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1. Don’t mope... MOAP!

It is now almost a year since Oxford was officially welcomed into the Met Office Academic Partnership (MOAP) scheme, at a glittering event held in the Martin Wood Lecture Theatre in Oxford Physics. This event was attended by Vice-Chancellors and other guests from the other partner universities (Exeter, Leeds and Reading) and the Chief Executive and Chief Scientist of the Met Office. It was a memorable occasion that included a welcome address by Prof. Dame Julia Slingo as Met Office Chief Scientist, presentations from each of the university Joint Chairs and a thoughtful and engaging reflection from Oxford’s Chancellor, Lord Patten of Barnes. It was a delight also to involve a large number of younger scientists from Oxford and the other participating institutions at a lively (and crowded!) poster session during the afternoon. I very much hope that the sense of excitement and optimism that this event engendered will continue as our partnership evolves!
But what is the Met Office Academic Partnership for? To begin with, it gives recognition and visibility to an already strong network of individual collaborations and joint research projects between Oxford scientists and researchers at the Met Office. These happened anyway, simply because of the mix of scientific expertise and interests among individuals in Oxford and the Met Office who have worked together in recent years. But we hope that, by being a formal member of the MOAP scheme, we may be able to expand Oxford's role on the national scene in climate research, focusing and leveraging new opportunities for external funding and ensuring that Oxford’s research has the largest possible impact, even beyond the usual confines of academic research. MOAP also provides an opportunity to engage with and even influence the strategic direction of the Met Office itself, such as through Joint Chairs being invited to various events and workshops with senior Met Office management. This is a rare privilege and it is very encouraging that the Met Office actively seeks the views of the academic community with whom it develops its research programme.

So my role as Oxford’s Joint Chair is to increase an awareness among the wide diversity of Oxford’s academic community of what the Met Office does, and what opportunities there may to do some new and exciting research by working closely with colleagues in the Met Office and other university partners. To this end, and thanks to some new resources provided by the Met Office itself, we have been able this year to start a couple of new initiatives, aimed (a) at helping new researchers to consider making use of Met Office facilities, such as their Unified Model (UM) for climate and weather prediction, and (b) at engaging a new generation of students and young scientists in climate science. For the latter, a new scheme has therefore been set up to provide funding for up to 10 undergraduate summer internships throughout the University. The only constraints are that the research topic must be relevant to some aspect of weather or the climate, past, present or future. The first ten projects were funded this year, and you can read more about these projects below. We plan to offer the same scheme next year and beyond, so watch this space for the call for project proposals.

2. Unified Model support

For anyone interested in getting involved in climate modelling, either as a user of model output or to design and run new model experiments, the expense and complexity of learning how to use such massive facilities can be quite daunting. But help is now at hand!

William Ingram from AOPP is now charged with the task of acting as a consultant for anyone wishing to make use of the Unified Model (UM) system in their research. This can entail providing advice and training to new users as well as trouble-shooting for more experienced users, regardless of which department or institution within the University they may come from. If William cannot solve your problem, he is very likely to know someone who can and will advise accordingly. So please take the opportunity.

William will be organising a seminar in the new year to introduce his role in a more detail and to showcase the UM, as well as answering any questions you may have. In the meantime, why not take a look at the Met Office website to read more about the UM [http://www.metoffice.gov.uk/research/modelling-systems/unified-model].

3. University of Oxford MOAP undergraduate awards

Congratulations to 3 University of Oxford students who have been awarded prizes as part of the MOAP for their dissertation research. The 3 students are:

- Physics: Andrew Bailey - “The climate using stochastic models”
- Geography: Cara Duckworth: - “An Assessment of Coupled Climate Model Dust Emission Simulations over North Africa”
- Mathematics: Peter Baddoo - “Thermohaline Circulation and Climate Modelling”
4. MOAP summer internship programme 2014

(i) Parameterising the convective desalination of sea ice

Recent trends in the Arctic sea ice cover have seen a faster decline of sea-ice extent in summer than in winter, which means that a greater area of the polar oceans is freezing over each winter (with compensating ice melt in summer). This gives greater importance to physical processes relevant during the first year of ice growth. One such process is the convective desalination of ice, with dense salty brine draining from porous sea ice under the action of gravity and into the underlying ocean. This brine drainage from sea ice controls winter buoyancy fluxes across the polar oceans, driving ocean mixing and contributing to dense ocean currents. There are potential downstream impacts on key deep convection sites, ocean heat transport, and climate, and hence there has been considerable recent interest in developing parameterisations of salt fluxes from sea ice.

Oliver Humphries' project, working with David Rees Jones and Andrew Wells studied sea ice growth and salt fluxes to the ocean during time-dependent cooling conditions, by applying a recently-developed parameterisation of the convective desalination of sea ice that incorporates insight from detailed modelling of mushy-layer physics. For ice growth forced by an atmospheric temperature that oscillates in time, the parameterisation predicts episodic desalination events across the full depth of the ice, imposed on a persistent desalination signal from a basal layer. By varying the forcing conditions, we determined a scaling law for the resulting salt fluxes from the ice. We also discovered some new and interesting impacts of desalination on ice growth: under certain conditions, a significant drop in atmospheric temperature can actually cause the base of the ice to melt for a short period of time! This initially counter-intuitive result can be understood as a consequence of rapid convective desalination, with the resulting convective circulation entraining sufficient heat from the underlying warm ocean to initially melt the base of the ice, before the desalination rate decays and ice growth resumes. The results from this project lay the foundation for future comparisons to ongoing experiments involving laboratory analogues of sea ice growth. This will provide robust tests of the parameterisation and appropriate tuning of model parameters before incorporation into larger scale sea-ice models for climate prediction.

(ii) Atmospheric Circulation Regimes on Earth-like Exoplanets

Anouk Ehreiser, an undergraduate student from the University of Heidelberg and the Max Planck Institute for Astronomy in Germany, was awarded a MOAP summer internship to work with Peter Read in AOPP. As part of this project she set up and ran a number of atmospheric model simulations using the PUMA simplified GCM from the University of Hamburg to investigate the structure and properties of global circulation patterns under a range of conditions, both similar to the Earth and (in some cases) very different.

A large number (~1700) of planets have now been discovered around other stars, many of which are likely to have atmospheres though under very different circumstances to the Earth. Very little information can be measured directly concerning these exoplanets, so knowledge of their likely climate and atmospheric circulation has to come primarily from theoretical and model studies. This poses some very different challenges to those facing atmospheric modellers from other areas of atmospheric science, and so Anouk's project was intended to explore some of the factors that might result in global circulation patterns that were similar in some regards to the Earth, despite large differences in planetary size, rotation or composition.

Anouk's simulations explored the circulation regimes of planets in which both the size of the planet and its density were varied, to take account of the possibility of solid planets made not only out of rocky material, like the Earth, but also out of much less dense ices and much more dense iron-rich materials. This resulted in large changes in the surface gravity (by orders of magnitude in some
materials. This resulted in large changes in the surface gravity (by orders of magnitude in some cases). Even then, however, some basic features of the resulting circulation were found to resemble the Earth, provided the size of the planet (and its rotation) were scaled appropriately. They hope to write up these results shortly, and their implied scaling laws, for a short publication in the planetary science literature.

(iii) Weather Station Calibration

As part of a summer project John Evans, working with Don Grainger in the Earth Observation Data Group, investigated the calibration and accuracy of a weather station that is operated on the roof and provides live readouts of the weather to a webpage on the Physics Department website. To do this the archive of data gathered by the station was compared to other nearby sources of meteorological data using the Met Office Integrated Data Archive System (MIDAS) database, in particular the nearby Radcliffe Observatory and also the automated weather station at RAF Brize Norton outside the city. However there were some problems attempting to compare data from stations with different locations and exposures, particularly with quickly varying values such as wind speed, and so it was decided to build an alternative sensor package with more precise sensors that could be collocated with the existing weather station.

Calibration functions for each sensor (temperature, pressure etc) were obtained by comparing them to the readings from the more precise sensors, and also to the MIDAS data as an additional check. For example, the figure shows the comparison of daily temperature readings at the Radcliffe Observatory with the same time at the Physics weather station - the best fit line to the data identifies that the Physics data has a constant offset of -1.443(6) C from the Observatory from the ideal 1:1 line (also shown), and a relative linear slope of 0.971(5). These numbers can be used in a linear calibration function for the Physics department data

Calibration functions were identified for temperature, pressure, relative humidity and rainfall, but the wind sensor proved very difficult to calibrate due to the high dependence of the wind on exact exposure. Additionally the sunlight sensor was identified as potentially unreliable, as it did not always appear to activate at the same level of sunlight. Any further work should focus on those sensors in particular.
(iv) Extratropical cyclones in a warmer, moister climate: A recent Atlantic analogue

Gloria Li from Oxford Maths was awarded a MOAP summer internship to work with Tim Woollings in AOPP. She spent her time here analysing reanalysis data, in particular tracking statistics of extratropical cyclones provided by Kevin Hodges who collaborated from Reading.

As the atmosphere warms its moisture content increases, and it has been thought that this might intensify cyclones due to the effects of latent heat release. However, while models do indeed predict increased rainfall from cyclones they do not generally show a related increase in storm intensity. This project was motivated by a desire to test this model prediction against observations.

Atlantic Multidecadal Variability (AMV) has given recent warm and cool periods in the North Atlantic which form partial analogues of future climate warming. Gloria analysed the cyclone data for these warm and cool periods and found very similar results to the future projections; cyclones rained more during the warm period but were not more intense by other measures such as vorticity or wind speed. This lends some confidence to the model projections of future change. Gloria led the drafting of a Geophysical Research Letters paper on the project, which has been accepted for publication.

[v]

(v) Uncertainty and detectability of climate response to large volcanic eruptions

Fabian Wunderlich, working with Dann Mitchell and Lesley Gray decided that instead of continuing directly with his Masters course after doing a bachelor's degree in meteorology at the Freie Universität Berlin, he used the chance to do a five-month internship at the Atmospheric Physics Department of the University of Oxford. The project he was involved is about the surface temperature and pressure response after large volcanic eruption in re-analysis and CMIP5 models. Many observational studies could show that large volcanic eruptions are associated with a mainly dynamic driven positive NAO in the first two winters after volcanic eruptions and a mainly radiative driven cooling over the equatorial region. All available re-analysis data sets show a realistic and similar representation of these responses. CMIP5 models can only provide a limited reproduction of these effects with a general overestimation of the tropical surface temperature cooling. These results could be shown for the first time using Detection and Attribution methods and will be included in a paper he is currently writing.

Fabian says, "I'm pleased that with my work I can contribute to the research of my working group and therefore I want to thank Daniel Mitchell and Lesley Gray for facilitating this great experience. The fact being away from the duties of the study allowed me to gain a good insight into the research working routine, establish contacts in different institutes and obtain practical experience besides the study. Hence, is will be easier for me to start my career when I have finished my master studies in meteorology in Berlin".  

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Over the summer, Amy Creese, working with Richard Washington completed a summer research internship within the Climate Research Lab in the Oxford Centre for the Environment. Having just finished a degree in geography with a strong emphasis on climate science, Amy was keen to continue with some of the research conducted as part of my dissertation into Congo rainfall climatology. The Congo is one of three core global regions of latent heat release, but due to data accessibility and ongoing political tensions, there is a severe paucity of observational data. This has meant the area has been starkly neglected in terms of climatological research, despite its overwhelming importance.

Her previous work indicated that CMIP5 model data was highly variable over this region, as might be expected with a lack of observations, and so used this opportunity to more thoroughly interrogate model and reanalysis datasets in this region. Amy found that model rainfall totals varied by a factor of five across some models, which works out as more than two metres of rainfall difference annually. The distribution of model rainfall also differs significantly, with some showing a strong eastern maxima and some a western maxima. Further research suggested that the location and magnitude of rainfall was related to the amount of moisture flux convergence. This strongly suggests that moisture flux convergence may be a useful tool in constraining the models further, and determining which are more accurate. The MOAP internship has allowed her to follow up on this relationship, finding potential links between rainfall within the basin and moisture flux entering the basin to the east and the north, which could provide a solution to the problem of data scarcity.

As of October, Amy will be starting the new Environmental Research Doctoral Training Programme, with emphasis on the Physical Climate Stream. Hoping to continue her research on the Congo for a DPhil in Geography and the Environment, with her research from the MOAP internship contributing to her first paper. The internship has been a great opportunity to work within a fast-paced research environment, and good preparation for the DPhil.
(vii) Southern African Rainfall in Climate Models

Callum Munday, working with Richard Washington, experienced climate research for the first time during his undergraduate dissertation. During this research he investigated climate model (CMIP5) simulation of precipitation in southern Africa and how it may be controlled. While this was an enjoyable and, he hopes, an interesting project, it left a number of unanswered questions which he was eager to investigate.

Luckily, The Met Office Academic Partnership (MOAP) made funds available so that he was able to work at the Climate Research Lab in the Oxford University Centre for the Environment during the summer. This enabled him to extend and improve his understanding of model behaviour in southern Africa, and in particular to answer some key questions arising from his dissertation research.

For the summer season in southern Africa (December to January), he had previously found that the CMIP5 ensemble overestimated rainfall compared to reanalyses and satellite data by up to a factor of 1.5, with large differences between models in the ensemble. Furthermore, he had suggested that external factors, such as the simulated strength of the subtropical high pressure cell in the adjacent South Atlantic Ocean may play a critical role in determining model precipitation. However, he had yet to map out a complete causal mechanism between precipitation in the subcontinent and external forcings. During his MOAP research, he investigated these mechanisms by relating precipitation with moisture flux from different locations into southern Africa and its subsequent convergence in the continental interior. Hopefully, a better understanding of these processes in the CMIP5 ensemble will engender a better interpretation of present biases and future precipitation predictions.

He has now started on a Doctoral Training Programme in Environmental Research run by NERC, and hopes to continue his research on model representation of the southern African climate system for his DPhil project. He feels that the MOAP internship has certainly eased the transition into postgraduate research.

(viii) Identifying gravity wave momentum fluxes

Mark Johnson, working with Scott Osprey, identified gravity wave momentum fluxes (GWMFs) using historical wind-speeds retrieved from the European Centre for Medium-Range Weather Forecasting (ECMWF) numerical weather prediction model, and compared them to observations taken by the HIRDLS instrument on NASA’s AURA satellite. He compared GWMF data with precipitation data from the ECMWF model, in order to investigate the importance of convection in gravity wave generation.

He found several strong correlations (up to r=0.82) between GWMF and precipitation when averaged over active monsoon regions, matching well with HIRDLS observations and hinting that...
averaged over active monsoon regions, matching well with HIRDLS observations and hinting that non-orographic parametrisations might be improved by including convective sources in future models.

Mark is currently writing the beginnings of a paper, which will be fleshed out by his supervisor, and hopefully published later this year. He says that the placement has given him a small taste of life as a scientist, and will certainly help inform his future plans.

This contour plot is a single day snapshot of GWMF at 100(hPa), as identified from the model.