resource shock detection

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Data

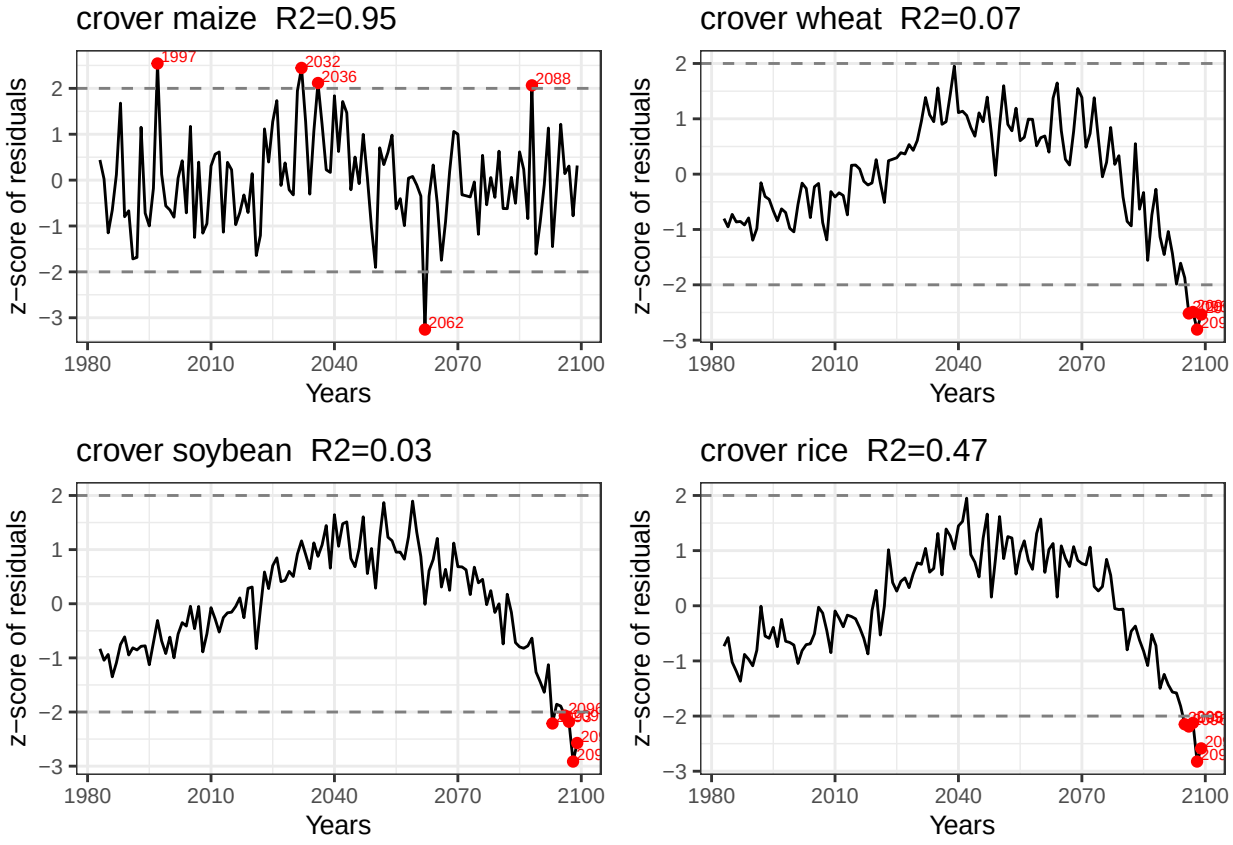
Example data picked for this test: agriculture sector, CROVER crop model, GFDL-ESM4 climate model, SSP585 climate experiment, and 4 agricultural crops: maize, wheat, soybean, rice.

For each method used, the residuals of the method are computed and z-scored, and shocks are identified as crop yields exceeding 2SD from the mean (below -2 and above 2 or the z-scored residuals).

Detecting annual resource shocks

Detrending with linear models

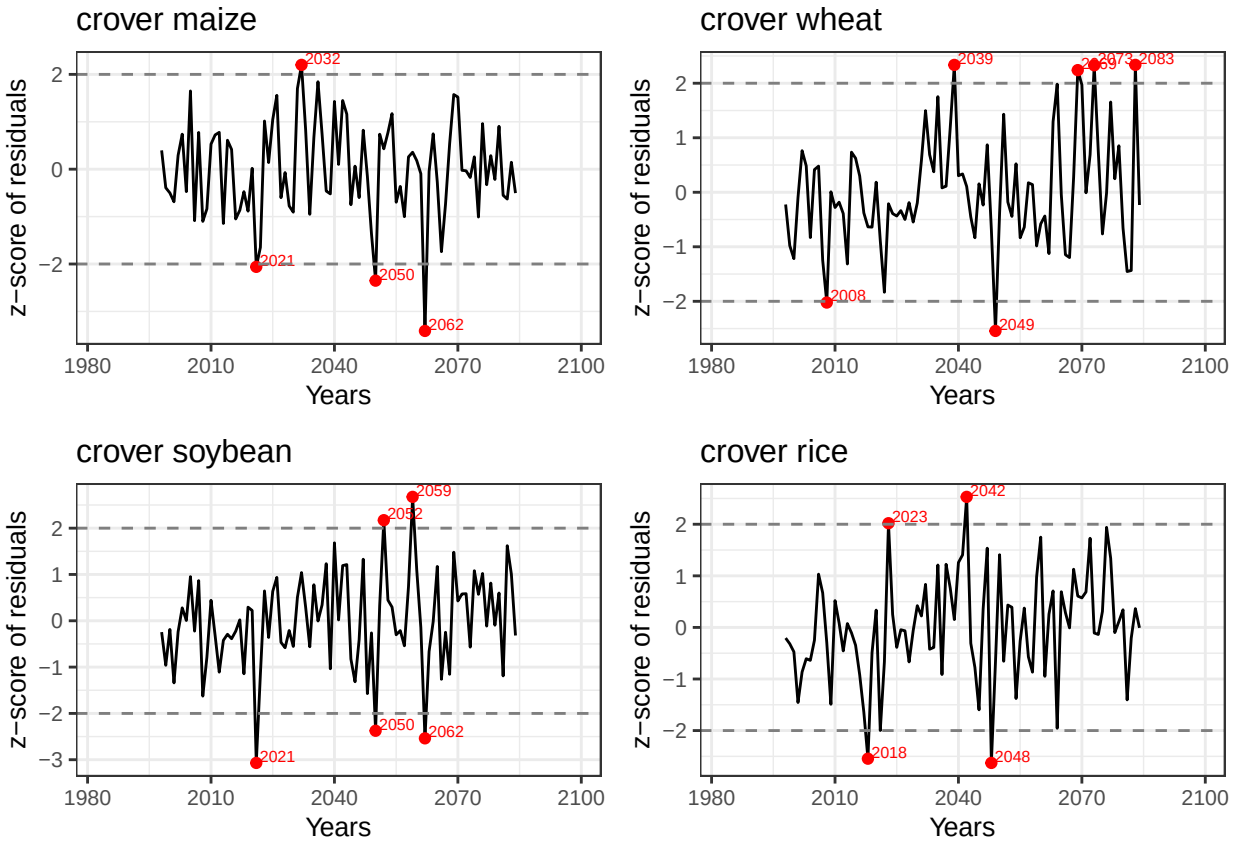
This method is most straightforward used in Fredston et al., 2023 but does not work well for non-linear trends (which is most cases in long-term data from ISIMIP). In the example shown below, on the maize crop data seems to be properly detrended by the linear model. This is also evident from the R-square of the model (95% for maize, and <50% for other crops).



31-year moving average

A 31-year average works well but it might not apply to the entire time-series of the dataset. The rolling window of 31 is chosen as it eliminates most of the interannual (e.g., ENSO, NAO, etc) and decadal variability (PDO) in the climate/ocean system (it is also often used in IPCC assessments).

The rollmean() function from the 'zoo' R package is used, where the k rolling window parameter needs to be chosen.



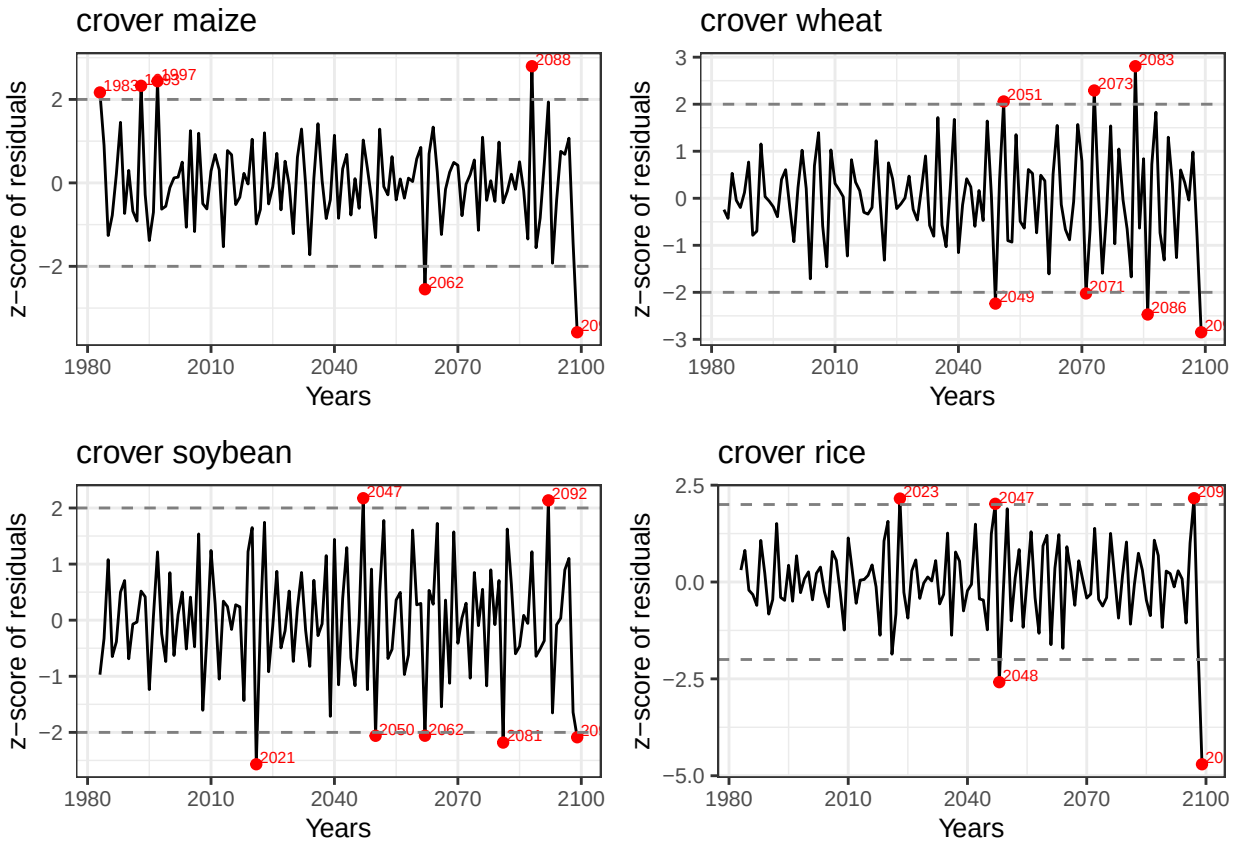
An extrapolation of the time-series could be considered, as done in a previous publication: "The past anthropogenic warming is here estimated by applying a 31-year running mean with a linear extrapolation for the last 15 years, assuming constant warming rate based on the last 31 years."

Savitzky-Golay

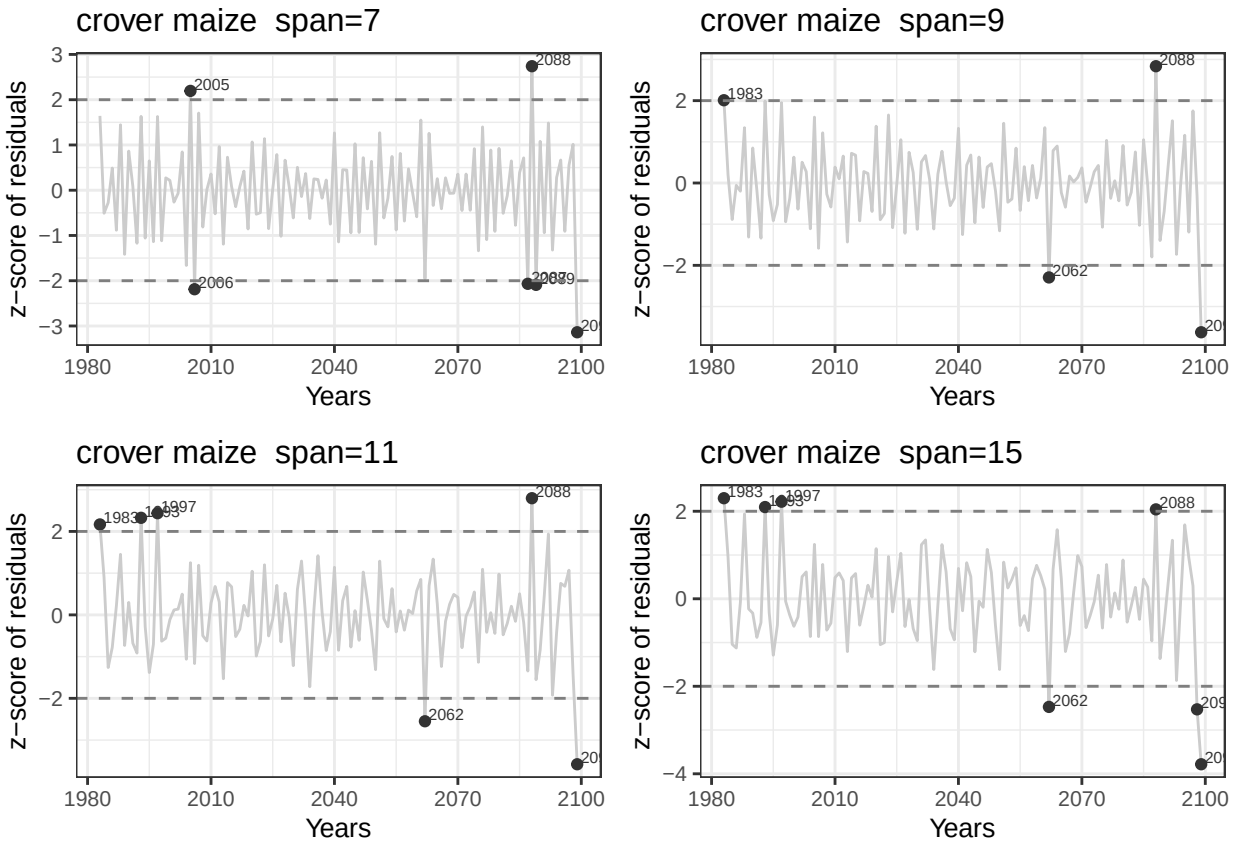
A Savitzky-Golay low-pass filter (e.g., as in this paper) can detrend the data to isolate shocks.

- See brief description of low-pass filters here.
- See brief description of Savitzky-Golay filters here.

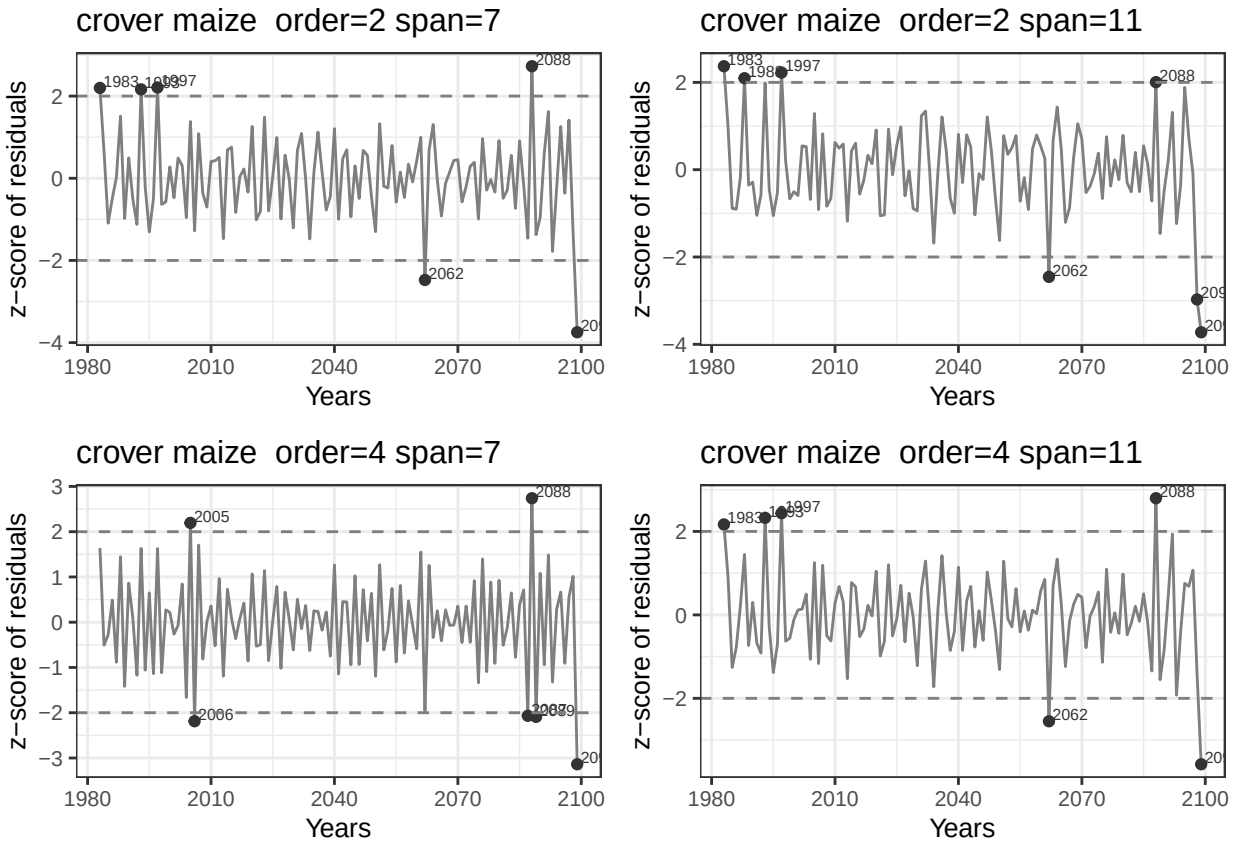
The savgol() function from the 'pracma' R package is used, where the derivative order parameter *dorder* is set to 0 for smoothing, the filter order parameter *forder* is set to 4 for a quartic filter, and the filter length parameter *fl* is set at 11.



Sensitivity to filter length Filter order is set at 11.

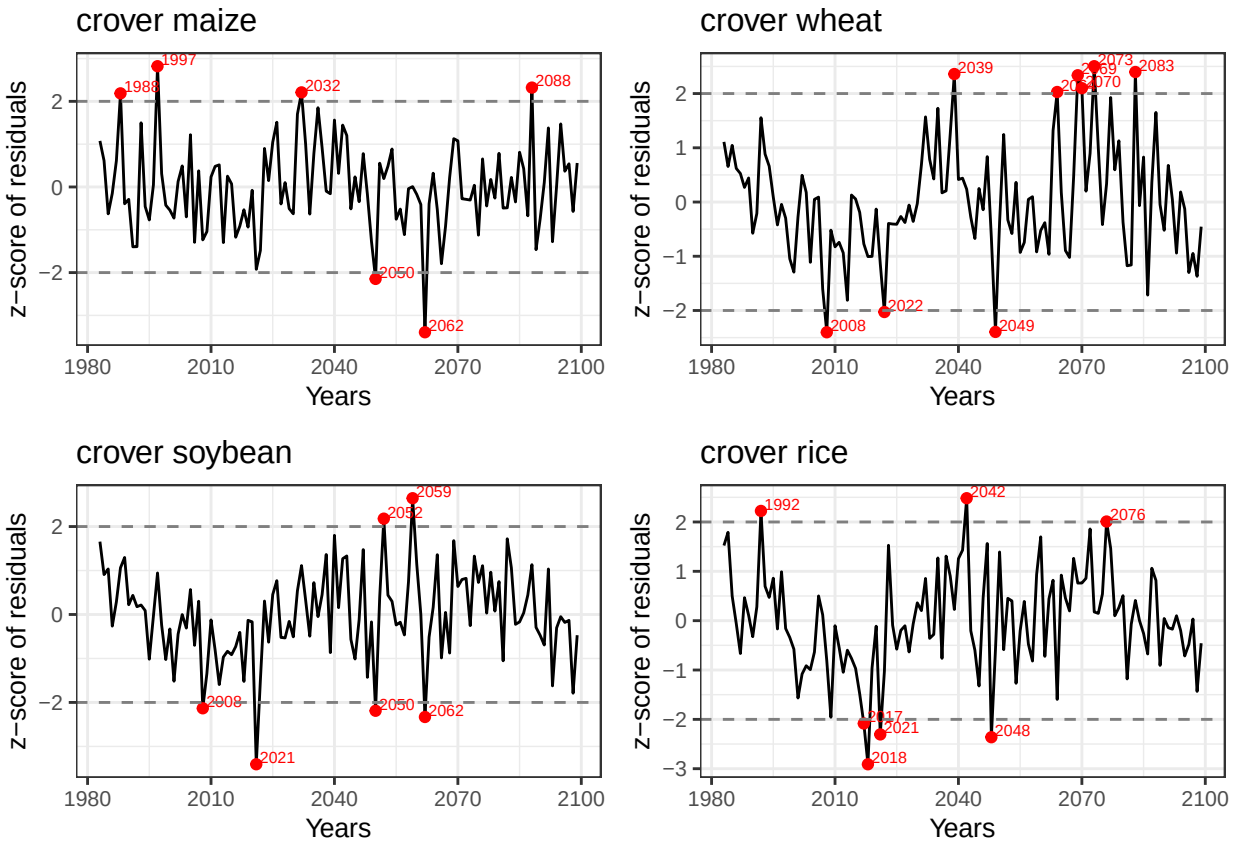


Sensitivity to the filter order and length Filter is either quadratic (2), or quartic (4), and filter length is either set a 7 or 11.

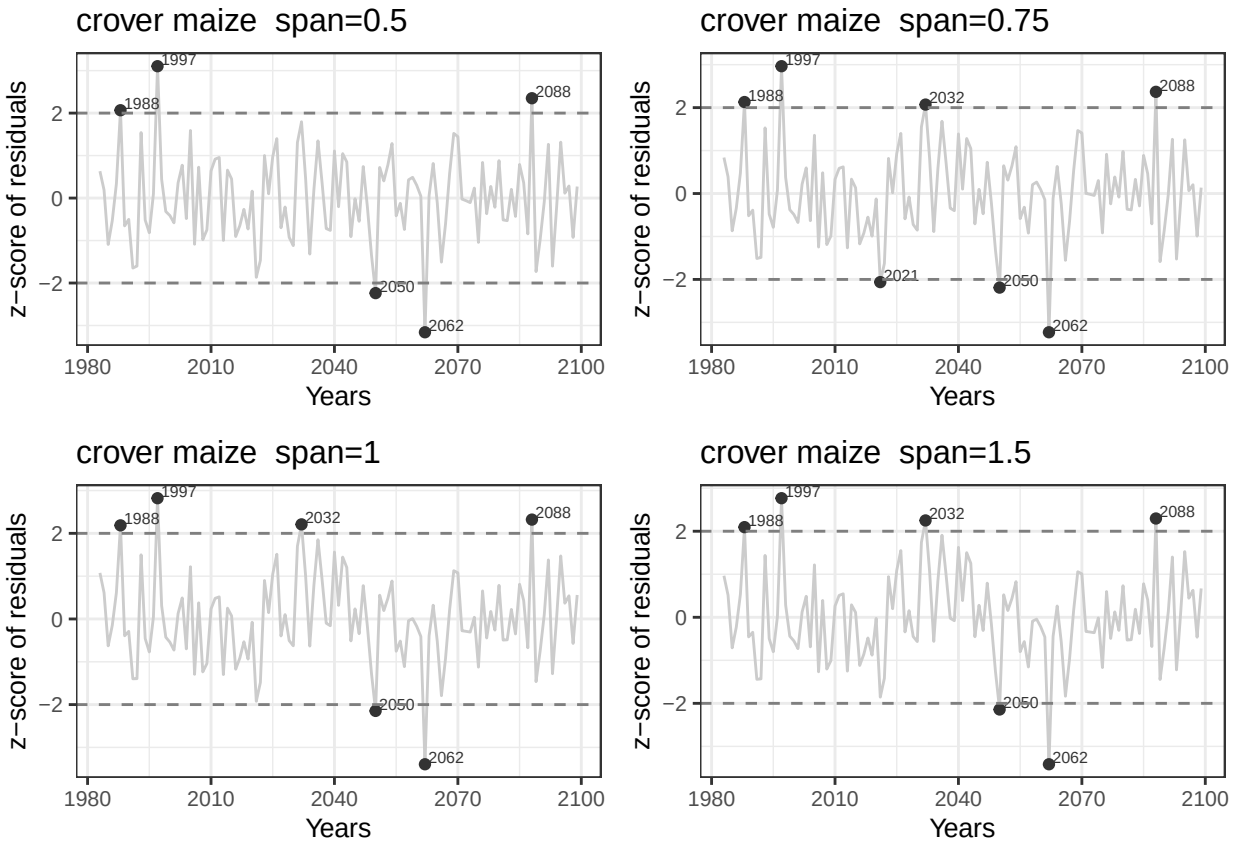


Smoother across crops

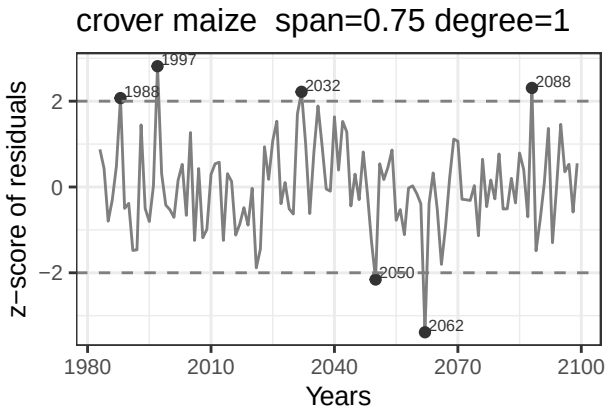
The loess() function from the 'stats' R package is used, where the parameter controlling the degree of smoothing span is set at 1, and the degree of the polynomial is 2.

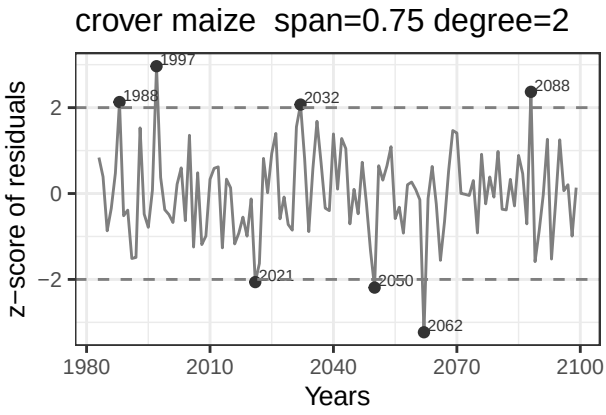


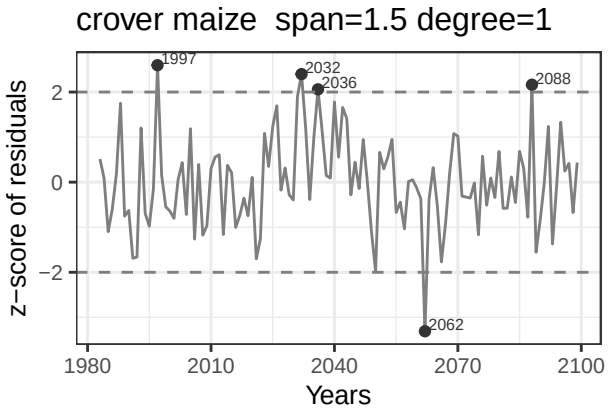
Sensitivity to smoother span Testing the sensitivity of the shock detection to the smoother span, we can see that for the maize model example, we detect 5, 6, or 7 shocks for a span from 0.5 to 1.5.

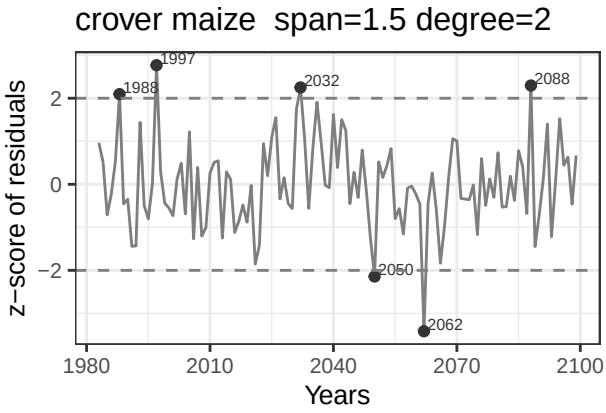


Sensitivity to smoother span and degree Sensitivity to the smoother span and polynomial degree.


crover maize span=0.75 degree=1
z−score of residuals
Years
1997
1988
2032
2088
2050
2062
2
0
−2
1980
2010
2040
2070
2100


crover maize span=0.75 degree=2
z−score of residuals
Years
1997
1988
2032
2088
2021
2050
2062
2
0
−2
1980
2010
2040
2070
2100


crover maize span=1.5 degree=1
z−score of residuals
Years
1997
2032
2036
2088
2062
2
0
−2
1980
2010
2040
2070
2100


crover maize span=1.5 degree=2
z−score of residuals
Years
1997
1988
2032
2088
2050
2062
2
0
−2
1980
2010
2040
2070
2100