

# Time Series Analysis

## Lecture 3

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Autoregressive Models and Moving Average Models

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# Autoregressive Models

Model Estimation, Model Identification,  
Model Selection  
Example 3

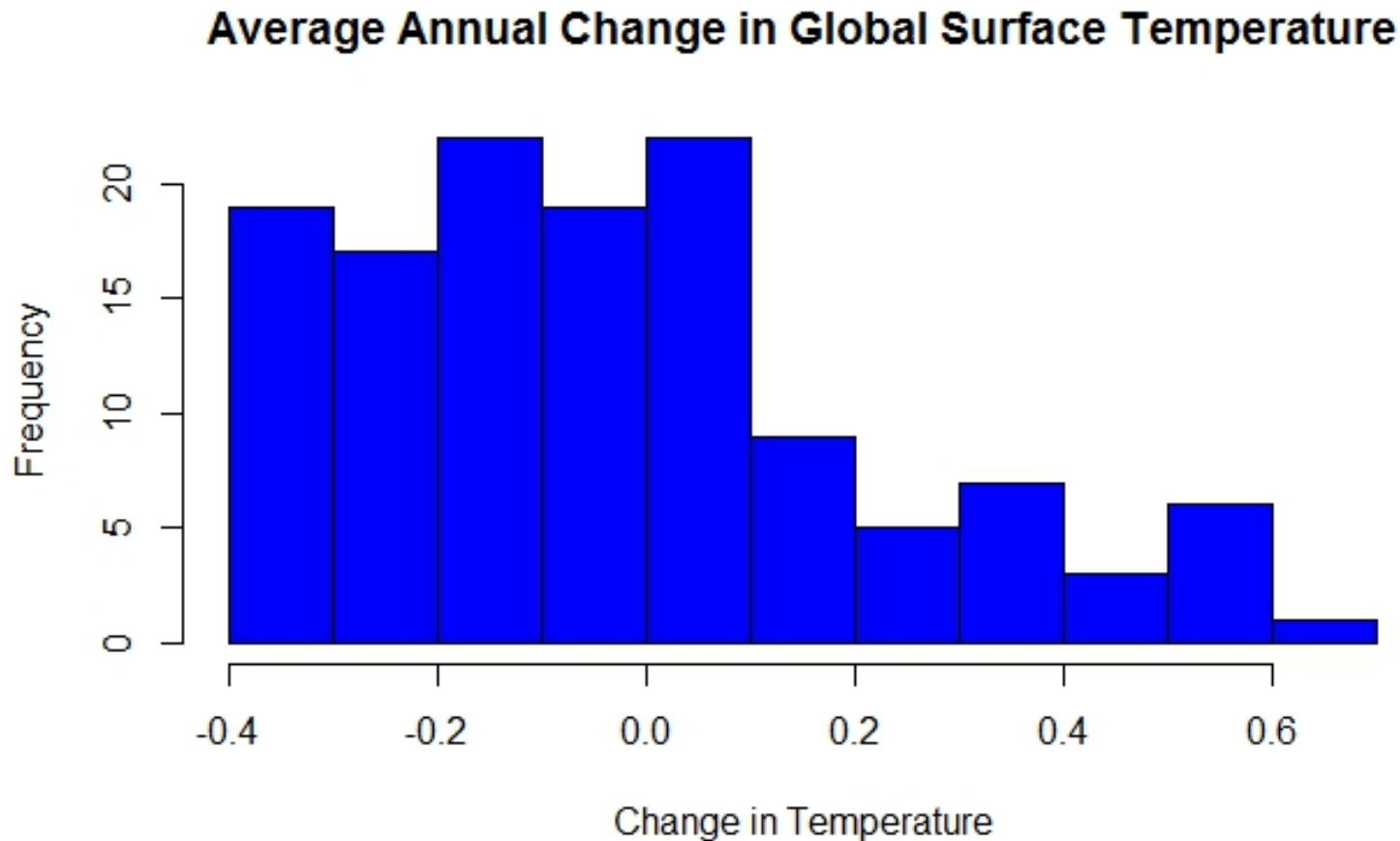
## Example 3: Global Surface Temperature

- Global surface temperature measured in annual average.
- Annual series from 1880–2009.
- Let's try to fit an AR model to this series.
- After loading and cleaning the dataset, examine the series:
  - The series has 130 (annual) observations.
  - It measures the annual change.

```
> str(gtemp)
Time-Series [1:130] from 1880 to 2009: -0.28 -0.21 -0.26 -0.27 -0.32 -0.32 -0
.29 -0.36 -0.27 -0.17 ...
> head(gtemp)
[1] -0.28 -0.21 -0.26 -0.27 -0.32 -0.32
```

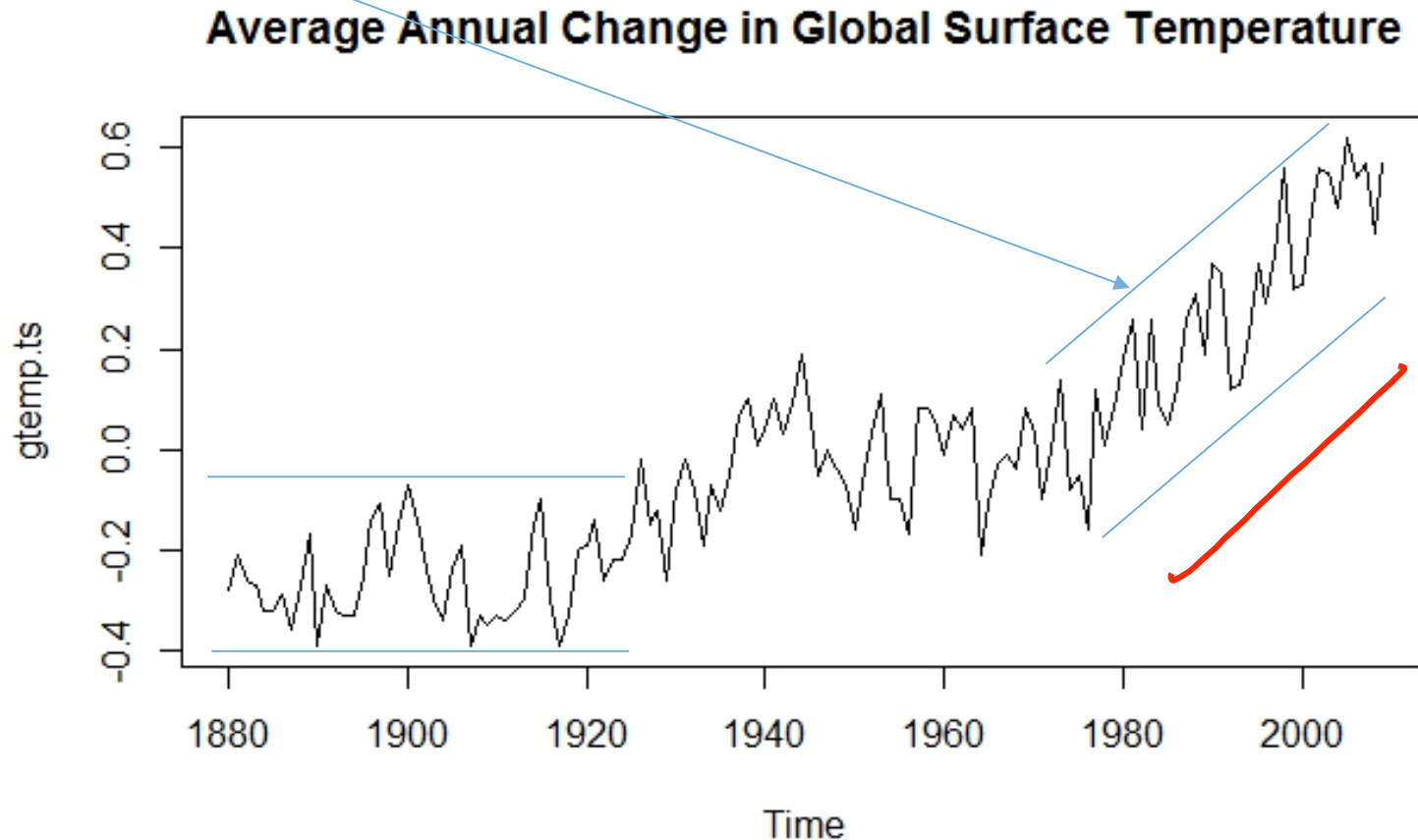
## Example 3: Global Surface Temperature

The histogram shows that the density is skewed.



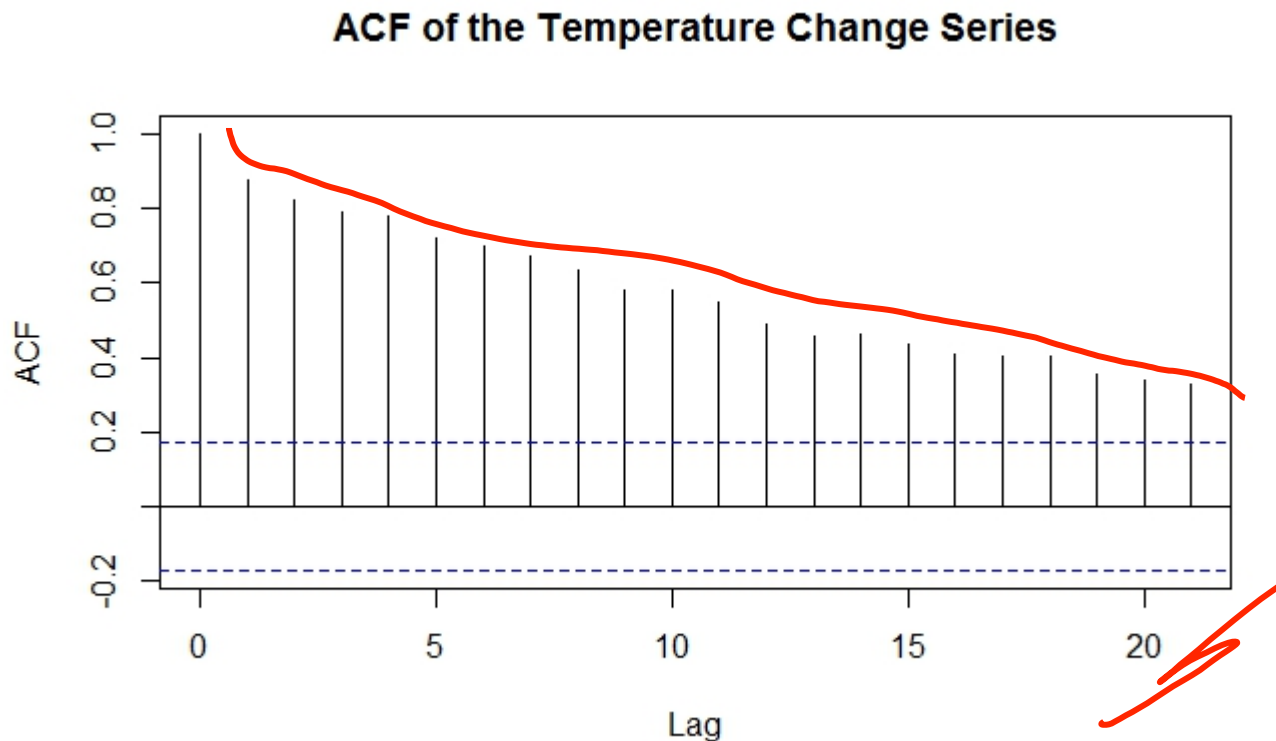
## Example 3: Global Surface Temperature

An upward trend is apparent in the time series plot.



## Example 3: Global Surface Temperature

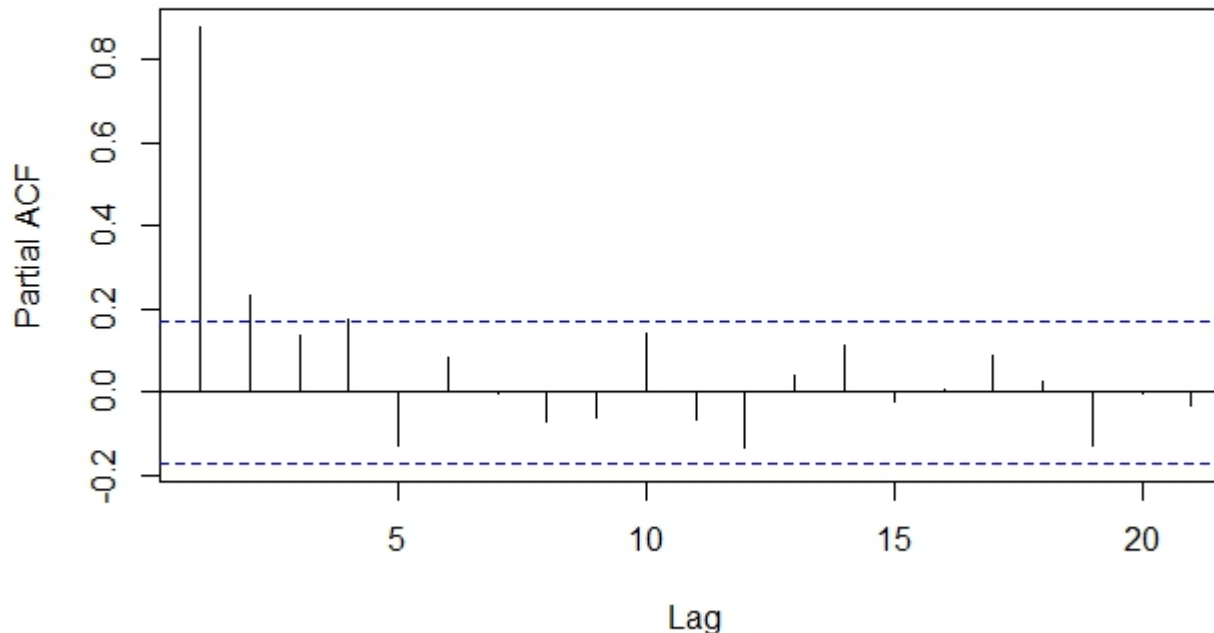
The ACF of the series confirms the strong persistence due to the trend. The autocorrelations decline to zero very slowly.



## Example 3: Global Surface Temperature

The PACF shows only a low but slightly statistically significant correlation at lag 1.

**PACF of the Temperature Change Series**



Although there is a trend that needs to be account for before fitting an AR model, we have not studied the techniques to handle trends yet.

Let's continue with the example and fit an AR model using the `AR()` function

```
> gtemp.ar <- ar(gtemp.ts, method="mle")  
Warning messages:  
1: In arima0(x, order = c(i, 0L, 0L), include.mean = demean) :  
  possible convergence problem: optim gave code = 1  
2: In arima0(x, order = c(i, 0L, 0L), include.mean = demean) :  
  possible convergence problem: optim gave code = 1  
3: In arima0(x, order = c(i, 0L, 0L), include.mean = demean) :  
  possible convergence problem: optim gave code = 1
```

So, the model fails to converge and the estimation cannot be completed!

This is a good news: Even if we “forget” to remove (or ignore) the trend before fitting an AR model, R would generate an error.



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