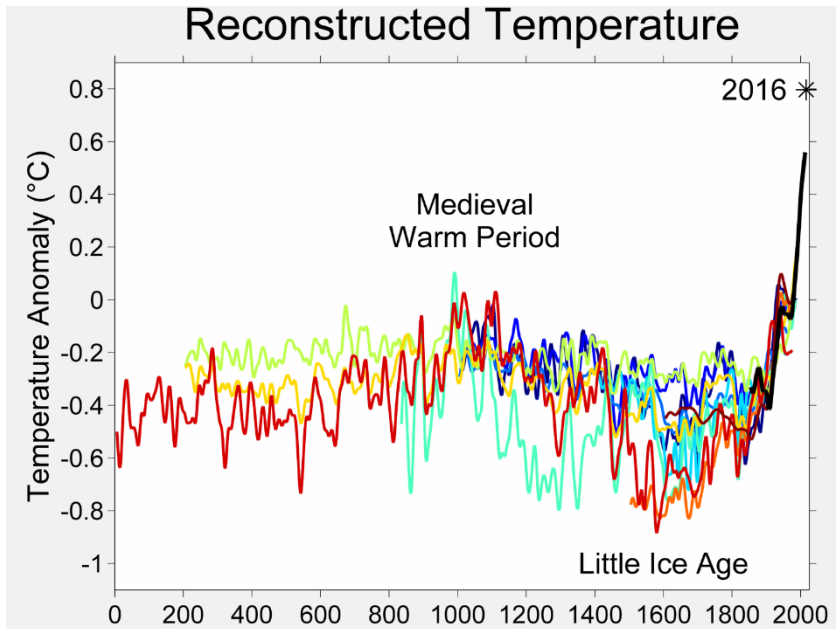


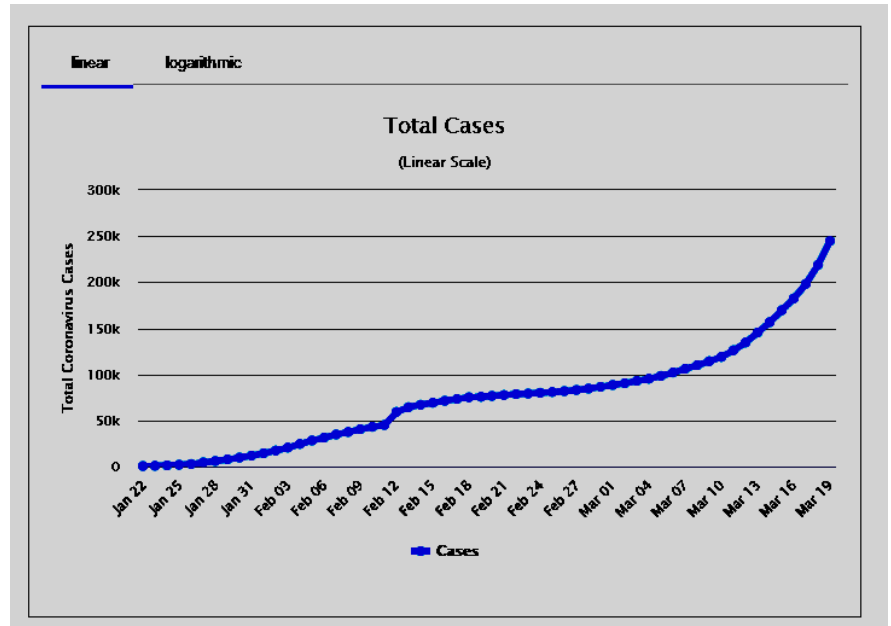
UNCERTAINTY in SCIENCE & LIFE

We will look at this in various ways. Focus on:

- (i) Global Temperatures & Climate Change
- (ii) Coronavirus Escalation



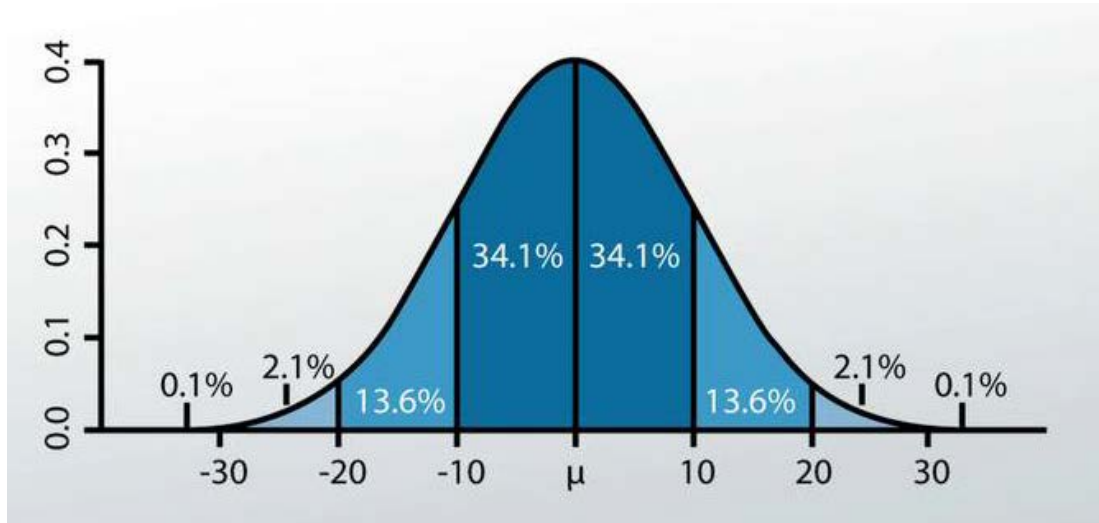
Global T, last 2000 yrs,
Different measures



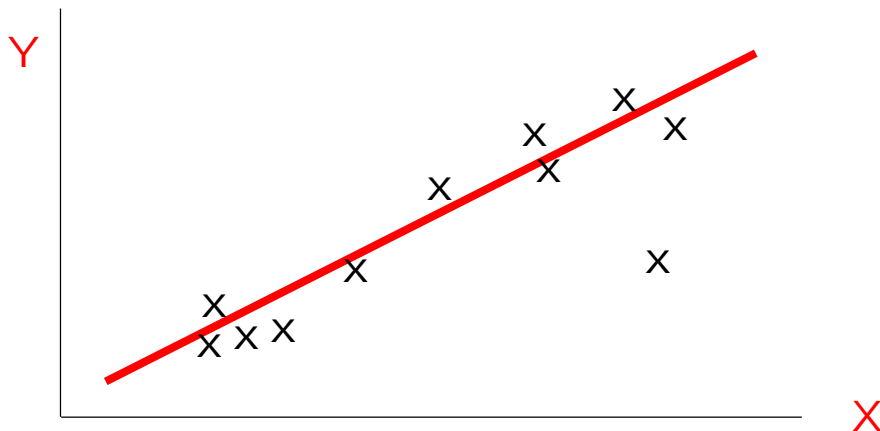
Recorded Coronavirus cases,
from Jan 22, 2020, to Mar 20, 2020

RANDOM ERRORS & "FALSE POSITIVES"

In the videos you have looked at, you saw that we can get "false positives" ; way out on the edge of the Bell curve



Question – how do we know we have a false positive?



Are any of these results false?

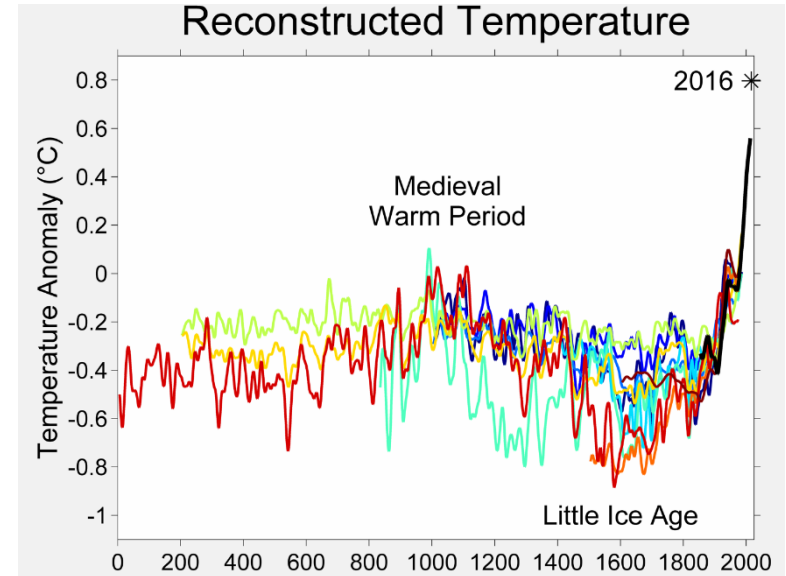
SOME DETAILS ON CLIMATE CHANGE

Temp record for last 2,000 yrs

These different measures include:

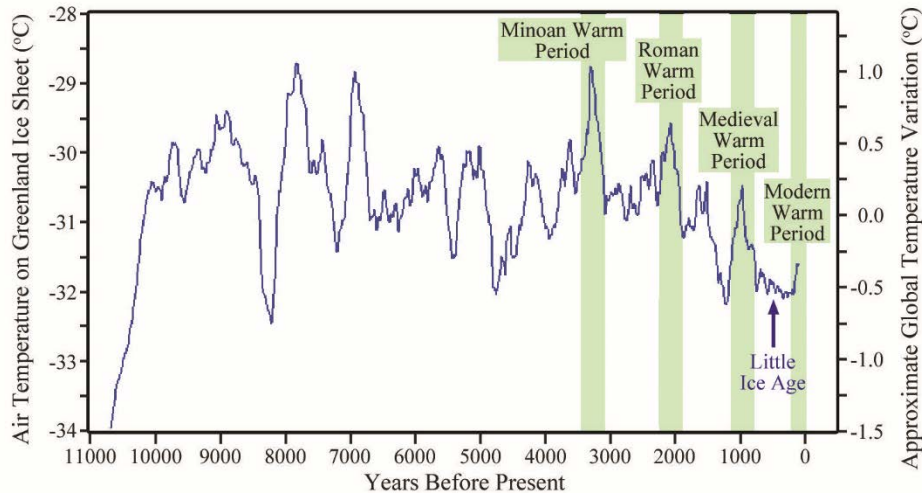
- Tree rings
- Ice cores
- Lake sediments
- Corals

Note they are GLOBAL AVERAGES

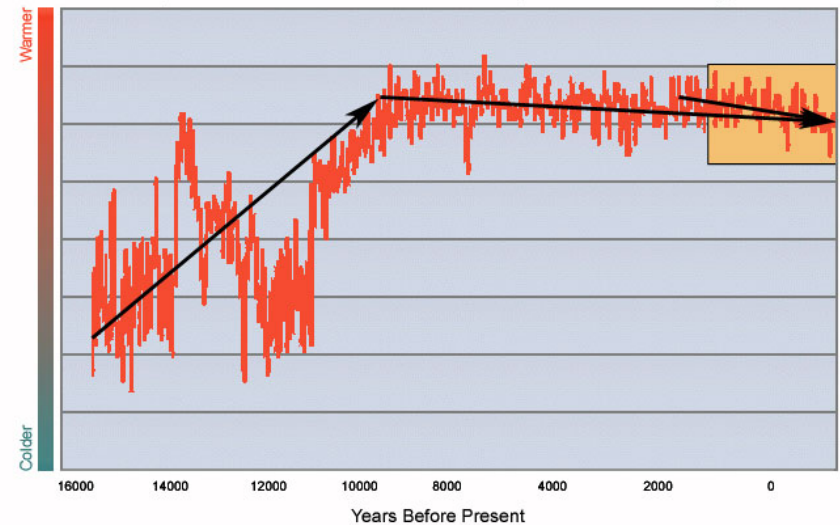


Temp record for last 16,000 yrs

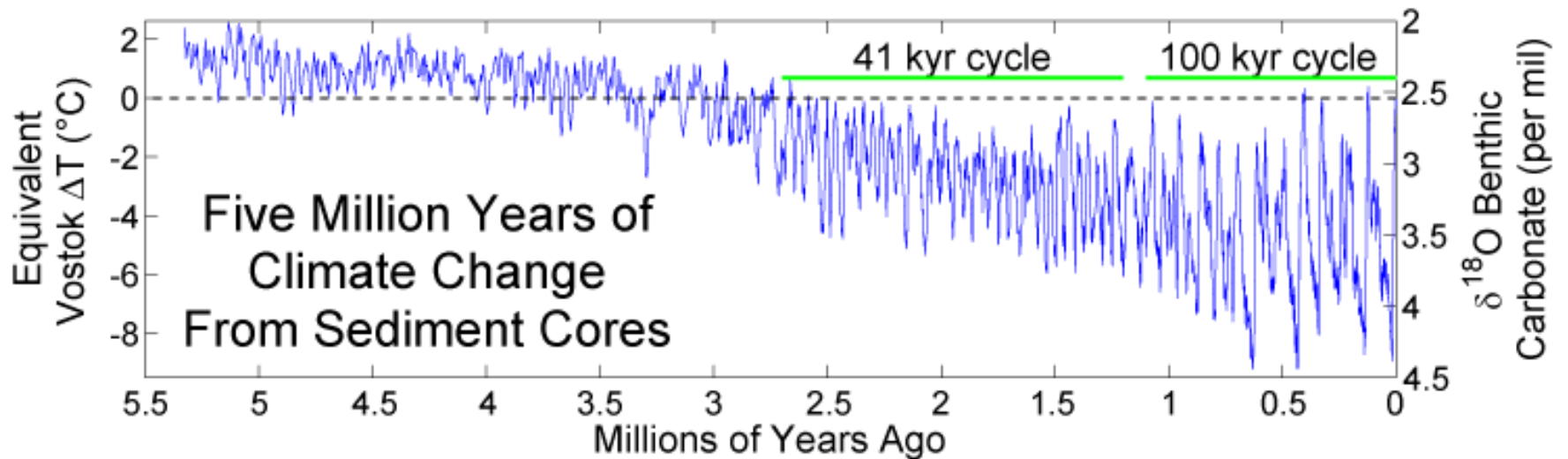
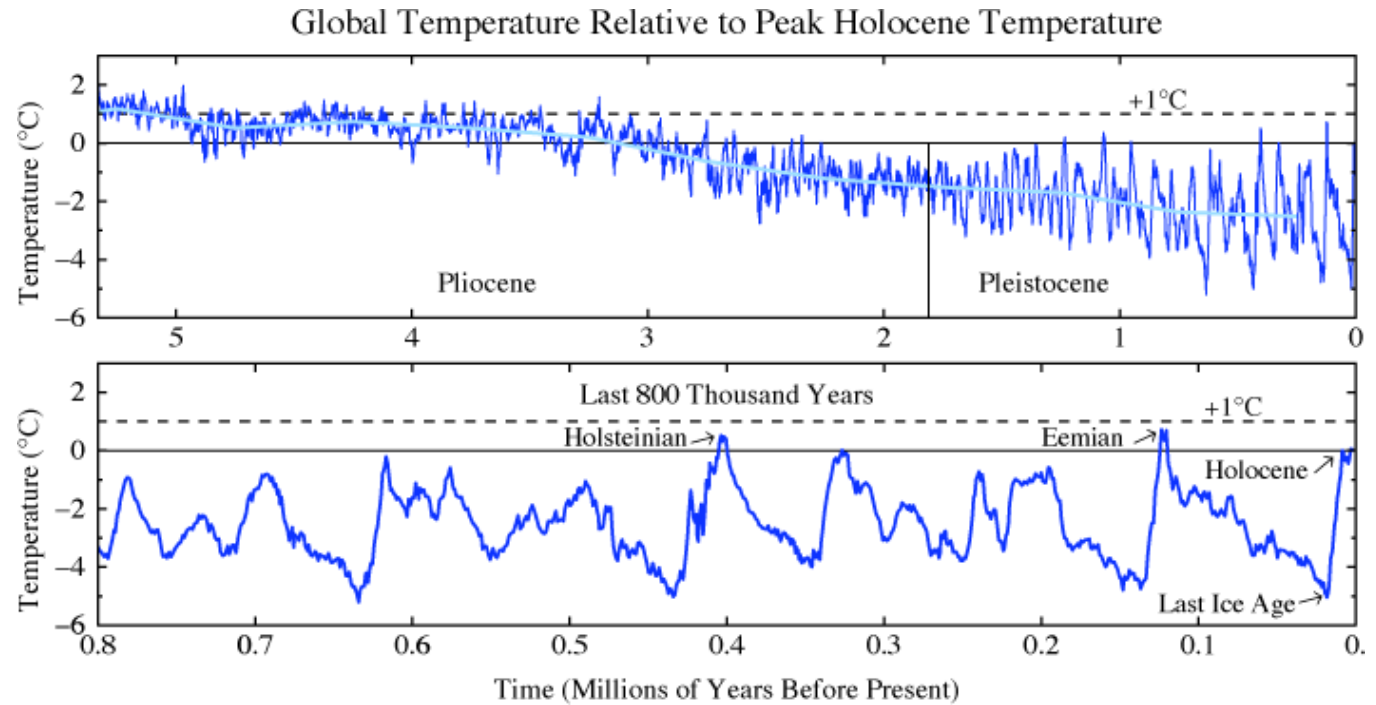
Global Temperature Variation Over the Last 10,000 Years



16,000 Years of Global Temperature Change

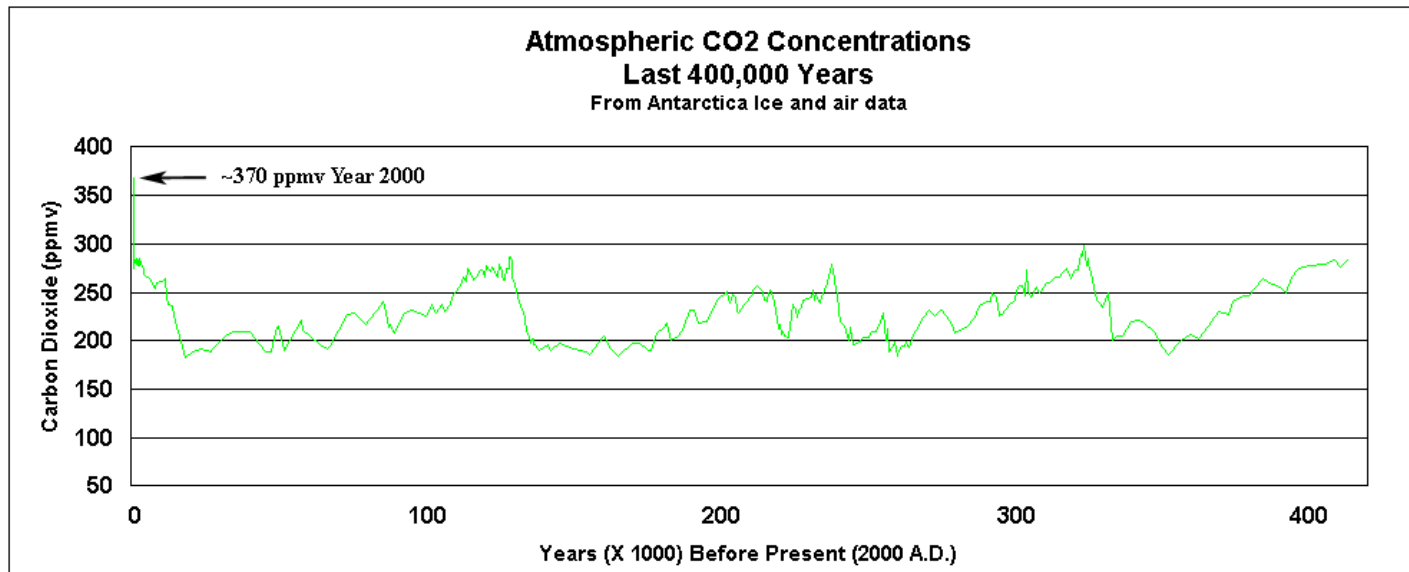
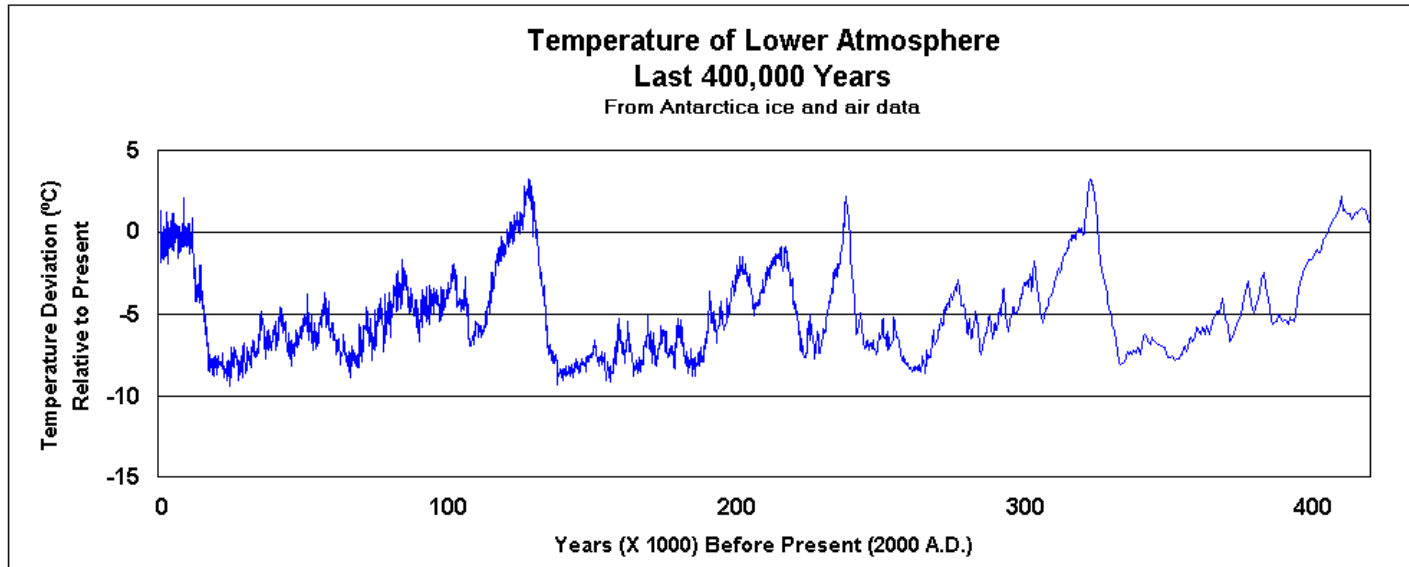


Temp record for last 5 million yrs



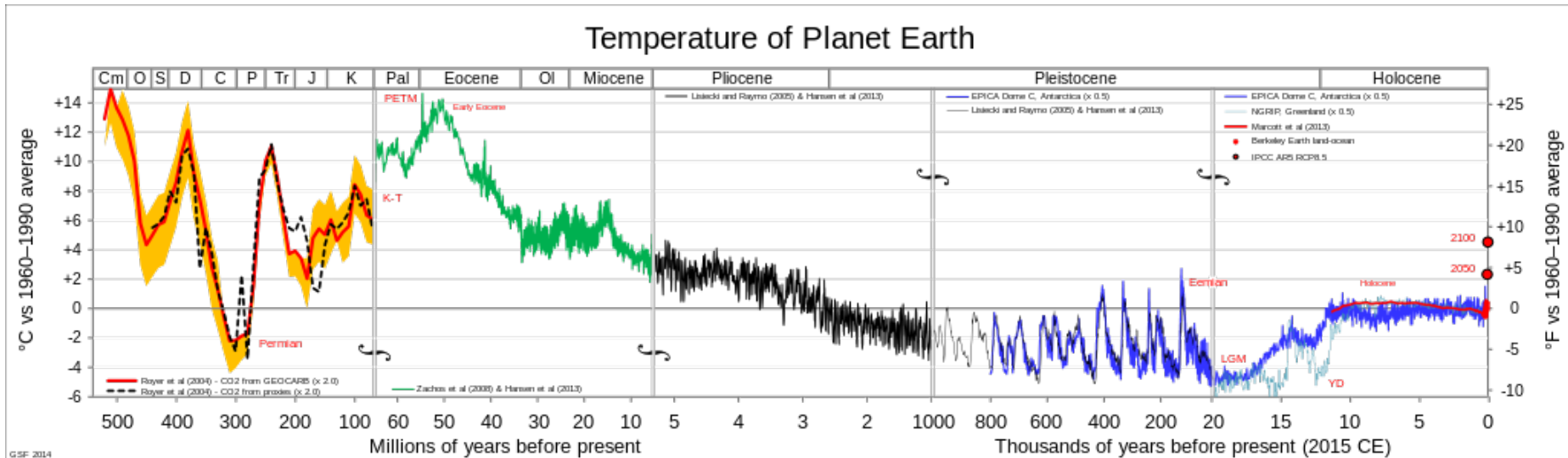
CORRELATION between T & CO₂ LEVELS

We show this over a 400,000 yr period



TEMPERATURE RECORD OVER THE LAST 550 MILLION YRS

You need to look carefully at this plot



Questions you should ask yourself:

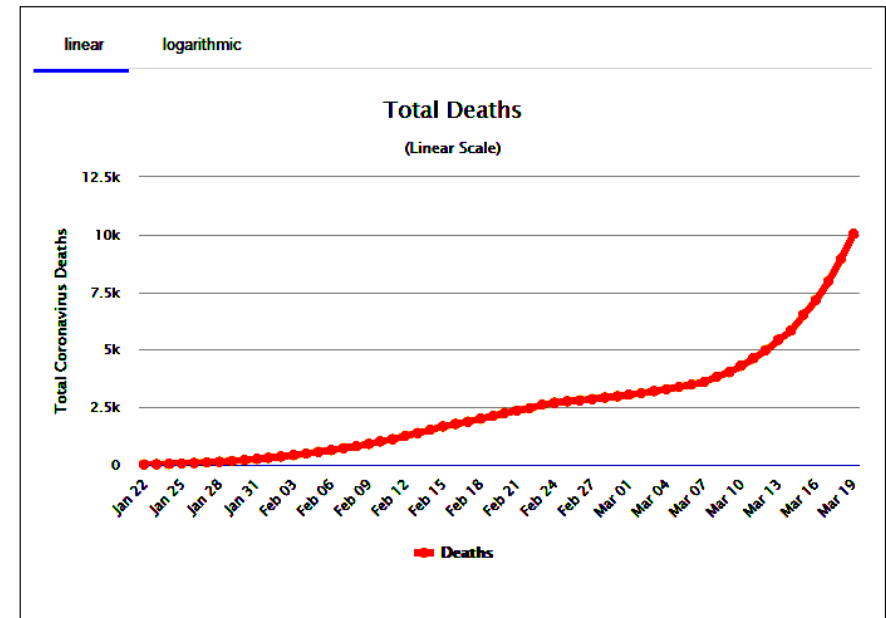
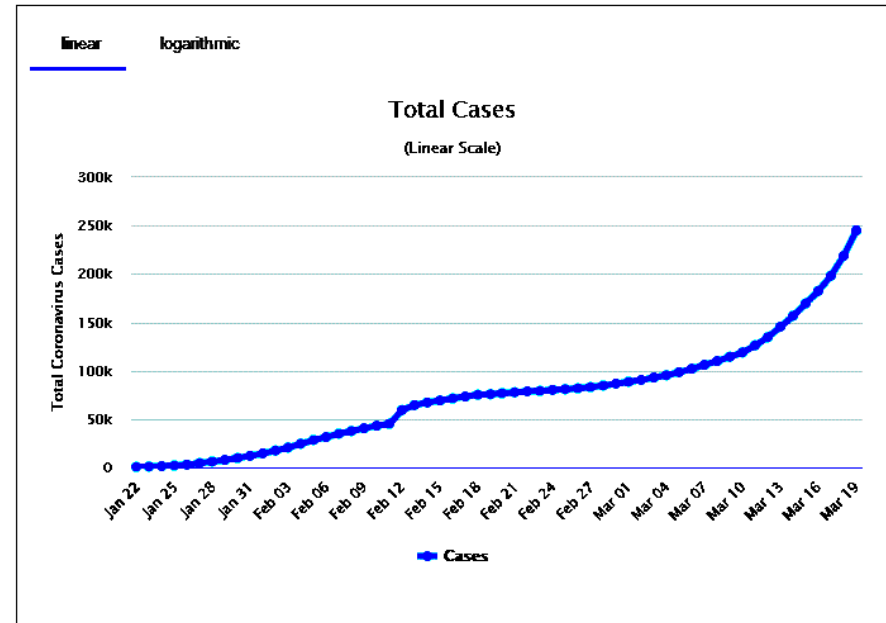
- Is this the best way to be plotting this data?
- How else could you plot it?
- What are the errors in this data (random or systematic)?
- What are the uncertainties in the data and where do they come from?
- Most important - WHAT DO WE LEARN FROM THIS DATA?
- Also important - HOW DO WE CORRELATE IT WITH OTHER DATA

DATA on CORONAVIRUS OUTBREAK (COVID-19)

These plots seem straightforward, so we can ask:

- What does each one tell us?
- How are they correlated with each other?
- What kinds of error are involved in getting this data?
- How do we think they will extrapolate into the future (what factors control this, & how uncertain are they)?

These plots are from the early stages of COVID (Jan 22, 2020 to Mar 19 2020). By this time lots of epidemiology groups were predicting what was going to happen after this.

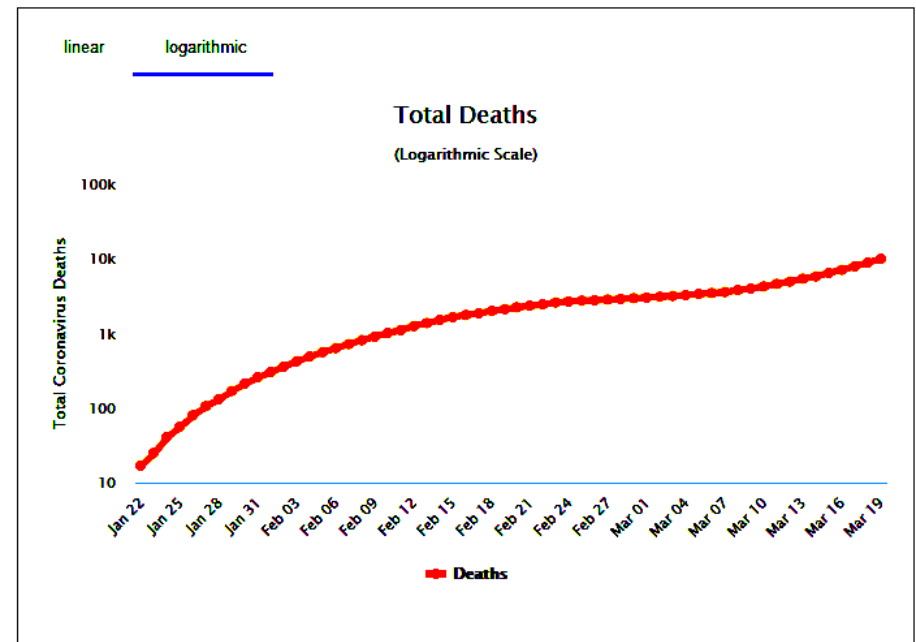
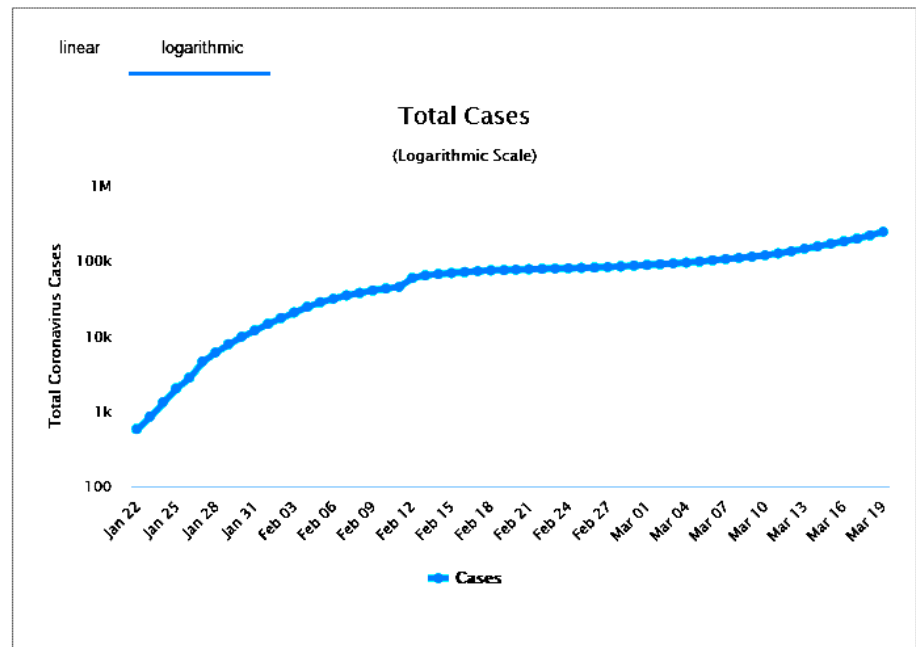


Now let us replot the data as LOG-LINEAR PLOTS

Let's ask the same questions again....

- What does each one tell us?
- How are they correlated with each other?
- What kinds of error are involved in getting this data?
- How do we think they will extrapolate into the future (what factors control this, & how uncertain are they)?

These plots are also from the early stages of COVID (Jan 22, 2020 to Mar 19 2020).

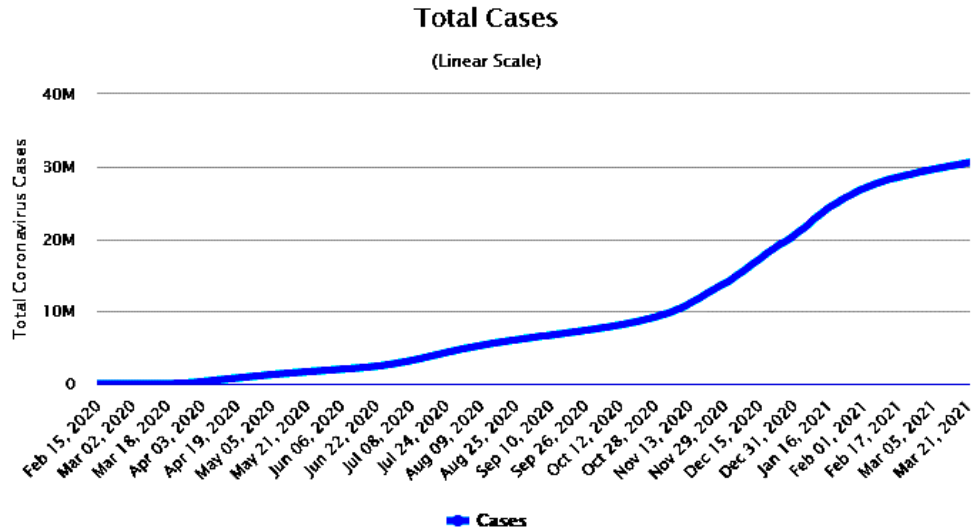


More on COVID

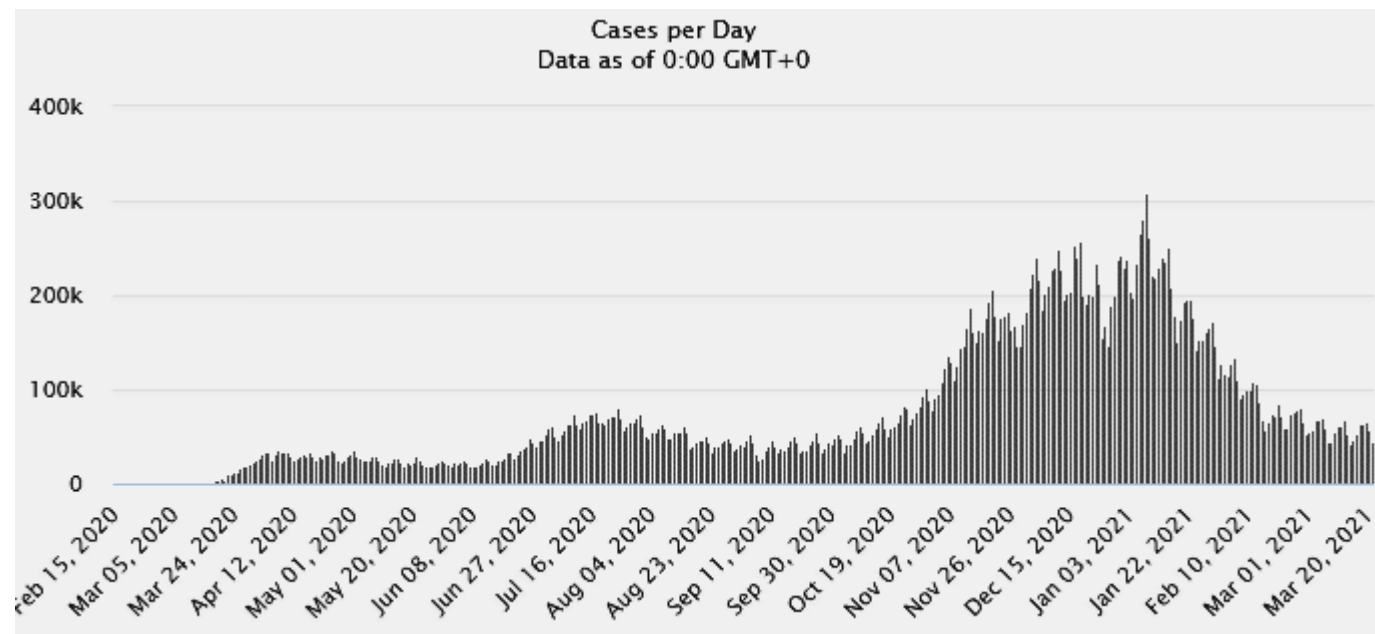
The graphs you just saw were from the first couple of months of COVID. As noted above, Lots of epidemiology groups then came out with “predictions” of what was going to happen.

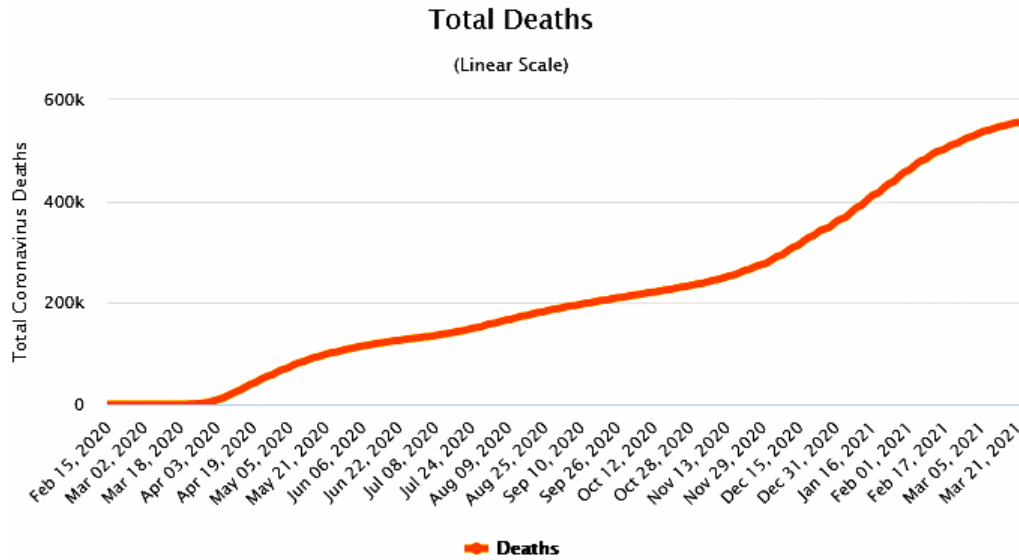
So what did happen?

linear logarithmic



This is what happened to case rates in the USA (from Jan 22, 2020 to Mar 20, 2021)



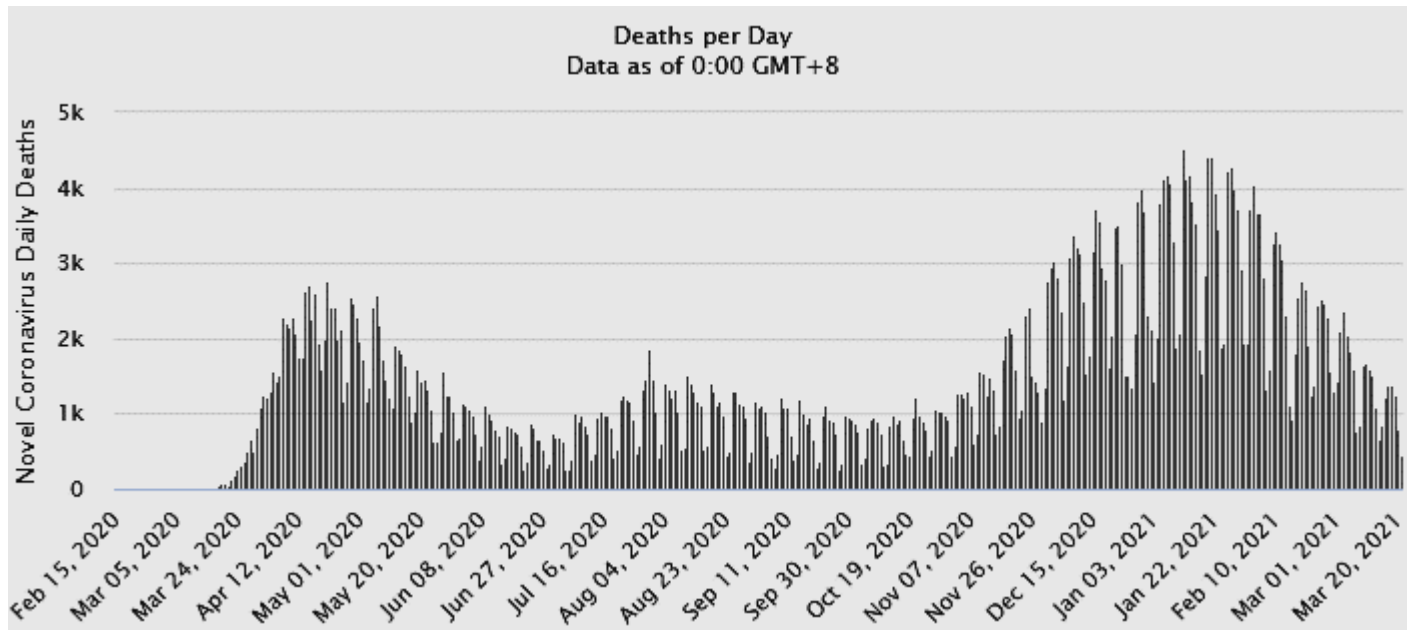


This is what happened to death rates in the USA (from Jan 22, 2020 to Mar 20, 2021)

USA population:
324 million

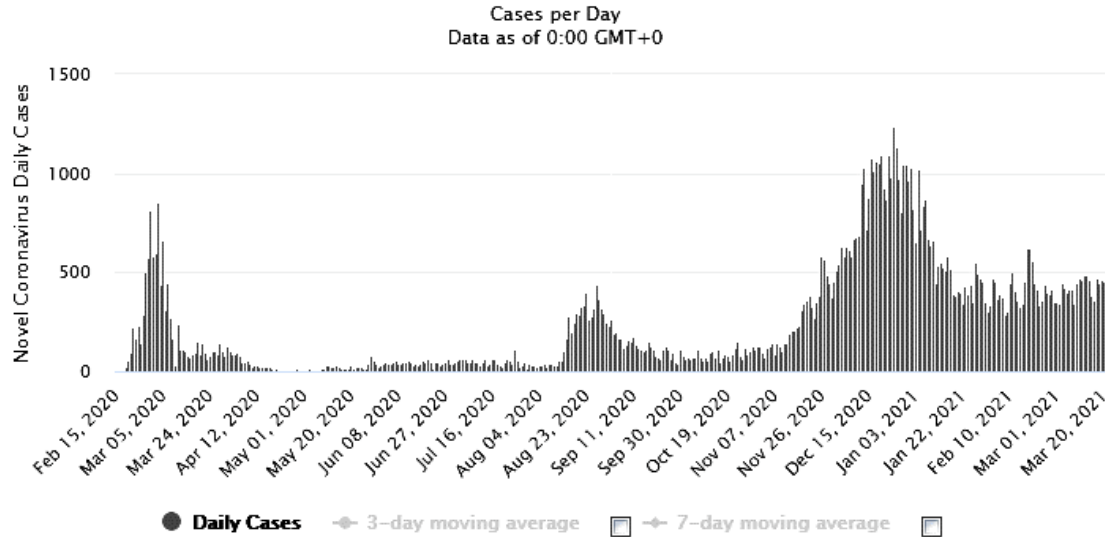
Cases to date: 30,567,167

Deaths to date: 555,861



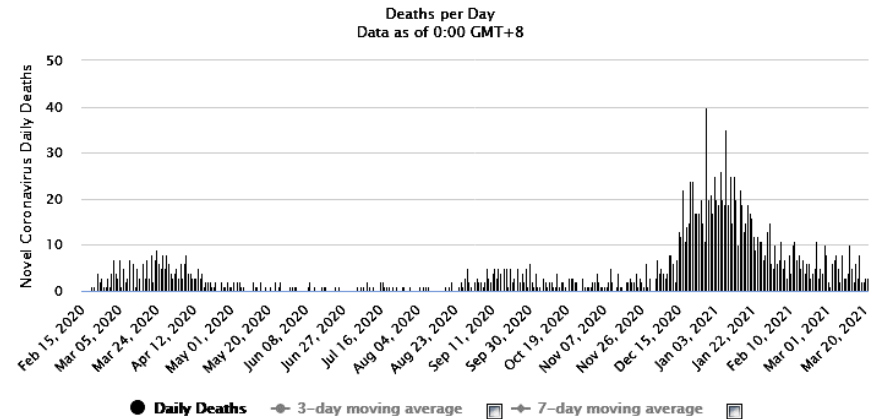
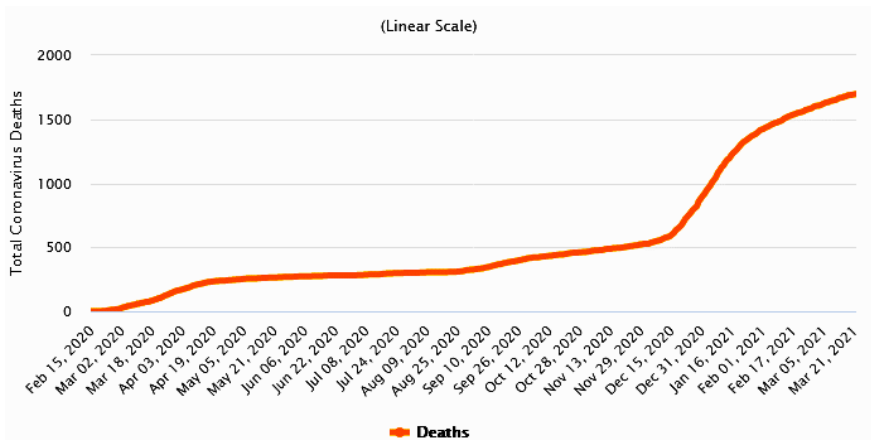
This is what happened in Sth Korea from Jan 22,2020 to Mar 20 2021

Population in Sth Korea: 52 million



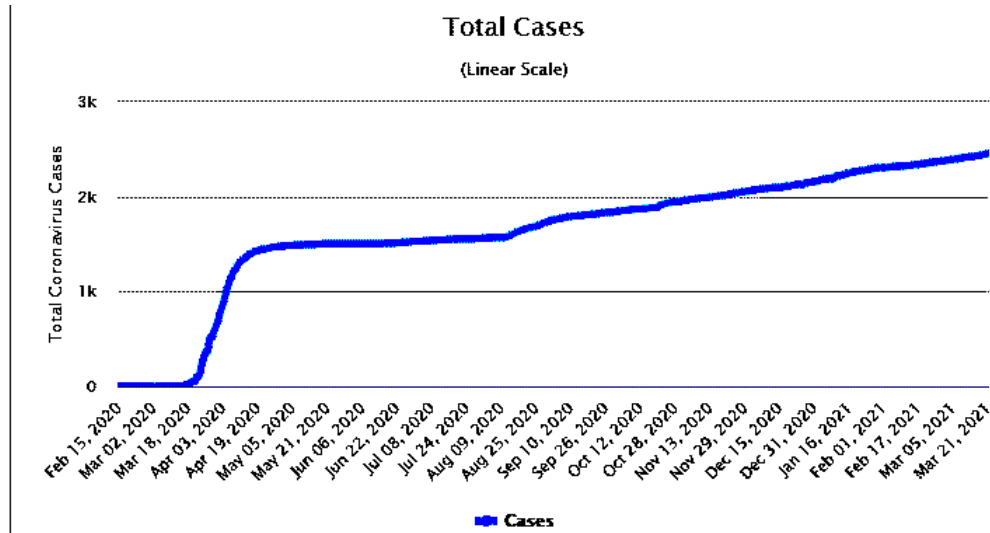
Cases to date:
99,075

Deaths to date:
1,697

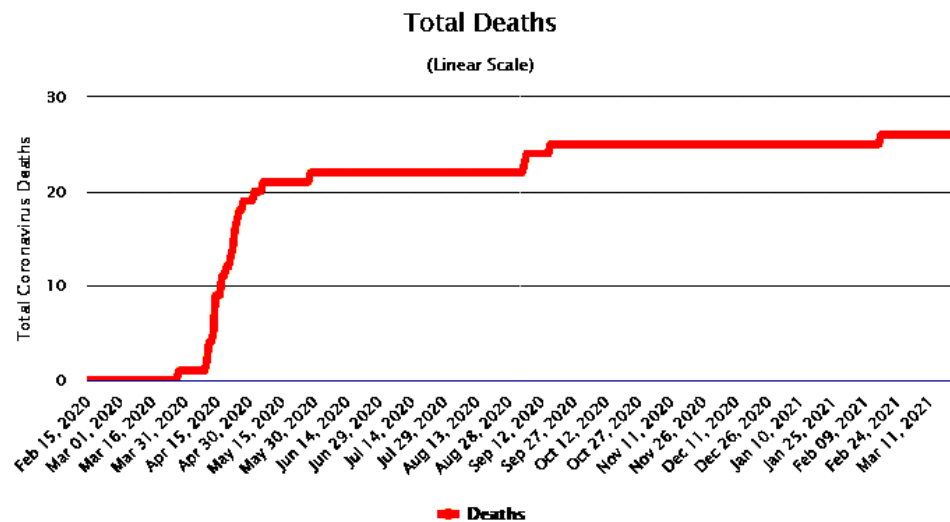


This is what happened in New Zealand from Feb 15, 2020 to Mar 21 2021

Population of New Zealand: 5.1 million



Cases to date:
2,492



Deaths to date:
26

An obvious question – did anybody predict these patterns?

If not, why not?

SUMMARY

ERRORS

As we know already, there are lots of errors in data collection, & these may be random or systematic

If we try to compile data using different measures of the same quantity, we often see both random and systematic differences between these (cf climate change data)

When we have many factors playing a role in the final results, there will often be large fluctuations that look like random errors but are possibly real (cf climate change data)

It is **REALLY IMPORTANT** to replot data in different ways, to look for hidden features and even hidden patterns (such as the existence of multi-periodic oscillations in climate data, and the existence of different mechanisms in COVID-19 data).

MODELS & THEORIES

All the data in the universe, and a computer the size of Jupiter, will not help you if you don't have a [theoretical framework](#) (sometimes called a "model") to understand the data.

If this framework is wrong it will give wrong predictions. If it is right it will make accurate predictions. Then you know that you have discovered at least some of the real mechanisms operating in Nature. As Einstein put it – you will have “pulled back a piece of the veil”.