Fertilizantes

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Matrícula:

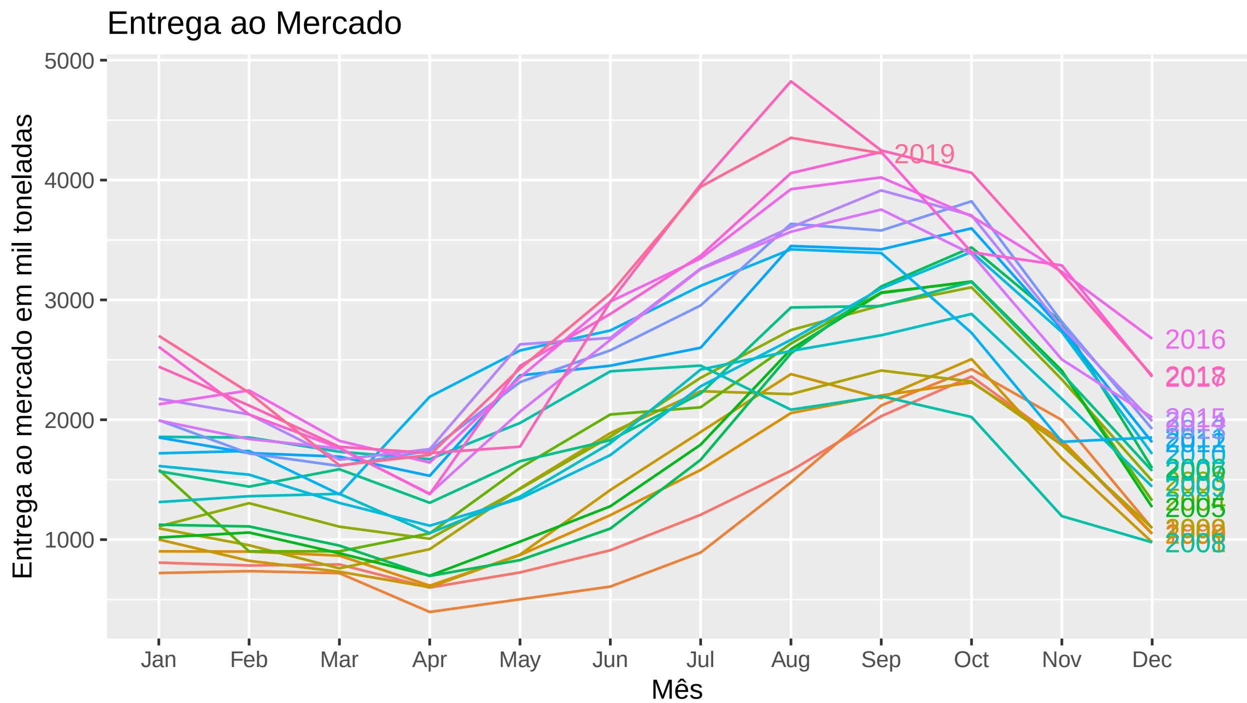
Load Data

```
df = read_excel("Fertilizantes.xlsx")
# Converter para timeseries com frequencia mensal
ts.total = ts(df$consumo, frequency = 12, start = c(1998,1))

# Separar em treino e teste
ts.train = window(ts.total,end = c(2017,12))
ts.test = window(ts.total, start = c(2018, 1))
```

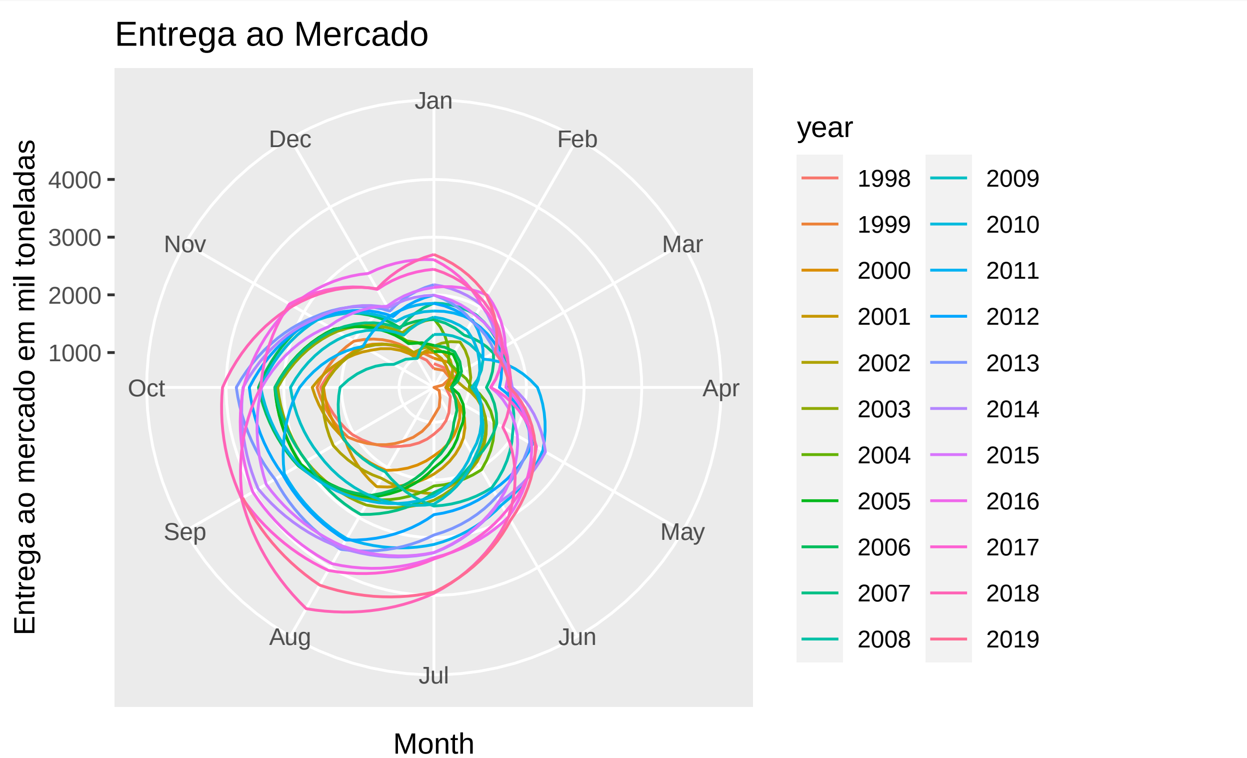
Plot data

```
autoplot(ts.total) + ggtitle("Fertilizantes Entregues ao mercado")+
  ylab("mil toneladas")
```

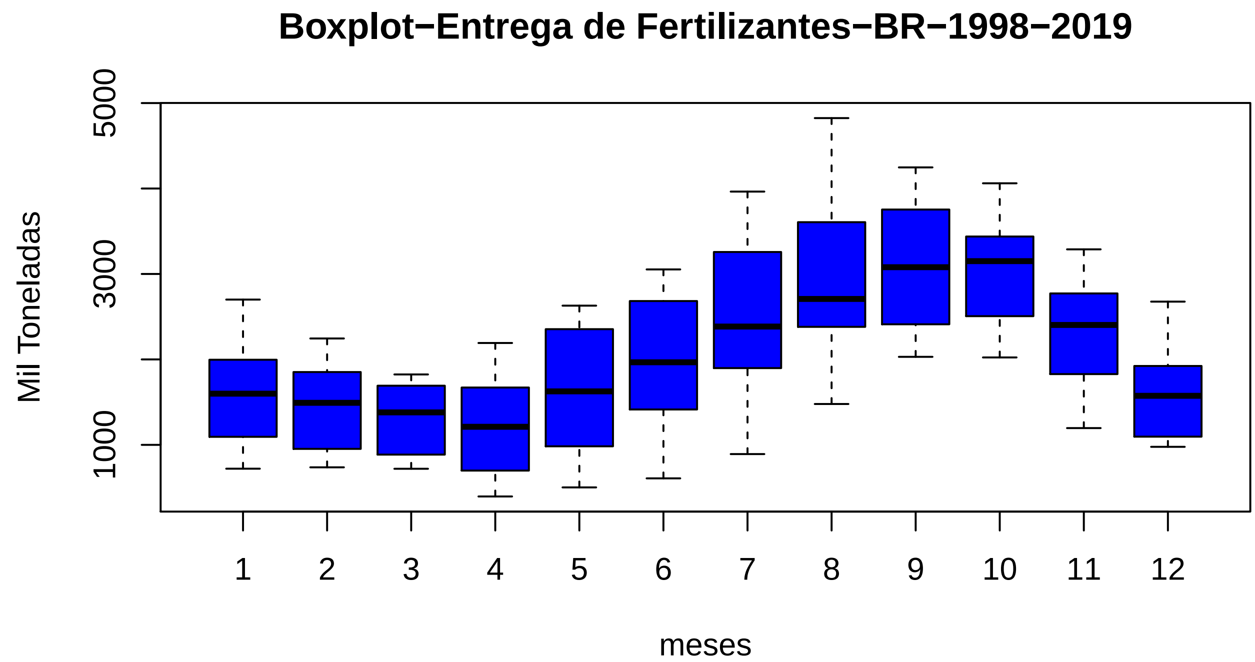
```r
ggseasonplot(ts.total, year.labels = TRUE, year.label.left = TRUE)+
  ggtitle("Entrega ao Mercado") +
  ylab("Entrega ao mercado em mil toneladas") + xlab("Mês")
```




```r
ggseasonplot(ts.total, polar=TRUE) +
  ylab("Entrega ao mercado em mil toneladas") +
  ggtitle("Entrega ao Mercado")
```



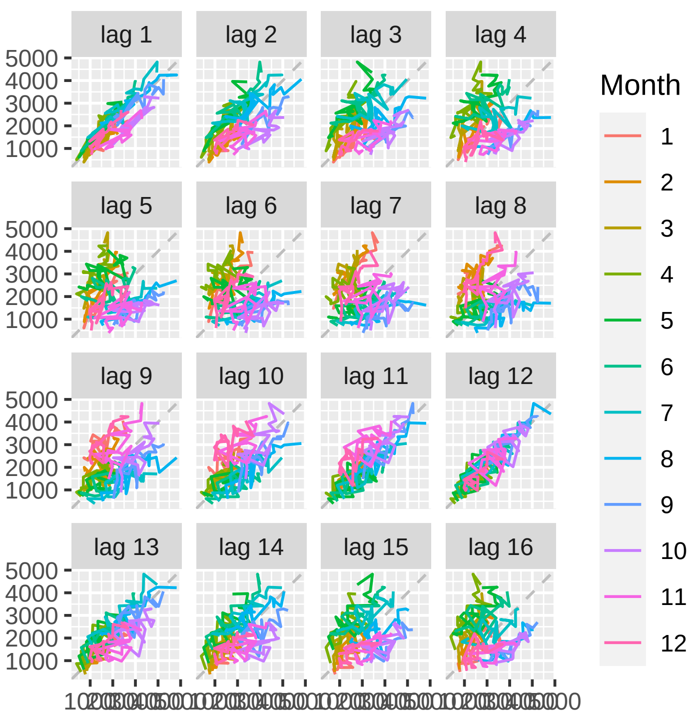
```r
boxplot(ts.total~cycle(ts.total),xlab="meses", ylab = "Mil Toneladas" ,
        col="blue", main ="Boxplot-Entrega de Fertilizantes-BR-1998-2019")
```



Lag Plot

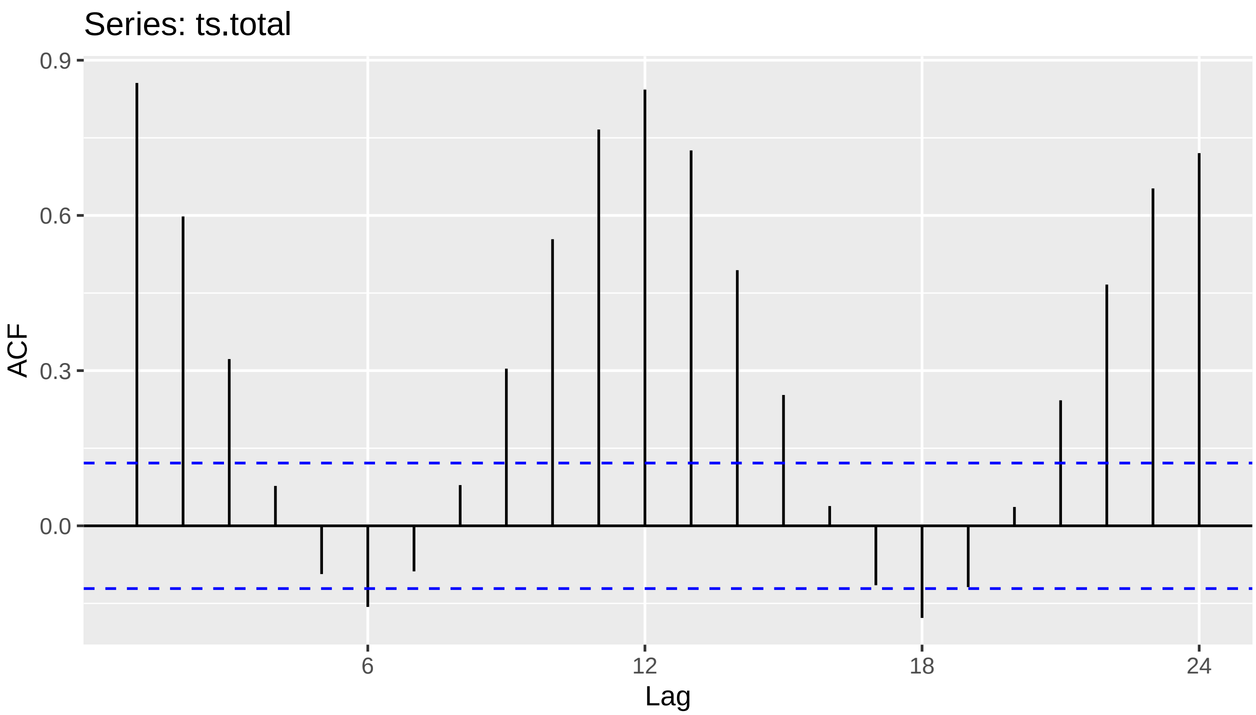
Indica a sozanalidade a cada 12 meses

```r
gglagplot(ts.total)
```



Auto Correlation Function (AFC)

```
ggAcf(ts.total)
```



Decomposição

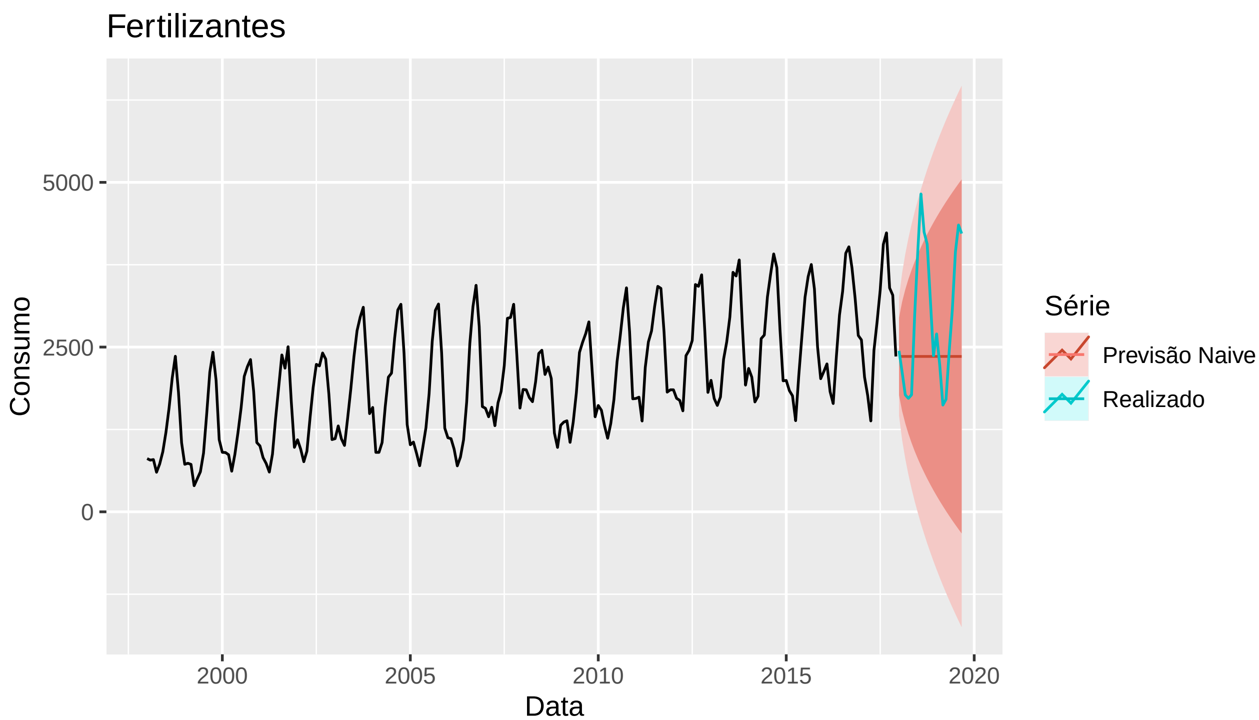
Modelos

```
plot_forecast = function(modelo, nome_modelo, train_set, test_set, tslm = FALSE){
  if (tslm){
    modelo = fitted(modelo)
  }
  autoplot(train_set) +
  autolayer(modelo, series = paste("Previsão", nome_modelo)) +
  autolayer(test_set, series = "Realizado") +
  xlab("Data") +
  ylab("Consumo") +
  ggtitle("Fertilizantes") +
  guides(colour = guide_legend(title = "Série"))
}
```

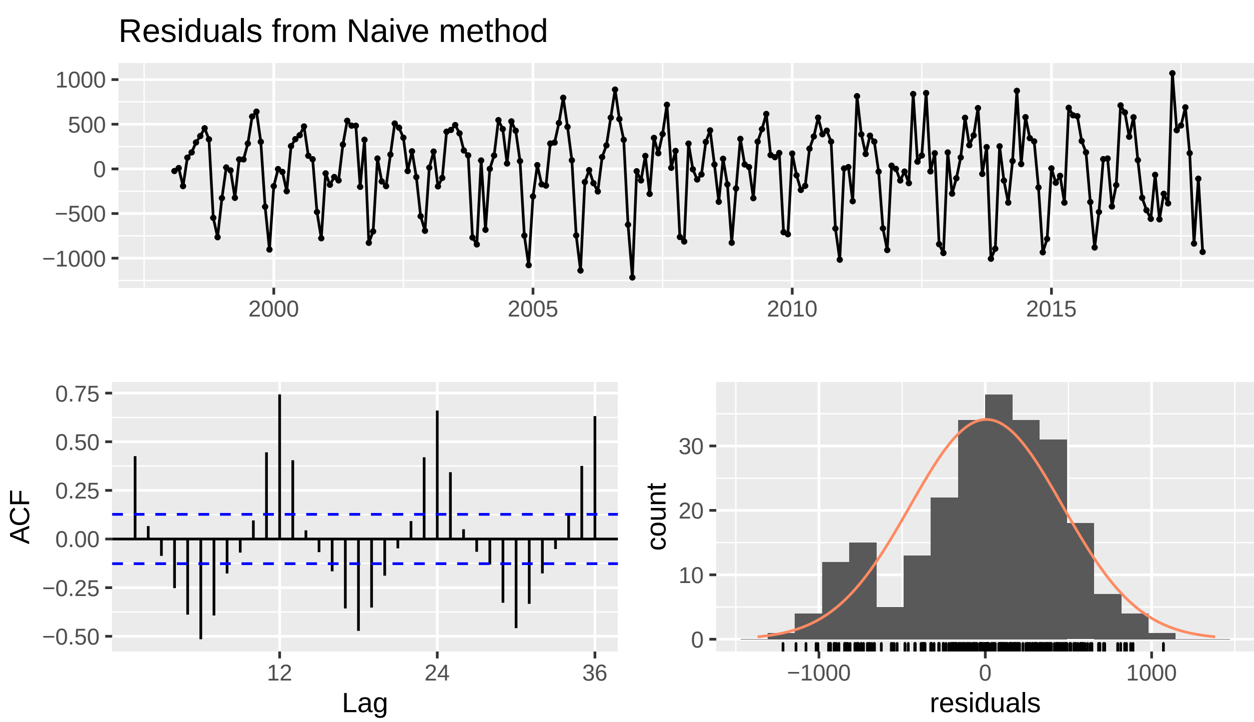
Transformação Box Cox

Naive

```
fit.naive = naive(ts.train, h = 21)

plot_forecast(fit.naive, 'Naive', ts.train, ts.test)
```




```
checkresiduals(fit.naive)
```




```
	Ljung-Box test

data:  Residuals from Naive method
Q* = 755.72, df = 24, p-value < 2.2e-16
```

```
Model df: 0.   Total lags used: 24
```

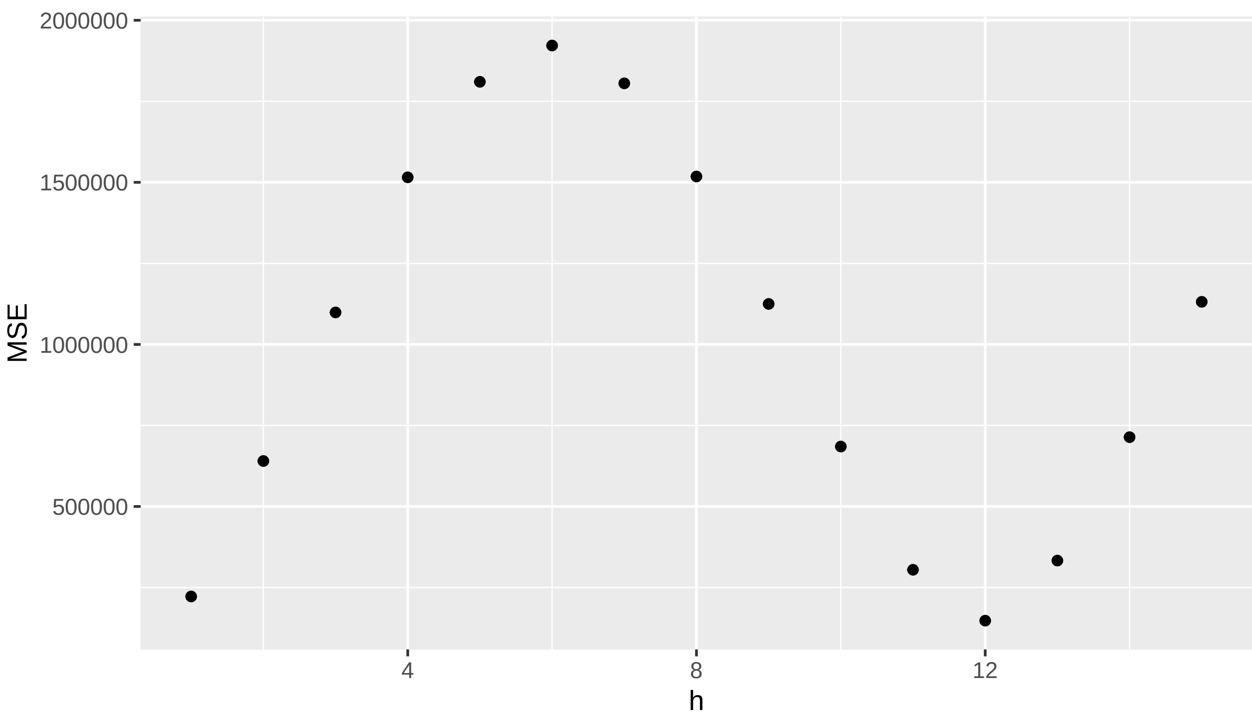
```r
accuracy(fit.naive, ts.test)
```

```
                     ME      RMSE      MAE       MPE     MAPE     MASE
Training set   6.485356  457.5677 362.7699 -2.723405 20.42512 1.271487
Test set     582.714286 1174.7456 922.1429  9.265054 28.66327 3.232057
                  ACF1 Theil's U
Training set 0.4258930        NA
Test set     0.7784592  1.428229
```

```r
ts.test %>% tsCV(forecastfunction=rwf, drift=TRUE, h=1) -> e
# RMSE
e^2 %>% mean(na.rm=TRUE) %>% sqrt()
```

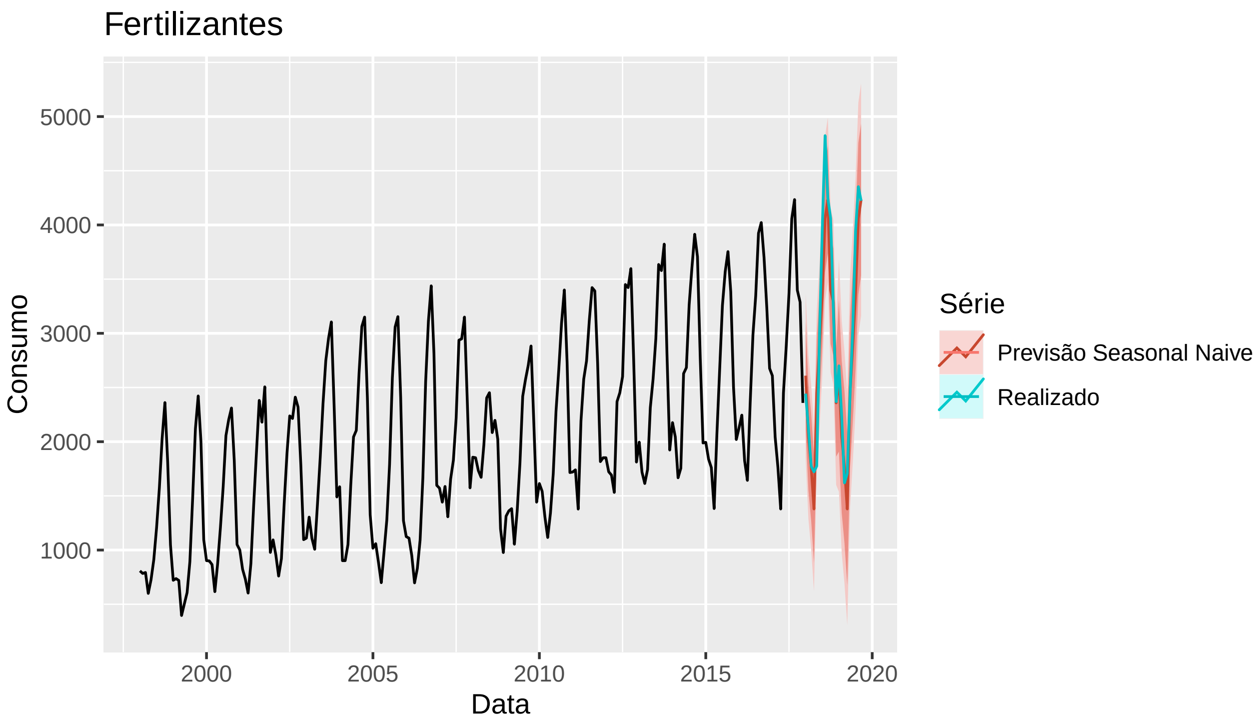
```
[1] 676.972
```

```r
# Cross Validation para diferentes horizontes de previsão
e <- tsCV(ts.total, forecastfunction=naive, h=15)
# Compute the MSE values and remove missing values
mse <- colMeans(e^2, na.rm = T)
# Plot the MSE values against the forecast horizon
data.frame(h = 1:15, MSE = mse) %>%
  ggplot(aes(x = h, y = MSE)) + geom_point()
```

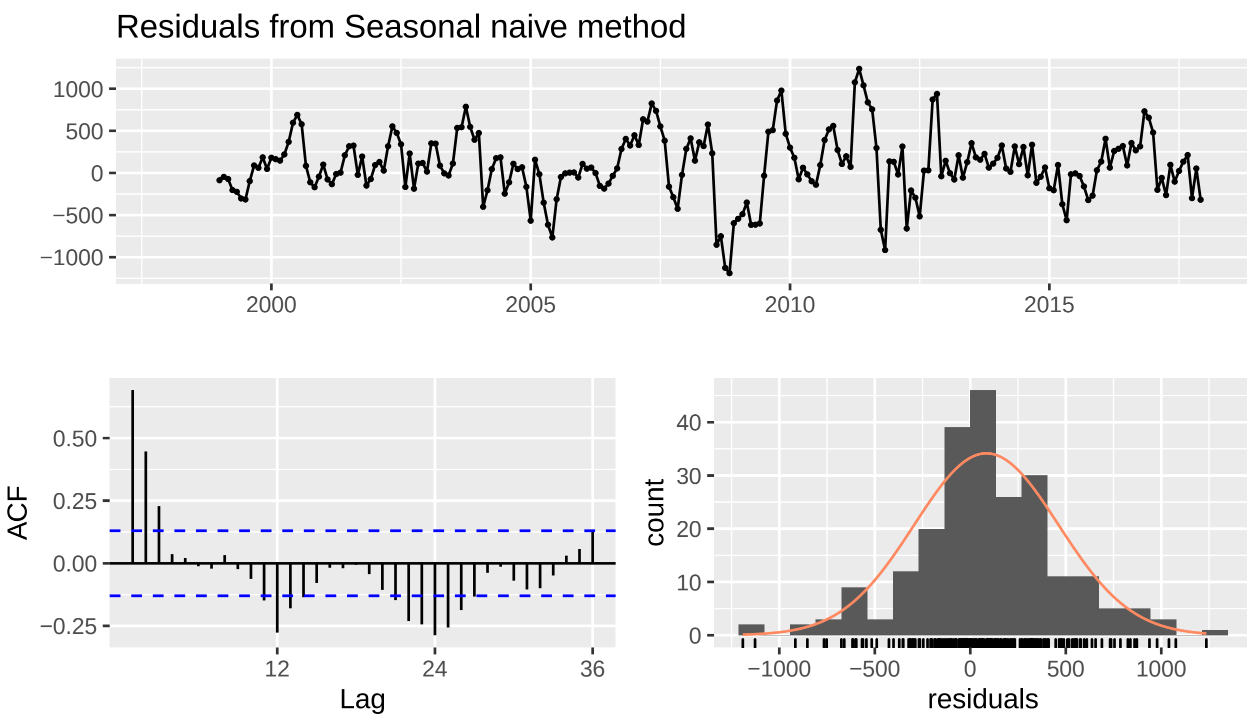


Seasonal Naive

```r
fit.seasonal_naive = snaive(ts.train, h = 21)

plot_forecast(fit.seasonal_naive, 'Seasonal Naive', ts.train, ts.test)
```




```
checkresiduals(fit.seasonal_naive)
```



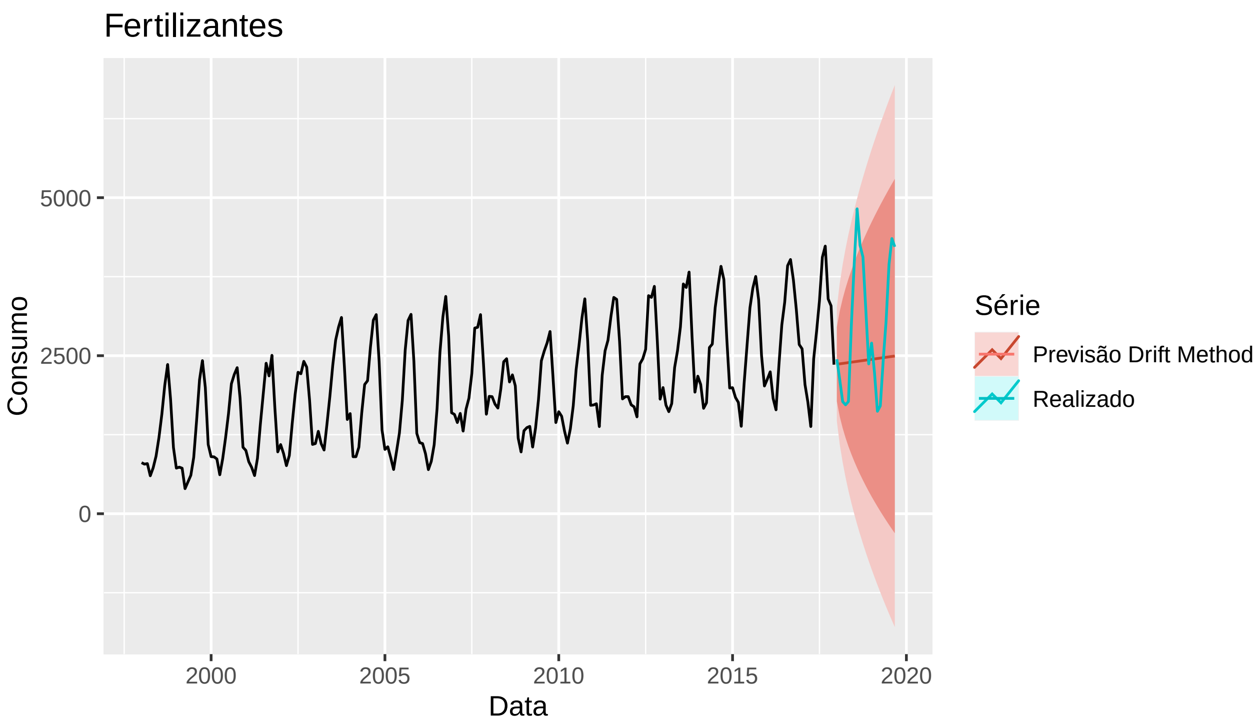

```
	Ljung-Box test

data:  Residuals from Seasonal naive method
Q* = 267.28, df = 24, p-value < 2.2e-16

Model df: 0.   Total lags used: 24
```

```
accuracy(fit.seasonal_naive, ts.test)
```

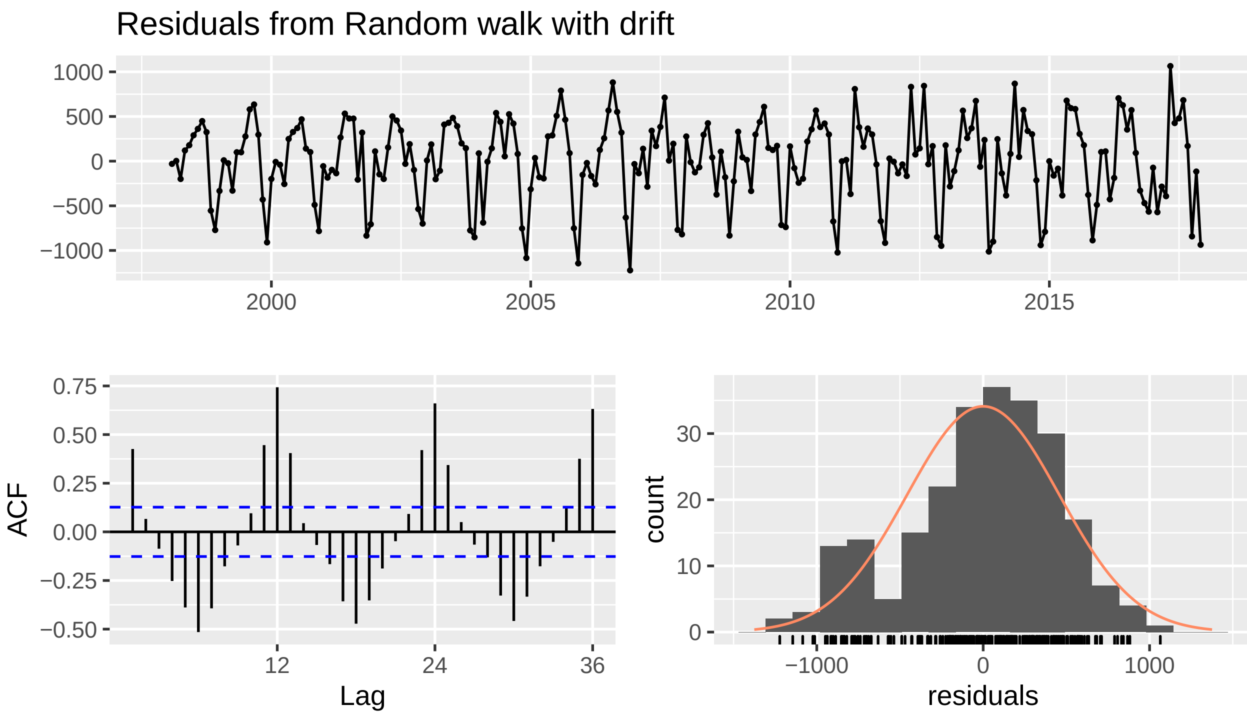
```
                    ME     RMSE      MAE      MPE      MAPE      MASE
Training set  84.11842 386.4534 285.3114 2.053698 16.213822 1.0000000
Test set     149.00000 353.1331 252.6190 3.614895  9.052387 0.8854152
                   ACF1 Theil's U
Training set  0.6910538        NA
Test set     -0.0642013 0.5585835
```

Drift Method

```
fit.drift = rwf(ts.train, h = 21, drift=TRUE)

plot_forecast(fit.drift, 'Drift Method', ts.train, ts.test)
```




```
checkresiduals(fit.drift)
```



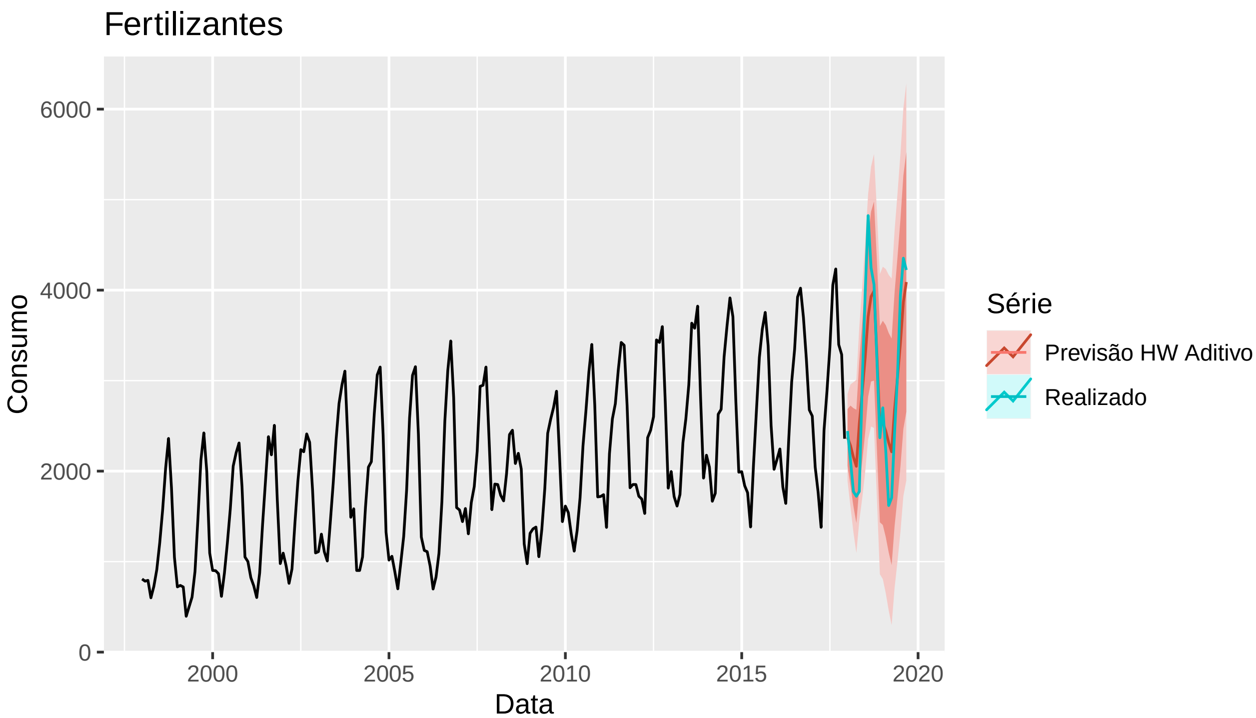

```
    Ljung-Box test

data:  Residuals from Random walk with drift
Q* = 755.72, df = 23, p-value < 2.2e-16

Model df: 1.   Total lags used: 24
```

```r
accuracy(fit.drift, ts.test)
```

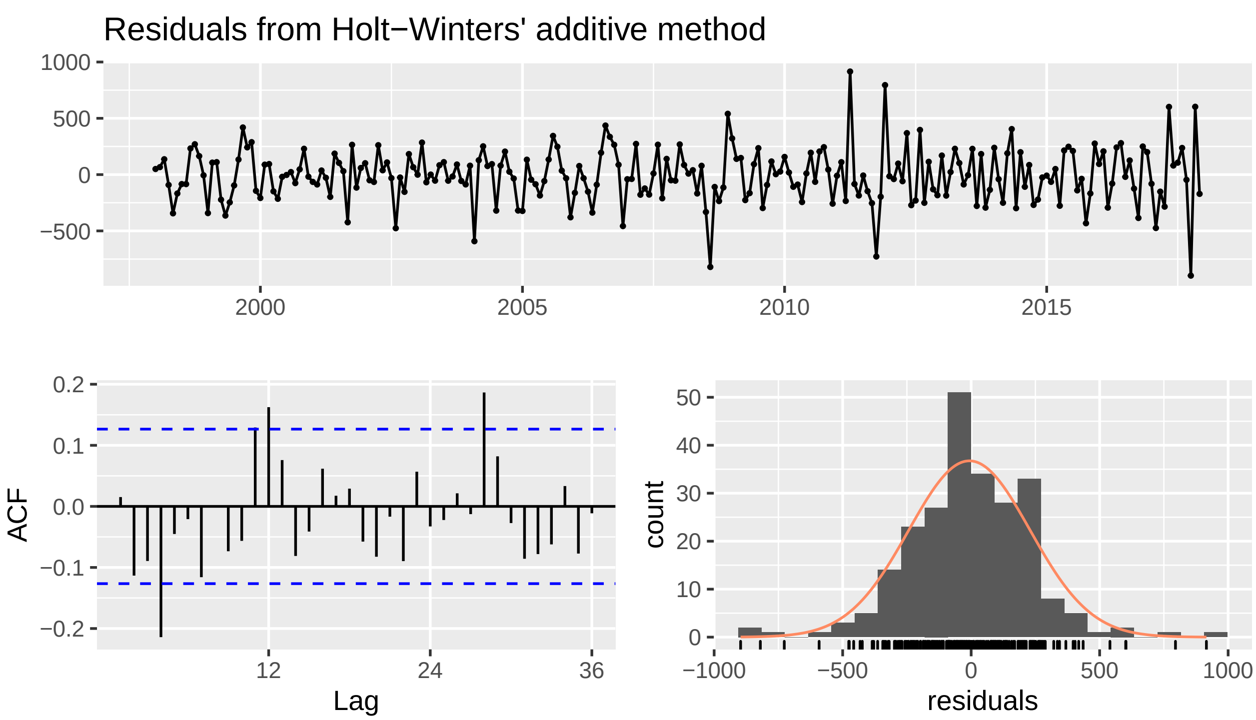
```
                       ME      RMSE      MAE        MPE     MAPE     MASE
Training set 8.466449e-14  457.5218 362.0537 -3.130732 20.43960 1.268977
Test set     5.113754e+02 1130.8064 897.5384  6.679907 28.52849 3.145820
                  ACF1 Theil's U
Training set 0.4258930        NA
Test set     0.7791228  1.403644
```

Holt Winther Aditivo

```r
fit.HWA = hw(ts.train, seasonal = "additive", h = 21)

plot_forecast(fit.HWA, 'HW Aditivo', ts.train, ts.test)
```




```
checkresiduals(fit.HWA)
```



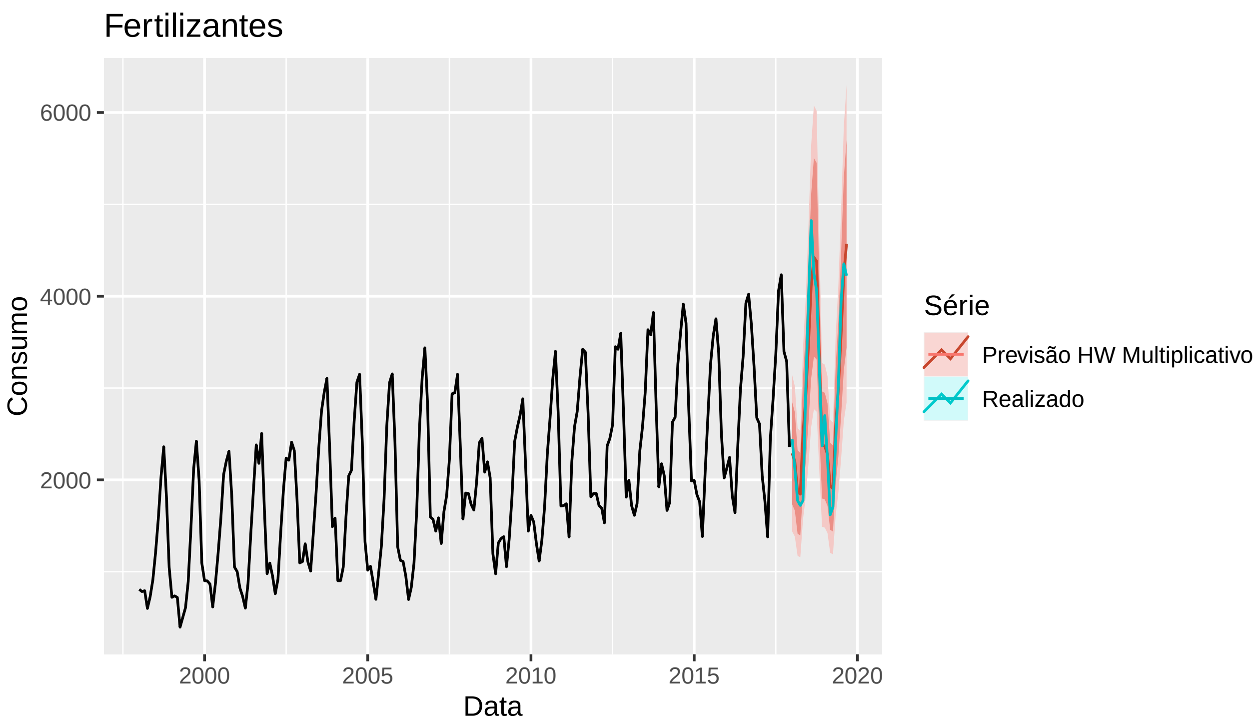

```
    Ljung-Box test

data:  Residuals from Holt-Winters' additive method
Q* = 44.44, df = 8, p-value = 4.698e-07

Model df: 16.   Total lags used: 24
```

```r
accuracy(fit.HWA, ts.test)
```

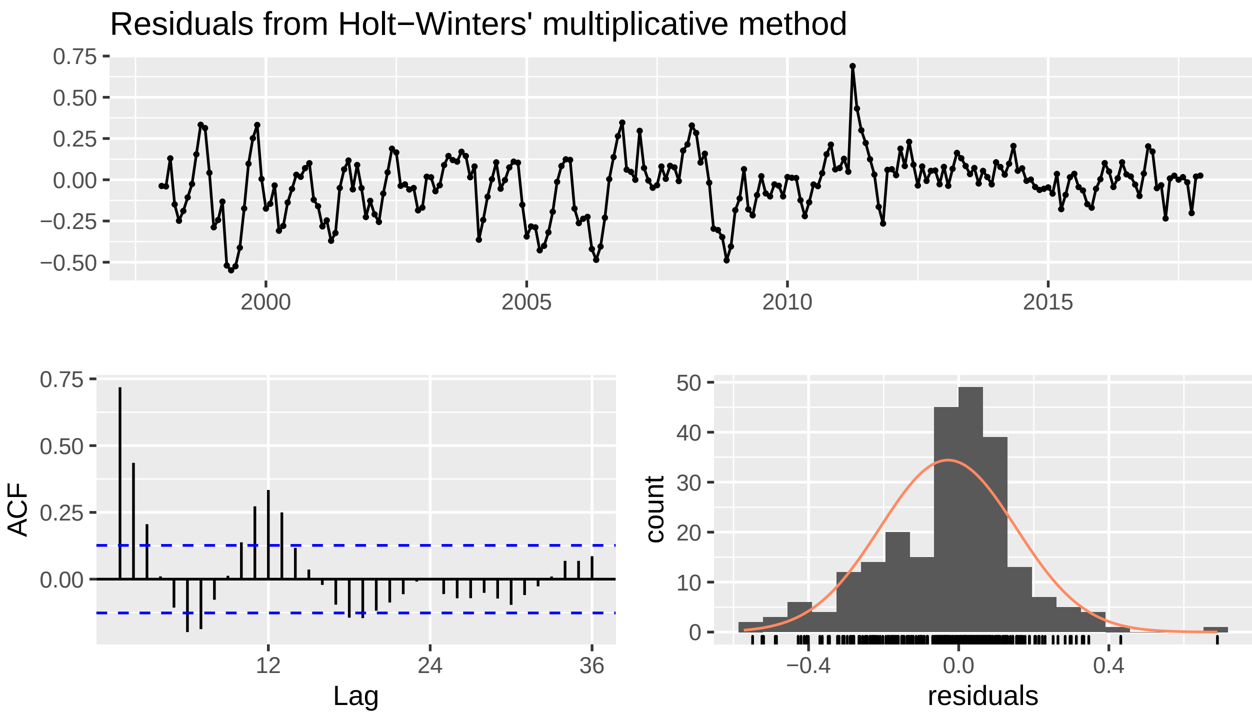
```
                    ME      RMSE      MAE       MPE     MAPE      MASE
Training set -6.732527 235.7490 177.3663 -1.845077 10.65438 0.6216586
Test set     10.773607 444.7325 344.3640 -4.764962 13.46534 1.2069759
                   ACF1 Theil's U
Training set 0.01524887        NA
Test set     0.60033259 0.7347298
```

Holt Winther Multiplicativo

```r
fit.HWM <- hw(ts.train, seasonal = "multiplicative", h = 21)

plot_forecast(fit.HWM, 'HW Multiplicativo', ts.train, ts.test)
```




```r
checkresiduals(fit.HWM)
```



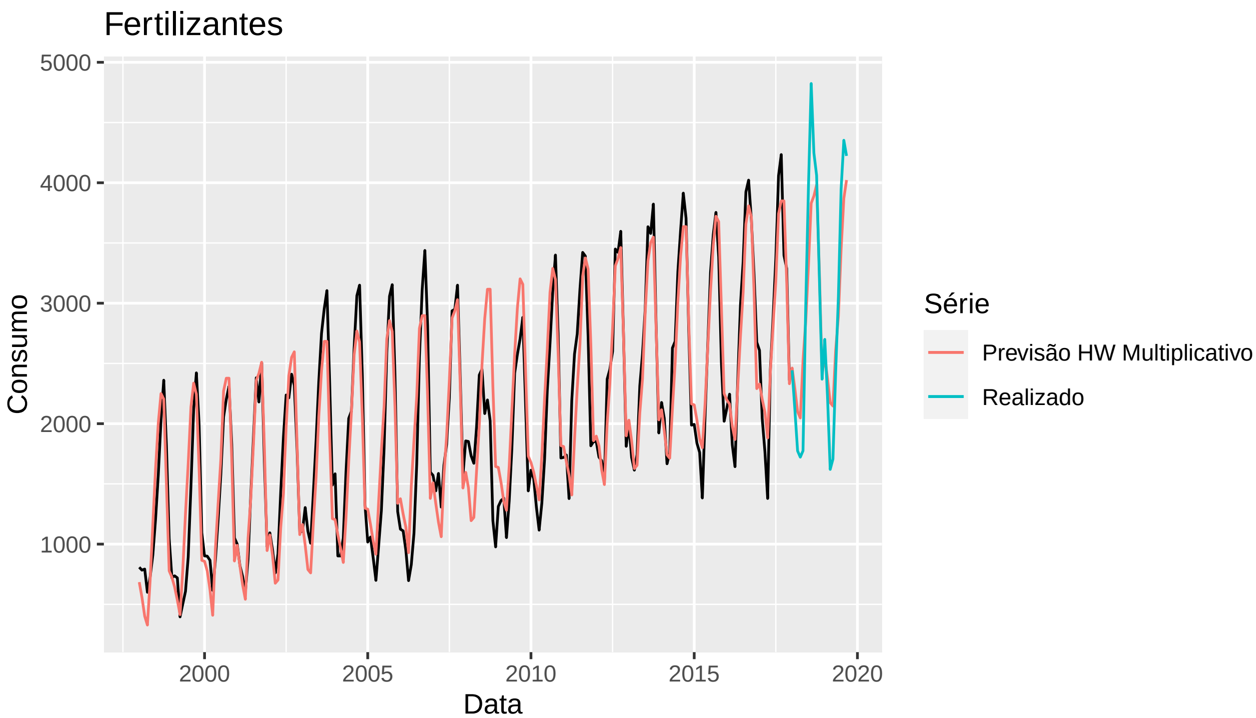

```
    Ljung-Box test

data:  Residuals from Holt-Winters' multiplicative method
Q* = 296.95, df = 8, p-value < 2.2e-16

Model df: 16.   Total lags used: 24
```

```r
accuracy(fit.HWM, ts.test)
```

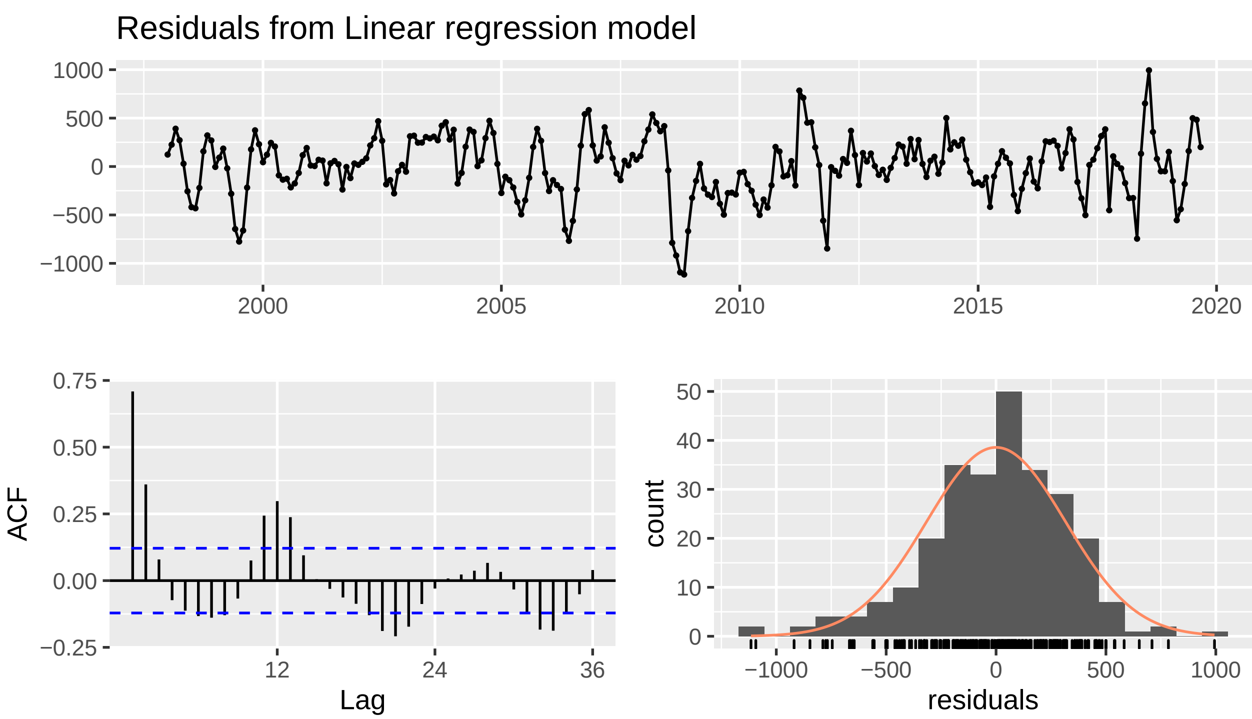
```
                    ME     RMSE     MAE       MPE      MAPE      MASE      ACF1
Training set -31.64425 321.7064 240.876 -7.286976 16.200865 0.8442565 0.6941948
Test set     -20.18829 311.6655 239.485 -2.836586  8.754973 0.8393811 0.2452657
             Theil's U
Training set        NA
Test set     0.5216854
```

Dummy

```r
fit.dummy <- tslm(ts.total ~ trend + season + bizdays(ts.total) + easter(ts.total))

plot_forecast(fit.dummy, 'HW Multiplicativo', ts.train, ts.test, tslm = TRUE)
```




```
checkresiduals(fit.dummy)
```

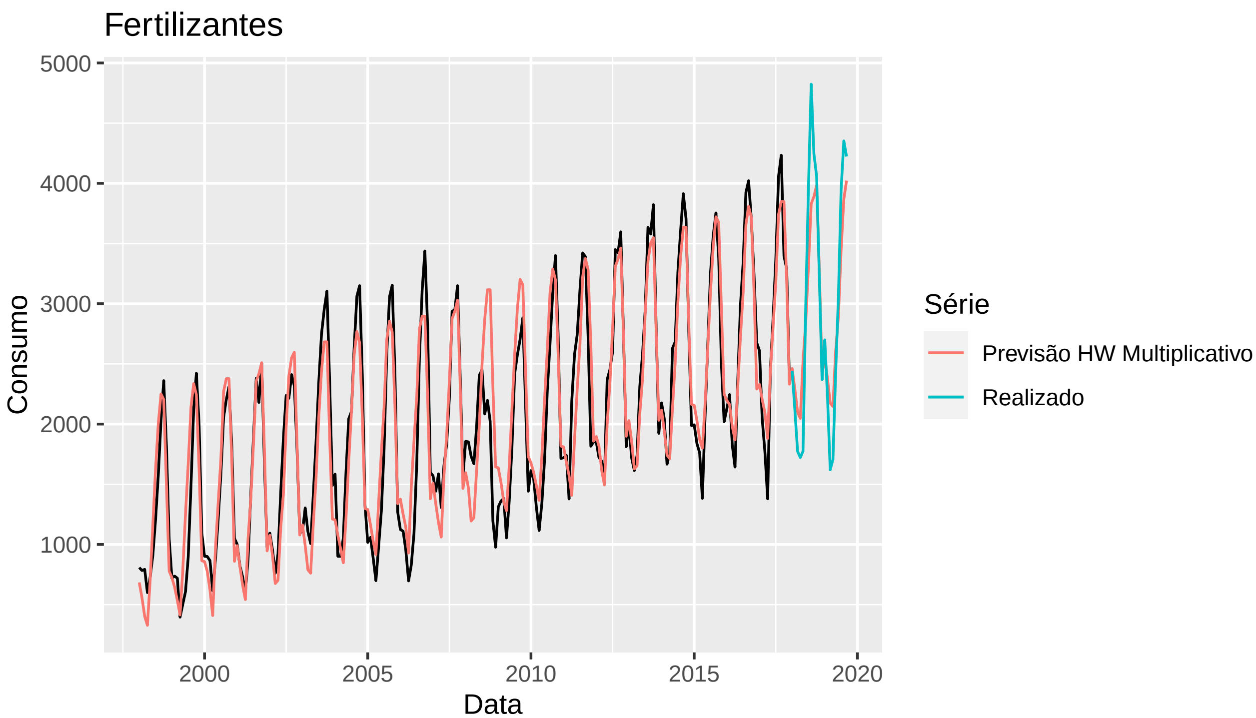



```
	Breusch-Godfrey test for serial correlation of order up to 24

data:  Residuals from Linear regression model
LM test = 156.21, df = 24, p-value < 2.2e-16
```

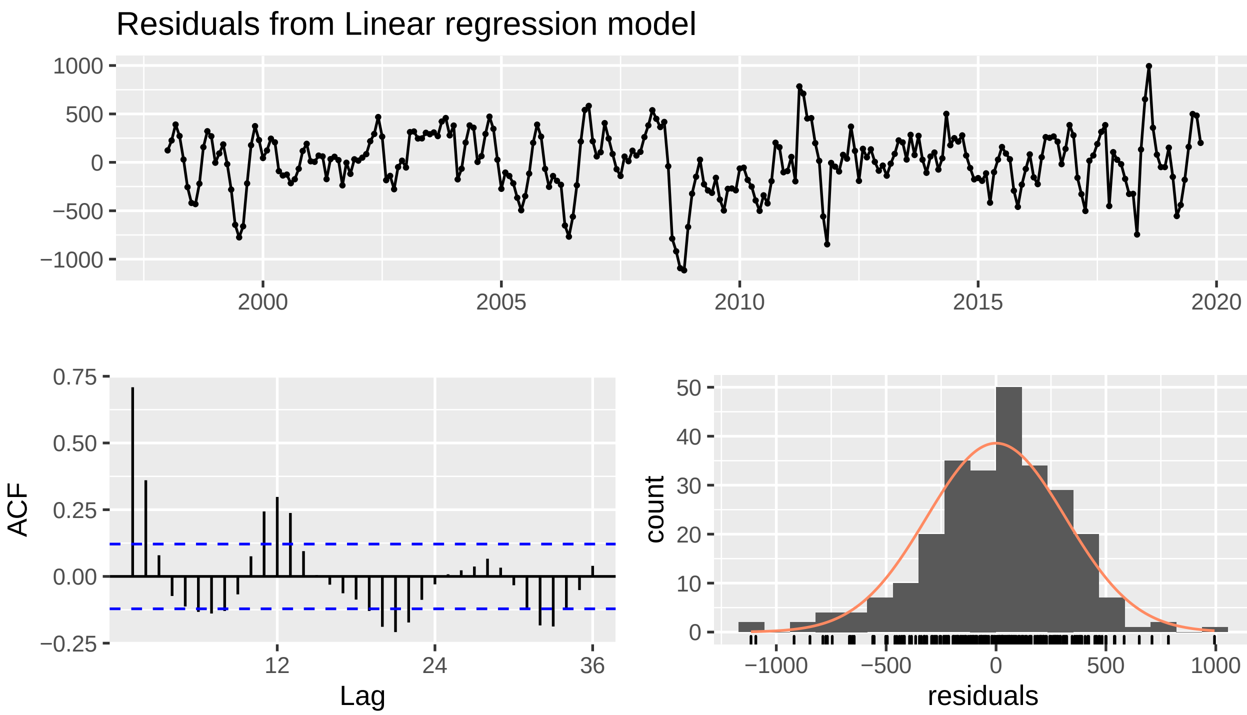
```
accuracy(fitted(fit.dummy), ts.test)
```

```
                ME     RMSE      MAE       MPE     MAPE      ACF1 Theil's U
Test set 33.21546 407.9278 319.9621 -3.560641 12.24497 0.6258391 0.6743043
```

```
fit.fourier <- tslm(ts.total ~ trend + bizdays(ts.total) + fourier(ts.total, K = 6) + easter(ts.total))

plot_forecast(fit.fourier, 'HW Multiplicativo', ts.train, ts.test, tslm = TRUE)
```




```
checkresiduals(fit.fourier)
```




```
    Breusch-Godfrey test for serial correlation of order up to 24

data:  Residuals from Linear regression model
LM test = 156.21, df = 24, p-value < 2.2e-16
```

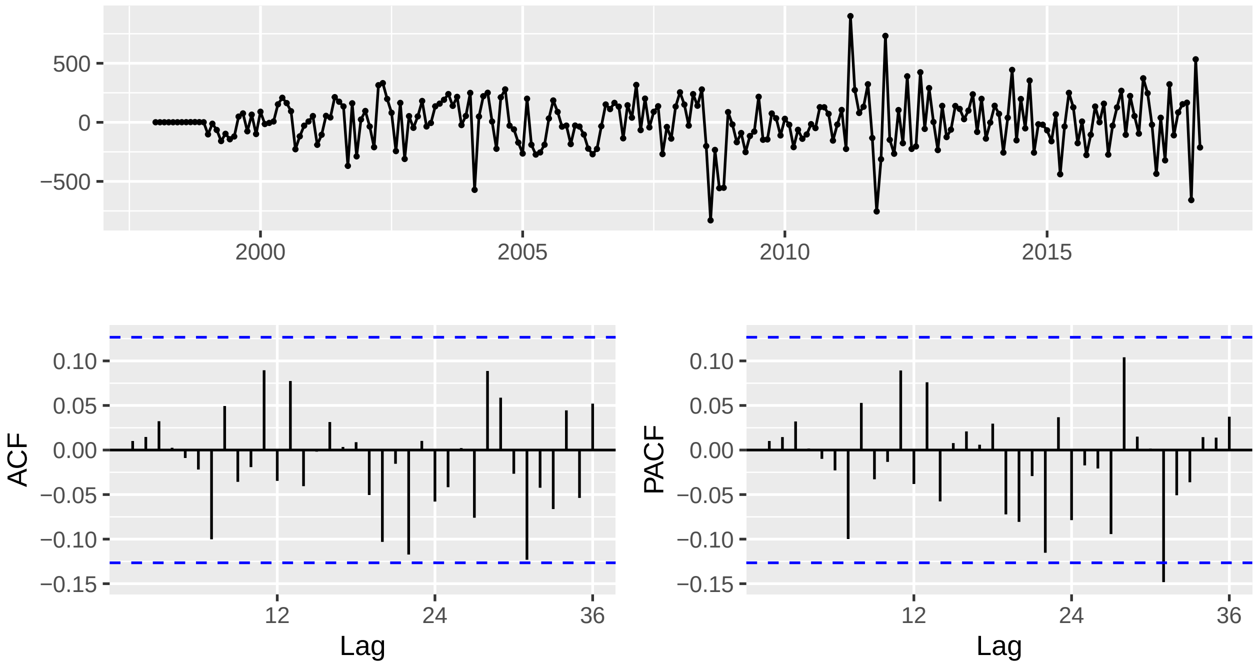
```r
accuracy(fitted(fit.fourier), ts.test)
```

```
               ME     RMSE      MAE       MPE     MAPE      ACF1 Theil's U
Test set 33.21546 407.9278 319.9621 -3.560641 12.24497 0.6258391 0.6743043
```

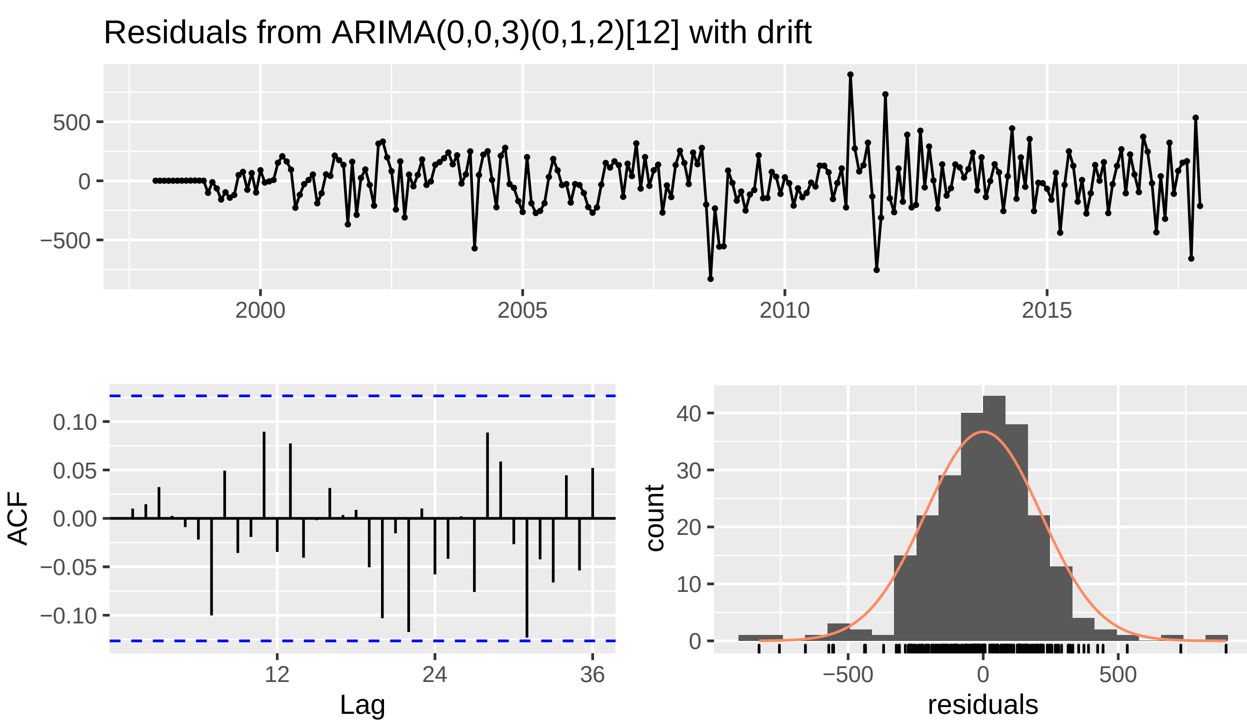
```r
arima.ts <- auto.arima(ts.train)
arima.ts
```

```
Series: ts.train
ARIMA(0,0,3)(0,1,2)[12] with drift

Coefficients:
         ma1     ma2     ma3     sma1     sma2   drift
      0.7751  0.5347  0.3254  -0.6427  -0.1657  7.1279
s.e.  0.0641  0.0738  0.0611   0.0775   0.0758  0.8615

sigma^2 estimated as 49661:  log likelihood=-1559.33
AIC=3132.65   AICc=3133.16   BIC=3156.66
```

```r
ts.train %>%
  Arima(order=c(0,0,3), seasonal=c(0,1,2), include.drift = TRUE) %>%
  residuals() %>% ggtsdisplay()
```




```r
fit.Arima <- ts.train %>%
  Arima(order=c(0,0,3), seasonal=c(0,1,2), include.drift = TRUE)

checkresiduals(fit.Arima)
```



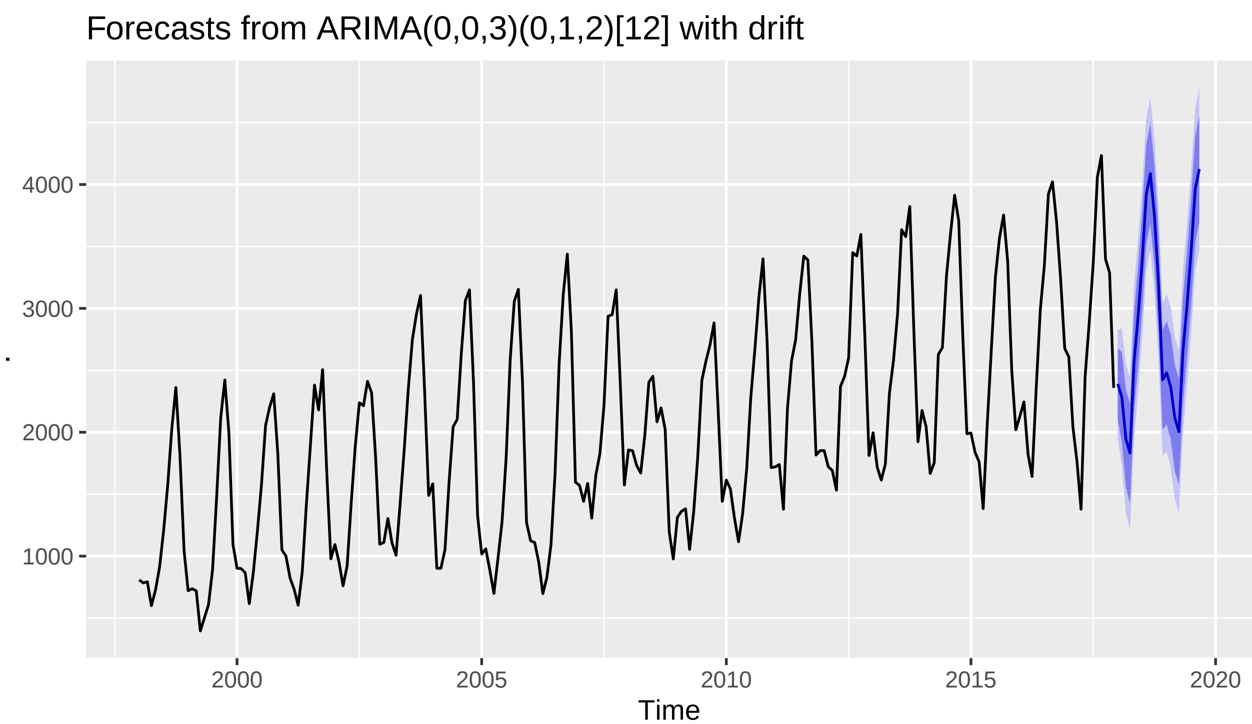

```
	Ljung-Box test

data:  Residuals from ARIMA(0,0,3)(0,1,2)[12] with drift
Q* = 16.705, df = 18, p-value = 0.5435
```

```
Model df: 6.   Total lags used: 24
```

```r
prev.Arima <- fit.Arima %>% forecast(h = 21)
prev.Arima
```

```
         Point Forecast    Lo 80    Hi 80    Lo 95    Hi 95
Jan 2018       2390.252 2104.619 2675.885 1953.414 2827.090
Feb 2018       2284.539 1923.159 2645.919 1731.855 2837.222
Mar 2018       1946.680 1554.358 2339.002 1346.675 2546.685
Apr 2018       1831.652 1428.473 2234.831 1215.044 2448.261
May 2018       2564.853 2161.675 2968.032 1948.245 3181.462
Jun 2018       2937.756 2534.577 3340.935 2321.147 3554.365
Jul 2018       3385.411 2982.233 3788.590 2768.803 4002.020
Aug 2018       3919.714 3516.535 4322.893 3303.105 4536.323
Sep 2018       4088.122 3684.943 4491.301 3471.513 4704.731
Oct 2018       3748.366 3345.188 4151.544 3131.758 4364.973
Nov 2018       3203.144 2799.968 3606.320 2586.540 3819.749
Dec 2018       2422.801 2019.630 2825.973 1806.204 3039.399
Jan 2019       2479.934 2064.037 2895.832 1843.874 3115.995
Feb 2019       2364.509 1941.146 2787.872 1717.031 3011.986
Mar 2019       2114.740 1687.871 2541.610 1461.900 2767.580
Apr 2019       2005.195 1577.035 2433.356 1350.380 2660.010
May 2019       2658.362 2230.201 3086.522 2003.547 3313.177
Jun 2019       3026.497 2598.337 3454.658 2371.682 3681.312
Jul 2019       3459.950 3031.789 3888.110 2805.135 4114.765
Aug 2019       3961.424 3533.264 4389.585 3306.609 4616.239
Sep 2019       4124.930 3696.769 4553.090 3470.115 4779.745
```

```r
prev.Arima %>% autoplot()
```




```r
accuracy(fit.naive, ts.test)
```

```
                    ME      RMSE      MAE       MPE     MAPE     MASE
Training set   6.485356  457.5677 362.7699 -2.723405 20.42512 1.271487
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                  ACF1 Theil's U
Training set 0.4258930        NA
Test set     0.7784592  1.428229
```

```
accuracy(fit.seasonal_naive, ts.test)
```

```
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Training set  84.11842 386.4534 285.3114 2.053698 16.213822 1.0000000
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                   ACF1 Theil's U
Training set  0.6910538        NA
Test set     -0.0642013 0.5585835
```

```
accuracy(fit.drift, ts.test)
```

```
                       ME      RMSE      MAE       MPE     MAPE     MASE
Training set 8.466449e-14  457.5218 362.0537 -3.130732 20.43960 1.268977
Test set     5.113754e+02 1130.8064 897.5384  6.679907 28.52849 3.145820
                  ACF1 Theil's U
Training set 0.4258930        NA
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```

```
accuracy(fit.HWA, ts.test)
```

```
                    ME     RMSE      MAE       MPE     MAPE      MASE
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Test set     10.773607 444.7325 344.3640 -4.764962 13.46534 1.2069759
                   ACF1 Theil's U
Training set 0.01524887        NA
Test set     0.60033259 0.7347298
```

```
accuracy(fit.HWM, ts.test)
```

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Test set     -20.18829 311.6655 239.485 -2.836586  8.754973 0.8393811 0.2452657
             Theil's U
Training set        NA
Test set     0.5216854
```