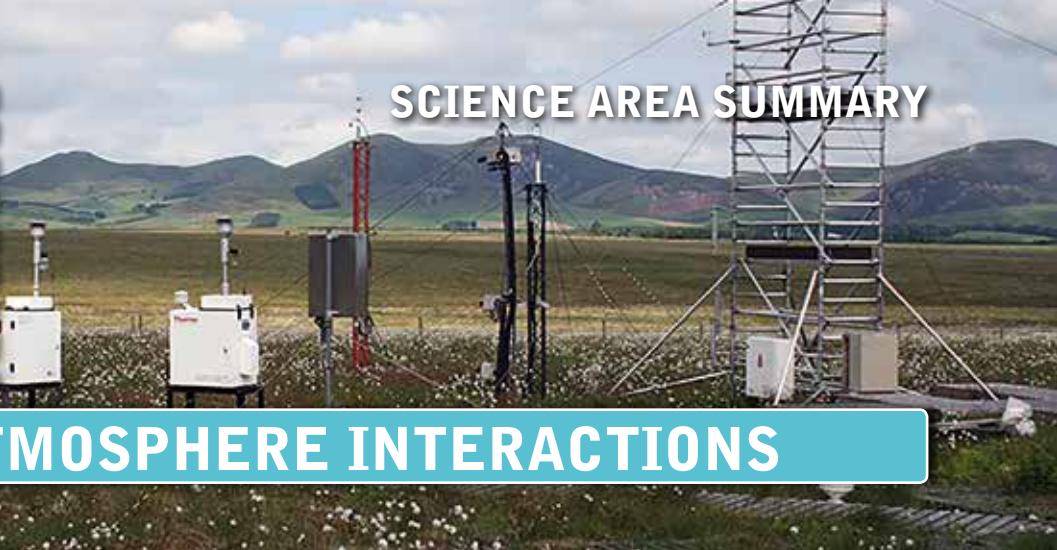


- Ecological Processes & Resilience
- Environmental Informatics
- Monitoring & Observation Systems
- Natural Capital
- Natural Hazards
- Pollution & Environmental Risk
- Soil
- Sustainable Land Management
- Water Resources

## SCIENCE AREA SUMMARY



# BIOSPHERE-ATMOSPHERE INTERACTIONS

**Understanding and quantifying the interactions between the biosphere and the atmosphere based on measurements, experiments, and modelling of greenhouse gases, reactive air pollutants, water, and energy.**

## Context

The exchange of gases and aerosols between the Earth's surface and the atmosphere plays a fundamental role in determining air quality, and is an important driver of climate at both regional and global scales. In turn, biological communities and the physical environment change in response to changes in climate and atmospheric pollution. The biosphere and atmosphere are dynamic, constantly reflecting these interactions and feedbacks.

Unique data holdings, long-term monitoring networks, experimental facilities, and models underpin CEH's international leadership in biosphere-atmosphere interactions. Our work centres on quantifying surface-atmosphere exchanges to further our understanding of the responses of ecosystems to atmospheric drivers, and the feedbacks that govern these processes. This research supports UK, European, and global policies to mitigate the environmental and health impacts of pollution, land use, and climate change.

## Our Research

Biosphere-Atmosphere Interactions focuses on the sources and sinks of greenhouse gases (GHGs), air pollutants, particulate matter, water, and energy between the Earth's surface and the atmosphere.

We quantify fluxes and transport of matter and energy, pollutant impacts on the above- and below-ground biota, and how changes in ecological communities feed back on atmospheric composition. We study a wide range of habitats such as forest, grassland, wetlands, urban areas, and cropland, including bioenergy crops.

Our vision is to integrate long-term monitoring, field manipulations, gradient studies, laboratory experiments and Earth observation data to understand the underlying physical, chemical and biological controls on GHGs and other atmospheric pollutants. Quantifying these processes is essential for a wide range of environmental models including those concerning climate change, pollution impacts and land-surface interactions.

### Over the next five years we will:

- use state-of-the-art measurement and modelling techniques to quantify biosphere-atmosphere exchanges in major biomes, including tropical, polar, agricultural, forest, moorland, and urban ecosystems.
- improve process-based understanding of biosphere-atmosphere exchange by linking ecological dynamics with biogeochemical cycling and GHG emissions.
- develop and integrate long-term measurements and networks across the UK and internationally, and incorporate our understanding into next-generation models.
- provide guidance to stakeholders of the benefits of different management strategies for reducing atmospheric pollutants and GHGs, and mitigating their effects.

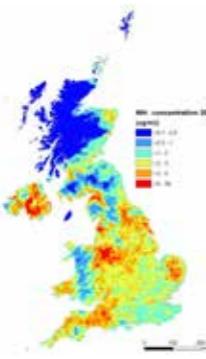
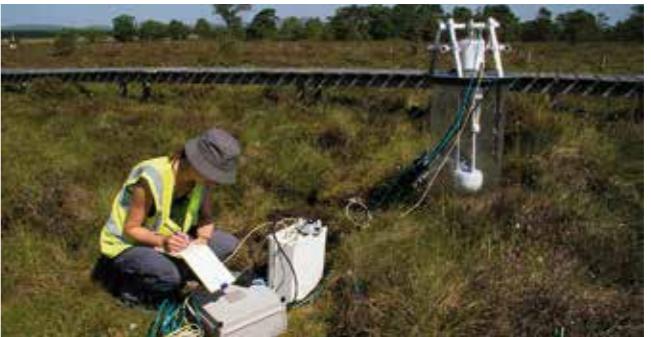


**Centre for  
Ecology & Hydrology**  
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# Science Excellence to Impact

<p>1969: Pioneered micrometeorological measurements of water, energy, and heat fluxes (Thetford Forest Micrometeorological Experiment).</p> <p>1980s: Took leading role in European network of reactive gas measurements (<b>BIATEX</b>).</p>		<p>2000s: Led JULES model development and evaluation; took leading role in European risk assessment modelling for ozone fluxes.</p> <p>2002: Pioneered the measurement of urban pollutant fluxes with micrometeorological techniques. Established world's first real-time ammonia emission field experiment (Whim bog).</p>	<p>2010: Founded the International Nitrogen Initiative.</p> <p>2011: Quantified black carbon and ozone effects on climate change; published The European Nitrogen Assessment.</p> <p>2012: Quantified feedbacks between climate warming and CO<sub>2</sub> accumulation.</p> <p>2013: Published Our Nutrient World: a global assessment of nutrient excess and deficiency.</p>
<p>&lt;1990</p> <p>1982: Demonstrated impact of acid deposition in the UK.</p> <p>1989: Developed integrative land-surface model <b>MOSES</b>.</p>		<p>1990s</p> <p>1990s: Led most detailed study to date of water and carbon exchange from habitats in the Amazon (<b>ABRACOS</b>).</p> <p>1996: Established first UK Biosphere-Atmosphere Interactions measurement site (Auchencorth Moss), and the UK Ammonia Network.</p> <p>1997: First verification of UK GHG budget by aircraft measurements.</p>	<p>2000s</p> <p>2004: Launch of online UK Air Pollution Information System (<b>APIS</b>).</p> <p>2008: Led Bioenergy-GHG Crop Network; developed eddy-covariance methodology for aerosol chemical components.</p>
			<p>2010s</p> 

## Future Research Objectives

**Quantify biosphere atmosphere-exchange in major biomes across regional and global scales.**

### By 2019, we will:

- implement improved UK agricultural N<sub>2</sub>O emission factors, based on soil moisture and crop type.
- quantify the seasonality in volatile organic carbon emissions and aerosol deposition above Amazonian rainforest.

**Improve process-based understanding of biosphere-atmosphere exchange.**

### By 2019, we will:

- use precision-controlled exposure facilities to understand the modifying effects of climate drivers on air pollution exchange and impacts on biota.
- quantify feedbacks between nitrogen deposition, elevated ozone, and the above-and below-ground ecological community.
- identify critical feedbacks between ecological and hydrological processes and GHGs/air pollutants across a range of sensitive ecosystems.

**Integrate measurements and networks; incorporate new understanding into models.**

### By 2019, we will:

- enable the UK GHG network to operate under harmonised procedures covering both natural and managed landscapes.
- incorporate the nitrogen cycle and nitrogen-ozone interactions in Earth system models.
- integrate high-quality measurements across global biomes into the next generation of climate and pollution models.

**Support policies to reduce atmospheric pollutants and GHGs and mitigate their impacts.**

### By 2019, we will:

- publish an analysis of societal benefits of improved nitrogen use efficiency and reduced reactive nitrogen emissions.
- develop mitigation options to reduce the overall impact of multiple interacting pollutants.

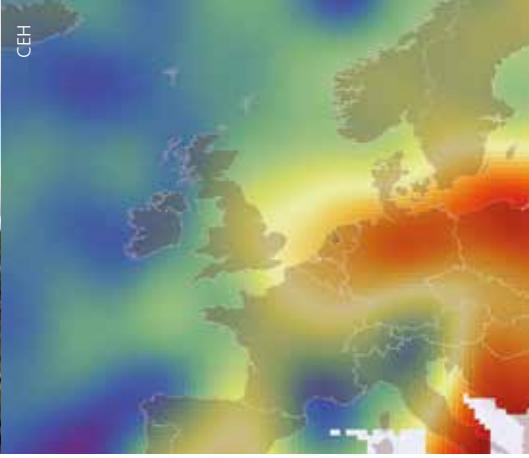


Photo: Cloud Nine

## Partnerships

Since the 1970s we have led or co-led the development of measurements, instruments, exposure facilities, models, and risk assessments aimed at understanding the production, fate, and impact of GHGs and air pollutants. To deliver our research we have established long-term field experiments, exposure facilities, and monitoring sites in the UK, and conducted field campaigns across both UK and global biomes. We have applied our knowledge to developing a comprehensive suite of process and transport models such as the land-surface exchange model JULES. Our unique strength lies in connecting our measurements, experiments, monitoring networks, and models to both increase scientific understanding and deliver practical recommendations to managers and policy-makers.

We collaborate with UK and international partners at universities, scientific institutions, and industries. Our scientific findings, long-term data, and expertise support regulatory bodies and advisory committees such as Defra, the Met Office, UN conventions on air pollution and climate change, the EU, and industries at scales from the local to the global.

## Contact

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