Small water stable isotopes

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Introduction

In this example, you'll work with a $\delta^{15}N$ isotope record from Small Water, a small corrie lake in the UK Lake District. Begin by loading some packages

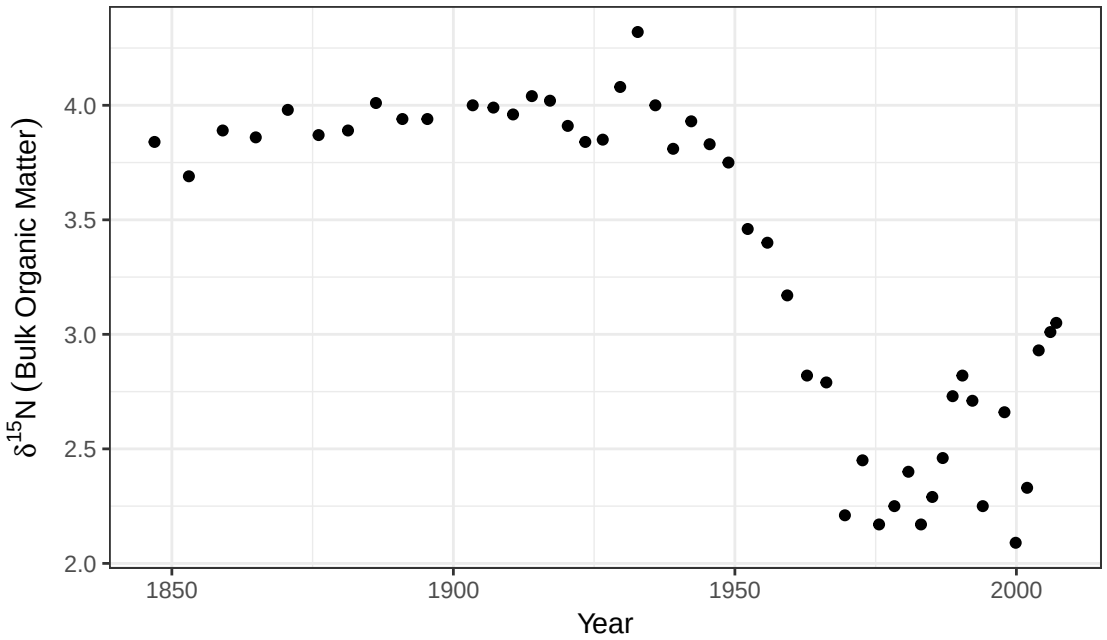
```
library("mgcv")
library("ggplot2")
theme_set(theme_bw())
```

```
  Depth   d13C  TotalC d15N TotalN DryWeight     Year
1   0.2 -27.57  806.49 3.05  64.21       8.2 2007.083
2   0.4 -27.67  949.33 3.01  73.26       7.6 2006.039
3   0.8 -27.63 1305.52 2.93  93.25      11.6 2003.960
4   1.2 -27.62 1136.04 2.33  86.09       9.6 2001.902
5   1.6 -27.48 1028.27 2.09  93.80      10.9 1999.872
6   2.0 -27.39  809.91 2.66  79.98       9.9 1997.878
```

Next load the data

```
small <- readRDS("small-water-isotope-data.rds")
head(small)
```

Next we prepare a plot of the data using **ggplot2**

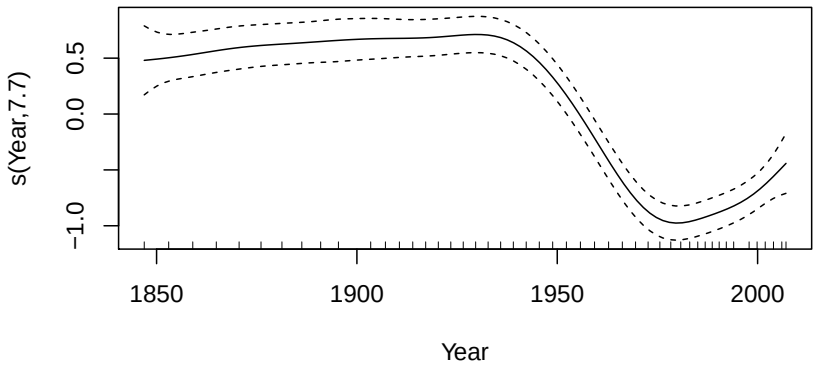


To fit a GAM with an autocorrelation structure we need the `gamm()` function, with an extra "m"

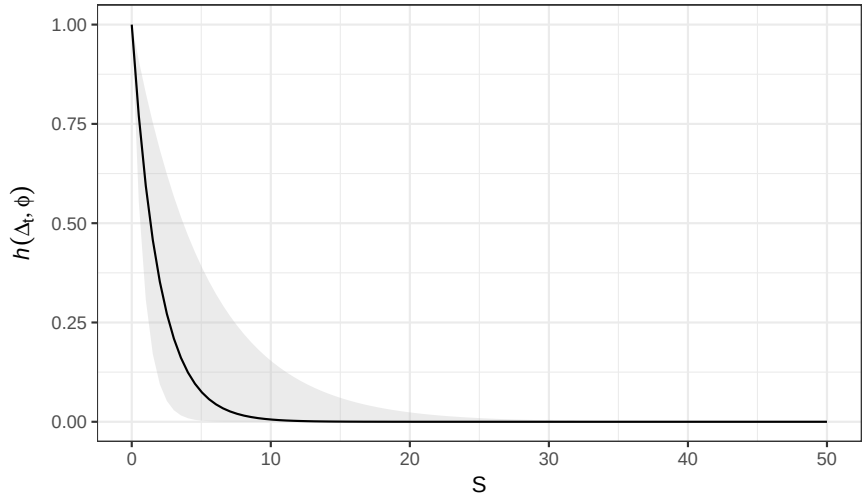
The `gamm()` function fits using a mixed model and as such as two different sides, a GAM side and a mixed model side. We need to look at each side to get out relevant information. the `intervals()` function extracts a confidence interval and estimate for the ϕ parameter which is the measure of autocorrelation

```
Family: gaussian
Link function: identity

Formula:
d15N ~ s(Year, k = 15)

Parametric coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.30628    0.03363    98.3   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
          edf Ref.df     F p-value
s(Year) 7.702  7.702 52.06  <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.932
  Scale est. = 0.034952  n = 48
```

```
Approximate 95% confidence intervals

 Random Effects:
  Level: g
              lower     est.    upper
sd(Xr - 1) 4.610843 15.79172 53.72186

 Correlation structure:
        lower      est.     upper
Phi 0.3109821 0.5968837 0.8292791
attr(,"label")
[1] "Correlation structure:"

 Within-group standard error:
    lower      est.     upper
0.1424442 0.1869542 0.2453725
```



What does this correlation function look like? Here we pull out details of the structure and draw the corresponding correlation function



The fitted model and data can be plotted using the code below