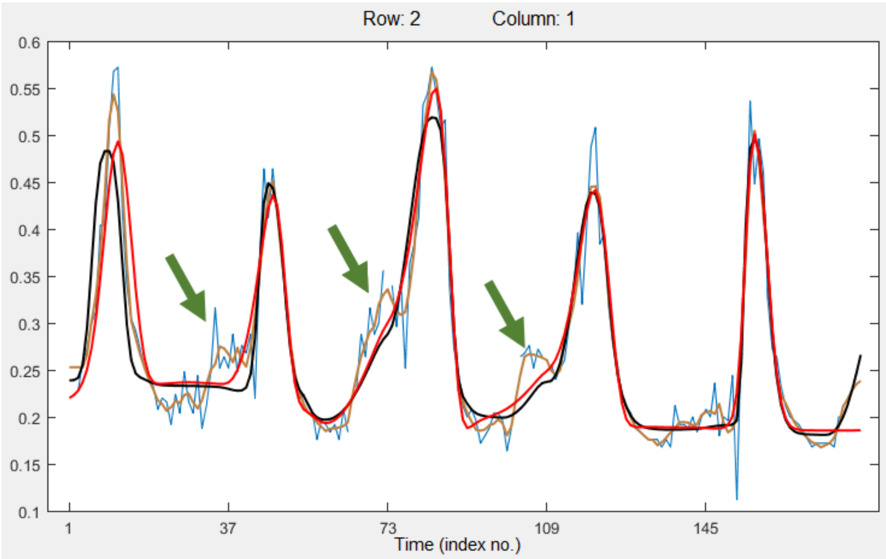
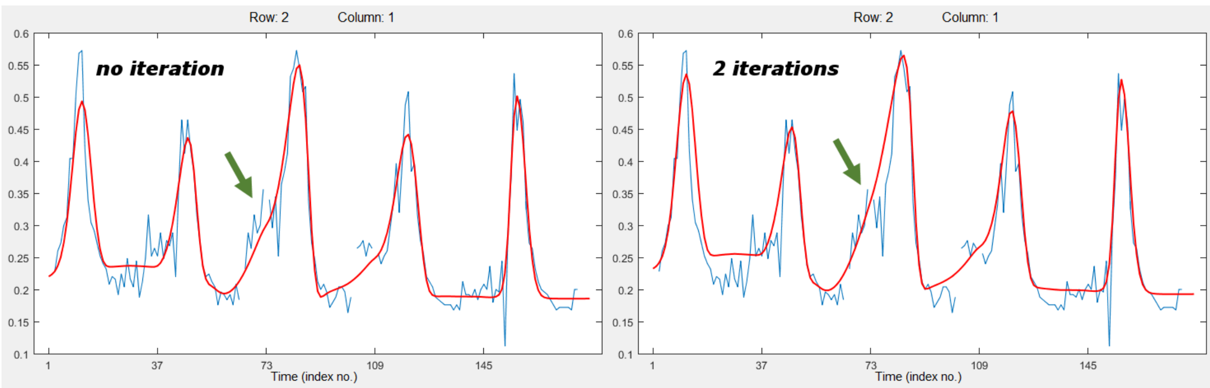
Analyzing point data with TIMESAT

Model answers

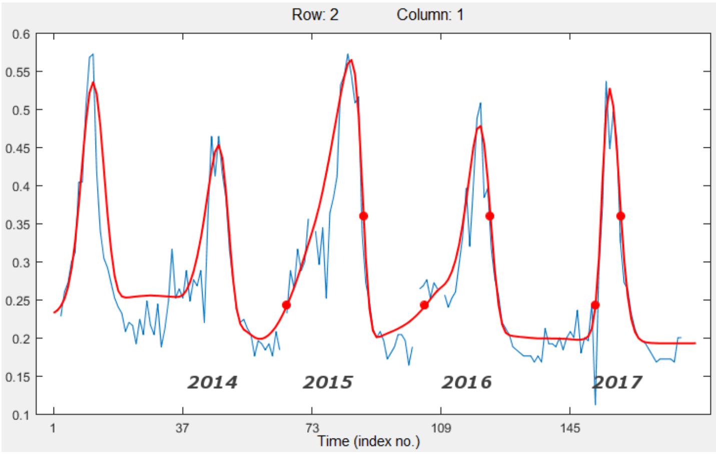
1. The three filtering methods actually perform rather similar (when all applied with default settings). The largest differences are probably for row 2 and row 4 during the early season (low NDVI values). The Savitzky-Golay filter shows small fluctuations before the main season (when NDVI is relatively low) because it more closely follows the original data points that seem to indicate a small increase of NDVI before the real season starts. See also the green arrows in the figure below. Instead, the Assymetric Gaussian and Double Logistic simply model a single green-up. To understand why the NDVI itself is showing this behaviour may require further field knowledge. It could for example be due to cloudy conditions during the early season, but also because of mixed vegetation types with different start of green-up.



2. The fitted profile becomes as a whole somewhat higher (larger NDVI values), because the values larger than the initial fitted value receive more weight in the next fitting. For most points the differences are relatively small, and do not substantially affect the temporal pattern. However, this need not be the case everywhere. For our sample points, the largest difference is again for row 2 (see figure below, for example near the green arrow). Particularly when the data are more noisy (as in the figure below near the green arrow) the iterative fitting will have a greater impact.



3. The threshold for determining SOS/EOS is determined as being at the NDVI level corresponding to 50% (therefore the setting 0.5) of the amplitude. For EOS the programme looks at the amplitude between maximum and the subsequent minimum. For SOS the programme looks at the amplitude between the same maximum and the minimum level before that.
4. An "absolute value" threshold means that the SOS/EOS are determined when the fitted curve attains the NDVI-value of 0.5. In 2014 and 2016 this value is not attained. In 2017 the fitted curve does seem to attain the value, and I am not sure why TIMESAT does not retrieve SOS/EOS. Possibly this is because only two fitted dekad values are slightly larger than 0.5, making the retrieved season too short to be considered correct by the programme.
5. For "relative amplitude" also a single threshold value is obtained for the entire pixel time series, just as with "absolute value". While for our sample pixels the threshold corresponding to the relative amplitude is slightly lower (when keeping the parameters below constant at 0.5), this lower threshold is not the main difference. Rather the main difference is the fact that per-pixel the threshold can change because it depends on the amplitude of the data. This is generally desirable because in an image we may find pixels with varying amplitudes, whereby a fixed absolute value threshold may result in no retrievals when the NDVI for that pixel does not reach that threshold level. See also Section 4.3 and Figure 15 (p.24-25) of the TIMESAT user manual.
6. If the threshold is set to lower values, this in general means that the SOS date will become earlier, because the fitted curve reaches than value sooner. Similarly for EOS, the date will become later.
7. There will be no retrieval. The 0.1 threshold is not reached for that year. If cannot find both an SOS and EOS, it will not return any estimate on phenological parameters.



8. For row 6, clearly in 2016 the maximum NDVI was only 0.36, whereas in other years the value was around 0.8. Because I have not been in the area during that time, I can only explain it by saying that there was less green vegetation development during that year. While drought could be a factor, likely this can also be related to conflict/security. Based on Google Earth imagery, the area seems to me a wheat growing area, and perhaps that year no crop was grown. Based on your own knowledge and/or through studying media-reports, you may be able to gain a better understanding of the causes of these vegetation dynamics.
9. The retrieved dates for row 6 are in the Table pasted below. The year 2014 corresponds to the first line of data (season=1), because phenology is not estimated for 2013. So for 2014 the SOS-date (Start t.) is 40.35. This relates to dekad numbers. If we first subtract a full year (=36 dekads), then we have 4.35 for SOS. This means

somewhere between dekad 4 and 5. Dekad 4 corresponds to 1-10 February, and dekad 5 to 11-20 February. In Section 2 of the practical we explained that we may interpret each dekad as being assigned to its mid-date. To be very precise then dekad 4 would correspond to 5.5 February, and dekad 5 to 15.5 February. Now we only need to add 0.35 (because the value is 4.35) times 10 days = 3.5 days to 5.5 February, so our start of season date should correspond to 9 February 2014.

Logistic fit:							
Seas.	Start t.	End t.	Length	Base val.	Peak t.	Peak val.	Ampl.
1	40.35	50.59	10.24	0.1435	46.60	0.8093	0.6658
2	68.46	86.75	18.29	0.1240	80.63	0.8052	0.6811
3	112.2	120.9	8.673	0.1194	117.1	0.3495	0.2300
4	150.7	158.8	8.094	0.1190	155.2	0.7526	0.6336

10. For the next season we have a retrieval of Start t. of 68.46. We note that we cannot subtract two full years (2*36dekads=72), meaning that the SOS is still in 2014. Subtracting 36 dekads gives 32.46, so the SOS is between dekad 32 and 33. Dekad 32 corresponds to 11-20 November (mid-date 15.5 November), and dekad 33 to 20-30 November (mid-date 25.5 November. Following the logic of the previous question, we then get a SOS of 20 November. The answer is therefore 20 November 2014. This example shows that seasons can span multiple calendar years.
    a. Try to find an explanation why the season started so much earlier in this season as compared to the SOS of question 9. Is a different crop cultivated with a longer season? Is no crop cultivated in this year, but does the natural vegetation simply emerge without soil cultivation (e.g. ploughing) taking place? Does it link to weather differences between the years? I do not know, but the difference is striking.
11. The smallest is 2016 (3.115), followed by 2017 (4.760), 2014 (6.126) and 2015 (11.19).
12. The length of the season is reported as "Length" in the table above. Again, the length is report in dekads. For ease of calculation, let's assume that a month has 30 days, then we get:
    a. 2014: 10.24 dekads = 3.4133 months = 3 months + 12 days
    b. 2015: 18.29 dekads = 6.0967 months = 6 months + 3 days
    c. 2016: 8.673 dekads = 2.891 months = 2 months + 27 days
    d. 2017: 8.094 dekads = 2.698 months = 2 months + 21 days

    We can thus observe a large variability in season length, with particularly 2015 having a very long vegetation season as compared to the others.
13. Indeed for almost all rows the 2015 season (that year with an SOS generally at the end of 2014) is much longer than the other years, often by several months. The only exception is for row 4, for which also in 2014 a relatively long season is detected.