

CATS CENTRE FOR
THE ANALYSIS
OF TIME SERIES

Annual Report

Annual Report
2009-2010



THE LONDON SCHOOL
OF ECONOMICS AND
POLITICAL SCIENCE ■



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Munich RE



Welcome

Foreword by Chair of CATS, Professor Henry Wynn



We are proud of the achievements of CATS over the last ten years, a decade that has seen the Centre grow considerably both in terms of personnel and activity. One of the most remarkable achievements perhaps has been the establishment of a strong international profile in the area of climate change which many comparable institutions would be proud of. This has been an era of policy making in addition to the science, at a national and international governmental level and in the private sector, such as insurance. It has been a period where the 'truth' has been at a premium. CATS is, we hope, known for its frank and honest approach and with Professor Leonard Smith at the helm has steered a careful course. CATS has come of age and this has been both acknowledged and reinforced in particular with its involvement in the Munich Re programme, the ESRC Centre for Climate Change Economics and Policy, and its seat in the Grantham Research Institute for Climate Change and the Environment. Behind and leading up to these has been strong research output with a firm mathematical basis in non-linear time series, simulation and statistical modeling, all fed by good science and a rich portfolio of research grants. Conducting high level scientific research in areas with, at times, a global decision support imperative requires the right mix of vision, pragmatism and even nerve. We are very proud of and grateful to our like-minded internal and external partners who have been with us on the journey and for the continuing support of the LSE leadership. At a personal level it is a privilege to be associated with CATS.

Professor Henry Wynn
Chair, CATS



Message from the Director, Professor Leonard Smith

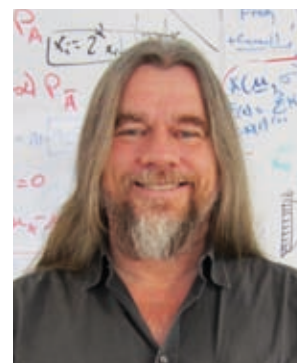
In 2010 CATS was very happy to celebrate its tenth anniversary, which we marked with an 'anniversary event' in the autumn¹. Presentations captured just some of the wide range of CATS' work within the fields of mathematics, nonlinear dynamics, and modern time series analysis. 2010 has thus been a year to reflect on CATS' achievements over the last decade, and to give thought to future directions and possibilities.

In the proposal that led to the formation of the Centre for the Analysis of Time Series, Professor Howell Tong stressed the key role interdisciplinarity played in the history of time series. He cited joint ventures with fields ranging from physics to cement production and stressed the LSE's distinguished history in the field, a history which he and Qiwei Yao have since extended.

In the last ten years, CATS has revisited some of the historical themes that gave birth to time series analysis. Yule was interested in sun spots and then, with Walker, in understanding the weather; while Fisher's original work focused on weather as well, namely attempts to see through it. Work of lasting value in time series as statistics navigates a path between a rock and a hard place: one must avoid too intense a focus on one particular set of observations or even one particular scientific field, and proceed with mathematical rigour while not slipping into mathematics itself and proving things of no real relevance. To the extent that we have succeeded, I believe we owe a debt both to the environment found within the Centre and to the breadth Professor Tong embraced from the beginning. Visitors to CATS soon learn we ask a lot of questions, if not out of deep insight, then out of ignorance of why things have always been done that way. The wide ranging background of our members requires a clear presentation of ideas, often several. CATS focused on 'Knowledge Transfer' long before the term came to represent a source of funding. I am happy our seminars are sometimes referred to as 'Roasts'.

By nature, CATS has many lives. Building on the foundational work reuniting statistics and dynamical systems laid by Professor Tong in its early days, CATS has considered an amazing array of 'time series' as diverse as passport applications, the stability of the national electricity grid, and the temperature at London's Heathrow airport. And the future? As Niels Bohr noted, 'Prediction is difficult, especially of the future'. CATS profile has grown not by making forecasts, but by analysing the models and forecasts of others, the framework(s) in which they are made, and the manner in which they are used and evaluated. I expect that this big picture will continue to serve CATS well, although the details will depend on the interests of the next generation. I would hazard a guess that a strand towards finance will grow stronger, bringing together weather and insurance in innovative ways; the analysis of weather and climate dynamics per se will no doubt remain central as it has since the time of Yule, Walker and Fisher; and the melding of information theory with nonlinear statistics in the context of real world questions will continue to yield rigorous results both puzzling to philosophers and of value beyond academia. Perhaps slow dynamical systems like pine beetle populations and forest dynamics will come to the fore?

In terms of which time series observations will drive this research, I am happily clueless. The joy of the analysis of time series is in large part extracting insight from observations, sharing that insight, and exploring out-of-the-box connections that often prove unreasonably effective. For ten years CATS has provided a warm environment, supporting a diverse group of people in pursuing that insight, sharing, and exploration. I believe it is that environment of healthy scepticism, intellectual rigour, and unreasonable hope which makes CATS a special place, and which will ensure nontrivial contributions to our understanding whatever detailed pathway the future holds.



Professor Leonard Smith

¹ lse.ac.uk/CATS/newsAndEvents/CATS_Anniversary.aspx

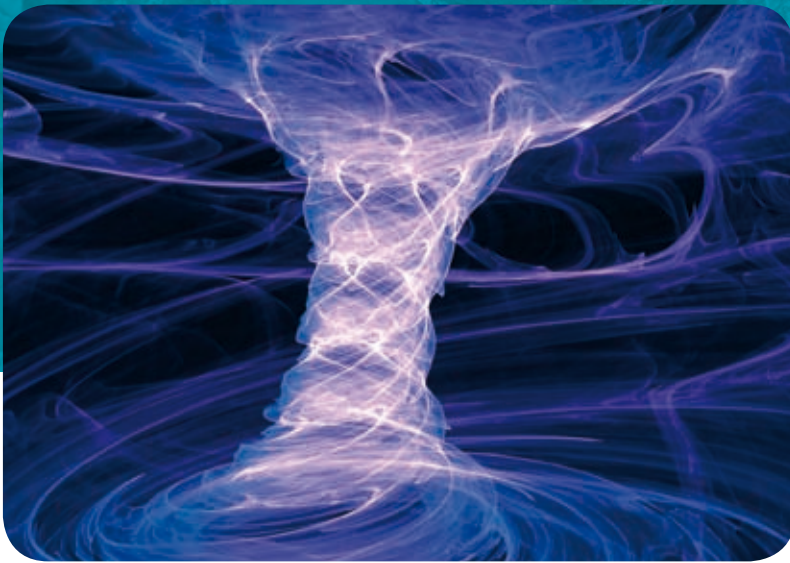
10 year highlights

Over £5.5m from 37 grants
from 19 sponsors

Over 100 papers in peer-
reviewed journals and 18
books/chapters

Expansion to 37 staff,
associates and visiting
appointments

5 PhD graduates and 7 PhDs
in progress



Research projects 2009-10

End-to-End Quantification of Uncertainty for Impacts Prediction (EQUIP). Funded by NERC, EQUIP brings together the UK climate modelling, statistical modelling, and impacts communities to work closely together for the first time on developing risk-based prediction for decision making in the face of climate variability and change. EQUIP is a collaborative project involving 11 UK Universities and research institutions. In CATS our focus is to contrast information from statistical models of observational time series with the output of complicated dynamical models of the atmosphere/ocean system. Our aim is to quantify the spatial and temporal scales on which these different methods can provide quantitative input to policy decisions. The project began in January 2010 and runs until December 2012. At LSE the project is led by Leonard Smith and David Stainforth.

Blue Gene project. Sponsored by Lloyd's of London and utilising the computational resources of the Hartree Centre, the Blue Gene project aims to examine the ability of state of the art general circulation models to shadow the observations; starting with EC Earth (the models considered will vary with the permissions granted the Blue Gene team). The aim is to consider both seasonal time scales and beyond, investigating the durations over which models can shadow temperature in Nino3.4 and the Atlantic Main Development region, and establish a methodology of lasting value in evaluating the relevance of large models to the insurance sector, as well as evaluating the current state of the art. This will also set the baseline for designing climate shadowing experiments over decadal periods. In addition, we would hope to assist in climate@home the (US version of climateprediction.net) and to use the climate@home model(s) in parallel shadowing experiments, investigating experimental design incorporating the synergistic use of distributed computing informed by focused Blue Gene runs.

RAPID-RAPIT is a NERC funded collaborative project led by the National Oceanography Centre, Southampton, that will attempt to quantify the likelihood of a shut down in the Meridional Overturning Circulation (MOC) in the North Atlantic. At LSE the project is led by David Stainforth and funds a PhD student who will study the relationship between models and reality in the context of climate change. The research will work towards the design of ensemble experiments which can evaluate the spatial and temporal scales on which complex climate models can potentially provide quantitative information about the future real world climate. In constructing such a design the student will use simple non-linear systems, and simple and intermediate complex climate models. On weather forecasting timescales techniques have been developed to quantify how long a model can remain close to, shadow, observations. Here the aim is to look at the application of such techniques to climate and climate change, to illustrate and refine the methods with simple models, and to work towards an experimental design which may be applicable to complex climate models, probably within the context of a distributed computing methodology. Such an approach has the potential to

Research projects 2009-10 continued



clarify where and how model based forecasts can add value to real world decisions and to guide and evaluate the improvement of climate models. The project began in October 2009 and runs until September 2013.

Integrated Ocean Observing Systems. Since 2007 CATS has received funding from the US National Oceanic and Atmospheric Administration (NOAA) to fund a professorial fellow, Dr Ralph Rayner, as the industry liaison for the US Interagency Ocean Observation Committee (IOOC) and the US Integrated Ocean Observing System (IOOS) that it coordinates. Dr Rayner acts as the information point for a broad range of relevant industries; implements and manages a network for the exchange of information; and organises outreach workshops which promote the socioeconomic benefits of ocean observations. He also supports the interface between US IOOS and regional initiatives in other countries as well as the interface

with the United Nations coordinated Global Ocean Observing System. Dr Rayner gave a presentation on the Global Ocean Observing System at the CATS 10th Anniversary event in October 2010. lse.ac.uk/CATS/newsAndEvents/AnnivDocs/Rayner_talk.pdf

Evaluating the Economics of Climate Risks and Opportunities in the Insurance Sector.

This is a research programme funded by Munich Re as part of the Centre for Climate Change Economics and Policy. The programme focuses on informing the insurance sector on the impacts of alternative approaches to carbon finance and emission trading; aiding the design of trading schemes and suggesting new financial service products to be developed; informing decision-makers, at the company level and the country level, on how better to balance investment between mitigation and adaptation, survivability and sustainability. The programme runs until September 2013. For further details see: www.cccep.ac.uk/Research/Programmes/Munich-Re/home.aspx

Managing Uncertainty in Complex Models (MUCM) is a Research Councils UK funded project that started in 2006. It is held by a consortium of five universities – Sheffield (the lead partner), Durham, Aston, Southampton and LSE. It is led at LSE by Professor Henry Wynn. MUCM is a multidisciplinary project concerned with quantifying and reducing uncertainty in the predictions of complex models across a wide range of application areas, including basic science, environmental science, engineering, technology, biosciences, and economics. The first phase of MUCM drew to a close in September 2010 and is followed by a second two-year phase (MUCM2). There is special emphasis on a number of areas of interest to the wider CATS programme, including stochastic simulation and modelling for decision making.

Can a Citation Database give a Fair View of Research Quality? Developing multi-faceted statistics for the insightful comparison of researchers, departments, and universities.

Funded by STICERD. This project aims to develop, illustrate and evaluate new measures of research quality based on quantitative analysis of the quantity, quality and diversity of citations to an individual's published research papers; to illustrate the need for multi-variate measures; to demonstrate variations between fields of study, and develop methods to account for these variations; and to evaluate the strengths and weakness of proposed statistics, in particular how transparent they are and how easily it might be manipulated.

Ensemble-based Predictions of Climate Changes and their Impacts (ENSEMBLES). This project was funded by the European Commission under the 6th framework programme to research climate change and its impacts in Europe. The research was conducted between September 2004 and December 2009 by a consortium of 66 research institutes, mostly from Europe, and led by the Met Office Hadley Centre. The project helped develop an ensemble climate forecast system for use across a range of timescales (seasonal, decadal and longer) and spatial scales (global, regional, local). The modelling system is being used to produce probabilistic scenarios of future climate for a quantitative assessment of impacts in a range of applications, to provide policy-relevant information.

Publications 2009-10

For further details of CATS publications see: lse.ac.uk/CATS/publications/

Journal papers

LA Smith, MC Cuéllar, H Du and K Judd (2010) *Exploiting dynamical coherence: A geometric approach to parameter estimation in nonlinear models*, *Physics Letters A*, 374, 2618-2623.

RF Rayner (2010) *The US Integrated Ocean Observing System in a global context*. *Journal of the Marine Technology Society*, 44 (6).

J Baker (2010) *Achieving forest carbon information with higher certainty: A five-part plan*. *Environmental science & policy*, 13 (3), 249-260.

R Hagedorn and LA Smith (2009) *Communicating the value of probabilistic forecasts with weather roulette*. *Meteorological Applications* 16 (2): 143-155.

E Sáenz-de-Cabezón and HP Wynn (2009) *Betti numbers and minimal free resolutions for multi-state system reliability bounds*. *Journal of Symbolic Computation*, 44 (9), 1311-1325.

P Barrieu and H Louberge (2009). *Hybrid cat bonds*. *Journal of risk and insurance*, 76 (3). pp. 547-578. ISSN 0022-4367.

F Giammarino and P Barrieu (2009). *A semiparametric model for the systematic factors of portfolio credit risk premia*. *Journal of empirical finance*, 16 (4). pp. 655-670. ISSN 0927-5398.

Books and chapters

P Barrieu and O Scaillet (2010). *A primer on weather derivatives*. In 'Uncertainty and environmental decision making: a handbook of research and best practice'. Editors JA Filar and A Haurie, Springer, ISBN 978-1-4419-1128-5.

P Barrieu and S. Tobelem (2010) *Asset allocation under model risk*. In: The Risk Modeling Evaluation Handbook Editors: Greg N. Gregoriou, Christian Hoppe and Carsten S. When, MacGraw-Hill.

E Riccomagno and HP Wynn (2010) *An introduction to regression and errors in variables from an algebraic viewpoint*. Approximate Commutative Algebra, Texts and Monographs in Symbolic Computation, 193-203.

S Tobelem and P Barrieu (2010) *Robust asset allocation under model risk*. In 'Alternative Investments and Strategies'. Editors R Kiesel, M Scherer & R Zagst, World Scientific. ISBN 978-9814280105.

J Church, RF Rayner, et al (2010) *Sea-level rise and variability: synthesis and outlook for the future*. In 'Understanding sea-level rise and variability'. Editors JA Church, PL Woodworth, T Aarup and WS Wilson, Blackwell Publishing, ISBN 978-1333334524.

H Maruri-Aguilar and HP Wynn (2010) *Generalised design: interpolation and statistical modelling over varieties*. In 'Algebraic and geometric methods in statistics' 159-173. Editors P Gibilisco, E Riccomagno, MP Rogantin and HP Wynn, Cambridge University Press. ISBN 978-0521896191.

RF Rayner and B MacKenzie (2010) *A first order assessment of the impact of long-term trends in extreme sea levels on offshore structures and coastal refineries*. In 'Understanding sea-level rise and variability'. Editors JA Church, PL Woodworth, T Aarup and WS Wilson, Blackwell Publishing, ISBN 978-1333334524.

Books and Chapters continued



RF Rayner (2010) *Incorporating climate change within asset management*. In 'Asset management – whole life management of physical assets'. Editor C Lloyd, London, Thomas Telford Press, ISBN 978-0-7277-3653-6.

The following four chapters all appeared in the volume 'Optimal Design and Related Areas in Optimization and Statistics' of the Springer series 'Springer Optimization and Its Applications', 2009 Vol. 28, edited by L Pronzato and A Zhigljavsky www.springer.com/series/7393. This volume was dedicated to Henry P. Wynn, reflecting his broad range of research interests, focusing in particular on the applications of optimal design theory in optimization and statistics. ISBN 978-0-387-79935-3.

PE Caines, R Deardon and HP Wynn *Bayes nets of time series: stochastic realizations and projections*.

A Giovagnoli, J Marzioletti and HP Wynn *Bivariate dependence orderings for unordered categorical variables*.

L Pronzato, HP Wynn and A Zhigljavsky *A dynamical-system analysis of the optimum s-gradient algorithm*.

R Haycroft, L Pronzato, HP Wynn and A Zhigljavsky *Studying convergence of gradient algorithms via optimal experimental design theory*.



Other outputs

P Barrieu & LA Smith 'Risk, Reward and Realism: Climate Science, Models and Informed Risk Trading', *Trading Risk* magazine, 09 April 2010.

S Tobelem and P Barrieu (2009). *Robust asset allocation under model risk*. *Risk magazine*, 76 pp. 91-95. ISSN 0952-8776.

Munich Re programme Visiting Professor Arthur Petersen was involved in the co-ordination of a Dutch governmental evaluation of the quality of the regional chapters of the IPCC AR4 WG II report (on impacts, adaptation and vulnerability). The report '*Assessing an IPCC Assessment: An Analysis of Statements on Projected Regional Impacts in the 2007 Report*' was published by the Netherlands Environmental Assessment Agency in July.

Simon Dietz 'High impact, low probability? An empirical analysis of risk in the economics of climate change' Munich Re Technical Paper 2, September 2009.

René Carmona, Max Fehr and Juri Hinz 'Properly designed emissions trading schemes do work!' Munich Re Technical Paper 3, November 2009.

Leonard Smith was quoted in a news feature in *Nature*: '*The real holes in climatescience*', *Nature* 463, 284-287, January 2010. lse.ac.uk/CATS/publicity/Nature_Jan21_RealHolesInClimateScience.pdf

Professor Leonard Smith was quoted in a *Nature* news piece discussing the above Dutch government IPCC report. '*Few fishy facts found in climate report*', *Nature* 466, 7303, 08 July 2010. lse.ac.uk/CATS/publicity/PBL_IPCC_Nature_08Jul2010.pdf

David Stainforth '*Climate science in the spotlight may not be such a bad thing*', article in *The Guardian*, 12 February 2010. See: lse.ac.uk/CATS/publicity/Stainforth_Guardian_12Feb2010.pdf



In 2010 **Dr Max Fehr** was awarded the 'Walter Saxer-Versicherungs-Hochschulpreis' prize from ETH in Zurich for his PhD thesis – title 'Market Design for Emission Trading Schemes'. The prize is awarded for research in insurance mathematics or related fields, by a consortium consisting of Generali Assurances, PricewaterhouseCoopers, Swiss Life, Swiss Re, Winterthur Insurance, Zurich Financial Services.

He was also awarded the ETH Medal for his PhD Thesis. The medal is awarded to the top five PhD theses at ETH.



Activities 2009-10

Talks and presentations

Details of these presentations can be found on the CATS website at: lse.ac.uk/CATS/talksPresentations/

A number of CATS people, gave presentations at the 11th International Meeting on Statistical Climatology (IMSC) in Edinburgh, 12-16 July 2010. The presentations included: 'When is a model relevant?' (Leonard Smith); 'The inapplicability of traditional statistical methods in climate ensembles' (David Stainforth); 'Comparing Cloud Feedbacks in Perturbed-Physics Ensembles from two different GCMs' (Falk Niehoerster); 'SVD on ICE - On the linearity of climate change simulation with GCMs' (Falk Niehoerster); 'Climate model evaluation and models of natural variability' (Ana Lopez); 'Analysis of long term persistence in a perturbed physical ensemble' (Ana Lopez); and 'Are Current Flaws in Bayesian Approaches to Climate Projection Fatal?' (Leonard Smith).

Max Fehr and Pauline Barrieu organised two sessions for the 'Energy and Emission Markets' stream of the EURO XXIV (24th European Conference on Operational Research), in Lisbon, 11-14 July 2010. Max also gave a talk entitled: 'Option Pricing in the European Unions Emission Trading Scheme'. 'Extracting Insight from Predictions of the Irrelevant: Can the Diversity in Our Models Inform Our Uncertainty of the Future?' presented by Leonard Smith at 28th International Conference on Mathematical Geophysics Modelling Earth Dynamics: Complexity, Uncertainty and Validation, Pisa, June 2010.

Nicola Ranger co-chaired a session and spoke at NATO ARW workshop on Climate Change: *Global Change and Local Adaptation*, 6-9 June, 2010, in Hella, Iceland. The event led to work contributing to two book chapters for a new Springer book on adaptation decision making as an outcome to the conference.

'Stochastic Modelling of Deteministic Systems' seminar presentation by Thomas Stemler (UWA) at LSE, 10 June 2010, during his 6-week visit to CATS.

'Climate Prediction: Lessons from Simple Non-Linear Systems' presented by David Stainforth at Birkeland Workshop on Complex Natural Systems in Tromso, Norway, 27-31 May 2010.

'The Bayesian's Burden: Non-linear Models, Probability and Insight', a plenary talk presented by Leonard Smith at Models & Simulations IV conference, Toronto, 7-9 May 2010.

'Interpretation of decadal tropical cyclone forecasts for decision-support: application to insurance and disaster risk reduction along the US Gulf Coast and the Caribbean', presented by Falk Niehoerster at the AMS conference on Hurricane meteorology in Tuscon Arizona, May 2010. This is joint work with Nicola Ranger on long term hurricane adaptation projects.

Nicola Ranger and Falk Niehoerster presented at Howard Kunreuther's Risk Management and Decision Processes Centre at

Wharton Business School, Philadelphia, and held a CCCEP-Wharton academic workshop on long-term hurricane risk and insurance implications, 17-18 May 2010.

'Improving the IPCC's uncertainty management in assessing climate change, impacts and responses' presented by Munich Re programme Visiting Professor Arthur Petersen at LSE, 13 May 2010.

'Can we expect to predict the climate when we cannot shadow the weather?' presented by Leonard Smith at EGU (European Geosciences Union) General Assembly, Vienna, 2-7 May 2010.

'Examining Uncertainties In Climate Models: Forecasting The Impact Of Best And Worst Case Climate Scenarios On The Future Of The ILS Market', presented by Leonard Smith and Pauline Barrieu at ILS Europe, Le Meridien Picadilly, London, 26-28 April 2010.

'Modeling Emission Trading Schemes', presented by Max Fehr at Industrial-Academic Forum on Commodities, Energy Markets, and Emissions Trading, 9-10 April 2010, Fields Institute, Toronto.

'The Bayesian's Burden: Or Why Physicists Shrug and Statisticians Scoff', presented by Leonard Smith at NCAS/NERC Earth System Science Spring Summer School, York, 9 April 2010.

'Getting beyond the statistics: Towards Quantifying the Geometry of Model Error', presented by Leonard Smith at RMetS meeting on model error, Met Office, Exeter, 8 April 2010.

Leonard Smith and Nicholas Stern 'Uncertainty, Ambiguity and Risk in Forming Climate Policy', presented at 'Handling Uncertainty in Science', Royal Society, London, 22 March 2010.

'Climate Models: Current Science and Common Sense', presented by Leonard Smith, and chaired by Professor Nancy Cartwright, at the ESRC Centre for Climate Change Economics and Policy Lecture – part of the ESRC Festival of Social Science, LSE, 16 March 2010.

PhD student Joe Daron gave a seminar at the Met Office on the work that he carried out as an intern there, titled 'Probabilistic Networks for Climate Risk', 15 March 2010.

'Using Empirically Inadequate Models to inform Your Subjective Probabilities: How might Solvency II inform climate change decisions?', presented by Leonard Smith at Oxford Maths Institute meeting on 'Climate: Methods for Model Comparison and Criticism in the context of data assimilation', Oxford, 12 March 2010.

'Translating Seasonal Forecasts into Year Ahead Hurricane Numbers: The Outlook and Some Recent Advances in ENSEMBLES', presented by Leonard Smith at Environmental Risk Management workshop (NERC + Maths KTN), Lloyds, 24 February 2010.

'Causation and explanation in our nonlinear world', presented by Leonard Smith (with comments by Roman Frigg) at Barcelona Conference on Causality and Explanation in Physics, Biology and Economics, 18 February 2010.

'Decision-Making with Climate Models', Presented by Leonard Smith, Roman Frigg, Seamus Bradley at LSE Choice Group seminar, LSE, 3 February 2010.

'Challenges in the Extraction of Decision Relevant Information from Multi-Decadal Ensembles of GCMs', Presented by Dave Stainforth at SAMSI workshop on Climate Change, February 2010.

'Examining Uncertainties In Climate Models: Forecasting The Impact Of Best And Worst Case Climate Scenarios On The Future Of The ILS Market', presented by Leonard Smith at 7th Insurance Linked Securities Summit, New York, 28-29 January 2010.

'Evaluating high dimensional models given only a few observations: Anomalies, re-analyses and reality', presented by Leonard Smith at workshop Exploring Complex Dynamics in High-Dimensional Chaotic Systems: From Weather Forecasting to Oceanic Flows (ECODYC10), at MPIPKS, Dresden, 25-29 January 2010.

'Difficulties in Deriving Forecast Probabilities From General Circulation Models and Efforts to Estimate Uncertainty in Future Climate projections', presented by Dave Stainforth at 'Nonstationarity, Hydrologic Frequency Analysis and Water Resource Management' workshop, 13-15 January 2010, Boulder Colorado.

'Quantitative Decision Support Requires Quantitative Use Guidance: Communicating deep-uncertainty and model-noise', presented by Leonard Smith at AGU USA, 15 December 2009.

'The Search for Relevant Climate Change Information to Support Adaptation Decision Makers: Lessons from Reductionism, Emergence and the Past', presented by David Stainforth at AGU USA, 15 December 2009.

'Uncertainty Estimation in Regional Climate Change: Extracting Robust Information from Perturbed Physics Ensembles', presented by David Stainforth at AGU USA (Contributed talk), 15 December 2009.

'Using Ensemble Prediction Systems to improve risk management in the Energy Markets', presented by Leonard Smith at Weather Challenges for the Energy Market, Berlin, 9-10 December 2009.

Two posters were presented by Leonard Smith at the ENSEMBLES Final Symposium, Exeter, 16 November 2009: 'On Weighting Seasonal Models', and 'Evaluating Model Skill Relative to a Dynamic Climatology'.

'Data Assimilation for Earth System Models: What's the Point?', presented by Leonard Smith at WCRP-CLIVAR: Initialization of Earth System Models for Decadal Predictions, at KNMI, Utrecht, 4-6 November 2009.

'Toward Decision-Relevant Probability Distributions: Communicating Ignorance, Uncertainty, and Model-Noise', presented by Leonard Smith at Defra/Met Office will hold an Royal Society/Royal Meteorological Society meeting on the science of the UK Climate Projections, 15 October 2009.

'One Two Three More: Challenges to Describing a Warmer World', presented by Leonard Smith at 4 degrees and beyond, Oxford, 28-30 September 2009.

'Experimental Design and Interpretation of Policy-relevant Climate Model Ensembles', presented by Leonard Smith at the SAMSI 2009-10 Program on Space-time Analysis for Environmental Mapping, Epidemiology and Climate Change, Opening workshop on Climate Change, 13-16 September 2009.

'Climate Models and their Information Content for the Insurance Industry', presented by Leonard Smith (with David Stainforth, Ana Lopez and Edward Tredger) to the ABI Climate Change Data Seminar, 27 August 2009.

'Data Assimilation: What's the point?', presented by Leonard Smith (with David Stainforth, Ana Lopez and Edward Tredger) at American Statistical Association/JSM, Washington DC, 03 August 2009.

'When might a climate model prove fit for purpose? Expected Uncertainty -or- Big Surprise', presented by Leonard Smith at Max Plank Institute meeting, Dresden, 31 July 2009.

'How does the diversity in our models inform us about the uncertainty in our future?', presented by Leonard Smith (with Ana Lopez, Dave Stainforth, Ed Tredger and Roman Binter) at Symposium I, 'Interpreting Models in a Climate Change Context', of the Munich Re programme, London, 20 July 2009.

'Seeing Through our Models: Coping with an inconvenient ignorance in a changing climate', presented by Leonard Smith at Cutting Edge Lecture McGill University, 16 April 2009.

'Risk and Uncertainty: Understanding the Limits of Predictability' presented by Leonard Smith at GEOS Small Sea Change: Big Business Impacts Meeting Washington DC, 14 April 2009.

Other events

In July 2009, a scientific symposium was held entitled **'Interpreting models in a climate change context'** as part of the Munich Re programme. The symposium brought together experts in a range of different modelling techniques relevant to issues of climate and climate change risk management. By discussing the various approaches to interpreting model results, it explored how models are best used to improve decision-making and risk assessment. Further details of the symposium and the presentations can be found at: www.cccep.ac.uk/Events/Past/2009/munich-re-symposium-1.aspx

In April 2010 several researchers from CATS held a workshop on US hurricane seasonal/long-term risk scenarios, with members of Munich Re.

An insurance industry roundtable was held on 26 May 2010, entitled **'How can Climate Change Science and Economics better Support the Insurance Industry'**, as part of the Munich Re programme. 18 representatives of the insurance industry attended and engaged in discussions with the aim of helping improve LSE's understanding of the needs of the insurance industry related to climate change science and economics.

The Roundtable event was also used to present an Industry Brief, produced as part of the Munich Re programme, by Nicola Ranger and Bob Ward: **'Aiming for a 2oC Goal: What does it Mean for the Insurance Industry?'**. The brief is available at: www.cccep.ac.uk/Publications/insuranceBriefs/aiming-for-2degree-goal.pdf

Nicola Ranger participated in a 'town hall' meeting hosted by the Wharton School (with Professor Howard Kunreuther – LSE Munich Re Programme Visiting Professor) on the interpretation of long-term hurricane projections for decision-support, New York, 11 March 2010.

Visiting Academics

Professor Keith Beven, Professor of Hydrology and Fluid Dynamics at Lancaster Environment Centre, was appointed a Visiting Professor to CATS in May 2010. He made a first visit to CATS in June, giving an informal talk/discussion on model uncertainty.

Arthur Petersen, Director of the Methodology and Modelling Programme at the Netherlands Environmental Assessment Agency (PBL), visited CATS and the Centre for Climate Change Economics and Policy for 4 weeks in April/May as part of his appointment as Visiting Professor on the Munich Re programme.

Professor Howard Kunreuther, also Visiting Professor on the Munich Re programme, visited LSE for a couple of days in April 2010. The main focus of discussions was the hurricane risk scenarios and adaptation work, part of CATS/CCCEP Munich Re programme collaboration with Howard. Meetings were also held with Rowan Douglas (Willis Re), Robert Muir-Wood (RMS), Gordon Conway (DFID) and Erik Chavez (World Bank).

Stephan Lewandowsky, Australian Professorial Fellow at the Cognitive Science Laboratories, School of Psychology, University of Western Australia, visited CATS and gave a talk on 24 May 2010 entitled 'Climate Change: Consensus or Dogma, Hoax or Religion?'

Two other UWA researchers visited CATS in May/June 2010: Dr Thomas Stemler, (a postdoc of CATS Visiting Senior Fellow, Kevin Judd) visited LSE for six weeks, and Dr James Springham visited CATS for two weeks.

Visiting Fellow Jochen Broecker made a short visit in May. Jochen was previously a postdoctoral research officer at CATS and is now a scientist at the Max Planck Institute for Physics of Complex Systems in Dresden.

Who we are

Senior faculty

Professor Leonard Smith

Director of CATS
Professor of Statistics
Senior Research Fellow of Pembroke College, Oxford

Dr Pauline Barrieu

Co-director of CATS
Reader in Statistics

Professor Henry Wynn

Chair of CATS
Professor of Statistics

Research staff

Dr Hailiang Du

Postdoctoral Research Assistant, funded by the Grantham Research Institute on Climate Change and the Environment.

Dr Max Fehr

Postdoctoral Research Assistant, funded by the Munich Re programme.

Dr Ana Lopez

Research Officer, funded by the ESRC Centre for Climate Change Economics and Policy

Dr Falk Niehörster

Postdoctoral Research Assistant, funded by the Munich Re programme.

Dr Nicola Ranger

Research Fellow, funded by the Munich Re programme.

Dr Ralph Rayner

Professorial Research Fellow, funded by NOAA.

David Stainforth

Senior Research Fellow, funded by the Grantham Research Institute on Climate Change and the Environment.

Dr Swenja Surminski

Senior Research Fellow, funded by the Munich Re programme.

Emma Suckling

Postdoctoral Research Assistant, funded by the NERC EQUIP project.

Research students

Roman Binter

Research student

Thesis topic: how informative climate models are to decision making in the insurance industry.

Supervisor: Leonard Smith
Funded by EPSRC/Lloyd's.

Joe Daron

Research student

Thesis topic: Extracting decision-relevant information from climate models for the insurance industry

Supervisor: David Stainforth
Funded by EPSRC/Lloyd's.

Daniel Hawellek

Research student

Thesis topic: Dynamical systems

Supervisor: Henry Wynn

Funded by EPSRC/Lloyd's and the Grantham Research Institute at LSE.

Sarah Higgins

Research student

Thesis topic: links between seasonal weather forecasts and global cereal prices.

Supervisor: Leonard Smith

Alex Jarman

Research student

Thesis topic: Quantitative Applied Climate Economics and the Insurance Industry

Supervisor: Leonard Smith

Funded by the Munich Re programme

Trevor Maynard

Research student (and CATS Visiting Senior Fellow)

Thesis topic: robustness of general insurers to trends and cycles including climate change.

Supervisor: Leonard Smith

Ed Wheatcroft

Research student

Thesis topic: the relationship between models and reality in the context of climate change.

Supervisor: David Stainforth

Funded by NERC as part of the RAPID-RAPIT project.

Noha Youssef

Research student

Thesis topic: optimal design for computer experiments

Supervisor: Henry Wynn

Funded by EPSRC as part of the Managing Uncertainty in Complex Models (MUCM) project

Who we are continued

Centre management

Lyn Grove

Centre manager

Associate members from across LSE

Dr Simon Dietz

Deputy Director of the Grantham Research Institute on Climate Change and the Environment and Deputy Director of the Centre for Climate Change Economics and Policy; senior lecturer in the Department of Geography and Environment.

Dr Sam Fankhauser

Principal Research Fellow, Grantham Research Institute on Climate Change and the Environment

Dr Roman Frigg

Senior Lecturer in Philosophy, Department of Philosophy, Logic and Scientific Method; Deputy Director of the Centre for Philosophy of Natural and Social Science (CPNSS).

Professor Conor Gearty

Director of the Centre for the Study of Human Rights; Professor of human rights law

Professor Mary Morgan

Professor of the History of Economics, Department of Economic History.

Professor Nick Stern

Chair of the Grantham Research Institute on Climate Change and the Environment; Chair of the Centre for Climate Change Economics and Policy; IG Patel Professor of Economics and Government at the Suntory and Toyota International Centres for Economics and Related Disciplines (STICERD); Chair of the Asia Research Centre; and Director of the India Observatory at LSE.

Visiting appointments

Dr D James Baker

Senior Visiting Fellow

Director, Global Carbon Measurement Program, William J. Clinton Foundation

Professor Keith Beven

Visiting Professor

Professor of Hydrology and Fluid Dynamics at Lancaster Environment Centre

Dr Jochen Bröcker

Visiting Fellow

Scientist at the Max Planck Institute for Physics of Complex Systems in Dresden

Dr Milena Cuellar

Visiting Fellow

Adjunct Assistant Professor of City University of New York (CUNY) at Bronx Community College

Dr Jerome Ellepola

Visiting Fellow

Shell Projects and Technology Organisation in the Netherlands

Dr David Frame

Senior Visiting Fellow

Deputy Director of the Smith School of Enterprise and Environment, and Visiting Lecturer in the Department of Physics at the University of Oxford. He is also a Hugh Price Fellow at Jesus College.

Dr Neil Gordon

Senior Visiting Fellow

General Manager, Science Research and Development, at Meteorological Service of New Zealand Limited

James A Hansen

Visiting Senior Fellow

Lead Scientist in the Probabilistic-prediction Research Office at the US Naval Research Laboratory, Monterey.

Professor Nigel Harvey

Visiting Professor

Professor of Judgment and Decision Research, UCL

Dr Kevin Judd

Senior Visiting Fellow

Associate Professor at the School of Mathematics and Statistics, University of Western Australia

Dr Reason L Machete

Visiting Fellow

Research Fellow, Department of Mathematics, University of Reading.

Dr Simon Mason

Visiting Senior Fellow

Research Scientist, Climate, Disasters, International Outreach at the International Research Institute for Climate and Society, The Earth Institute, Columbia University.

Trevor Maynard

Visiting Senior Fellow (and part-time PhD student)

Deputy head of exposure management
at Lloyd's of London.

Dr Patrick E McSharry

Visiting Fellow

Head of the Catastrophe Risk Financing centre at
the Smith School of Enterprise and Environment.

Dave Parker

Visiting Senior Fellow

Head of Forecasting, EDF Energy

Professor Arthur Petersen

Munich Re Programme Visiting Professor

Director of the Methodology and Modelling Programme at
the Netherlands Environmental Assessment Agency (PBL).

Dr Mark Roulston

Visiting Senior Fellow

Dr Roulston was recently a Probability Forecast
Applications Specialist at the UK Met Office.

Dr Antje Weisheimer

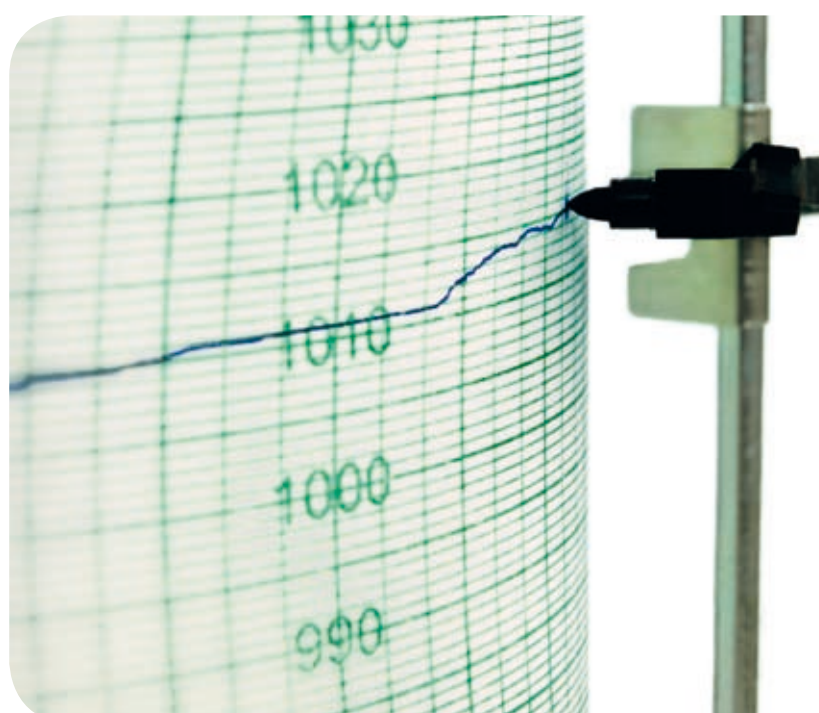
Visiting Fellow

Dr Weisheimer currently works at the European Centre
for Medium Range Weather Forecasts (ECMWF).

Roland Young

Visiting Fellow

Postdoctoral researcher in Peter Read's Atmospheric
Oceanic and Planetary Physics group, University of Oxford



Financial summary 2009-10

New Funding Awards Received

	No.	Financial Year 2009-10 Amount Awarded £
Research Councils	3	315,043
UK Industry and Commerce	2	50,766
European Commission	-	-
Other Sources	1	53,552
	6	419,361
Total Value of Funding Received		419,361

Income and Expenditure Statement

	Financial Year 2009-10 Amount £
Income From:	
Research Councils	49,454
UK Industry and Commerce	15,723
European Commission	8,673
Other	630,231
	704,081

Non-Contract Research Income

LSE and other non-contract income	53,356
	53,356

Total Income	757,438
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Expenditure

Staff Costs	326,233
Non-Staff Costs	201,192

Total Direct Costs	527,425
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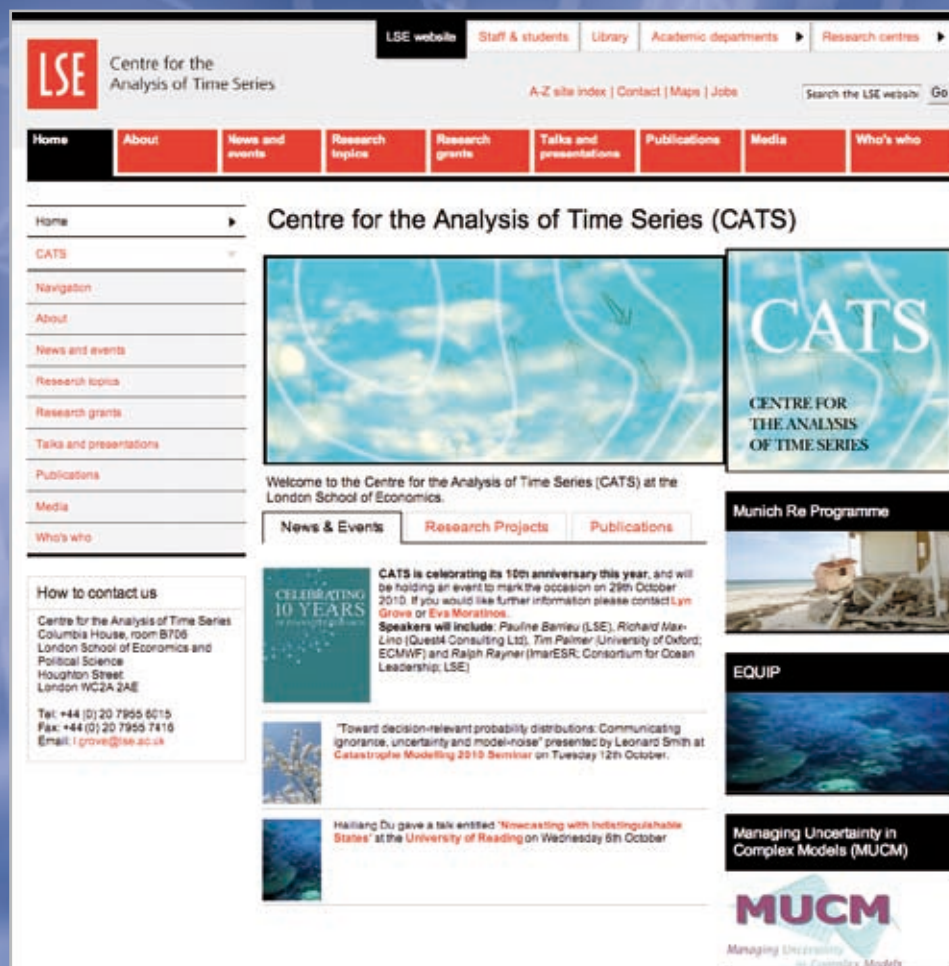
Overheads	230,013
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Overhead Recovery Rate as a % of Staff Costs	70.5
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Overhead Recovery Rate as a % of Total Costs	43.6
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Further Information

Further information on all CATS work and activities, papers and other publications, can be found on our new website, lse.ac.uk/CATS



This report is available in alternative formats please contact:
Lyn Grove, CATS

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CATS

CENTRE FOR
THE ANALYSIS
OF TIME SERIES

Centre for the Analysis of Time Series
Columbia House, Room B706
The London School of Economics and Political Science
Houghton Street
London WC2A 2AE

Tel: +44 (0)20 7955 6015
Fax: +44 (0)20 7955 7416
Email: l.grove@lse.ac.uk



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