1. Sea surface temperatur

   (a) Estimate of the slope is 0.004658, with p-value=0.0390

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -9.327356   4.460400  -2.091   0.0369 *
Date         0.004658   0.002252   2.068   0.0390 *
```

   (b) $F = \frac{(SS_R - SS_F)/(df_R - df_F)}{SS_F/df_F} \sim F_{df_F - df_R, df_F}$, so we have a p-value<0.0001

```
                                      Df       SumSq      Mean Sq
Full Model(Penalized Spline)      709.583  629.5491      0.88721
Reduce Model(linear)               733     854.18        1.1653
```

   (c) df for Penalized spline with spar=5 is 21.43, and df for Penalized spline with default spar is 4.425. Penalized spline with spar=5 is "wigglier".

```
                df     spar knots
f(Date,spar=5) 21.43    5    34
f(Date)        4.425 73.04    34
```

   (d) Penalized spline curves with default spar is estimating long-term trends. Penalized spline curves with spar=5 is estimating short-term oscillations.

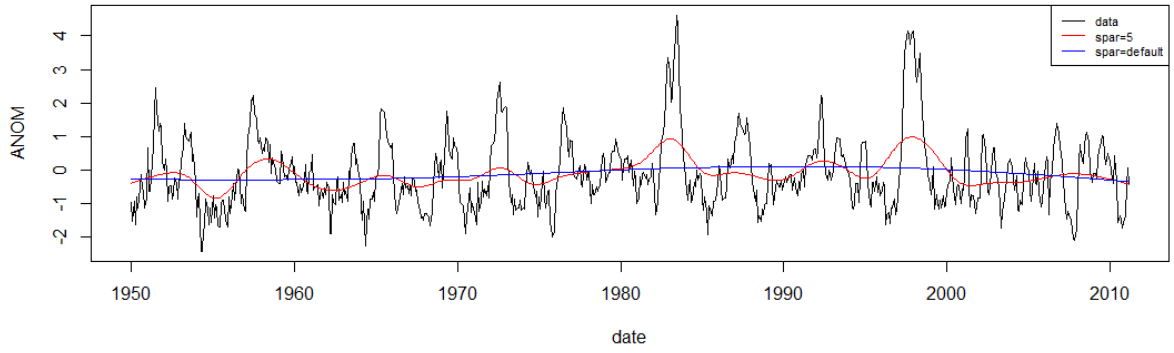

Figure 1: Temperature over time, overlay with penalized spline curves

2. fossil

   (a) The estimated smoothing parameter is 2.927. The model d.f. associated with this smooth is 12.15

```
           df  spar knots
f(age) 12.15 2.927    25
```

   (b) 95% prediction interval for the strontium ratio of shells that are 115.236 Myr's old is (0.70719, 0.70729)