

# Mathematics 2013 Conference

**M**athematics 2013, the continuation of the series of annual one day conferences on mathematics and its applications took place on 14 March. It was again held at Mary Ward House in Tavistock Place, London.

The aim of this series of conferences is to bring together people with an interest in mathematics and its applications to be introduced to a number of wide-ranging mathematical issues from sectors such as government, academic research, industry, education, finance etc.

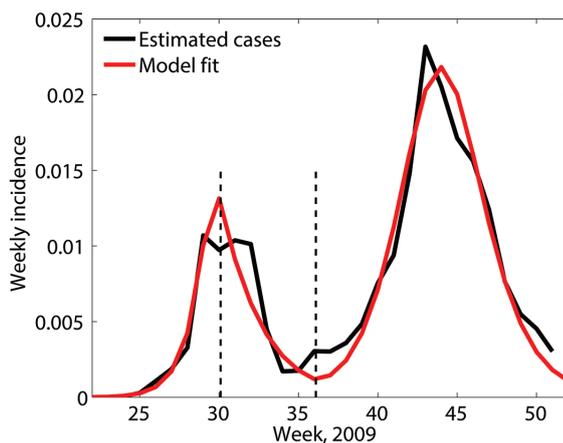
This year the theme of the conference was the mathematics of planet Earth; an IMA contribution to the global activities being undertaken as part of the international Mathematics of Planet Earth 2013 programme [1]. Around 70 people attended to network with others, listen to a superb range of talks and enjoy the reception in the late afternoon.

Robert MacKay FRS, CMath FIMA, the current President of the IMA, thanked everyone for coming and gave a brief introduction to the day after noting that it was pi-day (14 March, or 3.14 using the US dating convention)!

## 1 Swine-flu and epidemic modelling

Ken Eames FIMA (London School of Hygiene and Tropical Medicine) and Ellen Brooks-Pollock FIMA (University of Cambridge) provided an entertaining double act as they described the model they'd produced to represent the relationships among the numbers of people susceptible to, infected by and recovered from the swine-flu epidemic in the UK in 2009.

A significant feature of their model is that children and adults are treated as separate, but interacting, groups, with the children generally having many more interactions with others than adults, during school terms. This accounts for the double peak in number of infections, one peak either side of the school summer holiday, observed during 2009. Their model predictions are compared with observations in the figure below.



Effect of school holidays. Courtesy of Ken Eames – adapted from [2]

They described how mathematical modelling can help determine vaccination strategy, but noted that getting good data can be a problem. To help with data collection with regard to flu, they encouraged everyone to register with the online flu-survey [3].

## 2 Climate Dynamics

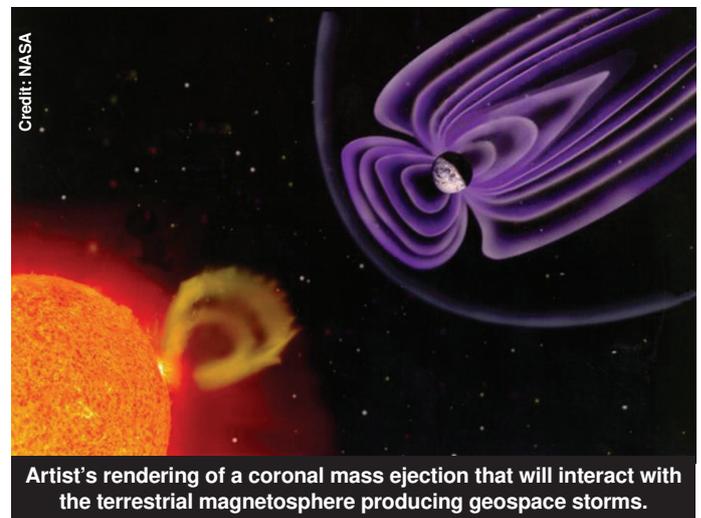
Valerio Lucarini (Universities of Hamburg and Reading) considered climate dynamics as a problem of statistical mechanics. He

noted that our climate is a complex system, which means it is composed of interconnected parts that, as a whole, exhibit collective properties which transcend the features of the individual parts. The scientific method is challenged as theoretical models can't be compared with repeated experiments – there's only one Earth!

He went on to discuss how Ruelle Response Theory can be used to study the impact of deterministic and stochastic forcing functions on non-equilibrium statistical mechanics systems like the Earth's climate.

## 3 Bunched black swans

Nick Watkins (British Antarctic Survey, Cambridge) used the metaphor of 'bunched black swans' to refer to long range correlated, wild events. He was particularly concerned about 'burst' events in the context of space weather arising from the interaction of the solar wind with the Earth's magnetosphere (see figure below), but also gave examples from the areas of climate and finance.



There are many more extreme size coronal mass ejections (a massive burst of solar wind and magnetic fields rising above the solar corona), for example, than one might traditionally expect. Examples of more than expected extreme events on Earth are runs of hot days above a fixed threshold (e.g. as in summer 1976). He and his colleagues use linear fractional stable motion models as well as multifractal models to describe these 'black swan' events. Nick noted that Mandelbrot had long ago anticipated much more of the analyses of such events than he is often given credit for.

## 4 Mathematics education globally

Rosalind Mist (Advisory Committee on Mathematics Education) discussed how mathematics education world-wide can impact on education policy in England. She asked how we can learn from other jurisdictions (a 'jurisdiction' may be a Country or part of a Country – such as Florida or Alberta). Politicians are often keen on 'policy borrowing', but this doesn't always work because of differing backgrounds and cultural norms that might exist. Politicians also tend to have flavour-of-the-month jurisdictions; for example, New Zealand is currently trending!

The obsession with others is often centred on two comparison sets: TIMSS and PISA. The former seeks to compare 4th and 8th graders in Number, Algebra, Geometry, Data and Chance; the latter looks at 15 year olds in OECD countries and compares Analysis, Reasoning and Communication skills.

Rosalind gave some interesting details on a number of specific countries, how they do and how this might affect the UK.

## 5 IMA 50th Anniversary Book Prize

Just before the lunch break Ahmer Wadee CMath FIMA, CSci presented a prize to Paul Williams for his article that has been accepted for publication in the book being produced to commemorate the 50th anniversary of the IMA next year.

## 6 Mathematics and Energy World-Wide

David Ogle CMath FIMA, CSci (EDF Energy) spoke about the mathematics needed to support nuclear energy past, present and future. He showed how mathematics was abused in the case of protection against extreme events in the case of the Fukushima power plant. He also spoke about how that disaster had affected the approach to the 'Beyond Design Basis' accidents for the proposed Hinckley Point C power station in the UK. He noted, in particular, a more detailed assessment of flooding risk. Although Hinckley Point is not at such risk of facing a tsunami as is Fukushima, pluvial (water table), fluvial (river) and coastal flooding are all possible.



David Ogle speaking at Maths 2013. Credit: Edward Stansfield.

David emphasised the need for mathematically literate people, not only at graduate level, but apprentice level also, to design, build and operate our future nuclear power stations.

## 7 Mathematics and Global Security

Richard Pinch CMath FIMA, CSci gave his views on mathematics in the context of global security (he was at pains to point out that the views he expressed were his own, not those of his employer). He listed two groups of global security risks: 1. Water; Food; Housing; Energy, for which many people in the world don't have security and for which there is competition; 2. Personal; Economic; Health; Information, for which people want law and order.

He noted that the correlative of security is 'risk'. The usual measure of risk is the product of probability and impact, but in this context there are a number of issues with this, such as the non-linearity of impact/utility, the incomparability of impacts and the effect of extreme impacts.

Most of his security risks need to be thought of in terms of global networks. These provide significant modelling challenges.

Models can be used to describe, predict and control, but if they are often so complex that control is extremely difficult. We need a common language of risk for decision making, and new mathematics for models of complex networks and for data algorithms.

## 8 Demography World-Wide and the Actuarial Response

Chris Daykin (Independent Consultant and Former Government Actuary) spoke about the impact of an ageing population on social systems and pensions. The ageing population is caused by falling fertility and a steadily increasing life expectancy. He showed some fascinating figures for rising old age dependency for several countries. Traditionally, actuaries use an old age dependency ratio defined as (Numbers aged 65 and over)/(Numbers aged 15–64), but he asked: Is 65 the appropriate retirement age to use? Who starts work at 15 these days? What we really need is a dependency ratio defined as (Numbers receiving a pension/Numbers at working ages), and he noted that 65 cannot realistically remain the retirement age. For example the table below shows the pension age that would be required in 2050 to maintain the 2010 dependency ratio.

Country	Pension Age
Sweden	71.3
UK	71.7
Hungary	72.1
France	72.8
Germany	73.9
Italy	74.7
Ireland	75.0
Netherlands	75.5
Spain	76.0

He showed a number of interesting global statistics and projections on fertility and mortality and their impact on old age dependency. He concluded by noting that actuaries are seeking a better understanding of patterns in historical data; improving modelling approaches; trying to anticipate changes; quantifying uncertainty and recognising that they can't *predict* the future but should think in terms of *projecting* instead.

## 9 IMA in 2013: Where Are We?

Robert MacKay ended by listing many of the IMA's achievements during the last year (such as the completion of the HESTEM contract and the winning of the Initial Teacher Training contract) and by noting some of the challenges for the coming year (such as the negative impact of the government's open-access publication policy on IMA income, and the problem of increasing the numbers of paying members).

Alan Stevens CMath FIMA

### REFERENCES

- 1 <http://mpe2013.org/>
- 2 Eames KTD, Tilston NL, Brooks-Pollock E, Edmunds WJ (2012) Measured Dynamic Social Contact Patterns Explain the Spread of H1N1v Influenza, *PLoS Comput Biol*, vol. 8, no. 3.
- 3 [www.flusurvey.org.uk](http://www.flusurvey.org.uk)