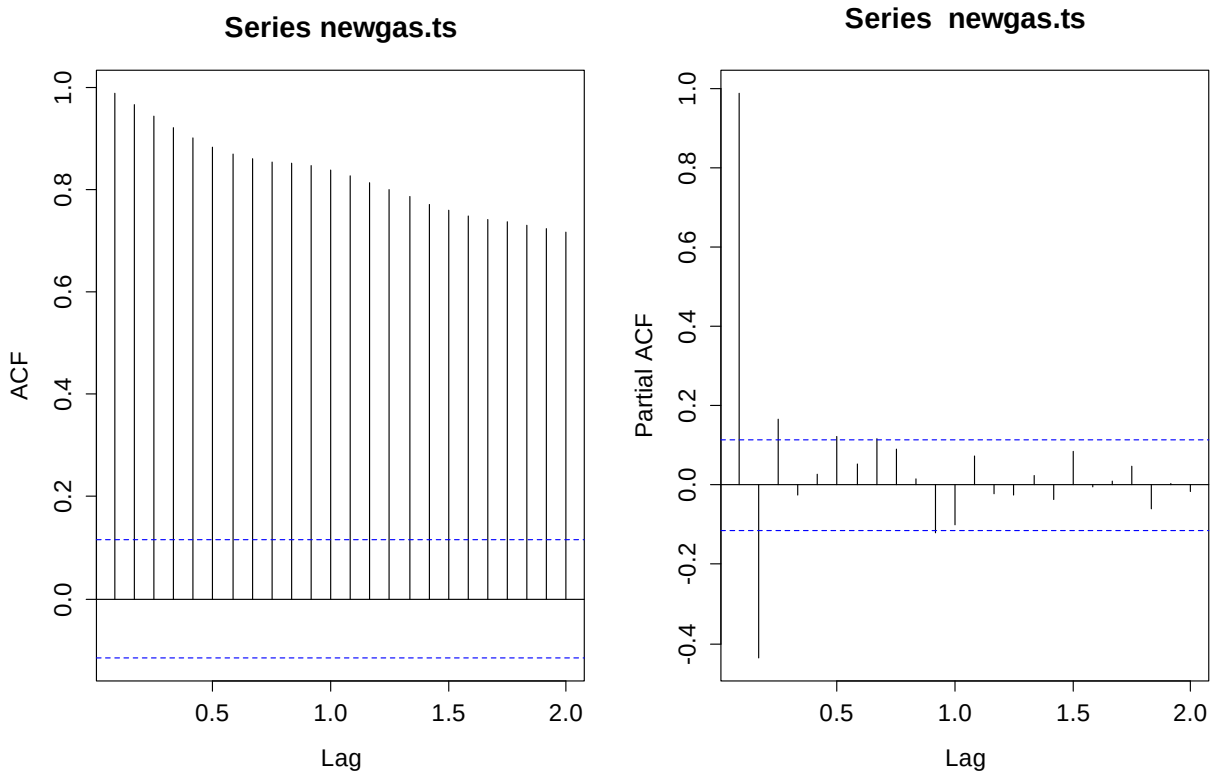
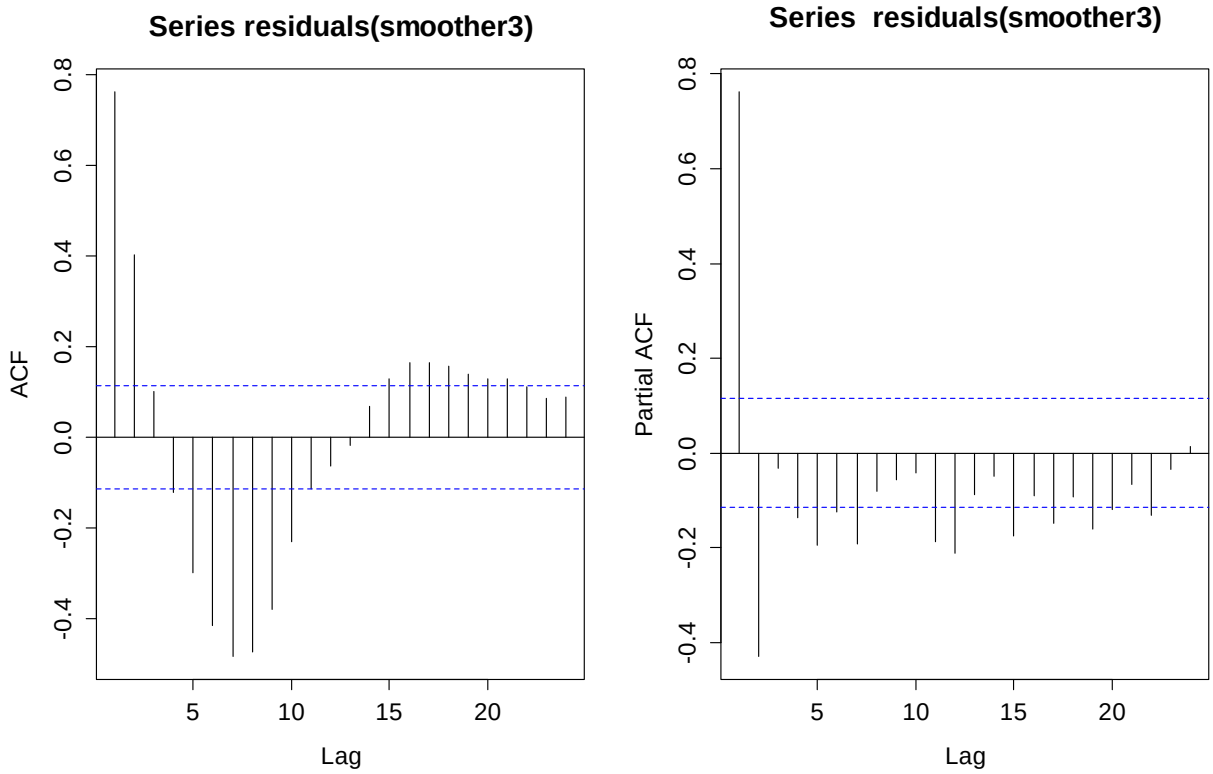
ACF of the updated gas price time series:



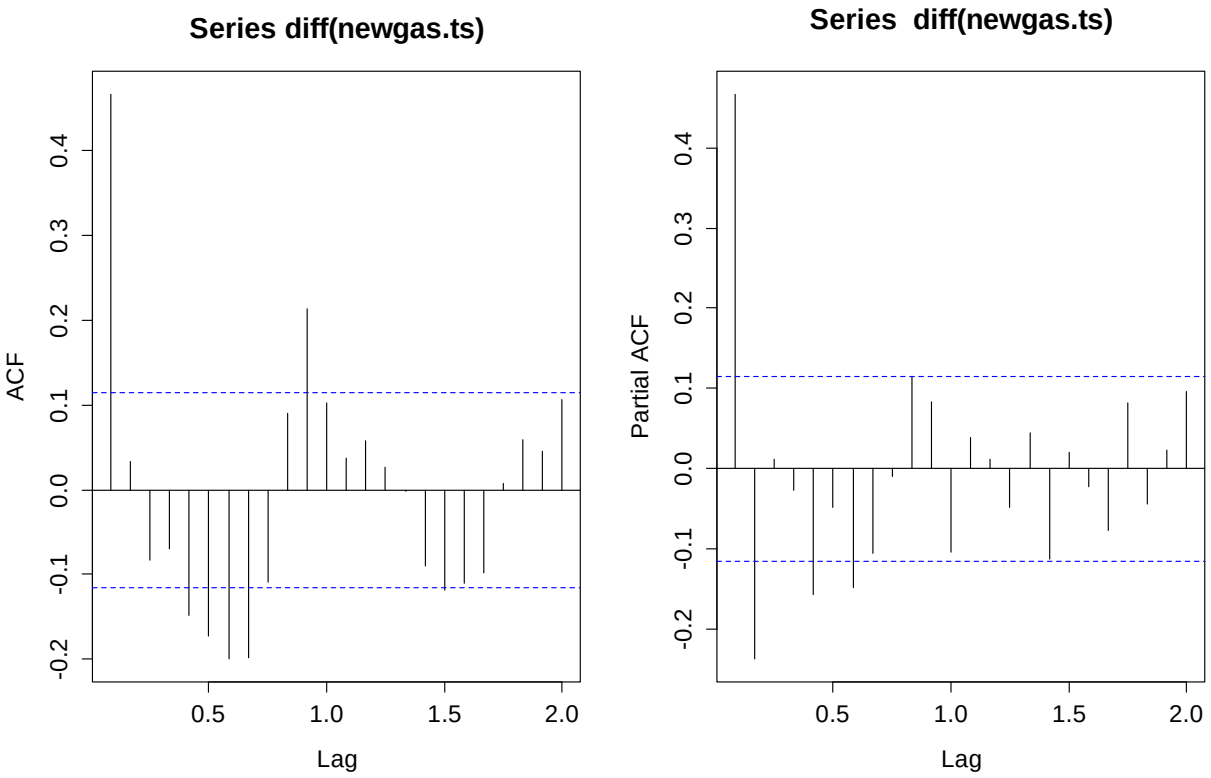
We can see a noticeable improvement in the level of autocorrelation based on incorporating the trend+seasonal model in "smoother1"

```
> require(mgcv)
>  smoother3<-gam(newgas.ts~s(time(newgas.ts),k=25,bs="ts")+s(cycle(newgas.ts
),bs="cc",k=12))
>  acf(residuals(smoother3))
>  pacf(residuals(smoother3))
```



Maybe differencing can make a non-stationary process into a stationary process, so let's try that:

```
> acf(diff(newgas.ts))
>  pacf(diff(newgas.ts))
```



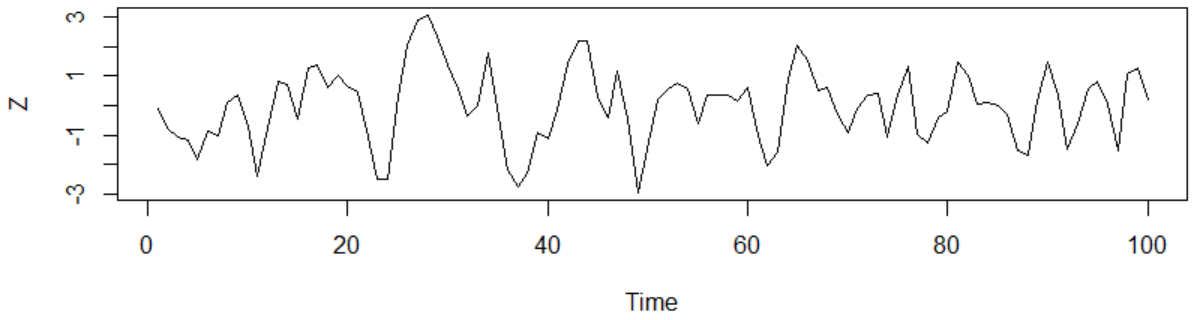
Order 2 Autoregression: The current observation is linearly related to previous observations:

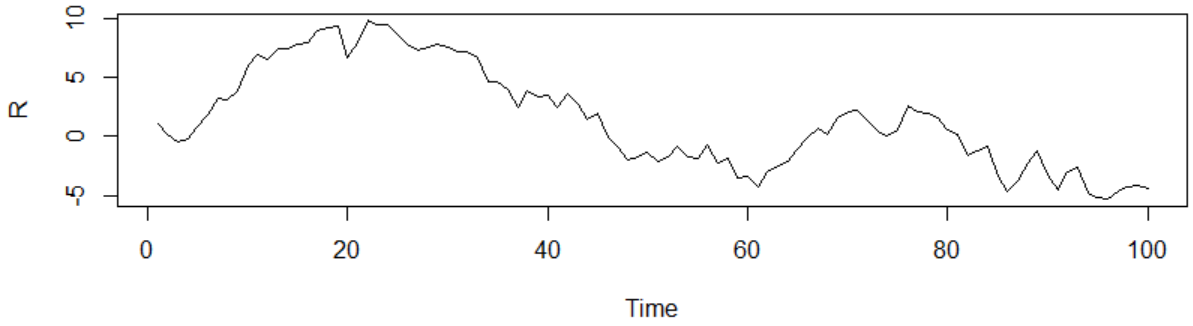
- For example: $Y_t = .8Y_{t-1} - .3Y_{t-2} + e_t$

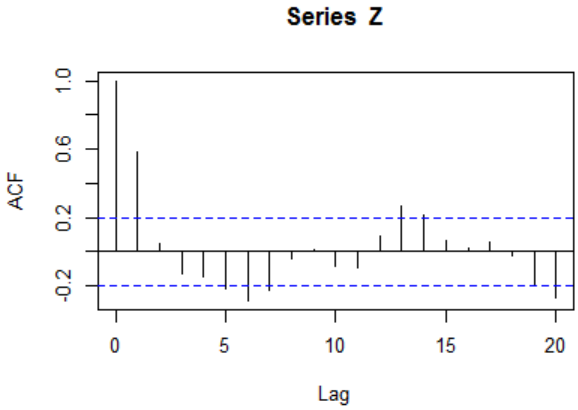
`arima.sim` provides an easy way generate a simulated TS with a particular autoregressive structures:

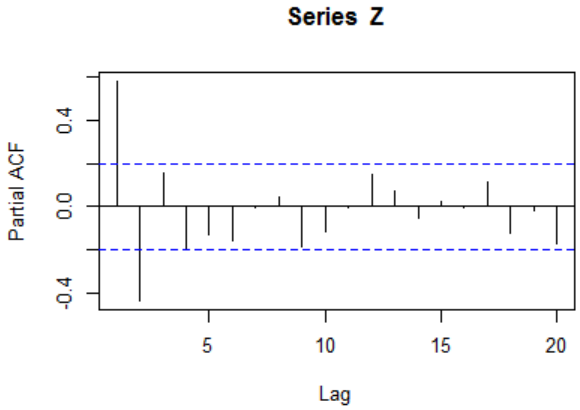
```
> set.seed(13579)
>  par(mfrow=c(2,1))
>  Z<-arima.sim(n=100,model=list(ar=c(0.8,-0.3)))
>  plot(Z)


>  R<-arima.sim(n=100,model=list(ar=c(.99)))
>  plot(R)
```

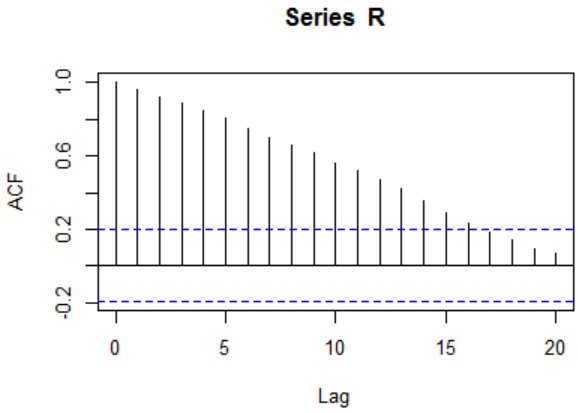
```
> par(mfrow=c(2,2))
>  acf(Z)
>  pacf(Z)
>  acf(R)
>  pacf(R)
```

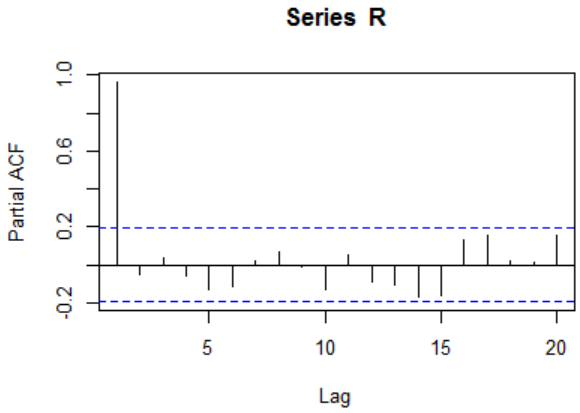






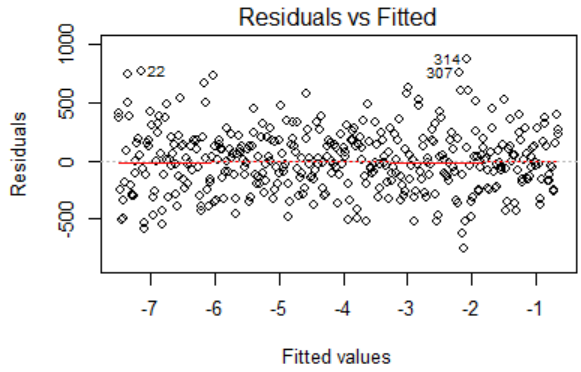


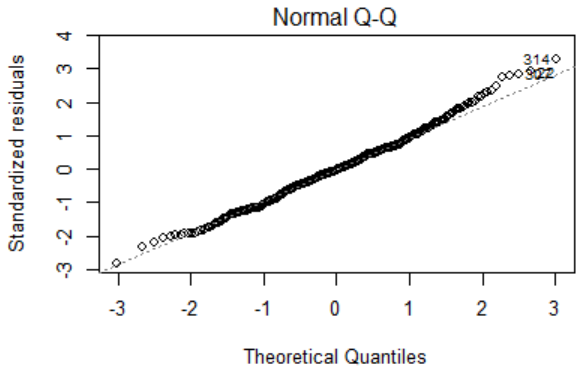


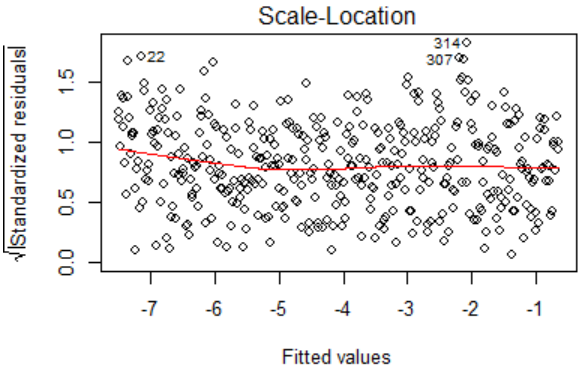


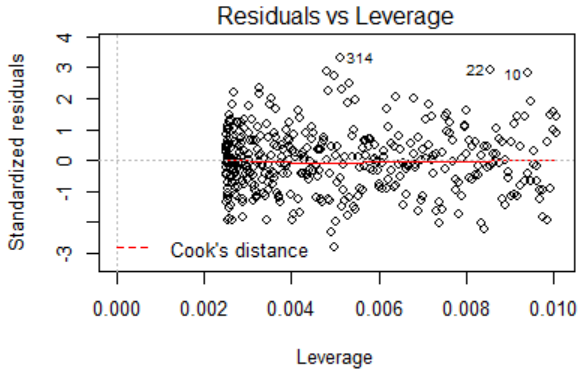
If you have missing observations, you can use `acf(Y,na.action=na.pass)`

```
> m1<-lm(wavets~time(wavets))
>  plot(m1)
```










```
>  require(nlme)
>  gls_ar1<-gls(wavets~time(wavets),correlation=corAR1())
>  summary(gls_ar1)
Generalized least squares fit by REML
  Model: wavets ~ time(wavets)
  Data: NULL
       AIC      BIC    logLik
  5448.437 5464.342 -2720.218

Correlation Structure: AR(1)
 Formula: ~1
 Parameter estimate(s):
      Phi
0.4798266

Coefficients:
                 Value Std.Error     t-value p-value
(Intercept)  -5.122120  45.28790 -0.11310130  0.9100
time(wavets)  0.012364   0.19748  0.06260998  0.9501

Residual standard error: 268.2062
Degrees of freedom: 396 total; 394 residual
>  gls_ar2<-gls(wavets~time(wavets),correlation=corARMA(p=2,q=0))
>  summary(gls_ar2)
Generalized least squares fit by REML
  Model: wavets ~ time(wavets)
  Data: NULL
      AIC      BIC   logLik
  5259.52 5279.402 -2624.76

Correlation Structure: ARMA(2,0)
```

```
 Formula: ~1
 Parameter estimate(s):
      Phi1       Phi2
 0.7653410 -0.6216623

Coefficients:
                Value Std.Error    t-value p-value
(Intercept)  -9.158543 21.712744 -0.4218050  0.6734
time(wavets)  0.020608  0.094856  0.2172527  0.8281

Residual standard error: 266.4447
Degrees of freedom: 396 total; 394 residual
>  par(mfrow=c(2,2))
>  acf(residuals(gls_ar1))
>  acf(residuals(gls_ar1,type="normalized"))
>  acf(residuals(gls_ar2))
>  acf(residuals(gls_ar2,type="normalized"))
```