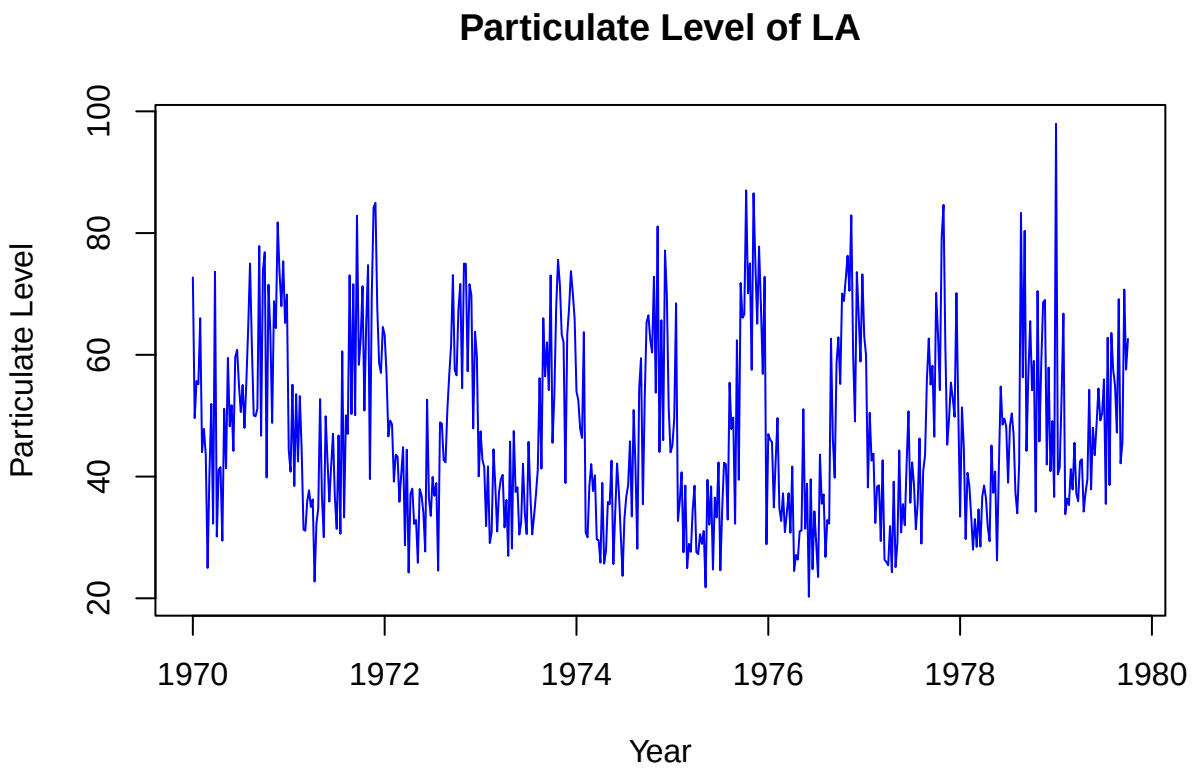
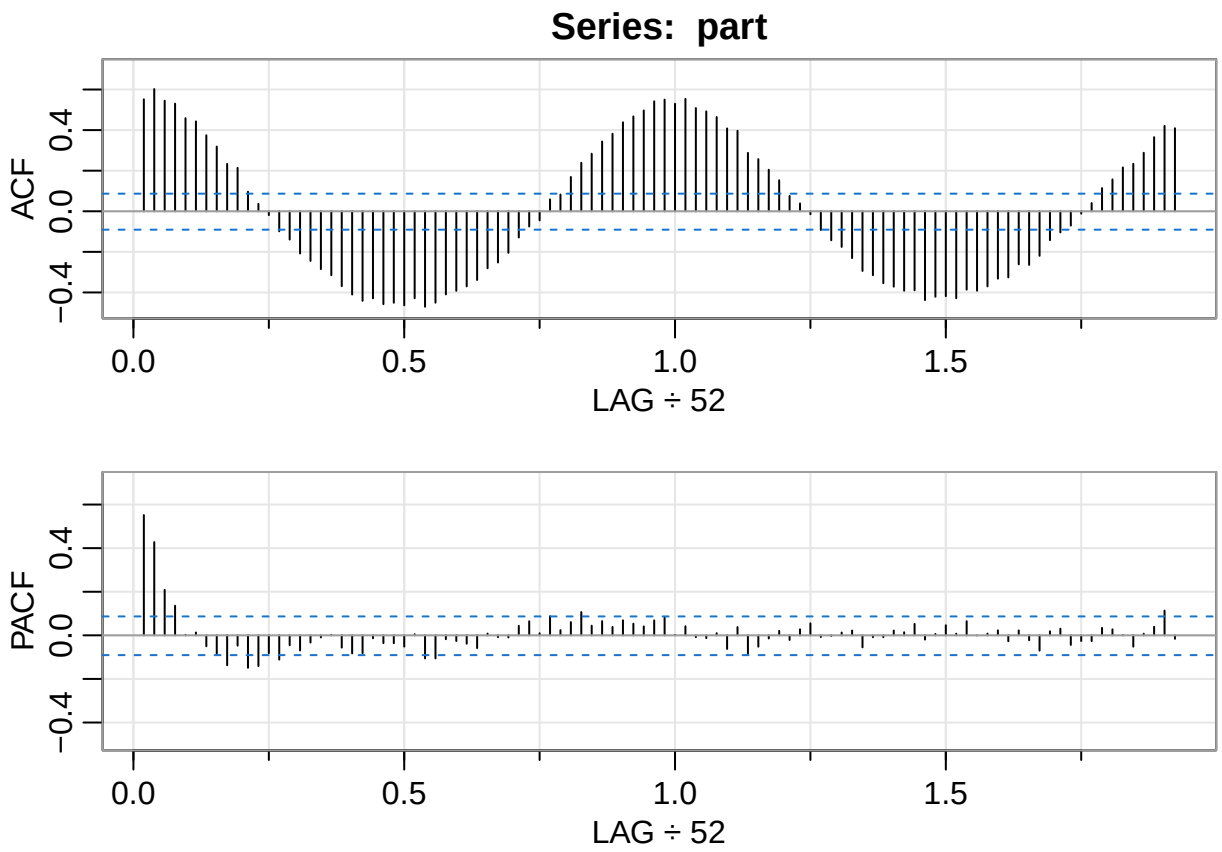
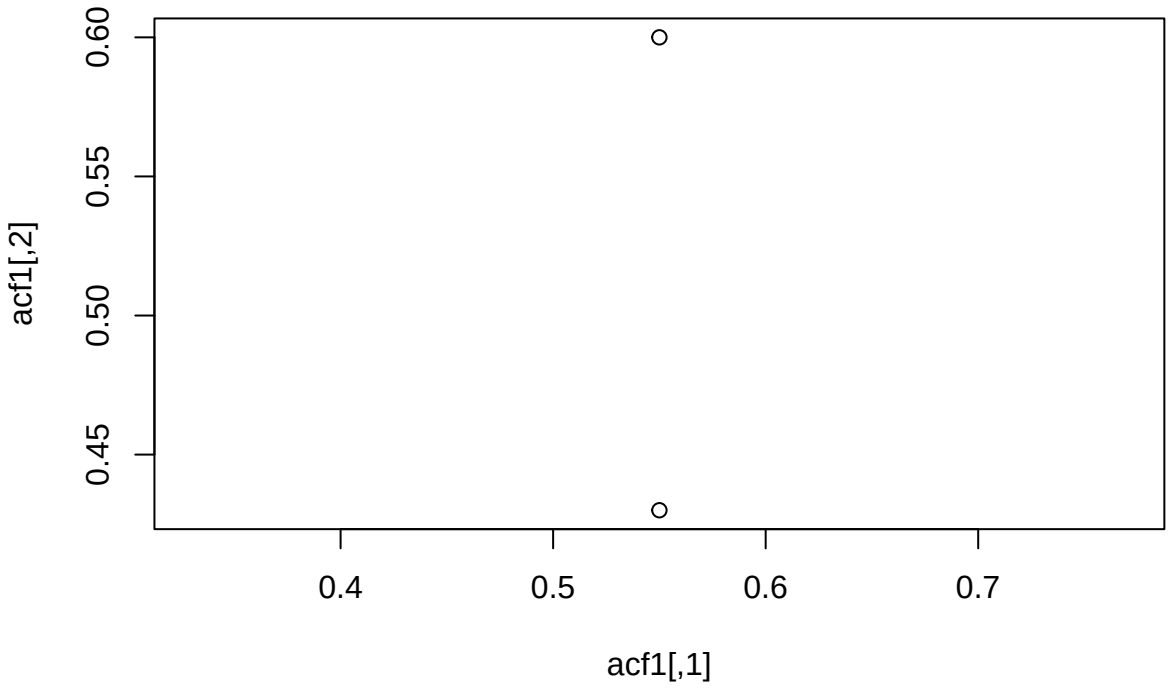
```
library(astsa)
data(part)
plot(part, xlab="Year", ylab="Particulate Level", col="blue", main="Particulate Level of LA")
```



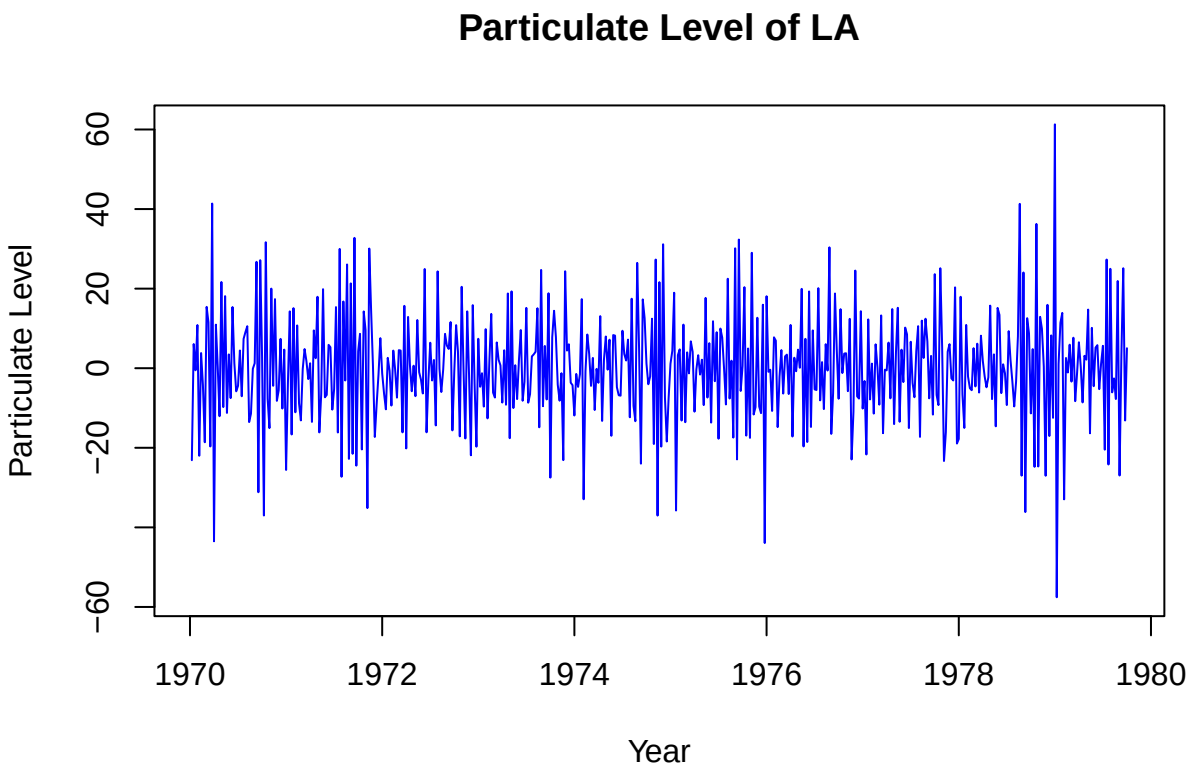

```
acf1 = acf2(part,100)
```


Series: part
ACF
0.4
0.0
−0.4
0.0
0.5
1.0
1.5
LAG ÷ 52
PACF
0.4
0.0
−0.4
0.0
0.5
1.0
1.5
LAG ÷ 52

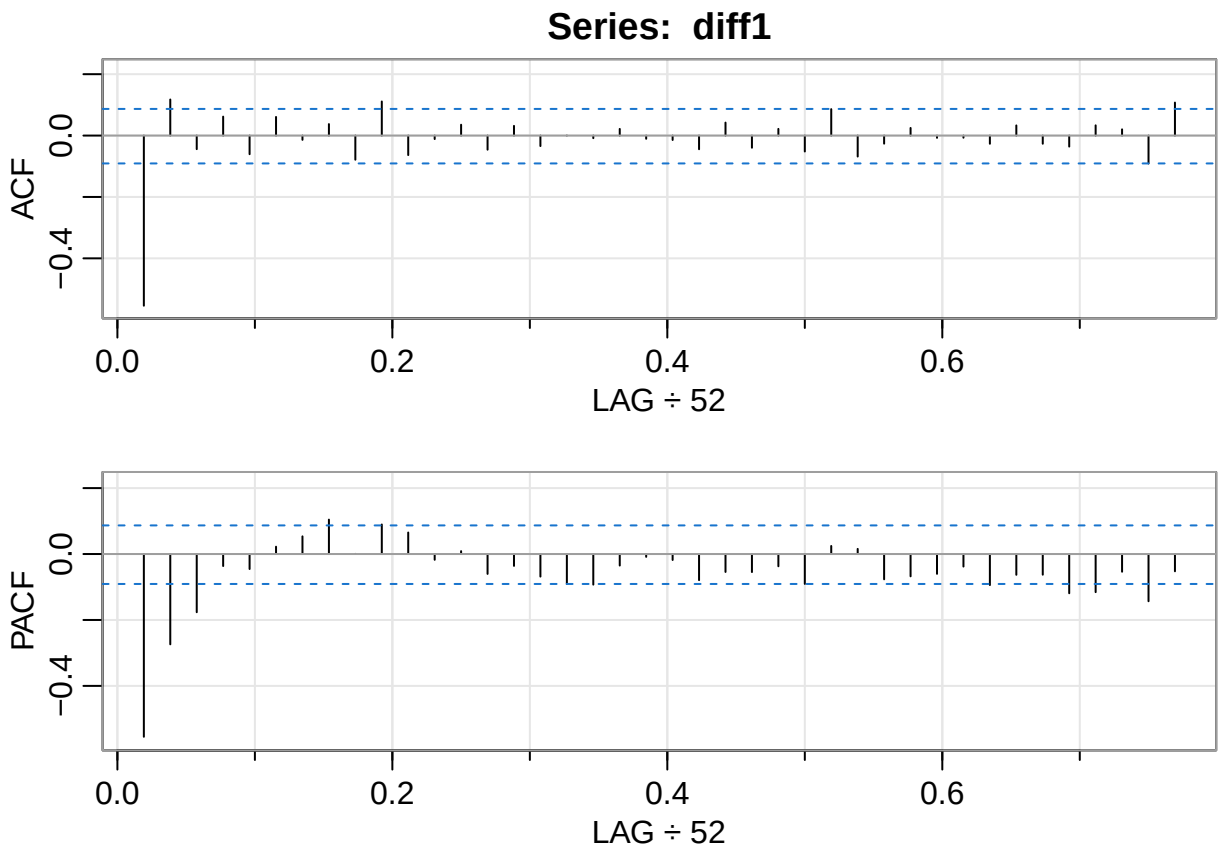
```
plot(acf1)
```



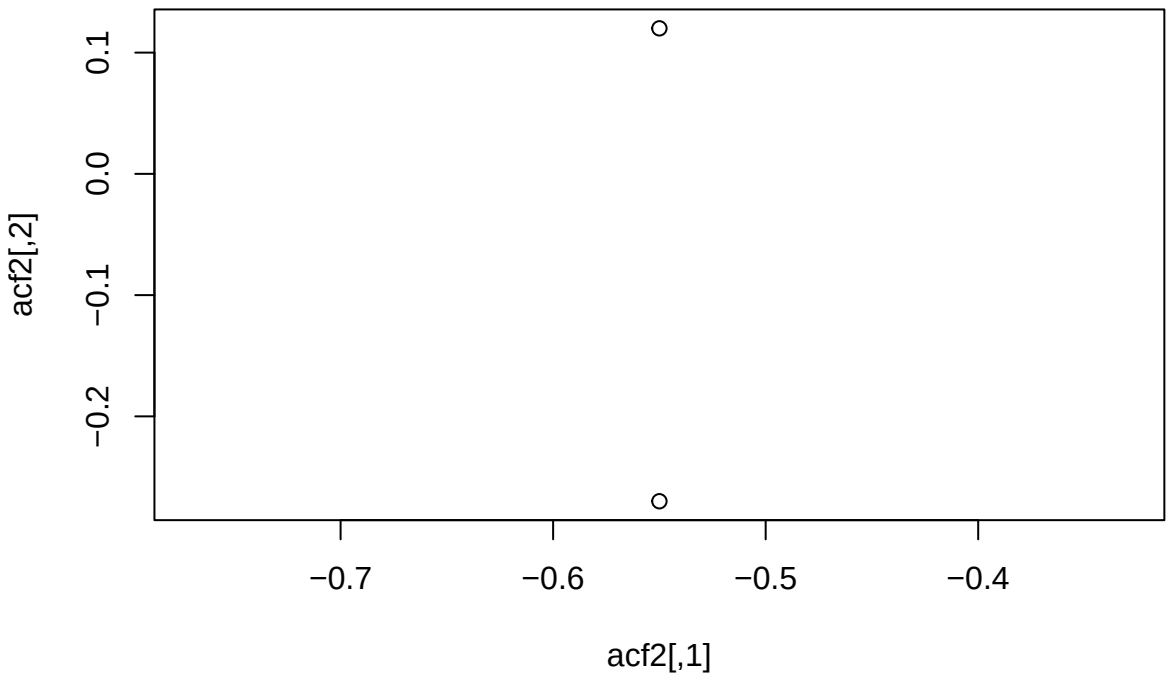

```
diff1 = diff(part)
plot(diff1, xlab="Year", ylab="Particulate Level", col="blue", main="Particulate Level of LA")
```




```
acf2 = acf2(diff1,max.lag=40)
```


Series: diff1
ACF
0.0
−0.4
0.0
0.2
0.4
0.6
LAG ÷ 52
PACF
0.0
−0.4
0.0
0.2
0.4
0.6
LAG ÷ 52

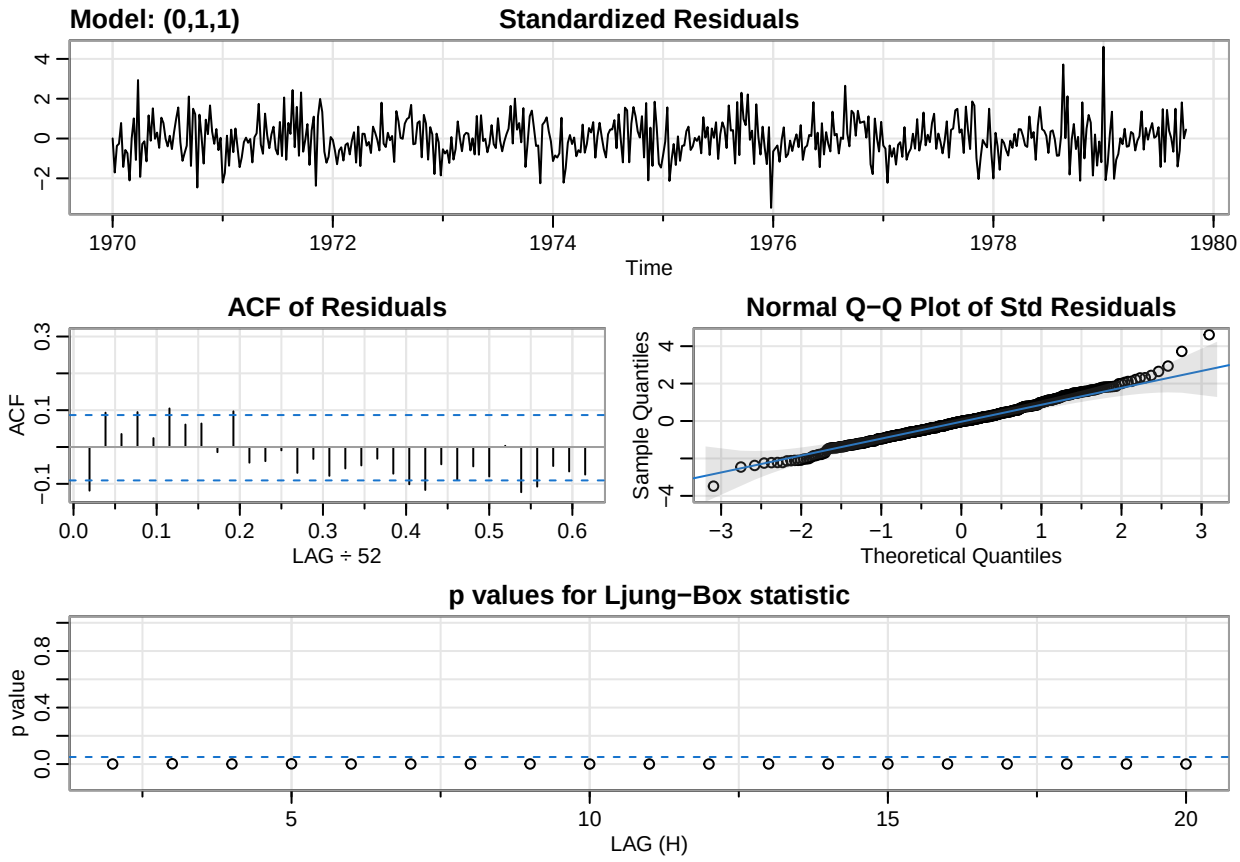
```
plot(acf2)
```




```
# first model ARIMA(0,1,1) or ARIMA(1,1,1)
```

```
ARIMA1 = sarima(part, 0,1,1, details = TRUE)
```

```
## initial  value 2.658350
## iter   2 value 2.443989
## iter   3 value 2.438417
## iter   4 value 2.436966
## iter   5 value 2.436796
## iter   6 value 2.436793
## iter   7 value 2.436792
## iter   8 value 2.436792
## iter   8 value 2.436792
## iter   8 value 2.436792
## final  value 2.436792
## converged
## initial  value 2.435162
## iter   2 value 2.435144
## iter   3 value 2.435138
## iter   3 value 2.435138
## iter   3 value 2.435138
## final  value 2.435138
## converged
```



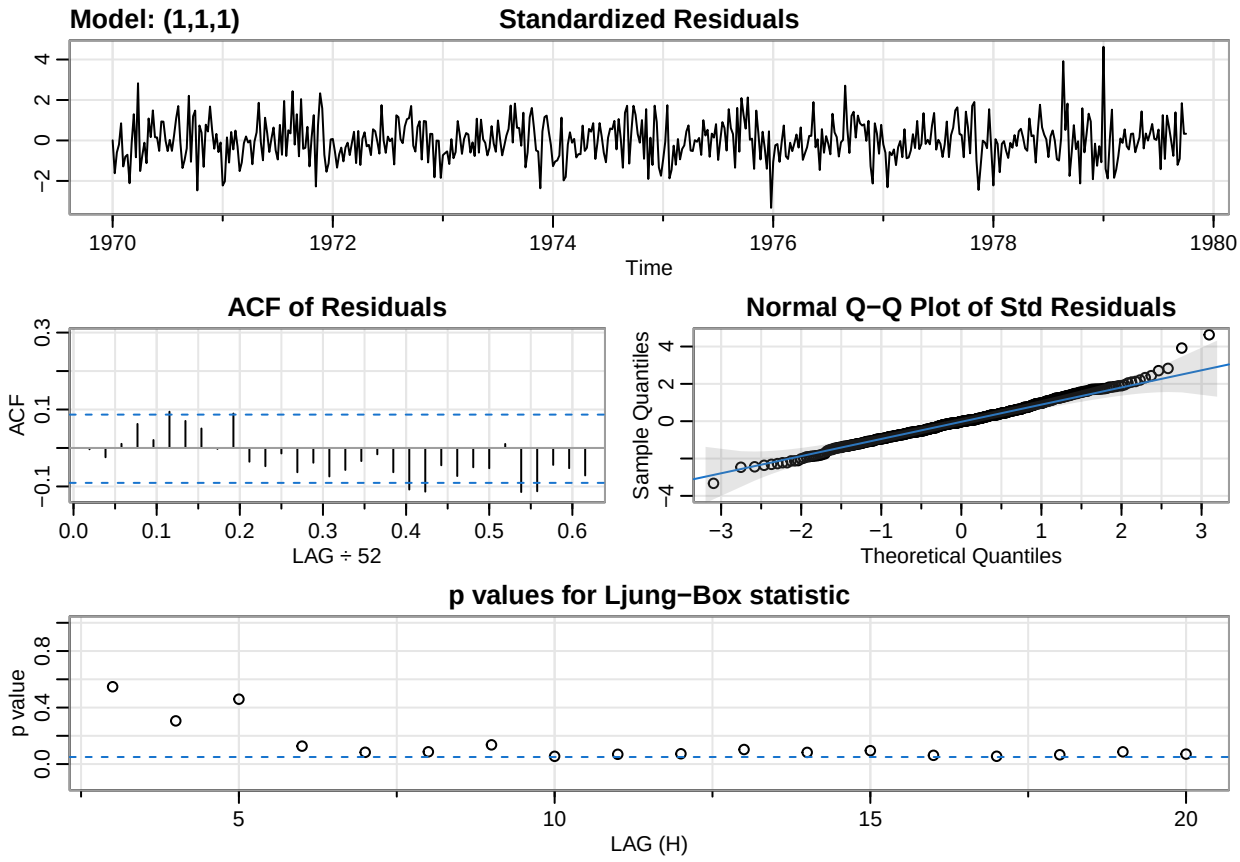

```
ARIMA1
```

```
## $fit
##
## Call:
## arima(x = xdata, order = c(p, d, q), seasonal = list(order = c(P, D, Q), period = S),
##     xreg = constant, transform.pars = trans, fixed = fixed, optim.control = list(trace = trc,
##         REPORT = 1, reltol = tol))
##
## Coefficients:
##           ma1  constant
##       -0.6410   -0.0005
## s.e.   0.0279    0.1826
##
## sigma^2 estimated as 130.2:  log likelihood = -1954.02,  aic = 3914.03
##
## $degrees_of_freedom
## [1] 505
##
## $ttable
##          Estimate     SE  t.value p.value
## ma1       -0.6410 0.0279 -22.9570  0.0000
## constant  -0.0005 0.1826  -0.0027  0.9979
##
## $AIC
## [1] 7.719987
```

```
##
## $AICc
## [1] 7.720034
##
## $BIC
## [1] 7.745007
```

```
ARIMA2 = sarima(part, 1,1,1, details = TRUE)
```

```
## initial  value 2.656747
## iter   2 value 2.477600
## iter   3 value 2.425108
## iter   4 value 2.420577
## iter   5 value 2.417888
## iter   6 value 2.417125
## iter   7 value 2.417056
## iter   8 value 2.417052
## iter   8 value 2.417052
## final  value 2.417052
## converged
## initial  value 2.419684
## iter   2 value 2.419681
## iter   3 value 2.419680
## iter   4 value 2.419679
## iter   5 value 2.419679
## iter   5 value 2.419679
## iter   5 value 2.419679
## final  value 2.419679
## converged
```

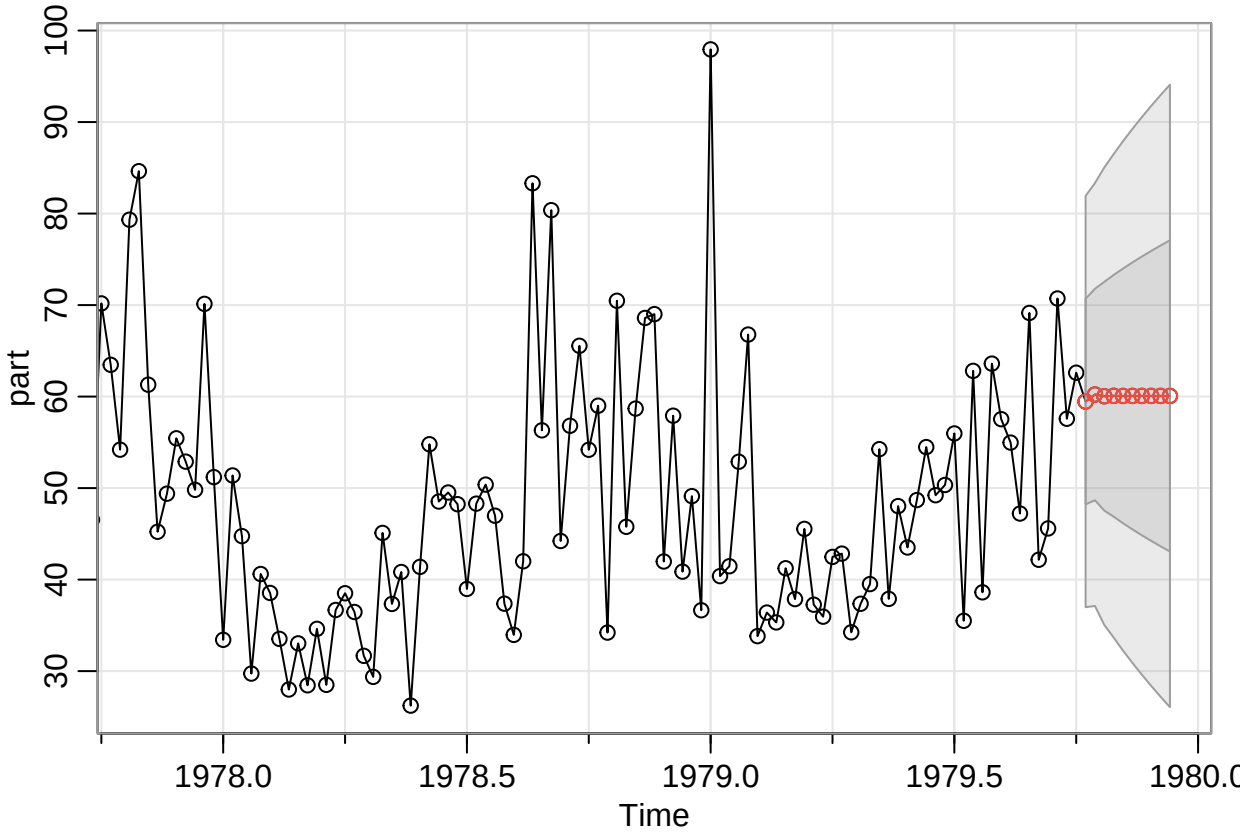



```
ARIMA2
```

```
## $fit
##
## Call:
## arima(x = xdata, order = c(p, d, q), seasonal = list(order = c(P, D, Q), period = S),
##     xreg = constant, transform.pars = trans, fixed = fixed, optim.control = list(trace = trc,
##         REPORT = 1, reltol = tol))
##
## Coefficients:
##           ar1      ma1  constant
##       -0.2444  -0.5162   -0.0004
## s.e.   0.0594   0.0489    0.1945
##
## sigma^2 estimated as 126.2:  log likelihood = -1946.18,  aic = 3900.36
##
## $degrees_of_freedom
## [1] 504
##
## $ttable
##          Estimate     SE  t.value p.value
## ar1       -0.2444 0.0594  -4.1152  0.0000
## ma1       -0.5162 0.0489 -10.5484  0.0000
## constant  -0.0004 0.1945  -0.0023  0.9982
##
## $AIC
```

```
## [1] 7.693015
##
## $AICc
## [1] 7.693109
##
## $BIC
## [1] 7.726376
```

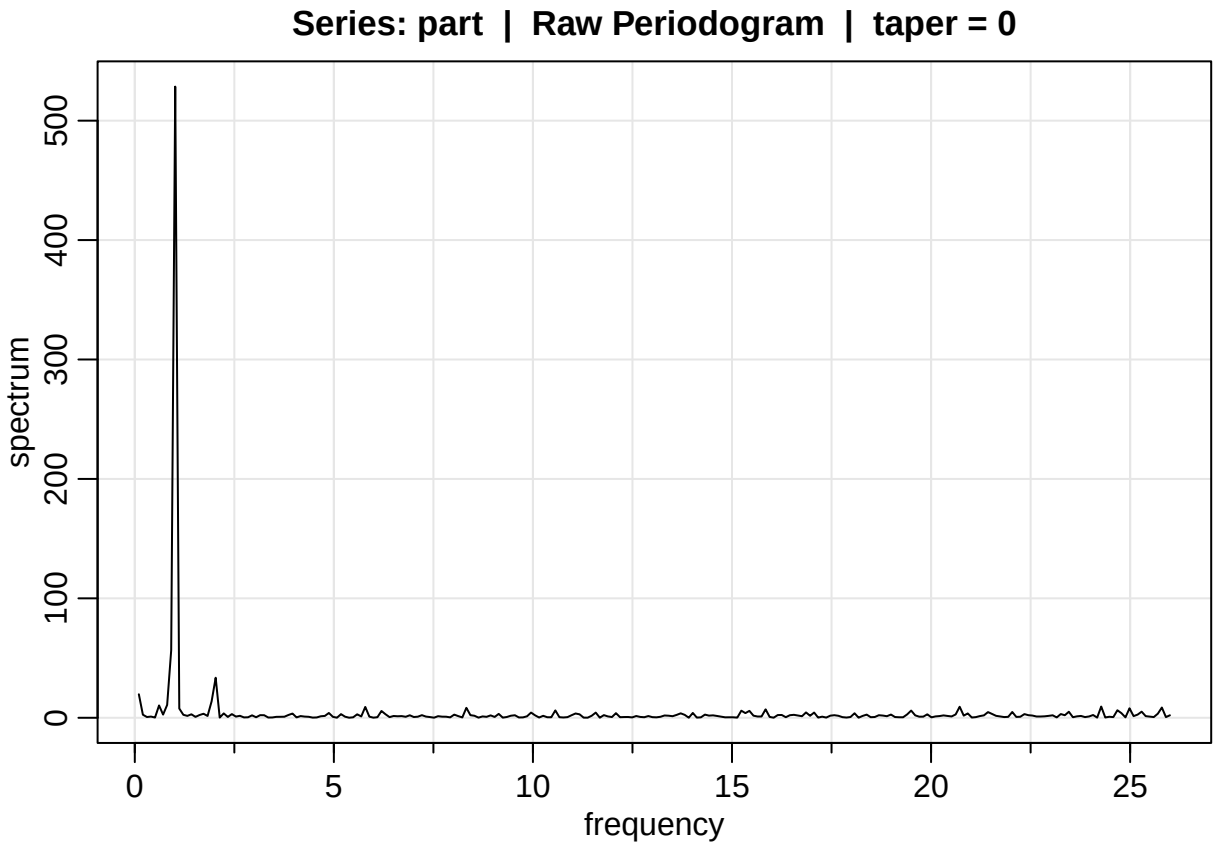
```
pred1 = sarima.for(part, 10, 1,1,1)
```




```
upper <- pred1$pred + qnorm(0.95) * pred1$se
lower <-pred1$pred - qnorm(0.95) * pred1$se
(data.frame("Prediction" = pred1$pred,
"PI 90% Lower Bound" = lower, "PI 90% Upper Bound" = upper))
```

```
##    Prediction PI.90..Lower.Bound PI.90..Upper.Bound
## 1    59.45651           40.97575           77.93727
## 2    60.22659           41.22333           79.22985
## 3    60.03786           39.47314           80.60258
## 4    60.08344           38.35325           81.81362
## 5    60.07175           37.17162           82.97189
## 6    60.07406           36.07594           84.07218
## 7    60.07295           35.02142           85.12448
## 8    60.07268           34.01110           86.13425
## 9    60.07220           33.03809           87.10630
## 10   60.07177           32.09898           88.04456
```

```
part.per = mvspec(part, log="no")
```




```
P1 = part.per$details[order(part.per$details[,3], decreasing="TRUE"),]
P1[1,1];P1[2,1];P1[3,1]
```

```
## frequency
##    1.0156

## frequency
##    0.9141

## frequency
##    2.0312
```

```
1/P1[1,1];1/P1[2,1];1/P1[3,1]
```

```
## frequency
## 0.9846396

## frequency
##  1.093972

## frequency
## 0.4923198
```

```r
part.u1 = 2*P1[1,3]/qchisq(0.1,2)
part.u2 = 2*P1[2,3]/qchisq(0.1,2)
part.u3 = 2*P1[3,3]/qchisq(0.1,2)
part.l1 = 2*P1[1,3]/qchisq(0.9,2)
part.l2 = 2*P1[2,3]/qchisq(0.9,2)
part.l3 = 2*P1[3,3]/qchisq(0.9,2)

result = data.frame(DF=c(P1[1,1],P1[2,1],P1[3,1]),Spec=c(P1[1,3],P1[2,3],P1[3,3]), Upper=c(part.u1, par
result
```

```
##       DF     Spec     Upper     Lower
## 1 1.0156 528.5134 5016.2378 229.53045
## 2 0.9141  56.5113  536.3613  24.54255
## 3 2.0312  33.5363  318.3005  14.56463
```

$$\delta X_t = X_t - X_{t-1}$$