Solar Influences
on the Magnetosphere, Ionosphere and Atmosphere
Sunny Beach, Bulgaria, 26-30 May 2014

Variability of solar cycles and solar dynamo with fluctuations of the dynamo governing parameters

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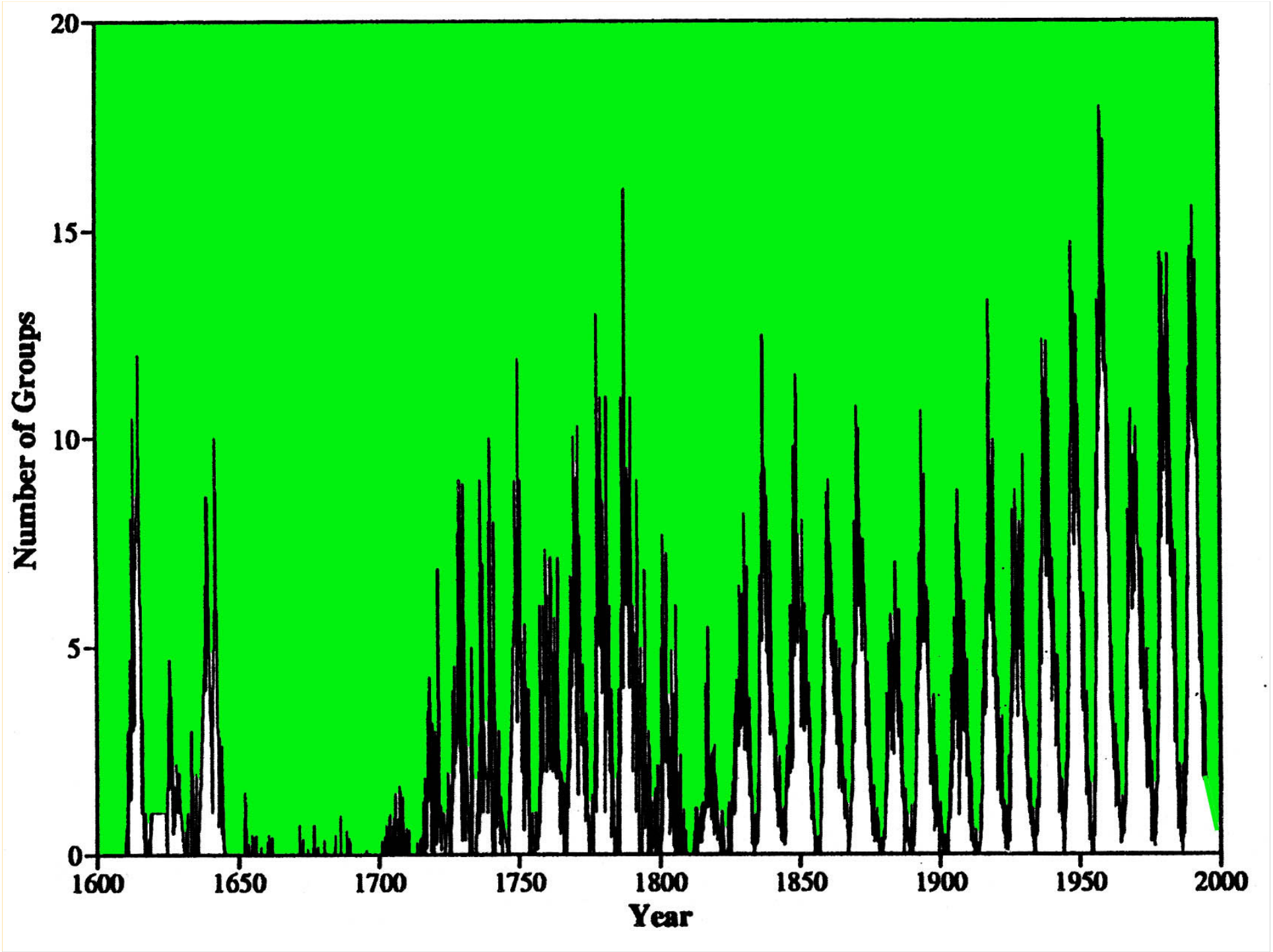
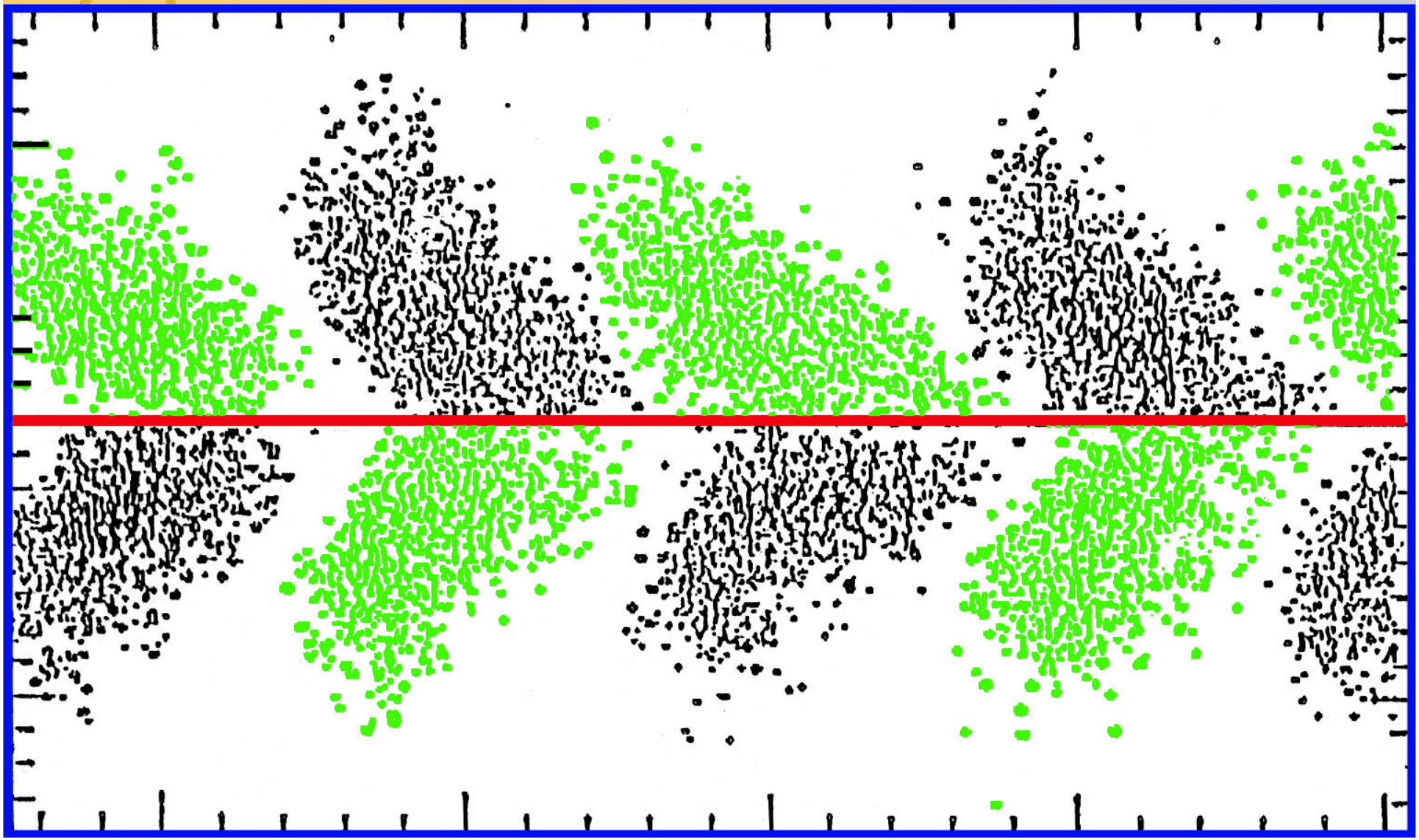
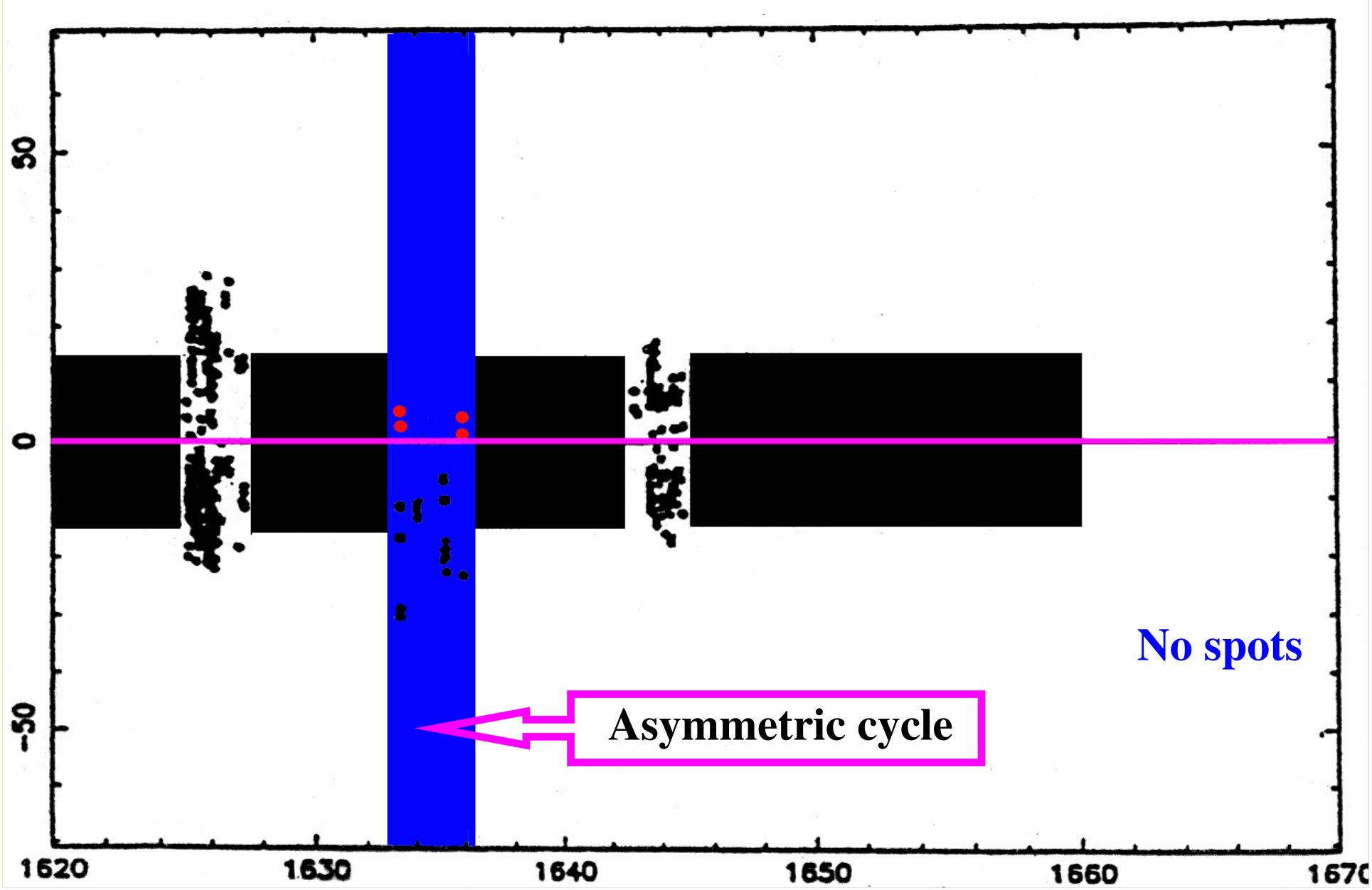

20
15
10
5
0
Number of Groups
1600
1650
1700
1750
1800
1850
1900
1950
2000
Year

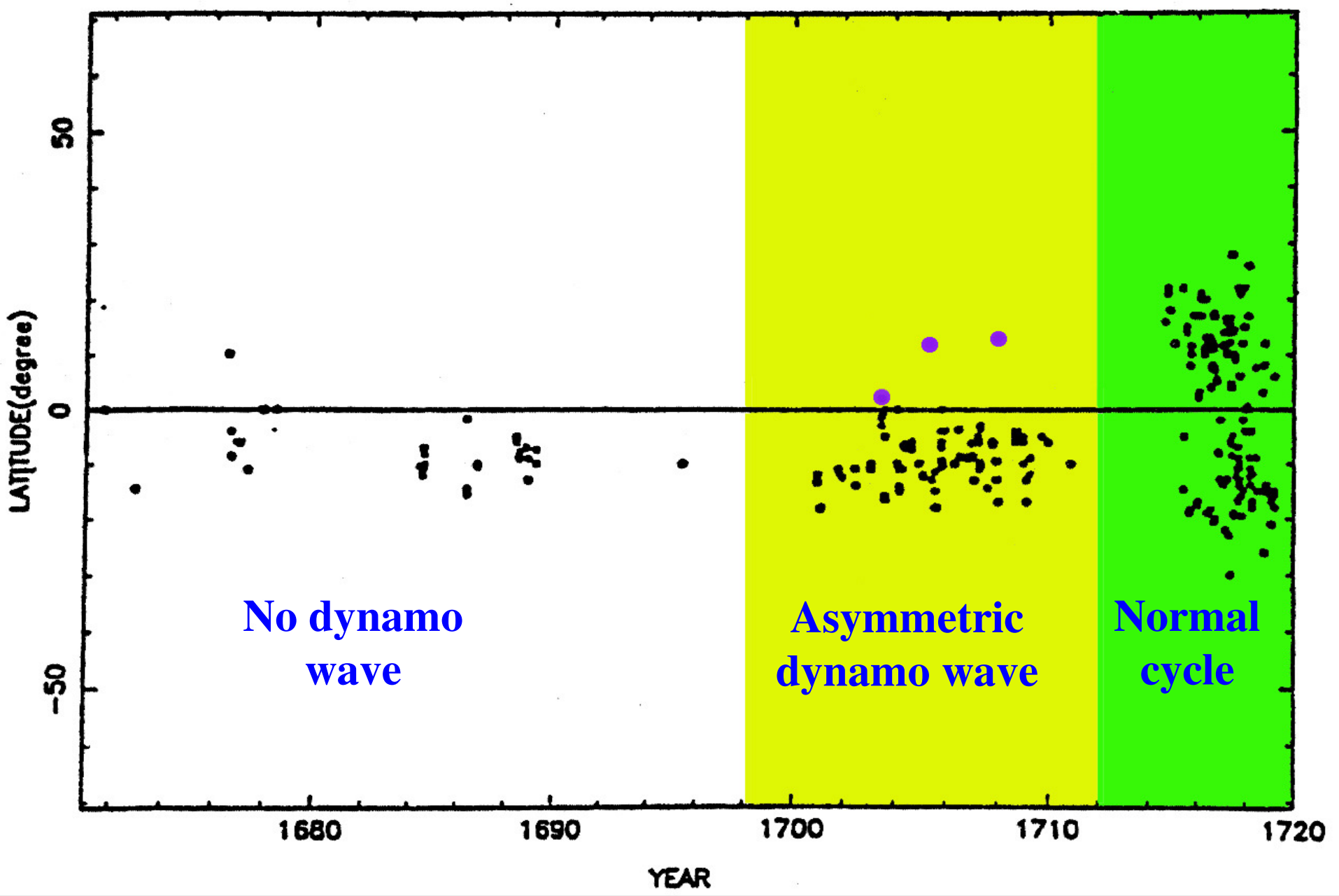
Normal cycle



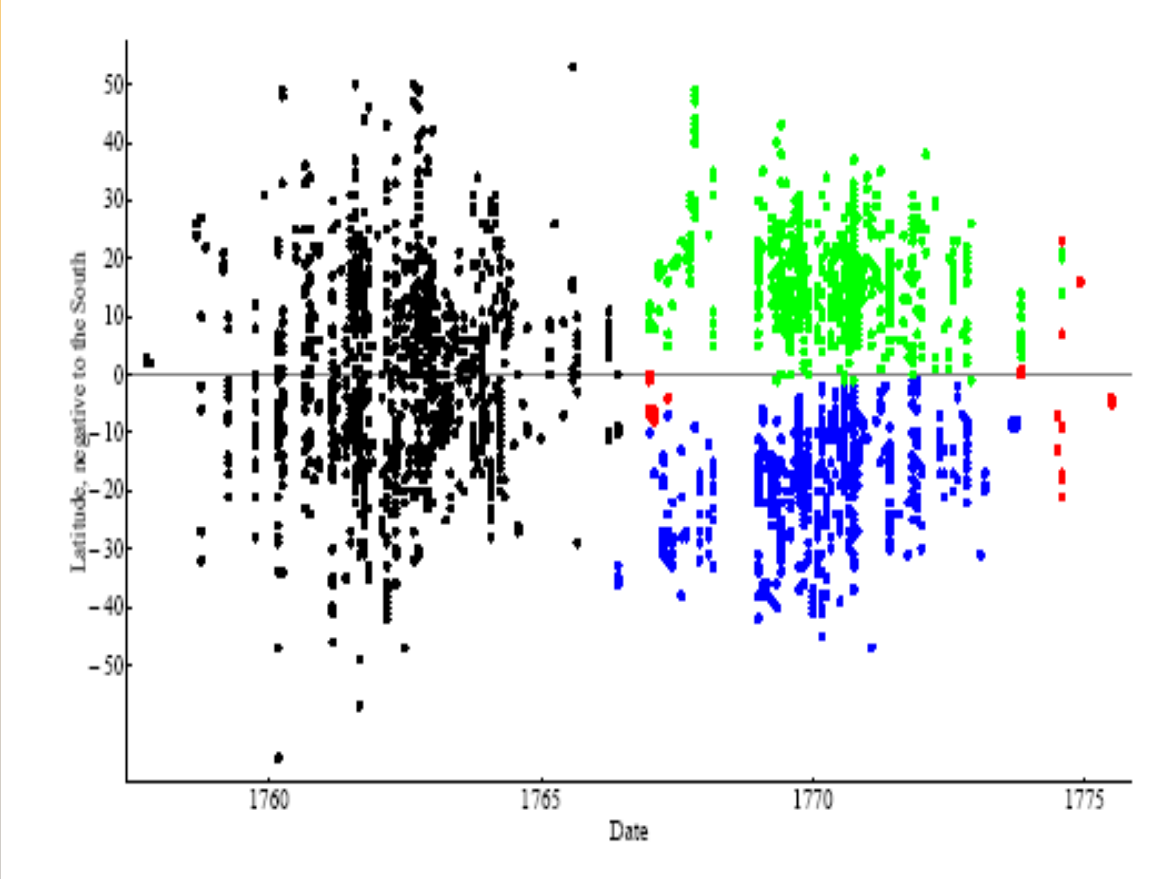
Beginning of the Maunder minimum

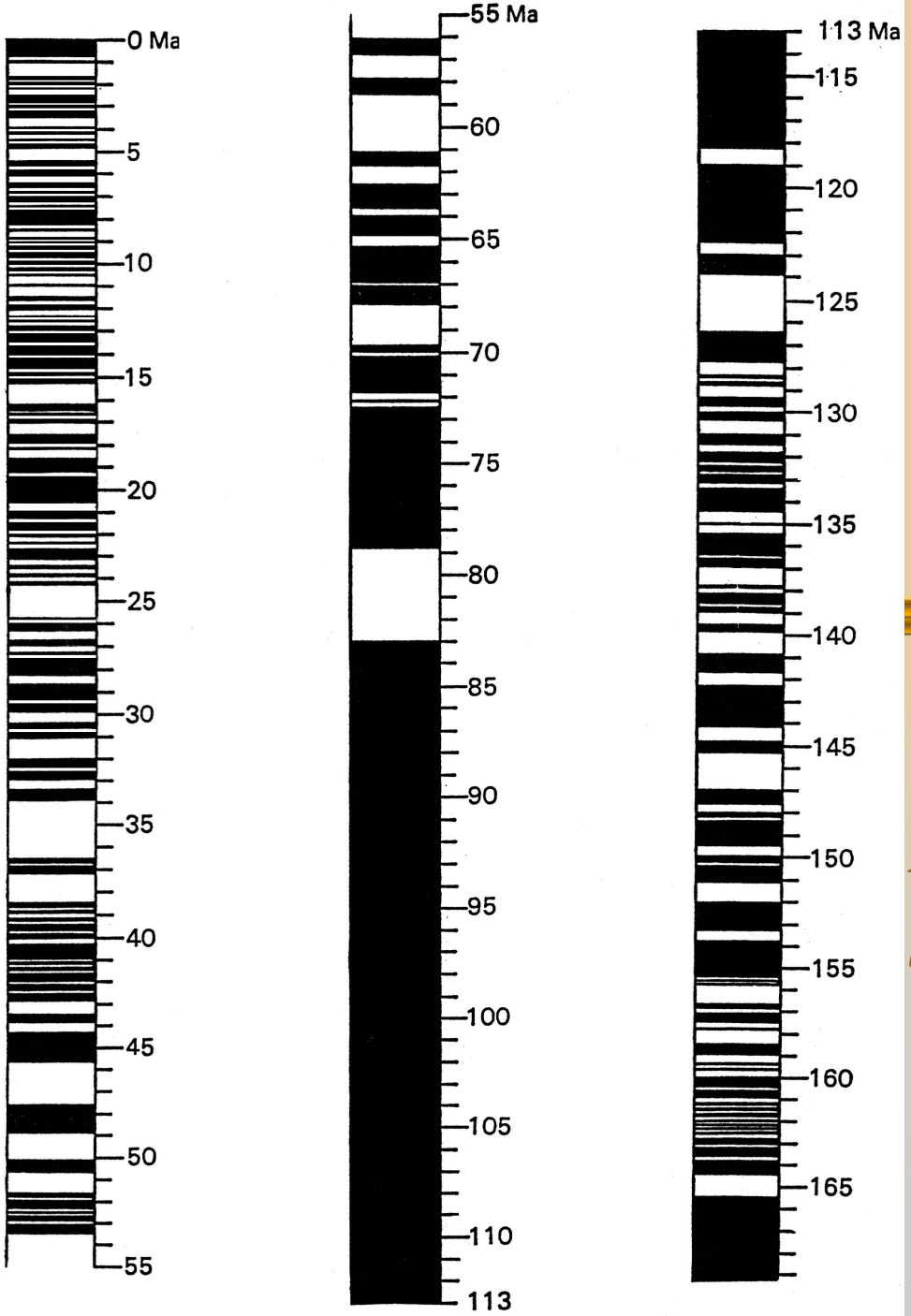


End of the Maunder Minimum



Solar Cycle in XVIII cent.





Magnetostrophic timescale

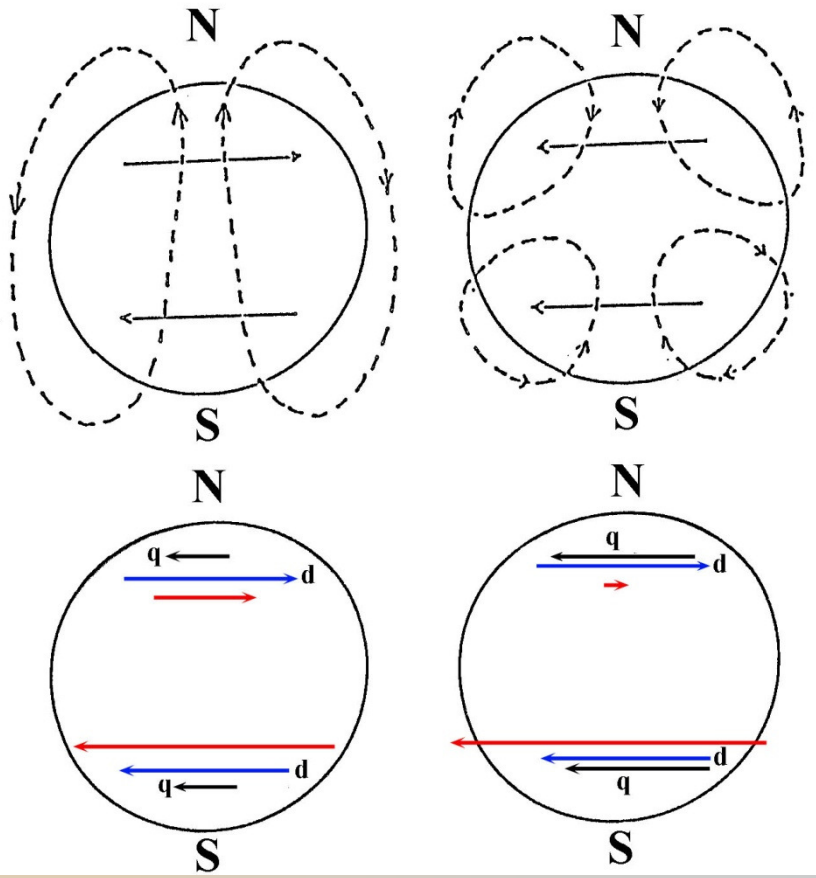
Parker Dynamo

$$B_P \xrightarrow{\Omega} B_T$$

Differential rotation

$$B_T \xrightarrow{\alpha} B_P$$

Mirror asymmetry



Fluctuations of governing parameters.
Alpha is weak and fluctuations are stronger (up to 20%)

Suggested by Hoyng in 90th

Novelty: long-term fluctuations

α-effect

$$\alpha = \frac{\tau < v \ \mathrm{rot} \ v >}{3}$$

$$E = \alpha B$$

An estimate for fluctuations

- $N=10^4 \quad N^{-1/2}=0.01$
- Alpha = 0.1v
- Alpha fluctuations are about 10%
- Diffusion Fluctuations about 1%

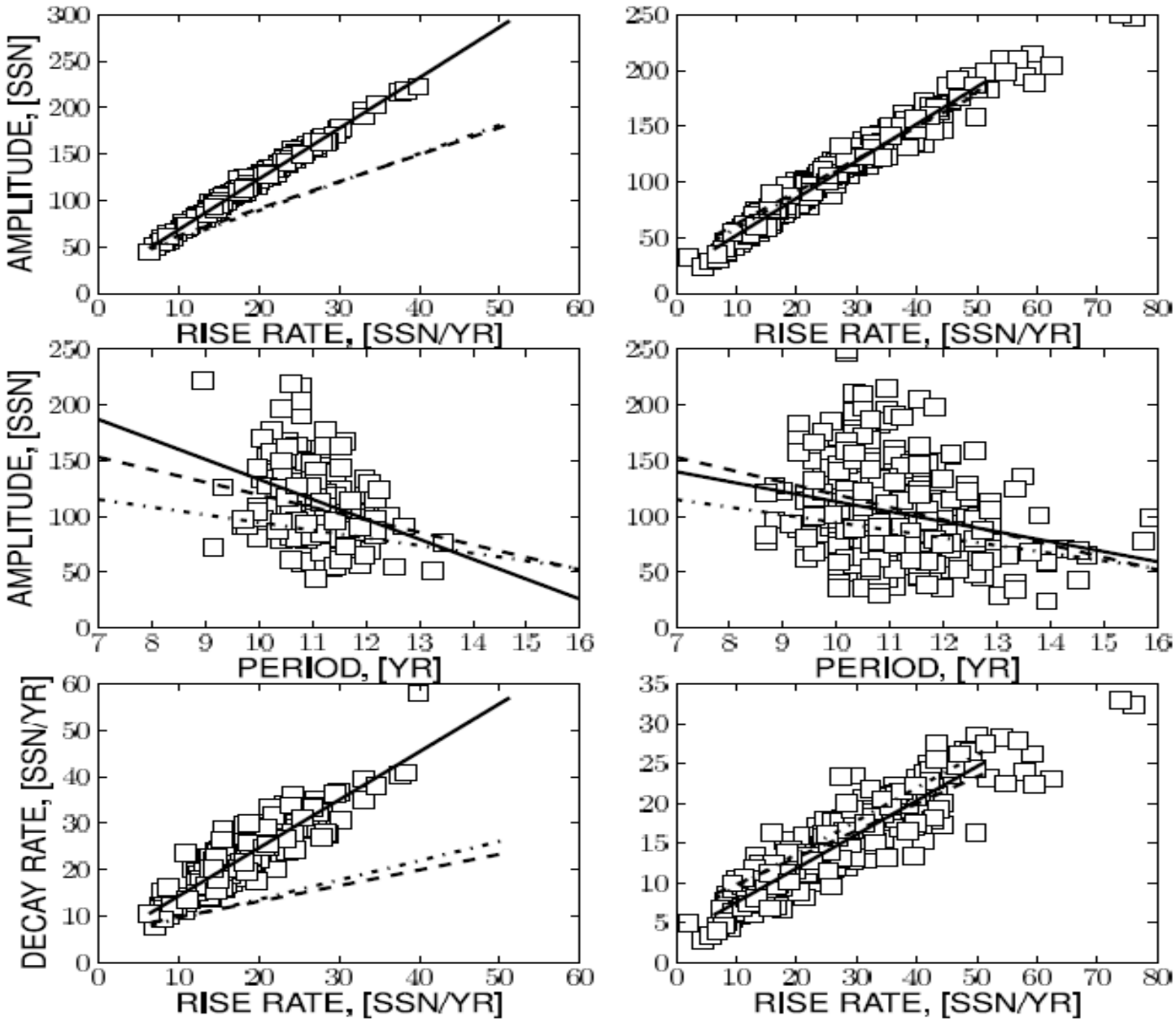
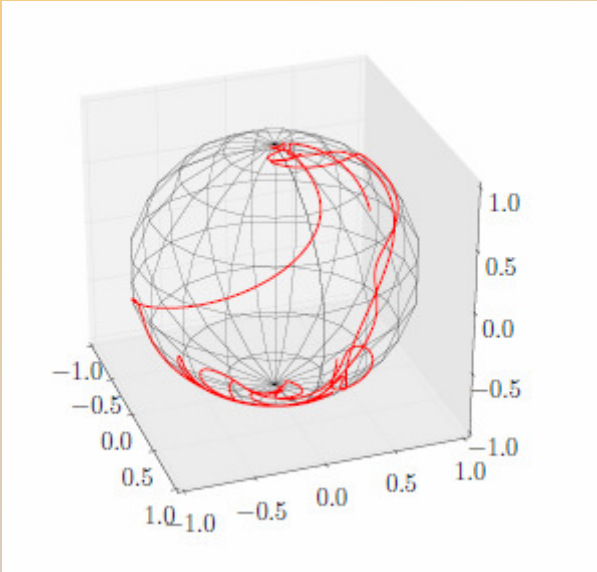
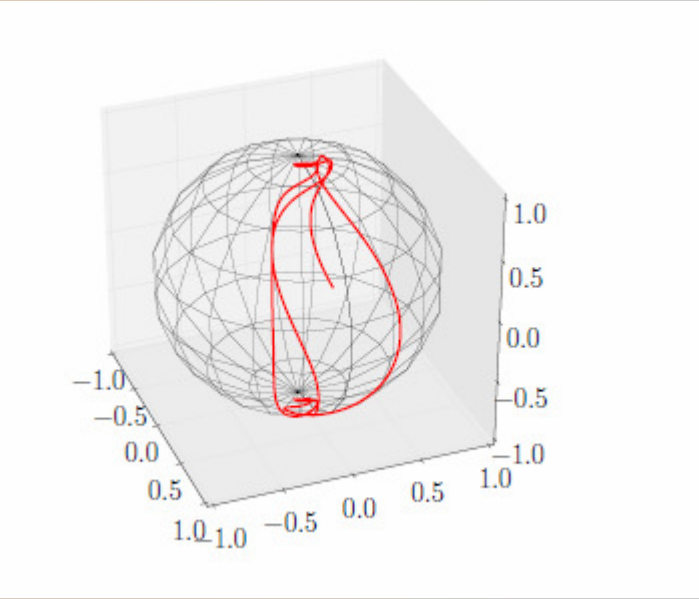


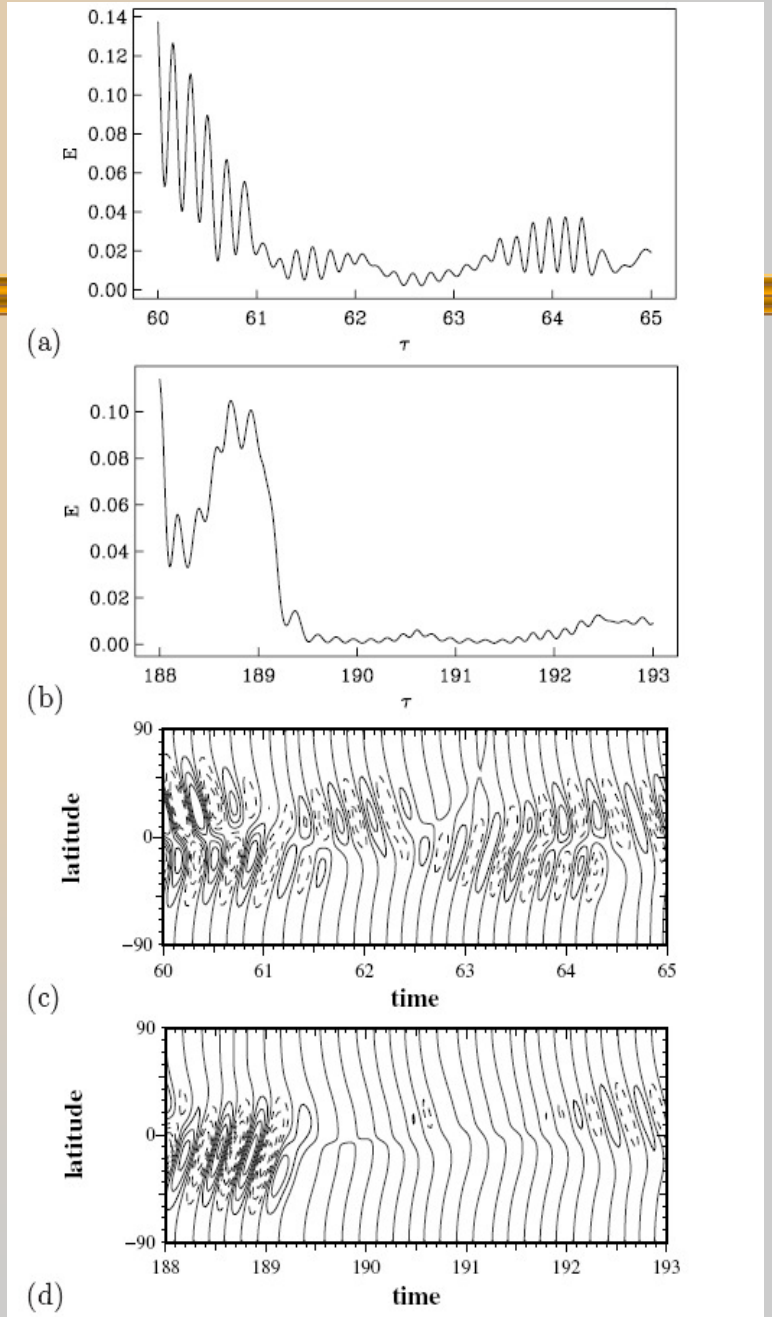
Figure 7. The Waldmeier relations for 1D1 (left) and 2D1 (right) models. The linear fits are shown the solid lines, the dashed lines shows the fits for the SIDC data and the dash-dot line - for the NIMV data.

Solar dipole reversals according to the observational data





Grand Minima



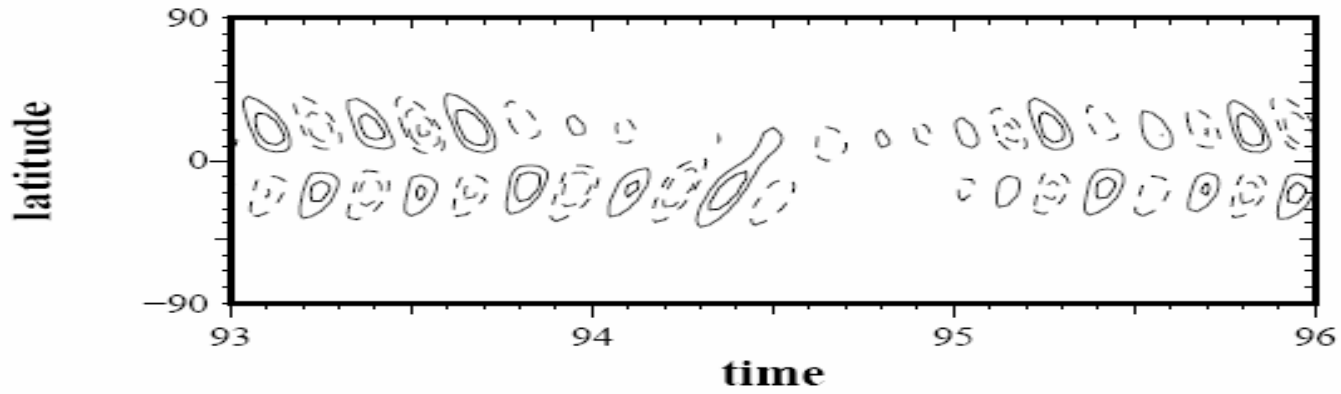


Figure 4. Simulated butterfly diagram for toroidal magnetic field in simple Parker migratory dynamo with algebraic α-quenching and fluctuating $\alpha(\theta, t)$ and basic dipole-like symmetry. Contours show toroidal field strength, with solid contours indicating positive values and broken contours negative values. Time is given in arbitrary dimensionless units not years.

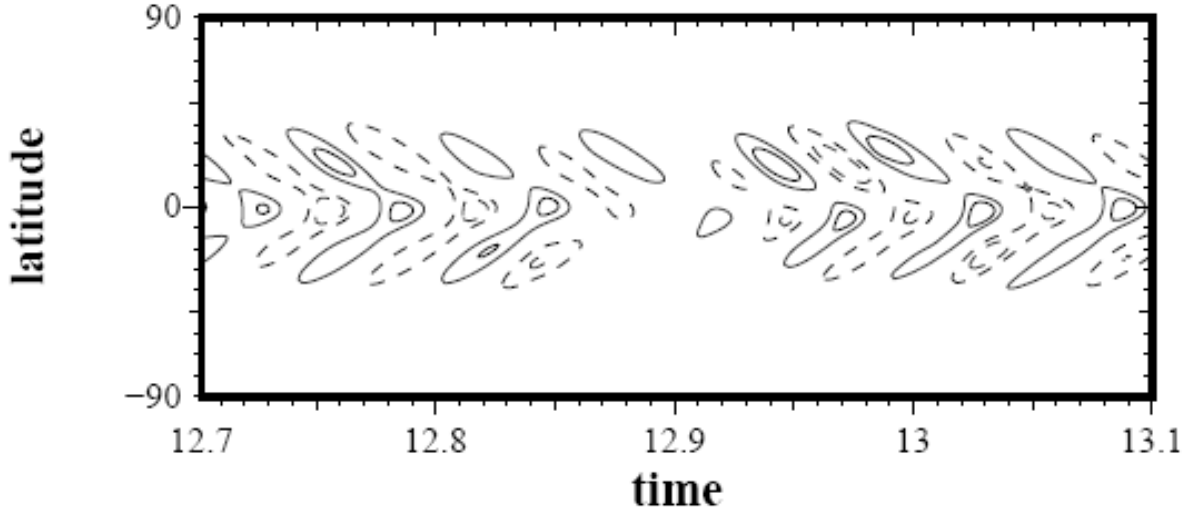
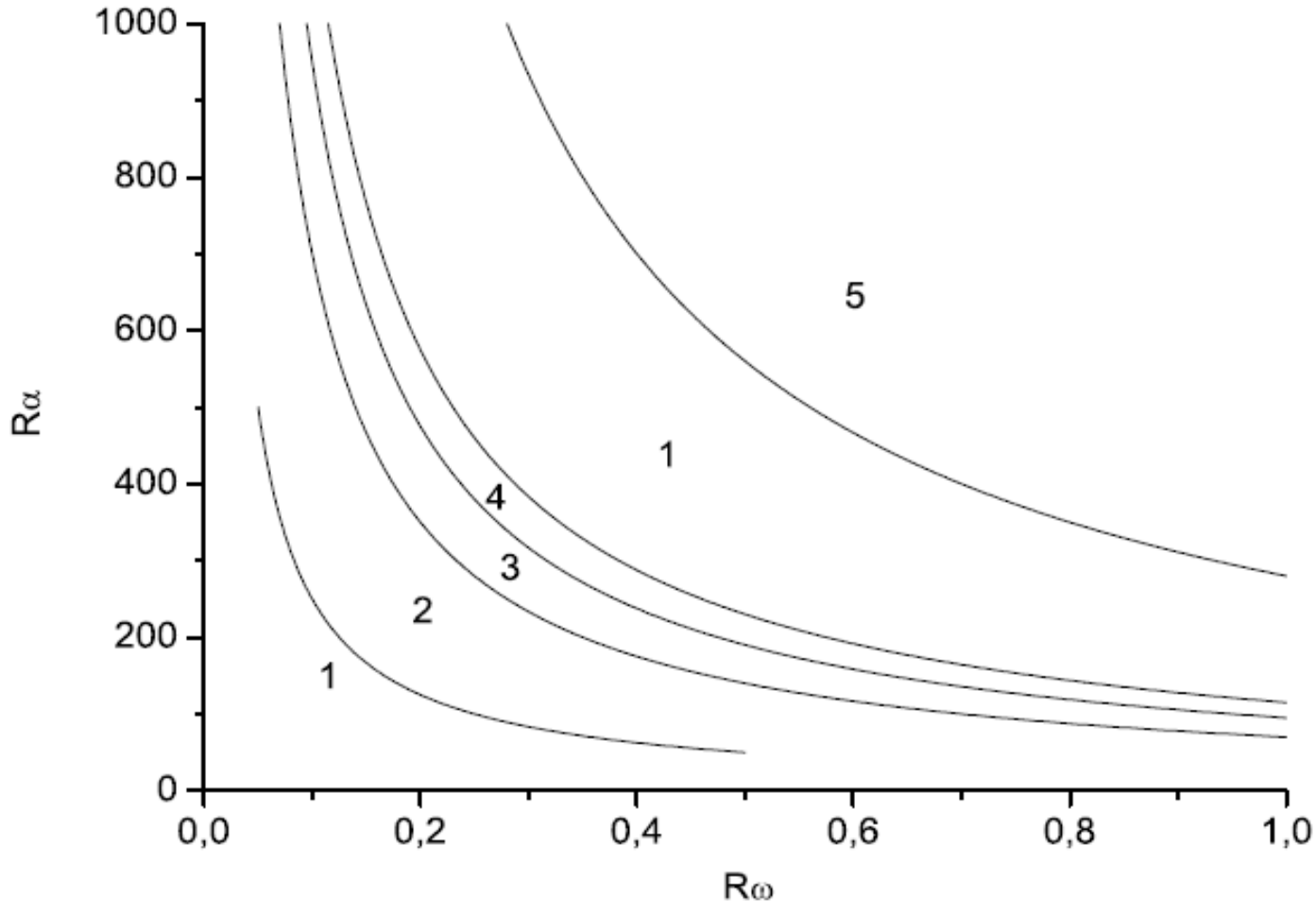
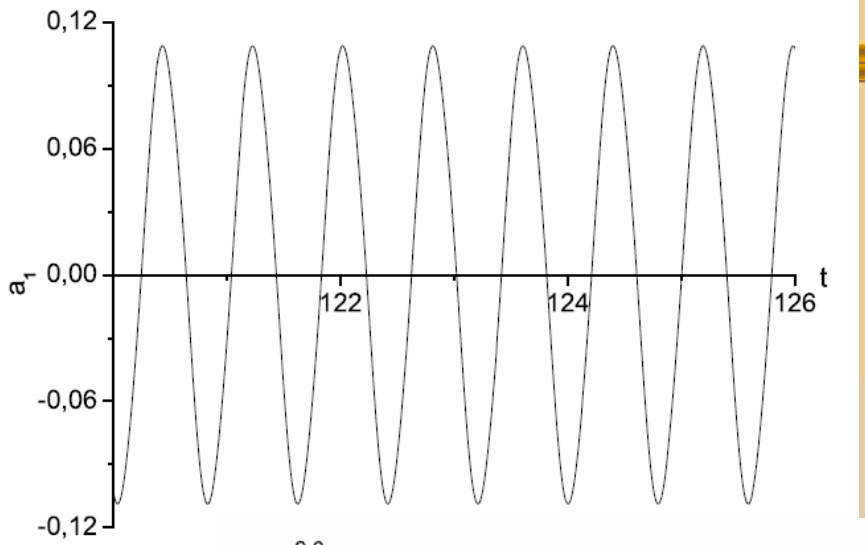


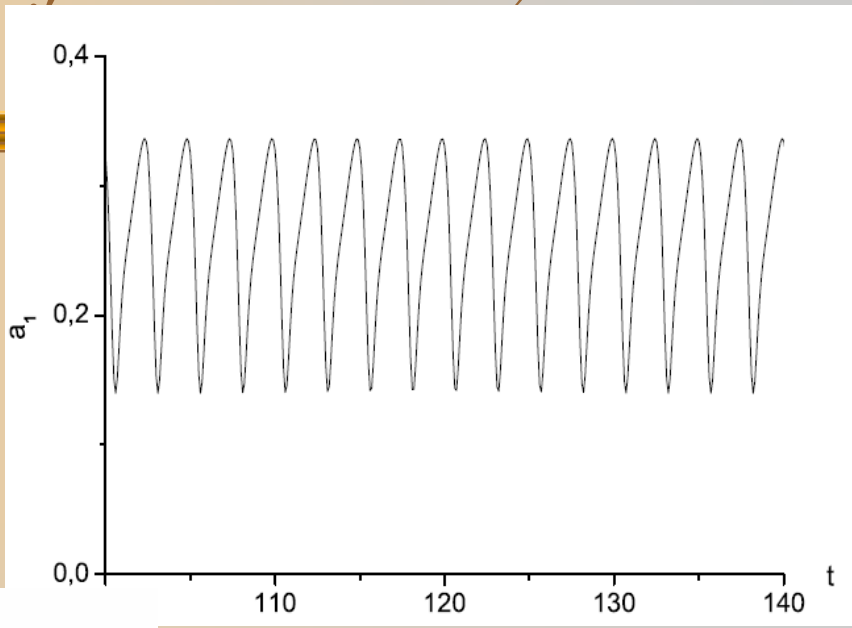
Figure 3. A simulated butterfly diagram for the toroidal magnetic field in a simple Parker migratory dynamo with algebraic α-quenching and fluctuating $\alpha(\theta, t)$ and basically quadrupole symmetry. Contours show toroidal field strength, with solid contours indicating positive values and broken contours negative values. The diagram suggests the presence of various types of complicated dynamics, such as transition to mixed parity and quadrupole-like configurations, lost cycles etc. Time is given in arbitrary dimensionless units not years.

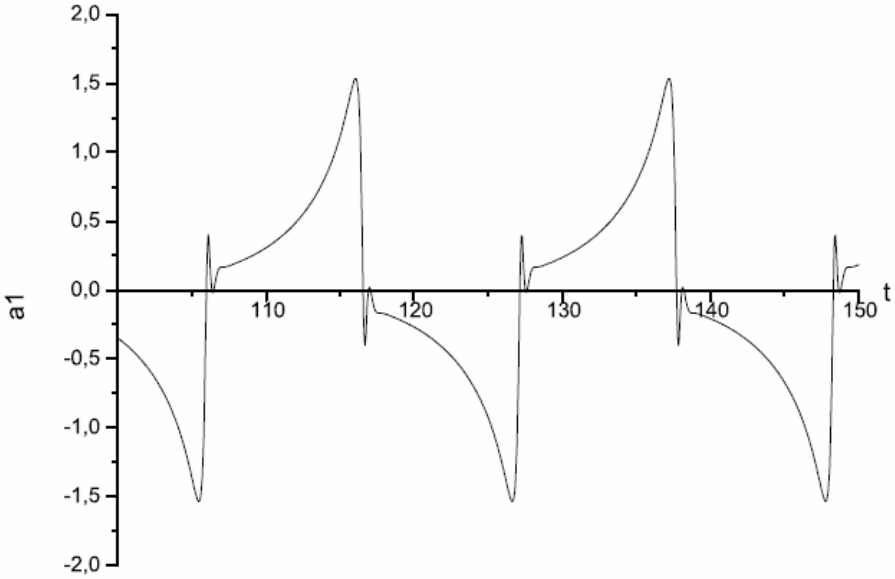
Geodynamo



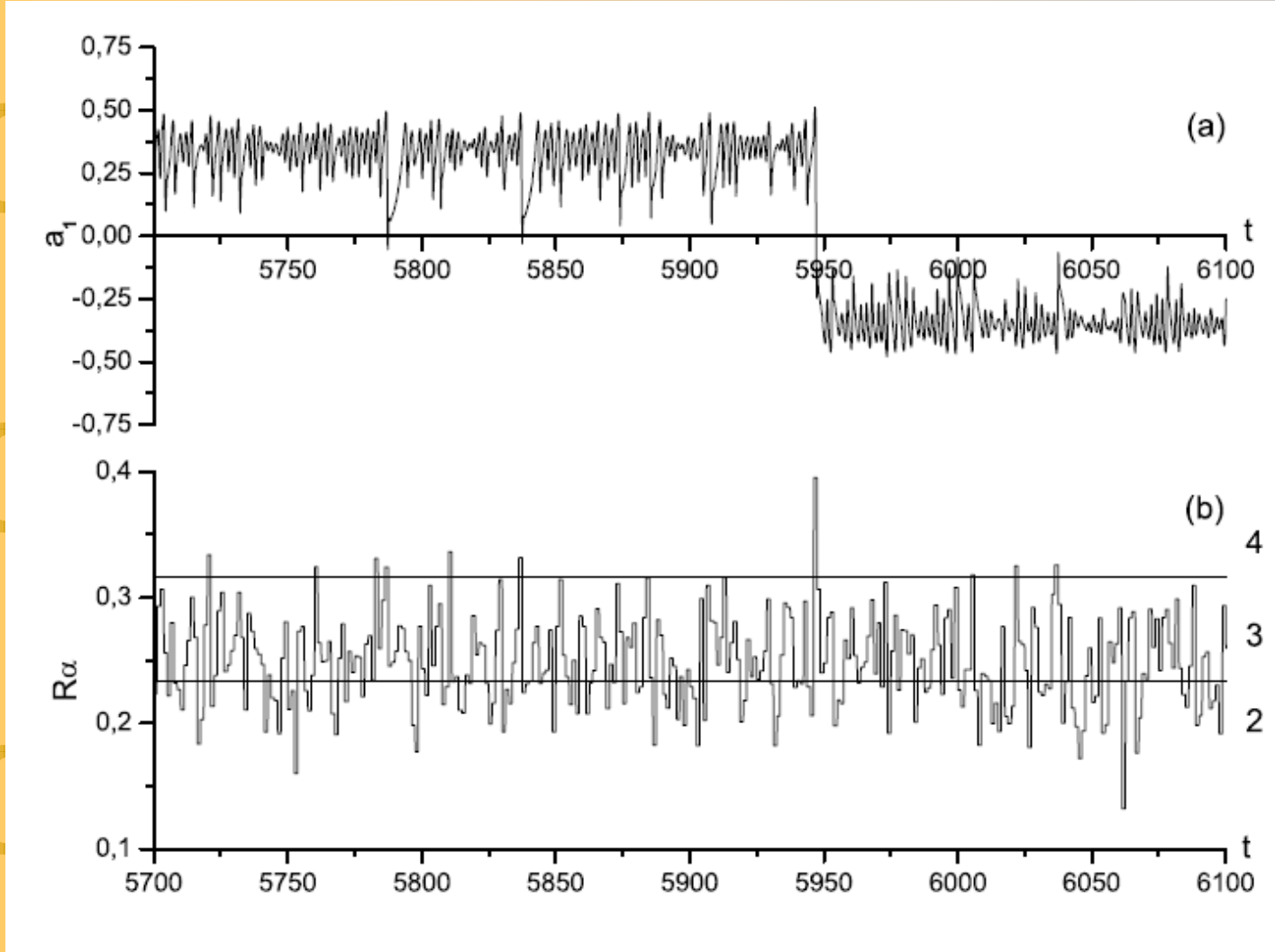
Basic Regimes of Parker Dynamo







Field Reversals



Simulated and observed timescales