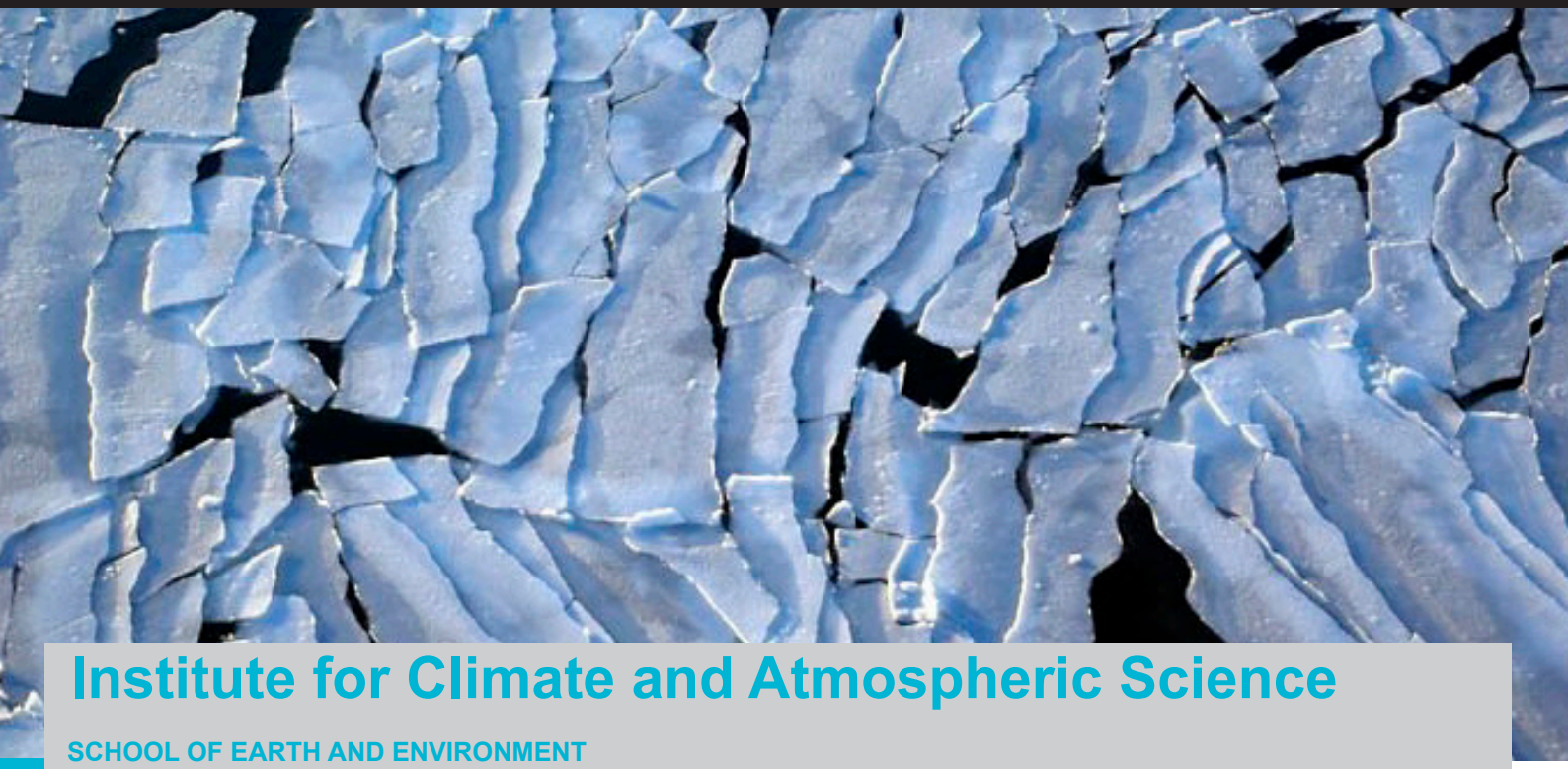
UNIVERSITY OF LEEDS

ICAS Newsletter

Issue 8
November 2016



Institute for Climate and Atmospheric Science

SCHOOL OF EARTH AND ENVIRONMENT

IAN BROOKS REACHES THE NORTH POLE!

Ian Brooks and his team participated in the Arctic Ocean 2016 expedition as part of a scientific team collecting data from the central Arctic Ocean.

The 6-week cruise took them to the North Pole, and down the Lomonosov Ridge towards Greenland to study interactions between the atmosphere and sea-ice.

The expedition involved two icebreakers, Oden and its Canadian counterpart Louis S. St-Laurent, with data acquisition occurring on both of them.

The polar expedition was a collaboration between the Swedish Polar Research Secretariat and the Canadian Government (via the Canadian Hydrographic Service, Natural Resources Canada and the Canadian Coast Guard).

Continues on next page

INSIDE THIS ISSUE

IAN BROOKS REACHES THE NORTH POLE!

Continued from front page

Some 60 people joined the ship in Longyearbyen on Svalbard at the beginning of August, including several very different science projects sharing time on the ship. The Meteorological Team, led by Ian, included ICAS post-doc John Prytherch along with two early career researchers Anna Fitch (from the Swedish Meteorological and Hydrological Institute) and Piotr Kupiszewski (from ETH, Zurich and the Meteorological Institute, Stockholm University).

On joining the Oden the meteorology team immediately started sorting out all the instrumentation that needed reinstalling. Most of the work was done back in May, with all the sensors installed and tested, but they didn't want to leave them on the mast for the two months before the cruise started.

After a week of resolving numerous problems with their equipment they finally got the majority of the measurements underway. The expedition headed north towards the region of the Amundsen Basin and northern Amerasia Basin, one of the most remote regions in the Arctic. improvements of models, changes on ice and global sea depth and in the sea ice thickness in the Arctic.

Photos: The Meteorology team (Top L), Anna Fitch launching weather balooon in gale force winds (Top R), De-icing camera after freezing fogs begins (Bottom L), The Louis S St Laurent and Oden part company (Bottom R). Credit Ian Brooks.
Front page photo: Sea ice, Arctic. Credit: Ian Brooks.

SUCCESS AND CONGRATULATIONS

CONGRATULATIONS TO BEN MURRAY APPOINTED TO CHAIR IN ATMOSPHERIC SCIENCES

Ben Murray graduated with a First-Class MChem Honours degree from the University of Wales, Swansea, in 1999. This included a period spent working in Professor M. A. Tolbert's research group at the University of Colorado in Boulder, USA, where he worked on phase changes in atmospheric aerosols. Following this, Ben undertook a PhD at the School of Environmental Science at the University of East Anglia where he worked on heterogeneous chemistry in mesospheric ice clouds.

Ben then moved to Vancouver, Canada, in 2004, for a post-doctoral fellowship with Professor Allan Bertram at the University of British Columbia, researching phases of ice in the Earth's upper troposphere. Returning to the UK in 2006, he took up a permanent academic position at the University of Leeds, first in the School of Chemistry and then in ICAS, in the School of Earth and Environment, where he HAS just been promoted to Professor of Atmospheric Science.

RESEARCH EXCELLENCE

Congratulations to **Leighton Regayre** who recently enjoyed PhD success and whose degree is now being awarded with recognition of Research Excellence by the University. Leighton was one of this year's PGR Publication Prize winners with his Paper in Journal of Climate: The Climatic Importance of Uncertainties in Regional Aerosol–Cloud Radiative Forcings over Recent Decades. Reagayre et al. J. Climate 2015.

WINNER OF EARLY CAREER ORAL PRESENTATION AWARD

Congratulations to **Catherine Scott** who won the Early Career Oral Presentation Award at the International Global Atmospheric Chemistry (IGAC) meeting at Breckenridge Colorado USA held 26-30 September 2016.

IGAC is a community of 4, 000 scientists working in the field of atmospheric chemistry and there were over 200 early career scientists presenting in Breckenridge. Cat's presentation was on the impact of land-use change on climate.

PROMOTION TO ASSOCIATE PROFESSOR

Congratulations to **Andrew Ross** on his promotion to Associate Professor in Dynamic Meteorology.

ICAS IN THE MEDIA

UK Climate Change Risk Assessment Evidence Report

Andy Challinor contributed a chapter to the 'UK Climate Change Risk Assessment Evidence Report'. The report concluded that the impacts of climate change are already being felt in the UK and urgent action is needed.

In the independent report to Government, the Committee on Climate Change's Adaptation Sub-Committee sets out the most urgent risks and opportunities arising for the UK from climate change. The report was covered in The Guardian and The Independent. The University has also covered the story on the University of Leeds Corporate Website: http://www.leeds.ac.uk/news/article/3888/report_highlights_urgent_climate_change_risks_for_the_uk.

Greenland Ice Loss Doubled

Mal McMillan is quoted in IFL Science, the Guardian and Chicago Tribune in which he talks about a new study he's lead author on with Andrew Shepherd, Kate Briggs and Anna Hogg of ICAS and the **Centre for Polar Observation and Modelling (CPOM).**

The study, which appeared in Geophysical Research Letters, looks at satellite observations of Greenland ice loss and how the European Space Agency's Cryosat mission reveals dramatic ice loss from Greenland.

Scientists back from the cold

Jim McQuaid and Liane Benning talked to Keeley Donovan on the Paul Hudson Weather Show. This summer they returned from Greenland for the NERC Black and Bloom project which is aiming to quantify the 'bioalbedo' contribution to the darkening of the ice sheet.

Listen to the interview on Paul Hudson's Weather Show on 13/08/16, you can follow the project via http://blackandbloom.org and also @Glacier_Albedo.

MRES PRESENTATIONS

ICAS's Climate and Atmospheric Science MRes saw the students give their final presentations representing a great selection of ICAS research.

- **Understanding changing climatology of extreme precipitation over Europe: James Warner**
- **Impact of ice sheet meltwater in the North Atlantic on European winter climate variability: Nigel Clifford**
- **Dynamics of North Atlantic jet regimes following major stratospheric sudden warmings: Gibbon Masukwedza**
- **Observations of horizontally oriented ice crystals (HOIC) in the clouds above Greenland: Seb Cole**
- **Tropical cyclone re-intensification after landfall over the American continent: Astrid Perez Bencomo**
- **The role of radiative forcing during the global hiatus: Sophie Randall**
- **Characterising the East Asian summer monsoon: Ailish Graham**
- **Humidity and temperature control on crop growth mechanisms and modelling: Victor Palacios Fermoso**

Our MRes programme is designed primarily as a research training pathway and provides students with an excellent platform to move into research facing careers. However this training is highly relevant beyond just PhD studies but with many industries clamouring for highly numerate problem solving scientists, the opportunities for our students are many and wide ranging from the insurance sector to renewable energy suppliers.
The course includes over 65% of the final mark being derived from an independent research project. This means that the students receive an excellent training in undertaking independent research projects. In addition to the main research project, the course provides access to a wide range of graduate and undergraduate taught modules which the students select to provide them with additional skills in atmospheric science. Many of these are selected because of their applicability to their chosen research project.

Photo: The new cohort of MRes (Climate and Atmospheric Science) making observations as they ascend Goatfell (Arran) as part of the field course which marks the start of their year of studies in Leeds.

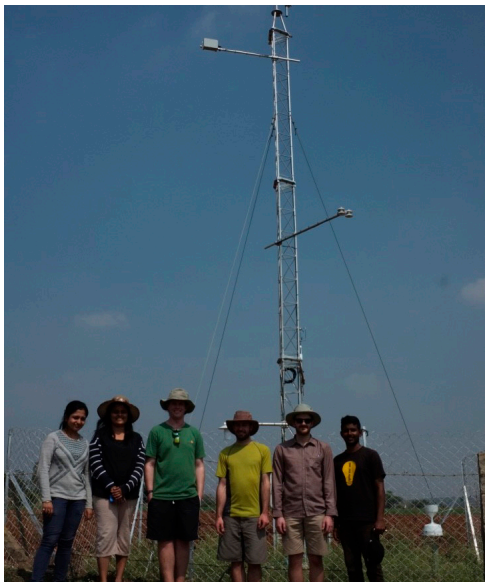
WORLD-FIRST FIELD EXPERIMENT IN INDIA - INCOMPASS PROJECT

A team of scientists from ICAS is playing a leading role in a world-first field experiment in India, to improve weather and climate predictions of the monsoon. The group, led by Professor Doug Parker, forms part of the Anglo-Indian INCOMPASS project, which is making unprecedented observations of the land, ocean and atmospheric systems controlling the monsoon climate.

Research flights with the UK BAe146 research aircraft operated by the FAAM, have been conducted right across India, from the eastern and western reaches of the Indo-Gangetic plain in the north, to the Arabian Sea and Bay of Bengal, crossing the Deccan Plateau and Western Ghats in the south.

INCOMPASS has also established a remarkable network of research stations to measure surface energy balance across the subcontinent, through partnership between the UK Centre for Ecology and Hydrology (CEH) and a number of Indian partners, including the Indian Institute of Science (IISc). An observational "supersite" has been set up at Kanpur in the north of India, including instruments installed by the NCAS Atmospheric Measurement Facility (AMF) at Leeds.

INCOMPASS is jointly led by Andy Turner at the University of Reading and Prof GS Bhat at IISC.



Photos: Leeds PhD student Oliver Halliday (2nd from the right) spent 3 weeks earlier in the year assisting scientists from CEH Wallingford and the Indian Institute of Science, Bangalore, in the installation of observational stations in the south of India. The installation is now part of a network of stations which span the Indian peninsula and provide data for the ongoing INCOMPASS field campaign. Credit: Oliver Halliday.

Eight scientists from Leeds are taking part in the airborne and ground campaigns of INCOMPASS, while others are involved through computer modelling.

Leeds scientists are leading the investigations into "scale analysis" in the monsoon system, in partnership with the National Aerospace Laboratories (NAL) in Bengaluru and with the UK Met Office. Scale analysis means working out how the continental monsoon influences the development of individual rain systems, and the way in which individual storms can cause changes in the large-scale monsoon circulation. These processes are of critical importance to the improvement of weather and climate predictions. Doug Parker has very recently published a paper on this topic, showing how the onset of the monsoon rains is controlled by the behaviour of cumulus clouds in the pre-monsoon period: he will be using the new INCOMPASS measurements to test his theoretical ideas.

§ Parker DJ; Willetts P; Birch C; Turner AG; Marsham JH; Taylor CM; Kolusu S; Martin GM (2016) The interaction of moist convection and mid-level dry air in the advance of the onset of the Indian monsoon, Quarterly Journal of the Royal Meteorological Society, . doi: 10.1002/qj.2815

Returning from research flights conducted at only 500 ft above the Indian continent, Prof Parker said;

"The Indian Monsoon is the world's most important annual climatic phenomenon, affecting the lives of a billion people, and this is the first time that a state of the art research aircraft has performed comprehensive surveys over the sub-continent.

"We are getting unique data that will enable us to evaluate and improve weather and climate predictions for India. Most importantly we are collaborating closely with the leading Indian research groups in the data collection. I look forward to these collaborations continuing in future years, so that Indian and international forecast models gain the maximum benefit from the new measurements."

OUR NEW INTAKE OF PHD STUDENTS

Fourteen PhD students started in ICAS in October. Their projects vary from ice nucleation to climate impact to atmospheric chemistry reflecting the exciting width of ICAS research. ICAS has about 50 PhD students funded from a wide range of sources. Our NERC Doctoral Training Partnership (http://www.nercdtp.leeds.ac.uk,) is an important source of studentships, but every year ICAS staff are successful in funding studentships from a wide range of other sources. This year's intake of students shows an exciting trend towards even more diverse research. Seven of the eight NERC awards are CASE (Collaborative Awards in Science and Engineering), which greatly exceeds the ratio that we are expected to obtain. New students were given the opportunity to describe their research in a dedicated poster session at the ICAS Annual Science Meeting on 3 November.

Congratulations to our new students and a warm welcome to our Institute.

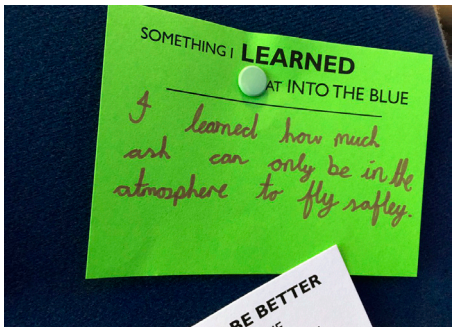
Student	Project	Supervisors	Funding
Michael Adams	Developing a new expansion chamber to study atmospheric ice nucleating particles	Murray, McQuaid	NERC Industrial CASE
Anne Barber	Behaviour of convective updraughts	Blyth, Boeing	NERC Industrial CASE
Andreas Chrysanthou	How will climate change affect the stratospheric circulation?	Maycock, Chipperfield	LARS2016/Open
Giannis Droutsas	How do climate, ozone, and crops interact to impact on health and nutrition	Challinor, Arnold	LARS2016/PICC
Niall Gandy	Collapse of the British-Irish Ice Sheet: the role of climate and sea-level changes	Gregoire, Hodgson (ESSI)	NERC DTP 2016 CASE BGS
Rachel HAWKER	The formation of ice clouds over the tropical Atlantic	Murray, Carslaw, Field	EU
Christopher Kelly	Solar and space weather impacts on atmospheric chemistry and connections to surface weather and climate	Chipperfield, Plane, Feng	NERC Industrial CASE
Laura Kiely	Interactions and feedbacks between deforestation , fire and rainfall over Borneo	Spracklen, Arnold, Marsham	NERC DTP 2016 CASE UBoC
Ben Pickering	Evaluation of 3D dual-polarized radar-based hydrometer classification algorithms over the UK	Neely, Blyth, Ext: Katie Norman	NERC Industrial CASE
Grace Porter	Developing a new microfluidics device to measure the concentration of atmospheric ice nucleating particle in the remote marine atmosphere	Murray	EU
Alberto Sanchez Marroquin	Measuring and identifying ice nucleating particles in the atmosphere	Murray, Burke, McQuaid	EU
Anya Schlich-Davies	Himalayan glacier response to future atmospheric forcing	Ross, Quincey (Geography)	LARS/PICC
Thomas Thorp	Unravelling arctic climate change: short-lived pollutant, forest fires and man-made sources	Arnold, Spracklen	NERC DTP 2016
Dean Walker	Seasonal forecasts of East African rainfall	Birch, Marsham	NERC Industrial CASE

OUTREACH: INTO THE BLUE

Ever wondered what links Frankenstein's monster with the biggest volcanic eruption in the past 200 years?

Well, last week scientists from the ICAS, the Centre of Excellence for Modelling the Atmosphere and Climate (CEMAC) and the Institute of Geophysics and Tectonics (IGT), joined forces to tell that story, and present some findings from their research along the way.

Anja Schmidt (ICAS, IGT) and **Kirsty Pringle** (CEMAC), along with a raft of helpful volunteers, including MRes and DTP PhD students, had a stall at the NERC "Into the Blue" science fair (http://intotheblue.nerc.ac.uk/).



The theme of their stall was "1816 – The Year Without a Summer", a famous climate event in which the 1815 eruption of Mount Tambora volcano in Indonesia sent huge amounts of ash and gases into the atmosphere, leading to unseasonably cold temperatures and storms across much of the Northern Hemisphere.

They used the 200th anniversary of this event to link to current research within the School of Earth and Environment into the effect of volcanoes on climate, an important topic in understanding the factors that affect our climate.

They also discussed the effect of volcanic ash on aeroplanes, and the challenges of accurately modelling the distribution of ash in the atmosphere.

To please the younger visitors, there was also the chance to build their own erupting mini volcano, and to take measurements from a home-made "smokin' volcano" using hand held particulate matter counters.

Photo: Kirsty Pringle and PhD student Lauren Marshall. Credit: Claire Harnett.

The event was a great success with over 4000 visitors attending over the five days.

So what does the eruption of Mount Tambora have to do with Frankenstein's Monster?

Well, in 1816 a young Mary Shelley took a trip to Lake Geneva, but instead of being able to enjoy some summer sunshine, the eruption caused the weather to be unseasonably gloomy, with chilly winds and heavy rain.

Amongst this summer of gloom, Shelley, along with fellow guest Lord Byron, decided to stay indoors and see who could write the best horror story. And so the story of Frankenstein's Monster was born.

Photo: Anja Schmidt and postdoc Cat Scott. Credit: Anja Schmidt.

FEATURED PAPER - DISCOVERING THE ORIGIN OF ATMOSPHERIC AEROSOLS

For the first time, based on years of measurements in the CERN CLOUD chamber, scientists in ICAS led by Prof Ken Carslaw have been able to build a computer model simulation of particle formation throughout the atmosphere based entirely on data from laboratory measurements. The results were published last week in the journal Science.

Photo: CERN Inside CLOUD chamber Credit CERN.

This is a milestone in our ability to understand the atmosphere. For over thirty years we have been able to build model simulations of atmospheric gas phase chemistry based on laboratory measurements of chemical reaction rates.

This capability has been essential to the development of our understanding of the atmosphere, such as predicting the formation of air pollution and simulating the destruction of the ozone layer. The same level of understanding has not been possible for particles in the atmosphere because of the enormous challenges involved in reliably measuring particle formation in a laboratory.

The CLOUD project involves a large international team of scientists from about twenty institutions and aims to understand how new particles are formed in the atmosphere through a process called “nucleation”. Nucleation occurs when certain molecules in the atmosphere cluster together and grow to form new particles.

Previous pioneering research in ICAS using the GLOMAP model (papers by Spracklen and Merikanto) showed the global importance of nucleation, estimating that about half of all cloud droplets are formed on aerosol particles created in this way. However, it was necessary to use either empirically fitted rates from field experiments or theoretical extrapolations to span atmospheric conditions.

CLOUD measures aerosol nucleation in a specially designed chamber under extremely well controlled environmental conditions and concentrations of nucleating gases. State of the art instruments track particle formation, growth and chemical composition from the very first molecular clusters up to particles of a few hundred nanometres in diameter that can go on to form cloud droplets.

One of the breakthroughs achieved by CLOUD has been to reach extremely low concentrations of contaminants in the chamber. This enables nucleation due to controlled amounts of selected gases to be studied without the complicating effect of undetected gases, which in retrospect seems to have bedevilled many previous experiments.

After several years of measurements, CLOUD has obtained enough data spanning a wide range of atmospheric conditions to enable ICAS scientists to build a global model of nucleation. In particular, CLOUD was able to make the first measurements at very low temperatures (down to 208 K) typical of the upper troposphere where a lot of nucleation takes place.

The new simulations using the GLOMAP model show that particles in the atmosphere originate from clusters of molecules containing sulphuric acid, organic compounds, and ammonia. For many years, sulphuric acid has been recognised as important for nucleation. However, the new results show for the first time that observed concentrations of particles throughout the global atmosphere can be explained only if these additional molecules participate in nucleation.

Another important result of the study is that ionisation of the atmosphere by cosmic rays accounts for nearly one-third of all particles formed. However, the simulations show that small changes in cosmic rays do not affect aerosols enough to influence today’s climate significantly.

The paper is the result of a concerted effort on experimental

FEATURED PAPER - DISCOVERING THE ORIGIN OF ATMOSPHERIC AEROSOLS

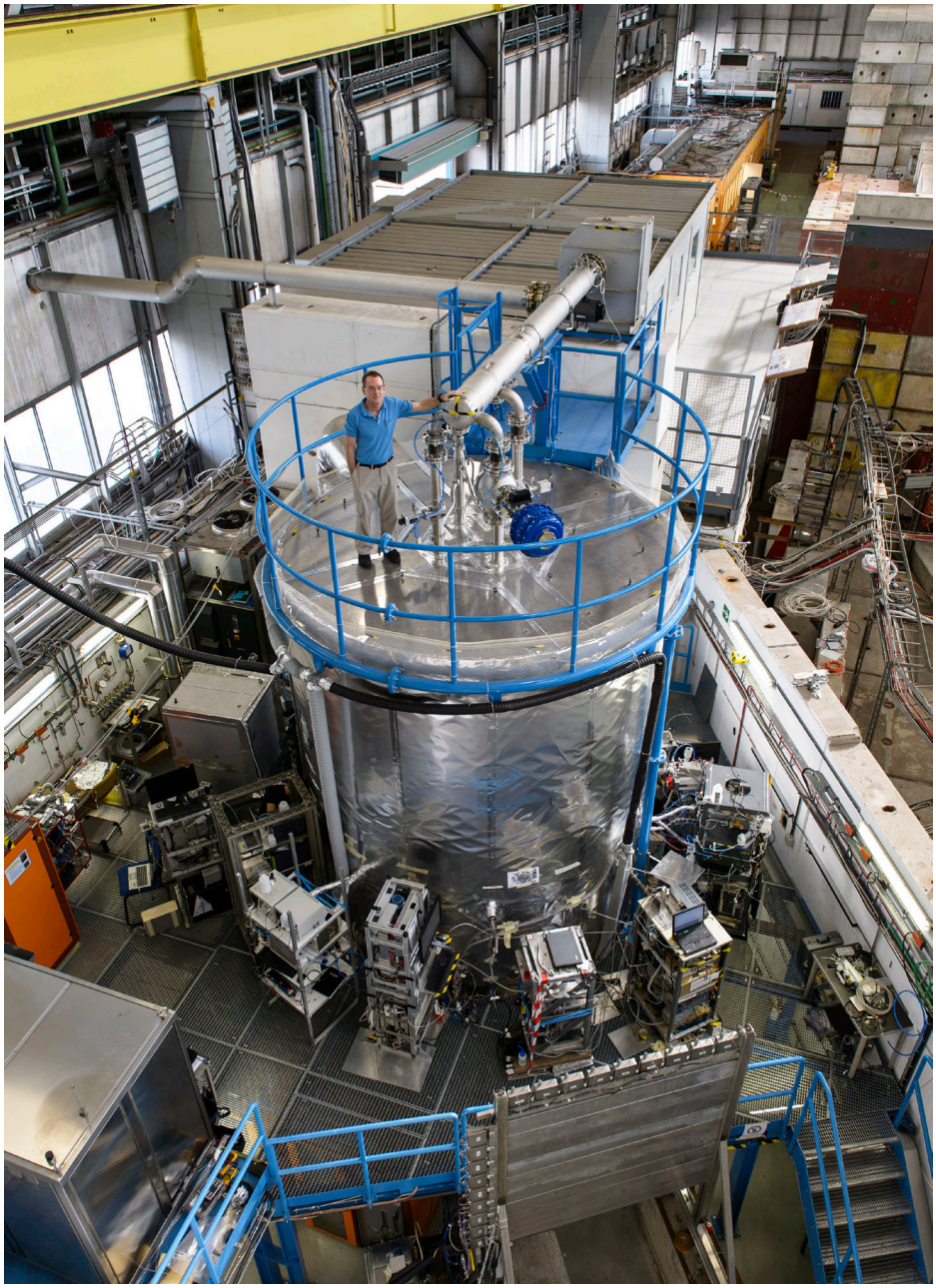
data collection, analysis and modelling over a seven-year period of two Marie Curie training networks funded by the EU. The first draft of the paper was written four and a half years ago, but the first attempts to develop model parameterisations revealed the need for new experimental data under a wider range of conditions. On the positive side, the long delays allowed new experimental data on organic nucleation to be included, resulting in a more complete model (Riccobono et al., 2014).

The research was originally the PhD thesis of **Eimear Dunne** (a Marie Curie ITN student at Leeds from 2009-2012) and was then picked up by CERN Fellow **Hamish Gordon** (now a postdoc at Leeds). Seven other postdocs at Leeds contributed to the model development, emissions and evaluation against ambient measurements (**Kirsty Pringle, Francois Benduhn, Graham Mann, Alex Rap, Carly Reddington, Nigel Richards, Kamalika Sengupta**).

This paper represents a big step for aerosol science, but it's certainly not the end point. Even after thirty years of development, gas phase chemistry models are still not complete, and the same goes for the aerosol system. CLOUD has an ambitious programme of experiments to explore many remaining questions.

Global atmospheric particle formation from CERN CLOUD measurements, Science (First Release, Oct 27, 2016): Eimear M. Dunne, Hamish Gordon, Andreas Kuerten, Joao Almeida, Jonathan Duplissy, Christina Williamson, Ismael K. Ortega, Kirsty J. Pringle, Alexey Adamov, Urs Baltensperger, Peter Barmet, Francois Benduhn, Federico Bianchi, Martin Breitenlechner, Antony Clarke, Joachim Curtius, Josef Dommen, Neil M. Donahue, Sebastian Ehrhart, Richard C. Flagan, Alessandro Franchin, Roberto Guida, Jani Hakala, Armin Hansel, Martin Heinritzi, Tuija Jokinen, Juha Kangasluoma, Jasper Kirkby, Markku Kulmala, Agnieszka Kupc, Michael J. Lawler, Katrianne Lehtipalo, Vladimir Makhmutov, Graham Mann, Serge Mathot, Joonas Merikanto, Pasi Miettinen, Athanasios Nenes, Antti Onnela, Alexandru Rap, Carly L. S. Reddington, Francesco Riccobono, Nigel A. D. Richards, Matti P. Rissanen, Linda Rondo, Nina Sarnela, Siegfried Schobesberger, Kamalika Sengupta, Mario Simon, Mikko Sipila, James N. Smith, Yuri Stozkhov, Antonio Tome, Jasmin Troestl, Paul E. Wagner, Daniela Wimmer, Paul M. Winkler, Douglas R. Worsnop and Kenneth S. Carslaw

Photo: CLOUD experiment at CERN. Credit: CERN



SCIENTISTS OBSERVE FIRST SIGNS OF HEALING IN THE ANTARCTIC OZONE LAYER

New research has identified clear signs that the hole in the Antarctic ozone layer is beginning to close.

Scientists from ICAS were part of an international team led by Professor Susan Solomon of the Massachusetts Institute of Technology to confirm the first signs of healing of the ozone layer, which shields life on Earth from the sun's harmful ultraviolet rays.

Recovery of the hole has varied from year to year, due in part to the effects of volcanic eruptions. But accounting for the effects of these eruptions allowed the team to show that the ozone hole is healing, and they see no reason why the ozone hole should not close permanently by the middle of this century.

These encouraging new findings, published in the journal Science, show that the average size of the ozone hole each September has shrunk by more than 1.7 million square miles since 2000 – about 18 times the area of the United Kingdom.

The research attributes this improvement to the 1987 Montreal Protocol, which heralded a ban the use of chlorofluorocarbons (CFCs) – then widely used in cooling appliances and aerosol cans. Professor Solomon said: "We can now be confident that the things we've done have put the planet on a path to heal. We decided collectively, as a world, 'Let's get rid of these molecules'. We got rid of them, and now we're seeing the planet respond."

Co-author **Dr Ryan R Neely III,** a member of NCAS and a Lecturer in Observational Atmospheric Science in ICAS, said: **"Observations and computer models agree; healing of the Antarctic ozone has begun. We were also able to quantify the separate impacts of man-made pollutants, changes in temperature and winds, and volcanoes, on the size and magnitude of the Antarctic ozone hole."**

Leeds colleague and co-author **Dr Anja Schmidt,** an Academic Research Fellow in Volcanic Impacts, said: **"The Montreal Protocol is a true success story that provided a solution to a global environmental issue."**

She added that the team's research had shed new light on the part played by recent volcanic eruptions – such as at Calbuco in Chile in 2015 – in Antarctic ozone depletion.

"Despite the ozone layer recovering, there was a very large ozone hole in 2015," she said. **"We were able to show that some recent, rather small volcanic eruptions slightly delayed the recovery of the ozone layer.**

"That is because such eruptions are a sporadic source of tiny airborne particles that provide the necessary chemical conditions for the chlorine from CFCs introduced to the atmosphere to react efficiently with ozone in the atmosphere above Antarctica. Thus, volcanic injections of particles cause greater than usual ozone depletion."

The ozone hole begins growing each year when the sun returns to the South Polar cap from August, and reaches its peak in October – which has traditionally been the main focus for research. The researchers believed they would get a clearer picture of the effects

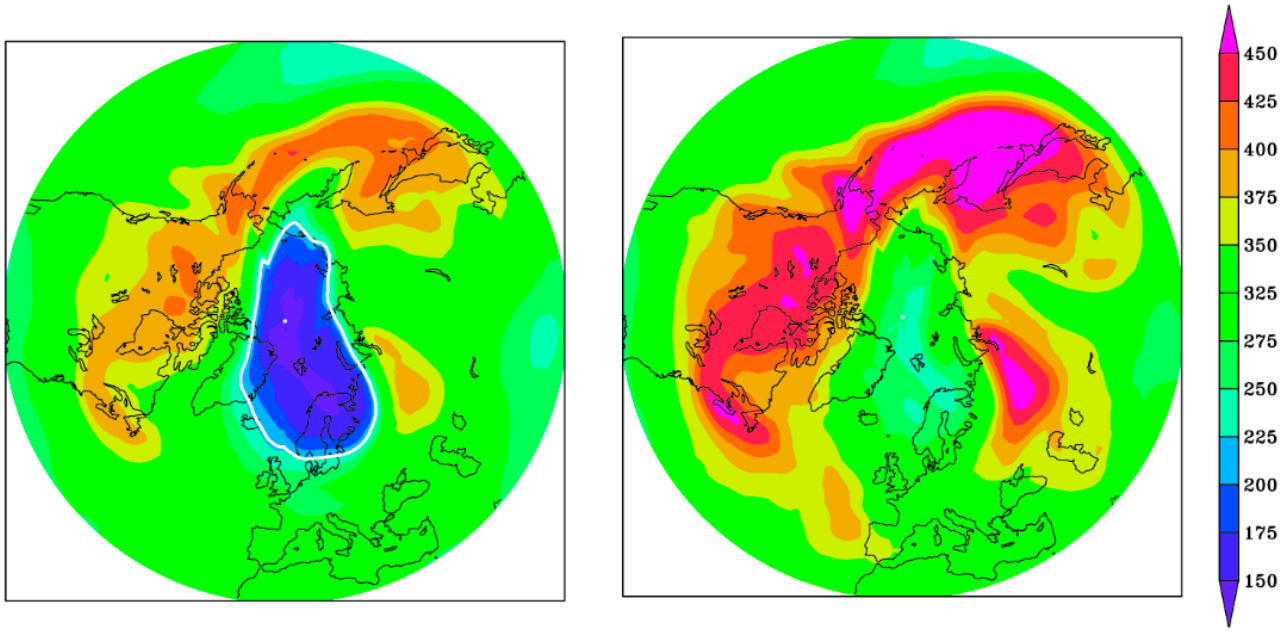


Image: Arctic ozone without the Montreal Protocol -left and following its implementation -right on 26 March 2011. Credit- Sandip Dhomse.

SCIENTISTS OBSERVE FIRST SIGNS OF HEALING IN THE ANTARCTIC OZONE LAYER

of chlorine by looking earlier in the year in September, when cold winter temperatures still prevail and the ozone hole is opening up. The team showed that as chlorine levels have decreased, the rate at which the hole opens up in September has slowed down.

Key facts

Scientists from the British Antarctic Survey discovered in the mid-1980s that the October total ozone was dropping. From then on, scientists worldwide typically tracked ozone depletion using October measurements of Antarctic ozone
Ozone is sensitive not just to chlorine, but also to temperature and sunlight. Chlorine eats away at ozone, but only if light is present and if the atmosphere is cold enough to create polar stratospheric clouds on which chlorine chemistry can occur
Measurements have shown that ozone depletion starts each year in late August, as Antarctica emerges from its dark winter, and the hole is fully formed by early October
The researchers focused on September because chlorine chemistry is firmly in control of the rate at which the hole forms at that time of year, so as chlorine has decreased, the rate of depletion has slowed down.

They tracked the yearly opening of the Antarctic ozone hole each September from 2000 to 2015, analysing ozone measurements taken from weather balloons and satellites, as well as satellite measurements of sulphur dioxide emitted by volcanoes, which can also enhance ozone depletion. And, they tracked meteorological changes, such as temperature and wind, which can shift the ozone hole back and forth.

They then compared yearly September ozone measurements with computer simulations that predict ozone levels based on the amount of chlorine estimated to be present in the atmosphere from year to year. The researchers found that the ozone hole has declined compared to its peak size in 2000. They further found that this decline matched the model's predictions, and that more than half the shrinkage was due solely to the reduction in atmospheric chlorine and bromine

Chlorofluorocarbon chemicals (CFCs) last for up to 100 years in the atmosphere, so it will be many years before they disappear.

OUTREACH:

Sarah Dennis was at the Great Yorkshire Show near Harrogate in the BBC weather tent talking to the general public and school children about weather stations and taking weather observations. As part of this she did an interview with BBC radio Sheffield on the Paulette Edwards afternoon show discussing weather stations and doing a weather experiment to determine cloud base height.

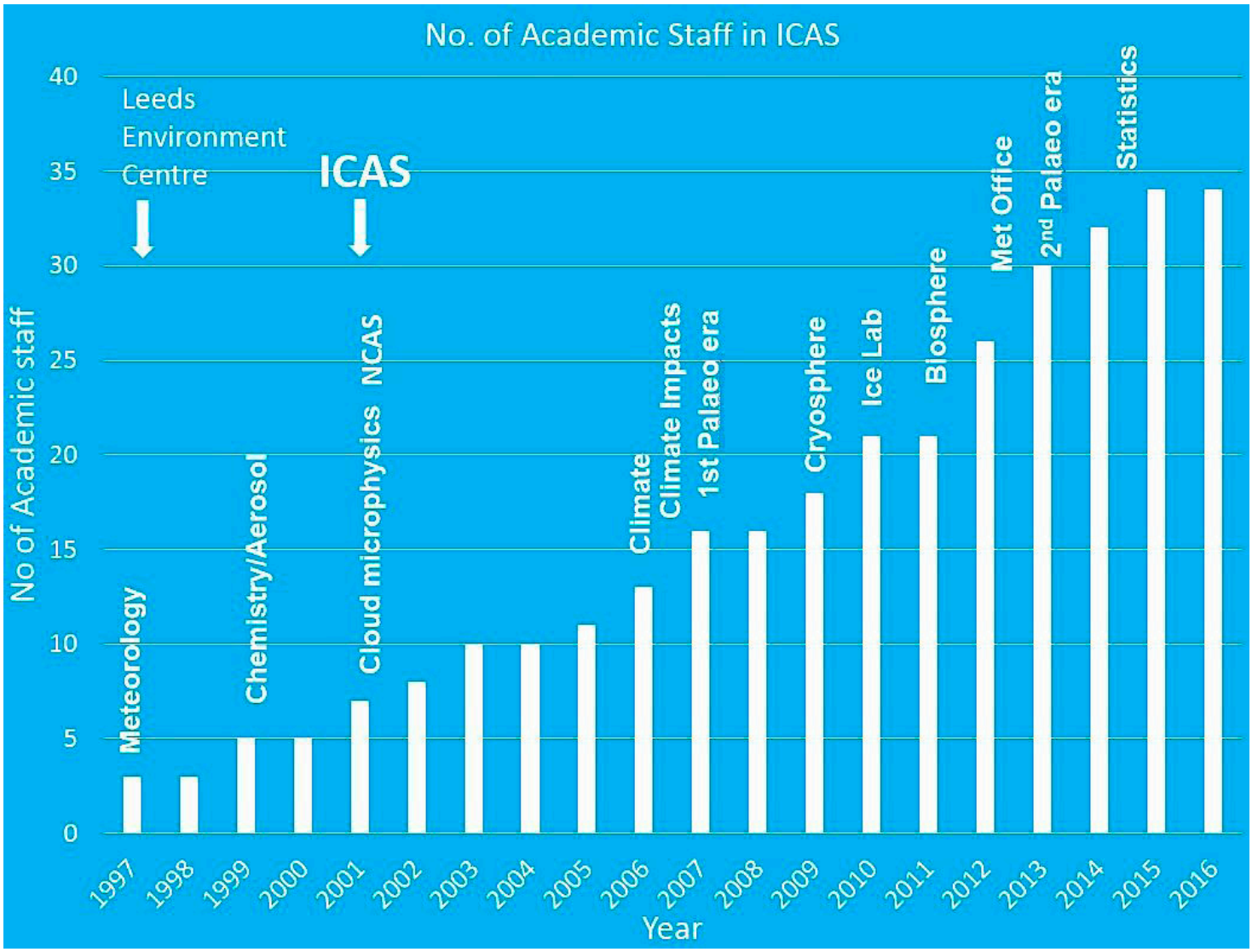
ICAS CELEBRATES 15 YEARS

ICAS celebrates 15 years this year. The institute has grown from 6 academic staff in 2001 to 35 today and is now one of the world's largest and most diverse university institutes for atmospheric and climate science. The number of PhD students in ICAS has grown from about a dozen in 2001 to about 50 today, and we also have about 50 postdocs.

The seeds of ICAS were sown in 1997 when Stephen Mobbs took over leadership of the Leeds Environment Centre, a cross-campus initiative with the School of Chemistry to draw together environmental research in Leeds. This small group, made up of Stephen, the late Sally McGill and a handful of lecturers straight out of PhD (Doug Parker, Andy Dougill, Andrea Jackson and Ally Lewis from Chemistry) had ambitious plans. On the back of funding from new environmental science teaching programmes the Environment Centre grew rapidly, and would subsequently become the School of Environment and later the School of Earth and Environment when it merged with Earth Sciences some years later. The idea to create research institutes within the School was motivated by the desire to allow the sustainability research to grow with some independence. This clearly paid off, as that early group of staff went on to create what is now the highly successful Sustainability Research Institute (SRI), which now has over thirty staff.

Since these early days, the number of academic staff in ICAS has grown almost linearly at an average rate of about two appointments per year (with the odd transient surges and hiatuses reflecting the climate that we study). The next two appointments, in 1999, were in response to an advert for an "Environmental Scientist or Manager"; Ken Carslaw and Martyn Chipperfield, the latter appointed while on his NERC fellowship. This approach of advertising a position and then somehow managing to appoint two or more people in one go typified the institute's approach over many years – taking every opportunity to attract the best people.

What is it that enabled ICAS's growth? Certainly Stephen Mobbs deserves enormous credit for pushing the whole thing forward and finding ever-creative ways of appointing staff and developing new income streams. Subsequent directors of ICAS (Mike Smith,



ICAS CELEBRATES 15 YEARS

Doug Parker, Steven Dobbie, Jim McQuaid and now Ken Carslaw) learned to be similarly aware of such opportunities. We brought people in through competitive personal fellowships (Chipperfield, Spracklen, Ivanovic and Maycock on NERC fellowships, Brooks through a University Research Fellowship, later Hill and Lee through Leverhulme Fellowships); through strategic partnerships or joint positions (Blyth, Gadian, Mann, Neely and others through the National Centre for Atmospheric Science (NCAS), Field and Birch through the Met Office Partnership and McMillan through the Centre for Polar Observation and Modelling); external funding initiatives (Forster through "Roberts Fellowships" in response to the Government's support for career development in STEM subjects); and several University initiatives, usually created by each new Vice Chancellor (Field as a Leadership Professor, Marsham through NCAS and the water@leeds University Transformation Fund to support interdisciplinary research; Haywood and Challinor through a Strategic Investment Fund). Most recently we have exploited the University's 250 Great Minds and other initiatives to support Academic Fellows, such as Schmidt, Gregoire, Maycock and Birch.

ICAS has been particularly good at supporting the careers of early career scientists who are now leaders in their field. Dominick Spracklen went from a PhD student at Leeds to Professor of biosphere-atmosphere interactions and John Marsham went from postdoc to Associate Professor. Two of ICAS's staff have progressed all the way from undergraduates at Leeds: Cathryn Birch, who was an undergraduate in environmental science, is now a University Academic Fellow and Anja Schmidt started in Leeds as an Erasmus Exchange student in geological sciences and is now an Academic Fellow pursuing research on the impacts of volcanism on climate.

ICAS has been a great institute in which to build an academic career. A large number of staff have chosen Leeds as their long-term home to grow their career from junior lecturer to professor. A few staff have gone on to other great departments over the years, such as Ally Lewis (professor at the University of York and NCAS deputy director), Mark Pritchard (National Institute of Water and Atmospheric Research, New Zealand), Maite Baeza Romero (Universidad de Castilla la Mancha), Peter Knippertz (professor at KIT), Vaughan Phillips (Senior Lecturer at Lund University), Mat Evans (professor at the University of York), Prof Mike Smith (now retired).

ICAS has always had a clear direction of travel and some guiding principles. First, we always recognised the importance of research diversity. The focus was originally atmospheric science (essentially mostly meteorology), but we grew to include chemistry and aerosols (1999), cloud physics (2001), climate science (deliberately adding a 'C' to what was formerly IAS in about 2005), climate impacts (2007), palaeoclimate (2007), cryosphere and Earth observation (2009), atmospheric laboratory studies (2010), the biosphere (2012), and most recently statistics and climate dynamics (2015).

Photo: The launch of the Priestley Centre, a recent initiative led by ICAS. Piers Forster signing the Memorandum of Understanding between Leeds and CICERO with Vice Chancellor Sir Alan Langlands. Credit: University of Leeds.

ICAS CELEBRATES 15 YEARS

A second reason for our success is that we always recognised the importance of maintaining a breadth of research capability: modelling, laboratory and field research, which others in the UK have not maintained as we have. Our research laboratories enable innovative measurements of aerosols and ice formation following the transfer of Ben Murray from the School of Chemistry in 2010. They are also used for the design and preparation of instruments for field campaigns in meteorology, aerosol and cloud physics, and chemistry. Innovative fieldwork was part of ICAS right from the beginning and now extends to using ships, aircraft, surface sites and radar. Our field campaigns to study the atmosphere, oceans and ice sheets have taken staff all over the world, including the Arctic and Antarctic, the Amazon, Africa and Indonesia. This field capability has also allowed us to offer outstanding field trip opportunities for our students and others from other UK universities. ICAS develops and uses an extraordinarily broad range of advanced models of atmospheric chemistry, aerosols, weather, climate and palaeoclimate. We lead the development of our own global atmospheric models and have become major users and developers of community models like the Met Office Unified Model and the NCAR WRF model.

ICAS's partnerships with external organisations have been a major factor in our success. Right from the beginning we had links to the Universities' Global Atmospheric Modelling Programme (UGAMP) and the Universities' Weather Research Network (UWERN), which would eventually become part of the National Centre for Atmospheric Science (NCAS), which provides the UK academic community with national capability in atmospheric science. Stephen Mobbs is now Director of NCAS and the Directorate is in Leeds. NCAS staff in Leeds include Blyth (cloud physics), Mann (global modelling), Neely (radar) and others. NCAS and ICAS have had a highly successful symbiotic relationship, with ICAS benefiting from facilities and expertise, while NCAS has benefited from their staff being closely connected with the wealth of related research in ICAS.

We have always had strong collaborations with the Met Office, and these have diversified enormously over the years to encompass meteorology, air pollution and climate, climate impacts and volcanic hazards. In 2012 this relationship became formalised when ICAS was a founding member of the Met Office Academic Partnership, leading to Doug Parker becoming the joint Met Office Chair. The close collaboration with the Met Office also led to us appointing Prof Paul Field to a 30% post through the University's Leadership Chair opportunity. This position has hugely accelerated our research on cloud-aerosol modelling of almost every type of cloud system important to weather and climate. More recently we have diversified our partnerships to include the National Centre for Earth Observation (NCEO) in 2008 and with the Centre for Polar Observation and Modelling (CPOM) in 2012, both of which have brought new research capability to Leeds. In 2015 we inaugurated a formal partnership with the Karlsruhe Institute of Technology (KIT), who have been long-term collaborators, leading to exchanges of staff and students.

ICAS has made a difference to the world. We publish over 100 journal articles a year, including about 8 per year in the top-ranked interdisciplinary journals like Nature and Science. We have made fundamental discoveries related to air pollution, the stratospheric ozone layer, clouds and storms, human perturbations to climate, ice sheet melting, volcanic impacts on climate and mass extinctions, palaeoclimate, and the way that climate change impacts global crops. We have also developed widely used atmosphere and climate models that enable more robust assessments of future changes. ICAS has also trained young scientists who have gone on to lead successful scientific careers in the UK, the United States, Australia, Asia, Africa and Europe.

The challenge for ICAS in future is to grow our research capability (i.e., the ability to do ever more ambitious research) while also diversifying. The field of climate and atmospheric science is evolving rapidly. In addition to developing fundamental knowledge on the weather, climate and pollution, we increasingly need to address societally relevant questions such as the consequences of overshooting the 2 oC global mean temperature target set out in the UNFCC Paris Agreement. We recognised the need to broaden our collaborations by proposing the creation of a campus-wide interdisciplinary theme related to climate, which led to the creation of the Priestley International Centre for Climate in 2016. Priestley is one of the University's flagship strategic investments in response to the global challenge of climate change, with £6.8 million invested in it over five years. To grow our research capability we also launched the Centre of Excellence for Modelling the Atmosphere and Climate (CEMAC) in 2016. CEMAC's vision is to significantly enhance and accelerate our high impact modelling-based research in weather, climate and atmospheric composition, and to train and educate a new generation of students and scientists in the latest techniques in scientific computing, data processing and visualisation. ICAS's remarkable growth has created a highly collaborative and exciting environment that manages to maintain a research-group feel, with continuous exchange of research ideas across all areas of our science. This collegiate atmosphere combined with our growing research partnerships and our recent appointments of new staff seeking stretch our science in new directions makes the next fifteen years look even more promising.

FEATURED PERSON: LEIGHTON REGAYRE

What is your role in ICAS?

I'm a research scientist in the Physical Climate Change group working on statistical aspects of the SMURPHS and CAMS74 projects, quantifying the causes of uncertainty in radiative forcing and surface temperature changes.

What do you like the most about ICAS?

ICAS has everything I need; Excellent mentors, challenging work, interesting seminars and great friends.

Why did you choose this career and how did you get here?

I've had a few previous careers; one as a statistician for the Department of Agriculture in Australia and another as a teacher here in the UK. I headed two secondary Mathematics departments in local schools and the only career progression was into Leadership roles with less student contact and more stress. I took a risk and spent a year studying for a masters degree in Atmosphere and Ocean Dynamics here at Leeds, which led onto my PhD research on aerosols. I initially imagined a research position was just a stepping stone towards a lectureship but I've found I really enjoy the excitement of research and expect it will be central to my staying in academia.

What scientific achievement are you most proud of?

In the last few months of my PhD I created (thanks to lots of help from a long list of people) a huge ensemble of climate model simulations. Statistical analysis of this ensemble highlights specific parts of the Met Office model which need to be developed in order to reduce aerosol radiative forcing uncertainty; one of the most persistent and challenging problems in atmospheric science. I'm proud that we have within our grasp a sophisticated means of reducing this uncertainty, but I'd be even prouder if we'd managed to do it already.

What does a typical working day involve for you?

My day usually starts with a leisurely breakfast with my wife followed by a swim, so I'm typically in a great frame of mind when I get to work. Most of my days are spent either performing statistical analysis, or interpreting results. My favourite days include producing and analysing global maps then discussing the implications of the results with others. That's the most colourful and satisfying part of my work and it usually comes at the end of a lot of modelling and data handling.

What's the most interesting aspect of your job right now?

Right now I'm working with a lot of experts from other fields and I'm enjoying broadening my awareness of the challenges in climate science.

What's the most challenging aspect of your job?

In my current work the statistical approach is limited by computing resource availability, which is a natural result of requiring large ensembles of complex, expensive models. I'd like to have time to develop our approach so that we needed fewer simulations to achieve the same quality of results.

How do you decompress outside work?

I play a lot of Euro-style board games (not Monopoly) with a lot of different people. It's social, playful and challenging at the same time. Exercise, mediation and the occasional gig help purge any residual workday stress.

What bit of information about you is likely to surprise your colleagues?

Most people won't know how much I enjoyed solo-paragliding this year. 50 meters high, soaring across a valley in the Yorkshire Dales, then accidently dive-bombing a sheep – it was ace!

Photo: Arctic sun. ASCOS campaign. Credit: Ian Brooks.