THE JOINT DTP CONFERENCE

In-Person Information Pack

ABOUT US

We are the Joint Doctoral Training Partnership (DTP) conference committee, comprised of students from three UK Natural Environment Research Council (NERC) funded DTPs: SSCP DTP, NERC DTP and SCENARIO. The theme of the annual Joint DTP conference is centered on the changes that are occurring at different scales within our seas, land, and skies. The name of our theme is 'From Sea to Sky: A Changing Planet'.

EVENT DETAILS

Date

1st and 2nd September 2022

Time

9am on Thursday to 5pm on Friday

Venue

University of Surrey.

TIMETABLE

Day 1 : Thursday 1st September 2022					
09:00	09:45	**Arrival and Registration**			
09:45	10:00	**Opening Remarks** Professor Sue Hughes, Scenario Co-Director			
10:00	11:00	**Key Note Speaker** Professor John Remedios, Director of NCEO, University of Leicester			
11:00	11:45	**Mineralogy and Geochemistry**	11:00	12:00	**Habitats and Conservation**
12:00	13:00	**Model UN** Debating the SDGs			
13:00	14:00	**Lunch**			
14:00	15:00	**EDI Workshop** Michael Hassell and Dr Mark Whelan			
15:10	16:10	**Earth and Space Observation**	15:10	16:10	**Evolution and Adaptation**
16:15	17:00	**Human Health and Infrastructure**	16:15	17:00	**Life Under Water**
17:00	19:00	**Poster Social** with drinks			
19:00	20:00	**Quiz** with buffet dinner			

Day 2 : Friday 2nd September 2022					
09:00	10:00	**Breakfast and Yoga**			
10:00	11:00	**Geology and Chronology**	10:00	11:30	**The Birds and the Bees**
11:00	12:15	**Atmosphere and Ocean Dynamics**	11:30	12:15	**Taxonomy and Phylogeny for Conservation**
12:15	13:15	**Climate, Policy and Industry** NCEO, The Walker Institute and xtonnes			
13:15	14:30	**Lunch**			
14:30	15:30	**The World We Live In**	14:30	15:30	**Water Pollution**
15:45	16:00	**Awards Ceremony**			
16:00	17:00	**Keynote Speaker** Dr Nadine Johnston, British Antarctic Survey			
17:00	17:30	**Final Remarks** Dr Thorwald Stein, Scenario Director			
17:30		**Picnic Social**			

ATTENDING THE CONFERENCE

Arrive

By 9am on Thursday 1st September. Registration and room key collection will be held in the Austin Pierce foyer upon arrival.

Accommodation

Accommodation will be in the University Court. Please see the University of Surrey Welcome Pack for accommodation details and a map. It's a 5 minute walk from the conference centre.

Conference Location

The keynote speakers, workshops, student talks and posters will all be in the Austin Pierce (AP) building, as well as breakfast, coffee, and lunch. Please see tables below for specific rooms:

Activity	**Room**
September 1st	
Arrival & Registration	Foyer of AP building
Opening Remarks & Keynote Speaker: Prof John Remedios	AP04
Student talks: Minerology & Geochemistry	AP01
Student talks: Habitats & Conservation	AP02
Workshop: Model UN	AP04
Lunch	AP03
Workshop: EDI	AP04
Student talks: Earth & Space Observation	AP01
Student talks: Evolution & Adaption	AP02
Student talks: Human health & Infrastructure	AP01
Student talks: Life Under Water	AP02
Poster Social	AP03
Quiz	Green Room in Wates House

September 2nd	
Breakfast	AP03
Yoga	32 MS 01 (Rik Medlik Building)
Student talks: Geology & Chronology	AP01
Student talks: The Birds & The Bees	AP02
Student talks: Atmosphere & Ocean Dynamics	AP01
Student talks: Taxonomy & Phylogeny for Conservation	AP02
Workshop: Climate, Policy & Industry	AP04
Lunch	AP03
Student talks: The World We Live In	AP01
Student talks: Water Pollution	AP02
Awards Ceremony	AP04
Keynote Speaker: Dr Nadine Johnston & Closing Remarks	AP04
Picnic Social	By the lake

STUDENT TALKS

Note to presenters: All student talks are in either room AP01 or AP02. Please see above list of locations to check the exact room for your session. Each session will be chaired by a member of the committee who will ensure you keep to time (max. 10 min talk) and oversee the Q&A (3mins) after each talk.

Below is a list of titles of each student talk. For the abstracts, please see the section towards the end of this document.

Mineralogy and Geochemistry

Isaac Taschimowitz - London NERC DTP - *The Equation of State of the MgO-CaO-SiO_2 Melt System Using Machine Learning*

Clara Matthews Torres - London NERC DTP - *The Variability of Mobile Chalcophile Element Fluxes Associated with Subduction Zone Magmatism in the Eastern and Western sectors of the Trans Mexican Volcanic Belt*

Todd Downing - London NERC DTP - *Trace element mapping of eudialyte group minerals by LA-ICP-MS in order to assess geochemical mobility*

Habitats and Conservation

Zosia Ladds - London NERC DTP - *Biodiversity in Urban Cemeteries*

Jessica Turner - London NERC DTP - *Hedgehogs in Greater London: A small mammal in a big city*

Chloe Metcalfe - London NERC DTP - *The effectiveness of terrestrial protected areas*

Tahir Khanzada - London NERC DTP – ***Title Pending***

Earth and Space Observation

Simon Opie - London NERC DTP - *Turbulence and instabilities in the solar wind: scale dependent processes and how to measure them*

Samantha Petch – SCENARIO - *Towards a regional inverse model for water-energy-carbon budgets over land*

Devon Francis – SCENARIO - *What happens if observations used to predict the weather are wrong?*

Marie Shaylor - SSCP DTP - *An Evaluation of Two Decades of Aerosol Optical Depth Retrievals from MODIS over Australia*

Evolution and Adaption

Sasha Bradshaw - London NERC DTP – *Meiotic drive adaptive testes enlargement during early development in the stalk-eyed fly.*

Aaron Halpern - London NERC DTP - *The universal foundations of life's ability to change - conserved features from the origin of genetic coding*

Nicole Barber - London NERC DTP – ***Title Pending***

Josh Reynolds - SSCP DTP - *Identifying non-recurrent rare mutations in Anopheles mosquitoes for evolutionary inference*

Human Health and Infrastructure

Marcus Annegarn - SSCP DTP - *Combining time-dependent density functional theory and the ΔSCF approach for accurate core-electron spectra*

Gina Charnley - SSCP DTP - *Investigating the impact of social and environmental extremes on cholera time varying reproduction number in Nigeria*

Pablo Jose Vallhonrat Blanco – SCENARIO – ***Title Pending***

Life Under Water

Lucy Mead - London NERC DTP - *Spatio-temporal and sex-specific patterns of residency and space-use in adult Angelsharks*

Stuart Negus - London NERC DTP - *Using drones to determine the population and community ecology of marine megafauna.*

Ceri Webster - SSCP DTP – ***Title Pending***

Geology and Chronology

Naima Harman - London NERC DTP – ***Title Pending***

Lily Moore - London NERC DTP - *Ritter Island; recreating a volcano remotely*

Theo Clayton - SSCP DTP – ***Title Pending***

Catrin Harris - SSCP DTP - *Storing CO_2 in the pores of rocks: Imaging carbon storage in realistic sandstones*

The Birds and the Bees

Aoife Cantwell-Jones - SSCP DTP - *Bumblebee museum specimens reveal increasing stress over the 20th century*

Alicja Witwicka - London NERC DTP - *Are we testing insecticides correctly? Evaluating insecticides with high-resolution molecular approaches*

Guy Mercer - London NERC DTP – ***Title Pending***

Tom Weeks - SSCP DTP – ***Title Pending***

Patrick Alexander Walkden - SSCP DTP – ***Title Pending***

Kerry Smith – SCENARIO – ***Title Pending***

Atmosphere and Ocean Dynamics

Rabiul Awal – SCENARIO – The relationship between atmospheric heat transport and monsoonal precipitation variability

Isabel Smith – SCENARIO – ***Title Pending***

Caleb Miller – SCENARIO - Measuring Changes in the Atmosphere Before Fog

Alanna Power – SCENARIO - Mixing Length Scales in a Cloudy Topped Marine Boundary Layer Simulation

Shammi Akhter – SCENARIO – ***Title Pending***

Taxonomy and Phylogeny for Conservation

Luis Moliner Cachazo - London NERC DTP - *Characterising freshwater biodiversity in the Okavango Delta (Botswana) using taxonomical and molecular techniques*

Maria Zicos - London NERC DTP - *Reconstructing the demographic history of the endangered Hispaniolan solenodon.*

Miranda Sherlock - London NERC DTP - *Genomic phylogeography of a refugial amphibian*

The World We Live In

Joy Ommer – SCENARIO - *Co-benefits of Nature-based Solutions for Disaster Risk Reduction*

Tom Griffiths - SSCP DTP – ***Title Pending***

Abu Taher Muhammad Abdullah - SSCP DTP - *Security implications and victimization of natural disasters and climate change in Bangladesh*

Jarmo Kikstra - SSCP DTP - *Bringing together multidimensional poverty and climate mitigation*

Water Pollution

Dan Shockley – SCENARIO – ***Title Pending***

Jordi Buckley - SSCP DTP - *Modelling crop growth and diffuse agricultural pollution under different climate change scenarios*

Arianna Olivelli - SSCP DTP - *Lead concentrations and isotope compositions of surface waters from the western South Atlantic Ocean*

Natasha Harris – SCENARIO - Shedding light on the organic matter black box: using fluorescence spectroscopy to understand sources and pathways of tryptophan like florescence organic matter

POSTERS

Note to poster presenters: Upon arrival and registration, you will be given a number for your poster which will correspond to a poster board position in AP03. Please put your poster up at the beginning of the conference to maximise people viewing your work. We then have a dedicated poster session within the schedule for people to ask poster presenters questions.

WORKSHOPS

Model UN: Debating the SDGs

This will be an interactive debate workshop where participants will be able to learn about the Sustainable Development Goals (SDGs). Participants will act as representatives of member states of the UN, voicing opinions of their country in a debate about the SDGs. This will be a fun opportunity to meet other conference attendees, learn more about the Sustainable Development Goals and debating.

EDI Workshop

Michael Hassell, Equality and Diversity Adviser at the University of Surrey and Dr Mark Whelan for the University of Surrey Doctoral College will introduce us to the concept of EDI and how it affects us as researchers.

Climate, Policy, and Industry

This session is designed to give students attending the conference an insight into organisations that are trying to address climate issues from either a research, policy or industry perspective. This will highlight the links between climate research, policy and industry.

We will hear talks from xtonnes, NCEO and the Walker Institute. xtonnes is a start-up that has developed carbon-management software to help companies quantify and reduce greenhouse gas emissions. NCEO (National Centre for Earth Observation) is a NERC funded research centre monitoring the health of our planet through satellite instruments to help address challenges such as climate change. The Walker Institute, based at the University of Reading, is an interdisciplinary research institute supporting the development of climate resilient societies particularly in Low Income Countries.

KEYNOTE SPEAKERS

Keynote Speaker: Prof John Remedios, Director of NCEO, University of Leicester

Professor John Remedios is Director of the National Centre for Earth Observation (NCEO), hosted within the Earth Observation Science group at the University of Leicester. His experience is in satellite data for observing the Earth: climate, air pollution, ocean temperatures and land-atmosphere coupling. He has also worked on instrument concepts for new satellite missions.

Professor Remedios works closely with space agencies, particularly with the UK Space Agency and the European Space Agency. He is Principal Investigator for the Along Track Scanning Radiometers (ATSRs) and plays major roles in a number of other satellite missions. He has been an expert adviser to ESA through ESA's Earth Sciences Advisory Committee and Future Technology Panel. He has also chaired the UK Space Agency Earth Observation Advisory Committee.

Keynote Speaker: Dr Nadine Johnston, BAS, University of Cambridge

Dr Nadine Johnston is a marine ecologist at the British Antarctic Survey, based at the University of Cambridge. Her research focusses on understanding the structure (i.e., biodiversity and community composition) and functioning (i.e., carbon and nutrient cycling, including climate regulation, and the transfer of energy through food webs to support productivity, fisheries, and wildlife tourism) of marine ecosystems within the Scotia Sea region, their links to the Southern Ocean, and the impacts that climate and other human stressors (such as fisheries, pollutants, and tourism) are having on this system.

Dr Johnston is Co-founder and Programme Manager of the regional programme 'Integrating Climate and Ecosystem Dynamics in the Southern Ocean' (ICED). She also has several external roles including a Member of the Southern Ocean Task Force (UN Decade of Ocean Science for Sustainable Development); Member of the Scientific Committee on Antarctic Research (SCAR) and General Assembly Representative in the European Marine Research Network.

SOCIALS

Thursday 1st September

There will be a poster social on Thursday from 5pm – 6:30pm in the Austin Pierce Building. Followed by a quiz and dinner at 7pm in Wates House.

Friday 2nd September

There will be a picnic social located by the lake at the University of Surrey at 5:30pm on Friday. Food will be provided for those who confirmed attendance and others may join, but food cannot be guaranteed.

EVENT SPONSORS

We are pleased to announce that this year the Joint DTP Conference received sponsorship from 4 companies: xtonnes, CERC, Nature Metrics and NCEO. We would like to thank them for their kind contribution the conference.

PRIZES

There will be prizes for the best student talks and posters which will be awarded at the end of the conference.

There are 4 categories:

- Best Student Talk (voted by judges) – Sponsored by Nature Metrics
- Best Student Talk (voted by students)
- Best Poster (voted by judges) – Sponsored by xtonnes
- Best Poster (voted by students) - Sponsored by NCEO

To vote for the best talk/poster please use this form:
https://forms.gle/qSdjpXN2iYzpMBJx5

PLEASE NOT THAT ANY VOTES CAST PRIOR TO THE CONFERENCE WILL BE DISCOUNTED.

PHOTOGRAPHY / DIGITAL MEDIA STATEMENT

INFORMATION

As organisers of the Joint DTP Conference we would like to take photographs of participants and their activities. Photographs and / or digital media may be used in our printed publications and / or on our website, in social media or in future publicity materials and third Party Media may also be invited to take photographs of the activities.

Please be aware of any signage / additional information which will identify where Photography is taking place and if you (or your guests) do not wish to photographed or filmed in the above manner, please email (dtpconf@protonmail.com), or inform the conference committee as soon as possible before the event in order for provisions to be made

No names or personal details will be published alongside any pictures unless specific permission has been requested and granted from these parties.

You have the right to request that your image be removed from the digital server and from any unprinted / unpublished publicity material on the web by contacting (dtpconf@protonmail.com). Use and/or access to your photo will be done so in accordance with the College retention schedule.

Please contact us at any time should you require clarification on this matter.

To find out more regarding data protection and your rights please visit https://www.imperial.ac.uk/data-protection. Please contact the organisers at any time should you require further information:

Email: dtpconf@protonmail.com

STUDENT TALKS - ABSTRACTS

Mineralogy and Geochemistry

Isaac Taschimowitz - London NERC DTP - The Equation of State of the MgO-CaO-SiO_2 Melt System Using Machine Learning

Determining how the Earth's initial magma ocean crystallised into a solid body is important for understanding Earth's evolution to its present-day state. One of the fundamental properties governing the crystallisation of the magma ocean is the relative density between the crystallising minerals and the melt phase. This is because their relative densities will control whether melts float or sink, and whether, for instance, an isolated basal magma ocean forms. However, the composition of the melt phase continually evolves as crystallisation occurs, and in particular the final stage melts are very different from the initial melt. As such knowledge of melt densities are needed over a much wider range of compositions than for the solid phases. One of the difficulties with predicting densities at any compositions is that normal equations of state such as the Birch-Murnaghan are difficult to extend to arbitrary composition. We present our initial results of fitting densities from obtained from DFT calculations over a range of compositions, pressures, and temperatures, to a Gaussian Process Regression model. Initial work has focused on the MgO-SiO2-CaO ternary system, but in future this can be extended to arbitrary compositions with the addition of new PVT data.

Clara Matthews Torres - London NERC DTP - The Variability of Mobile Chalcophile Element Fluxes Associated with Subduction Zone Magmatism in the Eastern and Western sectors of the Trans Mexican Volcanic Belt

Chalcophiles are a group of elements found concentrated in economic ore deposits. Many are well studied, but some are less well understood (e.g. W, Mo, Sb). The growing demand for these resources requires an understanding of the sources and mechanisms involved in transporting these elements to ore forming regions.

Popocatépetl Volcanic Complex and Colima Volcanic Complex are two continental arc stratovolcanoes which sit in the eastern and western sectors of the Trans-Mexican Volcanic Belt respectively. Although both volcanoes erupt magmas of similar basaltic-andesitic compositions, there is significant variation in their local tectonic environments including differences in slab inclination and distance from the subduction trench. It is unclear how or the extent to which these factors have influenced chalcophile element fluxing into each region and resulted in a lack of mineralisation. Well known element proxies e.g., Ba, Th and Nb have been used to constrain mobile chalcophile element contributions from the slab to the mantle wedge.

Major and trace element compositional data was collected from glassy melt inclusions (>25µm). Popocatépetl inclusion data (~40ka) show MgO content up to 2% and silica content between 60% and 80%. Th/Nb ratios show a dominant slab melt component. In contrast, Colima whole rock data (>4 ka) shows a larger fluid component relative to Popocatépetl. Tl behaves similarly to Ba suggesting mobilisation closer to the trench in the western sector whereas W, Pb and Sb behave more like Th and are mobilised further from the trench in the eastern sector.

Todd Downing - London NERC DTP - Trace element mapping of eudialyte group minerals by LA-ICP-MS in order to assess geochemical mobility

The Ilímaussaq Complex in South Greenland is a world-class example of macroscopic layering achieved by variable concentrations of black, red, and white minerals. These layers are primarily sub-horizontal in aspect and considered undeformed since their formation ~1160 Ma ago. They host eudialyte group minerals which contain elements of high economic value (e.g., Zr, Ta, Nb, rare earth elements). Despite decades of research and systematic field drilling campaigns, the origin of the layering and mineral

enrichment remains elusive. This is largely due to widespread metasomatic alteration and hydrothermal overprint of the complex. The objective of this study is to determine whether the macroscale fabric is of a magmatic or metasomatic origin. The work will involve trace element mapping to examine the 2D spatial distribution of elements within the eudialyte group minerals. This will allow us to characterize the evolution of eudialyte and its alteration sequences in response to fluid-rock events. This will be achieved through application of LA-ICP-MS as an imaging tool which can detect up to ppb over a wide isotopic range (7Li to 238U). Investigation of a suite of elements that are reactive to re-equilibration processes and geochemical interactions, including the growth and/or dissolution of accessory minerals, will enable us to interpret the ambiguous petrological record of magmatic evolution and metasomatism within eudialyte, all at a scale and resolution previously not possible before.

Habitats and Conservation

Zosia Ladds - London NERC DTP - Biodiversity in Urban Cemeteries

Recent centuries have seen dramatic change in land use, including extensive urbanisation. Urban green spaces vary greatly, from highly managed sites such well-manicured lawns in parks and gardens to more overgrown and unkempt spaces such as brownfield sites, wastelands and cemeteries. Burial grounds, including graveyards, churchyards and cemeteries, are common throughout urban areas and can represent important locations of ecological stability in an otherwise dynamic landscape. Little is known of the urban ecology of cemeteries, however. They provide important cultural ecosystem services, but their ecological functions are relatively unexplored. Urban cemeteries may be able provide important refugia for protected species which are struggling to compete in an extensively human-modified landscape, and due to their cultural protection, make ideal sites for biodiversity conservation.
London alone has 139 cemeteries, spanning 1300 ha, some of which are hundreds of years old and contain areas that have been undisturbed for decades. there is not currently a comprehensive evaluation of the role cemeteries play in urban biodiversity conservation.
Through extensive surveying and monitoring of London's cemeteries, we can begin to understand the role of cemeteries within the urban green landscape and ascertain whether they provide unique habitat provision when compared with parks. Determining habitat microsites, plant and mammal diversity of cemeteries, how habitat is utilised by mammals, and ultimately how biodiversity may be encouraged through wildlife-sensitive management efforts will enable us to understand how to make best use of these spaces.

Jessica Turner - London NERC DTP - Hedgehogs in Greater London: A small mammal in a big city

The West European hedgehog (Erinaceus europaeus) is a common, charismatic small mammal found in the UK and central Europe. The species has been declining rapidly in the UK over recent decades, but this trend shows a marked distinction between severe population losses in rural countryside, and built-up urban areas where populations have declined to a lesser extent and appear to be stabilising. However, urban hedgehog populations may be at risk from intense habitat fragmentation characteristic of urban landscapes, as greenspaces are lost and increasingly isolated by development. Urban hedgehogs have been comparatively little studied, with inconsistent results regarding the impact of fragmentation on their populations. Here, I use both habitat suitability mapping and mitochondrial genetic approaches to investigate the distribution and genetic structure of hedgehogs in greater London, the largest city in the UK. Results indicate that that the presence of greenspaces such as parks, allotments and gardens are vital for hedgehog populations, whereas highly built up, populated areas and the presence of competitor species (European badgers, Meles meles) are negatively related to hedgehog presence, whilst mitochondrial DNA analysis indicates the presence of several mitotypes across the study area. These results will provide valuable insights for the future management and conservation of hedgehogs in the urban landscape.

Chloe Metcalfe - London NERC DTP - the effectiveness of terrestrial protected areas

Protected areas (PAs) can slow or even reverse detrimental effects on biodiversity. I aim to determine how PAs can be future proofed for the conservation of mammals – a taxon sensitive to habitat fragmentation through land use and climate change. I test the effects of protected area characteristics such as their size,

connectivity, border complexity, and IUCN management and governance categories on mammal species richness and abundance. My analyses have shown that there is a significant increase in mammal abundance at sites located further within PAs, especially, those sites furthest from the border that are surrounded by a larger percentage of natural habitat. Species abundance was also found to be higher at lower elevation sites with high natural habitat surrounding them. Protection itself also had a positive impact on biodiversity; species richness was found to be 10% higher inside PAs compared to areas without protection. This study produces a globally relevant picture of how PA design can impact biodiversity outcomes, and how we can effectively meet global conservation targets, such as protecting 30% of land and sea by 2030.

Tahir Khanzada - London NERC DTP – **Pending**

Aquatic landscapes have changed dramatically due to threats posed by anthropogenic activity, and most systems are in decline. These threats include eutrophication, sea level rise, and land use change, and combating this decline necessitates the use of aquatic restoration and conservation techniques. Part of informing conservation at the catchment scale requires establishing what species, habitats and conditions are already present in order to establish a baseline.

The River Glaven catchment (north Norfolk, UK) offers a unique opportunity to study the temporal and spatial distribution of aquatic macrophytes. The catchment's lakes, ponds, backwaters, ditches, and river sections have been regularly surveyed over the last 20 years with near total geographical coverage of the area, totalling over 300 sites with over 700 individual surveys, with representation of almost 200 species.

This level of detail is unprecedented in a river catchment and allows unique conservation questions to be answered, such as if species are lost from one part of the river system due to sea level rise, are they still represented in other parts, and will overall catchment diversity decline? Do lakes, river sections, ponds, or backwaters harbour the most diversity, are these sites located in headwaters or further downstream, and what techniques can be used to most efficiently improve species diversity? This talk will explore these and other questions that can be answered using the Glaven database.

Earth and Space Observation

Simon Opie - London NERC DTP - Turbulence and instabilities in the solar wind: scale dependent processes and how to measure them

The solar wind is a continuous outflow of plasma expanding into interplanetary space powered by energy from the Sun. However, the solar wind is inherently turbulent and characterised by kinetic instabilities which transfer energy to small-scale fluctuations. These instabilities are driven by various sources of free energy (e.g. particle beams, differential flows, heat fluxes, temperature anisotropies) and make a significant contribution to the fluctuation spectrum at kinetic scales, where energy dissipation occurs.

Using statistical methods to analyse Solar Orbiter data we quantify the temporal and spatial scales of energy transfer processes with particular reference to scaling law behaviours in the turbulent solar wind. Taylor's Hypothesis (Taylor, 1938) allows us to infer spatial information from temporal data captured by a single spacecraft but what are the limits to this process and how can we untangle the connections between spatial and temporal information at all relevant scales within the solar wind?

Samantha Petch – SCENARIO - Towards a regional inverse model for water-energy-carbon budgets over land

We have aimed first to improve the understanding of regional water and energy budgets in large global catchments from observations, focusing on the period 2002-2013. We have utilised monthly satellite data from the Gravity Recovery and Climate Experiment (GRACE), building on ideas from the NASA energy and water cycle study (NEWS) (Rodell et al., 2015), but taking assessments to smaller spatial scales and including full monthly to interannual variability. Despite recent improvements in remote sensing capabilities, we still see inconsistencies amongst input datasets at both seasonal and interannual timescales.

We have coupled in an energy budget model, which is currently only constrained on long timescales in the absence of monthly energy storage data, using a novel artificial storage approach. This allows for the possibility to extend the method to using EO Land surface temperatures to constrain the seasonal cycle, and also, we think to extend the method to carbon budgeting in future. We have done sensitivity experiments looking at error covariances between different flux components where we believe the EO derived input products are not independent. We will show how seasonal water and energy cycles become optimised for various large scale river basins and we also look at the fluxes driving some of the interannual variability that is found over several basins. We next aim to extend our approach to include carbon budgets alongside the water and energy budgets to produce a truly coupled Earth system cycling analysis, with applications such as testing Earth system and Climate models.

Devon Francis – SCENARIO - What happens if observations used to predict the weather are wrong?

Satellite radiance observations have a significant impact in numerical weather prediction, but often have biased errors that need to be corrected. Many operational centres use an observation bias correction technique known as Variational Bias Correction (VarBC), which corrects the observations to a model run. However, if the model is biased, then this can contaminate the estimate of the observation bias correction. Unbiased observations can be used within VarBC as a source of the truth, so therefore unbiased observations play an important role in VarBC to reduce the contamination of model bias.

We extend the theory of VarBC to include both unbiased and bias-corrected observations, to find that the precision and the location of the unbiased observations are important in reducing the contamination of model bias in VarBC. Unbiased observations work best at reducing the contamination of model bias when they observe the same states as the bias-corrected observations. When unbiased observations observe different states to bias-corrected observations, strong background error correlations allow more information about model bias to be passed from unbiased observations to bias-corrected observations. These results show that, in operational systems, regions with sparse unbiased observations could be more susceptible to model biases within the radiance observation bias correction, as states with model bias may not be observed by unbiased observations.

Marie Shaylor - SSCP DTP - An Evaluation of Two Decades of Aerosol Optical Depth Retrievals from MODIS over Australia

We present an evaluation of Aerosol Optical Depth (AOD) retrievals from the Moderate Resolution Imaging Spectroradiometer (MODIS) over Australia covering the period 2001-2020. We focus on retrievals from the Deep Blue (DB) and Multi-Angle Implementation of Atmospheric Correction (MAIAC) algorithms, showing how these compare to one another in time and space. Considering Australia as a whole, monthly-mean AODs show similar temporal behaviour, with a well-defined seasonal peak in the Austral summer. However, excepting periods of intense biomass burning activity, MAIAC values are systematically higher than their DB counterparts by, on average, 50%. Decomposing into seasonal maps, the patterns of behaviour show distinct differences, with DB showing a larger dynamic range in AOD, with markedly higher AODs in northern and south-eastern regions during Austral winter and summer. This is counter-balanced by typically smaller DB values across the Australian interior. Site level comparisons with all available level 2 AOD data from Australian Aerosol Robotic Network (AERONET) sites operational during the study period show that MAIAC tends to marginally out-perform DB in terms of correlation (MAIAC = 0.71, DB = 0.65) and root-mean-square error (MAIAC = 0.065, DB = 0.072). To probe this behaviour further we classify the sites according to the predominant surface type. This analysis shows that MAIAC's advantage is retained across all surface types for R, and all but one for RMSE. For this surface type (Bare, comprising just 1.2% of Australia) the correlation coefficient of both algorithms is relatively poor, (MAIAC = 0.403, DB = 0.332).

Evolution and Adaption

Sasha Bradshaw - London NERC DTP – Meiotic drive adaptive testes enlargement during early development in the stalk-eyed fly.

The sex-ratio 'SR' X-linked meiotic drive system in stalk-eyed flies destroys all Y-bearing sperm. Unlike other SR systems, drive males do not suffer fertility loss. They have greatly enlarged testes,

which compensate for gamete killing. We predicted that enlarged testes arise from extended development with resources re-allocated from the accessory glands, as these tend to be smaller in drive males. To test this, we tracked the growth of the testes and accessory glands of wildtype and drive males over 5–6 weeks post-eclosion before males attained sexual maturity. Neither of the original predictions are supported by this data. Instead, we found that the drive-male testes were enlarged at eclosion, reflecting a greater allocation of resources to the testes during pupation. In addition, there was no evidence that the greater allocation of resources to the testes during adult development retarded accessory gland growth. There was evidence of a general trade-off with eyespan, as males with larger relative eyespan had larger accessory glands but smaller testes. These findings support the idea that enlarged testes in drive males arise as an adaptive allocation of resources to traits that enhance male reproductive success.

Aaron Halpern - London NERC DTP - The universal foundations of life's ability to change - conserved features from the origin of genetic coding

Biology is immensely variable, meaning that it's rare immutable traits and are hugely informative. The genetic code is one of these near-universal traits and it provides the informational platform for life's evolvability. Careful scrutiny of the assignment of amino acids to nucleotide triplets reveals fundamental rules underpinning genetic coding related to the physico-chemical properties of amino acids. The clearest of these patterns is a correlation in the hydrophobicities of amino acids and their anticodonic nucleotides. Using molecular dynamics simulations supported by NMR, we have demonstrated that this correlation may be due to preferential direct interactions between amino acids and nucleotides with similar properties. Our experiments show similar effects are observed throughout the translational system, where conserved chemical reactions and interactions should be able to occur spontaneously without specialized modern molecular machinery. This fits with a growing body of evidence that many the processes central to life can freely occur without the help of evolved catalytic enzymes and ribozymes, indicating a parsimonious path from modern life back to it's origin.

Nicole Barber - London NERC DTP – **Pending**

Primates demonstrate one of the most diverse ranges of locomotion in the mammal clade. The morphology of the foot, and in particular the tarsals, is likely to have played a critical role in the evolution of this diversity. Landmark-based geometric morphometrics has previously been applied to some tarsal elements to characterise tarsal shape, however their complex morphologies mean fixed landmarks alone may struggle to capture the full range of shape variation, particularly across a wide range of taxa.

Here we investigate the efficacy of fixed landmarks only compared to fixed and sliding semilandmarks for capturing tarsal morphology. Newly developed high-density landmark schemes utilising both fixed and curve semilandmarks were applied to a dataset of existing and newly collected surface and CT tarsal scans representing 32 genera and ~50 primate species. The LaMBDA package in R was used to formally assess the effectiveness of fixed landmarks alone in comparison to fixed and surface semilandmarks in capturing morphological variation across the group.

We find that fixed landmarks alone are not sufficient to capture the full range of morphological variation in the astragalus and calcaneus across Primates, and that the addition of semilandmarks to define key articular surfaces and structures drastically increases our ability to characterise tarsal morphology across the full range of Primates. The use of high-density landmark schemes will allow us to perform a more detailed analysis of the primate tarsal skeleton than has previously been possible using traditional shape data or fixed landmark approaches.

Josh Reynolds - SSCP DTP - Identifying non-recurrent rare mutations in *Anopheles* mosquitoes for evolutionary inference

Population genomic analyses utilising patterns of rare genetic variants have the potential to provide new information for evolutionary inference that may be otherwise undetectable by traditional approaches. Existing methods rely on the assumption that different copies of rare mutations are all descended from a single common ancestor, i.e. are identical by descent. However, this assumption may frequently be violated in taxa with high mutation rates or large effective population sizes, so that, by chance, the same rare mutations have in fact arisen independently. For example, such "recurrent" rare mutations are thought to

be appreciable in non-model organisms like the malaria vector mosquito Anopheles gambiae. To address this, we devise a new method to identify non-recurrent rare mutations from a sample of individuals, utilising the composition of their surrounding shared haplotypes. Based on differences in the sharing of rare variants between rare variant haplotypes, we determine a likelihood for a given haplotype being non-recurrent, which can then be confidently used for downstream analysis. We applied this method to data from the Anopheles gambiae 1000 genomes project (Ag1000G). We find that concern over recurrent mutation is valid in A. gambiae, but that our method can effectively identify non-recurrent mutants for this species. This approach can then be used to make various downstream inferences, such as the impacts of selection, site conservation, and chromosomal location effects on rare variants, and on the utility of such variants for population level inferences.

Human Health and Infrastructure

Marcus Annegarn - SSCP DTP - Combining time-dependent density functional theory and the ΔSCF approach for accurate core-electron spectra

Particulate Matter (PM) is widely regarded as a leading human health risk across the world. There is a strong correlation of PM levels with cardiovascular and respiratory disease of many forms. The pathogenic mechanism, however, is not understood. PM can be made up of a wide range of elements and species. Characterising PM present in the air is crucial for elucidating the means of harm and for identifying which forms of PM are the most harmful.

XAS and EELS measure the energy required to excite a core electron to an unoccupied state and provide insights into the elemental composition and chemical structure of materials. However, interpreting measured spectra is often challenging. There is a need to develop accurate modelling approaches to predict such spectra from first principles to guide the analysis of experimental data. To address this challenge, I have developed an approach that combines time-dependent density-functional theory (TDDFT) with the Delta-Self-Consistent Field (Delta-SCF) approach. XAS and EELS spectra are calculated using TDDFT and then shifted to align the lowest TDDFT excited state with the Delta-SCF result. Thus, the well-known inaccuracy of TDDFT for absolute core excitation energies is overcome without the need for any empirical parameters. I have applied this method to a test set of systems and obtained promising agreement with experiment.

Gina Charnley - SSCP DTP - Investigating the impact of social and environmental extremes on cholera time varying reproduction number in Nigeria

Nigeria currently reports the second highest number of cholera cases in Africa, with numerous socioeconomic and environmental risk factors. Less investigated are the role of extreme events, despite recent work showing their potential importance. To address this gap, we used a machine learning approach to understand the risks and thresholds for cholera outbreaks and extreme events, taking into consideration pre-existing vulnerabilities. We estimated time varying reproductive number (R) from cholera incidence in Nigeria and used a machine learning approach to evaluate its association with extreme events (conflict, flood, drought) and pre-existing vulnerabilities (poverty, sanitation, healthcare). We then created a traffic-light system for cholera outbreak risk, using three hypothetical traffic-light scenarios (Red, Amber and Green) and used this to predict R. The system highlighted potential extreme events and socioeconomic thresholds for outbreaks to occur. We found that reducing poverty and increasing access to sanitation lessened vulnerability to increased cholera risk caused by extreme events (monthly conflicts and the Palmers Drought Severity Index). The main limitation is the underreporting of cholera globally and the potential number of cholera cases missed in the data used here. Increasing access to sanitation and decreasing poverty reduced the impact of extreme events in terms of cholera outbreak risk. The results here therefore add further evidence of the need for sustainable development for disaster prevention and mitigation and to improve health and quality of life.

Pablo Jose Vallhonrat Blanco – SCENARIO - **Pending**

Bridge structures are essential components of the transport system that ensure connectivity within communities. Each year, many of these structures fail due to hydraulic actions and scour. The reaction of

each bridge to these hazards depends on its structural properties, and this response is associated to its susceptibility. Generally, susceptibility is evaluated by analysing the damage level of a structure under different scenarios. However, these analyses only consider one bridge configuration. The aim of this research is to compare different bridge configurations (integral, semi-integral, continuous, and simply supported) with the same span characteristics in several flooding event scenarios. By performing a susceptibility assessment to each of the bridges, the identification of which configuration is more robust under these actions can be evaluated.

Life Under Water

Lucy Mead - London NERC DTP - Spatio-temporal and sex-specific patterns of residency and space-use in adult Angelsharks

Understanding of species distribution and space-use is an essential prerequisite for effective marine conservation and management, and with a third of all chondrichthyan species now threatened with extinction, a chronic lack of data on basic ecology compounds extinction risk for many species. Squatina squatina (hereafter Angelshark), a bottom-dwelling coastal shark, is currently listed as Critically Endangered on the IUCN Red List of Threatened Species. Despite recent conservation attention, there remains a significant lack of ecological data related to this species, and understanding of Angelshark behaviour, distribution and movement remains extremely limited. In the present study, acoustic telemetry was used to collect detailed data on movement, residency and space-use in adult Angelsharks within the La Graciosa Marine Reserve in the Canary Islands, with the aim of addressing key knowledge gaps and informing conservation policy. Between July 2018 and April 2022, 104 adult Angelsharks (72 females, 32 males) were tagged with acoustic transmitters and detected across 12 receivers. Significant sexual variation was found in space-use and seasonal presence in the study area, with results suggesting some localised sex-segregation outside of Winter months, when presence of both males and females peaked. While detections were concentrated in the shallow waters between La Graciosa and Lanzarote (up to 24m depth), notable use of an offshore location (86m depth) indicated utilisation of deep-water habitat, not previously observed in this species. The present findings have implications for Angelshark conservation, particularly in relation to sex-specific space-use and use of deep waters across the study area and more widely.

Stuart Negus - London NERC DTP - Using drones to determine the population and community ecology of marine megafauna.

Understanding how species are distributed across space provides important information on their resource needs to fulfil their life cycles. However, obtaining this information for wide-ranging marine megafaunal communities is often difficult, as current methods (e.g. satellite tracking) tend to use small sample sizes that might not represent the community. Here, we used aerial drones as a novel monitoring tool to explore seasonal variation in community structure and habitat requirements of marine megafauna frequenting a biodiversity hotspot in the Mediterranean. Overall, 500 km of coastline in western Greece was surveyed in 2019 and 2020. First, surveys showed that juvenile, subadult and adult loggerhead sea turtles (Caretta caretta) had different foraging habitat requirements. Most juvenile turtles were recorded in high-density aggregations located in shallow (<2 m seabed depth) vegetated areas in front of wetlands. In contrast, most adult turtles were distributed at low densities over submerged sandbanks and reefs in deeper water along open coastlines, while subadults occupied areas that overlapped the other two groups. Second, by integrating surveys of the foraging and breeding distributions of loggerhead turtles throughout this same region, we showed that existing protected areas generally captured the habitat needs of both life-history phases. However, one high-density foraging spot and two intermediate-density breeding areas currently lack protection. Third, our surveys also showed that this region supports several other marine megafauna groups, including sharks, rays, dolphins and Cuvier beaked whales, which are considered indicator species of ocean health in the Mediterranean. In conclusion, our results show that aerial drones provide a useful tool for revealing the connectivity and structuring of marine megafauna, supporting their use as high-resolution tools for marine community monitoring.

Ceri Webster - SSCP DTP – **Pending**

Humans' ever-increasing impact on global oceans has dramatically modified marine biodiversity. These changes are disrupting the balance of ecosystems and threaten the abundance of resources the ocean provides to humanity. Biodiversity's complex nature poses a challenge as we strive to combat its decline. Current indicators evaluating trends in nature overwhelmingly consider only a single aspect of biodiversity; species diversity. Additional biases also exist as significantly fewer studies are conducted in the marine realm.

It is essential that global biodiversity, and all of its facets, are understood and monitored for us to successfully protect nature on land and sea. Scientists are increasingly using metrics that consider the evolutionary history or ecological roles of species and communities. However, the paucity of data on marine species has limited our understanding of biodiversity in the ocean, and the relationship between these metrics remains unclear.

In this study we aim to investigate the link between phylogenetic and functional diversity in sharks and rays (Chondrichthyes), at a global scale. Harnessing extensive phylogenetic and trait data, we evaluate the relationships between a variety of phylogenetic and functional measures. By investigating these links in marine species, we contribute to the understanding of biodiversity in the ocean. This study demonstrates that different biodiversity measures can capture a variety of biological features, highlighting the importance of measuring multiple facets of biodiversity beyond taxonomic diversity.

Geology and Chronology

Naima Harman - London NERC DTP – **Pending**

This research project aims to the provide the first high-resolution, independently dated, marine palaeoclimate record from ~110 ka BP to present for the Eastern Mediterranean. The chronology is based on tephrostratigraphy, which will underpin a planktonic foraminiferal oxygen isotope record from marine core MD81-LC32. This will enhance understanding of the drivers and mechanisms of climate change across the region within this time frame. MD81-LC32 is a 21m sediment sequence, obtained by the Marion Dufresne research vessel 60km south of Cyprus and 250km west of the Levantine coast. The development of a tephrostratigraphy has discovered 2 visible tephra layers, and 6 cryptotephra horizons. Major element analyses (WDS-EPMA) have been used to characterise both visible tephra layers, correlating them to the Yali-2 Pumice (dated to approximately 32.9 ka BP), and the Cape Riva eruption (22 ka BP). This new geochemical data represents the furthest eastward location of these tephras in the Mediterranean and provides the first proxy-independent correlation between the Aegean and Levantine Seas during this time period. These developments have important implications for synchronising palaeoenviromental archives and Levantine archaeological sites.

Lily Moore - London NERC DTP - Ritter Island; recreating a volcano remotely

The collapse of the remote Ritter Island, Papua New Guinea, in 1888 removed many cubic kilometers of material into the ocean. This event has since become a key case study for similar events due to its well-documented catastrophic collapse and subsequent tsunami.
A high-resolution structure from motion model of Ritter Island was produced using photogrammetry techniques from drone imagery. The resultant output of this model includes an orthomozaic image and a digital elevation model both with a resolution of 15.7cm/pixel. As this data is much improved to what was available for the island previously, it has become a valuable resource in the research into this collapse event. The elevation model provides excellent detail on the topography of the island producing a number of useful measurements. These include a peak altitude of 119.7m, angles of the eastern slope of 36.3° and western slope of 42.4° and the volume of the subaerial island is 13202708 m3. The resultant models were also used to identify structural features, vegetation cover and individual rock units used create a geological map of Ritter Island where there previously has been none.
The future of this project will use measurements of the mechanical properties of samples taken from this island, combined with the measurements that this model has provided to build a clearer picture of the nature of the catastrophic collapse of Ritter Island.

Theo Clayton - SSCP DTP – **Pending**

Surface crevasses are predominately mode I fractures that penetrate tens of metres deep into grounded glaciers and floating ice shelves. However, elevated temperatures have resulted in the production of surface meltwater, that flows into surface crevasses and applies additional tensile stresses to crack walls. This process is known as hydrofracture; and if sufficient, can promote full thickness crevasse propagation, and lead to iceberg calving events. Net ablation of glaciers has become of great concern, as it has become the largest contributor to sea-level rise.
To overcome the limitations of empirical and analytical approaches, we here propose a new phase field-based computational framework to simulate crevasse growth in both ice sheets and floating ice shelves. The model incorporates the three elements needed to mechanistically simulate hydrofracture of surface and basal crevasses: (i) a constitutive description incorporating the non-linear viscous rheology of ice, (ii) a phase field formulation capable of capturing cracking phenomena of arbitrary complexity, such as 3D crevasse interaction, and (iii) a poro-damage representation to account for the role of meltwater pressure on crevasse growth. To assess the suitability of the method, we simulated the propagation of surface and basal crevasses within grounded glaciers and floating ice shelves and compared the predicted crevasse depths with analytical methods such as linear elastic fracture mechanics and the Nye zero stress method, with results showing good agreement for idealised conditions.

Catrin Harris - SSCP DTP - Storing CO_2 in the pores of rocks: Imaging carbon storage in realistic sandstones

A major challenge for geological carbon storage is increasing confidence in storage security. Understanding subsurface processes is crucial for the success of CCS as net atmospheric emissions reductions depend on the fraction of CO2 retained long term. Trapping mechanisms ensure the permeance of CO2 sequestration within the subsurface. Current models predicting field-scale CO2 movement and trapping at several sites around the world do not fully capture the impact of heterogeneity on trapping dynamics. The aim of this work is to understand the effect of natural rock heterogeneities on the dynamics of capillary trapping during CO2 sequestration.

State of the art experiments at the Australian (ANSTO) and European (ESRF) synchrotrons have been carried out, achieving combined spatial and temporal resolution not possible with traditional lab-based techniques. We captured pore-scale trapping mechanisms with a field of view over the continuum core scale (5cm), allowing us to investigate how larger scale capillary heterogeneity trapping processes are impacted by pore-scale events. Understanding how natural geological heterogeneity impacts the distribution and amount of CO2 trapped within target storage sites may advise on choice of storage site and injection techniques to maximise the security of future storage projects.

The Birds and the Bees

Aoife Cantwell-Jones - SSCP DTP - Bumblebee museum specimens reveal increasing stress over the 20th century

Determining when insect populations have experienced stress in the past is fundamental to understanding how risk factors drive contemporary and future species' responses. However, quantifying historical stress levels has been challenging due to a lack of time-series data. A solution is to use historic specimens and detect morphological signatures of stress experienced at the time stressors emerged, to determine more accurately real-time population responses. Studying 3,336 specimens of four bumblebee species from five UK museums, I quantified stress levels experienced across Great Britain over the 20th century. The proxy of stress was the degree of fluctuating asymmetry – random deviations from bilateral symmetry – between the right and left forewings. Species differed significantly in their baseline stress levels, with stress being higher in the two range-expanding species. Importantly, stress increased over the 20th century, especially after c. 1925, with warmer, wetter years being associated with higher fluctuating asymmetry. These results show that stress in bumblebees rose throughout the 20th century, at least partially as a response to climatic trends that are predicted to continue under climate change.

Alicja Witwicka - London NERC DTP - Are we testing insecticides correctly? Evaluating insecticides with high-resolution molecular approaches

Social and solitary bees are important insect pollinators, yet their populations are declining because of intensified agriculture and the use of insecticides. Many authorised insecticides cause severe sub-lethal effects to multiple bee species, showing that the methods used in toxicity tests are inadequate. Toxicity

assessments are typically based on the survival of so-called surrogate species (mainly Apis mellifera workers) under acute, short-term exposure. In real-life scenarios, insects experience long-term exposure to low doses of insecticides. Moreover, post-exposure effects observed in wild pollinators and the surrogate species may differ due to differences in life histories and physiologies.
We present differences in gene activity between brains of Bombus terrestris exposed to three cholinergic insecticides: Clothianidin, Acetamiprid, and Sulfoxaflor. We compare chronic, low-dose exposure and acute, high-dose exposure. We show that the effects of insecticides on gene expression vary significantly between pesticides, but also between chronic and acute exposure.
Overall, our work highlights how high-resolution molecular approaches can improve our understanding of the effects of insecticides on bee health. Such toxicogenomic approaches, which are widely used in assessments of drugs for humans, are the best way forward to test the effects of insecticides on non-target species. We anticipate that such work can provide essential information for regulatory bodies and improve insecticide safety assessments.

Guy Mercer - London NERC DTP – **Pending**

Flupyradifurone (FPF) is a novel insecticide licenced in over 30 countries for use on bee attractive crops. The overemphasis of regulatory testing on worker mortality in one surrogate species, the honey bee, repeatedly results in the approval of agrochemicals that pose a risk to wild eusocial bee species. Consequently, additional testing undertaken by the academic community is crucial to adequately appraise the risk agrochemicals pose. For this reason, it must itself be appropriate.
Currently, there is a paucity of research surrounding the risk that FPF may pose to bumblebee species at field-realistic concentrations, especially its fitness effects at the colony level. Furthermore, the majority of existing bee toxicity studies selected pure FPF as a treatment, instead of its most widespread commercial formulation, Sivanto, which is actually released into the environment. This highlights an assumption made by the academic community: that the commercial formulation (Sivanto), which contains many untested co-formulants, and the pure active ingredient (FPF) exhibit similar effects, which may be incorrect.
To address this, we performed a comparative study between Sivanto and technical grade FPF on the bumblebee, B.terrestris. The project utilised a combination of B.terrestris based models, including queenright colonies and microcolonies, to elucidate any potential differences in fitness effects between Sivanto and pure FPF. The dosage regime was constructed using existing semi-field residue data and exposure occurred via both sucrose and pollen, which enabled close modelling of real-world exposure. Preliminary results indicate that exposure to field-realistic levels of FPF has no effect on survival or fitness in B.terrestris microcolonies.

Tom Weeks - SSCP DTP – **Pending**

Species sensitivity to forest fragmentation varies latitudinally, peaking in the tropics. A prominent explanation for this pattern is that a long history of landscape disturbance at higher latitudes has either removed fragmentation-sensitive species or resulted in the evolution of more resilient survivors. However, it is unclear whether this "extinction filter" is the dominant driver of geographic variation in fragmentation sensitivity, particularly because climatic factors may also drive latitudinal gradients in dispersal ability, a key trait mediating sensitivity to habitat fragmentation. Here we combine field survey data collected worldwide with a morphological proxy for avian dispersal ability (hand-wing index) to assess the macroecological drivers of fragmentation sensitivity in a sample of 1034 bird species. We find that fragmentation sensitivity is strongly predicted by dispersal limitation, and that other predictors – latitude, body mass, and historical disturbance events – have relatively limited explanatory power after statistically accounting for dispersal. In addition, we found that variation in dispersal ability was only weakly predicted by historical disturbance while strongly associated with inter-annual temperature fluctuations (seasonality). Our results suggest that evolutionary adaptation to seasonality plays a dominant role in shaping latitudinal gradients in sensitivity to forest fragmentation, emphasising the need for dynamic conservation strategies that account for geographical variation in species attributes.

Patrick Alexander Walkden - SSCP DTP – **Pending**

Human transformation of earth systems is reorganising biotic communities. However, the extent to which functional integrity has been compromised worldwide remains unknown, despite its importance for the continued delivery of ecosystem services. I analysed a global compilation of avian community composition in tandem with a functional trait database for the world's birds. Probabilistic hypervolumes were evaluated for 1732 bird communities across land use gradients, characterising avian trait space in unprecedented resolution. We show that compared to those in primary vegetation, hypervolumes across the land-use

gradient were profoundly restructured, typically being smaller, less dense and increasingly dissimilar. Hypervolumes aggregated for each land use within biogeographic realms and compared to null expectations, showed a tendency for less complete hypervolumes as human influence increased. Distinct regions of trait space corresponding to dietary guilds all exhibited reduced integrity to perform pest control, seed dispersal and pollination services. Patterns of redundancy differed among groups with granivores, and omnivores being favoured in agricultural and urban land uses, while invertivore redundancy collapsed across the gradient. These findings suggest that maintaining the functional integrity of bird communities will require conservation, restoration, or rewilding efforts that target regions of functional trait spaces that anthropogenic drivers have impoverished.

Kerry Smith – SCENARIO - **Pending**

Characterizing changes in trait diversity at large spatial scales can provide insights into the impact of human activity on ecosystem structure and function. However, the trait datasets that these studies rely upon are often incomplete or unrepresentative, and uncertainty remains as to the impact this has on estimates of trait diversity. To address this knowledge gap, we simulate random and biased removal of data from a near complete avian trait dataset to assess whether trait diversity metrics are robust to data incompleteness, and whether imputation is an effective method for overcoming gaps in empirical data. Specifically, we compared three methods commonly used to define trait diversity: distance-based methods, convex hulls and probabilistic hypervolumes. We found that trait diversity metrics were robust to moderate missingness and bias, even without imputation, and when imputation was used trait diversity metrics remained representative even with severe missingness and bias. In general, using imputation to estimate missing values was a more effective method for dealing with incomplete data than removing species with missing data. Probabilistic hypervolumes and distance-based metrics were particularly robust to missingness and bias when combined with imputation. While dedicated efforts to capture intraspecific variation and increase the number of traits represented should continue, our results suggest that available methods can successfully quantify large-scale trait diversity and allow us to estimate the impact of global change on the functional composition of ecosystems.

Atmosphere and Ocean Dynamics

Rabiul Awal – SCENARIO – The relationship between atmospheric heat transport and monsoonal precipitation variability

During the boreal summer monsoon, the temperature gradient between land and ocean in the Northern Hemisphere (NH) facilitates large transports of moist air masses towards the land regions, where their convergence causes precipitation. This is associated with an export of net energy (internal, potential, and latent energy) away from the land. On a global scale, there is a tight relationship between the location of the intertropical convergence zone (ITCZ) and the cross-equatorial atmospheric heat transport (AHT) on seasonal, interannual and climate time scales: a more northward cross-equatorial AHT is associated with a displacement of the ITCZ (as defined by precipitation) toward the equator. We further analyse the relationships between cross-equatorial AHT and common streamfunction-based measures of the ITCZ position and width found in the literature. However, it remains unclear whether links between energy transport and the monsoonal precipitation exist at the scale of monsoon regions.
To address this question, we combine data from the European Centre for Medium-Range Weather Forecast (ECMWF) reanalysis ERA5 and Global Precipitation Climatology Project (GPCP-version 2.3) rainfall data. In the annual cycle, the cross-equatorial northward AHT transport peaks in July and the annual net northward cross-equatorial AHT is -0.34 PW (negative sign denotes southward). A regression analysis confirms that the global ITCZ shifts southward when the cross-equatorial AHT is anomalously large, although we demonstrate this mainly happens over the Pacific Ocean. Outside of the Pacific sector, the relationship between cross-equatorial AHT and JJA precipitation is complex. For the West African monsoon region, greater northward cross-equatorial AHT is related to weaker rainfall along the Gulf of Guinea coast, while there is stronger rainfall in the Atlantic Ocean ITCZ. In the Indian sector, anomalous northward AHT is associated with a weak monsoon, marked by strong decreases in precipitation on the Western coast of India and the southern flank of the Himalayas.
In future work, the CMIP6 multi-model dataset will be analysed to examine future projection of AHT and its impact on monsoonal precipitation. The characteristics of the ITCZ will be explored using the same datasets.

Isabel Smith – SCENARIO – **Pending**

Atmospheric turbulence has a serious and costly impact on aviation. Turbulence makes up most weather-related in-flight accidents and costs the global aviation sector up to US$1 billion every year. Aviation is often impacted by Clear Air Turbulence (CAT), which is not visible on radar and is therefore extremely hard to detect in advance of an encounter. Previous literature has shown that climate change is strengthening CAT globally, with increased severity particularly over the North Atlantic, a busy flight route, within the winter months. These findings have been based on CMIP3 and CMIP5 climate models, which have now been superseded by CMIP6 (Coupled Model Intercomparison Project Phase 6) models with higher resolution. We build and develop these previous findings further by using the CMIP6 HighResMIP PRIMAVERA simulations, which have grid spacings from 135km to 25km. CAT has not previously been investigated with models that come this close to resolving individual patches of turbulence. Comparisons between several resolutions have given us a better understanding of how different climate models, and their grid spacings, represent turbulence. Despite some multidecadal and yearly variability, CAT is found to increase in frequency, in all turbulent severities, in time and with increased near-surface temperatures. Interestingly, atmosphere-only global climate models predict a smaller increase in CAT, in comparison to coupled atmosphere-ocean models. Our findings suggest that an increasing mean near-surface temperature over the North Atlantic will lead to further light to severe turbulence events, which results in longer travel times, and increased CO2 emissions into the atmosphere.

Caleb Miller – SCENARIO - Measuring Changes in the Atmosphere Before Fog

Fog is a weather phenomenon which has the potential to significantly disrupt travel and transportation. Although many advances have been made in forecasting the weather in general, predicting fog has still proven to be relatively difficult. In recent years, our ability to measure the atmosphere have significantly improved, as automated continuous readings of thermodynamic, optical, and electrical variables are now being regularly made around the world. These new measurements, alongside further analysis, could enable a better understanding of the processes driving the development of fog.
Here, we present a new study on the changes of several variables leading up to the initiation of fog. This will include a discussion of the instrumentation in use at the Reading University Atmospheric Observatory that is being used to study fog, the presentation of a number of case studies of individual fog events, as well as composite measurements for different variables during the time leading up to fog.

Alanna Power – SCENARIO - Mixing Length Scales in a Cloudy Topped Marine Boundary Layer Simulation

Advances in computational power have enabled numerical weather prediction models to run with kilometre and sub-kilometer scale grids. Such models can only partially resolve the dominant turbulent motions in the flow, and therefore turbulence still need to be parametrized. However, existing parametrization schemes are not valid as their underlying assumptions don't hold in these ``grey zone'' regimes. The grey zone occurs when the length scale of the dominant turbulent structure is of the same order as the grid spacing, meaning the resolution is fine enough to partially resolve the structures, but is too coarse to fully resolve all the turbulent energy. The grey zone poses a significant problem, as models struggle to accurately resolve cloud size and initiation time at coarse resolutions.

LES models usually fix key parameters to constants, but previous research shows that these parameter values vary widely in the grey zone regime. Setting parameters to constant values may cause an excessive dissipation of energy. This would exacerbate issues associated with the grey zone, as the turbulence structures are already experiencing less energy than expected due to being under-resolved in this regime. In an effort to overcome this issue, a flow dependant eddy viscosity model is applied to a cloudy-topped marine boundary layer case. The resulting flow dependant fields are analysed in order to investigate if clear relations exist between given parameters. Such relations could then be used in models as a grey zone adaption to more accurately represent the energy dissipation, rather than setting parameters to constants.

Shammi Akhter – SCENARIO – **Pending**

Identifying and analysing Tropical Cyclones (TCs) in Global Climate Models (GCMs) is an important but challenging task. In this study, TC activity over the Bay of Bengal (BoB) using six multi-ensemble GCMs (both the atmosphere only and coupled versions) in the PRIMAVERA project following the same protocol is examined in the present (1950-2014) climate. The TCs have been identified and tracked in the model data using the TRACK algorithm. The International Best Track Archive for Climate Stewardship (IBTrACS) data and ERA5 reanalysis data are used for comparison with the model TCs. We use the Genesis Potential Index (GPI) to study the large-scale environmental conditions associated with the TC frequency

in the high resolution (25 km) version of the models. Although the models struggle to reproduce the observed frequency and intensity of TCs, most models can capture the bimodal characteristics of the seasonal cycle of cyclones over the BoB (with fewer TCs during the premonsoon [April-May] than the post-monsoon [October-November] season). We find that GPI is able to capture the seasonal variation of the TC frequency over the Bay of Bengal in both the observations and models. After calibrating the maximum sustained windspeeds in the models with IBTrACS, we find that like the observations the proportion of strong cyclones is also higher in the premonsoon than the post-monsoon. The windshear term in GPI contributes the most to the model biases inall models during the post-monsoon season. This bias is caused by the weakening of the upper-level(200 hPa) easterly wind. This situation appears to be associated with a weaker-than-normal Walker circulation in the Indian Ocean region. During the pre-monsoon season, the environmental term inGPI dominating the model biases varies from model to model, however, the cause of a particular environmental term bias is consistent across the models. The relative humidity bias might be caused by an early onset of monsoon in the models during the pre-monsoon season. When comparing the atmosphere-only and coupled versions of the models, a reduction of 0.5°C in the Sea Surface Temperature (SST) and a lowering of TC frequency occur in almost all the coupled models compared to their atmosphere-only counterparts.

Taxonomy and Phylogeny for Conservation

Luis Moliner Cachazo - London NERC DTP - Characterising freshwater biodiversity in the Okavango Delta (Botswana) using taxo-nomical and molecular techniques

Freshwater organisms in the Okavango Delta and Lake Ngami (Botswana) provide direct and indirect benefits to people and the economy of the region, such as fisheries and water purification. However, their existence could be threatened by human activities (upstream water abstraction and planned hydropower structures) coupled with climate change. For their protection and in the current context of global freshwater biodiversity decline, it is essential to know their distribution, ecology, and status of the ecosystems that they inhabit. However, historically, Botswana has been largely understudied, with very scattered scientific records, and it was not until the 1970s when the first studies on freshwater biota were published. To date, studies on certain taxa from the Delta at species level, particularly within the macroinvertebrates are still scarce (e.g. Chironomidae, Ostracoda, Ephemeroptera, Trichoptera), the majority have not identified them beyond family level or morphospecies, and many ecological aspects are still unknown. Here, we present preliminary data from eDNA and kick net sampling that confirms the presence of new national records, including 2 genera of water beetles (Bagous and Hydrochus) and 2 entire phyla: Bryozoa (moss animals) and Nematomorpha (horse-hair worms). Future sampling and laboratory analysis will continue to improve the knowledge of freshwater diversity at species level in a very pristine and unique system.

Maria Zicos - London NERC DTP - Reconstructing the demographic history of the endangered Hispaniolan solenodon.

Solenodontidae (Eulipotyphla, Mammalia) are small insectivorous nocturnal mammals from the Caribbean, the only extant mammal group with venom delivery through their teeth. They are some of the only survivors of the non-flying mammals native to the Caribbean, most of which became extinct after human arrival to the region. They diverged from other existing insectivores approximately 73 million years ago, and consequently form a very unique evolutionary lineage, of which two species survive: the Hispaniolan solenodon (Solenodon paradoxus) on the island of Hispaniola (Haiti and the Dominican Republic), and the Cuban Solenodon (Solenodon cubanus/Apotogale cubana) on Cuba. Given the endangered status of both species, and their evolutionary distinctiveness, they are both considered priority species for conservation under the EDGE of existence programme.
This project proposes to study the demographic history of the hispaniolan solenodon and its relationship with the Cuban solenodon using whole-genome data, with the aim of better understanding its genetic conservation status and conservation requirements. Six new genomes were generated, including the first Cuban solenodon and first genome for the south-western population of Hispaniolan solenodon, and were combined with previously published genome data. Our genome wide data supports structure into three populations as previously suggested from mitochondrial only data, but goes further as we apply this whole genome dataset to explore gene flow, divergence dates, inbreeding coefficients and signs of genomic erosion.

Miranda Sherlock - London NERC DTP - Genomic phylogeography of a refugial amphibian

Phylogeography is the study of the distribution of genetic lineages in space. Modern advancements in molecular biology have facilitated the emergence of the nascent field of genomic phylogeography which incorporates high-resolution data to investigate fine-scale phylogeographic patterns. Large-scale and complex genomic datasets present some unique challenges due to their size – and so require additional effort to analyse and interpret.
Climatic oscillations in the Pleistocene resulted in transitions between glacial and interglacial periods, causing populations to undergo range-shifts to 'glacial refugia' (depending on species' optimal climatic conditions). With glacial retreat individuals could subsequently recolonise post-glacial regions, resulting in periodic connection and isolation between populations. The Iberian Peninsula comprises one of the three major Mediterranean Pleistocene glacial refugia, and was subdivided into multiple refugia which has contributed to the status of the Iberian Peninsula as a major biodiversity hotspot in the Western Palearctic. The Iberian pensinsula hosts multiple amphibian species, several of which have been the subject of phylogeographic studies including Rana iberica, Rana temporaria, Rana parvipalmata and Chioglossa lusitanica. Despite some general patterns being observed in phylogeographic patterns of refugial species, the distribution of genetic diversity and dispersal routes varies depending on several extrinsic and intrinsic factors including dispersal ability, climatic adaptations and life-history traits.
Here, a RADSeq dataset comprising 308 individuals from 51 populations of the frog Rana iberica has been genotyped for SNPs and analysed in a phylogeographic context, including population genetic structure and diversity.

The World We Live In

Joy Ommer – SCENARIO - Co-benefits of Nature-based Solutions for Disaster Risk Reduction
Nature-based Solutions function (NBS) as an umbrella concept for ecosystem-based approaches that are an alternative to traditional engineering solutions for Disaster Risk Reduction. Their rising popularity is explained partly by their entailing additional benefits (so-called co-benefits) for the environment, society, and economy. A question arising around the co-benefits are how significant and sustainable they will be. In order to consider these side effects in the decision-making on most suitable NBS, they need to be pre-assessed. The few existing frameworks for assessing co-benefits are lacking guidance on co-benefit pre-assessment that is required for the NBS selection and permission process. Going beyond these, this we developed a comprehensive guidance on quantitative pre-assessment of potential co-benefits and disbenefits of NBS tackling Disaster Risk Reduction by building on methods and frameworks from existing NBS literature and related disciplines. The quantification of co-benefits shall support decision-making in planning processes on suitability and sustainability of Nature-based Solutions and can assist in the preparation of Environmental Impact Assessments of projects.

Tom Griffiths - SSCP DTP – **Pending**
Progress in the development of fusion energy has gained momentum in recent years. However, questions remain across key subject areas that will affect the path to commercial fusion energy. The purpose of this review is to expose socio-economic areas that need further research, and from this assist in making recommendations to the fusion community, (and policy makers and regulators) in order to redirect and orient fusion for commercialisation: When commercialised, what form does it take? Where does it fit into a future energy system? Compared to other technologies, how much will fusion cost? Why do it? When is it likely that fusion reaches commercialisation? Investigations that have sought to answer these questions carry looming uncertainty, mainly stemming from the techno-economics of emerging fusion technology in the private-sector, and due to the potential for applications outside of electricity generation coming into consideration. Such topics covered include hydrogen, desalination, and process-heat applications.

Abu Taher Muhammad Abdullah - SSCP DTP - Security implications and victimization of natural disasters and climate change in Bangladesh
Bangladesh is one of the most vulnerable countries to disasters brought on by climate change because of its geographic location. This study explores how climate change and natural disasters are already having an impact on crime rates. Using 52 years of crime and climate data (1969–2020) gathered from Bangladesh Police and Bangladesh Meteorological Department respectively, national level correlation matrices, temporal and spatial distribution of crime and climate were produced. Socioeconomic surveys were also conducted in the three unions of the Satkhira (Gabura and Kolaroa) and Khulna (Uttar Bedkashi) districts to examine the relationship between climate change, disasters, crime, and criminality. The findings show

that for most crime categories, there is a strong relationship between climate change and crime. Even though there may not seem to be much of a connection between temperature anomalies and crime, given the expected temperature variability in the future, climate change may have a considerable effect on crime rates. Cyclones Aila and Amphan severely damaged the unions of Gabura and Uttar Bedkashi respectively. These destructive cyclones altered people's criminal behavior and crime patterns, damaging house, employment, livestock, agricultural land, and trees. Land and shrimp culture grabbing are the two most prevalent conflicts in the research areas that are being affected by the disasters. The household's daily life was made worse by corruption in embankment construction, relief distribution, and the Sundarbans entry pass issuance. Crime and conflicts associated to climate change and disasters will decrease with effective policing and multi-agency disaster risk reduction initiatives.

Jarmo Kikstra - SSCP DTP - Bringing together multidimensional poverty and climate mitigation

Pathways that stabilize climate change and minimize its impacts generally do not include detailed representations of inequality. With only a few exceptions, distributional implications have been calculated using post-processing tools and focused on monetary income indicators. Distributional considerations are generally not dynamically modelled, and multidimensional inequality or broader wellbeing is rarely considered. Societal implications of different pathways vary greatly, but aspects of justice and fairness are not well understood.

The presentation will analyse just transitions using the concept of minimum energy requirement to provide for Decent Living Standards (DLS) in order to link climate mitigation with distributive justice and multidimensional poverty.

We back out implied energy inequality in future climate mitigation scenarios by downscaling to countries IAM projections of regional energy demand (and decoupling), combined with future projections of structural distribution of energy within economies. We compare the resulting levels of energy in sectors to that required to achieve minimum thresholds of services in a decent living standard to achieve an understanding of the energy gap and approximate share of population consuming less energy than the minimum energy requirement.

In this presentation, we will in addition explore the implied sectoral (Buildings, Transport, Industry) energy deprivation across a range of scenarios that span a range of socioeconomic futures and climate mitigation ambition levels. We find that the projected share of population using less energy than the minimum energy requirement is much higher in the transportation sector than in the residential and commercial buildings sector.

Water Pollution

Dan Shockley – SCENARIO – **Pending**

Microplastics (MP) within groundwater is an area of increasing concern, particularly with groundwater drinking water sources. They have been identified as being of significant interest due to their geographical global extent, constituting approximately 25% of the world's drinking water sources. Only a handful of studies to date have identified MPs in groundwater, with no standardised strategy to sampling. Findings are highly variable between studies, indicating that the risk of transport is not uniform and that factors such as soil cover may be highly influential, particularly with MP transmission through soil, such as those from sewage sludge applied to land. Without concrete proof of a source-pathway-receptor link, mitigation of this risk will be problematic, and sampling of groundwater cannot be targeted without first understanding the mechanisms which govern MP transmission to groundwater.

Alongside soil column leaching experiments designed to assess under what conditions transmission will most likely occur, field sampling has been carried out across a range of groundwater abstraction and monitoring sites to determine whether microplastics can reliably be detected in UK groundwater samples and develop a robust methodology for their detection. This is the first time these have systematically been collected in the UK. The results of this survey are presented along with the methodological challenges encountered along with proposed key recommendations and solutions to these. A wider sampling strategy is also set out, both to support soil column leaching findings within this project and also to inform a more comprehensive assessment of microplastics in UK groundwaters.

Jordi Buckley - SSCP DTP - Modelling crop growth and diffuse agricultural pollution under different climate change scenarios

Agricultural crops represent some 10% of the Earth's land surface and their sustainable management is key to maintain ecosystem services and ensure food security. Arguably, the first step towards successful management of these croplands is a detailed understanding of their intricate energy,water,carbon and nutrient dynamics. This is best achieved via mechanistic ecohydrological modeling which facilitates the study of explicit processes such as crop growth and nutrient leaching. For example, this method allows us to investigate soil biogeochemical cycling under different fertilization practices which would otherwise be challenging using an alternative empirical modelling approach.

In this proof of concept study, we expand the T&C ecohydrological model to represent agricultural crops and the associated soil biogeochemical dynamics. This is accomplished via the introduction of a new model component which represents individual crop dynamics. Specifically, we develop new algorithms to represent crop-specific phenology, crop-specific carbon allocation schemes, as well as crop-specific management practices which span from sowing to fertilization to harvest. We apply T&C-crop to three agricultural catchments in the UK. Model validation is performed for several crop types in terms of leaf area dynamics, crop yield, hydrological dynamics and downstream nitrogen release.

Arianna Olivelli - SSCP DTP - Lead concentrations and isotope compositions of surface waters from the western South Atlantic Ocean

Anthropogenic emissions mainly enter the ocean from the atmosphere and have severely perturbed the natural lead (Pb) signal in the ocean. Their origin and impact can be revealed by analysing the Pb isotope composition of seawater.

Here, we present new data on Pb concentrations and isotope compositions of surface seawater samples collected from a GEOTRACES section (GA02) in the western South Atlantic in 2011. Considering our results in the context of backward particle trajectories in the atmosphere and known Pb isotope compositions of natural and anthropogenic sources, it reveals that the major source of Pb to the equatorial zone (0 – 20°S) is "inherited" Pb transported via surface currents. In the subtropical zone (20 – 40°S) Pb from urban and industrial emissions sources in coastal South American cities is predominant and the subantarctic zone (40 – 60°S) displays more diverse Pb isotope compositions, suggesting that both urban areas and natural dust from Patagonia are potential sources.

Our results furthermore show that the mean Pb concentration (16.8 ± 4.0 pM) of southwest Atlantic surface waters was 30% lower than observed in the 1990s (24.0 ± 15.0 pM). The mean Pb isotope composition of samples collected in the equatorial and subtropical zone has a signal closer to that of natural mineral dust from Patagonia and northern Africa than in 1996, but it still remains dominated by anthropogenic sources.

Overall, the decrease in Pb concentration and shift in isotope composition likely reflects the global effort to reduce anthropogenic Pb emissions.

Natasha Harris – SCENARIO - Shedding light on the organic matter black box: using fluorescence spectroscopy to understand sources and pathways of tryptophan like florescence organic matter

The River Thames passes through rural and urban centres, from the upper reaches in the Cotswolds to through to London. The river, and its tributaries, cover many different environments and land uses, so is exposed to a range of stressors such as sewage pollution or run off from agriculture. As Such, UKCEH has been conducting water quality monitoring of the Thames since 1997, which later expanded into the Thames Initiative. The Thames Initiative collects a wide range of chemical and biological data, at 19 sites across the Thames and its tributaries. For 18 months fluorescence spectroscopy was from 2012-13 and PARAFAC analysis was used to identify 4 fluorescence components, this research focusses on the role of the fourth component, C4. C4 has been identified as representing a tryptophan like peak. It is commonly found to be an indicator of sewerage pollution or anthropogenic activity. Multiple variate linear models using forward stepwise regression techniques have been applied to the data at each site investigate the sources of C4. The models had a mean R2 of 0.0.800 and used between 2-3 predictors (mean 2.21). Dissolved potassium was the most common (18 times) and dominant predictor (average beta coefficient = 0.680). The second and third most common predictor was dissolved calcium (7 times) and total bacteria counts (4 times). These

results were expected, as dissolved potassium has been used as a sewerage indicator. However, the regular occurrence of total bacteria suggests that the C4 component might have a bacteriological element as well.