Institution: University of Reading
Unit of Assessment: Mathematical Sciences

a. Overview

The Department is part of the School of Mathematical and Physical Sciences, which also includes the Department of Meteorology. Alongside the core mathematical research engagement, significant mathematical activity takes place jointly across the School and five posts are shared between the two departments. Further, the research environment is supported substantially at both Departmental and School level. The School runs a self-funded consultancy team, the Statistical Services Centre, working for clients across the UK and globally, and integrated into the teaching of statistics across the School, and a spinoff company (CountingLab) from our Centre for the Mathematics of Human Behaviour (CMOHB). The Department of Mathematics and Statistics was a founding partner in the University's Centre for Integrative Neuroscience and Neurodynamics (CINN) in 2009, and provides significant input to and leadership of its research activities. The Department is also a large partner in the NERC National Centre for Earth Observation (NCEO), led from the School, is a leading partner in the Reading Systems Biology Network, and has just won an EPSRC Centre for Doctoral Training, jointly with Imperial College.

The Department currently has 38 permanent academic and research staff, of which 5 are joint with other departments, plus 13 postdoctoral research staff and a Royal Society Industry Fellow. In total 31 Mathematics and Statistics staff (26.5 FTE) are submitted to this UoA as Category A, and three (2.6 FTE) are submitted to UoA 7. This research activity is organised in several research groups with significant overlap and interaction:

(A) **Analysis** - Pure, Applicable and Numerical (16.9 FTE +6 postdoctoral researchers), *including*
- Pure and Applicable Analysis
- Numerical Analysis and Computational Modelling
- Data Assimilation and Inverse Problems

(B) **Statistics and Applied Statistics** (5 FTE + 1 postdoctoral researcher), *including*
- Probability and Stochastic Analysis
- Applied Statistics

(C) **Complex Fluids and Theoretical Polymer Physics** (2.6 FTE + 2 postdoctoral researchers)
(D) **Centre for the Mathematics Of Human Behaviour** (1 FTE+1 Royal Soc. Ind. Fellow + 3 postdoctoral researchers)
(E) **Mathematical Biology** (1 FTE + 1 postdoctoral researcher)

b. Research strategy

Position since 2008: At the previous Research Assessment Exercise, the University made submissions to the Applied Mathematics and the Statistics and Operational Research UoAs, including in the latter the Medical and Pharmaceutical Research Unit, part of the Faculty of Life Science, selected staff of the Statistical Services Centre, and associated income.
Since the 2008 submission, the Department's research activity has grown in all of cohesion, strength and volume. In mathematics, we have consolidated the outward facing research areas while strengthening the core mathematical activity that is essential to support our interdisciplinary collaborations, in line with the aims stated in our 2008 Applied Mathematics submission. Consistently with this growth, research income generated by activities in mathematics has increased, from £859k in the previous assessment period to £3841k in the current one.
At the time of the RAE 2008, research in the Mathematics Department was organized around four main overlapping groups (Applied Analysis, Numerical Analysis, Operator Theory and Applications, and Theoretical Polymer Physics). Since then we have seen a significant restructuring, following a more focused and coherent strategic planning led by the Department but encouraged and supported by the University. As part of this restructuring, in 2010 we added to the Department a substantial Applied Statistics group, comprising 5 academic staff and associated research staff and PhD students (changing the Department's name at that time). After the adjustments following this merger, that saw some statistics staff move to the life science faculty or retire, this group currently comprises three of the 7.7 staff returned to the submission to the Statistics UoA in 2008. The drop

in income of the statistics group compared with the amount returned in 2008 is due to the fact that income associated with the Medical and Pharmaceutical Research Unit (now closed) and with the Statistical Services Centre is not included in the present submission. Indeed, since merging with Mathematics, the Applied Statistics group has diversified and, while retaining its research interests in applied and particularly medical statistics that characterised the 2008 submission, it has added activity, not foreseen in 2008, in theoretical statistics and probability. This activity links directly with current research interests in mathematics.

Vision: Our strategic vision now is organized around the following priorities:

(1) to support our stronger existing groups, in particular pure and applicable analysis, numerical analysis and applied statistics;

(2) to support focused interdisciplinary activity through our work in several areas namely: (2i) theoretical and computational aspects of research in weather and climate and Earth observation; (2ii) mathematical neuroscience, inverse problems and data assimilation, as a partner in the Centre for Integrative Neuroscience and Neurodynamics (CINN); (2iii) complex systems networks and applications to the digital economy and to the climate system; (2iv) mathematical biology, relevant to our role in the Reading Systems Biology Network;

(3) to develop substantial new activity in probability, stochastic analysis, and theoretical statistics to support our interdisciplinary work and integrate research themes across Mathematics and Statistics;

(4) to consolidate and expand further the core mathematical research areas that constitute the essential support for progress in the endeavours listed above.

Our first goal in the assessment period has been to reinforce our existing strength, and in our appointment strategy we have focused on Analysis, Applied Analysis and Numerical Analysis, building a significant group with expertise in wave propagation and scattering, data assimilation and inverse problems, analysis of nonlinear PDEs and spectral theory. In particular, the appointments of Levitin, Varvaruca and more recently Kolb, Virtanen and Katzourakis have strengthened significantly the analysis group and also added theoretical probability and stochastics expertise, while the appointments of Chernov, Moiola, Pryer and Reich have broadened and strengthened our numerical analysis group, adding scientific computing research experience. The appointments of Savov and Broecker, working in theoretical statistics, and Everitt, an applied statistician, have enhanced the Statistics group and made it a more coherent constituent part of the department, linking it with the activity of the Reading Systems Biology Group and CINN (Everitt) and the data assimilation group (Broecker). All of the above appointments have been made with the specific aim of integrating research across mathematics and statistics, and many have strengthened our links to Meteorology, particularly our links to NCEO and the Data Assimilation Research Centre, an interdisciplinary research group of 34 academic and research staff drawn from Mathematics and Statistics, Meteorology, and MetOffice@Reading, a 20-strong group of Met Office scientists embedded within the School.

We have invested significant effort and resources in coherent and distinctive mathematical activity supporting specific applications, and in this effort we have been able to take advantage of the strategic investment the university has made in the areas of meteorology and neuroscience research. In addition, as a purely departmental venture, we have established and continue to support the growth of the CMOHB, comprising two permanent members of staff and eight postdoctoral researchers. This group has recently been weakened by the move to Oxford in September 2013 of Grindrod and three postdoctoral researchers, but we aim to add one permanent member of staff to the group in the near future, to support its core mathematical research (e.g. in discrete dynamical systems) and to increase links across the Department and the School, and have already expanded the group and its interdisciplinary links in social and economics applications by appointing as associate members staff in the Economics, Systems Engineering, and Psychology schools already active in collaborations with the Centre.

Our interdisciplinary presence has expanded considerably since 2008, thanks to a significant increase in research funds granted to the associated mathematical research. Some of the appointments already made strengthen the large role we play in: (a) the NERC National Centre for Earth Observation (NCEO), in particular through the Data Assimilation Research Centre; (b) the Centre for Integrative Neuroscience and Neurodynamics (CINN); (c) the Reading Systems Biology Network. To increase the quality of our research activity further and initiate new collaborations with different mathematical research areas, starting in 2013 we have invested a percentage of

departmental research overheads into funding two two-year Departmental Postdoctoral Fellowships, one in mathematics and one in statistics, see section c.

Strategy for the future and institutional support: We occupy a distinctive position in the mathematical sciences community in terms of variety of applications of core mathematics research to other sciences: dynamics and numerical modelling of atmosphere and ocean; data assimilation and modelling of Earth observations; social networks and the digital economy; applied and medical statistics; neuroscience; polymer science. Recent strategic investment of the university in our Department (see section c) has allowed us to strengthen targeted areas of interdisciplinary research: numerical analysis and scientific computing; nonlinear analysis, with emphasis on the analysis of geophysical flows; and mathematical research that can strengthen interdisciplinary activity with CINN, complementing our inverse problems activity in this area.

The priority for the future development of our research activity is to support the core mathematical research areas that constitute the essential foundation for significant progress in these interdisciplinary applications, and the continued consolidation of our interdisciplinary profile.

We plan to continue to apply for the mixture of individual/small-group grants and large and interdisciplinary bids that has been successful in the REF period. The cross-departmental positions we have established (with Meteorology and with Biological Sciences) have strengthened our interdisciplinary and industrial research connections and placed us in a strong position to compete for such large bids (see section e). We expect that growth of staff numbers in Mathematics and Statistics will be possible on the basis of increasing grant income associated with new staff and activity, with the additional support of the steady increase we are experiencing in undergraduate student numbers (43% increase in UG entrants since 2010), and in international MSc students (70% increase since 2008).

While we cannot aspire to cover all mathematical research areas, we aim to concentrate on areas that will achieve overlap with existing research activity and support for significant progress in interdisciplinary applications. In particular, we aim to expand our activity: (i) to geometry/geometric analysis, to support and widen the activity in nonlinear PDEs, spectral theory and fluid dynamics; (ii) in analytic and computational number theory and graph theory, to complement the existing activity in analysis, probability, data assimilation and applications to large network analysis through the activity of CMOHB; (iii) in discrete and continuous dynamical systems theory to strengthen the theoretical activity of CMOHB; (iv) in theoretical probability and statistics, to sustain our data assimilation research and integrate the mathematics and statistics groups further. Indeed, the University has confirmed support for further appointments in such areas, subject to financial viability.

c. People, including:

i. Staffing strategy and staff development

Since 2010 and the creation of the current Department of Mathematics and Statistics, we have sought to support our growth specifically in the areas outlined in section b, and have appointed 13 new members of staff, of whom eight to newly created positions. These appointments have been in areas of strategic importance for the Department and the University, namely: pure, applicable and numerical analysis, supporting computational and modelling activities in weather and climate and sustaining our traditional strength in fluid mechanics and water waves; probability, statistics, applied statistics and data and network analysis, adding strength to our existing interdisciplinary collaborations. By 2012, we had established one new position in CMOHB, one at the interface of meteorology and statistics, one in the Data Assimilation group and one joint with the School of Biological Sciences. During 2012, the University made a sustained strategic investment in targeted research areas through its Academic Investment Project and the creation of 50 new positions across the institution. With the support of this project, we have appointed additionally five new members of staff (4.2FTE) to strengthen the interdisciplinary research themes: one in the area of inverse problems and applications of data, supporting our research collaboration with CINN, and four to strengthen the numerical and scientific computing expertise of the Department and the links with activity in Meteorology, and to support research in theoretical aspects of nonlinear, in particular geophysical, fluid dynamics models. As part of this recruitment we made a senior part-

time appointment (0.2 FTE) in numerical analysis and data assimilation, recruiting Reich to provide leadership for the expansion of numerical analysis and data assimilation towards research in atmosphere and oceans. Reich has immediately played a key role in a successful bid for an EPSRC Centre for Doctoral Training (CDT) joint with Imperial (see section e). The department has four other 0.2 FTE members of staff, three of these employed since the last RAE, and the fourth (Lucarini) appointed in 2009.

This increase in staff has been targeted to strengthen the research groups that comprise the departmental research structure. In summary:

(A) Pure, Applicable and Numerical Analysis - *7 appointments*
(B) Statistics and Applied Statistics – *3 appointments*
(C) Complex Fluids and Theoretical Polymer Physics – *2 appointments*
(D) Centre for the Mathematics Of Human Behaviour (CMOHB*) joint with*
(E) Mathematical Biology – *1 appointment*

Our strategic support of research activity has also resulted in a sustained increase in the number of postdoctoral researchers and PhD students. Currently the Department has 13 postdoctoral research members. We also host a four-year Royal Society Industry Fellow (Bowman) and two visiting professors (Cullen and Grindrod). Several young researchers who joined as PDRAs or on short-term departmental contracts have been supported to win prestigious Fellowships: Betcke, who left in 2010, won an EPSRC Career Acceleration Fellowship while a postdoctoral researcher in the Department; Lucarini (now 0.2FTE) was awarded an ERC Starter Grant; Moiola, who joined while a Fellow of the Swiss National Science Foundation, has been appointed to a permanent position from March 2013; Infusino is currently an INDAM-Marie Curie Fellow funded in full by her personal fellowship after spending one year as a PDRA on an ESPRC project (PI Kuna) in the Department. To continue this successful recruiting and to support the best candidates for Postdoctoral Fellowships, we have instituted two departmental Postdoctoral Fellowships, funded through departmental research overheads and named after Richard Rado who was an eminent, long-standing member of the Department. The appointed fellows are expected to seek external funding, taking advantage of our institutional support in preparing their application. We appointed in October 2013 two promising young researchers to these positions, one in Number Theory and the other in Applied Statistics. A further Postdoctoral Fellow, also in Number Theory, has been appointed in the Department at the same time, for a period of nine months, as the winner of an EPSRC Postdoctoral Prize.

Staff development: Giving staff clear guidelines and objectives for career progression and supporting them to achieve their full potential is of the utmost importance. We describe here the mechanisms we have in place to ensure this happens consistently, in particular for early career researchers, in line with the Concordat to Support the Career Development of Researchers, implemented across the University. To ensure this support is in place from an early stage, we have introduced in recent years several mechanisms to assist staff development and to help staff recognise milestones promptly. Every new member of staff and early career researcher affiliated with the Department has a personalised induction process, and is assigned as mentor a permanent member of the Department. The role of the mentor is to hold regular meetings to ensure that any issue arising is dealt with swiftly, to assist informally in every aspect of departmental life, to aid induction and to address career development issues.

All staff undergo a periodic Staff Development Review (SDR) with a regular reviewer, normally distinct from the mentor. This SDR is annual for most staff, including all temporary research staff, and has a strong emphasis on career development and objective setting for the coming year. In preparation for the SDR, research staff complete the School “Research Staff Development Prompter” form, designed to prompt identification of objectives for the coming year across the wide range of activities that will add to their CV and enhance future employment, in particular in academia and research careers.

We hold a biennial workshop for early career researchers, aimed at giving advice on career progression paths, pitfalls and opportunities, raising awareness on how to win grant funding, including personal fellowships, and increasing awareness of the growing importance of impact alongside traditional academic parameters. This workshop is led by our School Director of Research and more experienced early career staff, with expert input from across the University. In

addition, the School research staff organize a termly "Research Staff Discussion Forum" that reports comments, suggestions and complaints to the School Director of Research.

The University, among the first 10 HEI's institutions to win the EC HR Excellence Award, has an approved Code of Good Practice in Research, which serves as the institutional platform to provide solid support for research also at departmental level. In accordance with the Code, staff are regularly invited to an institutional training session on mentoring research staff. Each mentor is reminded by the School's administration of all key transitional moments. This structure has worked well in helping the senior departmental management to identify and support potential promotions of staff promptly. Additionally, we have worked hard to improve our School promotion arrangements to make the criteria and the selection process as fair and transparent as possible, and to ensure effective feedback and support in preparing cases. This has resulted in a much improved promotion rate, in particular of women and early career researchers. In particular, since 2010 and the creation of Mathematics and Statistics, we have had four promotions to professor (two female), two to reader, and three to senior lecturer within the Department.

In addition, we are committed to supporting fellowship holders in gaining permanent positions. Dance and Tindall (RCUK Fellows) have taken up permanent lectureships as joint appointments (with Meteorology and Biological Sciences respectively). Betcke (EPSRC Career Acceleration Fellow) was appointed lecturer after winning his fellowship, before moving to UCL. Lucarini (ERC Starter Grant holder) and Varvaruca (Whitehead Prize winner) were quickly promoted to Reader.

All staff involved in recruitment and selection complete training offered by the Centre for Quality Support and Development, which also offers regularly leadership and management development workshops and training activities. All members of staff are actively encouraged to take advantage of the excellent institutional support for accessing information on and writing research proposals.

Permanent staff members have a dedicated Staff Development Account (SDA) which is topped-up annually from general departmental funds, and by a share of 8% of the overheads of research grants funds won by the individual. The funds are used primarily for support of individual research goals, e.g. for research visits and visitors, conferences, equipment, PhD funding.

International staff: Among the permanent staff, 16 are British or British-trained. Hence the majority of staff are international, in keeping with the national trend in mathematics. In addition, approximately half of all the PDRAs and research fellows in the Department are international. We regularly host visiting scholars, usually on short visits but hosted long-term visits in 2012/13 of Prof. P. Svensson (6 months, Norwegian University of Science and Technology, Trondheim) and Prof J. Zheng (12 months, Donghua University, Shanghai).

In the assessment period, members of our staff have held visiting positions at the following institutions: University of Kyoto, University of Illinois at Chicago, University of Rome, University of Bielefeld, Rutgers University, University of Montreal, University of Crete, Centre of Advanced Studies of Norway, US Naval Research Laboratory at Monterey CA, Northwestern University.

Equality and diversity: The Department holds an Athena Swan Silver Award, currently undergoing preparation for renewal. We were the first mathematics department to achieve this award. We have also been granted supporter status for the Good Practice Scheme of the London Mathematical Society. The Department has four female professors (Nichols, Macdonald, Pelloni, currently joint Head of Department, and Todd), one senior lecturer (Ayres), two lecturers (Vukadinovic-Greetham and Dance) and four postdoctoral researchers, with two promotions to professor and one to senior lecturer in the REF period. We offer flexible working to all staff coming back from parental leave and all staff with small children - both Dance and Vukadinovic-Greetham have taken advantage of flexible working arrangements. We are committed to supporting equality and diversity, as testified for example by our multiple Heads of Department arrangement. This arrangement, whereby the administrative load is shared, exemplifies our efforts to make it possible for all staff members to participate in the decision making process without loading any single individual with a heavy time commitment. We also have a policy on the timing of meetings and seminars to make them accessible to all staff, by holding them only in designated core hours. We are committed to have all genders, ethnicities and backgrounds represented among the seminar speakers we invite, and monitor yearly the results of our commitment. The statistics show an increase since 2011 in the variety of representation.

In the last year, the School conducted a survey to assess how working conditions are judged by staff at all levels, specifically in terms of fairness and inclusiveness. In this survey, the effect of the changes in how we support research staff received very positive feedback.

ii. Research students

We have consistently increased the numbers of research students in mathematics in recent years, with the annual intake now almost doubled from 2008 to 8-10 new research students a year, of whom 98% have completed successfully in the REF period. The number of research students in statistics has remained stable. The total number of PhD awards has gone up from 0.83 per research-active staff member in the previous assessment period to 1.3. We publish a description of all available projects on our website, and advertise available studentships through dedicated websites such as *find-a-phd.com*. We are assisted by a central Admission team, and offers are made after interview for each studentship. In 2010 the University established an institutional Graduate School that coordinates the activity of the University as a postgraduate institution and the generic training for research students. The Graduate School has developed a Code of Practice on Research Students encompassing all aspects of the admission, support, progression, assessment and degree award for postgraduate students, and offers useful resources specifically for the cohort of research students, including research career advice.

Research students, along with research staff, are vital to maintain the timeliness and relevance of the research activity, both for the Department as a whole and for individual supervisors. We have made a substantial investment (e.g. through specifically postgraduate open days and lectures) in raising our profile with prospective postgraduate students and tightening our admission criteria to ensure we select students with the right background and a strong research potential. We currently have 47 PhD students in Mathematics and Statistics, of whom approximately 75% have funded studentships of 3.5 year duration. The funds for these come from a variety of sources: ring-fenced portion of the university DTG allocation (including four EPSRC-CASE studentships), DTG studentships won competitively within the University, other competitive University-funded home and international studentships, NERC funding through the NCEO and our activity in data assimilation, and industrial sponsorship through NERC-CASE studentships. We have just heard the successful outcomes of both EPSRC and NERC doctoral training centre proposals that will bring approximately 10 new studentships per annum into the Department, see section e.

The postgraduate students are an integral part of the Department's research environment. With departmental support, the students host their own seminars and research activities on a national scale, e.g. the national MAGIC postgraduate conference in 2010 and a SIAM Student Chapter.

Training in Mathematics and Statistics: All full-time PhD students in Mathematics and Statistics are required to complete 100 hours of training (corresponding to 50 credits) within the first two years. For mathematics PhD candidates, these credits can be obtained by attending and passing the assessment for four 20 lecture postgraduate level modules (or equivalent), or by attending summer schools with associated assessment. Interdisciplinary PhDs can meet these requirements in part by taking modules in other departments. The individual training programme is agreed for each student at the beginning of their course of study by the supervisor(s) and the Director of Postgraduate Research Studies. The majority of the broad subject training for mathematics students is obtained through taking and passing assessment for courses delivered remotely by the MAGIC consortium, a consortium of 18 universities we joined in 2008. The consortium delivers a coherent suite of postgraduate courses in mathematics using an interactive videolink. Participation in this consortium has allowed us to broaden significantly the research training we offer our postgraduate students, and Kuna now sits on its national teaching committee. In addition, we provide every year a week-long graduate level course, funded by the Department as well as other sources such as the London Mathematical Society (LMS). These courses have been highly successful, as measured by the feedback collected by the LMS and have attracted many external students. The most recent of these courses, on "Modern nonlinear PDE methods in fluid mechanics", secured funding not only from LMS, but also the Oxford and Edinburgh Nonlinear PDE Centres, and the Clay Institute, and attracted over 40 participants.

For our students in statistics, the standard training route is to complete first our MSc Biometry, supplemented by courses provided through the Academy for PhD Training in Statistics (APTS).

We require all PhD students to attend at least one of the weekly seminars. The students also

contribute seminars to the various informal seminar series and, as an important part of a supportive and social environment, run their own bi-weekly seminar series for PhD students only, and other research training events through their SIAM Student Chapter.

In addition, the Department runs an MSc in Numerical and Applicable Mathematics and an MSc in Biometry (with industrial studentships), and is partner in the interdisciplinary MSc in Data Assimilation and Inverse Methods in Geoscience and the MSc in Financial Engineering.

Professional Skills and Generic Training. In addition to subject-specific training, our PhD students are required to undertake training in professional and transferable skills. In large part this training is provided through the Graduate School's Reading Researcher Development Programme, structured to meet the national Researcher Development Framework and EPSRC training requirements. As with subject-specific courses, the selection of courses and events from this programme is made jointly by supervisor and student, facilitated by the University's Learning Needs Analysis Tool. Mathematics and Statistics have offered bespoke courses (e.g. in scientific typesetting with Latex and in statistics, ethics in research, and engaging the public with research). Additionally, our mathematics PhD students are required to attend departmental modules in Communication and Research Skills, specifically designed to improve both written and oral presentation of mathematics, and Computing Techniques and Projects, which provides students with practice in modelling and programming. These communication skills are further developed by attendance at conferences and other meetings, supported by external funds and a departmental commitment of £500 per student per annum, and a requirement of at least one conference presentation per student during the PhD. Students are also strongly encouraged to take part in the Industrial Modelling lecture series given by speakers from a range of industrial/research establishments, and to develop team-working in our Modelling Week, a one-week modelling camp in which groups of students work intensively on industrial case studies, producing results as a presentation and a joint report. All students are given the opportunity to contribute to the teaching of undergraduate courses, by taking an active part in our undergraduate tutorial programme, and we organise an in-house training day specific to the teaching of mathematics and statistics for all first year research students.

Monitoring and supervision of PhD candidates: In addition to weekly supervisory meetings, where the student and the supervisor(s) meet to discuss the specific project, each full-time student has two meetings a year with an individual monitoring committee, consisting of two members of staff other than the supervisor(s). This committee, operating in accordance with the University Code of Practice on Research Students, follows the individual student's development through the entire course of PhD studies. Its purpose is to review progress, to advise on training, to provide a forum for discussion of the student-supervisor relationship, and to provide additional points of contact and advice for the student. Most students are jointly supervised by two staff, particularly on interdisciplinary projects, and CASE students also have industrial supervision.

d. Income, infrastructure and facilities

Income: We have pursued actively a policy of encouraging and supporting applications for funding from a variety of government, charitable and industrial sources. All grant applications are peer-reviewed internally before submission. The associated funding is crucial for extending our activities, for funding postdoctoral positions, to confirm and strengthen our research reputation. External peer review of our grant applications is also crucial as feedback on our research.
This policy has resulted in a total (Mathematics and Statistics) research grant income of £4049 k for the period 2008-2013. For mathematics, the grant income is approximately three times more than over the previous assessment period, while the Statistics group, due to the major restructuring, increased theoretical focus, and the exclusion in this submission of income associated with the Statistical Services Centre, has seen a drop in funding. The grants we currently hold or have held in the REF period have been funded not only by the main research funding bodies (EPSRC, NERC, BBSRC, ERC, EU) but also charitable research funds (Leverhulme, Wellcome, BHF) and industry (e.g., SSE, Unilever). We have a strong track record of response to bids for large interdisciplinary grants, and are currently partners in RCUK Horizon Digital Economy Hub, RCUK/EPSRC MOLTEN, EPSRC NeuroCloud and BHF Virtual Platelet**.** In the preparation of research proposals we have excellent professional assistance from the

University Research and Enterprise office.

Infrastructure: The Department has been housed for many years in a dedicated building on the main campus of the University of Reading, including a mathematical research library, a staff common room and two computing laboratories. Due to the recent expansion, a significant institutional sum has been invested in upgrading a building adjacent and internally connected to the mathematics building, so all members of the Department of Mathematics and Statistics are housed in one site. The new space arrangements have allowed us to reflect our research groupings in the logistical situation of offices, and have allowed us to create new offices for our PhD students and a resource room dedicated to postgraduate students. The University has planning permission for a new mathematics building to be erected near the other buildings of the School, and this project is our long-term aspiration, as it would facilitate the many research links already established within the School, and promote new ones.

We provide up-to-date computing equipment for all permanent and research staff and PhD students, in addition to providing communal computing, printing, scanning and copying facilities. We also have a parallel computing cluster, with 500 cores, built up through a mix of EPSRC and University funding, supporting particularly the polymer group, but available as a resource across the department for large-scale scientific computing, and supported by a computing officer.

Consultancies and professional services: We offer consultancy services through the Statistical Services Centre, an internationally renowned and self-funded centre of the University, with an average annual turnover of £750k, and large contracts, e.g. currently a $1.2 million contract over three years with the McKnight Foundation. We also offer consultancy services through a newly established spinoff from the CMOHB, CountingLab, which provides algorithms, software and services for the prediction of human behavioural patterns, and won in 2013 1st place in the Global Energy Load Forecasting competition. Income from this activity is used to sustain our running costs, with the surplus currently supporting two two-year postdoctoral positions. A further eight members of academic staff have held research-related consultancy positions at private sector companies, e.g. Langdon with Schlumberger leading to joint papers in Quart J Mech Appl Math.

e. Collaboration or contribution to the discipline or research base

We have many research collaborations with groups across the UK, many of these larger and grant-funded in the REF period (e.g. with London Analysis Group, Warwick, Bath, Nottingham, Cambridge), and ongoing projects with groups in France, Germany, US, Japan, China, and Thailand. We have been part of funded research networks, both international such as ENIGMA (ERC) and national such as MOPNET (EPSRC), for which we were main organisers.
We run seminar series in analysis, pure mathematics, systems biology and statistics, plus weekly departmental seminars, a termly Distinguished Colloquium, a monthly School seminar in mathematical meteorology, and the School Annual Morley Lecture, inaugurated in 2012 by Prof Margaret Wright. We have organized, for the community, many events and courses at Reading: since 2009, three summer schools, five intensive postgraduate courses and 12 conferences, for example IMA conferences on Mathematics of the Climate System and on Nonlinear Waves. We have also organised meetings at international mathematics centres, the ICMS in Edinburgh, programmes in 2012 and 2013 at the INI in Cambridge, workshops at INI in 2010 and 2011, a Durham LMS Symposium, two Mathematisches Forschungsintitut Oberwolfach workshops, and will Co-Chair the SIAM NW14 meeting in Cambridge. In 2013 alone, we have run four externally funded workshops, the SIAM-UKIE annual general meeting, an LMS-EPSRC postgraduate instructional course funded by LMS, OxPDE, CANPDE and the Clay Institute, and two of our staff are organisers of a two-month programme at the INI on the Mathematics of the Fluid Earth.

A major recent collaboration has been a successful ESPRC application with Mathematics at Imperial College to create a Centre for Doctoral Training in the Mathematics of Planet Earth. This will support 8 PhD students in Reading, and it is strongly supported by the Met Office, the European Centre for Medium Range Weather Forecasts (ECMWF), and a wide range of commercial and international partners. The School has also won (November 2013) £4.9M of NERC funding to create a NERC DTP which will fund much research into the Department. These CDT/DTP bids are built in part on the Department's distinctive track record of interaction and research collaboration with industry. This is embedded in many of our research groups, with

funding from over 35 research grant project partners or CASE partners in the assessment period, two examples a current £1.6M contract with Scottish and Southern Energy that has supported several postdoctoral positions in the CMOHB, and funding from Schlumberger as project partner in two EPSRC grants and through a NERC CASE award. We have particularly strong links with weather and climate services. The Met Office or ECMWF were project partners for three research grants in the assessment period, and currently support four CASE students in the Department. Internationally, Potthast, head of data assimilation research at the DWD (the German met office), holds a part-time chair and funds and jointly supervises PhD research.

Leadership: Members of our staff have, in the assessment period, been regularly invited to contribute review articles to main journals or key reference publications (e.g., Acta Numerica, Nonlinearity, Polymer Science: a Comprehensive Reference) and sit on international and national academic scientific panels and committees (e.g. NSF, SIAM, INRIA). The University and School fully support staff engagement in service to the community, giving partial relief from academic duties to serve on external panels and advisory boards or in recognition of outreach activities. Several of our staff, including Chandler-Wilde, Grindrod, Levitin, Macdonald, Pelloni, and Todd, have been prominent in the academic community, holding leadership or advisory roles in the assessment period in industry, commerce, Research Councils, learned societies or professional bodies.

The following is not an exhaustive but rather an indicative list of the scope and breadth of our contributions during the REF period:

Prizes, honours and awards: Outstanding Young Scientist Award 2010 of the European Geosciences Union (Lucarini); 2011 Olga Taussky-Todd Prize Lecture, ICIAM (Pelloni); 2012 Whitehead Prize of the LMS (Varvaruca); 2012 WISE Awards shortlist (Nichols); Honorary Doctorate University of York (Macdonald).

Fellowships*:* 2 RCUK fellowships (Dance and Tindall); 1 EPSRC Career Acceleration Fellowship (Betcke – since transferred to UCL); 1 Swiss National Science Foundation Fellowship (Moiola); 1 ERC starting grant (Lucarini – now .2 FTE); 1 INDAM-Marie Curie fellowship (Infusino); 1 Royal Society Industry Fellowship (Bowman).

Main keynote lectures*:* ICIAM 2011 OTT Prize Lecture, International Congress on Computational and Applied Mathematics 2008, MAFELAP 2009, European Rheology Conference (Russia 2011 and Belgium 2013), IUPAC World Polymer Congress 2012, Elementary and Analytic Number Theory/Four Faces of Number Theory 2012, CliMathNet Conference 2013, IMACS International Conference on Nonlinear Evolution Equations and Wave Phenomena 2013.

Learned Societies*:* LMS council and committees; IMA council; IoP council, elected fellows of IMA, APS and RSS; President of SIAM UKIE; elected to council of RSS.

Editorial boards: LMS Proceedings, Journal and Bulletin; SIAM Review; SIAM Journal on Scientific Computing; SIAM Journal on Numerical Analysis; Physical Review Letters; Journal of Nonlinear Mathematical Physics; Rheologica Acta; European Physical Journal E; Statistics in Medicine; Computational Statistics and Data Analysis; Journal of Integral Equations and Applications, Journal of Computational Dynamics; GEM - International Journal on Geomathematics.

Advisory board membership: RCUK Programme advisory; BBSRC council; MOD DSAC; external advisory boards for mathematics institutes and centres (Oxford, Warwick, Bath, Brunel); Athena SWAN Steering Committee.

Industry: advisory board of SSE PLC R&D and Emnos GmbH.