

Science Landscape Seminar Reports: Meteorology and Climate Science

Background to the meeting

This seminar is one of a series convened by the [Council for Science and Technology \(CST\)](#), which is working to provide a map of the UK Knowledge Landscape as a whole. This mapping includes all areas of research carried out by academia, industry, charities and others.

The seminar series has brought together diverse sets of experts to discuss eight parts of the research landscape in depth; these areas are roughly aligned with the [UK government's eight great technologies](#).

The aim of this work is to provide decision makers with a clearer picture of the whole landscape and enable better strategic decisions to be made. We would also like the reports to prompt communities to think more about what they can do to ensure their areas continue to make the best case for themselves and operate in a coherent way. The seminar series is limited in scope, but has revealed the importance of a clear articulation of the strengths and requirements of different parts of the UK research landscape. Specific research communities may wish to hold further sessions of their own.

The discussion took place under the Chatham House rule. This document represents the views of this group and is published alongside an infrastructure resource (see below) which reflects the seminar's view of the meteorology and climate science landscape.

This meeting addressed meteorology and climate science research and development, and was asked to consider:

- Strengths and weaknesses of meteorology and climate science research in the UK;
- How the UK compares internationally; and
- What future concerns exist for the discipline.

1. Infrastructure list

To seed discussion, attendees were provided with a draft list of infrastructure relevant to Meteorology and Climate Science. The list is not exhaustive but does provide a summary of some of the key facilities for Meteorology and Climate Science research in the UK. It was updated in the light of discussion at the seminar to include, for instance, greater detail on some of our supercomputing resources has been added. The infrastructure list is available at:

www.gov.uk/government/publications/science-landscape-seminar-meteorology-and-climate-science.

2. Strengths and weaknesses of the UK meteorology and climate science

Seminar participants acknowledged that the UK is often seen as a world-leader in meteorology and climate science. They identified several key areas of strength:

- The Met Office is a good example of a strong national meteorological service and the Hadley Centre is one of the foremost research centres for climate science. The Hadley Centre provides the primary focus for climate science in the UK and provides world-class guidance on the science of climate change. It was noted that the UK's university sector in meteorology and climate science is also strong and is well-coordinated both internally and with the [Met Office](#) and [Hadley Centre](#).
- The [European Centre for Medium-range Weather Forecasts](#) (ECMWF) provides strong capacity in its role as both a research institute and producer of medium-range (3-10 days) weather predictions to its Member States.
- Public support for climate science is strong.
- The joined up approach to weather and climate is a strength. In the past there had been a split, given the relative sophistication of weather prediction models in comparison to climate prediction. This is increasingly not the case: there is growing appreciation of the importance of hazardous weather, a developing interest in decadal forecasts and therefore a clear need for a seamless approach to modelling and prediction.¹
- The [Natural Hazards Partnership](#) is a good model for how researchers, operational experts and policy makers can be brought together. The Partnership was established in 2011 and provides information, research and analysis on natural hazards. This is used for the development of more effective policies, communications and services for civil contingencies, governments and the responder community across the UK.

Despite these strengths, attendees mentioned a number of concerns about the future of the discipline:

- The UK's strong position in meteorology and climate science should not be taken for granted. Work will continue to be needed to ensure that the UK retains its place as one of the world-leaders in the subject.
- Observations data and modelling work are not as well connected as they could be. Models could be improved with more observations data.
- There is a need to future proof access to facilities and data. There are already structures in place to ensure that researchers *can* access data sets (such as those provided by the [Copernicus programme](#)); however, the *practicalities* of actually accessing this data are often complex and difficult to navigate. Developing some clear guidance and platforms to support access to data and facilities may help.
- Good collaboration is crucial to the UK's future success in this field: it would be helpful to continue to consider how the UK best collaborates in the field of climate science, internally, within the EU, and internationally.

¹ www.metoffice.gov.uk/media/pdf/a/t/Science_strategy-1.pdf

- There are likely to be shortages of skills, particularly computational skills, in the discipline.
- Oceans are an important part of climate science: making sufficient ocean measurements is essential to predicting future climate change. The UK may benefit from doing more work in ocean observations.

A number of participants spoke about what might be learnt from the US, which included:

- The US is strong in weather prediction policy. It has a vibrant and thriving weather services private sector which the EU often accesses and which generates revenue for the US government. This US success is the product of open and free weather data, and could be emulated as the Met Office data becomes increasingly open; and
- it also has strong capability in oceanography, particularly the National Oceanic and Atmospheric Administration (NOAA) which provides support for monitoring.

3. Collaboration

Direct wealth generation is rarely seen as an objective for research in meteorology and climate science. The motive more usually is to provide society with the benefits of better forecasts and predictions in a cost-effective way. The result may be that it is not always clear why widespread collaboration is commercially or economically beneficial. It may be that the UK should do more to consider how to build the most effective collaboration into the aspirations of future projects. The following considerations were put forward:

- There may be lessons from disciplines where collaboration is strong: for instance, in the EU aerospace industry, where it has been beneficial to pool resources to maintain a European aerospace industry, and in particle physics and astronomy, where the scale of the problems involved means that these groups need extensive, well-organised, collaboration to function. Meteorology and climate science may now be reaching a point where the challenges are becoming so great that one nation cannot solve them independently.
- The UK needs to continue to think carefully about what the future specific (infrastructure) needs of the discipline are likely to be and consider how these will be procured.
- Computing is one area where an increase in joint working is expected. As the demand on computing power continues, access to sufficient processing power will become increasingly difficult for a single nation to provide. In future, the UK will need to focus on finding ways to collaborate effectively to do large-scale computing efficiently.
- There is a need to connect software and hardware designers directly with scientists working in meteorology and climate science, to ensure effective design.
- While collaboration is desirable, a diversity of approaches is appropriate, particularly in climate modelling. The right mix would include centres that are attractive to a variety of scientists and where shared infrastructure can be used for a wide range of purposes.

4. Skills

The highly technical nature of meteorology and climate science means that the supply of skills is important. The seminar discussed the following issues:

- There is a real need for more people with scientific software and computational skills. Failure to develop these skills will be a threat to the UK's continued strength in meteorology and climate science.
- It is important to attract good mathematicians and physicists to the discipline, but it tends at school to be covered only in geography lessons. Meteorology, geophysics and other associated topics ought to be included at an earlier stage of the school curriculum, and in a wider variety of subjects.
- Some of the skills shortages could be resolved by developing ways to move individuals rapidly into the subject from other disciplines, at more advanced stages of their careers. As in many other (science and engineering) subjects, Masters' programmes are one way to achieve this.

5. Oceans

The seminar discussed the importance of oceans in assessing near-term climate change. The Intergovernmental Panel on Climate Change (IPCC) state with a high degree of confidence that oceans account for about 93% of the increase in the Earth's stored energy between 1971 and 2010. Melting ice, warming of the continents and warming of the atmosphere makes up the rest.² Participants made a number of relevant points:

- Ocean observations depend on measurements made *in situ*. This makes collection more challenging.
- Increased ocean monitoring and ensuring that measurements are connected effectively to research would mean that climate models could be better optimised.
- It would require a huge investment in infrastructure to get to grips fully with the scale of measurements needed. As a starting point, we should consider how to get the best out of the UK's existing ocean capability.

6. Future priorities

Finally, the seminar discussed a number of areas the discipline should consider as it moves forward. Participants identified a number of issues, including the need for:

- the discipline to communicate its case better. A better articulation of the economic benefits of meteorology and climate research would help secure both short- and longer-term funding. In particular, the discipline should make clear that accurately predicting weather and climate events plays a strong role in avoiding expenditure (for example in disaster recovery) rather than in generating wealth directly;

² IPCC Working Group I Contribution to the Fifth Assessment Report of the IPCC, on "The Physical Science Basis" p 265, Cambridge University Press, 2013

- better understanding of the extent of available research into the consequences of, and adaptation to, climate change, and how the benefits of this research could be maximised;
- further consideration of the role of weather forecasting and seasonal prediction in mitigating against loss of life and economic losses (for example from a flood event). This added value is not always captured well; and
- a better understanding of the role of oceans as heat reservoirs for purposes including predicting and modelling the jet-stream increasingly accurately.



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