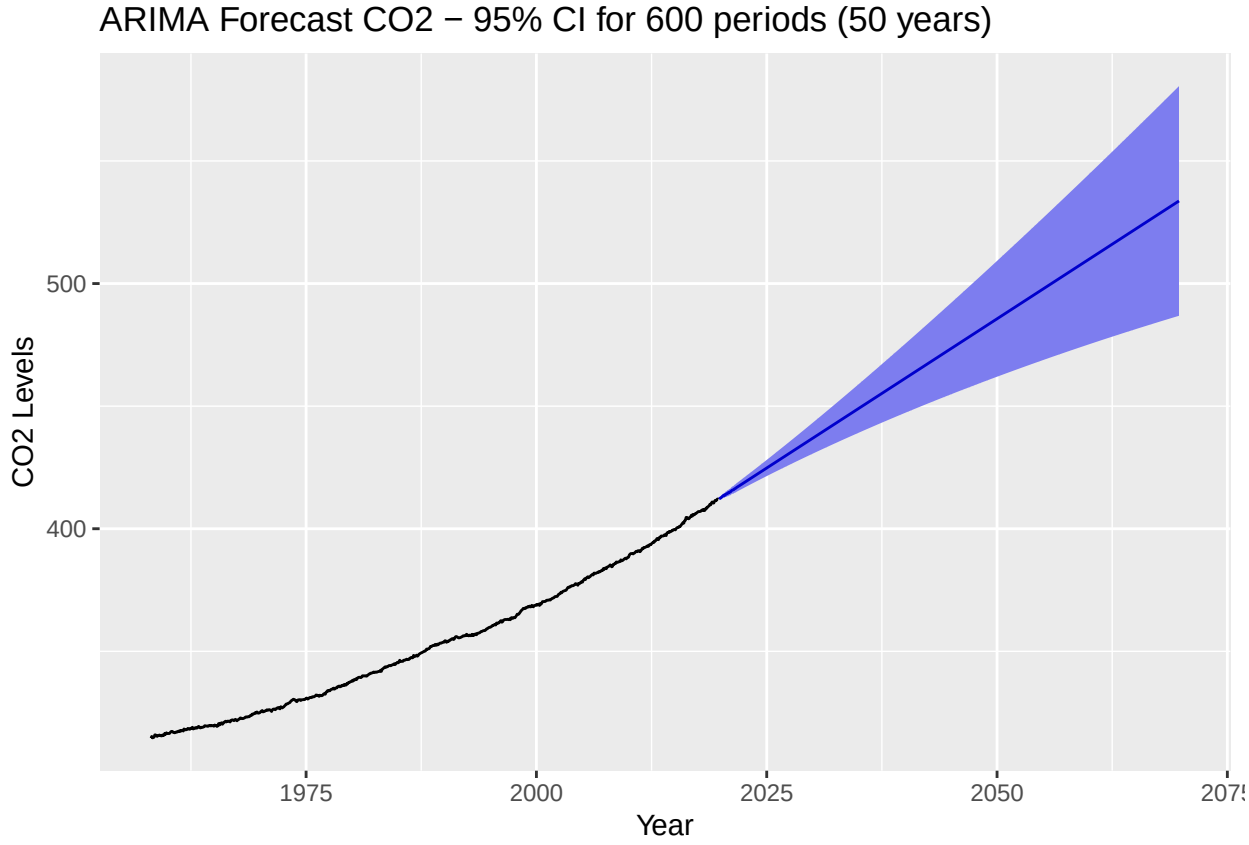
Analysis

Predict CO_2:

ARIMA - CO_2:

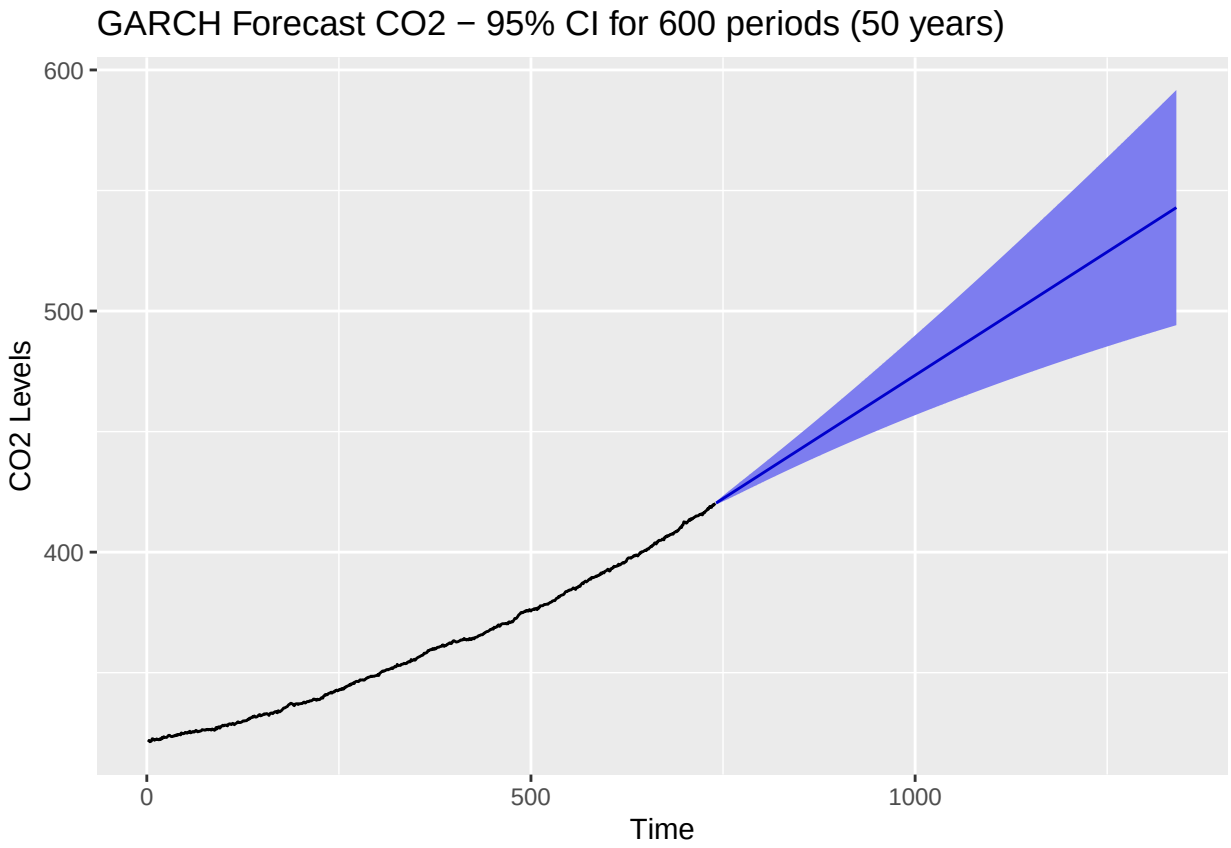
```
##
##  Box-Ljung test
##
## data:  c02.ts
## X-squared = 736.72, df = 1, p-value < 0.00000000000000022
```



GARCH - CO2:

```
##
##  ***** ESTIMATION WITH ANALYTICAL GRADIENT *****
##
##
##      I     INITIAL X(I)        D(I)
##
##      1     7.133030e+02     1.000e+00
##      2     5.000000e-02     1.000e+00
##      3     5.000000e-02     1.000e+00
```

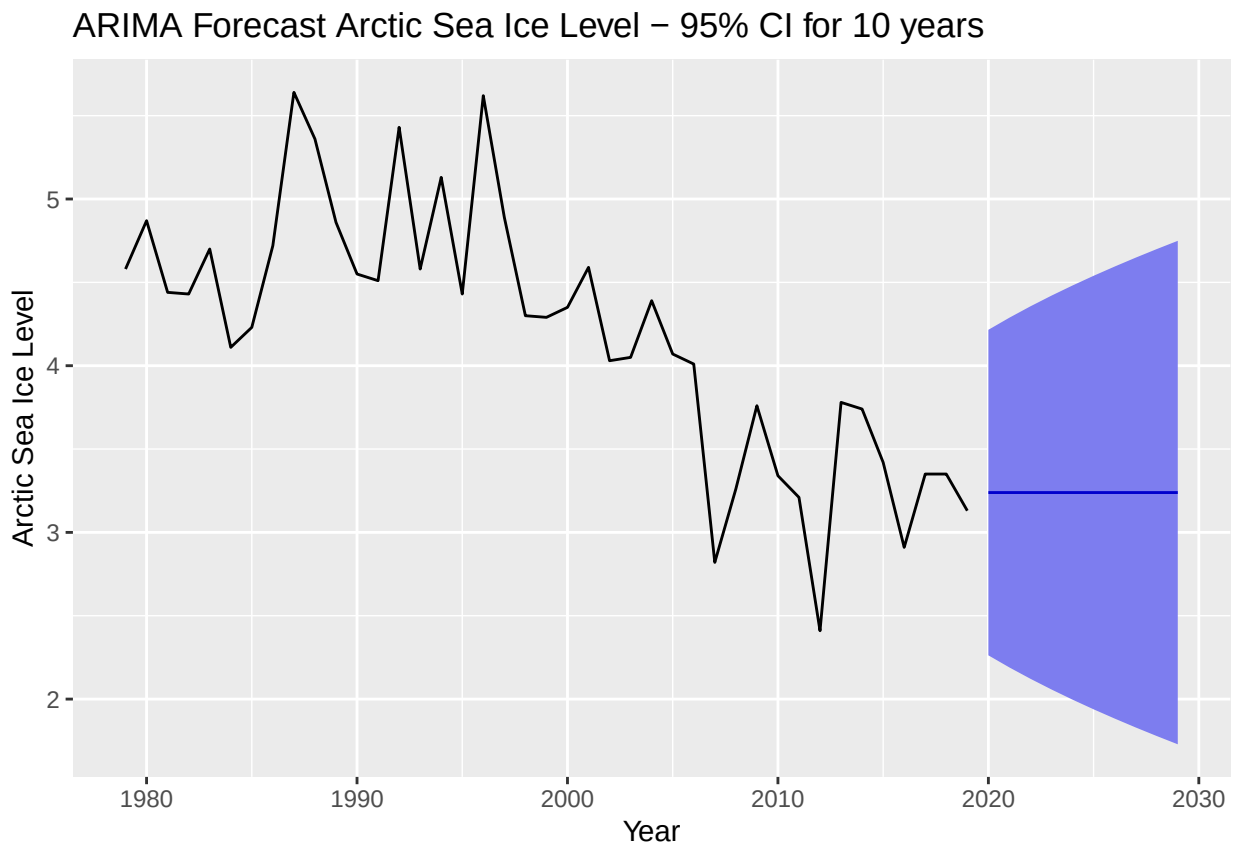
```
##
##     IT   NF      F         RELDF    PRELDF    RELDX   STPPAR   D*STEP   NPRELDF
##      0    1  9.584e+03
##      1    2  4.711e+03  5.08e-01  1.11e+01  7.0e-04  1.1e+05  1.0e+00  5.91e+05
##      2    4  4.708e+03  5.43e-04  6.41e-04  3.5e-05  2.0e+00  5.0e-02  3.88e-01
##      3    5  4.707e+03  3.67e-04  3.46e-04  3.5e-05  1.3e+00  5.0e-02  4.33e-04
##      4    7  4.707e+03  2.76e-05  2.64e-05  2.4e-06  6.0e+00  4.8e-03  1.20e-04
##      5    9  4.707e+03  5.13e-06  5.13e-06  4.9e-07  4.0e+01  9.6e-04  1.02e-04
##      6   11  4.706e+03  9.86e-06  9.86e-06  9.8e-07  5.8e+00  1.9e-03  9.66e-05
##      7   13  4.706e+03  1.81e-05  1.81e-05  1.9e-06  3.3e+00  3.8e-03  8.66e-05
##      8   15  4.706e+03  3.37e-06  3.37e-06  3.9e-07  4.1e+01  7.7e-04  6.82e-05
##      9   17  4.706e+03  6.64e-07  6.64e-07  7.8e-08  2.0e+02  1.5e-04  6.46e-05
##     10   19  4.706e+03  1.32e-06  1.32e-06  1.6e-07  2.5e+01  3.1e-04  6.39e-05
##     11   21  4.706e+03  2.62e-07  2.62e-07  3.1e-08  4.8e+02  6.1e-05  6.26e-05
##     12   23  4.706e+03  5.22e-07  5.22e-07  6.2e-08  6.1e+01  1.2e-04  6.23e-05
##     13   26  4.706e+03  1.04e-08  1.04e-08  1.2e-09  1.2e+04  2.5e-06  6.18e-05
##     14   28  4.706e+03  2.08e-08  2.08e-08  2.5e-09  1.5e+03  4.9e-06  6.18e-05
##     15   30  4.706e+03  4.16e-09  4.16e-09  5.0e-10  3.0e+04  9.8e-07  6.17e-05
##     16   32  4.706e+03  8.33e-09  8.33e-09  9.9e-10  3.7e+03  2.0e-06  6.17e-05
##     17   34  4.706e+03  1.67e-08  1.67e-08  2.0e-09  1.9e+03  3.9e-06  6.17e-05
##     18   36  4.706e+03  3.33e-09  3.33e-09  4.0e-10  3.7e+04  7.9e-07  6.17e-05
##     19   38  4.706e+03  6.66e-10  6.66e-10  8.0e-11  1.9e+05  1.6e-07  6.17e-05
##     20   40  4.706e+03  1.33e-10  1.33e-10  1.6e-11  9.3e+05  3.1e-08  6.17e-05
##     21   42  4.706e+03  2.66e-10  2.66e-10  3.2e-11  1.2e+05  6.3e-08  6.17e-05
##     22   44  4.706e+03  5.33e-11  5.33e-11  6.4e-12  2.3e+06  1.3e-08  6.17e-05
##     23   46  4.706e+03  1.07e-11  1.07e-11  1.3e-12  1.2e+07  2.5e-09  6.17e-05
##     24   49  4.706e+03  8.53e-11  8.53e-11  1.0e-11  3.6e+05  2.0e-08  6.17e-05
##     25   53  4.706e+03  1.70e-13  1.71e-13  2.0e-14  7.2e+08  4.0e-11  6.17e-05
##     26   55  4.706e+03  3.38e-14  3.41e-14  4.1e-15  3.6e+09  8.1e-12  6.17e-05
##     27   57  4.706e+03  6.80e-14  6.82e-14  8.1e-15  4.5e+08  1.6e-11  6.17e-05
##     28   58  4.706e+03 -2.12e+06  1.36e-13  1.6e-14  9.0e+08  3.2e-11  6.17e-05
##
##  ***** FALSE CONVERGENCE *****
##
##  FUNCTION     4.706351e+03   RELDX        1.629e-14
##  FUNC. EVALS      58         GRAD. EVALS      28
##  PRELDF       1.364e-13      NPRELDF      6.171e-05
##
##      I      FINAL X(I)        D(I)          G(I)
##
##      1    7.133030e+02     1.000e+00     1.122e-04
##      2    1.035450e+00     1.000e+00     1.380e+01
##      3    1.536755e-11     1.000e+00     1.436e+01
```



Predict Arctic Sea Ice Level:

ARIMA - Arctic Sea Ice Level:

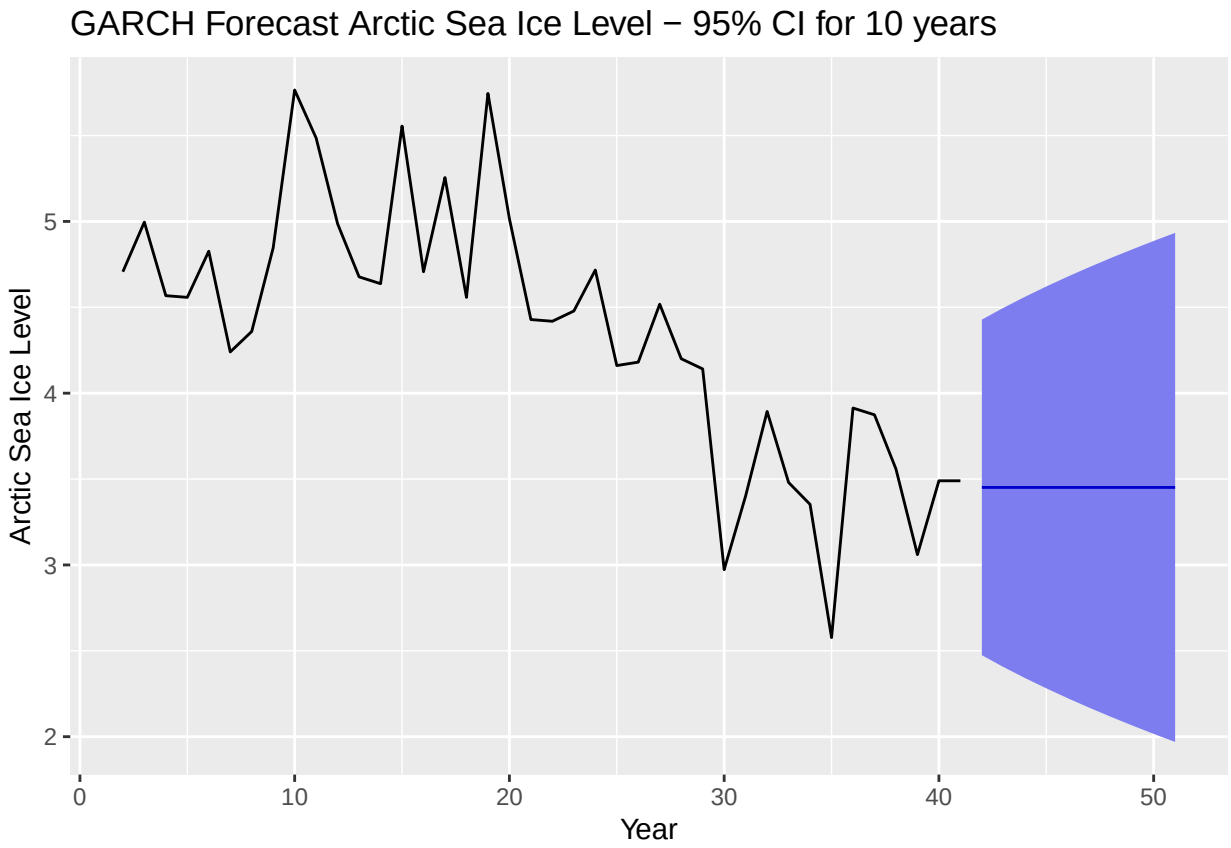
```
##
##  Box-Ljung test
##
## data:  ice.ts
## X-squared = 87.039, df = 5, p-value < 0.00000000000000022
```



GARCH - Arctic Sea Ice Level:

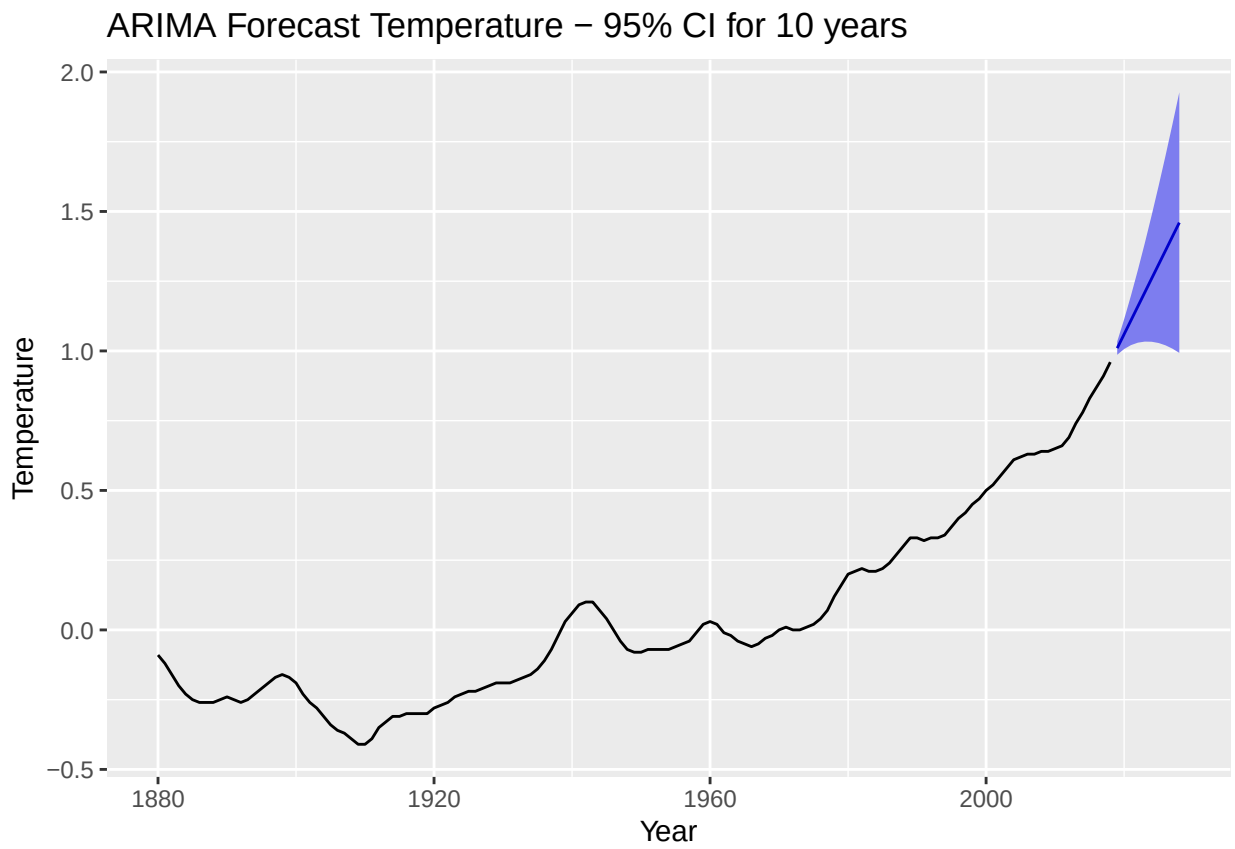
```
##
##  ***** ESTIMATION WITH ANALYTICAL GRADIENT *****
##
##
##      I     INITIAL X(I)        D(I)
##
##      1     5.367499e-01     1.000e+00
##      2     5.000000e-02     1.000e+00
##      3     5.000000e-02     1.000e+00
##
##     IT   NF      F         RELDF    PRELDF    RELDX   STPPAR   D*STEP   NPRELDF
##      0    1  2.390e+02
##      1    2  7.768e+01  6.75e-01  1.09e+01  8.8e-01  2.6e+03  1.0e+00  1.41e+04
##      2    4  7.750e+01  2.36e-03  2.65e-03  2.4e-02  1.9e+00  5.0e-02  1.10e-01
##      3    6  7.738e+01  1.50e-03  1.44e-03  2.1e-02  0.0e+00  5.0e-02  2.09e-03
##      4    7  7.731e+01  9.48e-04  8.91e-04  4.0e-02  3.7e-01  1.0e-01  9.20e-04
##      5   10  7.731e+01  1.32e-05  1.22e-05  4.6e-04  6.8e+00  1.0e-03  1.17e-04
##      6   12  7.730e+01  2.53e-05  2.53e-05  9.2e-04  5.5e+00  2.0e-03  3.18e-04
##      7   14  7.730e+01  4.88e-06  4.88e-06  1.9e-04  8.9e+01  4.0e-04  2.96e-04
##      8   17  7.730e+01  3.71e-05  3.71e-05  1.5e-03  3.8e+00  3.2e-03  3.01e-04
##      9   19  7.730e+01  7.01e-06  7.01e-06  3.1e-04  5.6e+01  6.4e-04  2.65e-04
##     10   22  7.730e+01  1.39e-07  1.39e-07  6.1e-06  2.8e+03  1.3e-05  2.77e-04
##     11   24  7.730e+01  2.78e-08  2.78e-08  1.2e-06  1.4e+04  2.6e-06  2.81e-04
```

```
##     12   26  7.730e+01  5.56e-09  5.56e-09  2.5e-07  6.9e+04  5.1e-07  2.81e-04
##     13   28  7.730e+01  1.11e-08  1.11e-08  4.9e-07  8.7e+03  1.0e-06  2.81e-04
##     14   31  7.730e+01  2.22e-10  2.22e-10  9.8e-09  1.7e+06  2.0e-08  2.81e-04
##     15   33  7.730e+01  4.44e-11  4.44e-11  2.0e-09  8.7e+06  4.1e-09  2.81e-04
##     16   35  7.730e+01  8.89e-11  8.89e-11  3.9e-09  1.1e+06  8.2e-09  2.81e-04
##     17   38  7.730e+01  1.78e-12  1.78e-12  7.9e-11  2.2e+08  1.6e-10  2.81e-04
##     18   40  7.730e+01  3.56e-12  3.56e-12  1.6e-10  2.7e+07  3.3e-10  2.81e-04
##     19   42  7.730e+01  7.12e-13  7.11e-13  3.1e-11  5.4e+08  6.6e-11  2.81e-04
##     20   44  7.730e+01  1.42e-12  1.42e-12  6.3e-11  6.8e+07  1.3e-10  2.81e-04
##     21   46  7.730e+01  2.85e-13  2.84e-13  1.3e-11  1.4e+09  2.6e-11  2.81e-04
##     22   48  7.730e+01  5.66e-14  5.69e-14  2.5e-12  6.8e+09  5.2e-12  2.81e-04
##     23   50  7.730e+01  1.14e-13  1.14e-13  5.0e-12  8.5e+08  1.0e-11  2.81e-04
##     24   52  7.730e+01  2.24e-14  2.28e-14  1.0e-12  1.7e+10  2.1e-12  2.81e-04
##     25   54  7.730e+01  4.52e-14  4.55e-14  2.0e-12  2.1e+09  4.2e-12  2.81e-04
##     26   56  7.730e+01  9.10e-14  9.10e-14  4.0e-12  1.1e+09  8.4e-12  2.81e-04
##     27   58  7.730e+01  1.80e-14  1.82e-14  8.0e-13  2.1e+10  1.7e-12  2.81e-04
##     28   60  7.730e+01  3.86e-15  3.64e-15  1.6e-13  1.1e+11  3.4e-13  2.81e-04
##     29   62  7.730e+01  9.19e-16  7.28e-16  3.2e-14  5.3e+11  6.7e-14  2.81e-04
##     30   64  7.730e+01  1.65e-15  1.46e-15  6.4e-14  6.6e+10  1.3e-13  2.81e-04
##     31   66  7.730e+01  0.00e+00  2.91e-16  1.3e-14  1.3e+12  2.7e-14  2.81e-04
##
##  ***** FALSE CONVERGENCE *****
##
##  FUNCTION     7.729938e+01   RELDX        1.292e-14
##  FUNC. EVALS      66         GRAD. EVALS      31
##  PRELDF       2.913e-16      NPRELDF      2.808e-04
##
##      I      FINAL X(I)        D(I)          G(I)
##
##      1    7.016953e-01     1.000e+00    -1.738e-02
##      2    1.022788e+00     1.000e+00     8.226e-01
##      3    1.478449e-14     1.000e+00     1.629e-01
```



ARIMA - Temperature

```
##
##  Box-Ljung test
##
## data:  temp.ts
## X-squared = 588.18, df = 5, p-value < 0.00000000000000022
```



GARCH - Temperature

```
##
##  ***** ESTIMATION WITH ANALYTICAL GRADIENT *****
##
##
##      I     INITIAL X(I)        D(I)
##
##      1     9.807248e-02     1.000e+00
##      2     5.000000e-02     1.000e+00
##      3     5.000000e-02     1.000e+00
##
##     IT   NF      F         RELDF    PRELDF    RELDX   STPPAR   D*STEP   NPRELDF
##      0    1 -9.001e+01
##      1    3 -9.412e+01  4.37e-02  1.61e-01  4.3e-01  1.5e+03  1.0e-01  1.23e+02
##      2    4 -1.117e+02  1.57e-01  3.17e-01  2.9e-01  2.0e+00  1.0e-01  2.50e+02
##      3    6 -1.295e+02  1.37e-01  1.08e-01  1.8e-01  2.0e+00  1.0e-01  2.21e+02
##      4    8 -1.331e+02  2.68e-02  2.77e-02  2.6e-02  2.0e+00  2.0e-02  1.60e+04
##      5   10 -1.405e+02  5.32e-02  4.76e-02  5.8e-02  2.0e+00  4.0e-02  3.70e+03
##      6   13 -1.405e+02  2.27e-05  2.31e-03  2.2e-03  2.4e+00  2.2e-03  7.21e+04
##      7   14 -1.409e+02  2.71e-03  4.28e-03  1.5e-03  2.1e+00  1.1e-03  5.77e+04
##      8   19 -1.495e+02  5.74e-02  7.14e-02  7.7e-02  2.0e+00  6.1e-02  5.53e+04
##      9   20 -1.550e+02  3.55e-02  1.03e-01  6.6e-02  2.0e+00  6.1e-02  3.85e+03
##     10   22 -1.620e+02  4.34e-02  4.00e-02  5.9e-02  2.0e+00  6.1e-02  5.41e+02
##     11   26 -1.628e+02  4.52e-03  4.64e-03  3.8e-04  7.5e+00  4.1e-04  2.11e+03
```

```
##     12   28 -1.630e+02  1.12e-03  1.20e-03  1.3e-04  9.5e+00  1.4e-04  8.27e+02
##     13   29 -1.630e+02  5.22e-04  1.14e-03  2.6e-04  2.3e+00  2.8e-04  7.02e+02
##     14   30 -1.631e+02  2.89e-04  4.26e-04  2.3e-04  2.0e+00  2.8e-04  6.59e+02
##     15   36 -1.714e+02  4.83e-02  9.03e-02  1.6e-01  2.0e+00  2.1e-01  6.34e+02
##     16   45 -1.721e+02  4.43e-03  2.05e-02  2.2e-04  4.5e+00  3.4e-04  5.21e-01
##     17   51 -1.728e+02  3.93e-03  1.01e-02  1.4e-01  1.6e+00  2.1e-01  5.73e-02
##     18   53 -1.740e+02  7.11e-03  8.84e-03  9.3e-02  1.0e+00  2.1e-01  4.37e-02
##     19   55 -1.743e+02  1.75e-03  2.07e-03  3.7e-02  9.2e-01  8.6e-02  3.51e-03
##     20   56 -1.744e+02  2.59e-04  2.86e-04  2.5e-02  0.0e+00  5.7e-02  2.86e-04
##     21   57 -1.744e+02  8.26e-05  7.48e-05  2.8e-03  0.0e+00  5.9e-03  7.48e-05
##     22   58 -1.744e+02  4.91e-06  4.12e-06  2.4e-03  1.6e-01  5.9e-03  4.16e-06
##     23   59 -1.744e+02  1.03e-06  8.77e-07  1.2e-03  0.0e+00  3.1e-03  8.77e-07
##     24   60 -1.744e+02  1.09e-07  9.27e-08  3.0e-04  0.0e+00  6.1e-04  9.27e-08
##     25   61 -1.744e+02  8.36e-09  7.93e-09  9.3e-05  0.0e+00  1.9e-04  7.93e-09
##     26   62 -1.744e+02  1.46e-10  9.95e-11  1.3e-05  0.0e+00  2.9e-05  9.95e-11
##
##  ***** RELATIVE FUNCTION CONVERGENCE *****
##
##  FUNCTION    -1.744045e+02   RELDX        1.281e-05
##  FUNC. EVALS      62         GRAD. EVALS      27
##  PRELDF       9.948e-11      NPRELDF      9.948e-11
##
##      I      FINAL X(I)        D(I)          G(I)
##
##      1    2.888764e-04     1.000e+00     6.755e-02
##      2    1.008626e+00     1.000e+00     2.168e-05
##      3    4.370590e-02     1.000e+00     1.087e-04
```