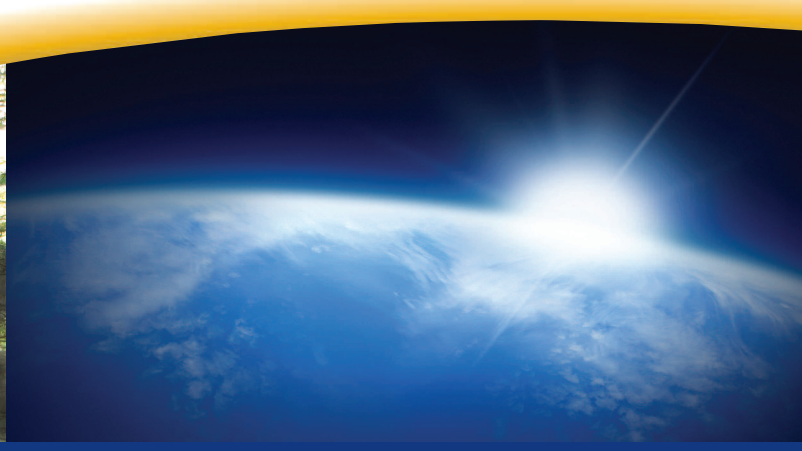
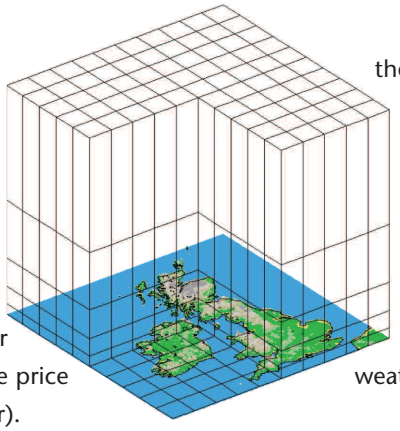
MATHEMATICAL MODELLING Series 1

The sun always shines on mathematics



Mathematics and applied mathematics are used in everyday life. Stock markets, mobile phones, car manufacturing, Google, Hollywood special effects, digital TV and satellites all use cutting-edge mathematics tools in their basic functions. The Mathematical Modelling Series presents a number of applications of mathematics in domains as varied as the human body, volcanology, telecommunications or finance.

What is the weather forecast for tomorrow? Hot or cold, sunny or rainy, we all want to know what the weather is going to be like. Weather forecasts do not just tell us what sort of clothes we should be wearing: they are increasingly important for outdoor events (such as concerts or football matches), agriculture (farmers want to know when their products will be at their best), or industry (the price of electricity varies drastically with the weather). Weather and maths go hand in hand, but can maths really tell you when the next sunny day will be?



How it works

Weather forecasting is an extremely difficult mathematical problem. A well-known difficulty is the so-called 'butterfly effect', where a tiny movement somewhere in the world (such as a butterfly flapping its wings) can cause huge changes elsewhere several days later: the chaotic nature of the weather potentially magnifies any movements. In short, to predict the weather with any degree of accuracy requires solving a set of complex equations on several grids covering the entire surface of the Earth (see figure in the centre). Even on a more local scale, forecasting the weather requires solving a huge system of equations. It takes into account the geography of the place (are there mountains?), the movement of the air, and the currents in the ocean such as the Gulf Stream. If you demand a forecast that is too detailed, it could take computers too long to calculate it. You have to find the right balance between speed of calculation and the detail of the weather forecast.

Conclusion

The weather is constantly changing, and is modelled by very complicated equations. Better mathematical models, and more and more powerful computers, lead to long-range forecasts becoming more reliable.

Parts of the curriculum used in this project:

- Integration
- Geometry, volumes and areas
- Matrices
- Newton's laws
- Energy conservation
- Differential equations

ACKNOWLEDGEMENTS AND MORE INFORMATION

This research is supported by the Mathematics Application Consortium for Science and Industry (MACSI) funded by the Science Foundation Ireland Mathematics Initiative Grant 06/MI/005.

If you want more information about MACSI and this project:

- Contact Martina O'Sullivan (project facilitator) – martina.osullivan@ul.ie
- Visit the MACSI website – www.macsi.ul.ie.

University of Limerick
Ollscoil Luimnigh
MACSI Mathematics Applications Consortium for Science & Industry
sfi Science Foundation Ireland