

# UK Eutrophying and Acidifying Atmospheric Pollutants Monitoring networks

## UKEAP

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**RICARDO-AEA**



# UK Eutrophying & Acidifying atmospheric Pollutants (UKEAP)

## OBJECTIVES:

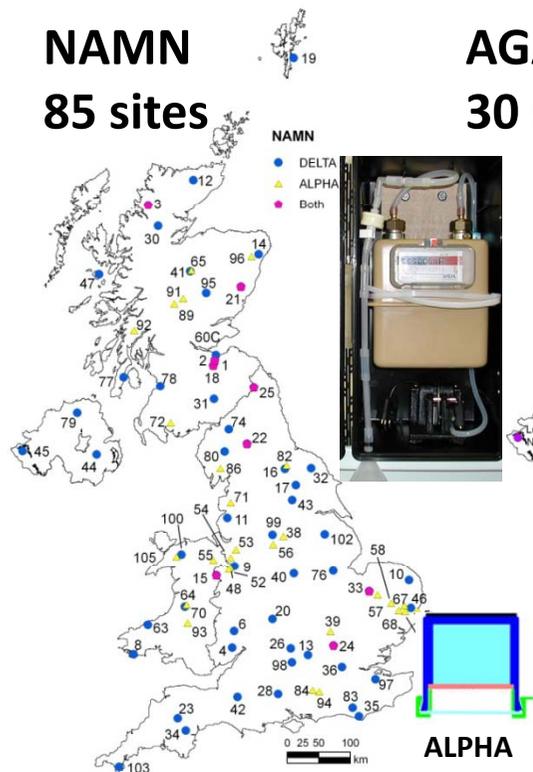
➤ Monitoring of concentrations and deposition of **eutrophying** and **acidifying** species in air and precipitation in rural areas of the UK with sufficient spatial and temporal resolution to allow:

- *Evaluation of policy measures to reduce concentration and deposition;*
- *Assessment of risks to ecosystems and exceedences of critical loads;*
- *Estimation of secondary components of  $PM_x$ .*

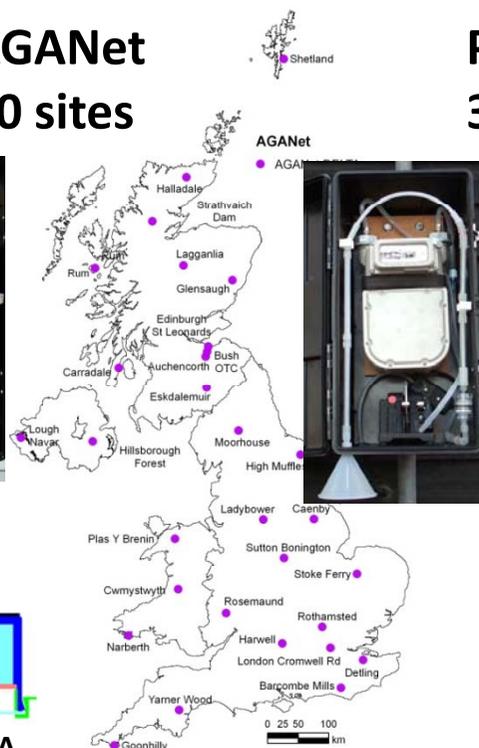
➤ Provide UK input to the European Monitoring and Evaluation Programme (<http://www.emep.int/>)

# UKEAP: Component networks

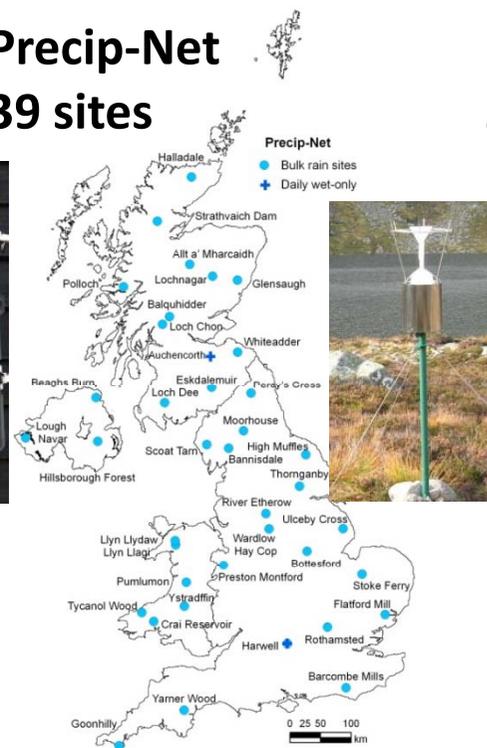
## NAMN 85 sites



## AGANet 30 sites



## Precip-Net 39 sites

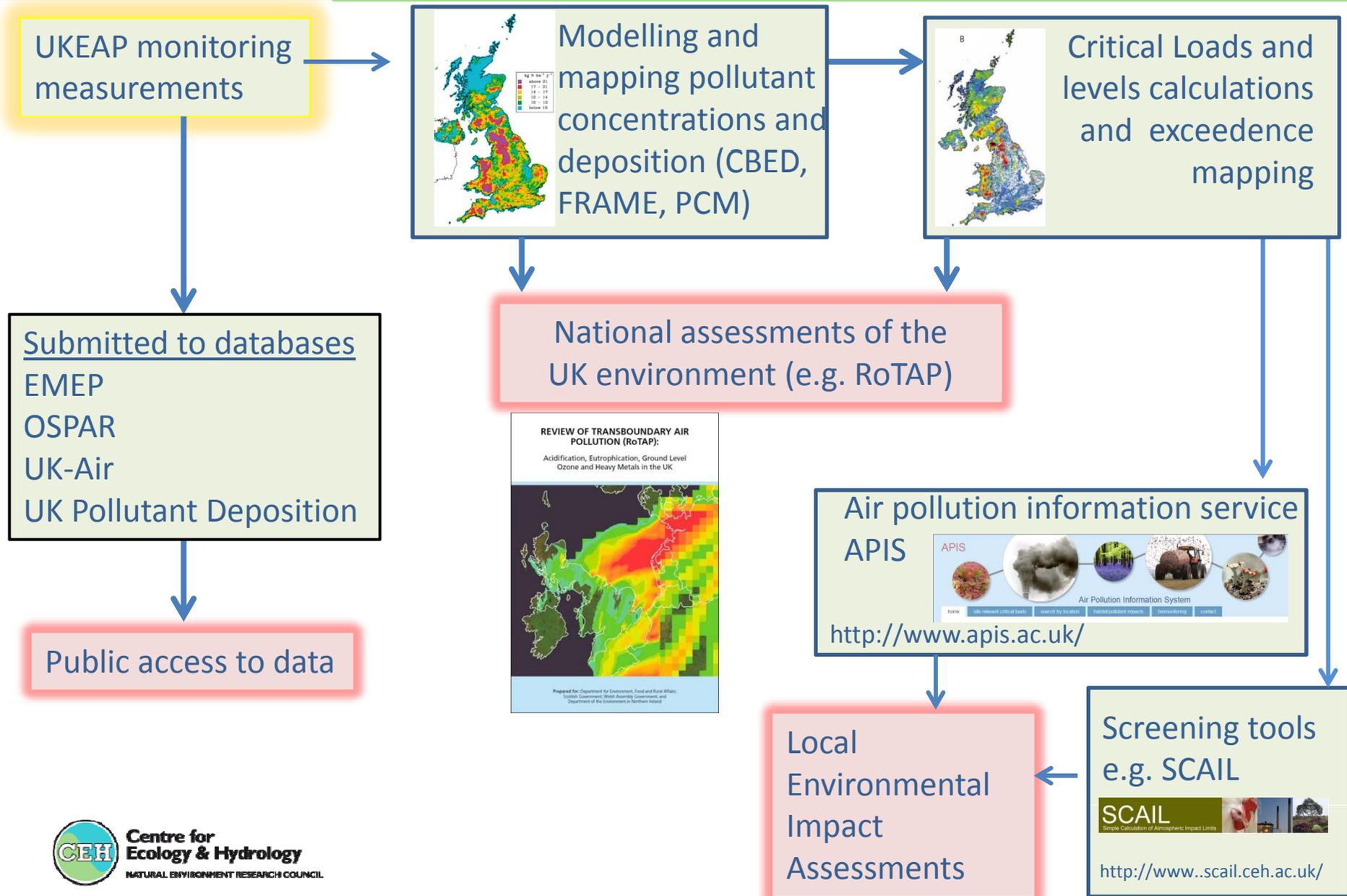


## NO<sub>2</sub>-Net 24 sites

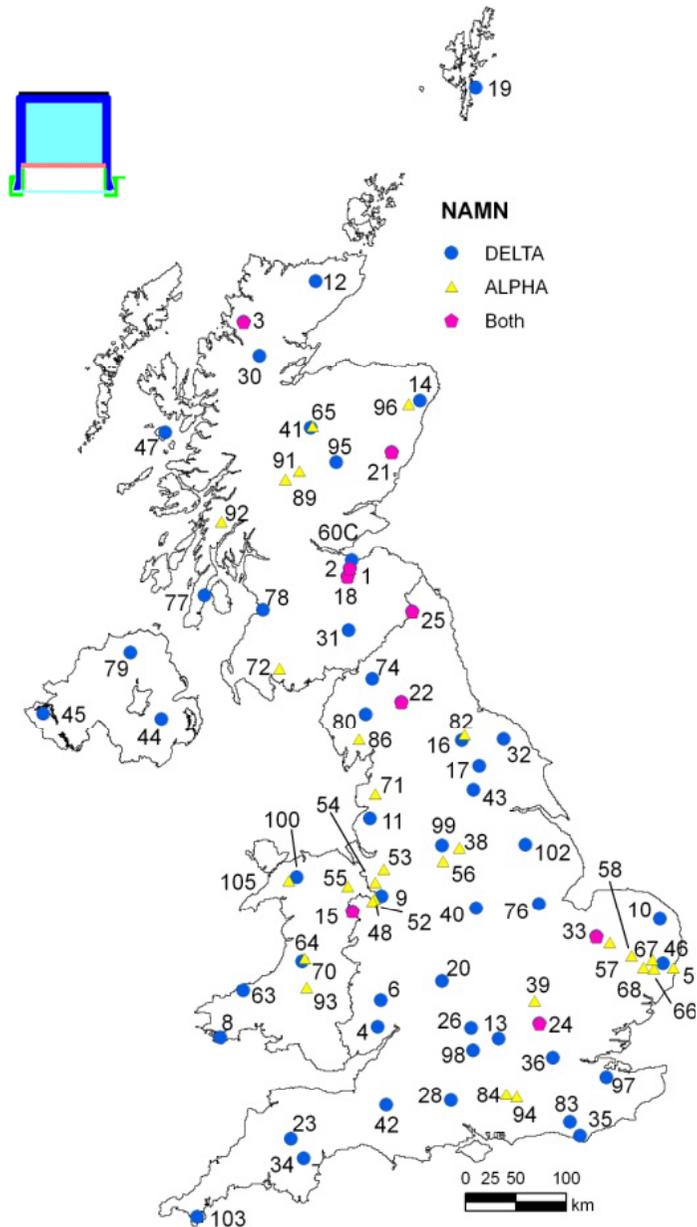


|            | NAMN  | AGANet   | Precip-Net   | NO <sub>2</sub> -Net |
|------------|---|--|--|----------------------|
| Method     | DELTA / ALPHA                                   | DELTA  | Bulk rain collector  | Diffusion Tubes      |
| Resolution | Monthly   | Monthly  | 2-weekly (daily at 2 sites)  | 4-weekly             |
| Species    | NH <sub>3</sub><br>NH <sub>4</sub> <sup>+</sup> | HNO <sub>3</sub> , SO <sub>2</sub> , HCl,<br>NO <sub>3</sub> <sup>-</sup> , SO <sub>4</sub> <sup>2-</sup> , Cl <sup>-</sup> ,<br>Na <sup>+</sup> , Ca <sup>2+</sup> , Mg <sup>2+</sup> | pH, conductivity,<br>NH <sub>4</sub> <sup>+</sup> , NO <sub>3</sub> <sup>-</sup> , PO <sub>4</sub> <sup>3-</sup> , SO <sub>4</sub> <sup>2-</sup> , Cl <sup>-</sup> ,<br>Na <sup>+</sup> , K <sup>+</sup> , Ca <sup>2+</sup> , Mg <sup>2+</sup> | NO <sub>2</sub>      |
| Inception  | 1996  | 1999   | 1985   | 1984                 |

# Measurement data uses

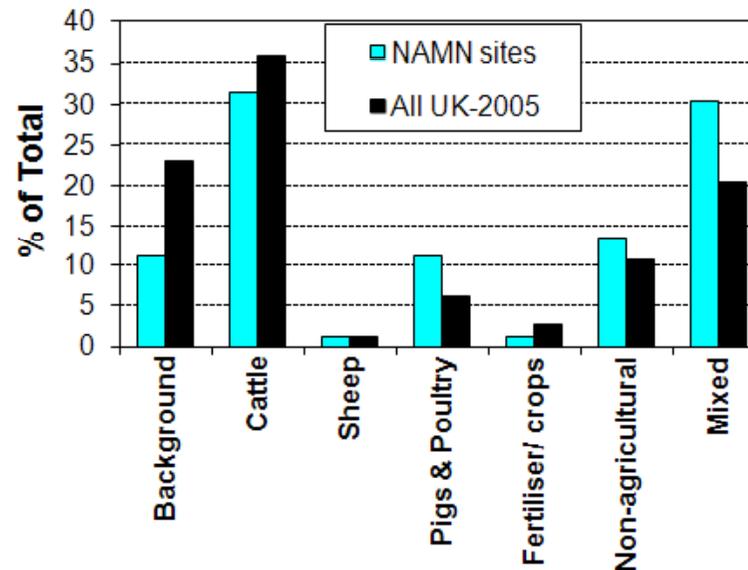


# National ammonia monitoring network NAMN



Sites selected such that:

- No proximity to large scale sources
- Higher density of sites in regions where ammonia is of interest, e.g. East Anglia
- 29 sites are on NNR/LNRs or research sites
- 11 on ECN sites
- 11 on AURN sites
- 2 urban sites

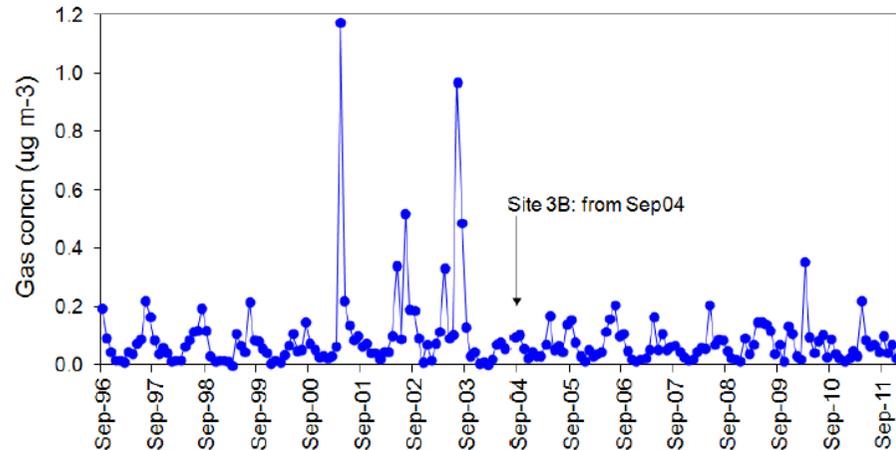


# Example sites

## Inverpolly

Site no: 3 / 3B  
 NGR: NC187088 / NC 187087  
 Method: DELTA

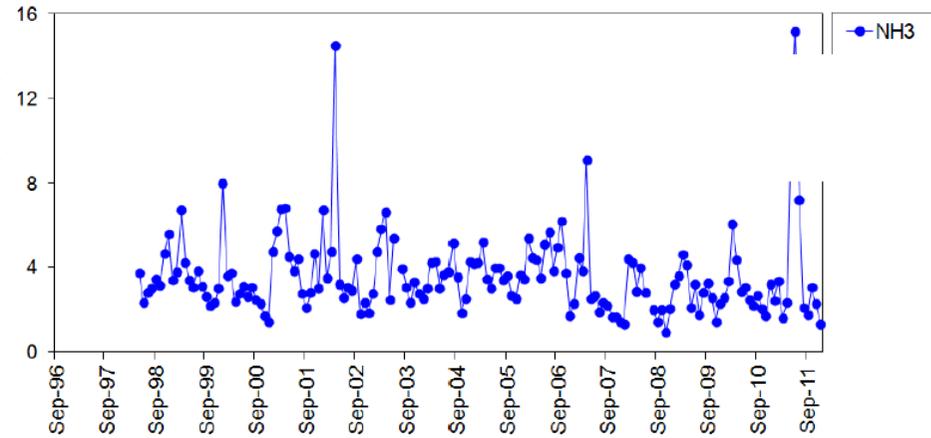
Site Environment: Remote upland moorland  
 Other measurement: Heavy metals  
 Site Operator: SNH



## Brown Moss 2

Site no: 9B  
 NGR: SJ563390  
 Method: DELTA

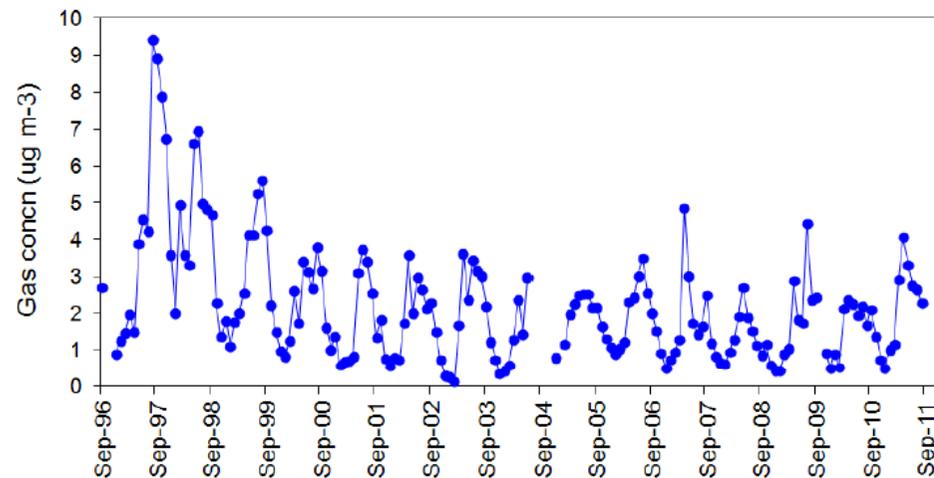
Site Environment: Garden in nature reserve, surrounded by agricultural fields  
 Other measurement:  
 Site Operator: Private individual



## Drayton

Site no: 20  
 NGR: SP184549  
 Method: DELTA

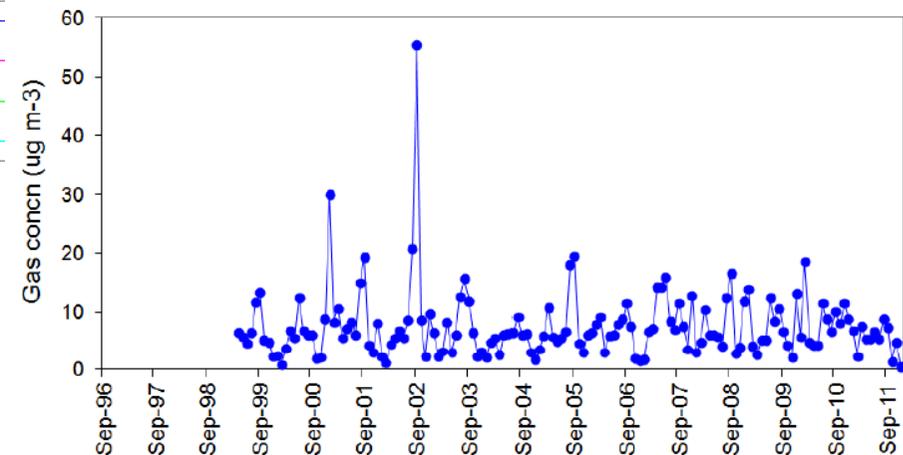
Site Environment: ADAS ground, surrounded by agricultural field  
 Other measurement: ECN site nearby  
 Site Operator: ADAS NSRU



## Auchincruive

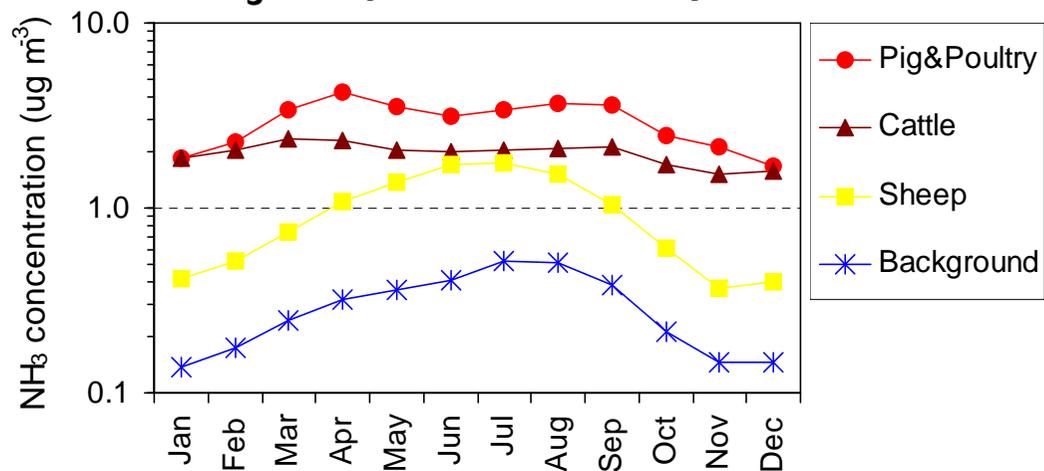
Site no: 78  
 NGR: NS379234  
 Method: DELTA

Site Environment: Grounds of Agricultural college  
 Other measurement:  
 Site Operator: SAC Auchincruive



# Annual cycles in NH<sub>3</sub>

## NH<sub>3</sub> temporal variability



## NH<sub>4</sub><sup>+</sup> temporal variability

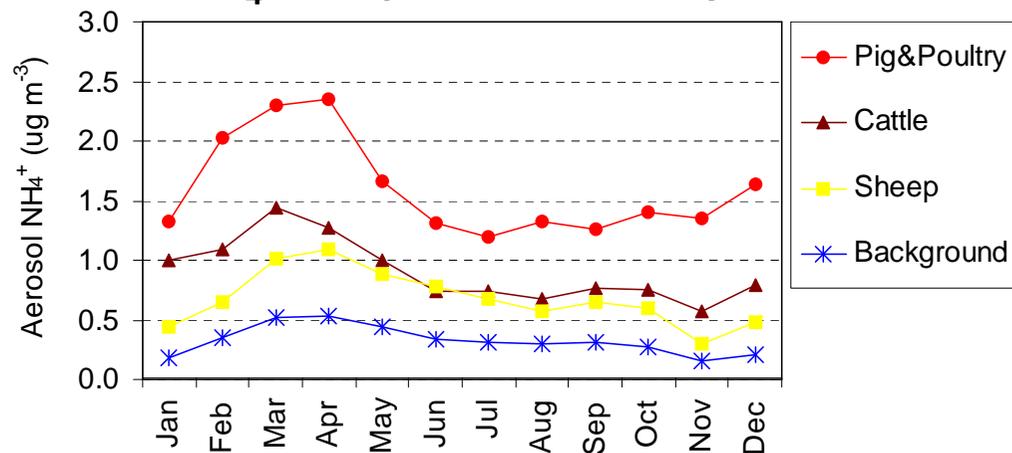
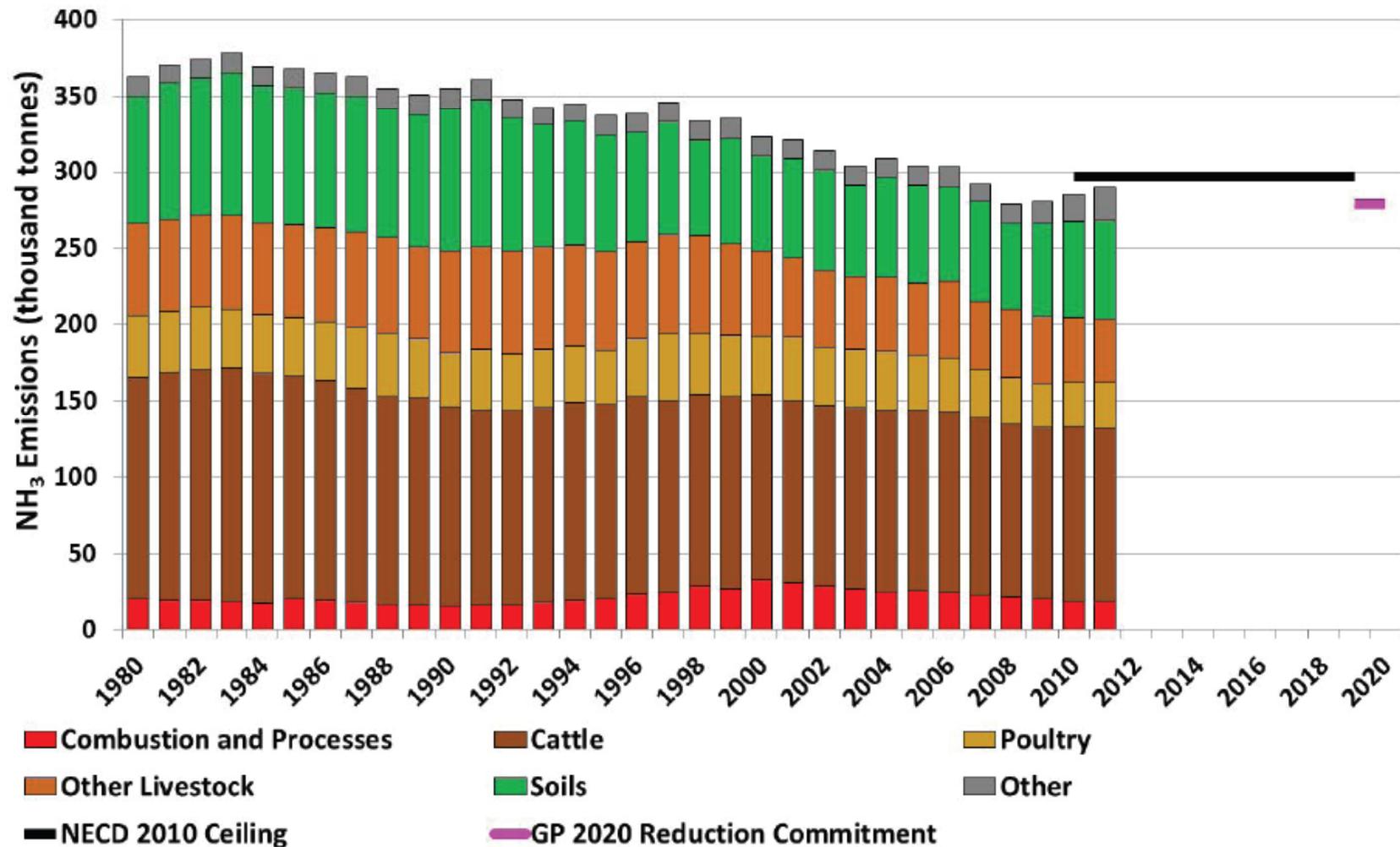
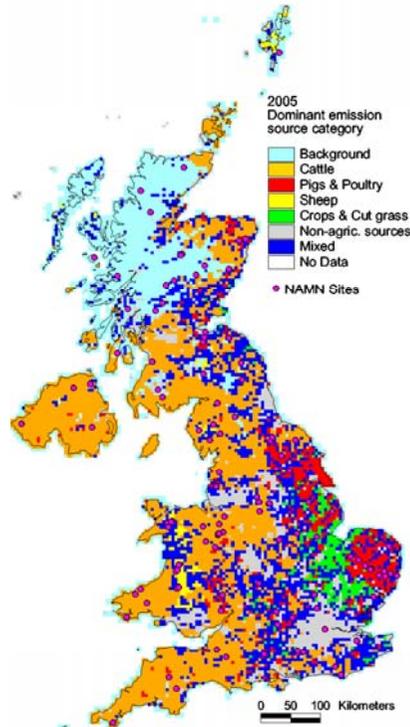


Figure 2.3.1: Time series of ammonia emissions from 1980 to 2011 with associated 2010 NECD target, and 2020 Gothenburg Protocol emission reduction commitment

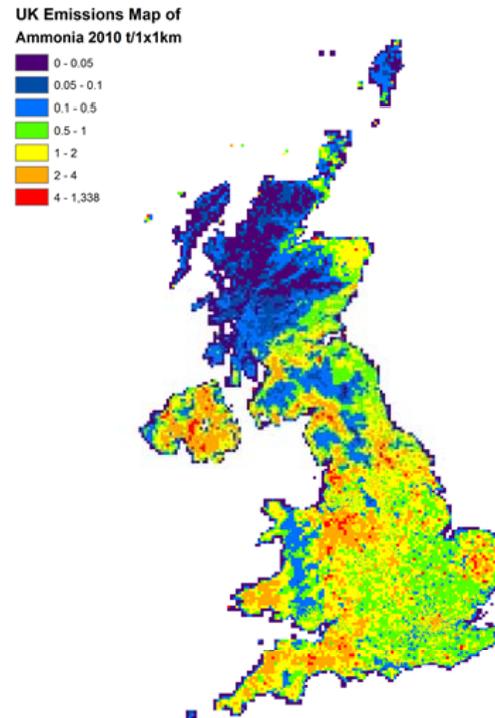


# NAMN: UK Mapping

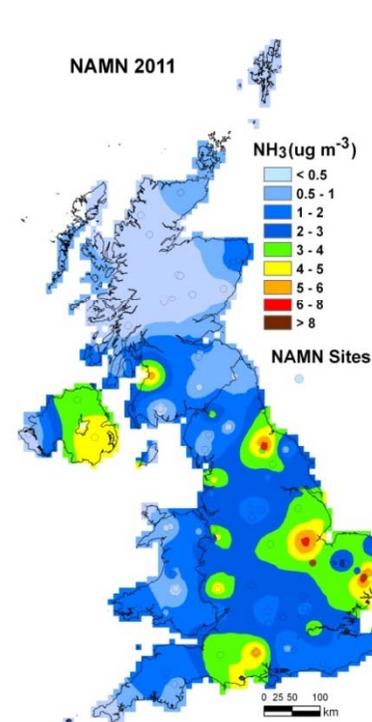
## NH<sub>3</sub> Emission Source Category Map



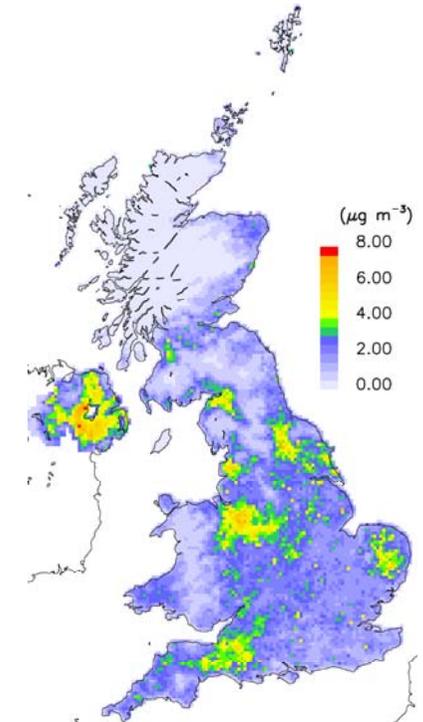
## NH<sub>3</sub> Emissions Map



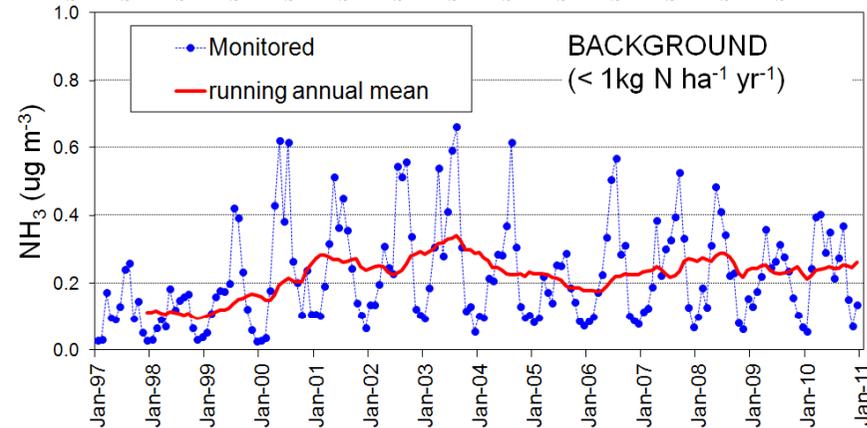
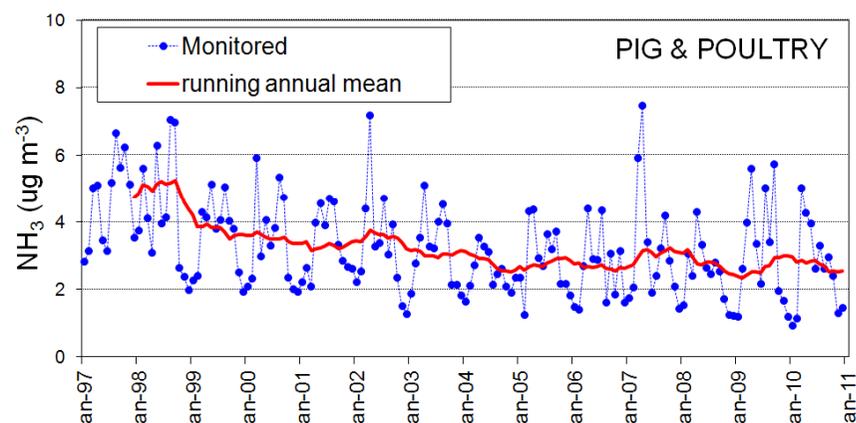
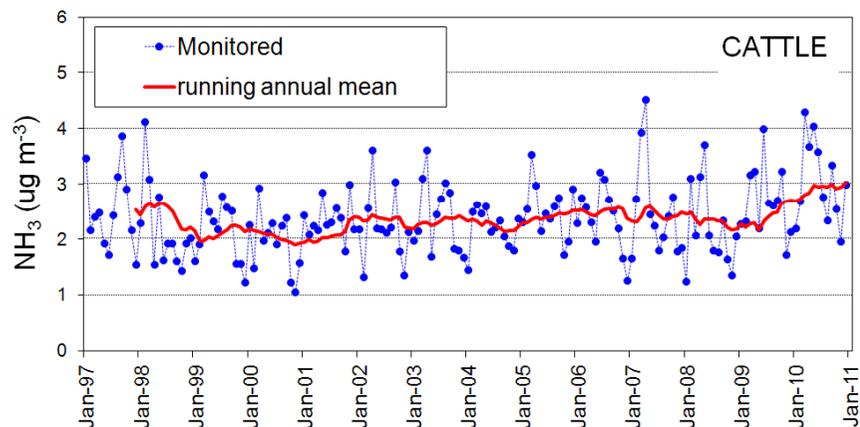
## NAMN 2011



## FRAME

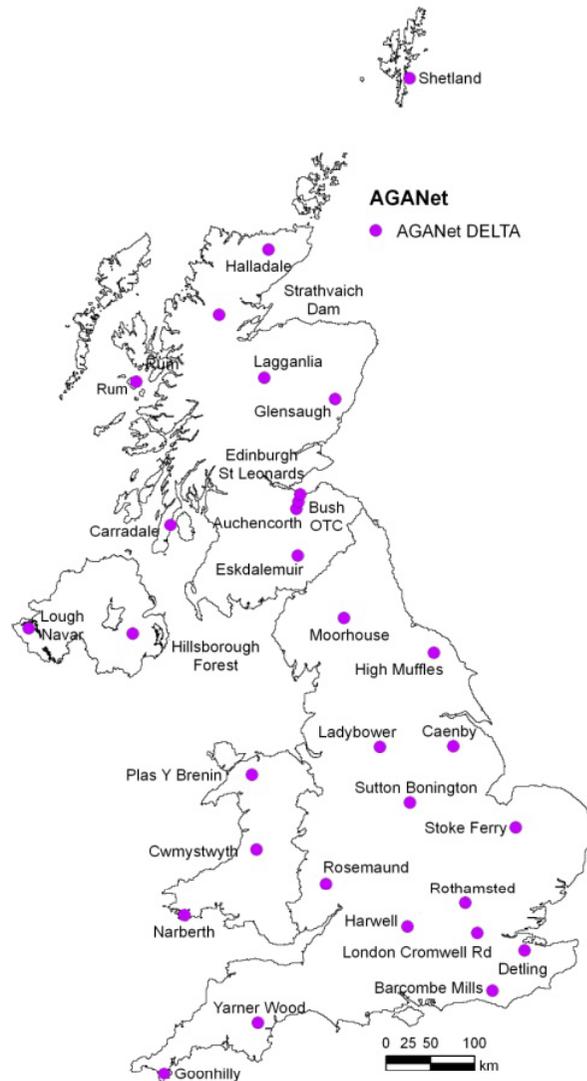


# NAMN: Time series



| % Change 2010/1998 | CATTLE  | PIG & POULTRY | BACKGROUND |
|--------------------|---------|---------------|------------|
| NAEI               | -9.3 %  | -42.5 %       | -          |
| NAMN               | +38.5 % | -38.5 %       | + 152 %    |

# Acid gases and Aerosol Network (AGA-Net)



Sites selected such that:

- Co-located with NAMN sites
- Sufficient coverage across UK to allow kriging of data
- 2 urban sites

DH2

DA1

DH1

DA2

**1. Basic filter**  
NO<sub>3</sub>, NO<sub>2</sub>, SO<sub>4</sub>,  
Cl, Na, Ca, Mg

**2. Acid filter**  
NH<sub>4</sub>



# DELTA System

## New DELTA system

### Current Design



DH2

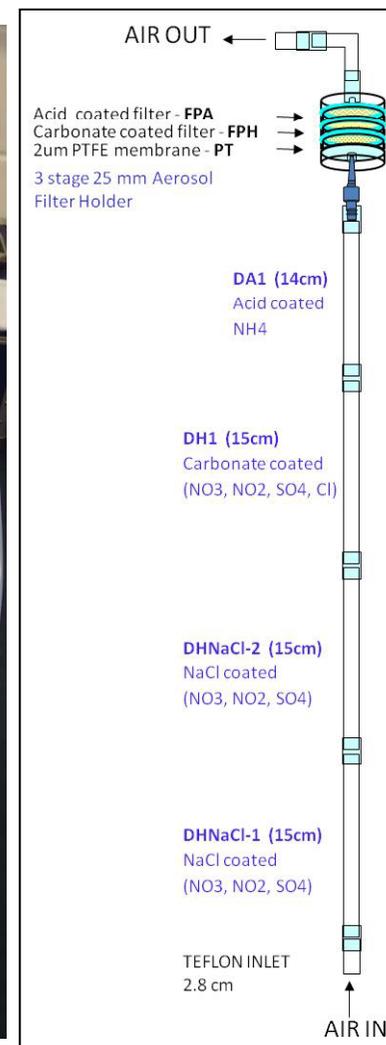
DA1

DA2

DH1

1. Basic filter  
NO<sub>3</sub>, NO<sub>2</sub>, SO<sub>4</sub>,  
Cl, Na, Ca, Mg

2. Acid filter  
NH<sub>4</sub>



### Rothamsted

Site no: 24

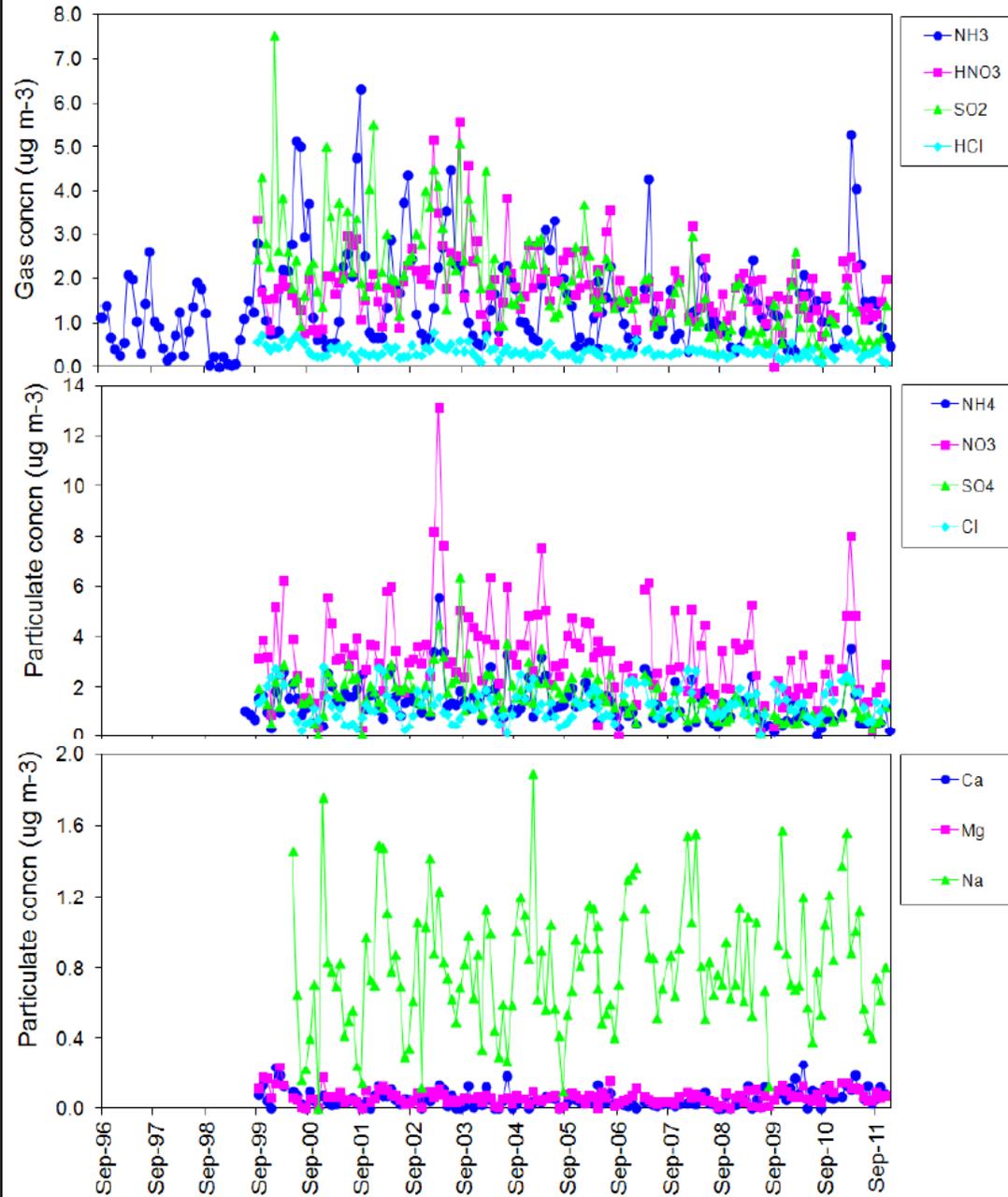
NGR: TL123129

Method: DELTA

Site Environment: Experimental station; agricultural landscape

Other measurement: Bulk rain, ECN

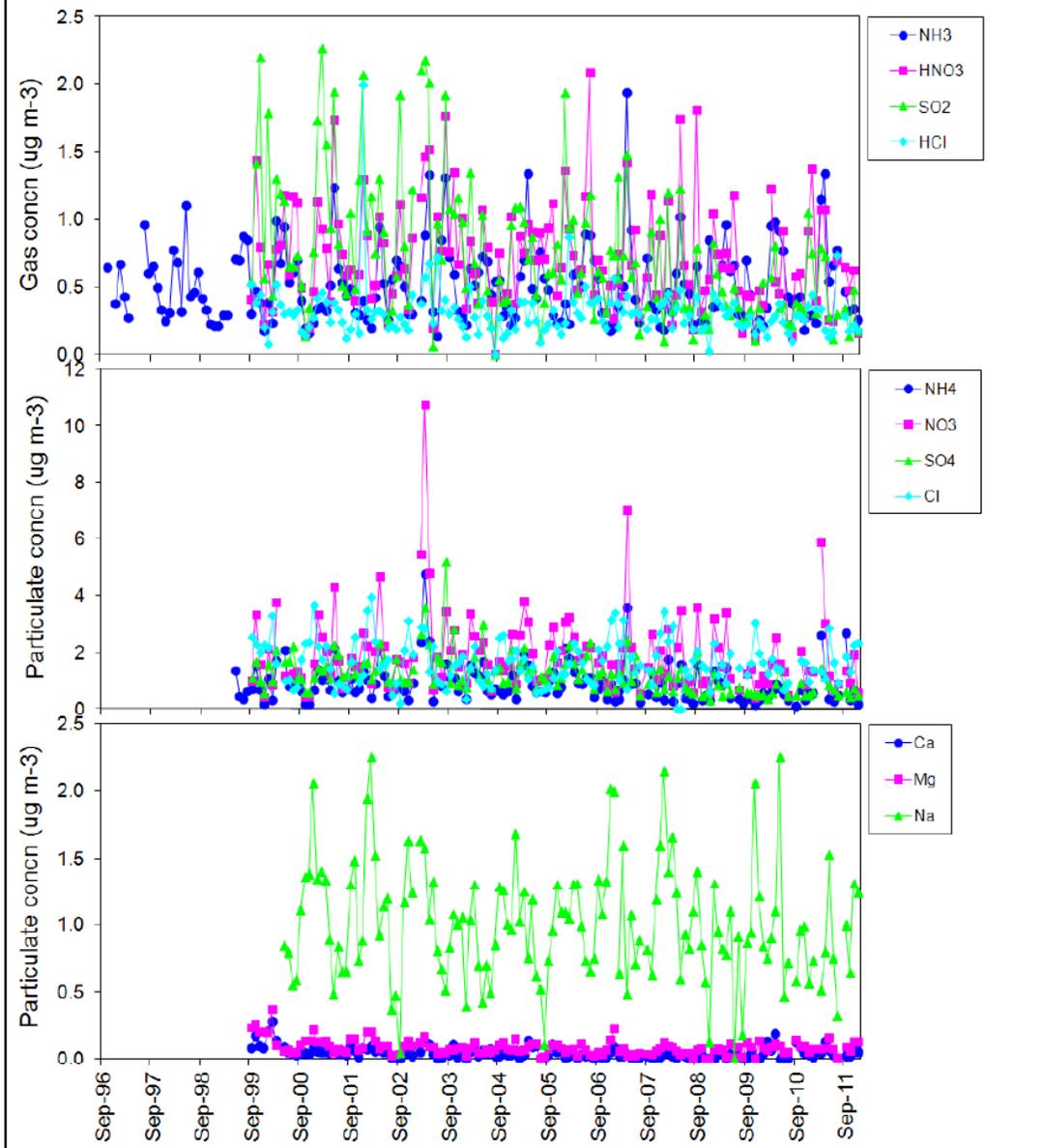
Site Operator: Rothamsted Research



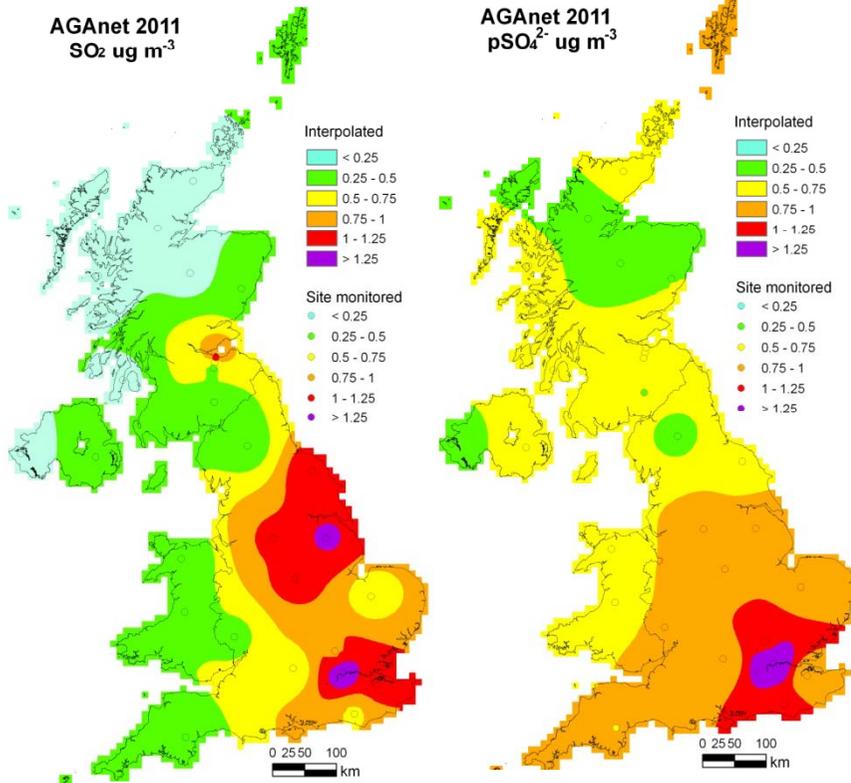
### Yarner Wood

Site no: 34  
NGR: SX786789  
Method: DELTA

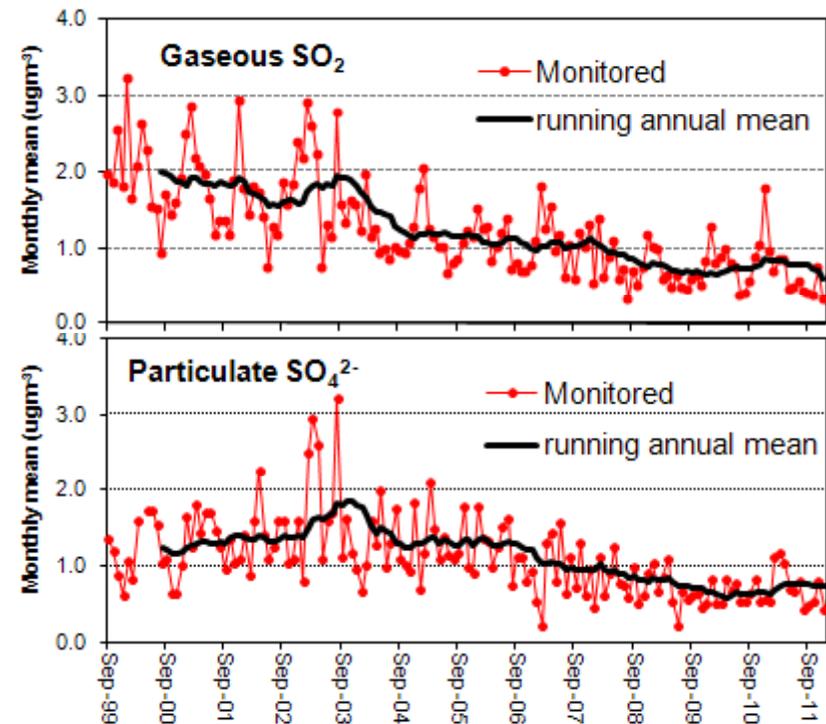
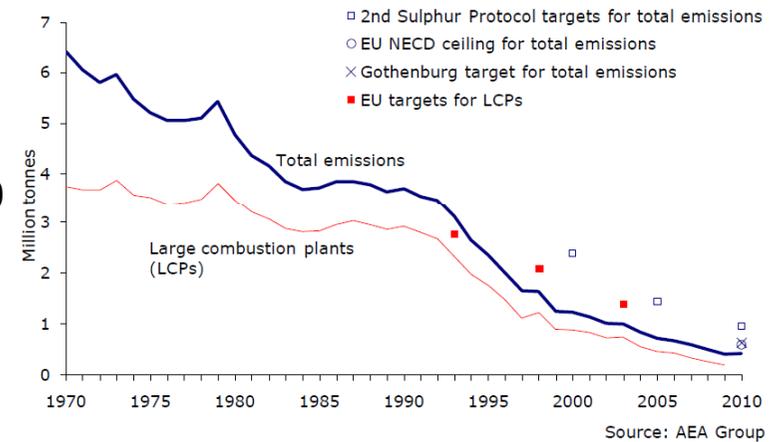
Site Environment: Grass clearing in Nature reserve  
Other measurement: Bulk rain, NO<sub>2</sub>, O<sub>3</sub>, Heavy metals  
Site Operator: Natural England



# AGANet: UK Sulphur changes

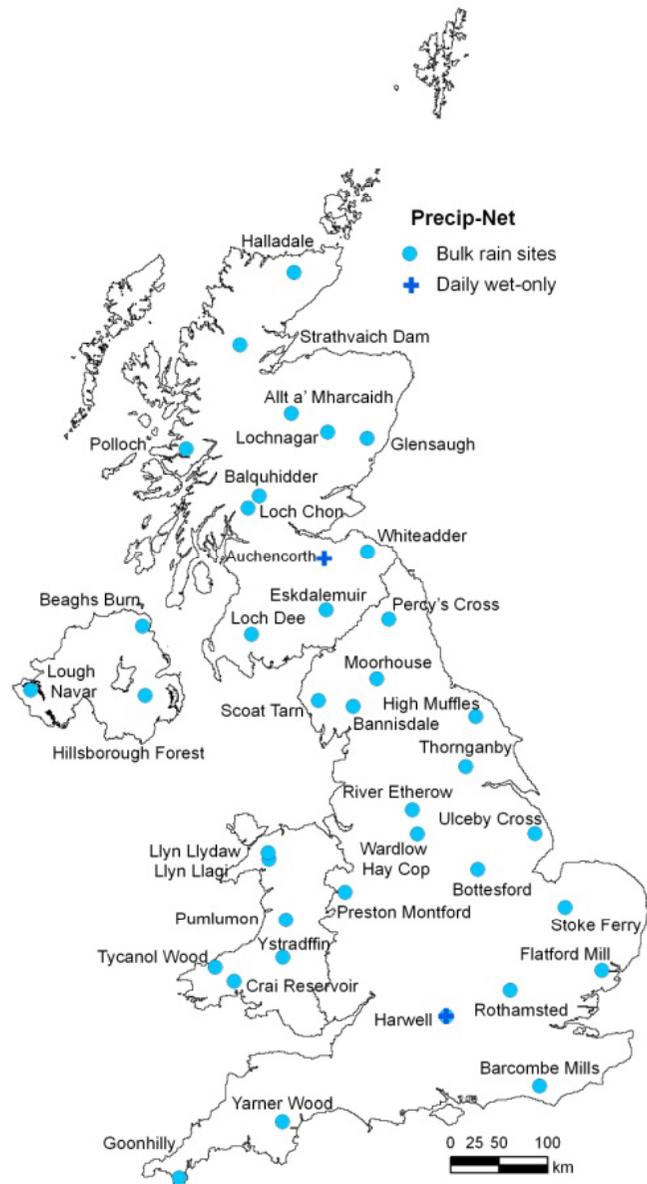


## UK SO<sub>2</sub> emissions and targets: 1970 – 2010



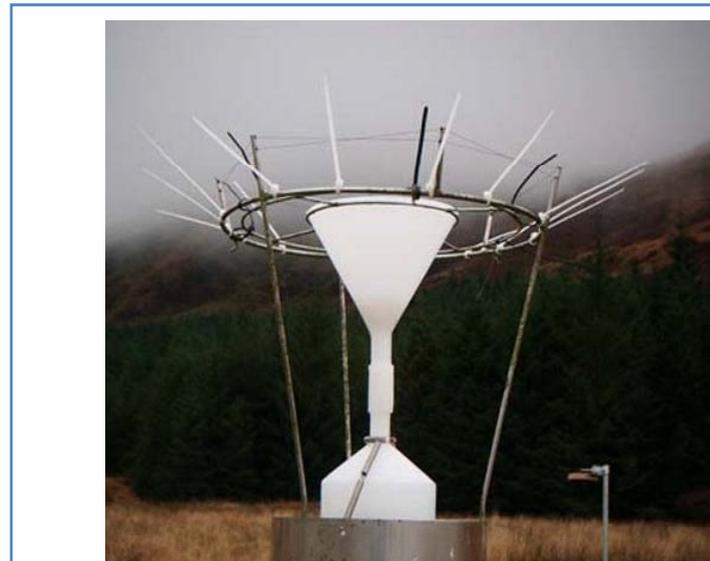
Source: Defra National Statistics Release: Emissions of air pollutants in the UK, 1970 to 2010

# Precip-Net

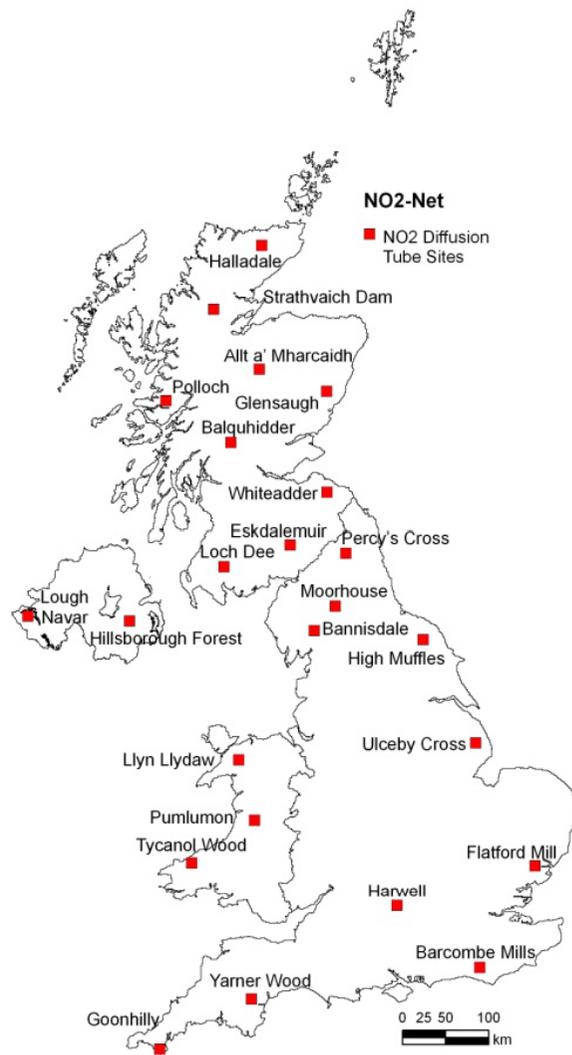


Sites selection (before my time!)

- driven by acid rain issues of the 1980s
- UK coverage for mapping purposes

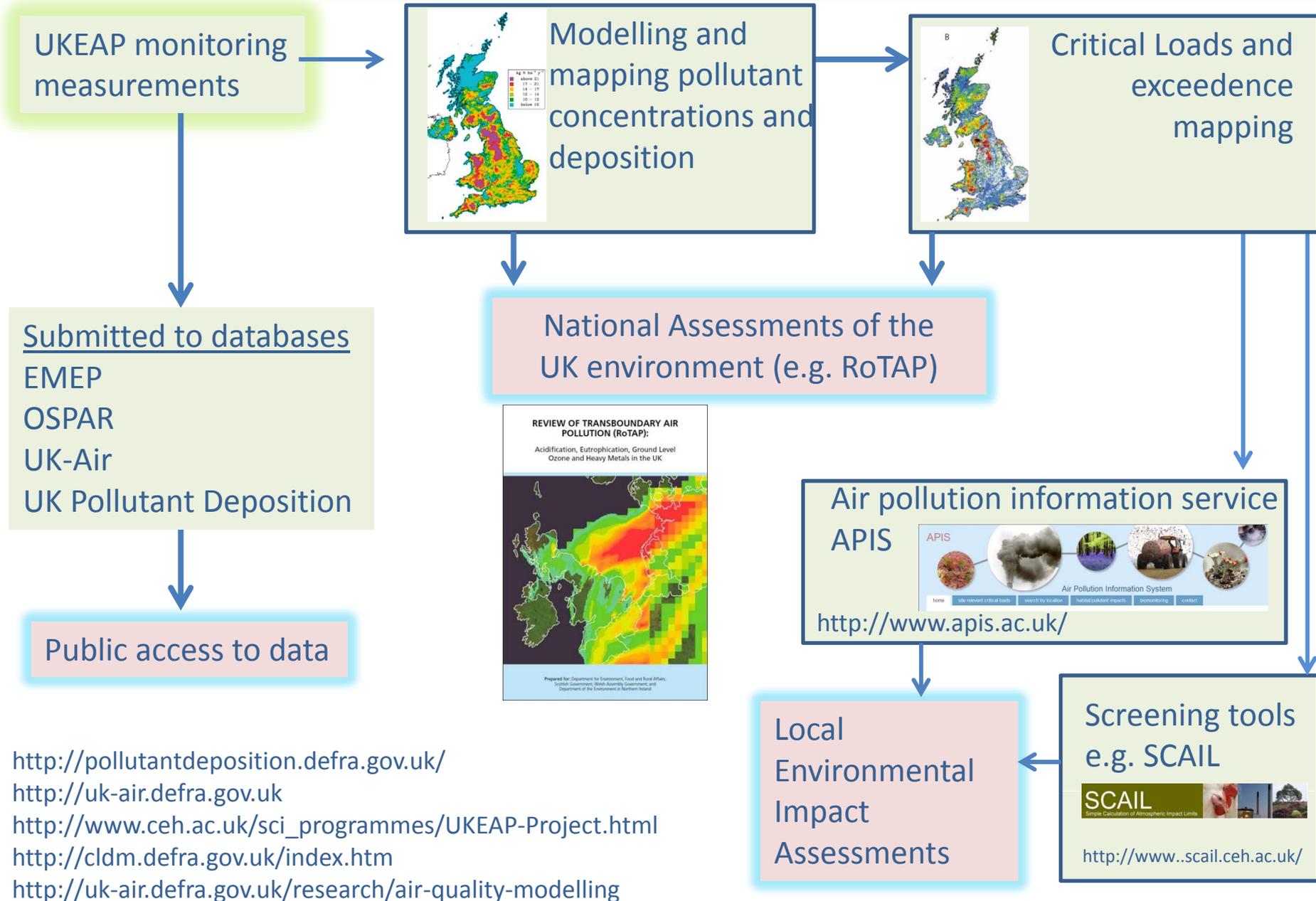


# NO<sub>2</sub>-Net



| Site Name                 | 2011 Concentrations | Data capture |
|---------------------------|---------------------|--------------|
| Allt a'Mharcaidh          | 1.55                | 100%         |
| Balquhiddier 2            | 2.63                | 97%          |
| Bannisdale                | 4.73                | 100%         |
| Barcombe Mills            | 10.7                | 100%         |
| Driby 2                   | 11.6                | 100%         |
| Eskdalemuir <sup>T</sup>  | 3.49                | 100%         |
| Flatford Mill             | 12.4                | 99%          |
| Forsinain 2/Halladale     | 2.07                | 92%          |
| Glensaugh                 | 3.42                | 100%         |
| Goonhilly                 | 4.56                | 99%          |
| Harwell <sup>T</sup>      | 12.2                | 100%         |
| High Muffles              | 7.73                | 100%         |
| Hillsborough Forest       | 7.39                | 100%         |
| Llyn Llydaw               | 3.07                | 100%         |
| Loch Dee                  | 3.75                | 75%          |
| Lough Navar               | 2.07                | 100%         |
| Moorhouse                 | 4.8                 | 100%         |
| Percy's Cross             | 5.23                | 92%          |
| Polloch                   | 1.42                | 100%         |
| Pumlumon                  | 4.2                 | 100%         |
| Strathvaich Dam           | 1.19                | 100%         |
| Tycanol Wood              | 3.52                | 96%          |
| Whiteadder                | 3.62                | 100%         |
| Yarnier Wood <sup>T</sup> | 4.93                | 100%         |

# Measurement data uses



# Summary

- UKEAP measurements underpin the capability to understand changes in rural air quality across the UK;
- It should be possible for significant future UK mitigation, emissions reductions and ecosystem exposure to be observed;
- S deposition is a driver of the acidifying input for sensitive catchments and to critical load exceedance and has been most important historically;
- Inputs of  $\text{NH}_x$  are the dominant driver of ecological effects of deposited N, and the importance of  $\text{NH}_x$  is predicted to increase relative to oxidised N, as  $\text{NO}_x$  emissions decrease further