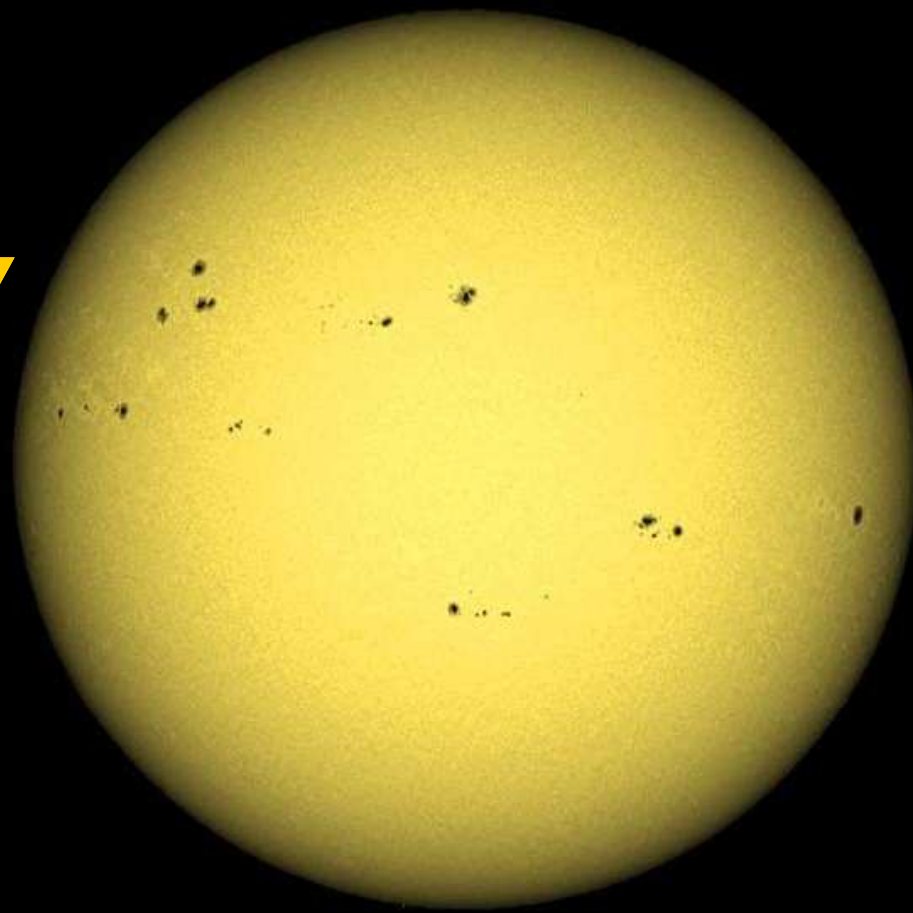


Solar activity



Erika Pakštienė

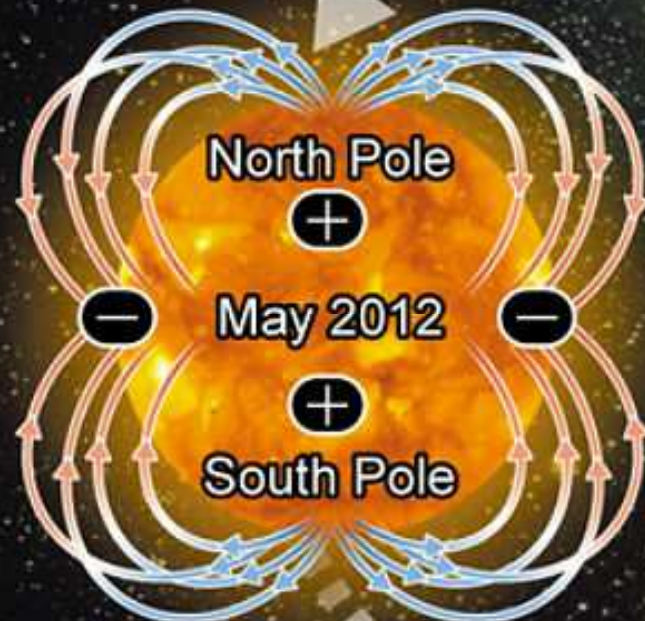
Vilnius University

Institute of Theoretical physics and Astronomy

Changes in sun's magnetic poles

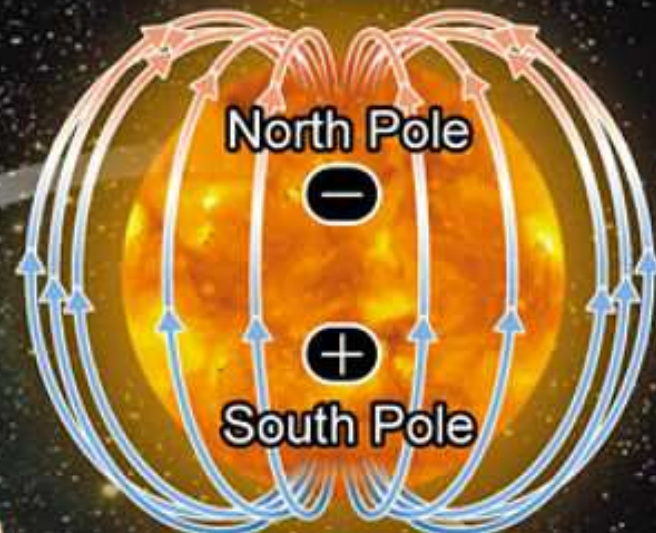
This time (2008-2012)

Only North Pole flips

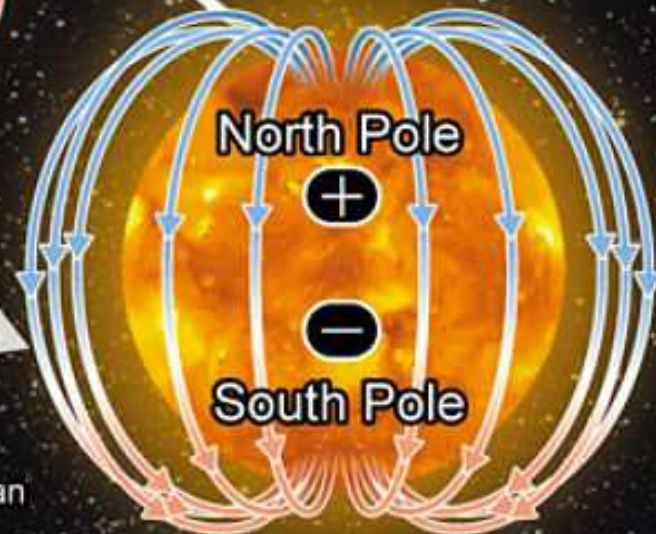


Four polar structure

Possible switching of South Pole's magnetic sign

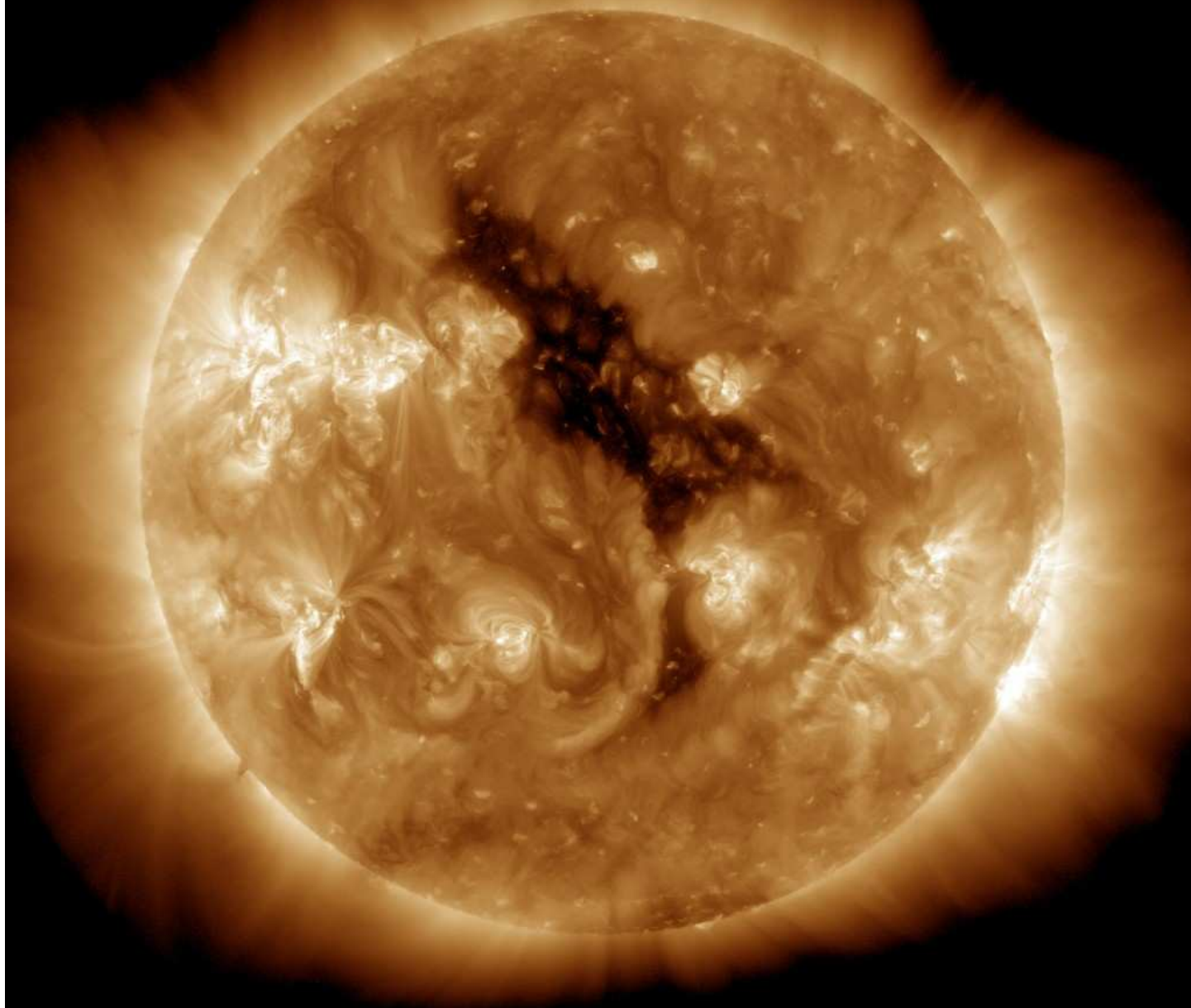


Flipping in cycles of about 11 years



Graphic provided by
National Astronomical Observatory of Japan
The Asahi Shimbun

Hole in corona, 2012-06-03



SDO/AIA 193 2012-06-03 17:45:08 UT

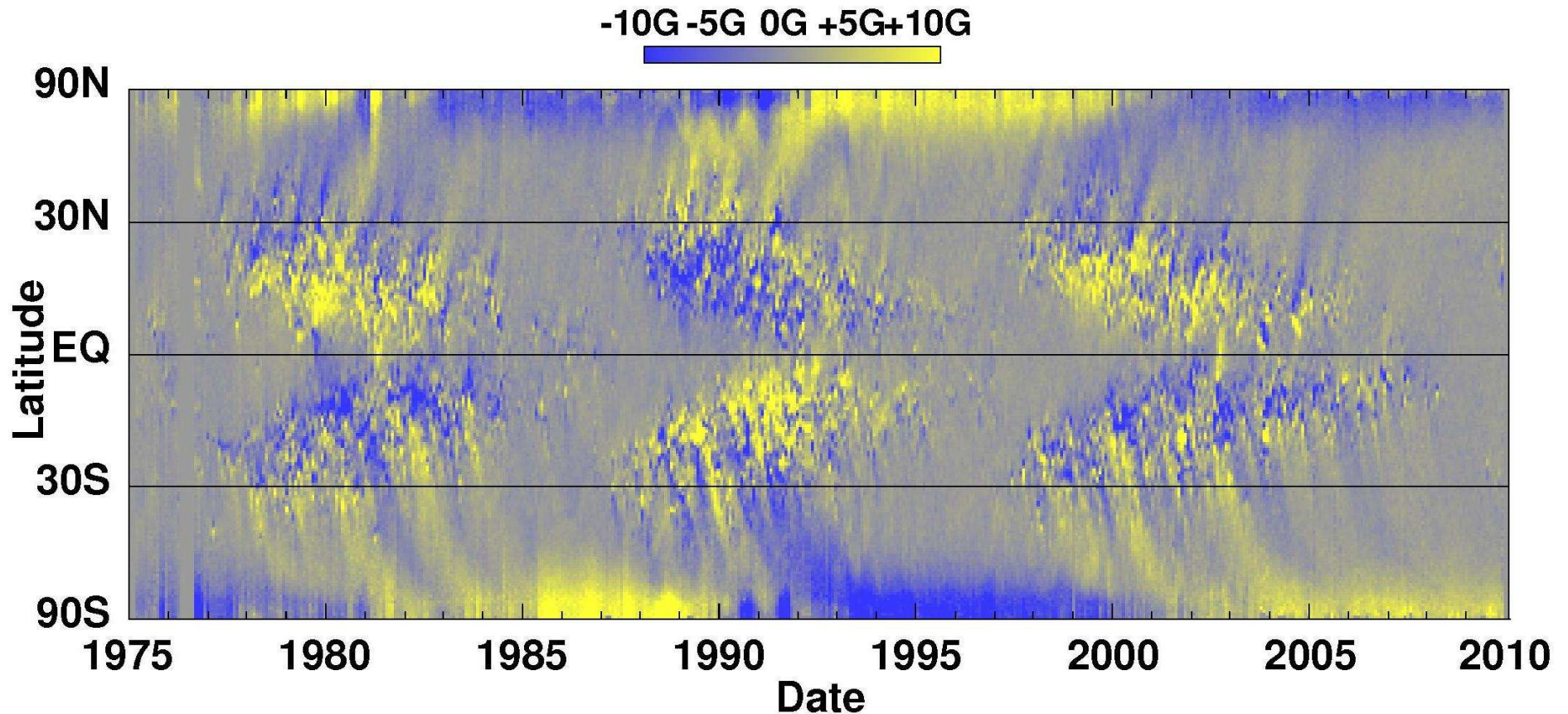
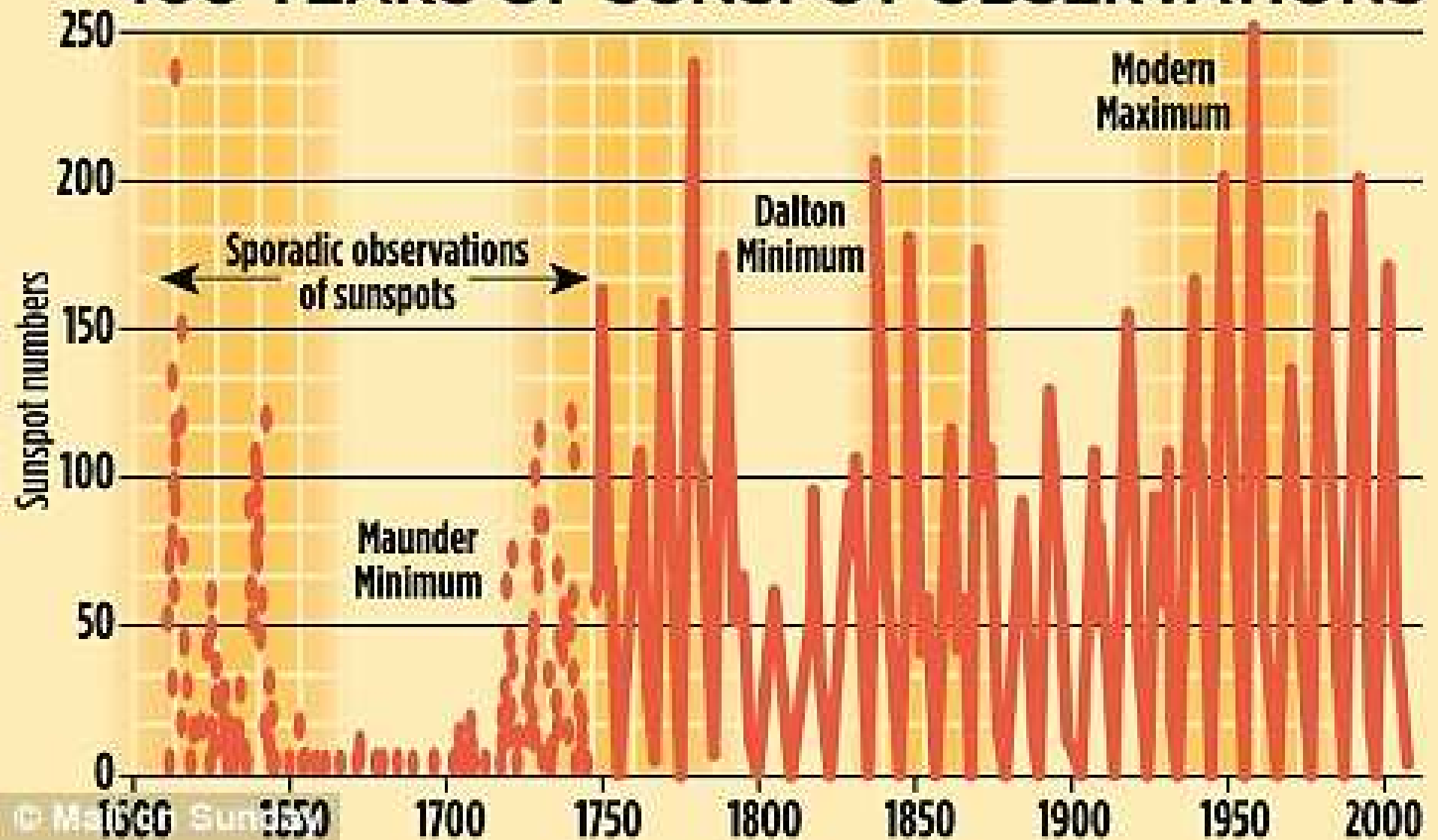
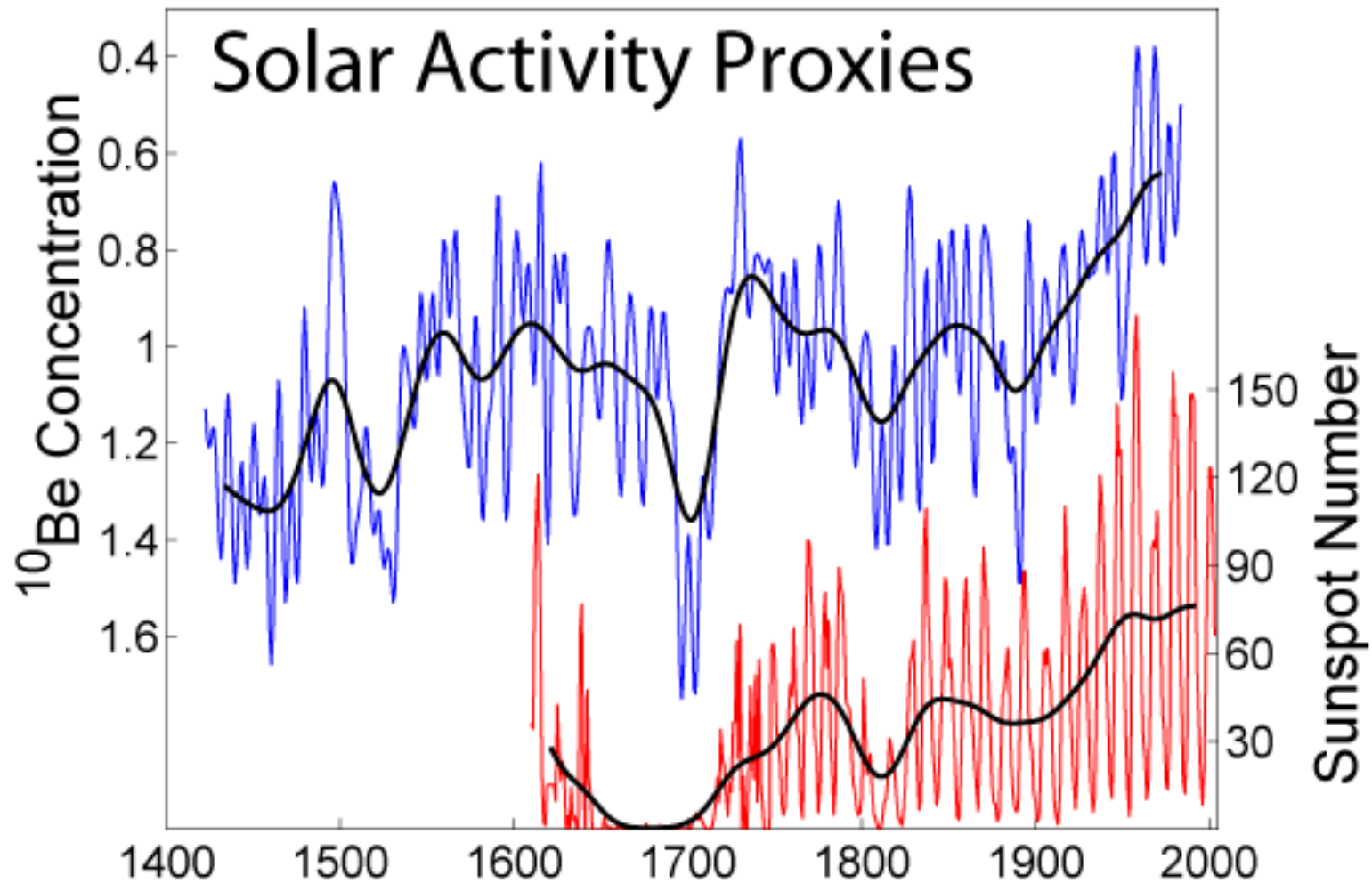


Diagram of the distribution of the sun's magnetic field over three 11-year solar cycles. Yellow represents magnetic field directed out of the sun. Blue represents magnetic field into the sun. Sunspots themselves produce the "Butterfly" pattern at low latitudes. The sun's meridional flow from the equator to the poles in each hemisphere carries magnetic remains of the sunspots to the poles. This produces the streaks seen at higher latitudes and reverses the magnetic polarity of the sun's poles every 11 years.

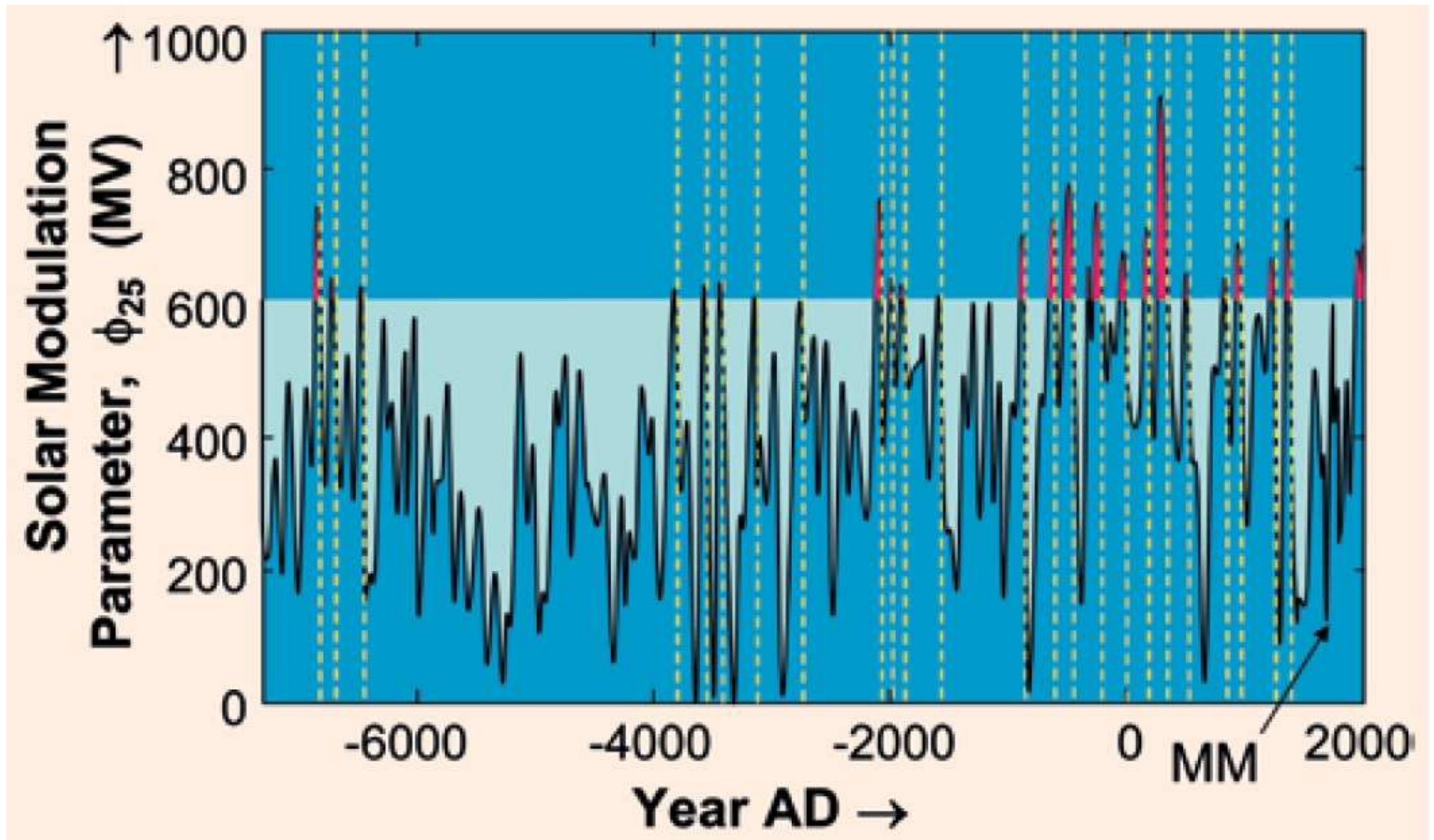
Image credit: NASA/MSFC/David Hathaway

400 YEARS OF SUNSPOT OBSERVATIONS





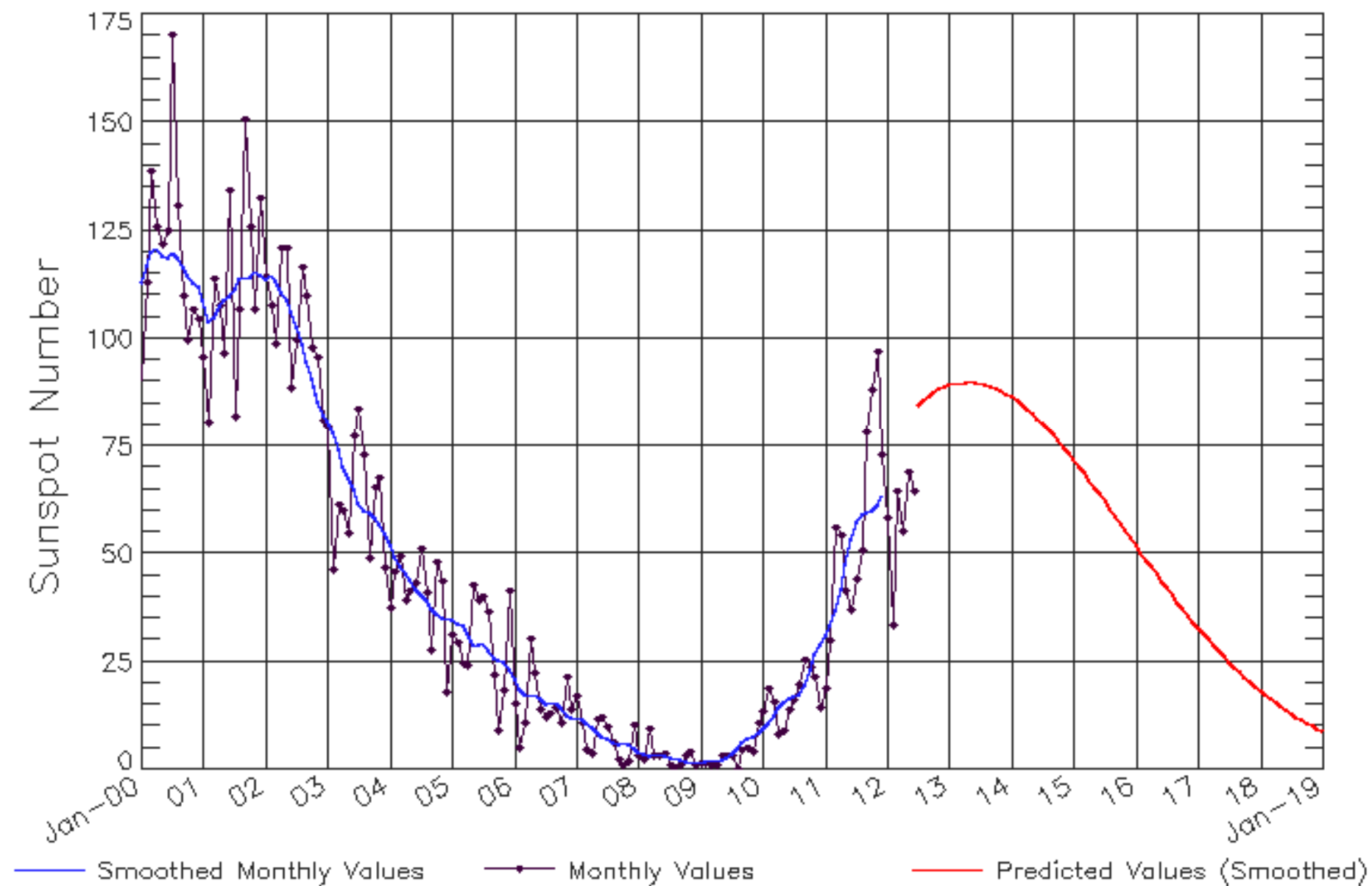
Cosmogenic isotopes such as ^{14}C and ^{10}Be , produced by the bombardment of Earth's atmosphere by galactic cosmic rays (GCRs), are subsequently stored in terrestrial reservoirs such as tree trunks and ice sheets.

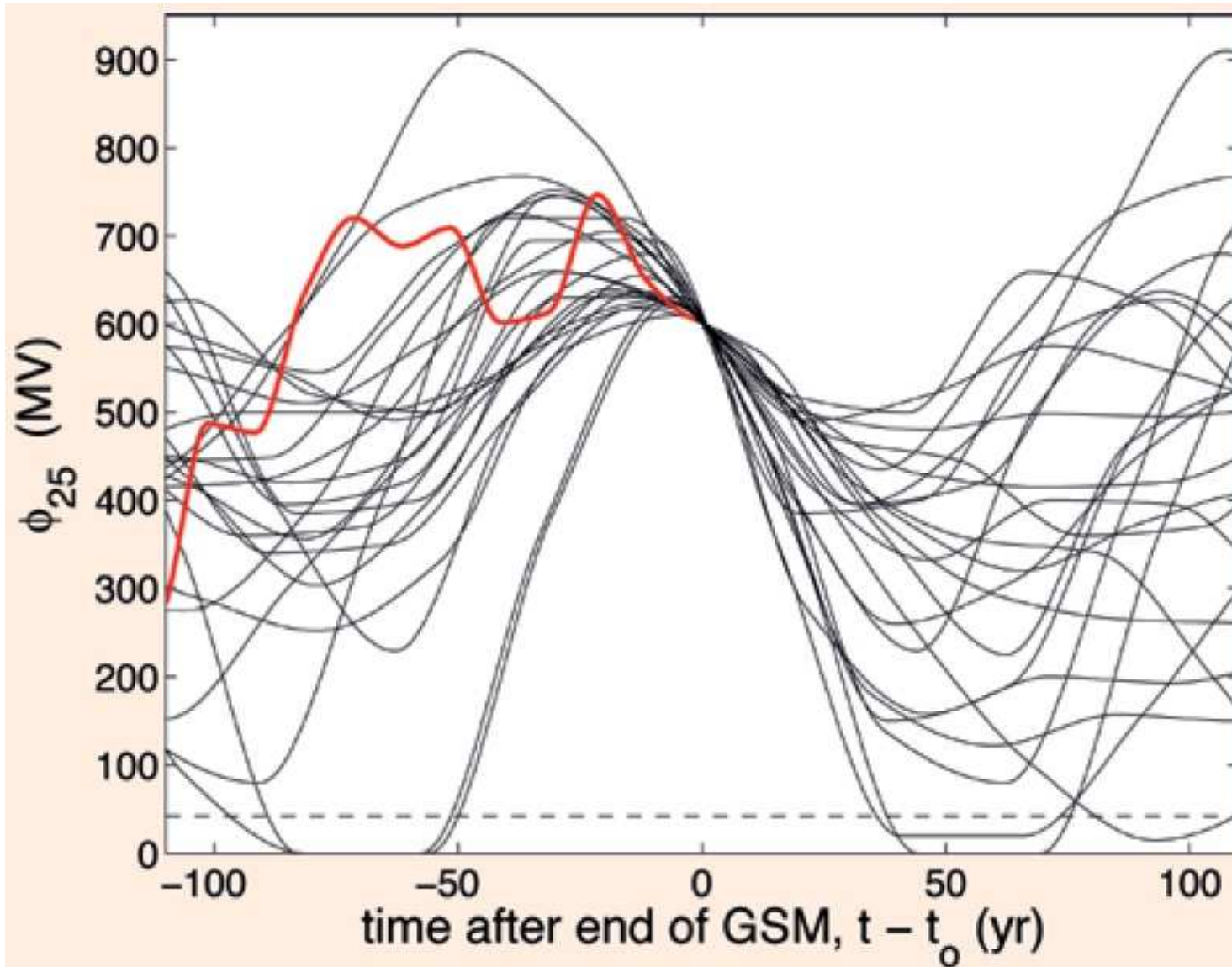


The composite of 25-year means of the heliospheric modulation parameter, ϕ_{25} , derived from ^{10}Be abundances in ice cores and modern neutron monitor data by Steinhilber *et al.* (2008). ϕ quantifies the shielding from galactic cosmic rays of the Earth by the Sun. The red areas are grand solar maxima (GSMs), defined to be when ϕ_{25} exceeds the current value. The yellow lines mark the ends of the 24 such GSMs detected in the 9300-year record. MM is the Maunder Minimum.

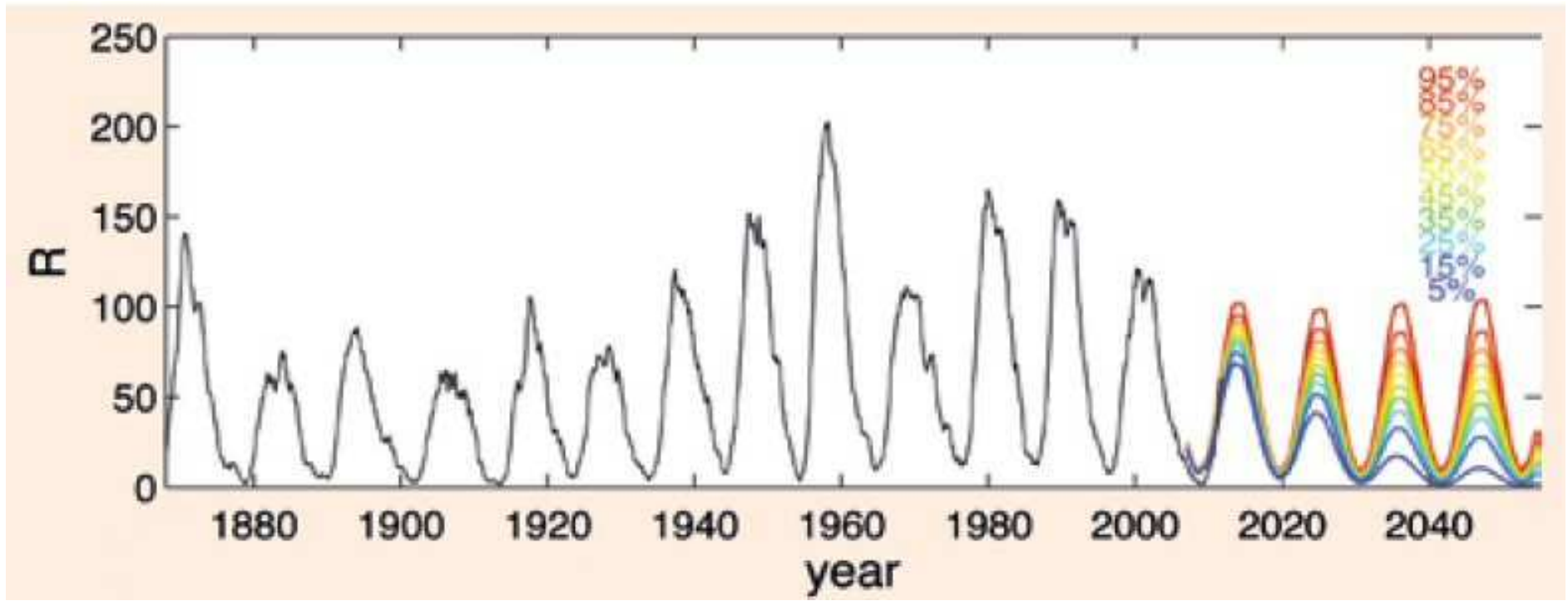
ISES Solar Cycle Sunspot Number Progression

Observed data through Jun 2012





Composite of the variation in ϕ_{25} around the ends of the. *The red curve is the variation for the recent GSM, updated to the present day with neutron monitor data, and shows the recent decline began in 1985. The horizontal dashed line is the level in the Maunder Minimum. (Lockwood 2012)*

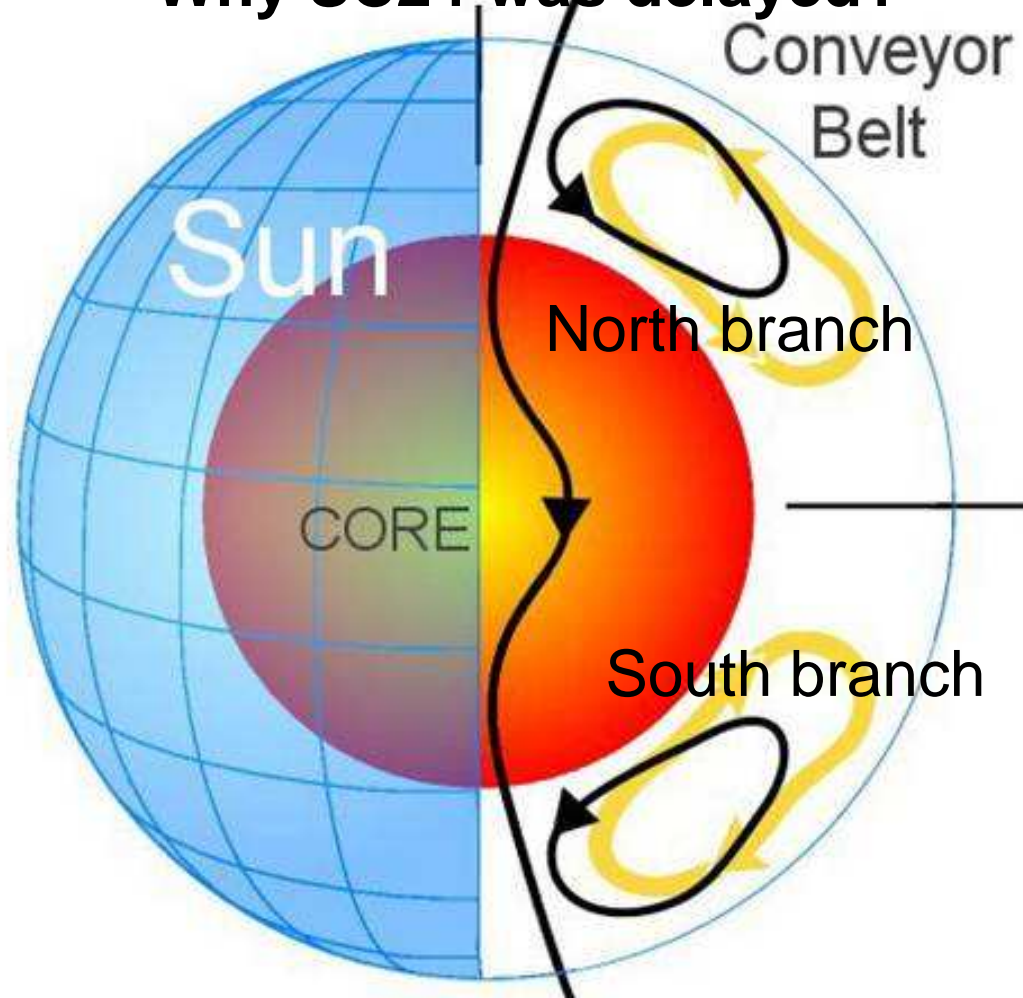


Observed past and predicted future variations of sunspot number, R . The black lines are monthly averages of observations (a 12-month running mean smooth has been applied). The red-to-blue lines show predicted variations of annual means at various probabilities, made from the 9300-year cosmogenic isotope composite by Steinhilber *et al.* (2008) using the procedure developed by Lockwood (2010) and Barnard *et al.* (2011). Red is for $P[<R] = 0.95$, blue for $P[<R] = 0.05$.

There is only a 5% probability of cycles maintaining an amplitude as large as SC23,
and there is a 5% probability of reaching Maunder Minimum levels within 40 years.

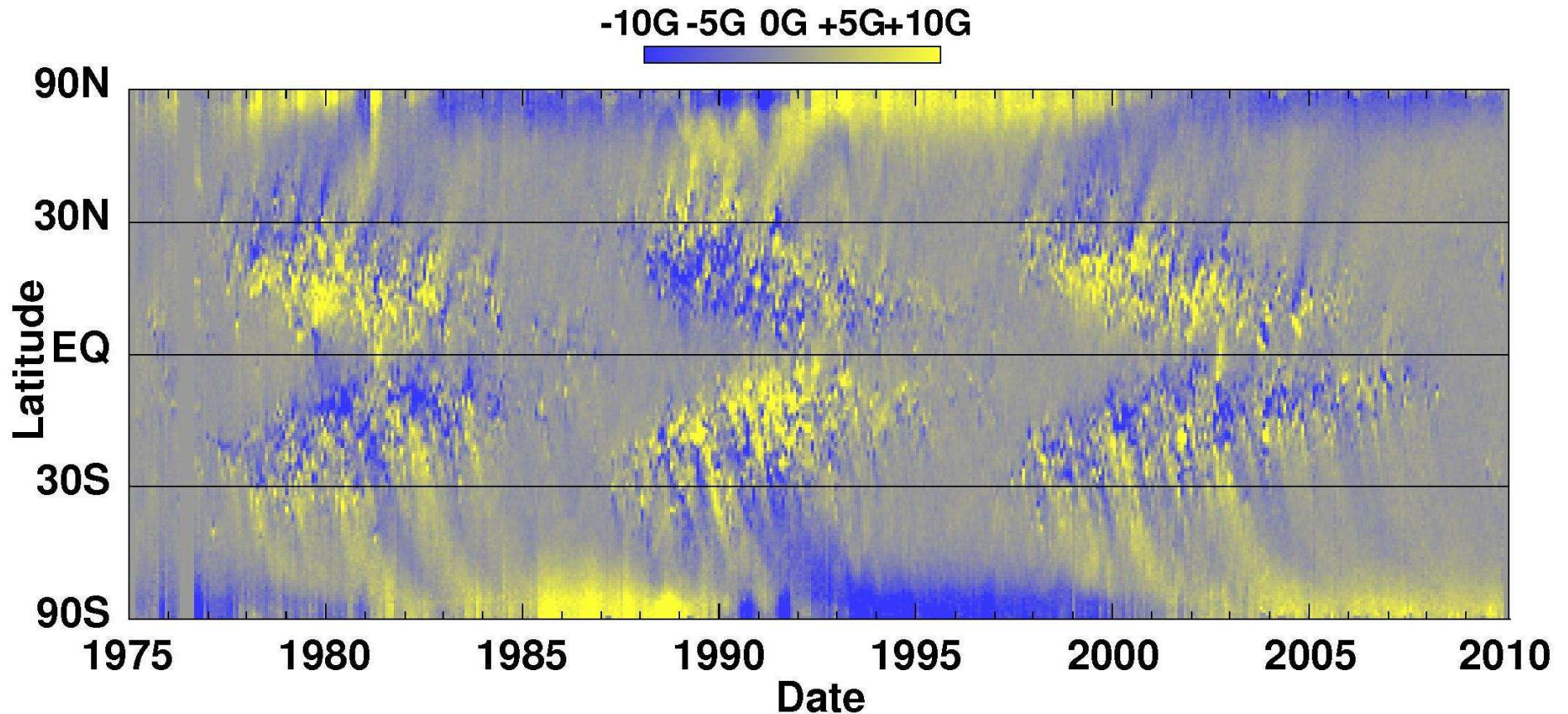
The most likely evolution is roughly midway between these two extremes.

Why SC24 was delayed?



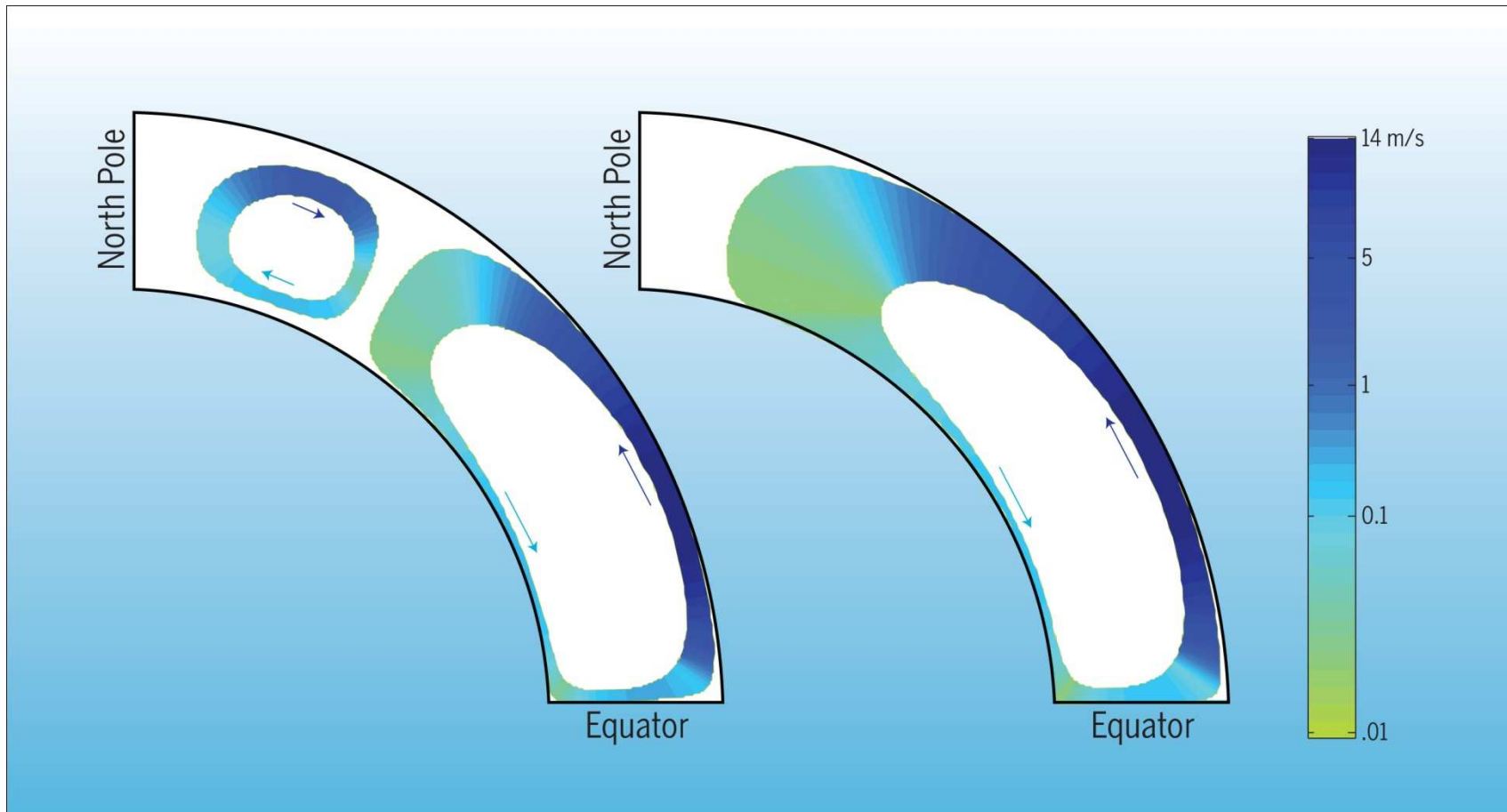
Great Conveyor Belt is a massive circulating current of hot plasma within the sun. It takes about 40 years to complete one circuit.

A new computer model that gets the physics right for all three aspects of this process: the magnetic dynamo, the conveyor belt, and the buoyant evolution of sunspot magnetic fields.



The sun's meridional flow from the equator to the poles in each hemisphere carries magnetic remains of the sunspots to the poles. This produces the streaks seen at higher latitudes and reverses the magnetic polarity of the sun's poles every 11 years.

Image credit: NASA/MSFC/David Hathaway

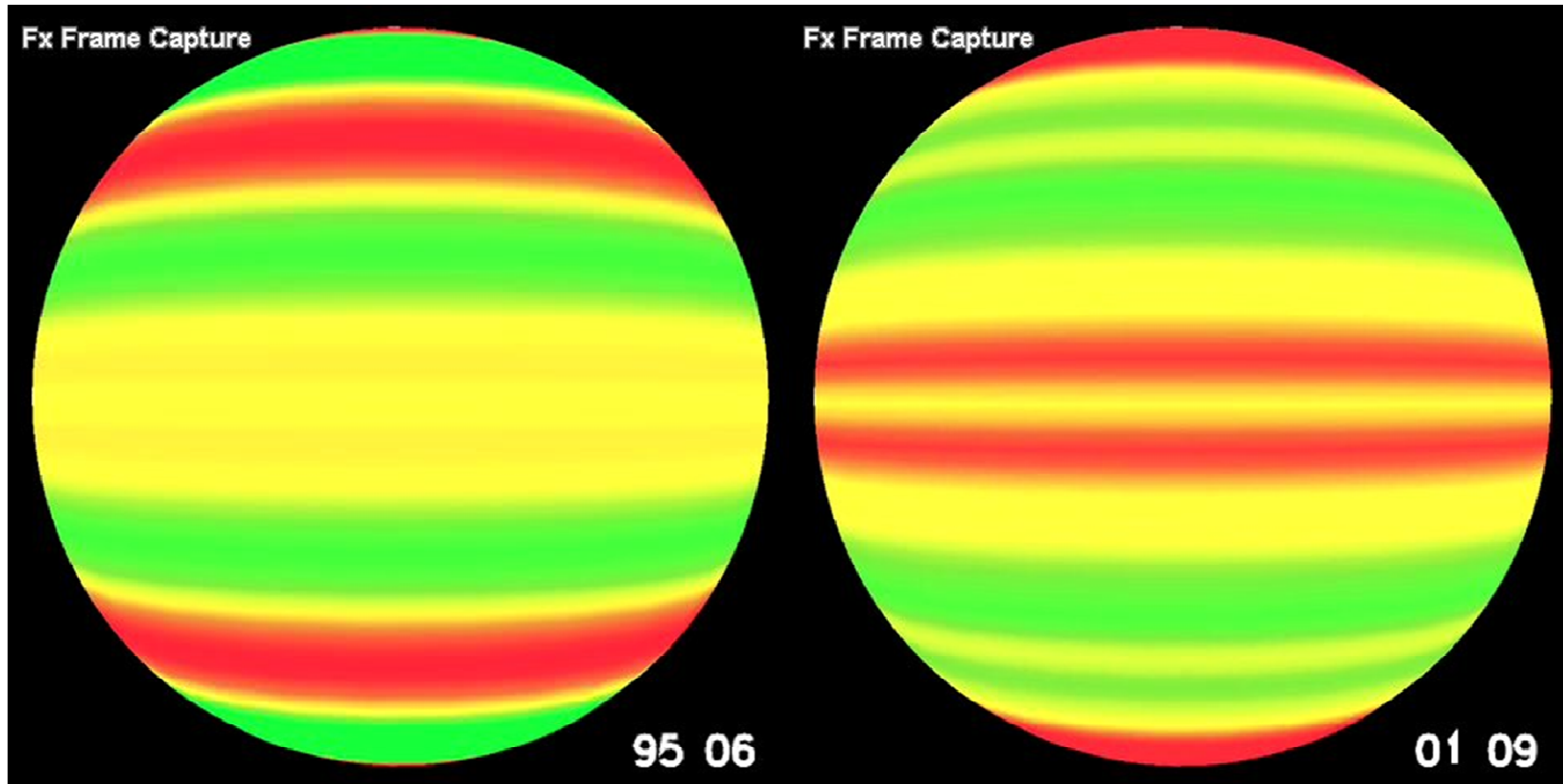


The increased length of the conveyor and its slower rate of return flow explained the prolonged 23rd cycle.

In the late **1990s** the conveyor belt **sped up**. When the remains of old sunspots reached the dynamo, they rode the belt through the amplification zone too hastily for full re-animation. Sunspot production was stunted.

In the **2000s** the Conveyor Belt **slowed down** again, allowing magnetic fields to spend more time in the amplification zone, but the damage was already done, SC24th delayed.

Will SC25 start?

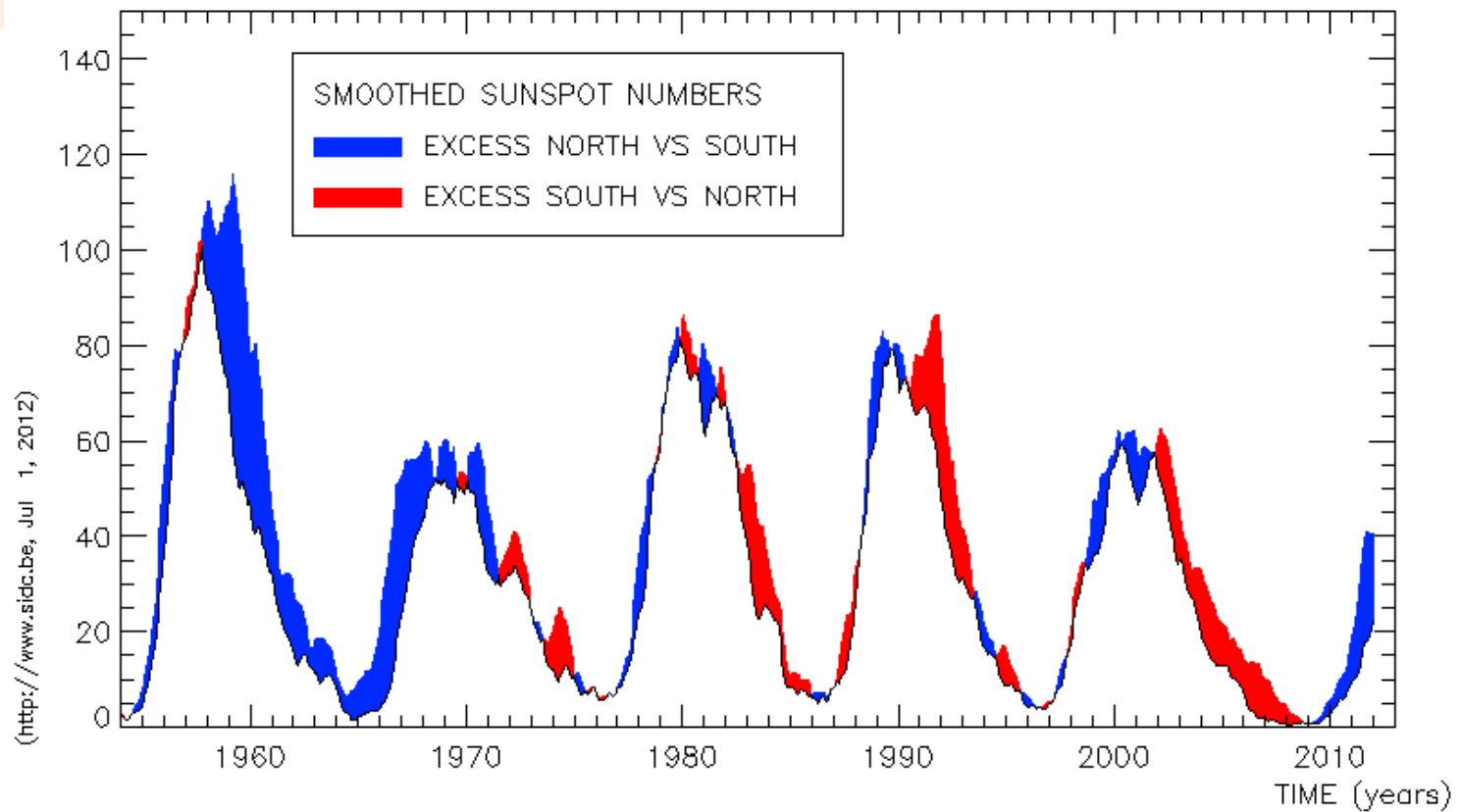
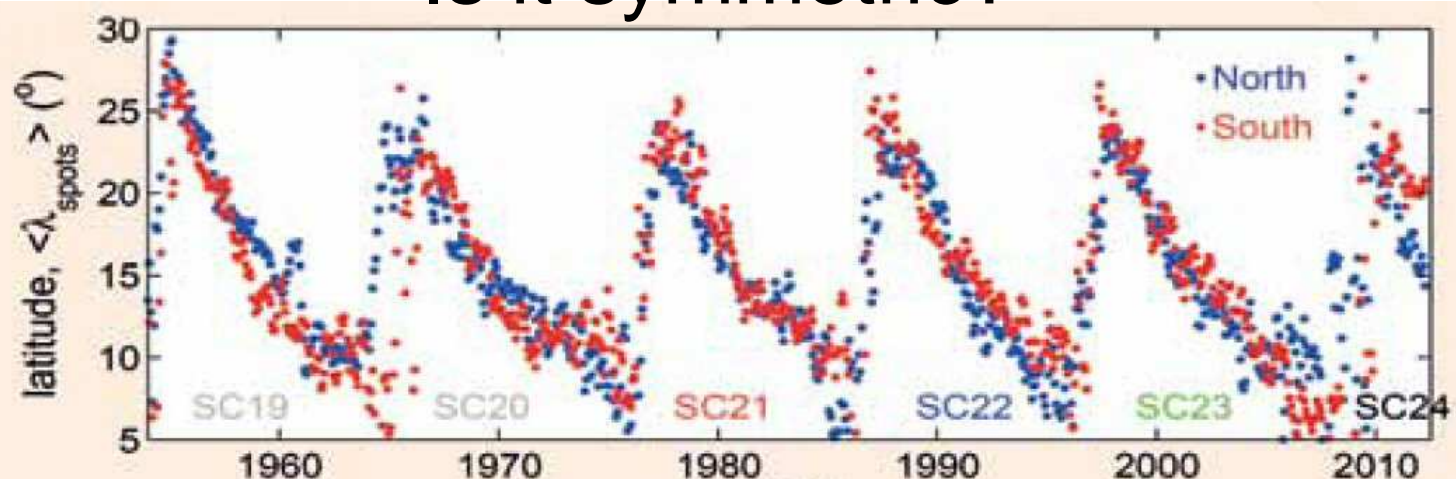


Jet streams or torsional oscillations.

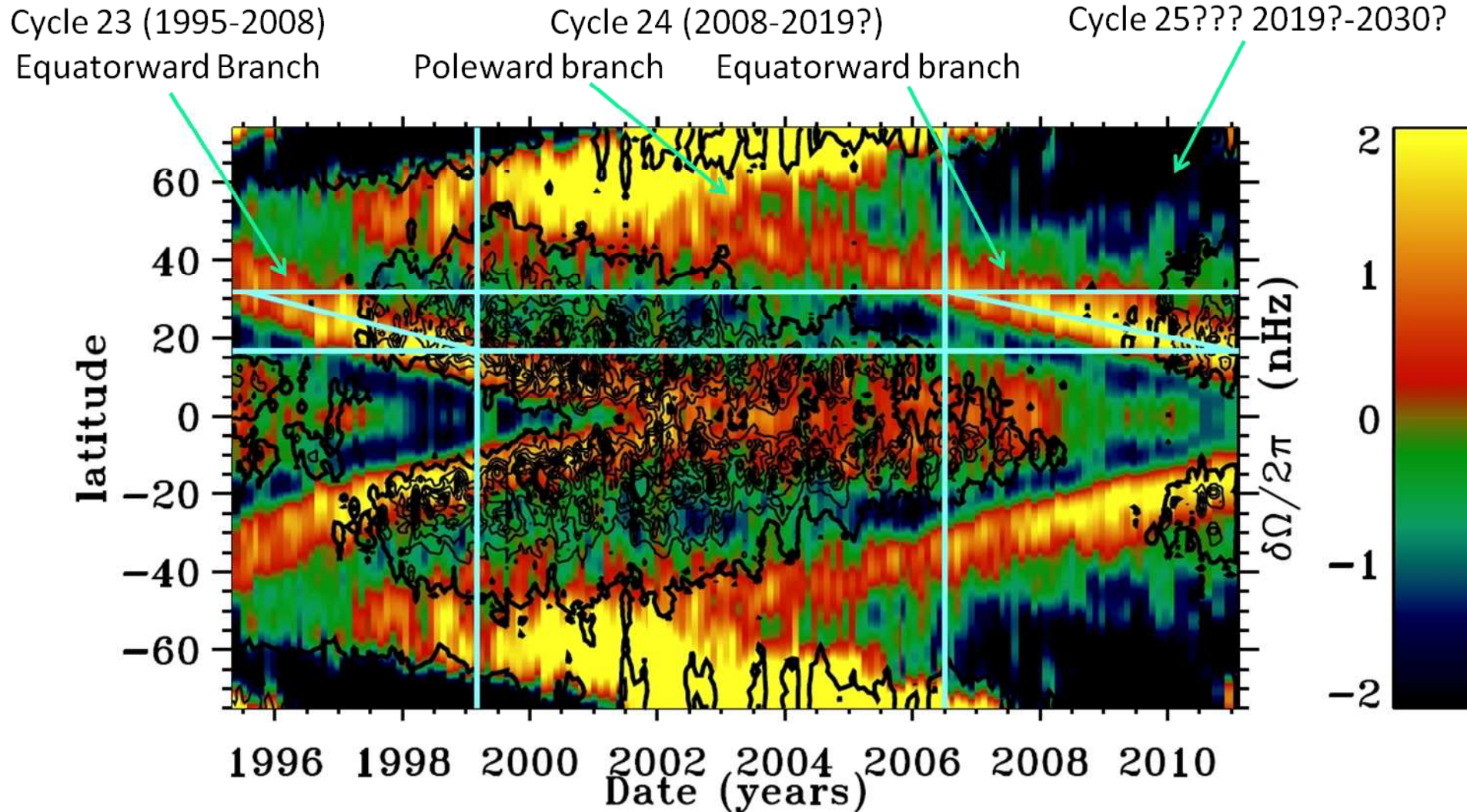
Zonal (west-east) "jet streams" rotate at a high speed around the sun. They initially form at the mid-latitudes during the solar minimum.

Then the "jet streams" migrate towards the equator and poles as the cycle progresses to the solar maximum. Sunspots appear when it reach 22° .

Is it symmetric?



Here is no sign yet that SC25 will start.



- Number of sunspots and prognosis of geomagnetic storms (every day updates): Spaceweather.com
- Webcam in north of Sweden to watch auroras in real time: Auroraskystation.se
- Photos of the sun in different wavelengths: umbra.nascom.nasa.gov/images/latest.html



Thank you!