



PostGraduate Institute
for measurement science

GRADPOST

Quarterly newsletter of the PGI



Summer
2021

Published
9 September

Edited by
Jennifer Blair
Jamie McMillan

An underwater photograph of a coral reef. The water is clear and blue, with sunlight filtering through from the surface, creating shimmering patterns. The coral is diverse in shape and color, ranging from brown to white. The overall scene is serene and beautiful, representing the natural world that is in crisis.

A climate in crisis

And metrology to the rescue

It feels like every summer for the last decade has brought ‘record breaking temperatures’ here in the UK, providing us with seaside trips, beer gardens and widespread flooding. Climate change is no longer a problem that can be put to the bottom of the To Do list, and thankfully many countries are taking notice and taking it seriously.

Our quest to stabilize emission levels before the planet reaches a tipping point is a daunting one, but it might be the one thing the human race has in common and, perhaps the one thing we could all unite behind. After all, we have seen just how powerful collaboration can be during the recent testing times and throughout the pandemic.

In this issue, we want to highlight the work done by the wonderful staff and students at NPL who are showing that metrology is a key part of tackling climate change. To our peers in the PGI after reading this edition we hope you are proud to wake up every day and work towards the advancement of knowledge and the betterment of society; you are making a difference. In your day to day life it may not always feel this way, but never underestimate your contribution to your field and the skill that it takes to stick with a problem long enough to solve it!

*Jennifer Blair
& Jamie McMillan*

Your friendly neighbourhood PGI Communications Ambassadors



Richard Barker

Head of Energy and Environment, NPL

Setting the scene

The health of the environment is increasingly a driver of our economies and society rather than unconnected source or sink for human activities. Human need for energy for comfort; heating and cooling, manufactured goods or transport is a principal source of environmental damage. Fulfilling societal needs such as energy, while assuring a sustainable environment is a “wicked” problem that demand a whole systems approach to solving.

The need to decarbonise our economy whilst maintaining and adapting to climate change is driving a huge transformation and a change in policy across the globe. The UK Government is committed to reducing the impact on the environment and to developing an energy system that is cleaner and more affordable while working with other Governments to develop a clean growth innovation.

Safe assessment of climate change crucially depends on the robustness of climate data and on the uncertainties associated with measurements. Metrology, the science of measurement, is now playing a new role in climate science, providing expertise and funded projects aiming at improving measurements capabilities and traceability of data.

NPL, as a publicly funded national laboratory has been helping the UK Government to support world-leading innovation in the UK and internationally. Our work is driving down the cost of renewables and low carbon technology and increasing our understanding of emissions and pollution. Our mission is to:

- Develop low cost sensors and data networks
- Test and verify the claims of new technologies used in the low carbon economy
- Develop accurate and internationally comparable standards to promote more accurate monitoring on a global scale
- Support the growth of the energy and environment sector

We apply the latest advances in measurement to make every stage of energy generation and transport more efficient, safe and affordable.



What contributes to climate change?



And what can be done about it?



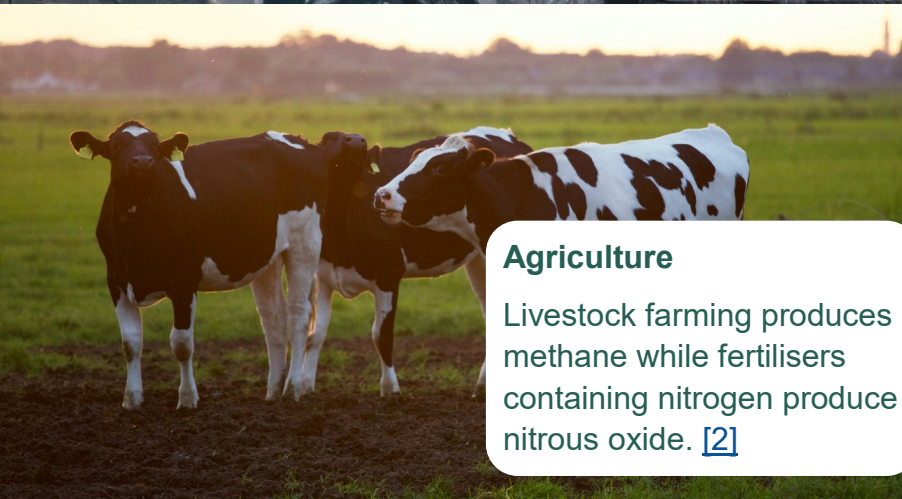
Energy

Generating energy from coal, oil or gas. Coal based generation accounts for 30 % of global CO₂ emissions. [\[1\]](#)



Green energy

Improving energy efficiency, electrifying transport and utilising low carbon energy sources eliminates large carbon contributions.



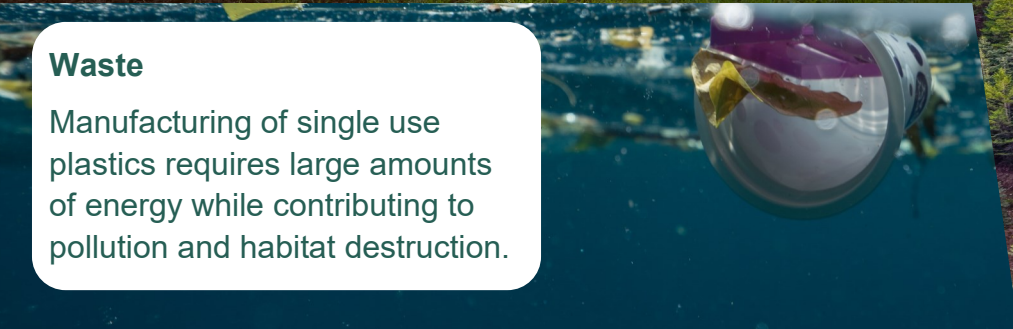
Agriculture

Livestock farming produces methane while fertilisers containing nitrogen produce nitrous oxide. [\[2\]](#)



Utilise natural carbon sinks

Forests absorb CO₂ from the atmosphere while marine ecosystems can transfer carbon to the ocean sediment. [\[3\]](#)



Waste

Manufacturing of single use plastics requires large amounts of energy while contributing to pollution and habitat destruction.



International collaboration

Financial incentives, policy changes and research agreements encourages a global effort towards combatting climate change.

G7 Summit:

What have world leaders promised to do?

The G7 summit is an annual gathering of world leaders representing the UK, USA, Canada, Japan, Germany, France and Italy (and guests) invited to discuss global matters and promote collaboration. The UK hosted the 2021 summit, with representatives from the EU, India, South Korea and Australia present. Topics covered during the summit included health initiatives for COVID recovery and readiness measures for future pandemics, environmental initiatives to tackle climate change and fair trade agreements to boost economic growth for a fair and green future [\[4\]](#).

HEALTH

- Have therapeutics, diagnostics and vaccines available within 100 days to prepare for future pandemics

LAND

- Plant trees (natural carbon sink)
- Improve appliance energy efficiency
- Reduce coal in favour of greener options, and support developing nations do the same
- Electrify transport



OCEANS

- Initiatives to reduce plastic use
- Prevent overfishing
- Conserve mangroves and coral reefs to boost biodiversity and provide extreme weather protection

FINANCE

- Funding pledged to support green and blue initiatives
- Research funding in place to further develop green technologies

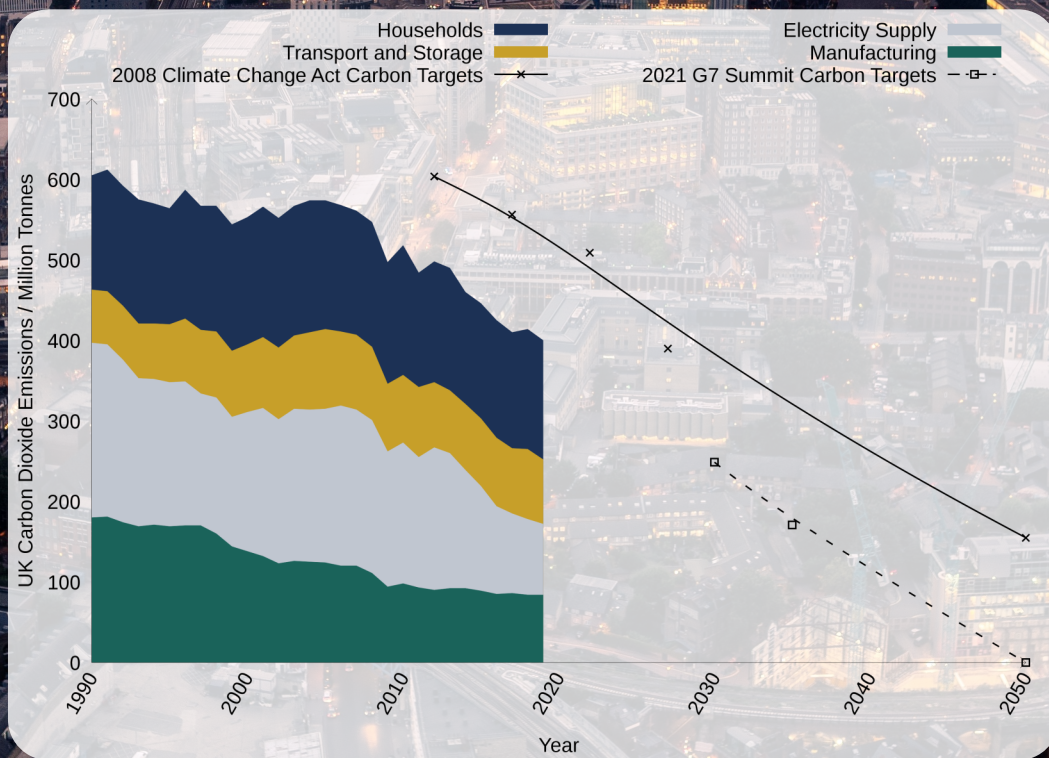
UK Emissions

How have UK emissions and targets changed over time?

The UK was the first country in the world to set out legally binding climate targets with the 2008 Climate Change Act [5]. Since then 8 other countries have followed suit [6] with many more committing to climate action, demonstrating how systematic changes can be effectively conducted when policy and science work together. Since the Climate Change Act milestone, how have our targets and emissions changed over the last decade of targeted effort?

The UK CO₂ emissions since 1990, milestones, targets and the contributions from major sources are shown in the figure below with the units measured in megatonne CO₂ equivalent. The 2008 Climate Act set targets (blue dots) based on the 1990 benchmark of 777.4 MtCO₂e, with 2 major goals of -34 % by 2020 and -80 % by 2050. At the G7 summit which took place in June 2021, these goals were updated to reflect the UK's greater ambitions, with targets of -68 % by 2030, -78 % by 2035 and to reach net zero by 2050. These targets are echoed by other developed nations across Europe and Asia, such as Sweden and Japan who aim for net-zero by 2045 and 2050, respectively [6].

If you wish to see the UK's latest figures for yourself, they are released by the Office for National Statistics [here](#), yearly.



Climate tips #1: What can I do?

While tackling climate change requires larger systemic changes to combat effectively, there are several things that we can change in our everyday lives that not only contribute to combating climate change, but save us money in the long run too! For example, 75 % of all domestic energy consumption in Europe is used for heating and cooling. Using thick curtains, blocking draughts and installing reflectors behind radiators help us control the temperature in our homes without using any extra energy. For more ideas, check the other bubbles in this edition of Gradpost or visit this [link](#).

London Green House Gas Emissions

To effectively reduce greenhouse gas emissions and prevent further climate change, we need to be able to measure these emissions. The London Greenhouse Gas network is one solution to this problem focusing on quantifying city-scale emissions. We achieve this by using a network of instruments across London that continuously measure atmospheric concentration and state-of-the-art Bayesian models that link emission rates and atmospheric dynamics. This enables us to measure the concentration of greenhouse gases in the air above London and track it back to where it was likely emitted.

In the UK, we have a national level equivalent of this network that has been running for a number of years and is known as the UK DECC (Deriving Emissions linked to Climate Change) Network, which feeds into the UK's official reports on greenhouse gas emissions. By building a local version that can focus in high resolution on London, the city with the UK's highest density of greenhouse emissions, we will gain key insights into emissions that the local policy makers can use. Ultimately, the aim is to provide information to policy makers to help London reach its net-zero emission goals in a timely and cost-effective way and to provide a blueprint for how this could be replicated in other cities across the world.

My paper, taking an initial look at modelling for one of the first London measurement sites, has been published [here](#) and my Policy Brief on the use of this technique (including a brief mention of this project) is available [here](#).



Daniel Hoare

*University of Bristol and NPL
PGI student*

Climate tips #2: Work

Use your own mug and only boil the amount of water you need – for two coffees a day, this prevents around 500 disposable cups from being wasted per year! This also translates to bottled water. If you can, turn appliances off at night rather than leaving them on standby, most computers also have power saving mode you can try. Lastly, prevent wasting paper by printing only what you need, and reuse wastepaper for scrap notes.

Climate tips #3: Transport

Transport contributes 25 % of all greenhouse gas emissions in Europe. Taking the train, car-pooling, or cycling can reduce our individual emission's contribution from our daily commute, however this may not always be a viable option. Removing empty roof racks, keeping tyres inflated and reducing the amount of unnecessary braking or accelerating can reduce emissions by improving our car's fuel efficiency when we do need to drive.

Metrology expertise to support Breathe London project



Mobile measurement units fitted to Google Street View cars, Geoff Ma



Geoff Ma

University of Cambridge and NPL PGI student

Air pollution is the biggest environmental health risk in world, and it is hard to escape, no matter where you live. It can seriously affect your health, the environment, and kills an estimated seven million people worldwide every year.

WHO data shows that 9 out of 10 people breathe air that exceeds WHO guideline limits

containing high levels of pollutants, with low- and middle-income countries suffering from the highest exposures. From smog hanging over cities to smoke inside homes, air pollution poses a major threat to health and climate.

My project focused on assessing air quality data that was captured by specially equipped Google Street View cars as part of the pilot Breathe London project. The data provides information on traffic emissions at a street-level and can identify trends, which may be related to policy interventions .

Mobile measurements are fundamentally different to static measurements as they are not inherently biased to the same physical location - and measure pollution on the road, not by the roadside. It is vitally important as mobile measurements will form part of a larger suite of tools that can be used to measure air pollution and inform decision making with more accurate data collection.

A key impact from this project could be the uptake of similar technologies around the world - particularly as the interest in mobile air quality metrology grows. This work will help shape future mobile air quality measurement projects, and the selection of instrumentation used to increase the accuracy and confidence in the data.

Climate Tips #4: Home

The tips for saving energy at work are largely applicable for use at home as well. In addition to this, using the washing machine only with full loads at a lower temperature (Unilever recommends 30 °C for their detergents) and avoiding using tumble dryers which can consume double the energy required for a washing machine cycle. If you are looking to buy new appliances or bulbs, check their energy efficiency rating. Efficient appliances consume less energy making them cheaper to run. Running boilers at 60 °C and turning thermostats down by even a few degrees can keep homes hygienic and comfortable for less waste. Additionally, setting the heating to a higher temperature does not heat our homes quicker! Lastly, consider installing a smart meter, or switching to a green energy supplier to offset the emissions of your energy usage before it even reaches your home.

UK Methane Levels and Causes - Ed and Alice



Alice Drinkwater

University of Edinburgh and
NPL PGI student

Ed and I research isotope ratios of the greenhouse gas methane. Methane is a highly prevalent and potent greenhouse gas – on a gram/gram basis, it is 28 times more powerful than carbon dioxide over 100 years. Methane levels have been increasing worldwide, however its growth rate over the past 20 years has not been consistent. We still don't have a clear idea of what sources are behind these changing growth rates.

Isotope ratios may provide a solution to this problem. Different sources of methane produce different amounts of heavy isotopes (for carbon, carbon-13, for hydrogen, deuterium). Therefore, by measuring isotopes in air samples we can gain an understanding of what sources produced the methane in that sample. These are measured as ratios relative to the most common isotope, due to them occurring in very low levels in air.

I have been placed at NPL for the past 18 months. During that time my research group and I have constructed and deployed 'Boreas', a machine which is capable of measuring methane and methane isotope ratios to a very good precision. This machine can identify and determine the cause of methane pollution events local to where it is based.

At first it was based at NPL and we built a timeseries of London air, being able to pinpoint pollution events from

anthropogenic sources (such as small fires, gas leaks) and biogenic sources (likely to be from nearby water treatment facilities). It has since been deployed to the Heathfield atmospheric monitoring station in West Sussex. This should measure more 'clean' air as it is based in a rural area, giving us a better idea of background methane levels in the UK.

Metrology is key to my research in the construction of a measurement machine. We've had to maximise the precision and accuracy of the machine, which has been a metrology challenge. The impact of this work is that we can better understand what sources are contributing to pollution events and background methane increases. This is helpful in determining what sectors should be focussed on in mitigation, to reduce greenhouse gas emissions in the UK (read Alice's paper on Boreas, [here](#)).

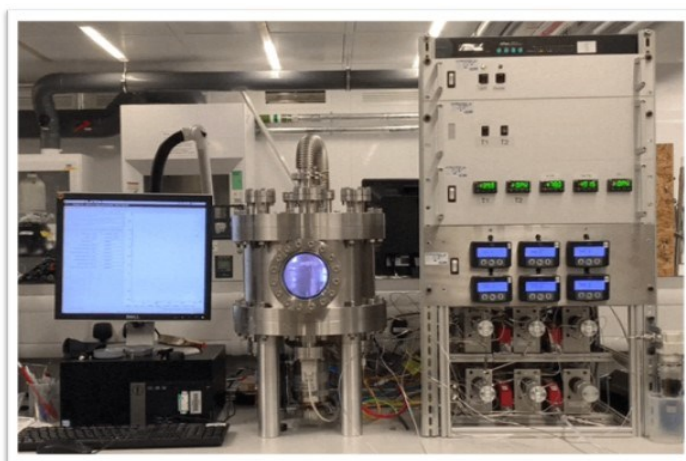


Image of Boreas, Alice Drinkwater

UK Methane Levels and Causes - Ed and Alice, contd.

Climate Tips #5: Water

Over 99 % of water on Earth is unusable by humans [7]. Most fresh water is trapped in glaciers, making drinkable water a rare resource! There are simple things we can do to save water, such as keeping the tap *off* when brushing our teeth (saving ~ 8 litres/minute), tending to leaky taps and toilets, and installing aerated shower heads to reduce water consumption during long showers. Watering our beloved plants in the morning or evening can cause less water to be lost to evaporation.

Climate tips #6: Reuse

Energy can be saved, and emissions can be prevented through recycling – 90 % of the energy needed to manufacture one aluminium can is saved by recycling an old one. While most of us recycle our household waste already, consider also donating or thrifting electronic appliances, clothing, and furniture items. Using rechargeable batteries allows the same product to be reused and they can also be recycled at the end of their life. Lastly, composting organic waste allows it to decompose naturally into fertiliser, whereas without access to air in landfill, it emits methane.



Edward Chung

University of Edinburgh and NPL PGI student

My work explores what more we can measure to expand our current pool of observations that can explain global to regional methane fluxes using computer simulations. We use measurements related to atmospheric methane to explain its fluxes, including the balancing between the source and the sink and identification of sources. However, there are many competing scenarios that can explain what we observe. Therefore, we need to add a new set of observations that can help us solve the problem by reducing the number of possible scenarios.

As a second-most important greenhouse gas, methane emissions from human activities should be monitored. Mitigation strategies require precise quantification of methane sources for them to be effective. My work relates to the efforts that goes into creating precise emission estimates by suggesting the measurement community which extra measurements would benefit the modelling community.

While I do not measure anything myself, measurements are used in the emission estimates. The method involves running chemical transport models, and if discrepancy occurs, the model would adjust the fluxes to minimise the model-measurement differences. Therefore for the emission estimate to be more accurate, we need the atmospheric measurements to be more accurate as well.

We currently have a paper submitted to *Global Biogeochemical Cycles* which is under review.

Tackling Global Challenges through Measurement Science

19 – 20 October 2021

Join us to hear about the excellent research produced by our Postgraduate Institute for Measurement Science (PGI) postgraduate researchers through talks and posters (see the conference themes below). Listen to inspiring presentations from high profile keynote speakers, leading academics and industrialists. There will also be a careers session to help delegates to explore post-PhD career options and a motivational talk. Click [here](#) to sign up using passcode: **metrology2021** - it's **free** and open to everyone!

Ensuring Wellbeing for All

Measurement science is critical in helping the UN member states achieve the 17 Sustainable Development Goals, which include 169 targets and 244 indicators addressing environmental and socioeconomic issues around the world, from improving diagnostic techniques and life expectancy, to meeting the international target of carbon net zero. This session will focus on research and technology projects designed to benefit a healthy society.

Creating a Science-Based Economy

As a result of the global pandemic, science will play an even greater role in enabling the UK's economic recovery and driving growth as well as supporting businesses, small to large. Metrology is pivotal not only in advancing scientific outcomes, but also in restoring public confidence in evidence-based policy decisions. This session will highlight industrial solutions as well as provide examples of data-driven research improving trust and decision making.

Linking Research Excellence through Communities

Collaborative and multi-disciplinary interactions significantly accelerate the ability to innovate through measurement science. By widening networks, transferring knowledge and the sharing of facilities, we can broaden the impact and reach of research. This session will shine a light on partnership working in the UK and abroad, and demonstrate how networks and collaboration can strengthen academic outcomes.

NETWORK

Socialise and network with other Industry, Academic and Postgraduate researchers. Have a coffee break on [HopIn](#) during the day or join activities in Gather Town in the evening.

RESEARCH

An insight into the breadth of measurement science PhD research conducted in collaboration with NPL.

CAREER

Consider post-PhD career opportunities through an interactive careers panel with Academic and Industry professionals including some of our PGI Alumni.

What will you get out of it?

ENGAGE

Hear from a number of fantastic expert international speakers and engage with them in the Q&A:

- **Principal Professor Sir Jim McDonald** (Principal and Vice-Chancellor, University of Strathclyde)
- **Professor Paul Monks** (Chief Scientific Adviser, Department for Business, Energy and Industrial Strategy)
- **Professor David Sampson** (Pro-Vice-Chancellor, University of Surrey)
- **Dr Alessandro Rossi** (UKRI Future Leaders Fellow and a Senior Lecturer, University of Strathclyde)
- **Dr Thierry Stora** (Project Lead CERN-MEDICIS, CERN)
- **Aliza Ayaz** (UN Youth Ambassador and Founder & Chair Climate Action Society)
- **Dr Jess Wade** (Imperial College Research Fellow, Imperial College London)

Any queries? Email the Conference team at pgiambassadors@npl.co.uk

Follow us on [Twitter](#) and [LinkedIn](#)

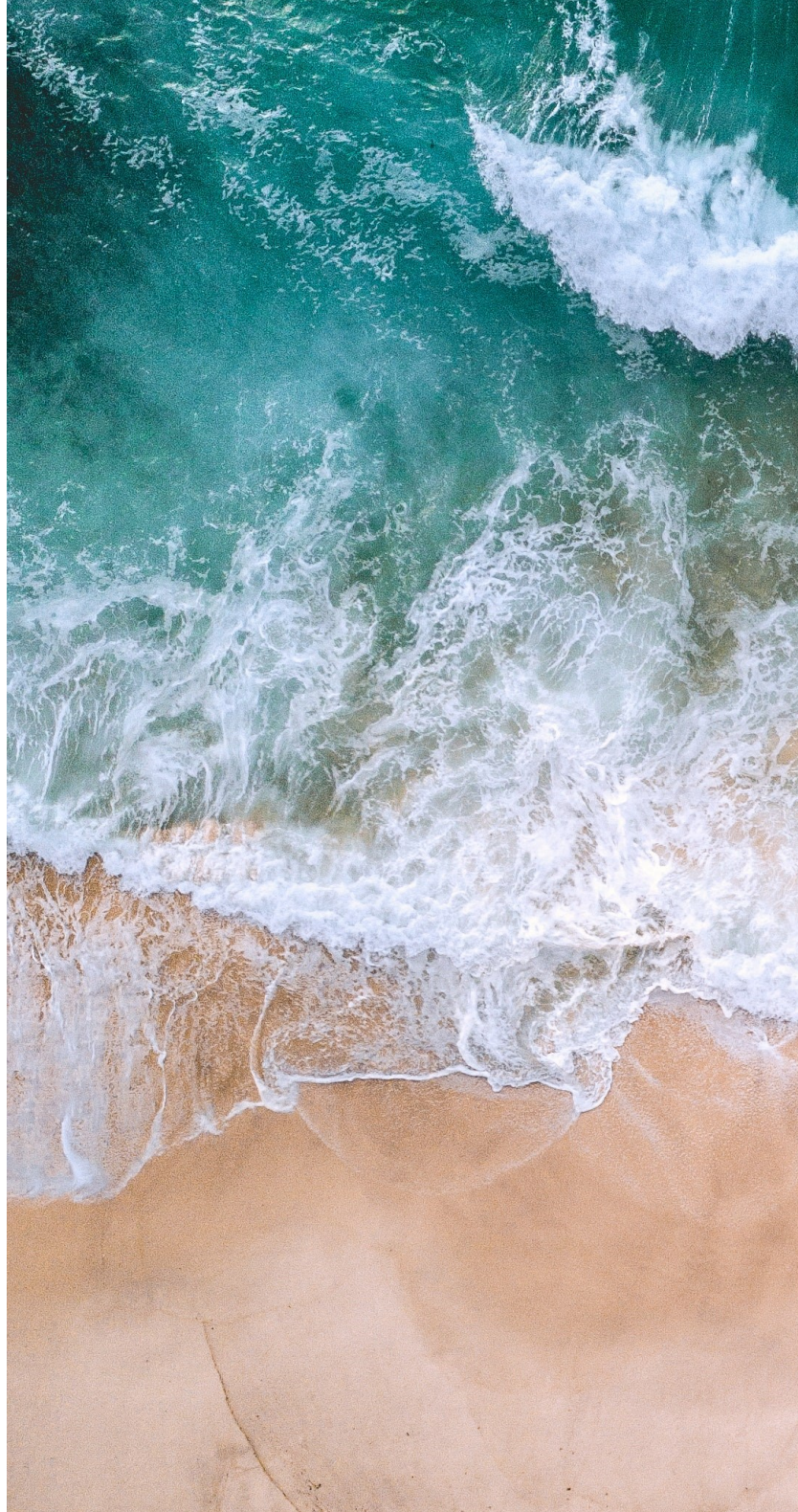
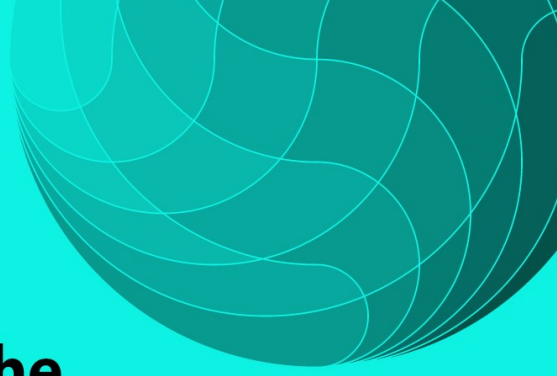
Supporting the ambitions of COP26

To coincide with the UK hosting COP26 this year, NPL has launched the **Measurement for our planet** programme, which will showcase NPL's energy and environment-related research and associated capabilities whilst highlighting the important role of metrology in supporting climate change mitigation, adaptation and decision making.

Measurement for our planet will provide further details on NPL's expertise in providing confidence in the data that underpins science-led solutions for improvements to climate science, greenhouse gas emissions measurement and in supporting the innovation that will enable a transition to a decarbonised economy.

To find out more visit:

www.npl.co.uk/measurement-for-our-planet





PostGraduate Institute
for measurement science




Get in touch

 www.npl.co.uk/pgi

 pgiambassadors@npl.co.uk

 [@PGImetrology](https://twitter.com/PGImetrology)

 [/pgimetrology](https://www.linkedin.com/company/pgimetrology)

 [@pgimetrology](https://www.instagram.com/pgimetrology)