36-315: Statistical Graphics and Visualization

Handout 11
Date: February 24, 2003

Cycle plots - Visualizing periodicity

A time series is *periodic* with period p if the intervals of length p resemble each other. Periodicity can be measured by correlating a series with shifted versions of itself.

A time series which is not strictly periodic can often be decomposed into periodic and non-periodic components.

Lag of a time series - The series shifted backward in time by one unit, or a specified number of units.

Correlation coefficient between a (standardized) time series and its lag:

$$\frac{1}{T}\sum_{t=1}^{T} x_t x_{t+lag}$$

Auto-correlation function (ACF) - The correlation coefficients between a time series and its lags. Equally-spaced peaks in the ACF suggest periodicity. The dashed lines are thresholds above which a correlation is statistically significant.

Cross-correlation function (CCF) - The correlation coefficients between a time series and lags of another time series. A peak suggests one series is a delayed version of the other.

Cycle matrix or "calendar" plot - The series is chopped into cycles of length p. Each row is one cycle (like weeks in a calendar).

Color encoding - White/Yellow is small value, Red/Black is large value.

Spiral plot - Time is represented by distance along a spiral and value is represented by color. Periods of the series can be lined up by scaling the time axis appropriately. Interpolation is typically used to fill out the spiral.

Plots can be evaluated by how well they allow comparison *across* cycles and *within* cycles.

List of figures:

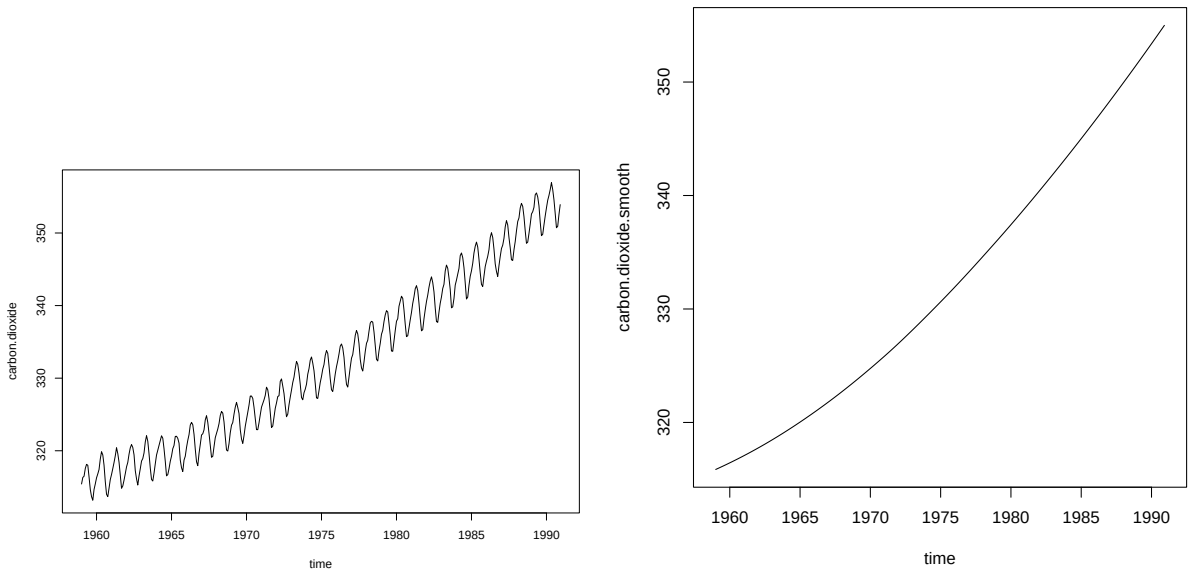
References

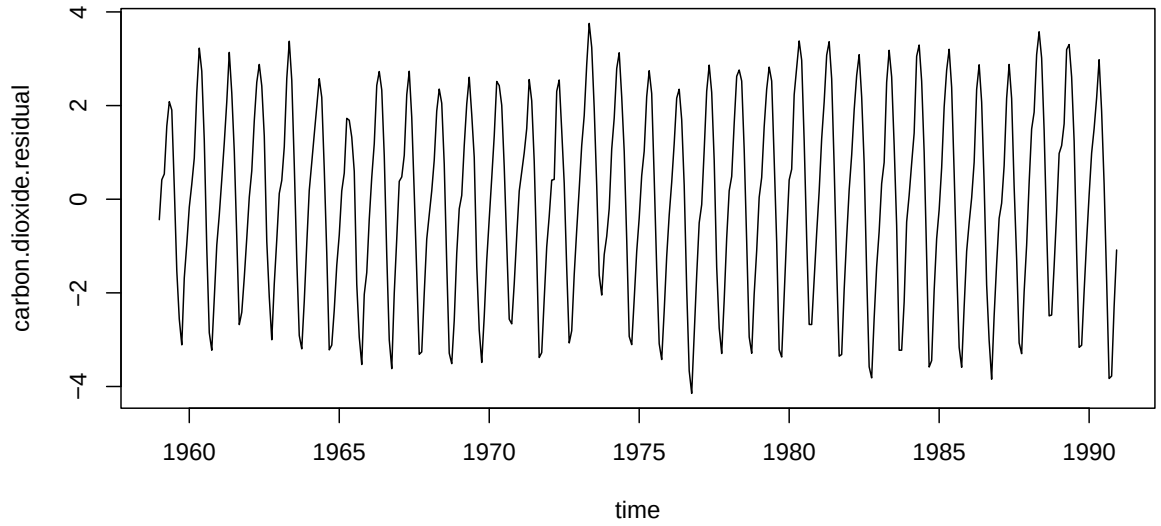
[1] Edward R. Tufte. *The Visual Display of Quantitative Information.* Graphics Press, Cheshire, CT 1983.

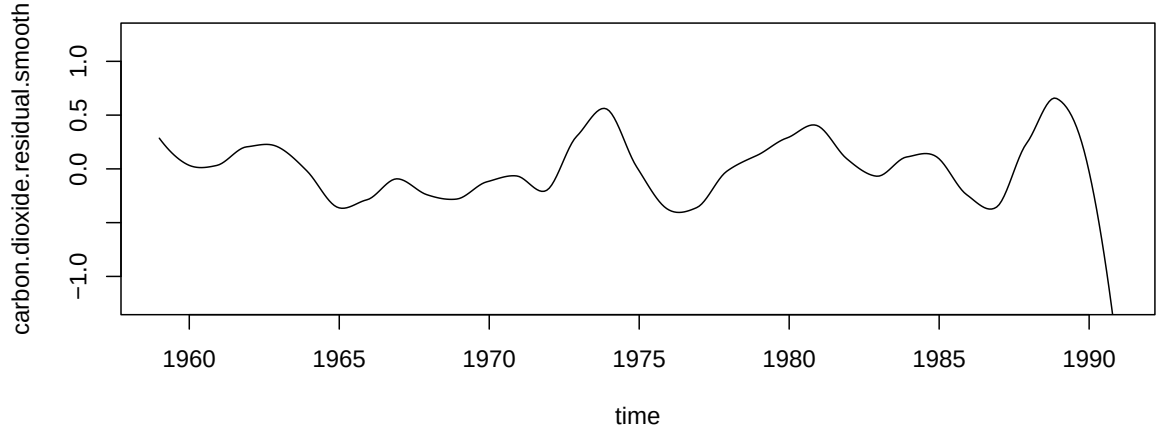
[2] J. V. Carlis and J. A. Konstan "Interactive Visualization of Serial Periodic Data", In Proceedings of ACM Symposium on User Interface Software and Technology, 1998. `http://citeseer.nj.nec.com/carlis98interactive.html`

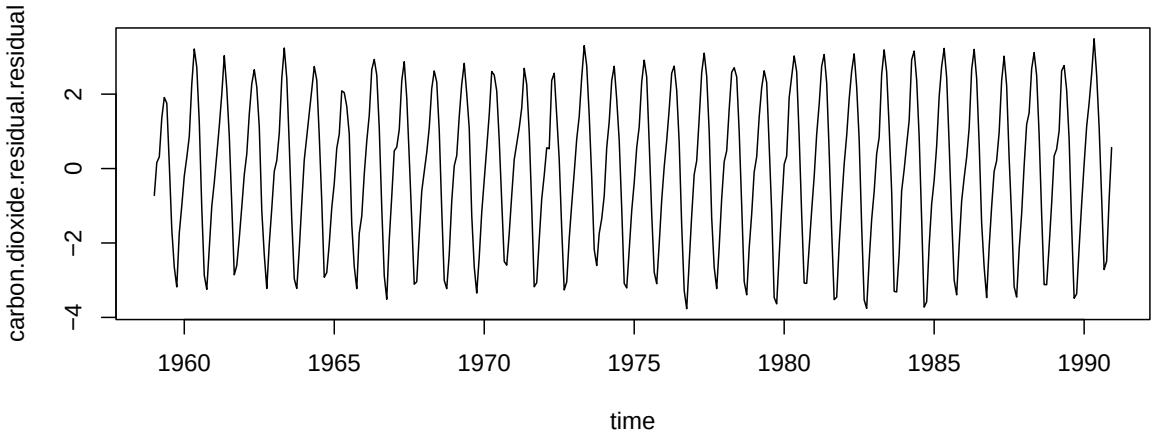
[3] M. Weber, M. Alexa, and W. Muller. "Visualizing Time-Series on Spirals", In Proceedings of the IEEE Symposium on Information Visualization, 2001. `http://www.igd.fhg.de/~alexa/paper/spiral.pdf`

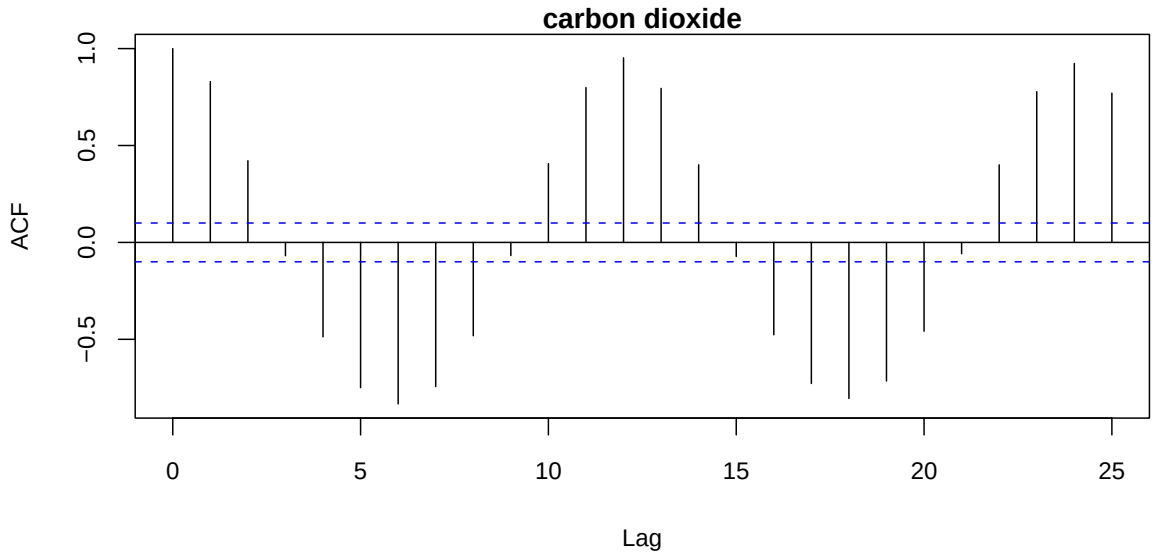
Carbon dioxide data:

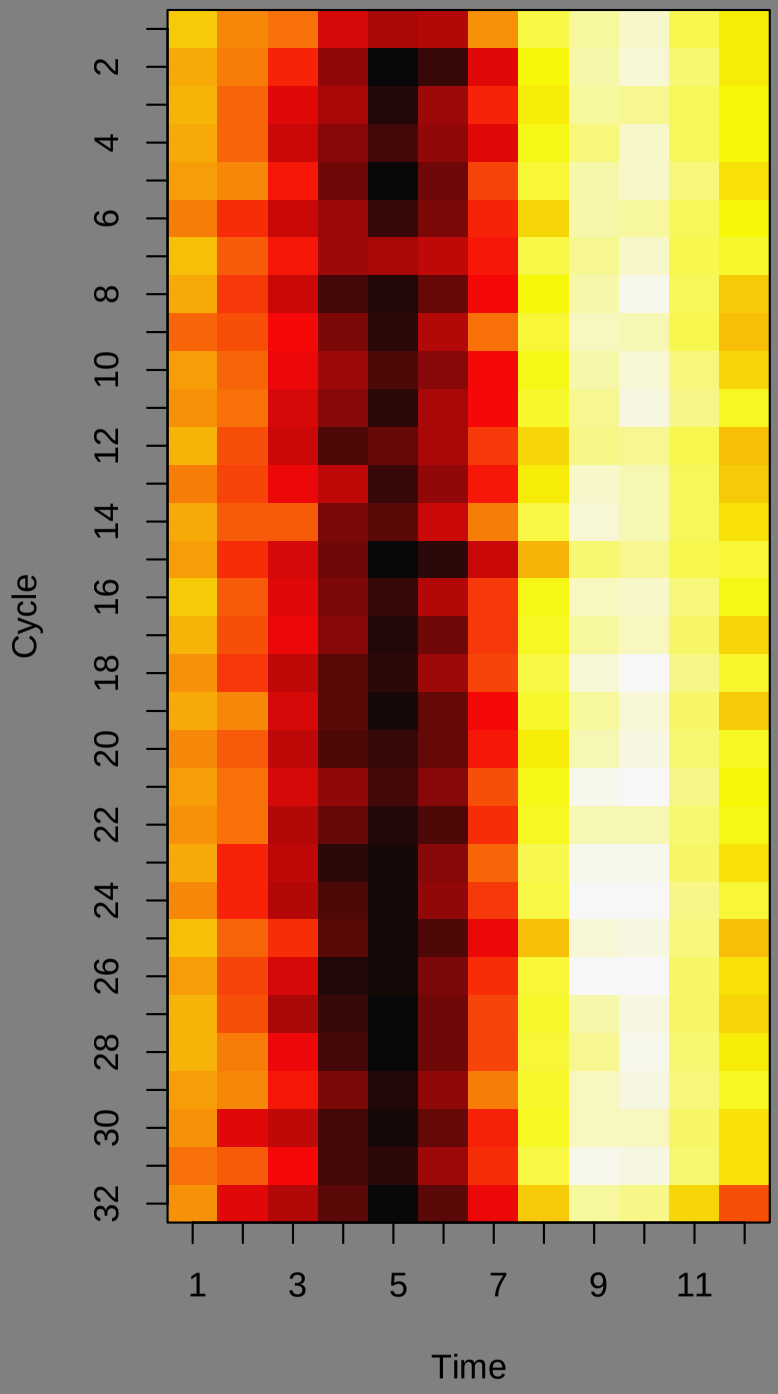


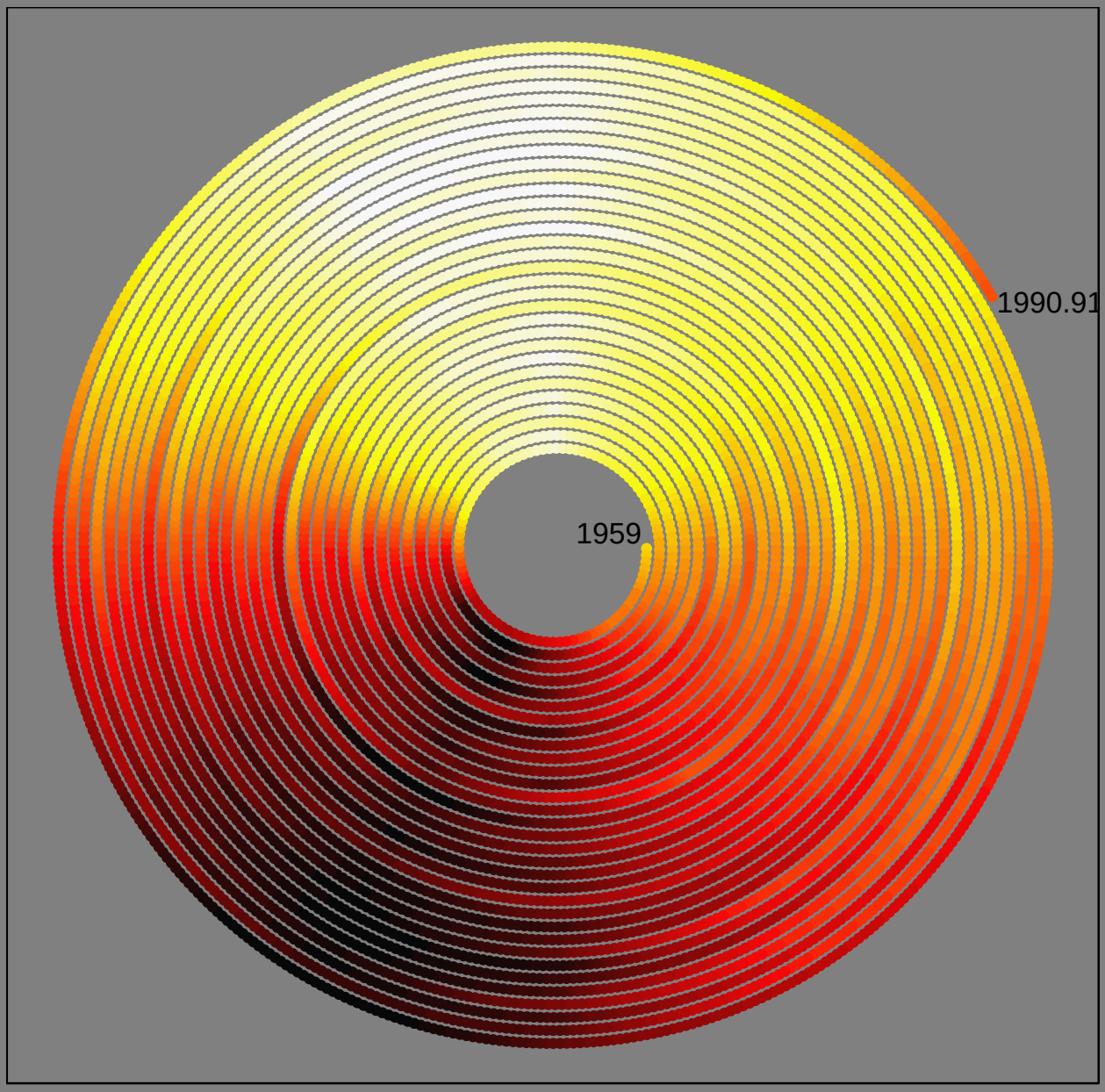




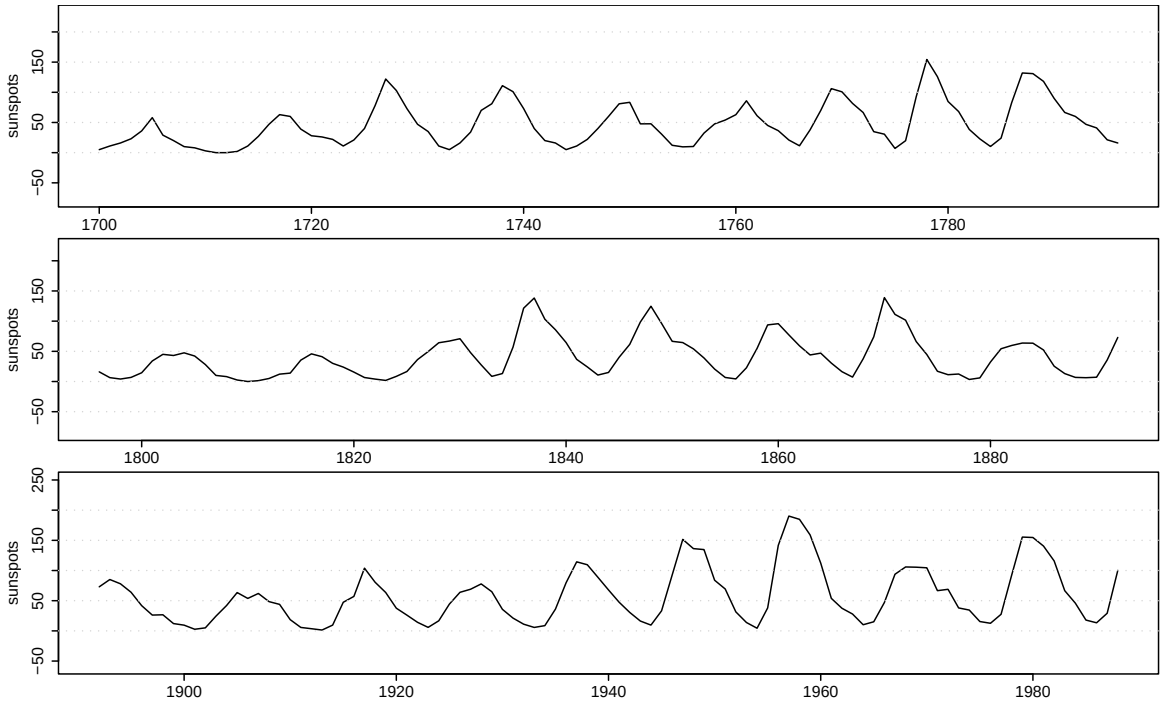

carbon.dioxide.residual.residual
−4
−2
0
2
1960
1965
1970
1975
1980
1985
1990
time

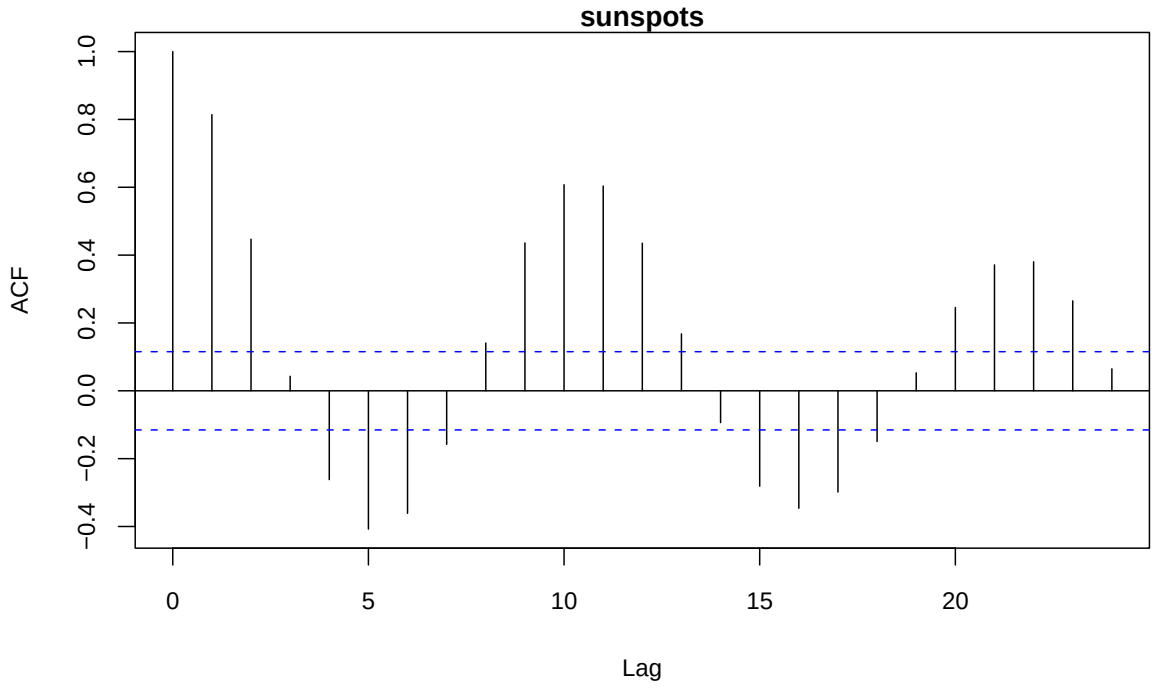

carbon dioxide
ACF
−0.5
0.0
0.5
1.0
0
5
10
15
20
25
Lag

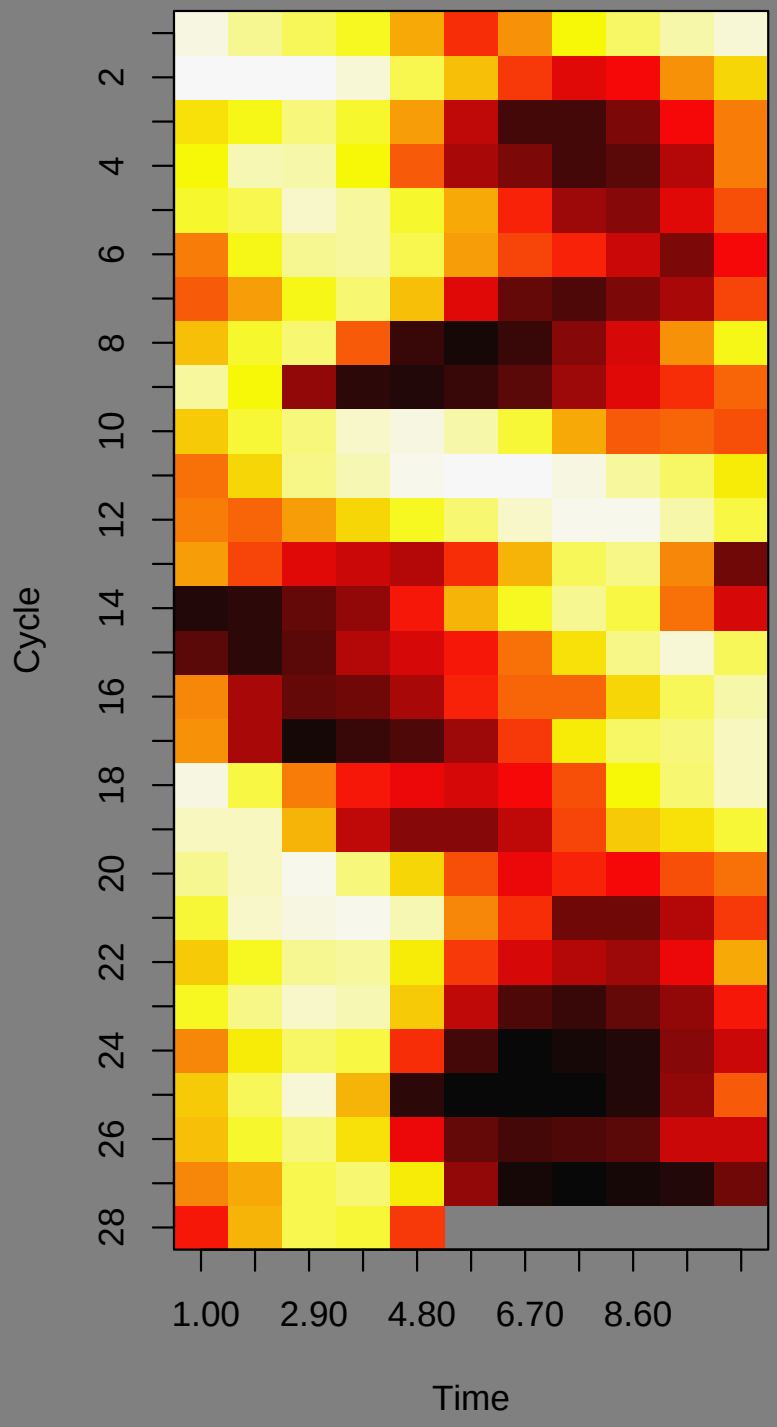

Cycle
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
1
3
5
7
9
11
Time

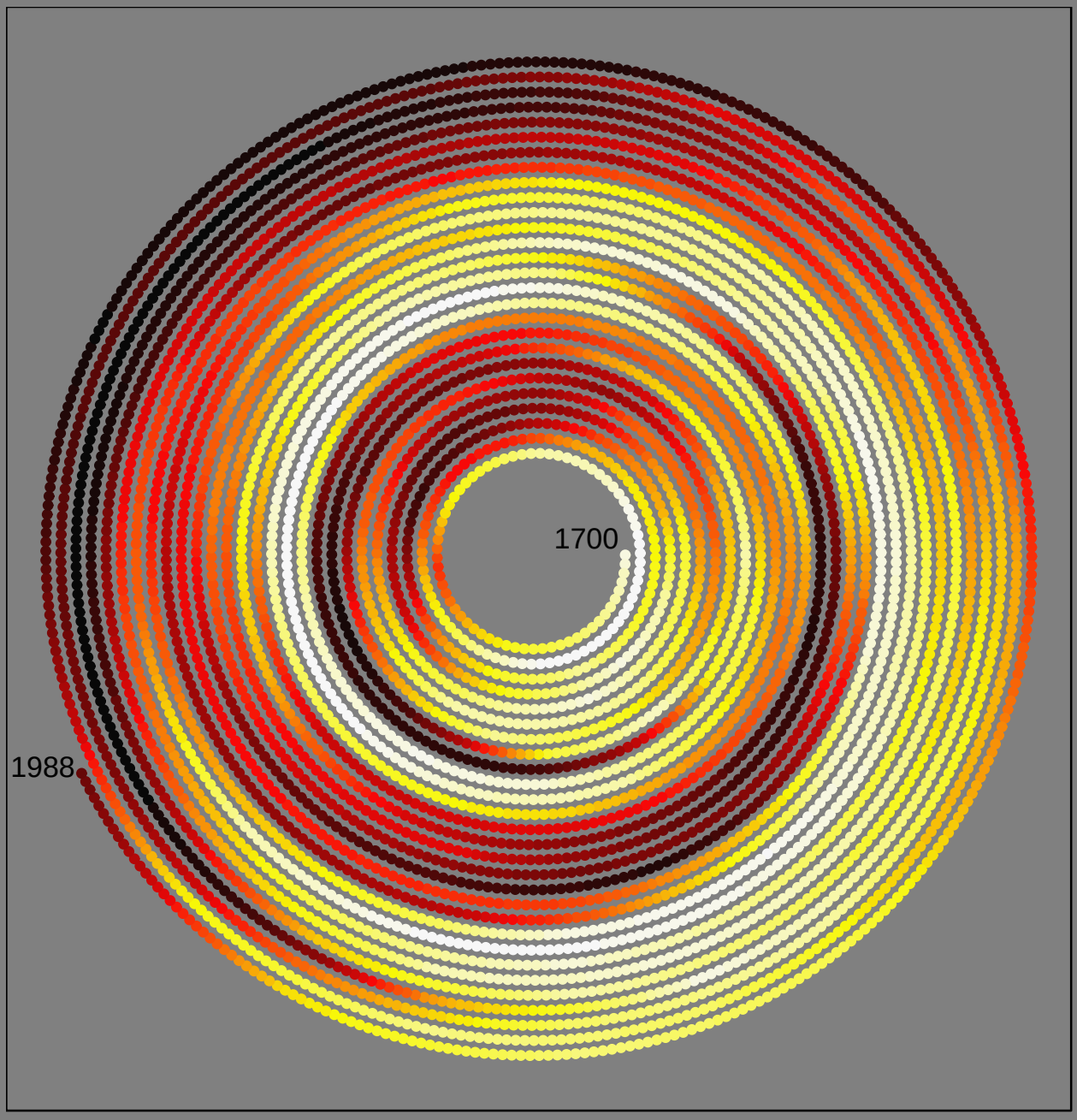

1990.91
1959

Sunspot data:

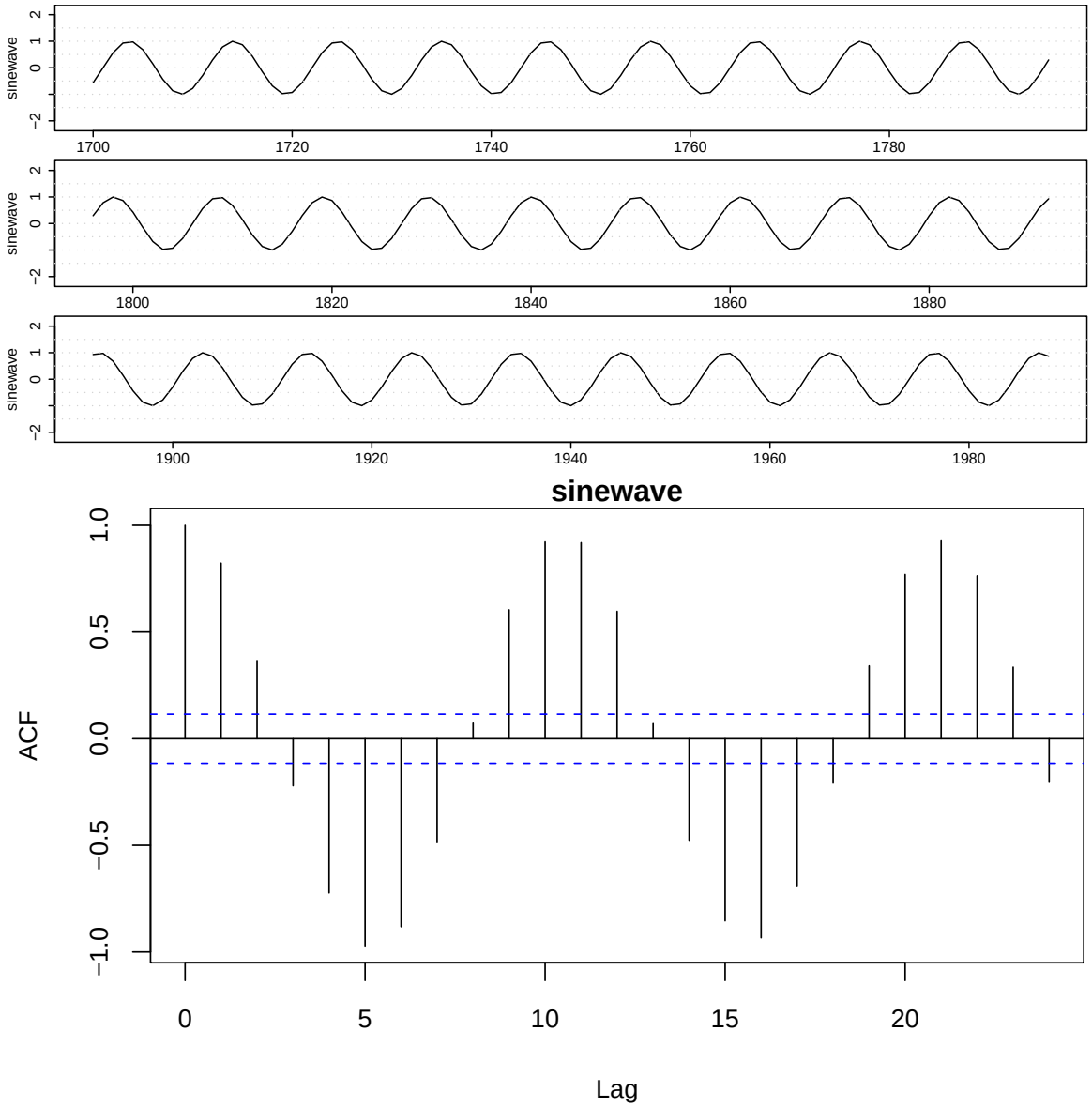




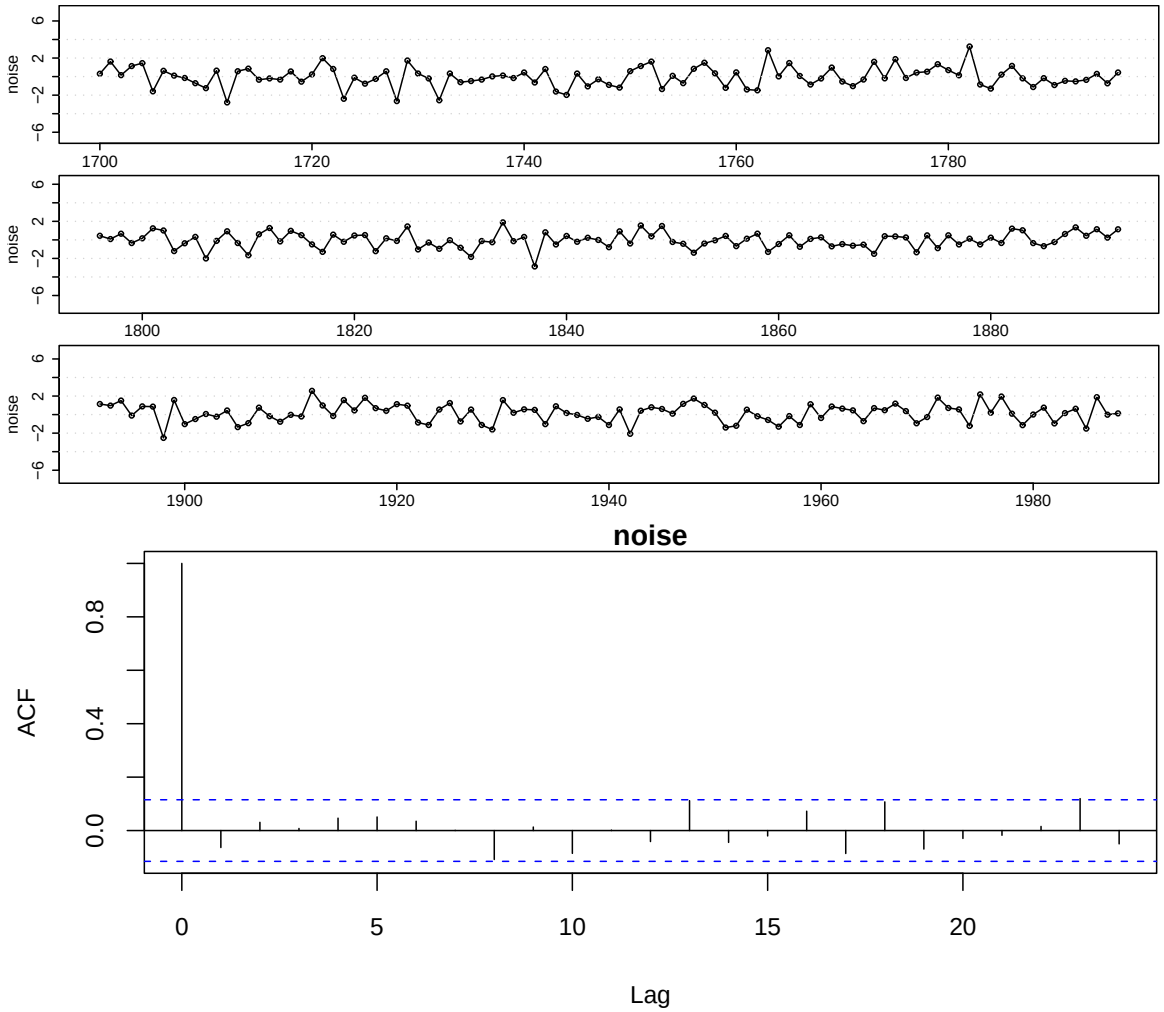

Cycle
2
4
6
8
10
12
14
16
18
20
22
24
26
28
1.00
2.90
4.80
6.70
8.60
Time


1700
1988

Pure sinewave:



Pure noise:


noise
6
2
−2
−6
1700
1720
1740
1760
1780
1800
1820
1840
1860
1880
1900
1920
1940
1960
1980
noise
ACF
0.8
0.4
0.0
0
5
10
15
20
Lag