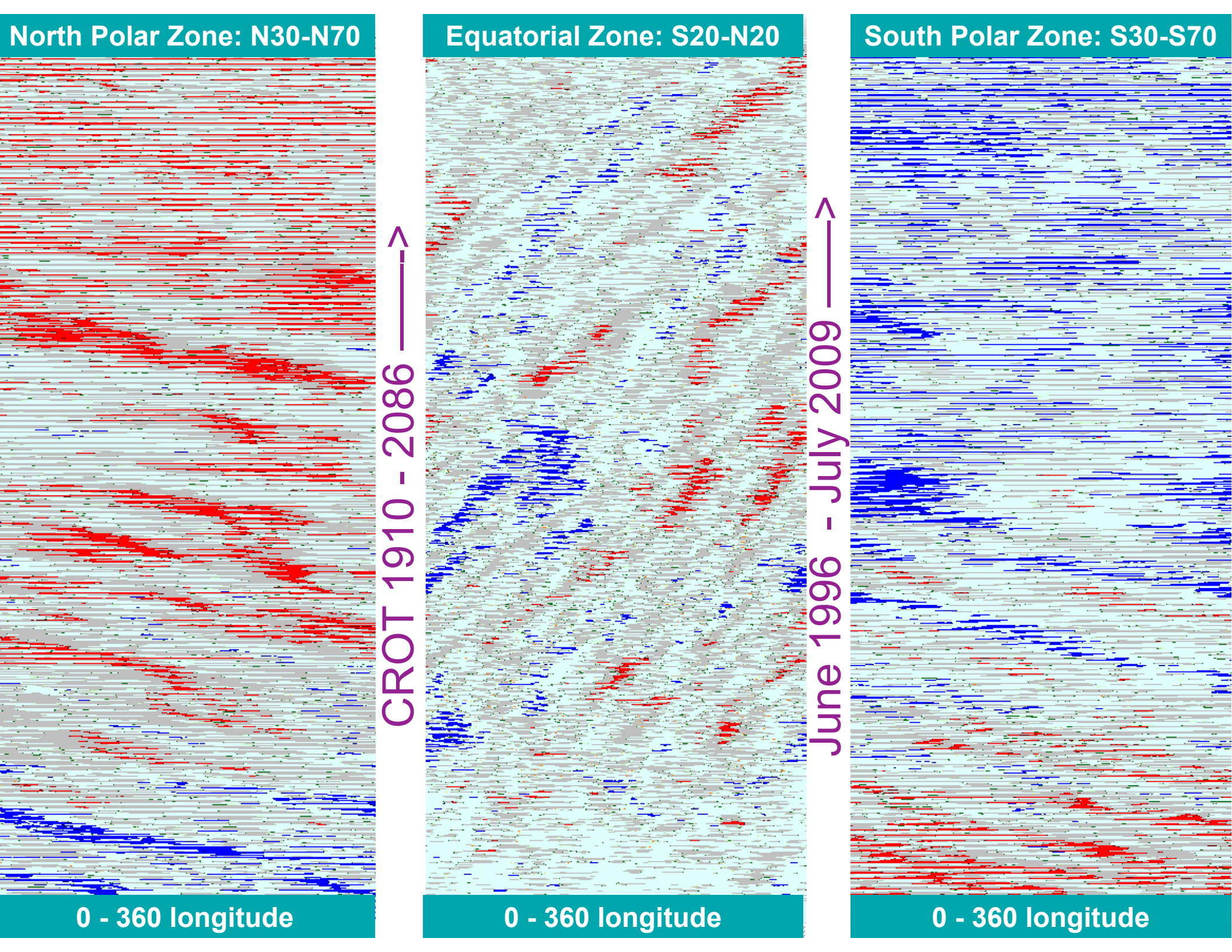


McIntosh & Wilson, 1985





de Toma et al. 2000


North Polar Zone: N30-N70
Equatorial Zone: S20-N20
South Polar Zone: S30-S70
CROT 1910 - 2086 ——>
June 1996 - July 2009 ——>
0 - 360 longitude
0 - 360 longitude
0 - 360 longitude