OCEANS 13

small sea changes, big decisions

In October 2005 LSE's Centre for the Analysis of Time Series (CATS) signed a memorandum of agreement with the Intergovernmental Oceanographic Commission (IOC) of UNESCO. This established the LSE/IOC Business Programme for Observing Systems. **Professor Lenny Smith**, director of CATS, explains more about its work and ambitions.

The salt water World Ocean, made up of the Pacific, Atlantic, Indian, Southern and Arctic oceans, covers almost three quarters of the Earth's surface. It has an area of 361 million square kilometers, a volume of 1,340 million cubic kilometers, and nearly half of the world's marine waters are over 3,000 meters (9,800 feet) deep. That much we more or less agree on.

But like the atmosphere, the Ocean changes every day. It changes more slowly than the atmosphere, perhaps, but with an inertia that demands respect. Observing, quantifying and interpreting those changes is a vast and crucial task since, ultimately, people's lives depend on the oceans now and will continue to do so in the future. Together, the atmosphere and oceans comprise that portion of the Earth's climate system that impact us most directly, and on a daily basis. That's why we're asking: How can industry and government best make use of our scientific understanding of this heavyweight tag team?

The LSE/IOC programme starts some serious ocean impacts modelling. The focus is not on pushing the frontiers of basic ocean science but on teasing out from existing scientific understanding whatever information will be most useful when it comes to ensuring social and economic well-being.

My colleague Dr Mary Altalo, a longstanding CATS visiting research fellow and vice chair of the Board of the Intergovernmental Panel of the Global Ocean Observing Systems, is the first director of the LSE/IOC programme. Our aim is to speed the transition from research to know-how, with the IOC handling the significant responsibility of ocean observation and aiding the advancement of ocean and climate science, while CATS casts the insights gained into impacts that can be exploited (or mitigated) and provides the educational link to sectors positioned to exploit this information. If you'll bear with me on more acronyms, the core observations come from the Global Ocean Observing Systems (GOOS), which provides real-time (and near real-time) data from ships and buoys around the world.

What are some of the main challenges we need to determine?

Firstly, exactly which questions of decision support will be addressed. Will it be port access/usage? Long-range shipping? Coastal safety? Or another key area requiring priority thought.

Secondly, how will we distill the mass of raw data into usable indicators?

And thirdly, how can we aid decision makers to see overlooked opportunities currently below the surface and to train staff to exploit the information stream?

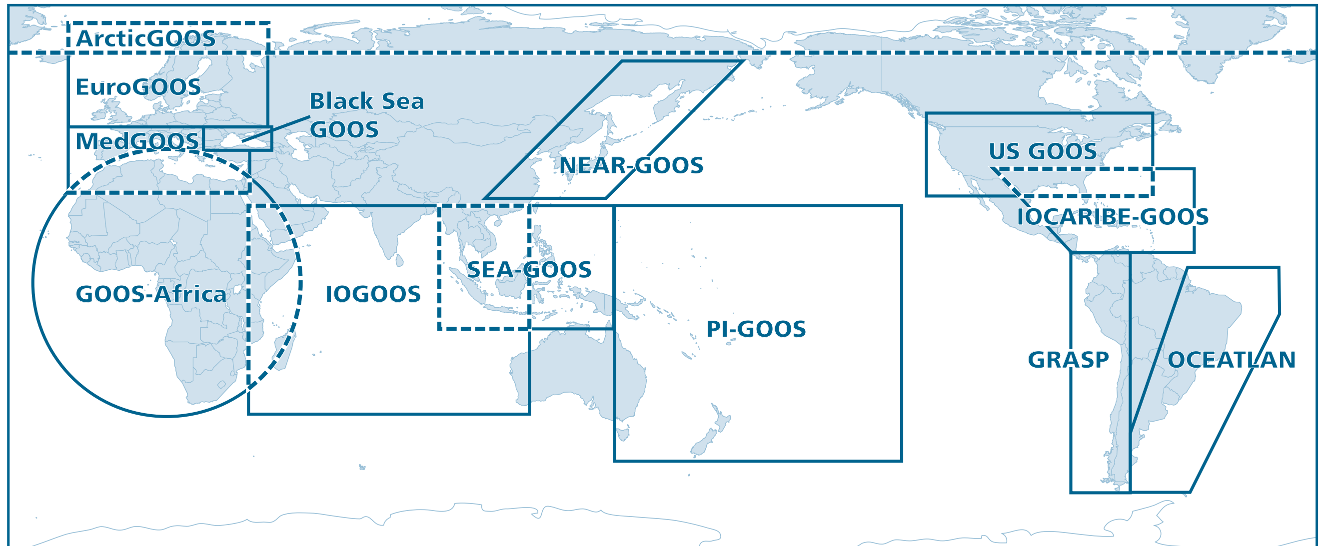
We have met similar challenges in our past work with Dr Altalo, adapting the information in modern ensemble weather forecasts for decision support in both the energy sector and the health sector. Today's oceans pose wider challenges.

Wider still is the challenge of communicating the insights and uncertainties of future climate change. The inconvenient truth reflected by observed climate change over the last hundred years must be confronted in the face of an inconvenient ignorance of what the future will hold. The evidence for global warming is almost universally agreed upon within science. That evidence stands independently of our ability to model the planet in detail, but our ability to foresee likely key developments over the current century does depend on getting the details right.

In order to see through our models we must respect their limitations, especially as those limitations decrease in the coming decades. Infrastructure decisions are made every day, and climate scientists must take care to provide a reasonable level of expectation management, particularly when we are asked for detailed projections that we know we cannot answer with any (decision-relevant) level of certainty: questions regarding, for example, likely changes in winds off the coast of Scotland in 2060. This is all the more important if that 'best available information' is for sale.

CATS has sharpened its skills in communicating the strengths and weaknesses of scientific forecasts for industrial decision support with our Operational Weather Risk day-long seminars for industry. With the support of the Department for Trade and Industry, the EPSRC, NERC and the Smith Institute, we have widened the scope of application of probabilistic weather forecasts, and working with particular industrial partners, including EDF, Scottish Southern Energy, and the National Grid, we have developed specific tools for real-time decision support.

What of 2007 and beyond? An easy prediction is that climate change research will remain in the news, with the next IPCC report due out in 2007, following this year's Stern Report from the UK Treasury. While CATS has contributed to both of these wide-ranging studies, our core aim here remains the provision of resources that enable decision makers to make better decisions, including decisions about the extent to which today's 'best available information' is relevant for their specific decisions. This core aim dovetails nicely with a growing focus in the wider climate community on impacts and decision support. The WMO meeting in Espoo, Finland, in summer 2006, for instance, issued a statement aimed at empowering decision makers in industry, government, and non-governmental organisations to help determine the future direction of climate research. CATS aims to help enable them to take up this more active role.



The 13 Global Ocean Observing Systems (GOOS) areas that cover the world's oceans

The fact that climate moves more slowly makes the problem of decision support both easier and more complex. Climate change will impact many sectors; CATS will build on our domain knowledge and partnerships in the energy sector, and in time hopes to provide support to other sectors as well. Lloyd's, for example, has just sponsored an Engineering and Physical Science Research Council CASE studentship which will investigate just how informative climate models are for questions of interest to the insurance and the re-insurance sectors.

This information will also be communicated back to the climate modelling community, of which CATS is a part, with the aim of promoting those model improvements that appear most likely to make the model useful in the relatively near term. It is critical to distinguish tactical tasks aimed at using today's best available information for all it is worth (but not more), from strategic tasks aimed at maximising the utility of the best available information in 2012; there is a tremendous difference in the allocation of scientific resources. One designs rather different climate modelling experiments, for example, when the aim is to extract information now about the future, than when the aim is to improve the model. Nevertheless, today's tactical results will ideally feed back to the modelling community to aid the achievement of tomorrow's strategic goals.

CATS

The Centre for the Analysis of Time Series was established in 2000 and is based within the Department of Statistics at LSE. The School has a long and distinguished history in time series analysis and as part of its strategic plan has invested heavily in developing a world class centre of excellence in this area.

For more on the LSE/IOC project, see www.lse.ac.uk/collections/cats or email cats@lse.ac.uk

There is much basic science here, and many fundamental open questions regarding how to best use statistics to relate the diversity we see in our models to the uncertainty we aim to quantify in our future. In a very real way, the modellers are a special kind of user, and feedback from decision makers, which provides new ways of seeing previously hidden weaknesses of the models, is of great value.

Of course, the basic questions answered by decision makers every year may not deal directly with climate *per se*: if the question is what kind of cable to put under the streets of London, the answer will depend on more than just how hot and dry the earth under those streets will be in 2020. Many considerations figure in decision making to avoid having to dig up those streets again decades ahead of plan. Meteorological uncertainty is but one ingredient that goes into such decisions, and such decisions are rarely so simple as to be described by a formula. It is at least as difficult for scientists to realise that there is no 'decision making' formula to be found, as it is for the decision makers to deal with the scientific formulas scientists use to describe the atmosphere and oceans.

A research organisation obliged to sell its latest wares must find itself in something of an impossible position: doing good science implies leading with your weaknesses, exposing flaws, faults, and the extent of your ignorance, while these are rarely the first things broadcast to potential clients when the goal is selling the information in the marketplace. Through the EC Framework 6 ENSEMBLES project, CATS is working with the Hadley Centre – without doubt leading the world in climate science – along with other researchers in European countries and around the world. CATS has the good fortune that our computers are much too small to produce forecasts, which allows us to play the role of a relatively neutral broker, evaluating the relevance of information and its robustness as models improve over the next decade. Remember, we are talking about projections to 2060 and 2100: the models we use today will be of only historical interest long before then. The challenge, then, is to help decision makers see today's science for what it is: science. Not engineering. The most exciting times in science are when we learn something new, when everything is changing; such times are likely to lie ahead for regional climate modelling. The fact that we can expect our 'best available information' to change over time places a special burden on those selling climate information today; care is needed to maintain the credibility of the science. But how can we present today's 'best available information' in such a way that decision makers also see changes in models and their output due to increased understanding as a good thing?

Robert Heinlein once wrote 'Climate is what you expect, weather is what you get.' Uncertainties of a changing climate make it harder to know what to expect; but the impacts of climate change will be felt through weather, along with slower changes in the environment, like sea level. Better probabilistic forecasts of the Earth's atmosphere and ocean, enabling us to see what is likely in the next two weeks or two months, is a win-win investment: of tremendous value in the current climate within which our economy has developed, and even more in a changed climate for which the economy has not been optimised.

Taking the view of the decision maker, not that of the meteorologist, casts weather and climate information in a different light: some huge uncertainties in the climate may carry rather minor implications for some decisions, while what a meteorologist might count as relatively small uncertainties can imply impacts where the decision to mitigate is justified by the uncertainty itself. Other decisions would be best informed by climate information currently beyond our grasp. Those decisions too will be taken today, hopefully with an understanding of the relevance of today's best available information. Communicating what we know we do not know can prove just as valuable as communicating what we are confident of. ■

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