Teaching Mathematics As If The Planet Matters

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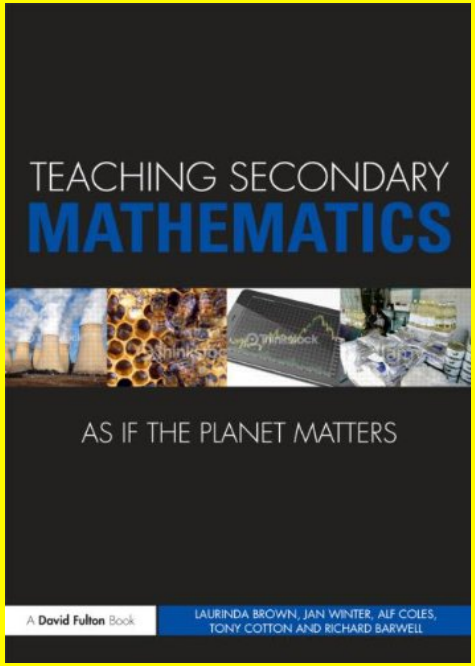
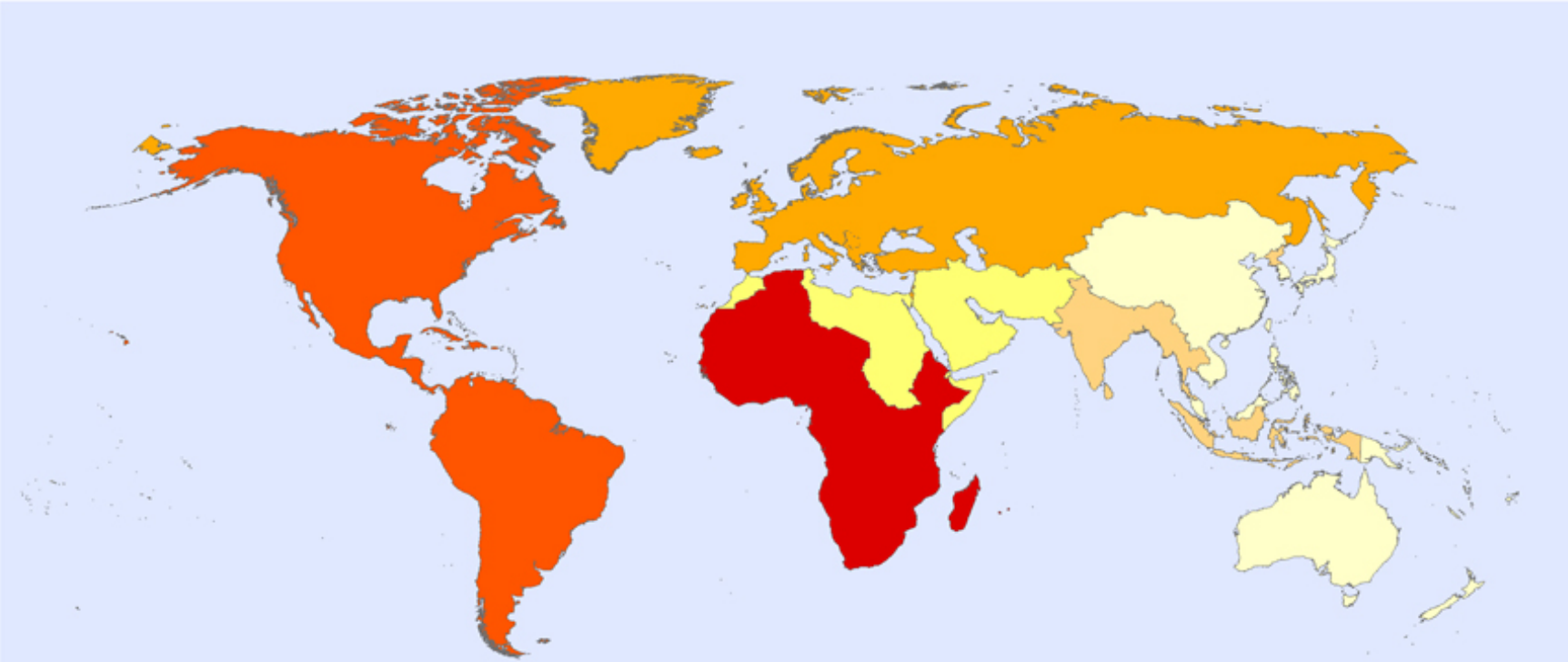
2nd Sept 2014



Spots!

- If you meet someone with a black spot, BOTH of you draw a (or another) black spot on your cards.

Adult HIV prevalence (15-49 years), 2012
By WHO region



Prevalence (%) by WHO region

- Western Pacific: 0.1 [<0.1-0.2]
- Eastern Mediterranean: 0.2 [0.1-0.2]
- South-East Asia: 0.3 [0.3-0.4]
- Europe: 0.4 [0.3-0.5]
- Americas: 0.5 [0.4-0.6]
- Africa: 4.5 [4.2-4.8]

Global prevalence: 0.8% [0.7-0.9]

0 875 1,750 3,500 Kilometers

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Health Statistics and Information Systems (HSI)
World Health Organization

World Health Organization

How to approach disputed topics?

- global issues threaten human life
- urgent action is need
- issues need to be addressed in classrooms

BUT …

- how do we maintain a critical stance?
- and respect the reality of the national curriculum / schooling pressures?
- … how would you use the Spots activity, for example?

Mathematics of Sustainability

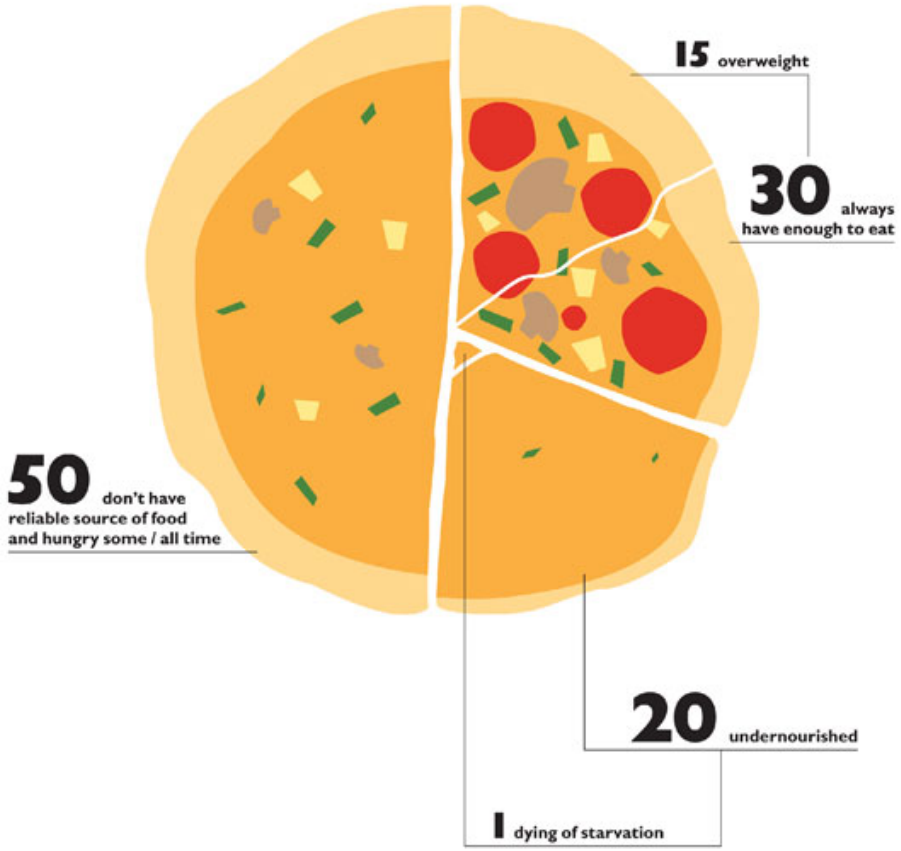
- Description
- Prediction
- Communication

If the world were a village of 100 people

NATIONALITY

If the world were a village of 100 people

FOOD



Critical Mathematics Education (Ole Skovsmose)

- We live in a technological society.
- Information technology involves a lot of mathematics.
- The mathematics embedded in information technology has tangible social effects.
- In summary, mathematics does not simply describe the world, it changes it. This is the *formatting power* of mathematics.

Implications … a critical mathematics education recognises:

- mathematising a system (like the climate) involves human beings making decisions.
- ostensibly mathematical decisions may reflect the political or economic interests of the people constructing the model.
- mathematics can bring an illusion of control over our environment.

Some key questions – relevant to any ‘crisis’ situation:

- How has mathematics helped shape the crisis?
- How is mathematics used to describe or model the crisis?
- What are the ethical and social consequences of the use of mathematics?

The Mathematics of Climate Change

A distinction

	CLIMATE	WEATHER
	Mean daily maximum temperature (°C) 1971-2000	Maximum temperature (°C) 25 October 2011
Edinburgh	12.2	9.5
London (Greenwich)	14.8	16.8

Table 3.1 Comparing the climate and weather of Edinburgh and London.

Source: http://www.metoffice.gov.uk/climate/uk/averages/19712000/ and

http://weather.lgfl.org.uk/Default.aspx

NASA and the National Oceanic and Atmospheric Administration (NOAA), agreed that 2010 tied with 2005 as the hottest since records began in 1880. Overall 2010 and 2005 were 1.12F (0.62C) above the 20th century average … [of] temperatures across the world.

(*Daily Telegraph*, 13 January 2011)

[In 2010] the UK recorded its coldest year since 1986 and its coldest December in 100 years, according to the Met Office.

(*The Guardian*, 20 January 2011)

NEW DELHI: Severe cold may well be making headlines in the past two weeks, but here's the big picture: 2010 was the warmest year ever in India since weather records began in 1901. The Indian Meteorological Department announced on Thursday that the mean annual temperature in the country during 2010 was as much as 0.93 degrees Celsius higher than the long term (1961-1990) average.

(*Times of India*, 14 January 2011)

– or

“if the world is getting hotter, why is there so much cold weather around?”

Global Temperature

- What is meant by “global temperature”?
- How do you think it is calculated?

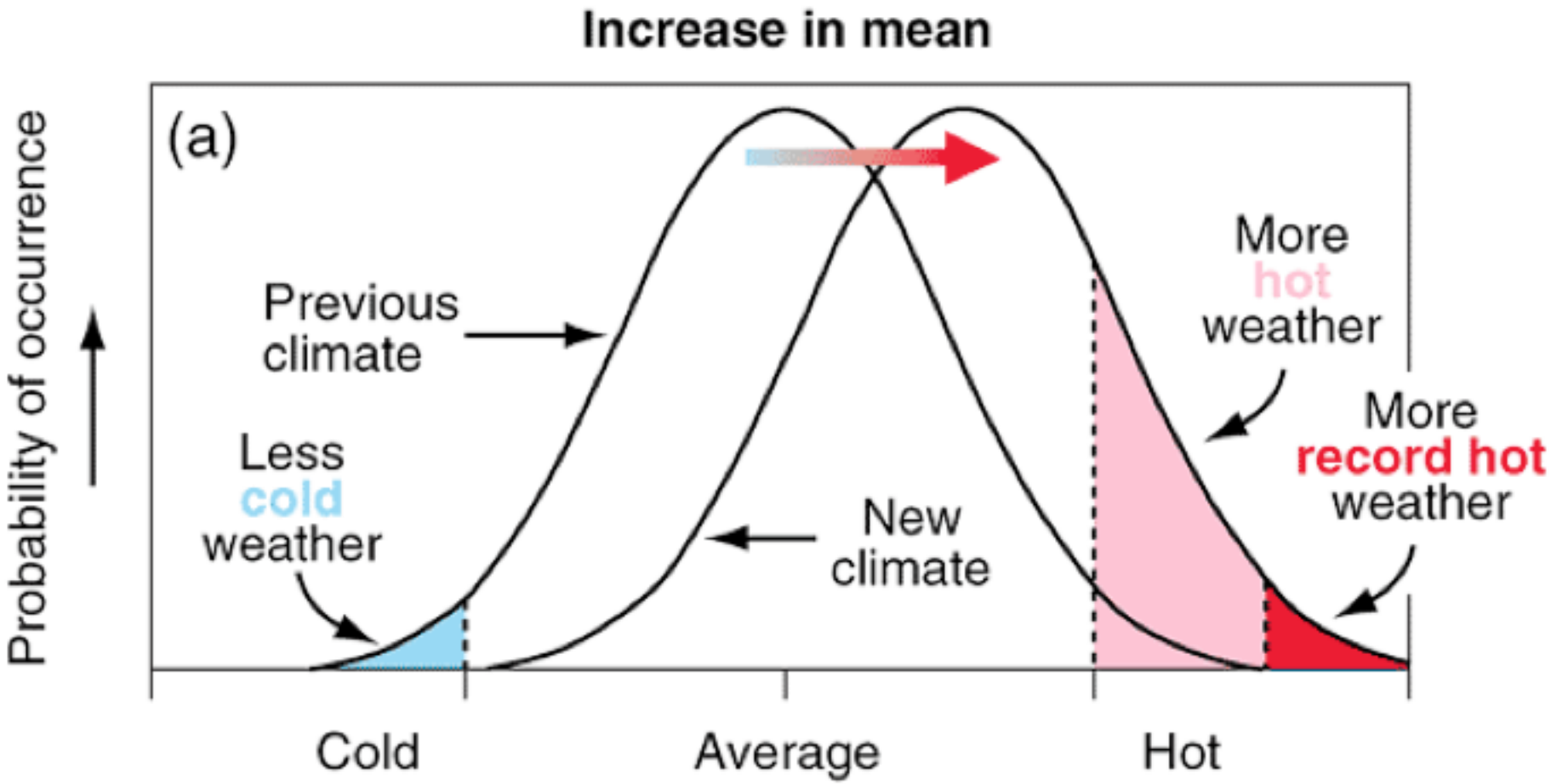
Getting data from where you live

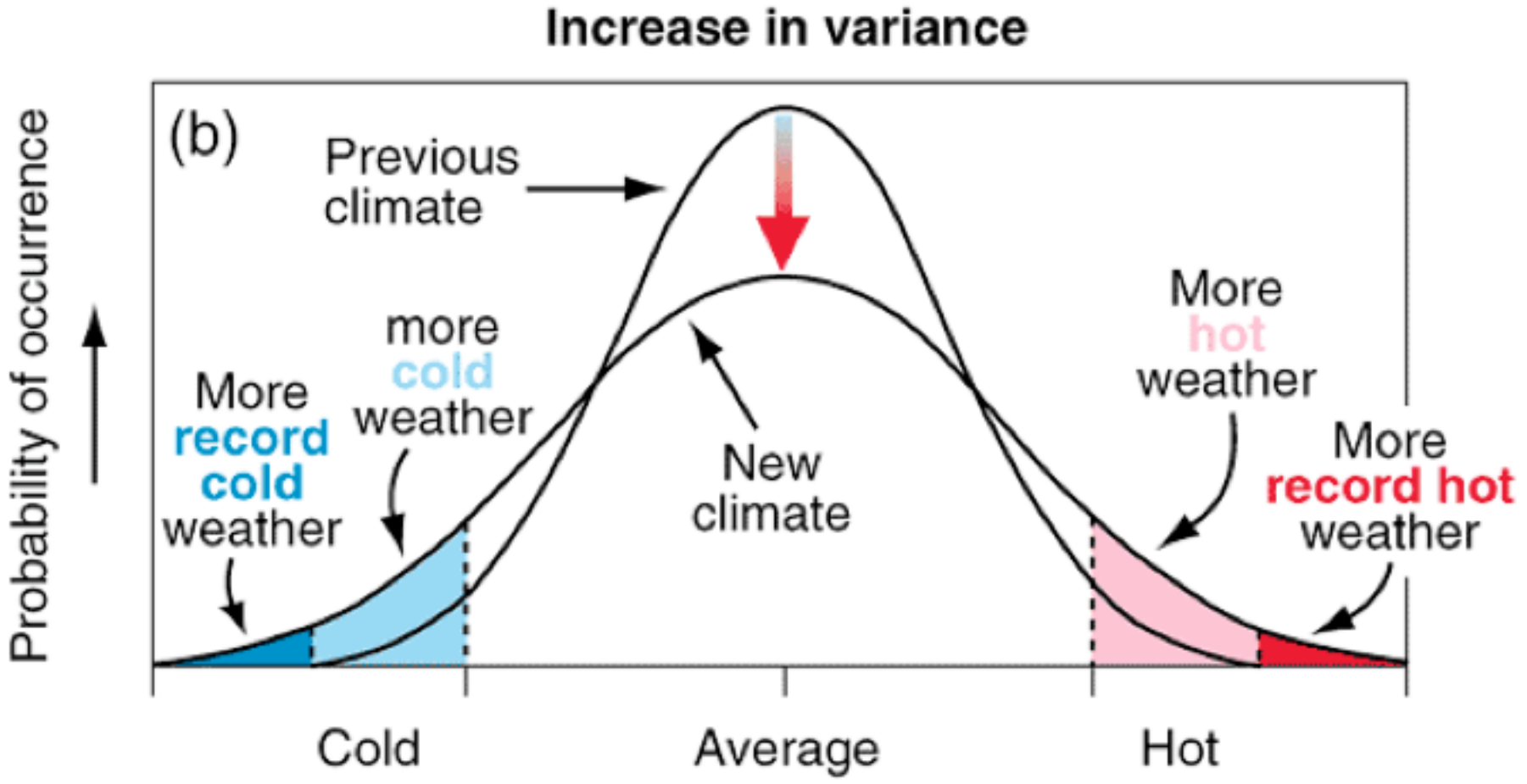
- Met Office website
- Look at the data for Sheffield, 1981-2010
- In pairs, discuss what you notice …
  - What could student teachers do faced with this data?
  - What other data would you want?

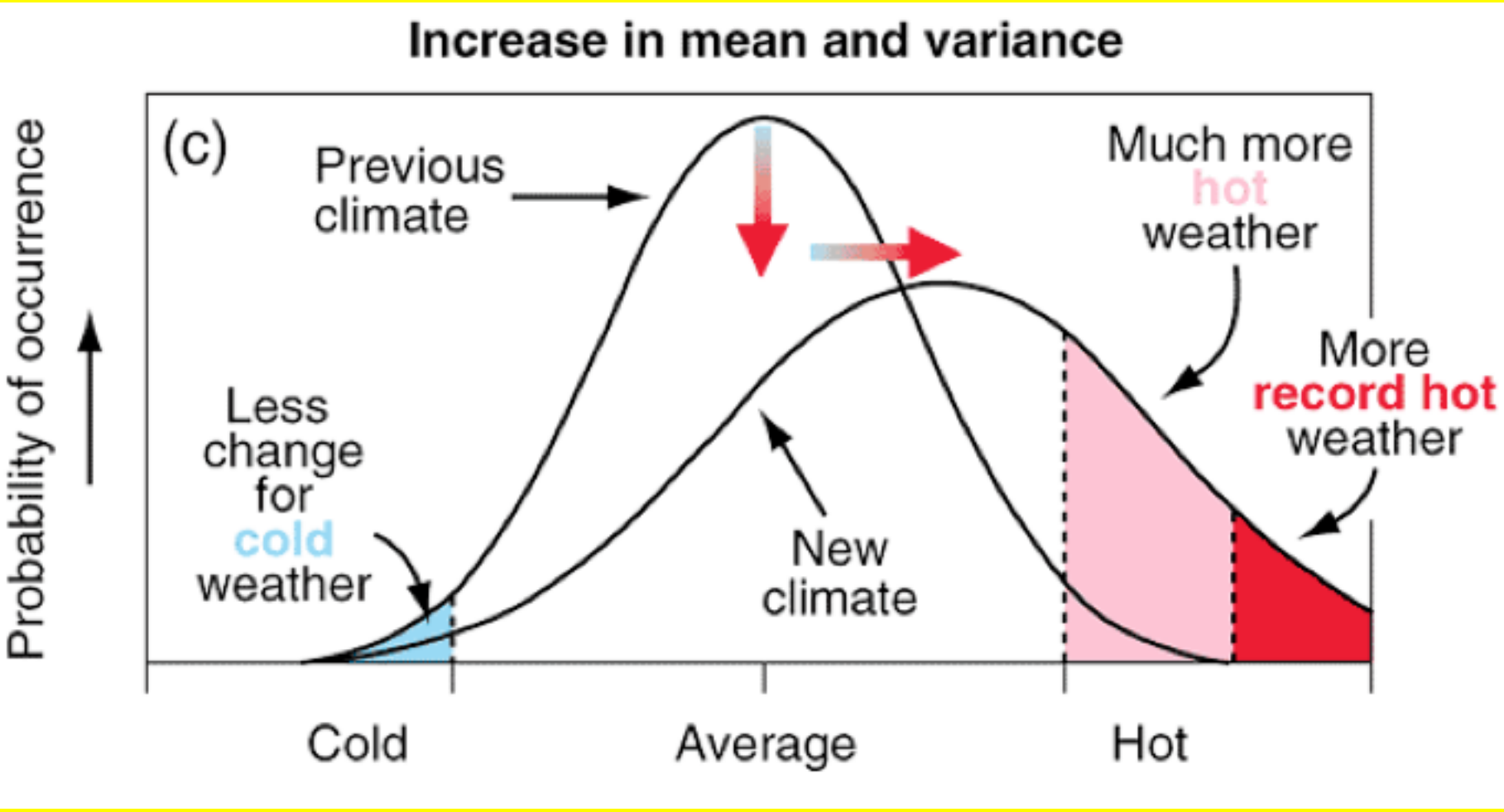
Assume average daily temperature follows a normal distribution. Sketch scenarios for **each possible** set of changes in mean & variance.

Mean Constant **Variance Constant**	**Mean Increases** **Variance Constant**
Mean Constant **Variance Increases**	**Mean Increases** **Variance Increases**

What implications are there for the frequency of extreme weather, in each case?


Increase in mean
(a)
Probability of occurrence
Previous climate
Less cold weather
New climate
More hot weather
More record hot weather
Cold
Average
Hot


Increase in variance
(b)
Previous climate
New climate
More record cold weather
more cold weather
More hot weather
More record hot weather
Probability of occurrence
Cold
Average
Hot


Increase in mean and variance
(c)
Previous climate
Much more hot weather
More record hot weather
Less change for cold weather
New climate
Probability of occurrence
Cold
Average
Hot

Mean maximum and minimum temperatures and standard deviations for two thirty-year periods in Sheffield, UK.

	Mean max temp (ºC)	**Standard deviation (ºC)**	**Mean min temp (ºC)**	**Standard deviation (ºC)**
1901-1930	12.6	0.51	6.0	0.39
1981-2010	13.4	0.66	6.6	0.56

Maximum Temperatures

	- 2 standard deviations	- 1 standard deviation	Mean maximum temperature (°C)	+ 1 standard deviation	+ 2 standa deviations
)1-1930	11.5	12.0	12.6	13.1	13.6
31-2010	12.1	12.7	13.4	14.0	14.7

ble 3.5a: Mean maximum temperature distributions for two thirty-year periods in

effield, UK.

Minimum Temperatures

	- 2 standard deviations	- 1 standard deviation	Mean minimum temperature (ºC)	+ 1 standard deviation	+ 2 standa deviations
1-1930	5.3	5.6	6.0	6.4	6.8
1-2010	5.4	6.0	6.6	7.2	7.7

le 3.5b: Mean minimum temperature distributions for two thirty-year periods in ffield, UK.

Some questions …

(for student-teachers, perhaps):

- How is mathematics used or misused in debates about the need for action?
- What mathematics do 'consumers' of information about climate change need to know to be able to make informed judgments?
- How do the interests of authors of information about climate change influence those authors' use of mathematics?

Discussion

Reflecting on this session's activities …

- What are the ethical/practical issues about using real data?
- What, as teacher educators, do we need to consider?
- What are suitable sources of data/appropriate topics for our or for classroom use?
- What kinds of *action* could student teachers take, in relation to global issues?

Three kinds of approach

Transformation

- Teaching and learning mathematics to analyse and critique the perspectives that shape how the world is understood and engage in action to change the world
- Outside world as origin of sustainability problems, for which mathematics may be one tool (or part of the problem)

Reformation

- Teaching and learning mathematics to relate mathematics to the world and to refine how things are done
- Outside world as origin of mathematics problems

Accommodation

- Teaching and learning mathematical facts and procedures
- Outside world used as a way of presenting mathematics

Where next?