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| **Research Group** | **Centre for Atmospheric Sciences** |
| **Date due** | **w/c 11/1/2021** |

Please complete this form to tell us about your future plans for your Research Group. You are asked to complete a 1 page strategic three-year plan for your Research Group and also to detail your plans for infrastructure and technical support, highlighting areas where investment is required, what academic hires would help to deliver your strategy, and outline your expected research income generation over the next year.

**Strategic Research Plan for next 3 years 2021-2023**

Over the next 3 years CAS will seek to continue to maintain and grow its core areas, largely through UKRI funding, particularly, though not exclusively NERC and also seek to widen our research portfolio by developing new areas of research that build on our strengths and link directly to University strategic areas, UKRI priorities and areas identified in the BEIS strategic research plan.

***Likely long-term directions which may require addressing through academic hires/infrastructure:***

A priority area for investment is in Climate/Earth System science. This is of strategic importance for UoM and for DEES since at present UoM has little capacity for work on integrated Earth System science yet many future challenges identified in the BEIS strategic plan and the UKRI strategies are based around sustainable solutions to environmental challenges and require an integrated science assessment to link to strong areas of mitigation, adaptation and engineering solutions elsewhere on campus. This area contributes significantly to the new Sustainable Futures Platform within the University and interfaces with multiple Institutes across campus. The investment should be seen in a wide context and may well involve use of climate model data sets or of data science methods to assess current and future Earth System challenges, linking to the new NERC Digital Solutions Platform. This area would align strategically with Environmental Science teaching priorities in climate science. Without such an investment Manchester needs to look externally for partners in this area.

***Main goals and targets to be achieved:***

Growth in income of 10%/annum over 3 years; Increase proportion of non-NERC funding income; Increase in PhD students building on overseas relationships and recruitment from new Masters programmes; maintain high quality outputs across the group; increase number of research fellows in the group

***Current activities that will grow or reduce:***

Environmental Data Science: Funding through the EPSRC UKCRIC capital programme for SmartCities has enabled substantial expansion of urban data networks. The NERC Digital Solutions Platform has also provided £7M strategic funding that can be aligned with this area. This offers substantial opportunities through new UKRI proposals and also leveraging industrial and government funding as well as developing research impact through smart city investments across GM.

Air pollution: CleanAir wave 1 funding has led to development of the Manchester Air Quality Supersite at the Firs and this will form the basis of further AQ research in the coming years.

Cloud physics research will build on the already funded NERC Clouds and Climate programme. These projects form a platform for further developing research in this area, including work with the Met Office e.g. existing work combining practical work in MICC to enhance the MO Unified Model representation of cirrus.

FAAM Mid Life Upgrade: NERC has prioritised an upgrade to the FAAM research aircraft as its next major capital project though at present BEIS sign off has not yet been guaranteed. The investment will be in the region of £50M and will involve substantial investment in science capability as well as the aircraft infrastructure. CAS is well placed to benefit from the capital investment and also the future research opportunities that an upgraded aircraft will deliver since we are one of the largest users of the current aircraft in the areas of Cloud Physics, Greenhouse Gases, Aerosols and Gas Chemistry

The group has been very successful in growing its capital equipment base. Investments through NCAS have been substantial (£145 k in 19/20 and £356 k in 20/21, on top of the AQ supersite £0.75M and UKCRIC £1M). UKRI capital investment is often released on short timescales so projections are difficult but NCAS provides access to these opportunities and is likely to do so in future. These may well grow as UKRI releases more capital funding in future.

We have substantial international linkages with India, China, Brazil and elsewhere and have had considerable success through the Newton and GCRF programmes. Most recently this has involved research on climate change, deforestation and the Amazon with Brazilian Agencies and the Met Office. It is clear that Newton and GCRF funding will change focus in future but it is likely that international partnership funding will continue in future and we are well placed to take advantage of these opportunities.

***Future areas for expansion and development.***

Air Quality and Human Health: the aerosol chamber has been successfully used in a pilot study to investigate health impacts of exposure to air pollution. This opens some major new avenues of research to be explored. It may require new infrastructure which could be in DEES or in FMBH at the Clinical Research Facility at the MRI. UKRI CleanAir Wave2 is providing the first main opportunity for developing funded research in this area.

Indoor Air Pollution: There is substantial interest in indoor air pollution that is likely to grow appreciably in the coming years and is likely to bring together work on standard pollutants with the developing bioaerosol area. Current UKRI CleanAir wave 2 funding opportunities include expansion of indoor bioaerosol research.

Greenhouse gas budgeting: There is a growing (and already substantial) interest in national GHG budgeting by measurement (in pursuit of IPCC 2015 agreements on validating national inventories). This is led by DEFRA and will be implemented by regulatory agencies such as the UK Environment Agency, with which we have active links. Our research in drone-based solutions and national measurement infrastructure has fed into this regulation historically and NERC, Environment Agency and UN CCAC programme funding to monitor emissions provide a springboard to grow in this area as validation frameworks are designed and rolled out operationally.

Bioaerosol work continues to increase substantially with many possible avenues of technical development, data science and environmental science challenges from urban indoor to climate scale influences in ice formation. There is considerable technical expertise and collaborations are being forged with laboratories that can generate bioaerosol to better characterise the instrument.

ACTRIS is an ESFRI programme and currently includes both our Aerosol and Cloud Chambers and potentially Holme Moss. Its predecessor, EUROCHAMP was a very successful vehicle for funding and drove substantial European collaboration resulting in very high profile publications. There is therefore a very significant opportunity. However, at present, there is also a significant threat to development. Although the UK has signed up to the Horizon programme the expectation is that the UK signs up to providing a contribution to ACTRIS. A submission to BEIS in March will determine if this happens. Nonetheless, we will continue to play a key role in coordinating access to ACTRIS infrastructure through the newly funded ATMO-ACCESS project, irrespective of UK participation in ACTRIS.

Cloud Physics instrument development: Recent investments in imaging and holographic instruments for cloud particle imaging place the group at the forefront of this field. Holographic imaging technology and coupling image analysis to novel data science methods is a key area of development. Changes in NCAS staff add to the expertise in the area to develop such techniques further. The expectation is that this will be a fruitful area for technological development in future.

The IAGOS is an International Research Infrastructure that uses commercial aircraft as a measurement network. UoM has had a long term involvement leading cloud particle measurements using a backscatter probe. There is planned expansion of the fleet as part of the infrastructure and also increase in the capability of the probe.

***Interactions with other RGs, institutes, departments, faculties***

Substantial involvement in numerous institutes across campus including MERI (Director); IDSAI (Management Board member) and MUI, and lead of the Centre for Crisis Studies and Mitigation mean that we are well integrated into University strategic research. The Urban Observatory and the NERC Digital Solutions Platform provide cross University integration.

Faculty has set up a number of Strategic Oversight Groups to develop themes around the UK strategic research plan. We have involvement in Net zero, Transforming Health and Healthcare; AI, data and transformative digital technologies; and Environmental solutions and Sustainability

We have strong links across multiple research groups across DEES. Aerobiology with MES is very strong and growing; carbon fluxes with EE; assessing dust using cloud probes is a collaboration with sedimentology leading to industrial collaboration with Rolls Royce.

Links to FMBH via air pollution and health through chamber research (see above), as well as mature and productive collaborations on solar radiation and photobiology.

Collaboration with MACE to investigate emissions from wood stoves has developed with industrial partners and will likely form the basis of a NERC proposal.

***Brief reflection on impacts to UN Sustainability goals and CO2 footprint***

Much of the research of the group fits to the UN Sustainable Development goals. Increased collaboration with researchers across University Institutes and involving the new Sustainable Futures platform meets several of the UN sustainable development goals particularly good health and well being; affordable and clean energy; sustainable cities and communities; responsible consumption and production. The group is well placed to play a role in helping the University deliver to this agenda.

Much of Atmospheric Sciences research is based around substantial laboratory investments and intensive field studies, particularly involving the research aircraft. International collaborations are also important to the group and involve measurements in many cases. These activities by their nature have a substantial carbon footprint. While recognising that these activities are important to continue and develop, we need to develop ways of minimise carbon footprint wherever possible. For example, minimising carbon costs of equipment shipping, reducing face to face planning for international collaborations, ensuring laboratory operations minimise carbon footprint.

*Please provide evidence to support the aspirations and how new developments will be realised. It is important that you consider the staff, technical support and infrastructure resources that will be necessary to deliver any increase in activity and to justify these in your plan. Please also indicate any plans for increasing your number of research fellows and how you see PhD studentship increase being generated and grown. Please indicate where you have staff or Early Career Researchers that would benefit from additional support in preparing applications for funding from either your Research Support Manager or an academic mentor.*

* ***Whats gone well/less well?***

Major advances in air quality research; large income successes in Cloud Physics, particularly the NERC Clouds and Climate programme; co-leadership of the NERC Digital Futures Platform; major capital investments through NERC (Supersite), EPSRC (Urban Observatory) and NCAS (multiple)

Covid has severely impacted field work activities and has led to delays to 3 international collaborative projects where our participation is funded by the NERC initiative in clouds and climate change, due to the pandemic this has delayed the work in the field but major progress is being made in this area

Covid is also having a substantial impact on productivity of several members of the group. Childcare and home schooling is affecting a number of our group and although we have key worker status pressures on school places mean child care is necessary for several of our staff. This is likely to impact negatively on our research plans, particularly since teaching duties are considerably more time consuming at the present time.

The lack of an active DTP has limited our intake of PGR students.

**Outline how you will use university/department infrastructure and technical support in the next year, highlighting where any investment is required**

Continued support for a workshop facility that can work with the research group, both to develop large new builds but also to be responsive to laboratory and field experiments rapidly. Close working between research staff and mechanical workshop needs to be maintained.

It is now close to 15 years since the CAS laboratories were opened. Though at present the laboratories function very well they are intensively used and infrastructure is likely to need replacing with increasing frequency as it ages. Provision needs to be made for this eventuality

CAS is likely to continue its use of the WRC analytical facilities in several areas.

Digital environment research will rely on broader IT support from HPC to edge computing development. Central Research IT provide a lagged baseline support, though developing new systems/tools may need additional support depending on the areas.

**Outline any upcoming staffing changes or gaps and opportunities to achieve strategic goals or maintain existing strengths**

NCAS is an extremely important area for CAS. It provides a base of funding to support 9 research staff on a rolling basis, provides a very valuable line of capital investment and facilitates integration into strategic UKRI activities. Geraint Vaughan, currently an NCAS Director, is due to retire. Geraint acts as the lead for NCAS in Manchester, manages the complex NCAS budget and is a member of the NCAS leadership team. We have been in discussion with NCAS about the continuation of NCAS at Manchester, how the local management of NCAS will go forward and potential new investments in areas where NCAS and UoM have mutual areas of interest. Discussions have progressed well thus far, and we are confident that the future of NCAS in Manchester is secure, we have a way forward for the management of the NCAS contract and are at an advanced stage of discussions around areas of new investment. Expanding capacity in the digital environment would require thoughts around the balance between in-house applied expertise which we are now building, or whether new appointments to bring in expertise in data science/machine learning methods are required.

**Research Income Generation for the next year**

Please detail your future plans for research income generation over the next 12 months (identifying the lead academic where possible). Please detail any planned applications in the table provided on the last page.

**UKRI and other UK funders (eg Royal Society, Leverhulme)**

*Please identify developing research programmes, highlight topics, large grant opportunities, UK/US collaborations and fellowships in your research area and your plans for targeting these programmes? When will they occur and who in the group will lead and who will contribute to the activity? Are there any obstacles to delivery?*

[DT] NERC Digital Environment will have targeted calls over 2021-22, further exploiting instrumented infrastructure.

NERC Highlight topic proposal (2021) - Grant Allen - Tropical methane emissions and their response to climate change.

NERC large grant (2021) – Grant Allen - Ageing of ancient carbon release and aqueous transport in the Arctic and quantification of spring melt methane pulse to atmosphere

**Other funding sources**

*Please identify developing research programmes funded from non-UK*

UN CCAC programme – oil and gas infrastructure emissions quantification

**Business engagement**

*Please describe the development of current industrial relationships or consortia and your plans for them. Are there any new industrial partnerships or areas of engagement that you see developing? Who in the group will lead these and what is the projected size and timescale? What plans do you have for applications for Industry Collaboration Funding (IAAs, KTPs) Innovate UK competitions and the Industrial Strategy Challenge Fund competitions? Would you like to enlist the help of the Business Engagement Office to support any of the planned activities of your Group?*

Grant Allen is working with JBPRM, BP, and Viridor waste solutions, to license drone software for methane flux monitoring of regulated landfills and national grid infrastructure.

Ann Webb working with Signify (part of Philipps lighting) on development of an existing product to deliver low level UV (see PDG and follow on proposals below). Already done some work on independently specifying the units for MHRA (ethical) approval.

*Please list any planned applications over the next 12 months:*

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| **PI and team** | **Sponsor/Call** | **Research Area/Proposal Title** | **Date** | **Value** | **Chance of success (%)** | **Comments** |
| James Allan | NERC Standard | Air quality from stoves | 1/12/2021 | £500K | 20 |  |
| David Topping | EPSRC | UKCRIC2 Facilities grant | [submitted early Jan] | £8.5M [£1.1 UoM] | unsure | 5 year rolling facilities cost to maintain each UO |
| Gordon McFiggans | UKRI CleanAir Wave 2 | Hazard Identification Platform to Assess the Health Impacts from Indoor and Outdoor Air Pollutant Exposures, through Mechanistic Toxicology | 1/9/2021 | £3.9M (£994K UoM) | 30 | Passed first sift |
| Martin Gallagher | UKRI Clean Air Wave 2 | NERC UKRI Clean Air Programme Grant (Consortium) - Outline approved. | 25/2/2021 | £740K | 30 | Passed first sift |
| Hugh Coe | NERC Large Grant | Dust-Ice | 1/6/2021 | £400K | 30 | Passed first sift |
| Hugh Coe | NERC Large Grant | Indian Air Pollution |  | £500K | 10 | Outline to be submitted March 2021 |
| Hugh Coe | NERC Standard Grant | Assessing the effects of covid-19 on air quality |  | £300K | 30 | Submission July 2021 |
| Gordon McFiggans | NERC Standard Grant | SOAPRA | 1/3/2021 | £600K | 30 | Final consideration |
| David Topping | EPSRC | City4 programme grant | 1/2/2021 | £8M [£1.2M UoM] | unsure | Past first submission. Led by Newcastle. 2 stages left, will know about invite to full by March |
| David Schultz | NERC/Standard | Jet-stream turbulence | January 2021 | £600k | 30 |  |
| David Topping / Martin Gallagher | NERC/Standard | Microbes on dust | 1/6/2021 | ~£800K | 20 | Would be resubmission |
| Gordon McFiggans | UKRI CleanAir Wave 2 | UnderstandING the sourcEs, traNsformations and fates of IndOor air pollUtantS (INGENIOUS) | 1/9/2021 | £3.5M (£421K UoM) | 30 | Passed first sift (York led) |
| Jonny Crosier and other cloud physics | NERC | Several options: need to prioritise (CCREST-cirrus, High Latitude ARCTIC BL Clouds, Stereo imaging and radar measurements of Ice |  |  |  | Requires group discussion |
| Grant Allen\ | NERC highlight | Tropical methane emissions and response to climate change. | 1/5/2021 | £4M (£700k UoM) | 20 | Outline phase - May 21 |
| Grant Allen | NERC large grant | Ageing of ancient carbon liberation and aqueous transport in the Arctic and quantification of spring melt methane pulse to atmosphere | 9/3/2021 | £3.7M (£700k UoM) | 20 | Outline phase – Mar 21 |
| Grant Allen, Dave Topping | NERC Standard | UK national GHG budgeting using remote sensing | 1/6/2021 | £700k (£400k UoM) | 20 | July standard grant round |
| Luis Garcia-Carreras | NERC New Investigator | Convective-Scale Impacts of Deforestation on Amazonian Rainfall | 1/2/2021 [final outcome expected] | £700k | 50 | July 2020 standard grant round. Final outcome expected soon, but received positive external reviews |
| Ann Webb | NERC Standard | ACCURATE MEASUREMENTS OF LIGHT SCATTERING BY SINGLE NON-SPERHICAL PARTICLES | Jan 2021 | ~£80k to UoM | 20 | Led by UH |
| Ann Webb | NIHR PDG | Can interior lighting with very low intensity UVB maintain serum 25OHD in clerical workers and older people, and can it protect against acute respiratory infections by inactivating viruses on high frequency touch surfaces? | Jan 2021 | ~£15k | 20 | Led by Sunderland NHS Trust, for Pilot/prep work |
| Ann Webb | DEFRA | Baseline UV and ozone measurements | March 2021 | ~£150k+/annum | 80 (if call comes) | Continuing grant, period of grant tbd |
| Ann Webb | NIHR | UV room lighting in care homes for vitamin D and mitigating influenza/covid | Late 2021 onwards |  |  | Built on PDG results (and existing smaller study happening anyway) |
| Ann Webb | BBSRC/MRC | Vitamin D synthesis in black skins | speculative |  |  | Revamped resubmission if opportunity arises |
| Martin Gallagher | NERC | FATIMA - UK | July 2021 | £500k | 10% | Dependent on US Consortium Grant Success – pending Jan/Feb 2021. If US grant successful and NERC grant not then FATIMA-US will provide UK with T&S to participate in one field campaign – dtails to be discussed |
| Paul Williams | NERC | airport emissions and impacts on local communities |  | £500K | 10% | Submission Dec 2021 |