

Low cost method for direct dry deposition measurements

John T. Walker, Ryan Daly
EPA Office of Research and Development

Kathy Barry, Marcus Stewart
Wood Environment and Infrastructure Solutions, Inc

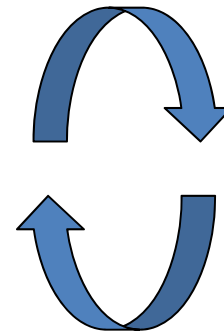
Chemical flux measurements in a network mode

- Optimized for spatial coverage
- Developing deposition budgets – not examining processes in detail
- Flux approach must be physically sound
 - Micrometeorological methods
- Need information on a suite of compounds (e.g., Nr), not just one analyte
 - Continuous measurements of multiple compounds not practical at a large # of sites
- Must be relatively low cost
- Must be suitable for routine network operations
- Time integrated measurement technique
 - Denuder/filter pack

Concept – Time integrated

- Direct flux measurement using traditional gradient methods

- Rather than 30-minute or hourly gradient measurements, gradients are sampled over extended periods of time from 1 – 4 weeks.



High concentration

ΔC

Flux

Low concentration

- *Time integrated gradient measurement*

- Original design of Conditional Time-Averaged Gradient (COTAG) system for SO₂ and NH₃ developed by Famulari et al. (2010)

- More recently used during the NitroEurope study



Famulari, D., Fowler, D., Nemitz, E., Hargreaves, K.J., Storeton-West, R.L., Rutherford, G., Tang, Y.S., Sutton, M.A., Weston, K.J. (2010). Development of a low-cost system for measuring conditional time-averaged gradients of SO₂ and NH₃. *Environmental Monit. Assess.*, 161, 11-27.

Concept – *Conditional sampling*

- Over the course of a day, the atmosphere can range from highly stable to highly unstable

Stable atmosphere



ΔC



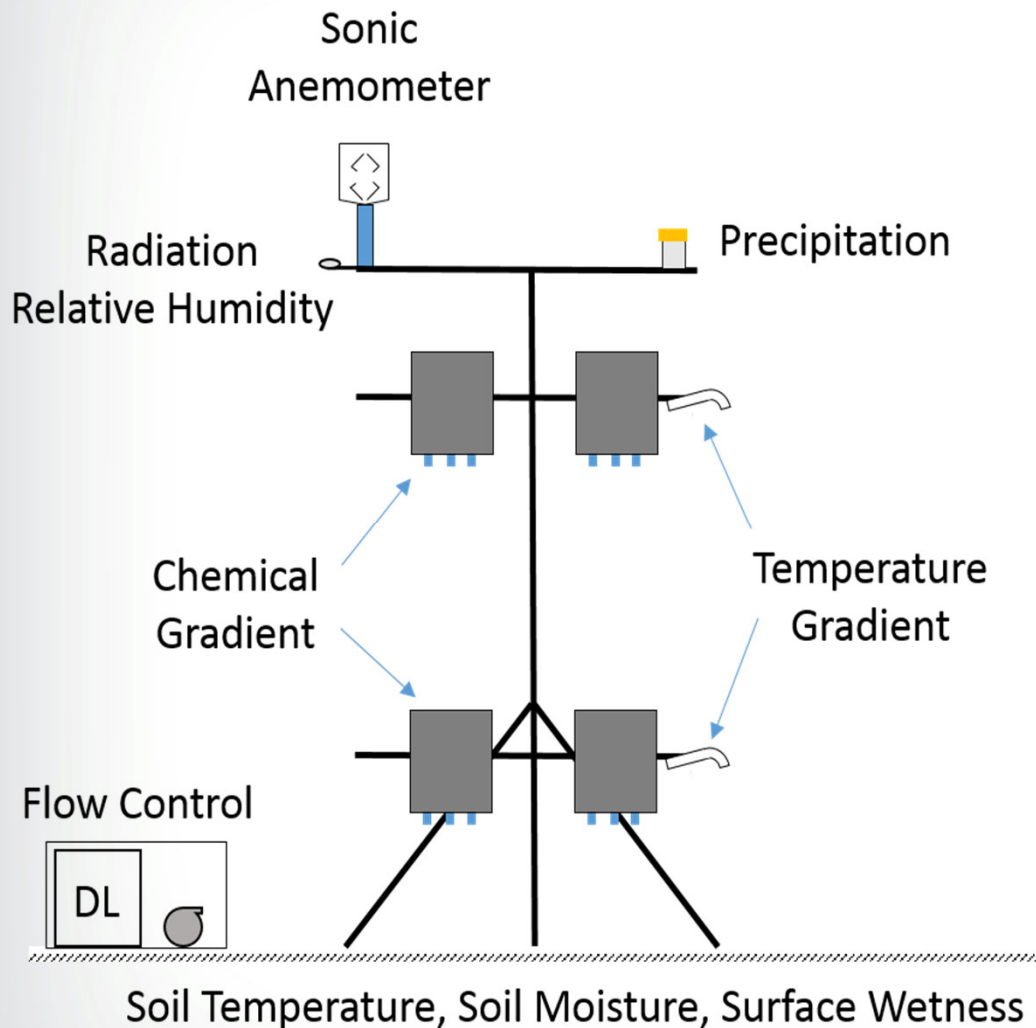
Unstable atmosphere

ΔC



- Averaging gradients over long periods could bias gradients and therefore fluxes due to large gradients during stable conditions
- Instead, sample over long periods during specific stability conditions⁴

Prototype configuration



Schematic of two-height conditional gradient sampling system

- 4 gradient sampling boxes
 - Duplicates at 2 heights
 - 3 heights, dups a 1 height
- 4 channels (conditions) per box
 - Neutral Stability
 - Slightly unstable
 - Slightly stable
 - Dead band
- Sonic anemometer
 - Turbulence
 - Momentum/heat flux
- Temperature gradient
- Surface conditions (RH, wetness, etc)

Gas and particulate measurements

- **DEnuder for Long Term Atmospheric sampling (DELTA)**
- Glass denuder/filter pack system
- NH_3 , HNO_3 , HONO, SO_2 , HCl, inorganic particles
- DELTA used for routine monitoring in UK
- Low flow rate
- Monthly sampling period

United Kingdom Eutrophying and Acidifying Network (UKEAP)

About the UKEAP: Acid Gas and Aerosol Network

UKEAP-Acid Gas and Aerosol Network (AGANet) consists of 30 sites. The network provides a long-term dataset of monthly speciated measurements of acid gases and aerosols that are used to provide temporal and spatial patterns and trends, and compared with results from dispersion models.

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Interactive monitoring networks map

Use the interactive map below to explore different UK monitoring networks. The map shows the current sites within the network selected. Information about the selected network is shown below the map.

Environment Agency

Map Satellite

Filter by network

- Automatic Urban and Rural Markers show latest pollution index
- Automatic Hydrocarbon
- Non-Automatic Hydrocarbon
- PAH
- TOMPs
- Black Carbon
- Heavy Metals
- Particulates
- Stratospheric Ozone and UV
- UKEAP: Precip-Net
- UKEAP: Acid Gas and Aerosol
- UKEAP: Rural NO2
- UKEAP: National Ammonia
- UKEAP: Automatic Mercury
- Show UK Regions Overlay

Map data ©2018 GeoBasis-DE/BKG ©(2009), Google, Inst. Geogr. Nacional, Mapa GISrael Terms of Use

Guide to map layer filters box: Expand map to fullscreen Hide filters

<https://uk-air.defra.gov.uk/networks/network-info?view=ukeep>

Gas and particulate measurements



Glass denuder
Single bore
10 cm length

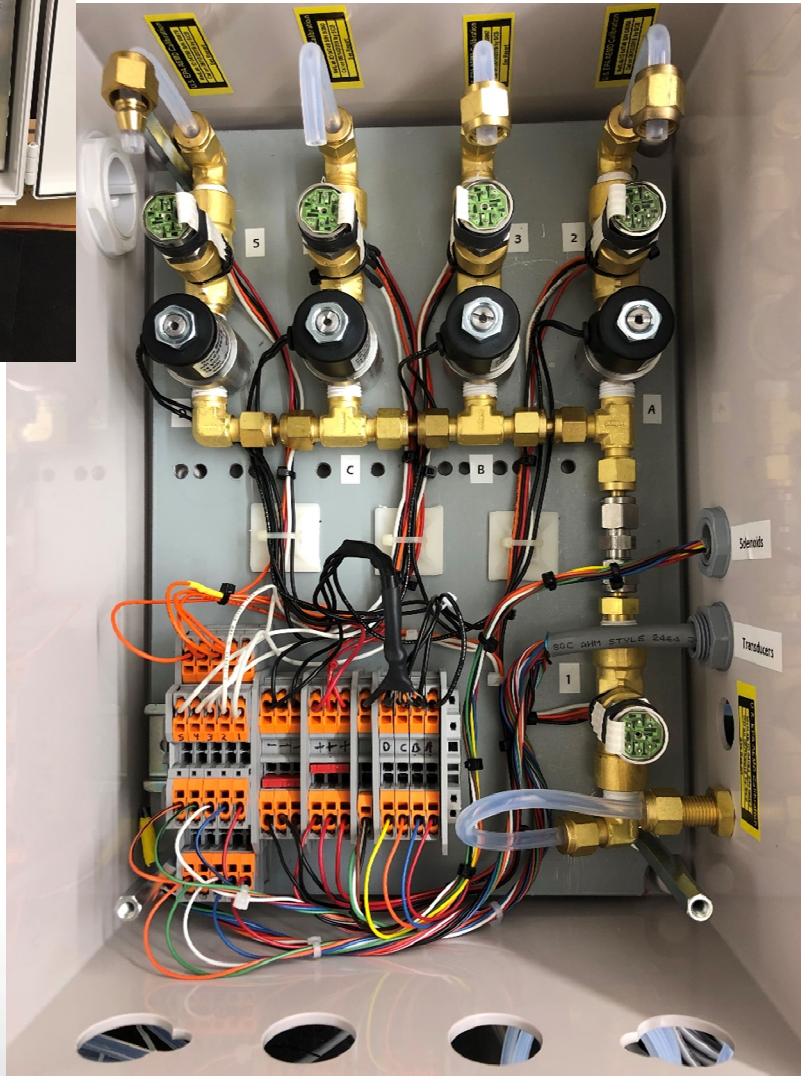
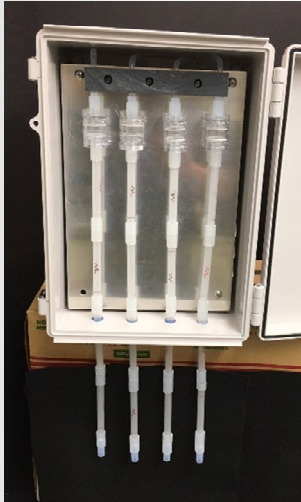
Three stage filter pack
25 mm diameter



4 denuders in series
X 4 sets per sample box

Flow system

Flow (0.32 Lpm) controlled by critical orifice



Status of EPA prototype

Completed as of September, 2019

- SOP for preparation and extraction of denuders/filter packs
- QA plan for scoping study field measurements
- Prototype hardware
 - Sampling boxes, flow system, micromet package
- Data acquisition/control
 - Flow conditions, valve switching, basic micromet

Underway

- Final flow testing
- Data acquisition
 - Valve/micromet feedback

Deployment into existing monitoring network

Site requirements

- AC power
- Site operator to change out samplers
- Suitable fetch
 - Flat, homogeneous surface to upwind distance of $\sim 100 \times$ sampling height

Where will this method work best?

- Windy sites
 - Satisfy “near neutral” stability conditions and turbulence threshold (greater data coverage)
- Sampling above forests will be difficult
 - Windy and rough (good for conditional sampling)
 - Small concentration gradients (challenging to measure)
 - May require longer sampling duration (monthly)