Highlight Topics 2018

Announcement of Opportunity

Issued on: 30 November 2017
Full Proposals deadline: 16:00 on 14 March 2018

1. Summary

NERC invites proposals for the fourth round of highlight topics, a route for funding strategic research. Highlight topics focus strategic research on defined topic areas, and will be delivered through independent projects. The highlight topics in this call are:

A. Emerging risks from microplastics in the marine environment
B. What is the 4PM? New understanding of soil organic carbon persistence to meet C offset targets
C. Policy-relevant climate science to quantify and manage the risk of climate hazards
D. Deep subsurface heat as a potential major future energy resource
E. Multiphase evolution of volcanic emissions
F. Preservation and potential of seafloor mineral resources
G. The impact of light pollution on biological processes
H. Understanding urban soil properties, functions, and below-ground inter-connections in delivery of ecosystem services
I. Impacts of future ship traffic and emission regulations upon gas-phase chemistry, aerosol composition and radiative forcing in the North Atlantic and Arctic atmosphere
J. Objective verification of national carbon budgets for assessing climate change mitigation measures

A notification of intent must be submitted via by 23 January 2018 16:00. The closing date for full proposals is 16:00 on 14 March 2018. Proposals must be submitted via the research councils' Joint electronic-Submissions (JeS) system. Full JeS proposals submitted without prior notification of intent will be rejected.

The maximum value for proposals under each topic area are provided below. For this Highlight Topic call, NERC will consider exceptional cases for exceeding the £1.5m limit for proposals to Topics A to I. Refer to section 5.5 for more detail.

2. Background

NERC's vision is to place environmental science at the heart of responsible management of our

planet. NERC's goals are to fund excellent, peer reviewed environmental science that helps us:

- understand and predict how our planet works
- manage our environment responsibly as we pursue new ways of living, doing business, escaping poverty and growing economies

NERC's strategic research funding supports research that addresses some major challenges of the 21st century: benefiting from natural resources, resilience to environmental hazards and managing environmental change.

NERC's funding streams for strategic research enable the environmental science community to play a role in setting priorities for research funding. Highlight topics are a funding stream that focuses strategic research on defined topic areas.

3. Scope

The following highlight topics have been selected for this call and are considered to be of equal priority. There are more highlight topics announced than available funding will support, so all topics will not, necessarily, result in funded grants. This is to ensure effective competition so that only the very best research is funded.

Proposals must address issues within a single highlight topic; proposals addressing more than one highlight topic will not be accepted. Where multiple proposals are invited within a highlight topic, they must be independent projects and coordination is not required between projects to achieve their aims.

A. Emerging risks from microplastics in the marine environment

Objective

This highlight topic builds on the UK's existing strong international standing in this field by supporting research that addresses a number of gaps in our understanding of marine microplastics and their potential impact on ecosystems.

Strategic context

Microplastics have been identified in diverse habitats and locations across the globe, and have increasingly been identified in animals, including those intended for human consumption or occupying important ecological niches. Microplastics are pieces, fibres, fragments and films of plastic smaller than 5 mm with no lower size limit that differ in size, shape, specific density and chemical composition, including synthetic textile fibres, microbeads from cosmetic and industrial applications and the breakdown of larger items. The small size of microplastics means that they are readily transported into the sea where they pose considerable risk to the marine environment and potentially to human health through the food chain because their size overlaps with the preferred prey size for a wide range of marine organisms. Toxicity could be caused by the plastic polymer itself, the additives it contains, or by other chemicals that associate with microplastics when they are in the ocean. The high surface area to volume ratio and hydrophobic nature of microplastics

enhances the absorption of priority pollutants and microbial communities, raising the likelihood of the movement and transfer of pollutants into tissues.

Whilst the scale and extent of microplastics has recently emerged, there is a lack of fundamental understanding of source to sink dynamics, how plastics behave once they reach the environment, and the risk they may pose to ecosystems. National and international environmental legislation places a requirement on the UK to keep contamination of marine habitats to a level that causes no harm, with a target date of 2020, and the continuous accumulation and longevity of plastic in the marine environment raises the potential for direct economic impacts on specific sectors and communities.

Scope

This highlight topic will require a broad range of environmental scientists to work together to understand current and future status, and work towards feasible solutions to reduce risks of microplastic pollution to ecosystems. Proposals are encouraged to develop partnerships, where appropriate, with government departments and agencies, and with industry (e.g. water, food).

Scientific advances

The main research questions that proposals for this highlight topic could address are:

a. What are the optimal methods for identifying and characterizing microplastics in diverse environmental media and biological tissues, are novel methods needed and if so, what do we require in terms of sensitivity, specificity and practicality?

b. What are the physico-chemical and ecological factors that govern how microplastics move, behave and interact with ecological and biogeochemical processes?

c. What is the potential for microplastics to cause ecotoxicity across levels of biological organization? Which mechanisms are most important (chemical, physical, biological) and are certain species or habitats more vulnerable to contamination and impact?

In addition, proposals may focus a limited amount of funding on addressing the question:

d. What are the potential impacts of marine microplastics on ecosystem services, and what are the options to monitor or mitigate these impacts?

Delivery

This highlight topic should be addressed by up to two projects, each up to the value of £1.5m at 80% FEC (£1.875m 100% FEC) and up to four years in duration. Individual proposals are not required to address all parts of the highlight topic scope.

B. What is the 4PM? New understanding of soil organic carbon persistence to meet C offset targets

Objective

This highlight topic will improve our fundamental knowledge of soil organic carbon (SOC) dynamics to help deliver carbon-offset targets through informing management practises that enable the

sequestration of carbon in soil. This will help inform current policy gaps and specifically explore options to deliver the **"4 pour mille"** (4p1000) initiative that advocates increasing SOC by 0.4% per year to both reduce the rise in atmospheric CO2 emissions, and contribute to overall improved soil health.

Strategic context

Soils are one of the largest stores of exchangeable carbon and offer significant potential for slowing the rise in greenhouse gas (GHG) emissions. This has important co-benefits for maintaining agriculture production and regulating water quality as SOC is the single most important property of soil, which underpins a wide range of soil functions. The 2015 Paris Agreement on tackling climate change targeted net zero global GHG emissions in the second half of this century to limit global warming to below 2°C. This has led to recent initiatives calling for a global effort to increase soil organic carbon (SOC) stocks for climate change mitigation and food security. The recently publicised 4 per 1000 initiative sets global targets to increase SOC by 0.4% per year to slow the rise in current emissions. However, the evidence base for implementing land management recommendations is limited due to uncertainties as to the long-term persistence of short-term SOC gains. Furthermore, evidence from GB national soil monitoring programmes suggest currently the direction of travel in our arable systems is a loss not an increase in SOC by 0.4% per year over the last 25 years and soil is a net contributor to the UK GHG budget rather than a net sink.

Scope

New technologies including "omics", isotopes and physical imaging enable detailed assessment of these processes, facilitating the testing of hypotheses of SOC stabilisation by providing new quantitative evidence for persistence mechanisms. New research needs to determine the biochemical nature and production pathways of SOC pools with different stabilities, and establish how management affects the biological and physico-chemical regulation of process rates at appropriate scales.

Scientific advances

Current soil models assume persistent SOC consists of recalcitrant "humic" macromolecules formed by undefined transformations of organic inputs. Recent research suggests that the dominant forms of stabilised SOC are in fact chemically labile but unavailable to decomposition agents.

This highlight topic considers the following questions to address the unresolved paradox: all SOC is essentially decomposable, so why does some of it persist?

1. *What are the biological, biochemical, and environmental processes controlling the transformation of organic inputs into persistent SOC entities?*
2. *How do these persistent entities emerge via biological, chemical and physical processes at soil pore to aggregate scales over time?*
3. *Can land management control the quantities of stabilised SOC stored in soil via these processes?*
4. *Can SOC persistence be further enhanced through knowledge of process mechanisms, i.e. beyond 4PM?*

Delivery

This highlight topic should be addressed by up to two projects, each up to the value of £1.5m at 80% FEC (£1.875m 100% FEC) and up to four years in duration. Individual proposals are not required to address all parts of the highlight topic scope.

C. Policy-relevant climate modelling to quantify and manage the risk of climate hazards

Objective

To deliver a state-of-the-art assessment of climate change hazards and approaches to managing associated risks, contributing to the sixth Coupled Model Intercomparison Project, CMIP6.

Strategic Context

The adoption of the United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement has brought into sharp focus the dearth of information relevant to an accelerated and combined adaptation-and-mitigation strategy for the next 30 years. The Paris Agreement aims to "Hold the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels…" Pursuit of these climate targets, and delivery of the Global Stocktake (in 2023), necessitates assessment of climate hazard interactions with ambitious mitigation policies. Near-term changes in climate hazards and their impacts exacerbate climatic and non-climatic risk, which has implications for achieving resilience to disasters (as set out in the UNISDR Sendai Framework) and the UN sustainable development goals.

Scope

This highlight topic will use policy-relevant climate modelling to quantify and manage the risk of climate hazards, including the model intercomparison projects under CMIP6.

Scientific Advances

The immediate challenge for climate science is to provide quantitative information about the emergence of climate hazards, in the next 30 years predominantly, and to provide options for emissions pathways and other mitigation strategies that safely avoid or manage the associated climate impacts. Climate change multiplies the risks associated with natural climate phenomena such as extreme rainfall events and can result in the exceeding of societally important thresholds e.g. air quality or heat stress levels that threaten human health and crop yields. The new CMIP6 models offer a step change in our understanding through unprecedented spatial resolution and representation of regional phenomena, inclusion of biogeochemical feedbacks that affect the climate response, and representation of climate forcing from short-lived reactive gases and aerosols. Specific research questions cover the emergence of climate hazards and emissions pathways to avoid such hazards and include:

<u>Emergence of climate hazards</u>

- How do forced variations in climate, from both natural and anthropogenic factors in the past 50 years constrain global and regional climate predictions of the next several decades?
- What is the current level of skill in decadal prediction of one or more climate hazard and how do we interpret new initialized predictions of the next decades?
- How does improved climate model resolution impact on our ability to simulate and estimate the potential for one or more climate hazard, e.g. global monsoon changes, extreme weather events, air quality, and other phenomena?
- How do we best quantify the changing likelihood of hazards such as heat stress that may be related to multiple impacts e.g. human health, agriculture etc.?

Near-term emissions pathways to avoid climate hazards

- What are safe and realistic post-Paris mitigation options for greenhouse gases, short-lived species and land-use change?
- How does the representation of new processes in models associated with carbon, nitrogen, phosphorous, aerosols and chemistry, wildfires and permafrost impact post-Paris emissions pathways?
- Can we better constrain uncertainties in climate feedback processes, using new in-situ and remote sensing data, to narrow the range of potential mitigation options?

Delivery

This highlight topic should be addressed by up to two projects, each up to the value of £1.5m at 80% FEC (£1.875m 100% FEC) and up to four years in duration. Applications should detail a clearly defined set of mid-point deliverables of publications aimed directly at IPCC (cut-off for papers to be accepted by summer 2020). The longer timescale delivery should be designed to feed into the Global Stocktake in 2023. Individual proposals are not required to address all parts of the highlight topic.

D. Deep subsurface heat as a potential major future energy resource

Objective

This highlight topic aims to bring about a reappraisal of knowledge of deep geothermal energy in the UK.

Strategic context

The UK faces binding targets for renewable energy generation by 2020, which require a total rethink of our energy supply towards sustainable sources. Deep natural subsurface heat offers a potentially huge resource of near zero carbon, renewable, geothermal energy (for direct heat usage or electricity generation), and its application is global. Fundamental to the successful exploitation of subsurface heat is a thorough knowledge of the thermal resource and fluid flow properties but we currently face major knowledge gaps in this. Much of the UK research on geothermal energy was carried out in the 1970s and 1980s, and many uncertainties remain from this period. It is thus timely to apply cutting-edge science, environmental monitoring, and heat extraction technologies to address the 'trilemma' of clean, affordable and secure energy supplies.

The ultimate impact of the enhanced scientific understanding resulting from this highlight topic will be greater development of, and uptake of, renewable deep geothermal energy in the UK. This will help facilitate the necessary move away from our current polluting energy technologies and our dependence on fossil fuels.

Scope

The focus of this topic is deep geothermal energy in the UK. Proposals will not use the NERC UK Geoenergy Observatories site in Glasgow as this will focus on urban renewal and low enthalpy shallow mine water geothermal rather than deep geothermal energy, the focus of this topic.

Scientific advances

Research questions that proposals could address include:

- What is the available energy in place? This would include a more precise quantification of subsurface temperatures and heat flux. Previous measurements were few in number and often shallow measurements did not reflect temperatures several km down.
- What are the processes controlling how fluids flow through hot rocks? What feedback mechanisms operate to modify fluid flow? This would include consideration of the high rates of fluid flow within natural hydrothermal systems/engineered geothermal resources, where fluids pass through significant temperature and pressure changes.
- Given that heat transport is dominated by fluid flow processes, what are the best indicators of fluid flow? This could include fluid chemical aspects and natural tracers, deep geophysical techniques, and heat flow measurements.
- How can long-timescale induced groundwater flow be maintained with minimal degradation of resources? This would include quantification of potential processes (e.g. dissolution widening flow paths, clogging of rock permeability, production of non-hydrocarbon gases, high dissolved load leading to scale precipitation in pipework) in deeper, hotter system exploitation.
- How does the behaviour of hot rocks change during development of geothermal resources, including the role and impact of hydraulic or thermal stimulation? This would include exploiting natural systems and the potential for subsurface (seasonal) storage of waste industrial heat for subsequent utilisation at times of need like a conventional geothermal resources.
- Can we quantify deep geothermal resources by developing exploration methods to identify permeable reservoirs and hydraulically conductive fracture zones? This could include geophysical methods to probe the deep subsurface (e.g. seismic and magnetotelluric techniques) and geological methodologies (e.g. advances in knowledge of the formation of palaeokarst).
- How and where can produced subsurface heat energy be combined with the needs of industry and dwellings to maximise effectiveness of co-location, and societal uptake of subsurface energy)?

Delivery

This highlight topic should be addressed by up to two projects, each up to the value of £1.5m at 80% FEC (£1.875m 100% FEC) and up to four years in duration. Individual proposals are not required to address all parts of the highlight topic.

E. Multiphase evolution of volcanic emissions

Objective

To improve characterisation of the multiphase processes experienced by volcanic emissions from source to sink to enable a significant step-change in our ability to predict eruption cloud evolution and deposition.

Strategic Context

Events similar to that of the April 2010 Icelandic crisis have a likelihood of between 5 and 50% of occurring over the next 5 years. Globally, volcanic eruptions occur daily, while historically large eruptions happen on decadal scales. There is, therefore, urgent need to understand and parameterise the processes that limits contemporary predictive capability if we are to minimise loss of life and optimise the balance between economic loss and safety as volcanic eruptions interact with society.

Scope

This highlight topic will focus on fundamental physical processes and feedbacks in the source region and during transport and deposition of volcanic emissions.

Scientific Advances

Contemporary model representations of the atmospheric transport of volcanic emissions show significant discrepancies with observational measurements in the atmosphere, on the ground and in the laboratory. This poor model validation indicates failure adequately: (1) to represent and to parameterise fundamental volcano-atmosphere processes, and (2) to process observational data to yield accurate metrics. We are particularly limited in our ability: (a) to predict volcanic emission concentrations in the atmosphere and on the ground; (b) to recognise and to quantify uncertainties in model outputs, and (c) to characterise the magnitudes and impacts of past events that inform our understanding of the future.

Research questions that proposal could address include:

- Under which circumstances, and to what extent, do the following have a controlling influence on effective ash sedimentation velocity: aggregation, disaggregation, electrostatic processes, precipitation and condensation processes, chemical reactions?
- How do ash particles interact with all phases of water in the atmosphere and with trace gases?
- How does the interaction between volcanic emissions and atmospheric turbulence on all scales influence the dispersion and sedimentation of particles?
- How do the two-way interactions between thermal plume dynamics, atmospheric dynamics, stratification and solar radiation influence the dispersion and sedimentation of volcanic emissions?
- How can improved characterisation of the interaction between volcanic emissions and the atmosphere be used to facilitate the retrieval of accurate metrics from ground-based and space borne remote sensing methods (including lidar and radar)?
- How can models, used operationally (e.g. the international Volcanic Ash Advisory Centres) and for research, best incorporate these parameters and account for uncertainties?

Delivery

This highlight topic should be addressed by up to two projects, each up to the value of £1.5m at 80% FEC (£1.875m 100% FEC) and up to four years in duration. Individual proposals are not required to address all parts of the highlight topic.

F. Preservation and potential of seafloor mineral resources

Objective

The aim of this highlight topic is to enhance our knowledge of the metallogeny of the oceans in order to verify the strategic value of and contribute to the global assessment of deep-sea mineral resources.

Strategic context

Deep-sea mineral deposits potentially represent vast metal resources, which could make a major contribution to future global raw material supply. These polymetallic deposits form a continuum from nodules and crusts rich in the major industrial metals (e.g. nickel, copper, cobalt, manganese, titanium) and many minor elements (e.g. tellurium, platinum, molybdenum, niobium, bismuth, rare earth elements) to seafloor massive sulphide (SMS) deposits containing abundant copper, zinc, gold and silver. It is this combination of enrichment in the major industrial and precious metals, and the extreme concentration of some critical E-tech elements that makes seafloor mineral deposits particularly attractive to science, industry and society. Increasing demand for these elements required to enable a low-carbon and high-technology society and pressure on land-based resources may necessitate the extraction of these deep-sea mineral resources within the next decade. It is predicted that by 2035, 10% of the world's minerals could come from the ocean floor. The UK has developed advanced technologies and skills during the growth of its oil and gas sector that are highly transferable to the extraction of deep-sea minerals, and the potential for increasing innovation is great.

Scope

Proposals will investigate deep-sea mineral deposits with a particular focus on extinct seafloor massive sulphide (SMS) deposits.It is expected that individual proposals will focus on one site but that several key research questions are addressed at that one location.

Scientific advances

Research questions that proposals could address include:

- What are the principal geological controls on deposit size? This question has a particular focus on the relationship between hydrothermal activity and ridge spreading rate.
- Are giant deposits forming in sedimented rifts, which insulate the systems and prevent loss of metals from surface vents?
- What are the optimum environmental conditions for seafloor massive sulphide (SMS) preservation and maximising metal concentrations? This question has a particular focus on:
    - post-depositional tectonic controls on fluid flow and the depth of seawater penetration;
    - the effects of oxygenated seawater on the system, and the subsequent mobilisation of metals through brine formation, mineral dissolution, ligand complexing, and dissolution of anhydrite;
    - the role of mineral–fluid–microbe interactions on the redistribution of metals; and
    - the importance of supergene processes (e.g. development of jasper-rich zones).
- What timescales do these alteration processes operate over?

- What is the extent and scale of vertical and lateral chemical zonation in SMS deposits, and what implications does this have for using seafloor sediment geochemistry as a vector towards mineralisation?
- Can information from drill cores be integrated with geophysical data to elucidate the 3-dimensional composition and architecture of SMS deposits, and develop more efficient and cost-effective exploration methods?

Delivery

This highlight topic should be addressed by up to two projects, each up to the value of £1.5m at 80% FEC (£1.875m 100% FEC) and up to four years in duration. Individual proposals are not required to address all parts of the highlight topic.

G. The impact of light pollution on biological processes

Objective

This highlight topic will provide an important evaluation of ecological and evolutionary consequences of the continuous and global increase in the extent of light pollution, specifically artificial light at night (ALAN).

Strategic context

As yet there has been no evaluation of the short- and long-term impact of a major environmental stressor: namely the continuous and global increase in the extent of light pollution. So far, the environmental impacts of other aspects of urbanisation (such as pollution, habitat loss and noise) have received far more attention than that of light pollution. This highlight topic will provide quantitative evidence of the nature of the impact and its likely effects on biodiversity and ecosystem processes in urban areas.

Scope

Artificial light at night is increasing rapidly across the world due to the spread of urbanisation. Adverse effects on wild organisms have to date been largely speculative. Studies of humans and laboratory animals indicate that the disruption of biological clocks increases disease and lowers survival. However, there is a striking knowledge gap on effects of circadian disruption on free-living organisms.

Given this knowledge gap, the key objective of this highlight topic is to understand better the potential short- and long-term impacts of ALAN on urban ecosystems, the capacity of organisms to adapt to it, or the ways in which its effects can be mitigated.

Scientific advances

It is inevitable that light pollution will continue to increase as the world becomes more urbanised – but what are the consequences, and how can any adverse effects be minimised? It is now accepted that light:dark schedules in humans may entrain biological clocks working at every level from gene expression through to daily temperature cycles, but little is known on the impact on urban organisms and urban ecosystems more broadly. Given this lack of knowledge, this highlight topic will address the following questions:

1. *The effect of ALAN on individual species*: To what extent are the natural circadian rhythms (operating at molecular, cellular and organismal level) of urban-living organisms disrupted by ALAN? How significant is the problem of migrating birds being attracted to light sources?

2. *The impact on ecological communities*: How does ALAN affect the interactions between species (e.g. predator-prey dynamics, interspecific competition), and hence the biodiversity of urban environments? Is this due to altered circadian activity rhythms, movement patterns (attraction vs. avoidance of light) or simply improved vision at night?

3. *The long-term consequences*: Does prolonged exposure to ALAN lead to the evolution of altered sensitivity to light schedules, or to the use of different environmental cues to entrain biological rhythms – or does it lead to the weakening of such circadian rhythms at the molecular, cellular and whole organism levels? Do urban populations evolve a reduced attraction to light sources?

4. *The potential for mitigation*: Is it possible to maintain 'natural' circadian rhythms in animals living in an urban environment through modification of the wavelengths or intensities of human light sources? Similarly, can lights be designed that are less attractive to wildlife?

Delivery

This highlight topic should be addressed by up to two projects, each up to the value of £1.5m at 80% FEC (£1.875m 100% FEC) and up to four years in duration. Individual proposals are not required to address all parts of the highlight topic.

H. Understanding urban soil properties, functions, and below-ground inter-connections in delivery of ecosystem services

Objective

This highlight topic will improve knowledge of urban soils to understand better their properties and how they deliver the ecosystem services required of them, including support of green infrastructure projects. The objective is to inform on the quality and quantity of ecosystem services provided by soils across urban landscapes, enabling more effective management at a range of spatial and temporal scales relevant to contrasting urban environments.

Strategic context

Urban ecosystems provide vital services to humans, but soils that underpin delivery of almost all of them are neither protected nor well understood. With increasing urbanisation, there is an urgent need to deliver a step-change advance in our knowledge of the properties within, and below-ground interactions between, all these major soil types across highly fragmented urban landscapes. The global area sealed under 'grey infrastructure' of roads, car parks and buildings now exceeds 580,000 km^2. We know more about the microbiology and biogeochemistry on Antarctica and in deep oceans than in soils under and around our buildings and streets, and yet this is where the majority of the global population lives.

We need to address this knowledge gap if we are to maximise the benefits from potentially novel biological communities and parent materials e.g. in carbon capture and contaminant containment, whilst minimising the potential threats including enhanced flood risk, structural instability and contaminant leakage. Healthy urban soils will be critical to the success of green infrastructure projects, which aim to work with nature to provide an ecological framework for improved social, economic and environmental health.

Scope

Typical urban soils include those under relatively undisturbed green spaces; "Technosols" formed from artificial material (rubble, spoil) or translocated from another site; and surface 'sealed' soils.

With increasing urbanisation, there is an urgent need to advance our knowledge of the properties within, and below-ground interactions between, all these major soil types across highly fragmented urban landscapes. The lateral and vertical extents of physical, chemical and biological interactions between adjacent sealed, unsealed, and Technosol soils in the patchwork urban landscape are unknown.

Scientific advances

Due to lack of research into the properties within, and interactions between, different urban soil types, we are unable to address the following three questions. The answers require new knowledge and are critical to developing scientifically informed management to deliver urban soil security and the essential ecosystem services underpinned by soils.

1. *Are there unique properties of urban soils that impact on their provision of ecosystem services?*

- To what extent do green space soils, Technosols, and sealed soils differ in structure and function from 'natural' soils due to novel parent materials, vertical and lateral discontinuities, water and solute transport, gas exchange, weathering urban pollutants, and biological activities?
- How does carbon behave in urban soils? For example, does black carbon soot increase organic carbon storage and reduce heavy metal and persistent organic pollutant toxicity in urban soils?
- Does sealing arrest the development of the underlying soil or divert it to a different endpoint, and is the type (e.g. asphalt versus concrete), depth, duration and lateral extent of sealing important?
- How biodiverse are urban soils, and are their microbial communities distinct (e.g. in sealed soils)?

2. *How important are lateral and vertical interactions between soils in fragmented urban landscapes?*

- How much connectivity occurs between different urban soil types? Over what vertical and lateral scales can carbon, nutrients, water, gases and organisms move between the soil types?
- What are the typical spatial scales of below-ground interactions between adjacent soils and their patch sizes and how does this impact on the success of green infrastructure projects across the urban landscape?

3. *How can we protect the functions and ecosystem services provided by urban soils?*

- What actions are needed to protect the functions of urban soils and improve their delivery of services such as flood mitigation, support for green, brown and blue infrastructure, water filtration, cooling of the urban heat island, own-grown food production, and biodiversity? Can we set standards for soil management in future green infrastructure projects?

Delivery

This highlight topic should be addressed by up to two projects, each up to the value of £1.5m at 80% FEC (£1.875m 100% FEC) and up to four years in duration. Individual proposals are not required to address all parts of the highlight topic.

I. Impacts of future ship traffic and emission regulations upon gas-phase chemistry, aerosol composition and radiative forcing in the North Atlantic and Arctic atmosphere

Objective

To increase our understanding of the impact of future ship traffic and emission regulations upon gas-phase chemistry, aerosol composition and radiative forcing in the North Atlantic and Arctic atmosphere.

Strategic Context

In January 2020 the maximum sulphur emission by ships in international waters will reduce from 3.5% to 0.5% by mass, as a result of new International Maritime Organisation (IMO) regulations. This will cause substantial changes in the chemistry, aerosol composition and radiative forcing in the North Atlantic basin, which contains several of the busiest shipping routes in the world. In the Arctic, the predicted increase in shipping traffic through the Northwest Passage will impact a relatively pristine environment. It is thus timely to develop the necessary observational strategy and modelling framework in order to quantify the present day state and understand the impact of shipping regulations and their atmospheric consequences.

Scope

This highlight topic will use the opportunity presented by the drastic reductions in sulphur emissions from ships in international waters in 2020 to understand impacts on atmospheric chemistry, aerosols, clouds, and climate in the North Atlantic and Arctic.

Scientific Advances

Anthropogenic activities have a marked influence on the atmospheric composition over the Atlantic Ocean and on the present day aerosol/climate. Quantifying this anthropogenic influence is challenging, however, in part due to the uncertainty surrounding the influence of natural, pre-industrial aerosol. Drastic reductions in sulphur emissions from ships in international waters in 2020 will present a unique opportunity to: 1) observe an environment more similar to the pre-industrial "past"; 2) test the skills of our present models; and 3) improve our understanding in order to forecast future change. To take advantage of this opportunity observation-based, present-day baselines will need to be established.

Alterations in ship traffic routes and sulphur emission changes across the Atlantic and Arctic oceans will have important ramifications for atmospheric chemistry (e.g. pH, SOx, NOx), aerosols (e.g. AOD and elemental composition), clouds, and climate. Such large changes will be very suitable for regional/basin-scale modelling and Earth Observation studies.

Research questions that proposals could address include:

1. Does reduced SO_2 make emissions of dimethylsulphide and other marine organics more important CCN precursors?
2. How do different methods for reducing sulphur emissions (using low sulphur fuel vs scrubbing ship exhaust) impact NOx, ozone, and trace metal cycling?
3. Will reduced ship SO2 emissions result in warming of the North Atlantic through the indirect and direct aerosol radiative effect?

4. How will the opening of the Northwest Passage as a major shipping route impact the Arctic environment?

Delivery

This highlight topic should be addressed by up to two projects, each up to the value of £1.5m at 80% FEC (£1.875m 100% FEC) and up to four years in duration. Individual proposals are not required to address all parts of the highlight topic.

J. Objective verification of national carbon budgets for assessing climate change mitigation measures

Objective

To improve evaluation of UK greenhouse gas (GHG) emissions at the sub-national and sectoral level; and provide better understanding of the UK's GHG sources and sinks.

Strategic Context

There is an urgent need to develop measurement systems to objectively quantify greenhouse gas fluxes to ensure that countries are accurately accounting for their contribution to climate change, assess implemented mitigation measures, and better understand the processes that lead to GHG feedbacks. In the UK the state-of-the-art is the estimation of GHG net flux at the regional or national scale. New developments are needed to evaluate emissions at the source-sector level (e.g. fossil fuel, biogenic, etc.), and at finer scales (e.g. county, metropolitan). This is required for three primary reasons. Firstly, emissions reporting measures and mitigation activities are predominantly concerned with specific sectors, rather than a country's net flux. Secondly, process-based model estimates of terrestrial and oceanic flux can be improved using atmospheric observations if their influence on the data can be disaggregated from other sources. Thirdly, concentrated sources such as cities make up a significant, and growing, fraction of national emissions and are typically at the forefront of mitigation activities (e.g. www.c40.org), but their emissions can be poorly constrained.

Scope

This highlight topic aims to develop the UK's measurement and modelling capability to improve GHG evaluation systems and better understand the UK's GHG sources and sinks.

Scientific Advances

Research questions that this proposal should address are:

1. What is the role of individual source and sink sectors and atmospheric transport in explaining the observed variability in the UK's atmospheric GHG observations?
2. Are reports of the UK's GHG emissions and the predictions of terrestrial and oceanic models consistent with atmospheric observations at the source-sector level?
3. What level of uncertainty remains in our estimates of GHG flux, when all available data have been used?

In answering these questions the following scientific advances may be delivered:

1. The development of time-resolved (i.e. hourly), high-resolution (~1km) process-based estimates of CO_2, CH_4 and N_2O emissions for the UK from anthropogenic, terrestrial and oceanic sectors, which are required to simulate atmospheric GHG variability
2. The development of new observations of tracers of sector-level GHG activity, which should involve making better use of established observations (e.g. CO as a tracer for fossil-fuel CO_2), expanding the UK's capacity in areas that began in the GHG Emissions and Feedbacks programme (e.g. $^{14}CO_2$ observations), and the development of new high-precision, high-frequency isotopic and chemical tracers (e.g. 222Rn, O_2, δ13C-CH_4)
3. The exploitation of remote-sensing observations for national and megacity-level flux estimation
4. Re-evaluation of the physical transport processes in atmospheric chemical transport models to improve their representation of high-resolution GHG transport
5. Improved methods for robust quantification of systematic uncertainties in both "bottom-up" and "top-down" flux estimates

Delivery

This highlight topic should be addressed by a single project up to the value of £3m at 80% FEC (£3.75m 100% FEC) and a duration of four years. Individual proposals are required to address all the research questions in this highlight topic.

4. Programme requirements

4.1. Programme funding

NERC has allocated £24 million to this call. Please refer to the individual highlight topic scope for the maximum duration and budget limits per project. There are more highlight topics than funding is available for, so that all highlight topics will not, necessarily, result in funded grants. This is to ensure that only the very best research is funded.

4.2. Implementation and delivery

The expected start date for projects funded under this Announcement of Opportunity is no later than 1 November 2018.

4.3. Knowledge Exchange and Impact

Knowledge exchange (KE) is vital to ensure that environmental research has wide benefits for society, and should be an integral part of any research.

All applicants must consider how they will or might achieve impact outside the scientific community and submit this with their application as a Pathways to impact statement, with associated delivery costs where relevant. Pathways to Impact activities do not have to be cost-incurring; it is not a requirement to include funded activities. Any funds required to carry out any proposed, outcome-driven activities identified within the Pathways to Impact **must** be fully justified within the Justification of Resources statement.

The Pathways to Impact will identify those who may benefit from or make use of the research, how they might benefit or make use of the research, and methods for disseminating data, knowledge and skills in the most effective and appropriate manner.

An acceptable Pathways to Impact is a condition of funding. Grants will not be allowed to start unless unacceptable Pathways to Impact are enhanced to an acceptable level within one month of notification of the panel outcome.

4.4. Data Management

The NERC Data Policy must be adhered to, and an outline data management plan produced as part of proposal development. NERC will pay the data centre directly on behalf of the programme for archival and curation services, but applicants should ensure they request sufficient resource to cover preparation of data for archiving by the research team.

4.5. NERC Facilities

Prior to submitting a proposal, applicants wishing to use a NERC service or facility must contact the facility to seek agreement that they could provide the service required. Applicants wishing to use most NERC facilities will need to submit a mandatory 'technical assessment' with their proposal. This technical assessment is required for aircraft but not for NERC Marine Facilities (NMF – Shiptime and/or marine equipment) and HPC. For NERC, this means a quote for the work which the facility will provide. A full list of the Facilities requiring this quote can be found on the NERC website. The costs for the service or facility (excluding NMF and HPC costs) must be included within the Directly Incurred Other Costs section of the Je-S form and also within the facilities section of the Je-S form. Further information on NERC services and facilities can be found on the NERC website.

Proposals to Topics A, I, F and J may require ship time and other marine facilities. Applicants wishing to use NERC's marine facilities must complete an online Shiptime and Marine Equipment (SME) application form on the Marine Facilities Planning webpage. The SME number should be included on the Je-S grant proposal form under Services and Facilities. SMEs for any projects in this Highlight Topic call must be submitted and approved by NERC Marine Planning by the time the proposal (Je-S form) is submitted, so that a pdf of the SME can be attached as a facility form. Applicants intending to apply for NERC's marine facilities should also contact Natalie Clark in NERC Marine Planning to discuss shiptime and equipment needs.

4.6. Programme management

Project PIs are responsible for the management and delivery of their projects. Coordination between projects within a highlight topic is not required.

4.7. Reporting requirements

There will be a requirement to report through the RCUK reporting system; this is required annually and continues for up to five years post grant end. As set out in Section G of the NERC research grant and fellowships handbook, successful projects are required to submit annual reports of Outputs and Performance Measures (OPMs) and a Final Expenditure Statement. For strategic research investments, including successful highlight topic grants, NERC additionally requires biannual progress reports.

5. Application process

5.1. How to apply

Applicants are encouraged to contact the NERC office at an early stage to discuss any questions on call procedures. The Research Grants Team (researchgrants@nerc.ac.uk) acts as the first point of contact for highlight topic grant proposals. Scientific and remit queries should be emailed to highlighttopics@nerc.ac.uk.

A notification of intent must be submitted by 23 January 2018 16:00. Tell us the topic you plan to apply against, the institutions, investigators and project partners that are expected to be involved and include a title and abstract of your planned work. The abstract will not be assessed, but NERC will use the information to plan the proposal assessment. **Full JeS proposals submitted without a prior notification of intent will be rejected.**

5.2. Full Proposals

Closing Date: 16:00 on 14 March 2018

Full proposal must be submitted using the Research Councils' Joint Electronic Submission system (Je-S). Applicants should select Proposal Type - 'Standard Proposal' and then select the Scheme – 'Directed' and the Call – 'Highlight Topics 2018'.

The Highlight Topics 2018 call will close on JeS at 4pm GMT on 14 March and it will not be possible to submit to the call after this time. Applicants should leave enough time for their proposal to pass through their organisation's Je-S submission route before this date. Any proposal that is incomplete, or does not meet NERC's eligibility criteria or follow NERC's submission rules (see NERC research grant and fellowships handbook), will be office rejected and will not be considered.

All attachments, with the exception of letters of support and services/facilities/equipment quotes, submitted through the Je-S system must be completed in single-spaced typescript of minimum font size 11 point (Arial or other sans serif typeface of equivalent size to Arial 11), with margins of at least 2cm. Please note that Arial narrow, Calibri and Times New Roman are not allowable font types and any proposal which has used either of these font types within their submission will be rejected. References and footnotes should also be at least 11 point font and should be in the same font type as the rest of the document. Headers and footers should not be used for references or information relating to the scientific case. Applicants referring to websites should note that referees may choose not to use them.

Applicants should ensure that their proposal conforms to all eligibility and submission rules, otherwise their proposal may be rejected without peer review. More details on NERC's submission rules can be found in the NERC research grant and fellowships handbook and in the submission rules on the NERC website.

Proposals for topics A-I (£1.5M grants) should be submitted in Standard grant format (10 page case for support – NERC research grant and fellowships handbook paragraph 203). Proposals for topic J (£3M grant) should be submitted in Large grant format (21 page case for support – NERC research grant and fellowships handbook paragraph 212). The full requirements are outlined in Section F of the NERC research grant and fellowships handbook.

Please note that on submission to council ALL non PDF documents are converted to PDF, the use of non-standard fonts may result in errors or font conversion, which could affect the overall length of the document.

Additionally where non-standard fonts are present, and even if the converted PDF document may look unaffected in the Je-S System, when it is imported into the Research Councils Grants System

some information may be removed. We therefore recommend that where a document contains any non-standard fonts (scientific notation, diagrams etc), the document should be converted to PDF prior to attaching it to the proposal.

No associated studentships can be requested under this call.

The expected start date for projects funded under this Announcement of Opportunity is 1 November 2018.

5.3. Eligibility

Normal individual eligibility applies and is in Section C of the NERC research grant and fellowships handbook. Research Organisation eligibility rules are in Section C of the NERC research grant and fellowships handbook.

NERC research and fellowship grants for all schemes may be held at approved UK Higher Education Institutions (HEIs), approved Research Council Institutes (RCIs) and approved Independent Research Organisations (IROs). Full details of approved RCIs and IROs can be found on the RCUK website.

Investigators may be involved in no more than two proposals submitted to this call and only one of these may be as the lead Principal Investigator.

5.4. Maximum funding limit for proposals

The maximum value for proposals under each topic area is provided in section 3. Proposals to topics A to I can request funding up to £1.5m at 80% FEC (£1.875m 100% FEC) and proposals to topic J can request funding up to £3m at 80% FEC (£3.75m 100% FEC). Costs for the NERC Marine Facility (NMF - ship time and marine equipment) will not be known at the time of application and do not need to be included within these limits.

5.5. Exceptional permission to exceed the funding limit

For this Highlight Topic call, we will consider exceptional cases for exceeding the £1.5m limit for proposals to topics A to I. The process for applying for exceeding the £1.5m limit is the same as for Standard grants (see Section B, paragraphs 14 to 17 of the NERC research grant and fellowships handbook.) The funding limit will only be extended in exceptional cases and any proposal, which exceeds the limit without permission, will be rejected. For this call, a case for exceeding the maximum limit must be submitted to researchgrants@nerc.ac.uk by 23 January 2018 at the latest and you should receive a decision within 10 working days.

6. Assessment Process

Full proposals will undergo expert peer review (see the pre-award assessment process and minimal/optimal review levels of grants). Applicants will have the opportunity to respond to reviewer comments before consideration by the highlight topic grants moderating panel, that will allocate final scores and rank proposals based on research excellence and fit to scheme of the scientific objectives (the appropriateness of the research proposed for the highlight topic; this call does not assess non-scientific objectives).

Where up to two grants may be awarded within a topic area, individual proposals are not required to address all parts of the highlight topic scope. Proposals will be scored independently. During the final ranking process, when considering which proposal for a specific topic to rank second the panels will review whether the science in the lower ranked proposal is sufficiently different from the first to

justify funding. The moderating panel will also examine the strength of the management arrangements, resources and whether the pathways to impact proposed are appropriate.

The moderating panel will be comprised of Peer Review College members, augmented if necessary by relevant experts from outside the College. The aim will be to use at least half from the core membership of the Peer Review College (expertise and conflicts of interest allowing).

NERC will use the recommendations of the moderating panel along with the overall call requirements and the available budget in making the final funding decisions. The highest ranked proposals will be funded, irrespective of the highlight topic to which they apply. However, the funding limit specified for each highlight topic will be applied. If the budget is not fully allocated using this approach or more funds are available, NERC may choose to fund additional high quality proposals from the ranked list.

7. Timetable

Summarise key dates e.g:

- Announcement published: 30 November 2017
- Notification of intent due: 23 January 2018 16:00
- Deadline for submission of full proposals: 14 March 2018 16:00
- Moderating panel meets: September 2018
- Latest start date for projects: 1 November 2018

8. Contact

For eligibility, application process and peer review queries, please contact researchgrants@nerc.ac.uk. For scientific and remit queries, please contact highlighttopics@nerc.ac.uk.