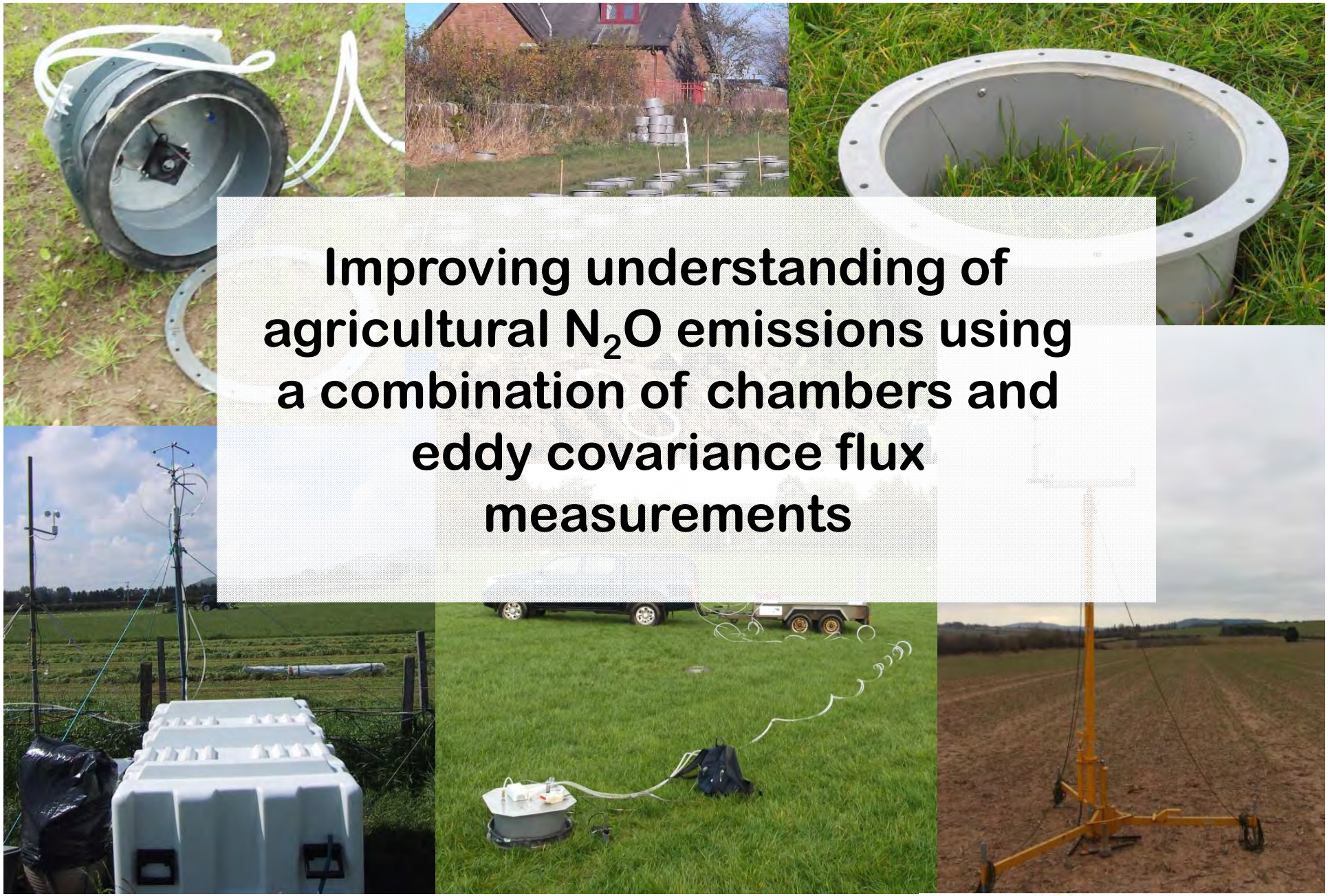

Improving understanding of agricultural N_2O emissions using a combination of chambers and eddy covariance flux measurements

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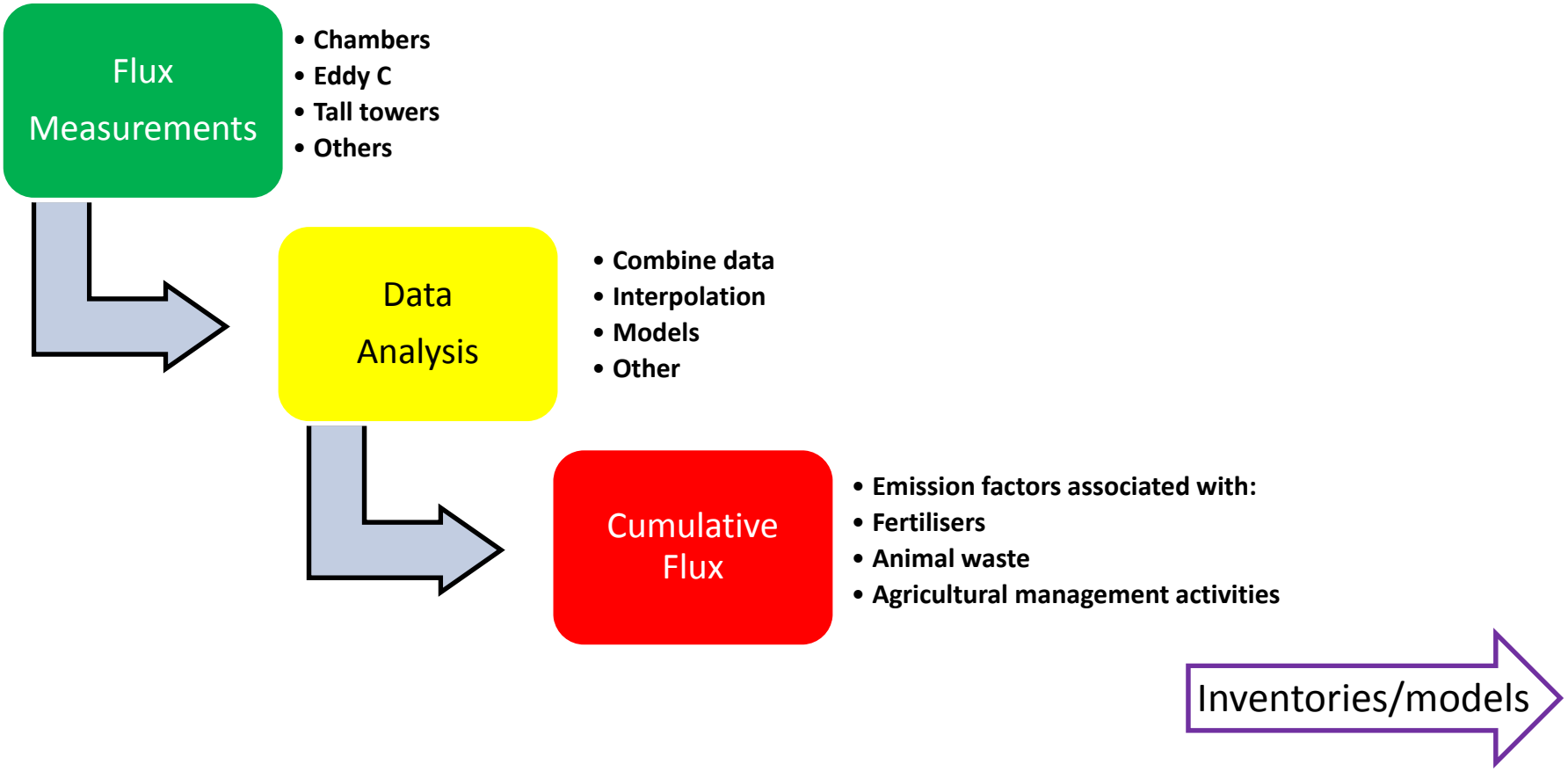
CEH Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL
AC0116 : Work Package 5, Verification of N_2O flux measurements

Typical N_2O Experiments



The goal of most agricultural N_2O research is to estimate cumulative fluxes in order to compare management practice and mitigate emissions.

Chamber Options

Static Chambers

- Account for about 95% of published literature on N_2O fluxes from agricultural sources
- **Cheap and easy to use**
- **Large uncertainties**

Dynamic Chambers

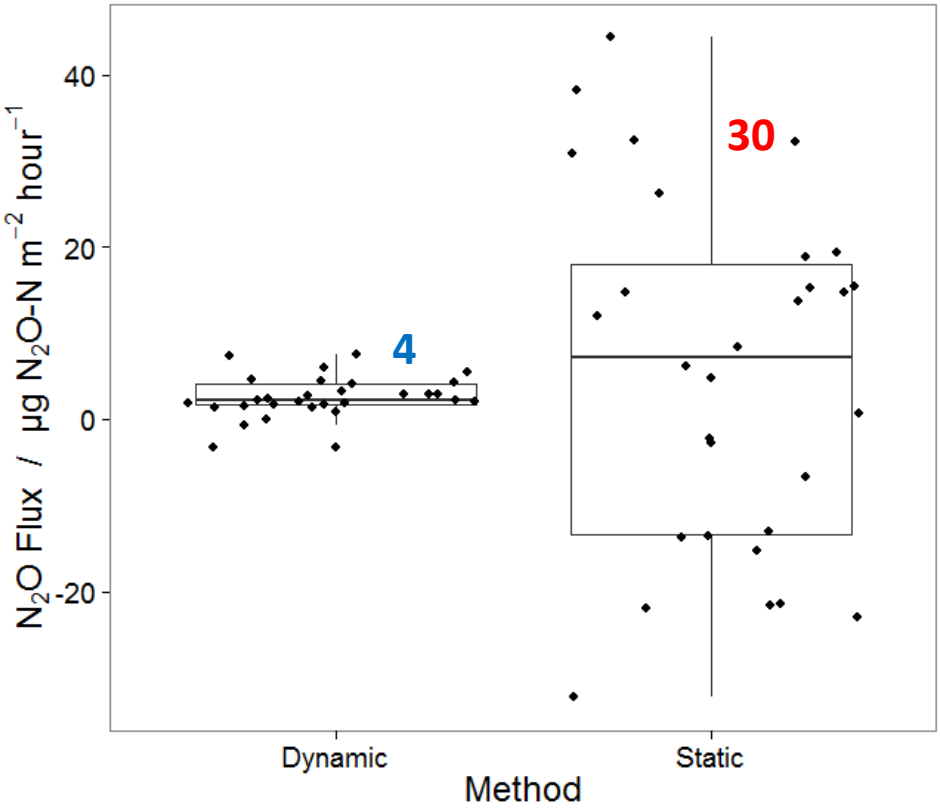
- Becoming more common
- **Improved flux detection limits for multiple greenhouse gases**
- **More expensive and difficult to run**

★ Both methods can be run manually or automatically (auto-chamber)

What's the Difference?

Precision / Detection Limits

Quantum Cascade Laser



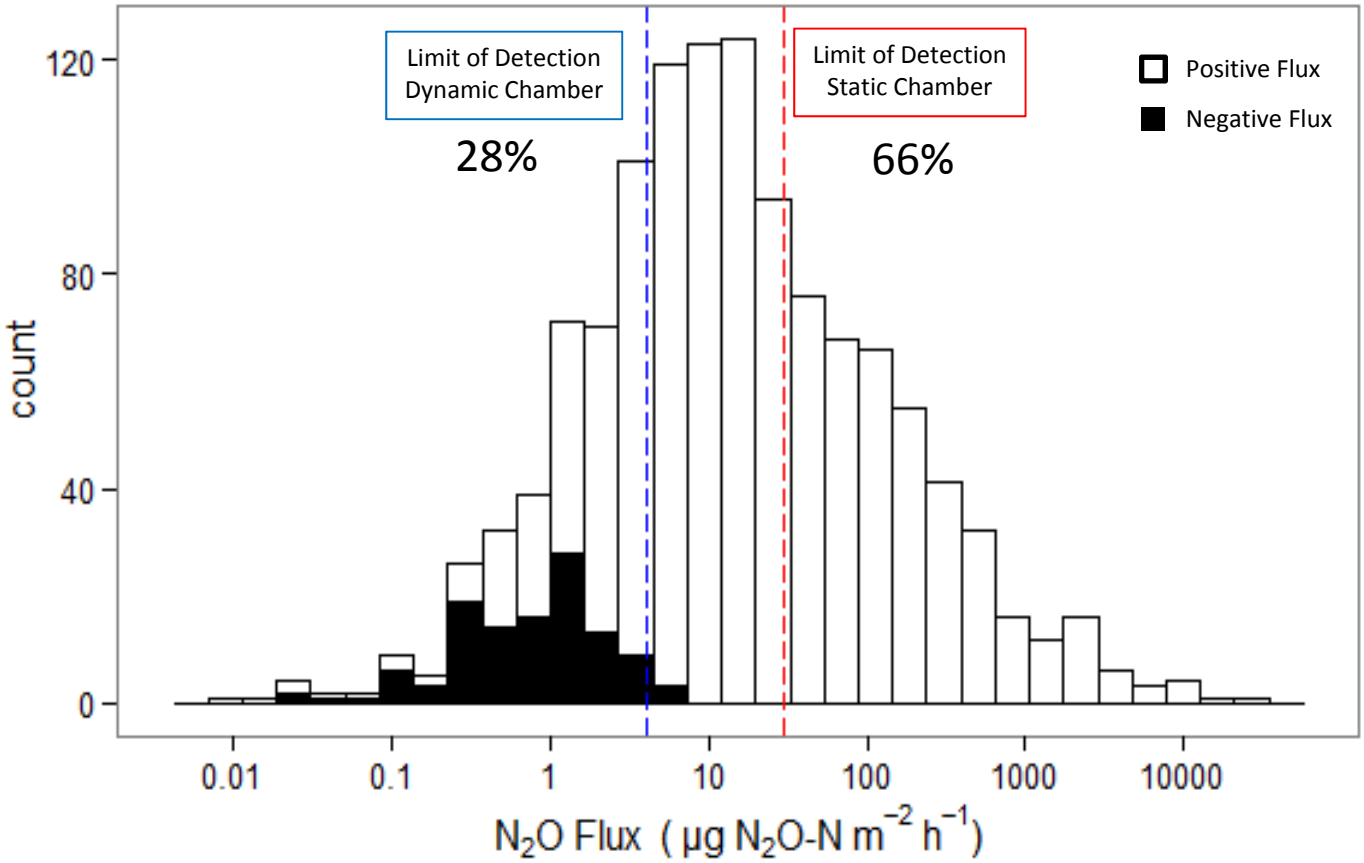
Gas Chromatograph

Lower detection limits improve our understanding of what is real and what is measurement uncertainty

1 nmol m^{-2} s^{-1} ≈ 10 µg N_2O-N m^{-2} h^{-1}

What's the Difference?

1220 dynamic chamber measurements

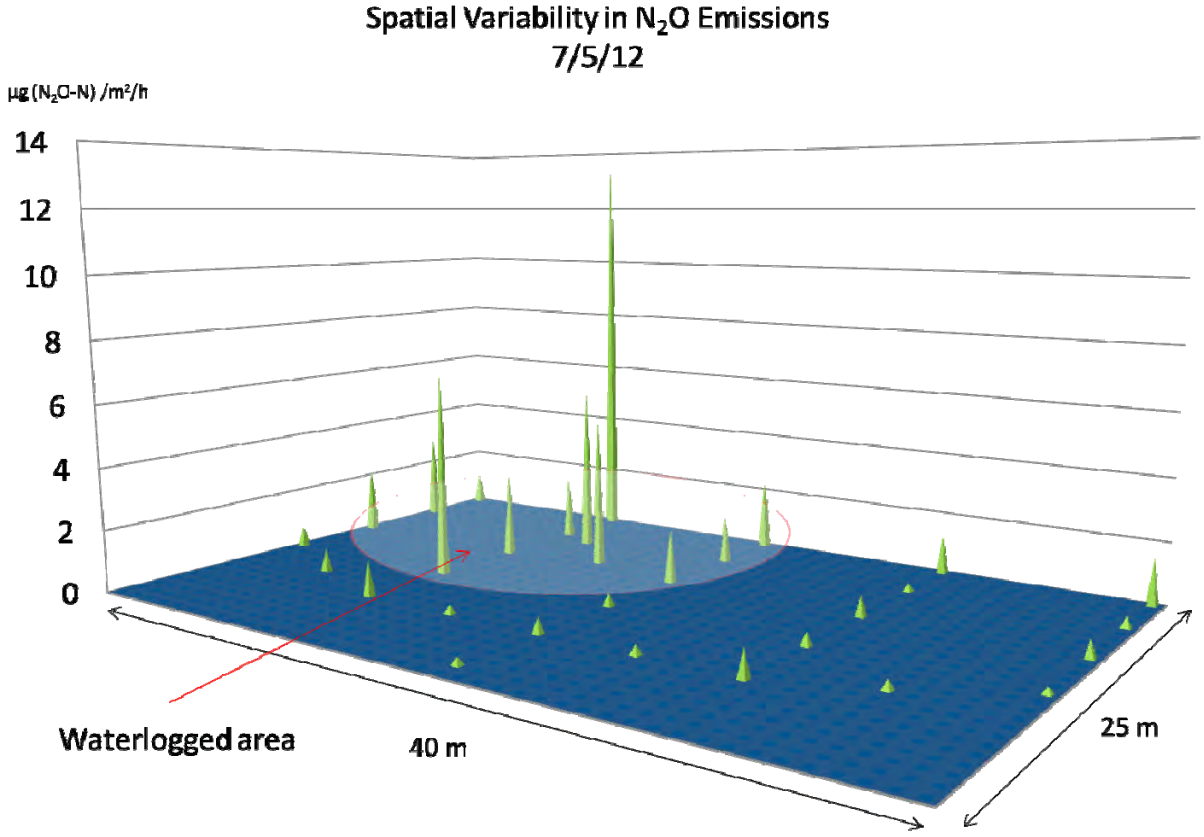


log-normal distribution

This helps understand measurement observations such as true spatial variability and negative fluxes

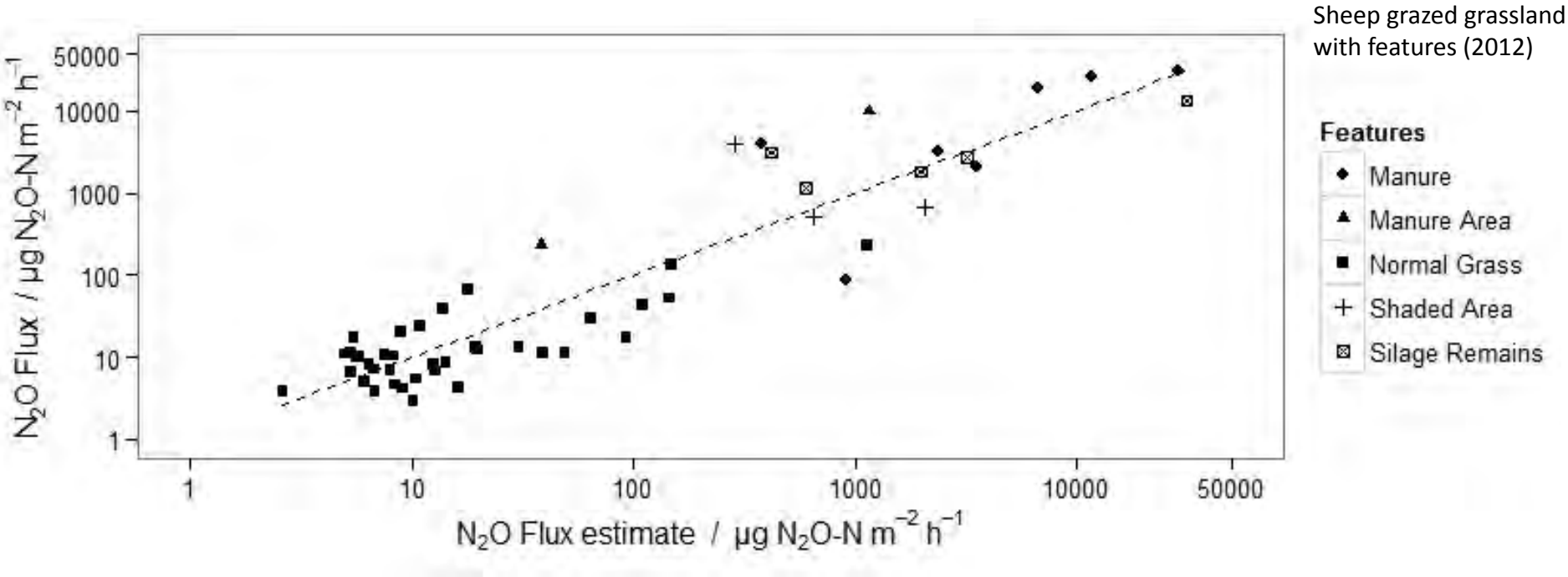
Spatial Variability

- N_2O is highly spatially variable
- Gap filling measurement data is extremely difficult
- Fluxes varying by orders of magnitude over short distances
- Most statistical methods used to predict N_2O spatial variability at the plot or field scale fail as measurements follows no spatial pattern



Grassland field (2012)
Dynamic chamber

Gap filling with soil measurements?



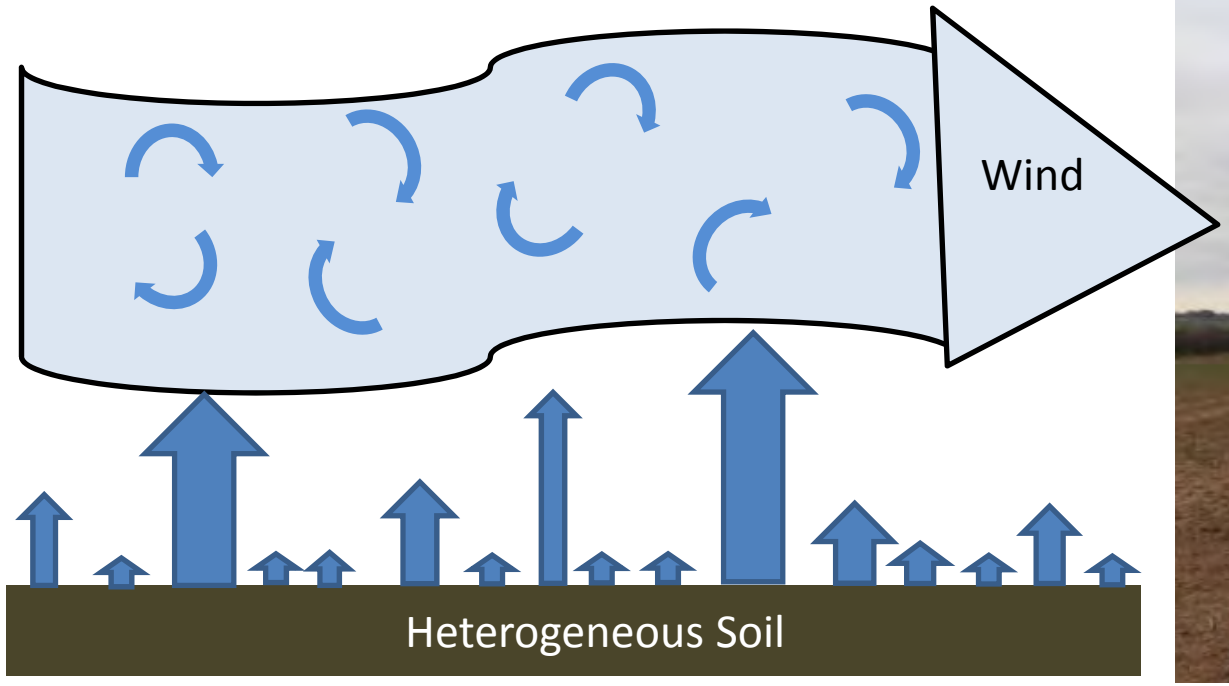
- Available nitrogen, WFPS, Total C, Total N, bulk density and other parameters are often used in regression analysis (expensive)
- N_2O fluxes are often larger under certain hotspot conditions, (i.e. Sheep urine patches or manure contamination with high available nitrogen)
- No universal consistency between N_2O flux and soil measurements for all measurement sites
- Not practical in most situations to use soil measurements to predict N_2O fluxes at the field scale (no spatial pattern in soil)

Eddy Covariance

- EC partially solves the problem of spatial and temporal N_2O gap filling of data
- Constant 30 minute integrated flux measurements average out much of the spatial variability of N_2O fluxes at the field scale (several 100 m^2)

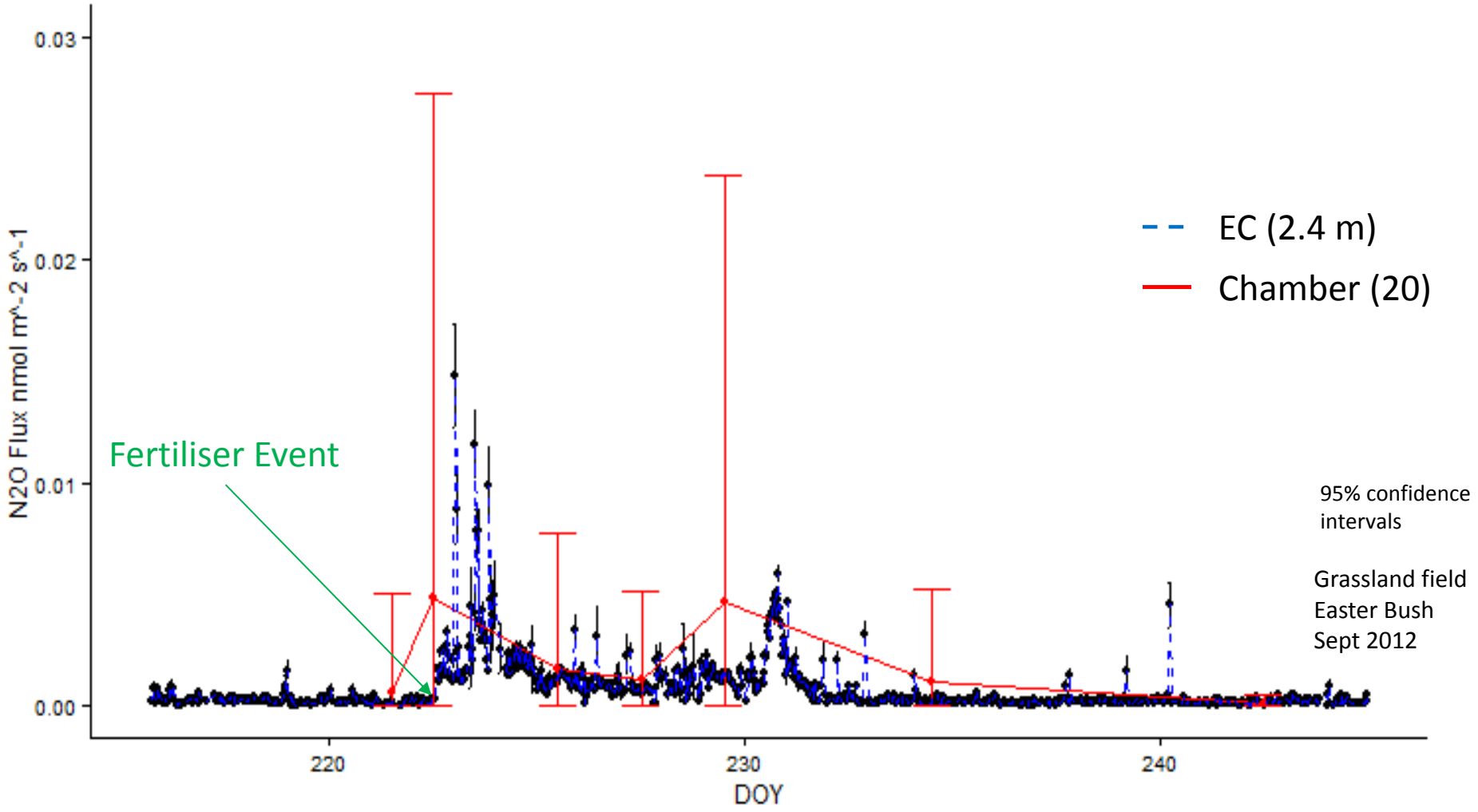
Important for N_2O studies

- EC is a non destructive sampling method which requires no manual sampling
- So less impact on site i.e. compression of soil, destruction of plant materials, disturbance of soil etc…



Eddy Covariance

- Eddy covariance can provide us with significantly more data than chamber methods from which fertiliser emission factors can be calculated

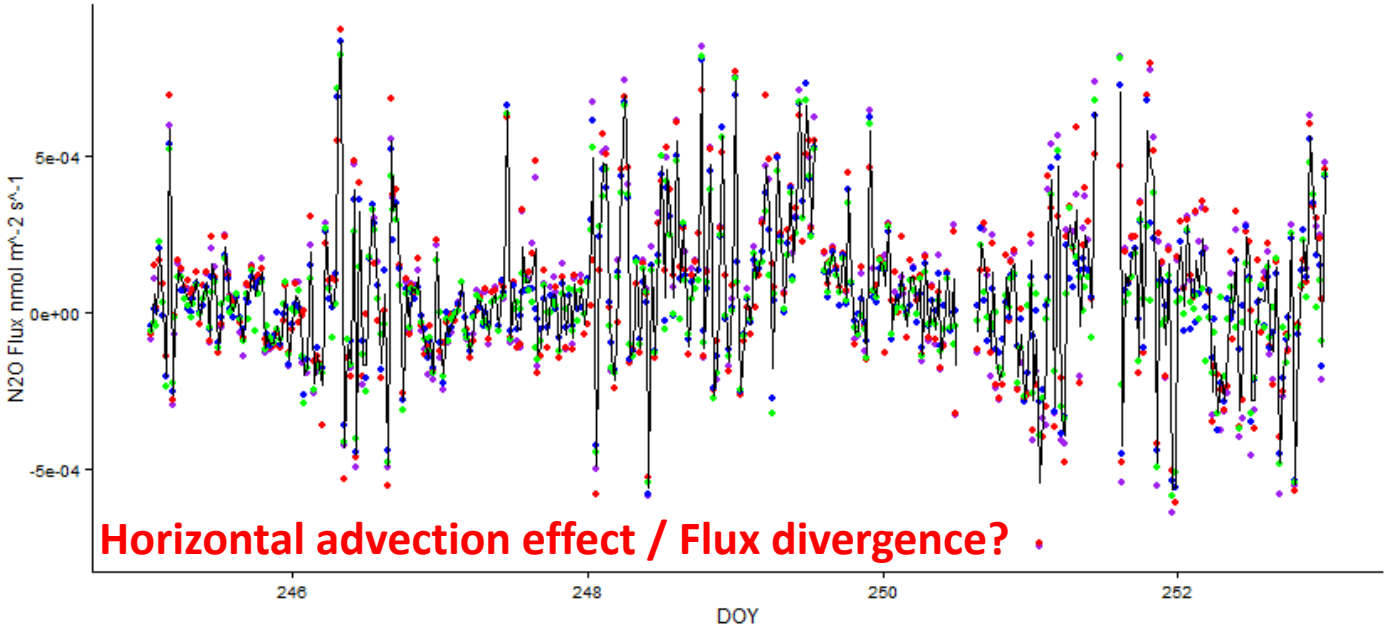


Eddy Covariance

- But, measuring N_2O flux using eddy Covariance has large potential for uncertainty
- Instruments can struggle to detect the very small atmospheric fluctuations required for EC measurements
- Multiple statistical corrections are applied to data sets, but noisy data can disrupt this

Example

One week of background N_2O fluxes calculated using 4 different methods



Cumulative Flux (1 week)

1 0.0253 nmol m^{-2}

2 0.0260 nmol m^{-2}

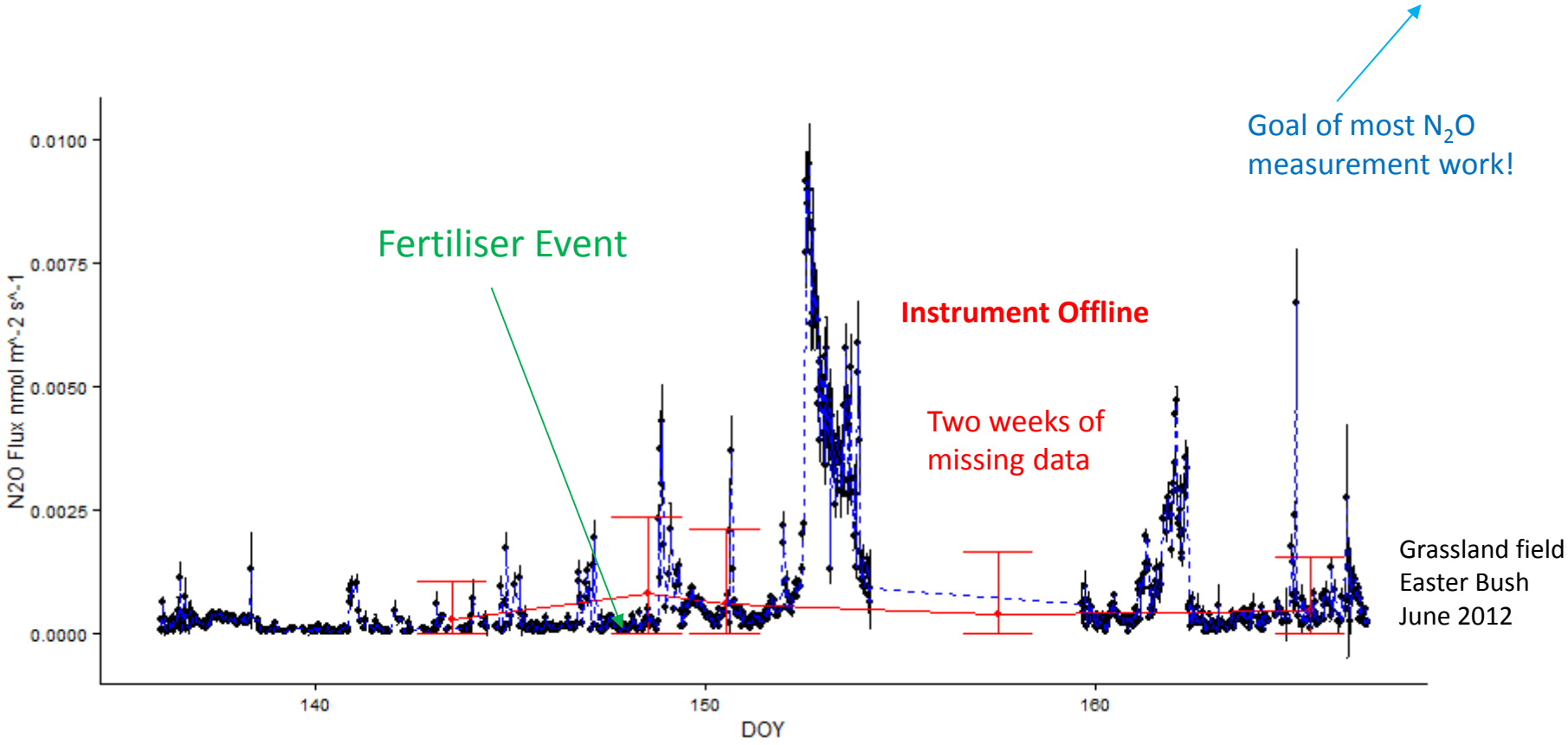
3 0.0215 nmol m^{-2}

4 0.0161 nmol m^{-2}

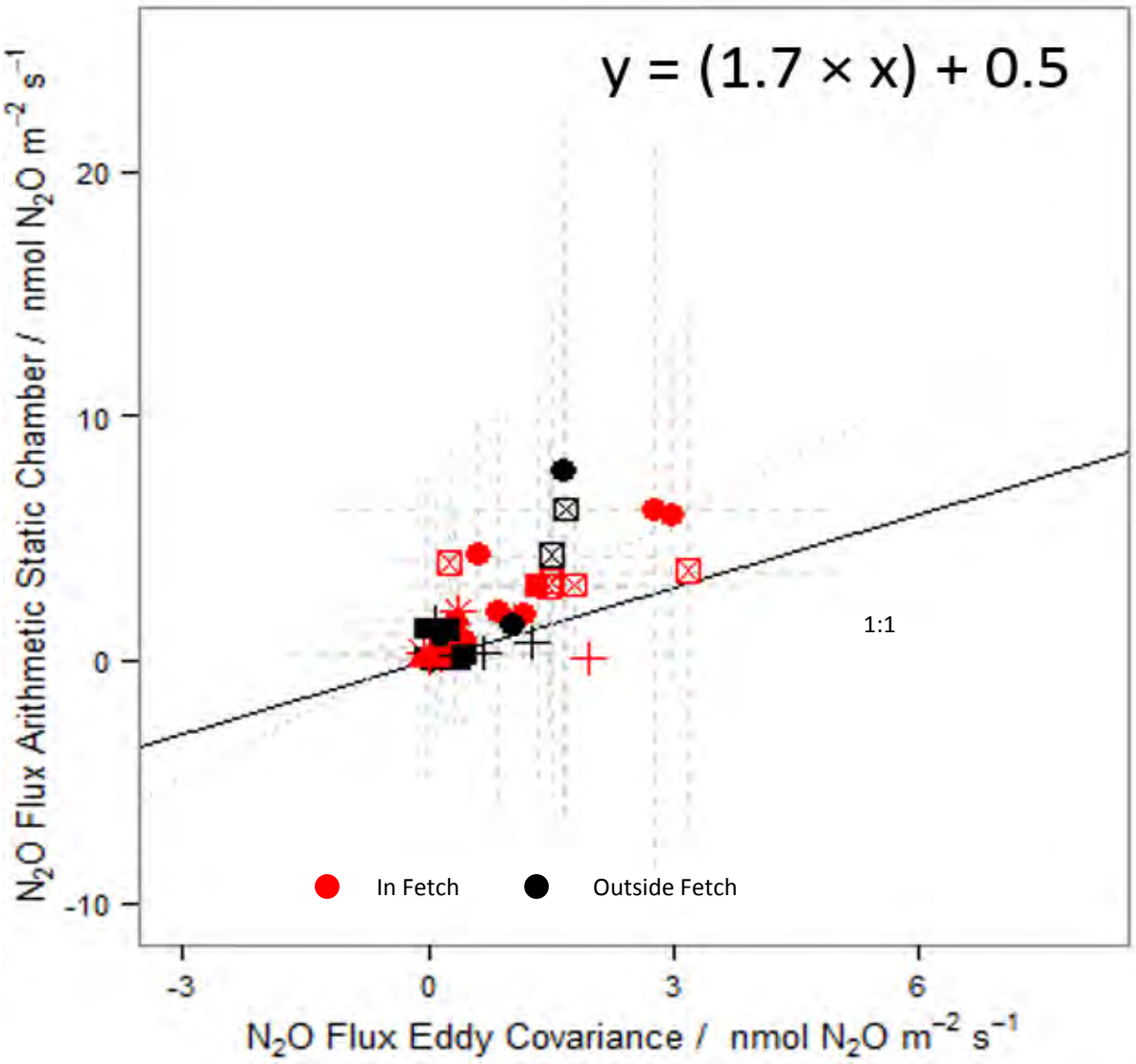
High signal noise means fluxes are vulnerable to lag time calculations
Up to 38 % in this case

Eddy Covariance

- EC requires in depth time lag analysis (CO_2 measurements help)
- Gap filling is still a major issue as N_2O follows no predictable pattern temporally
- Due to wind direction change and quality control, a large % of fluxes can be lost in some cases, which requires intensive gap filling for cumulative flux calculations (EF's)



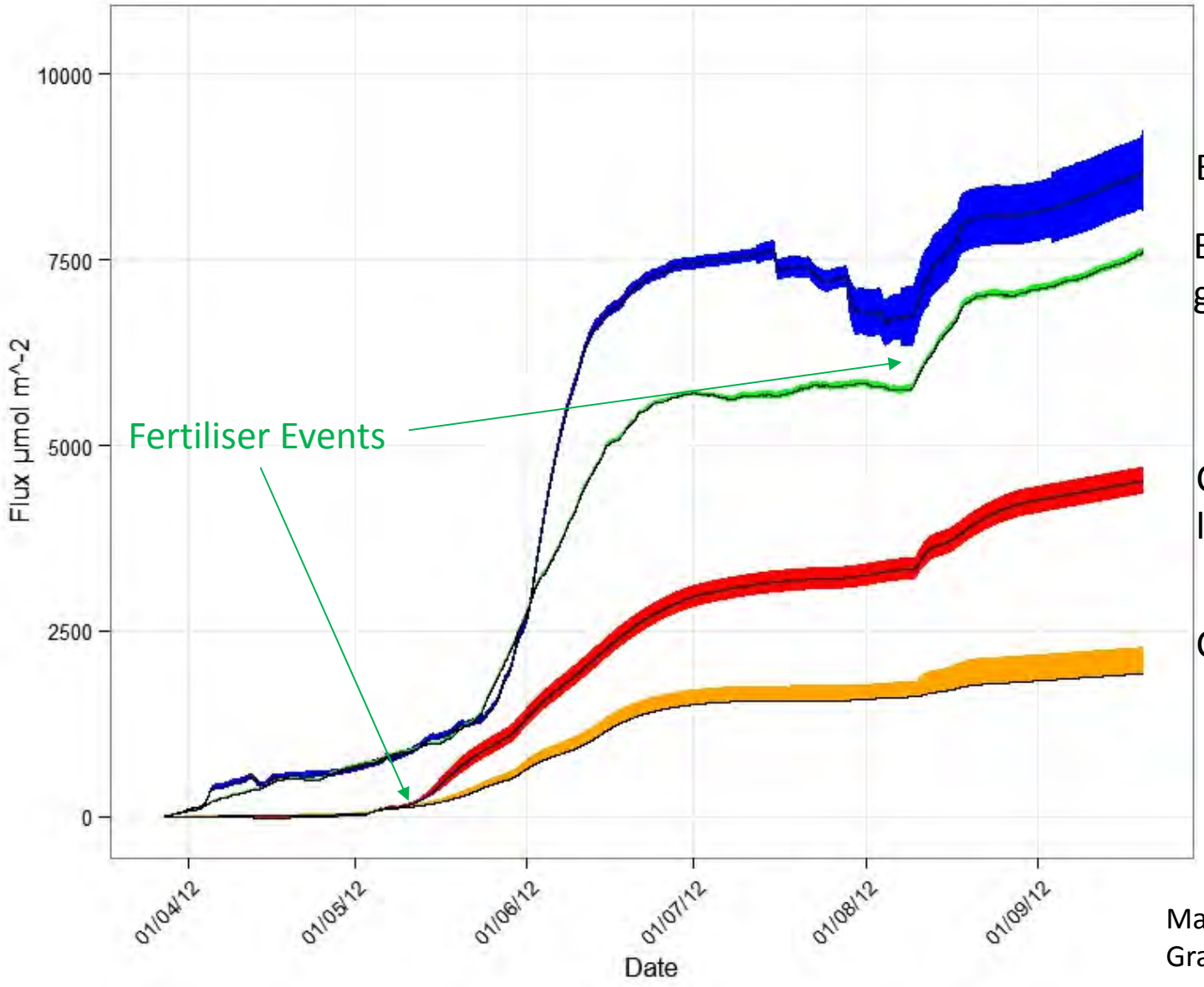
Comparison of Methods



- Direct comparisons between measurement methods at individual sites don't provide too much information due to high uncertainties in each method

- In this example N_2O fluxes measured using static chamber and eddy covariance methods at 6 different field sites across the UK are compared

Cumulative Flux



EC – linear gap filling

EC – mixed model gap filling

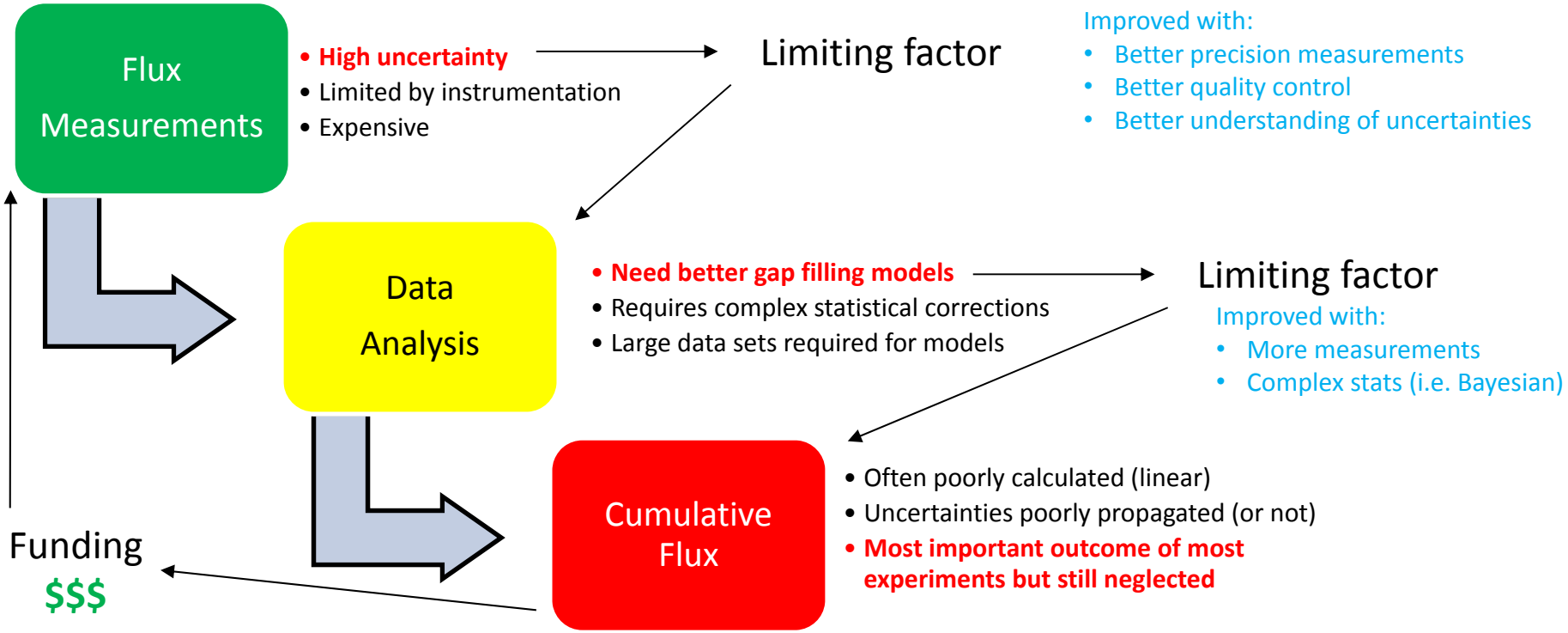
Chamber (mean) – linear gap filling

Chamber (median) – linear gap filling

May – Sept 2012 Easter Bush
Grazed grassland

Conclusions

- Measurement uncertainty needs to be better understood and carried into data analysis to propagate error
- Gap filling models and their associated uncertainties need to be improved in order to obtain better cumulative flux / emission factors
- Assumptions must be tested more rigorously!



Thanks for Listening

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