Low cost method for direct dry deposition measurements

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Chemical flux measurements in a network mode

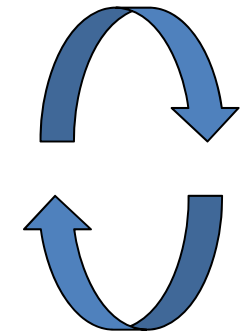
- Optimized for spatial coverage
- Developing deposition budgets – not examining processes in detail

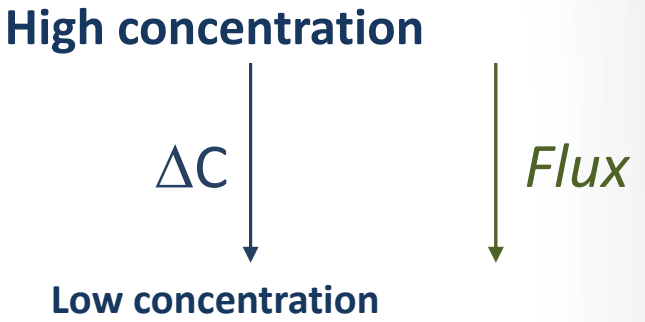
- Flux approach must be physically sound
  - Micrometeorological methods
- Need information on a suite of compounds (e.g., Nr), not just one analyte
  - Continuous measurements of multiple compounds not practical at a large # of sites
- Must be relatively low cost
- Must be suitable for routine network 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.
- *Time integrated gradient measurement*
- Original design of Conditional Time-Averaged Gradient (COTAG) system for SO_2 and NH_3 developed by Famulari et al. (2010)
  - More recently used during the NitroEurope study

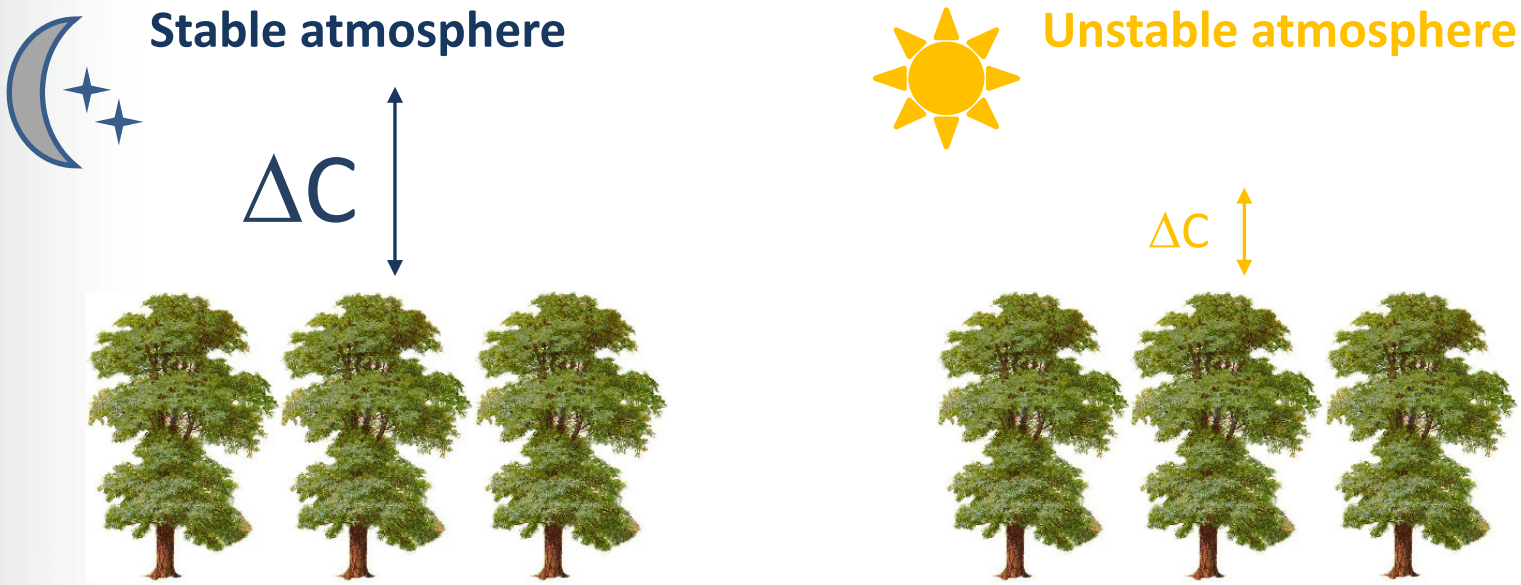




Famulari, D., Fowler, D., Nemitz, E., Hargreaves, K.J., Storeton-West, R.L., Rutherford, G., Tang, Y.S., Sutton, M.A., Weston, K.J. (2010). Development of a low-cost system for measuring conditional time-averaged gradients of SO_2 and NH_3. *Environmental Monit. Assess.*, 161, 11-27.

Concept – *Conditional sampling*

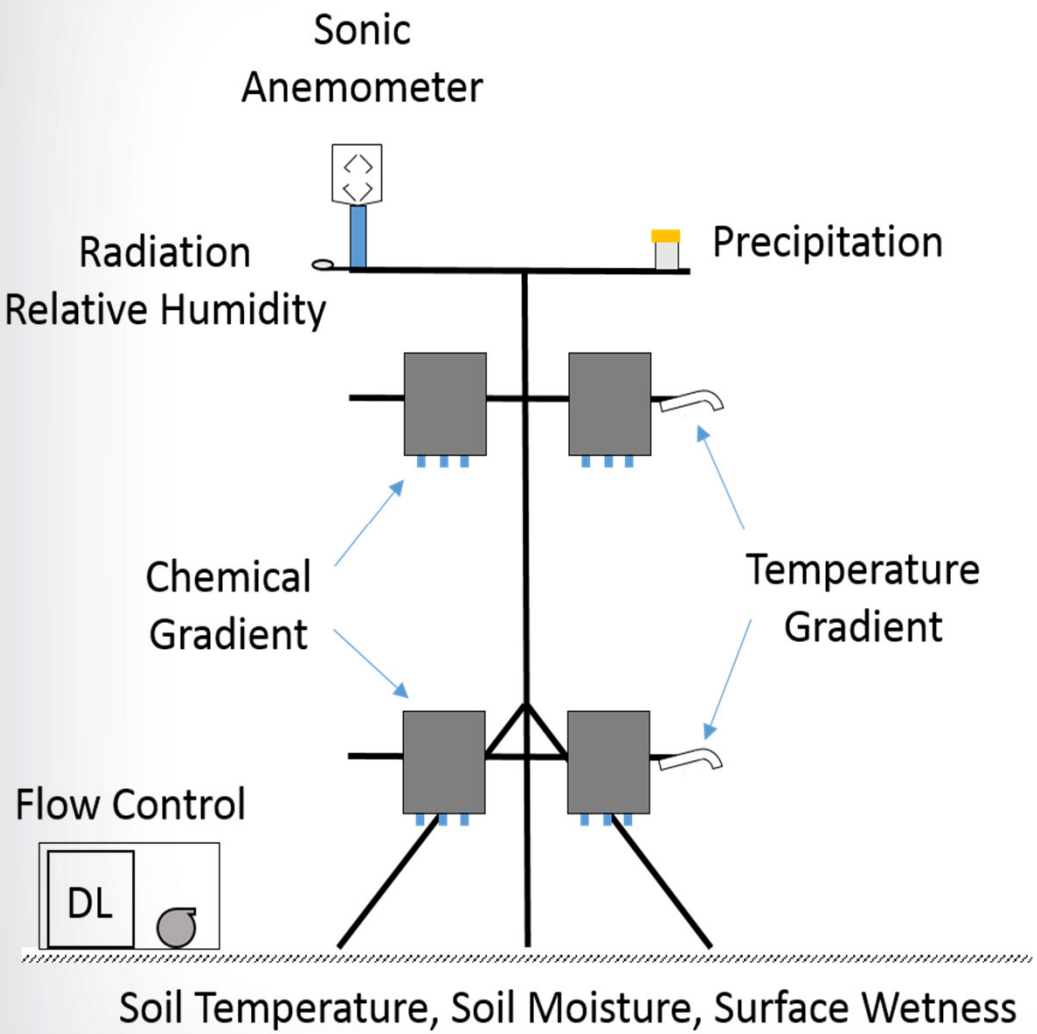
- Over the course of a day, the atmosphere can range from highly stable to highly unstable



- 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 conditions

Prototype configuration

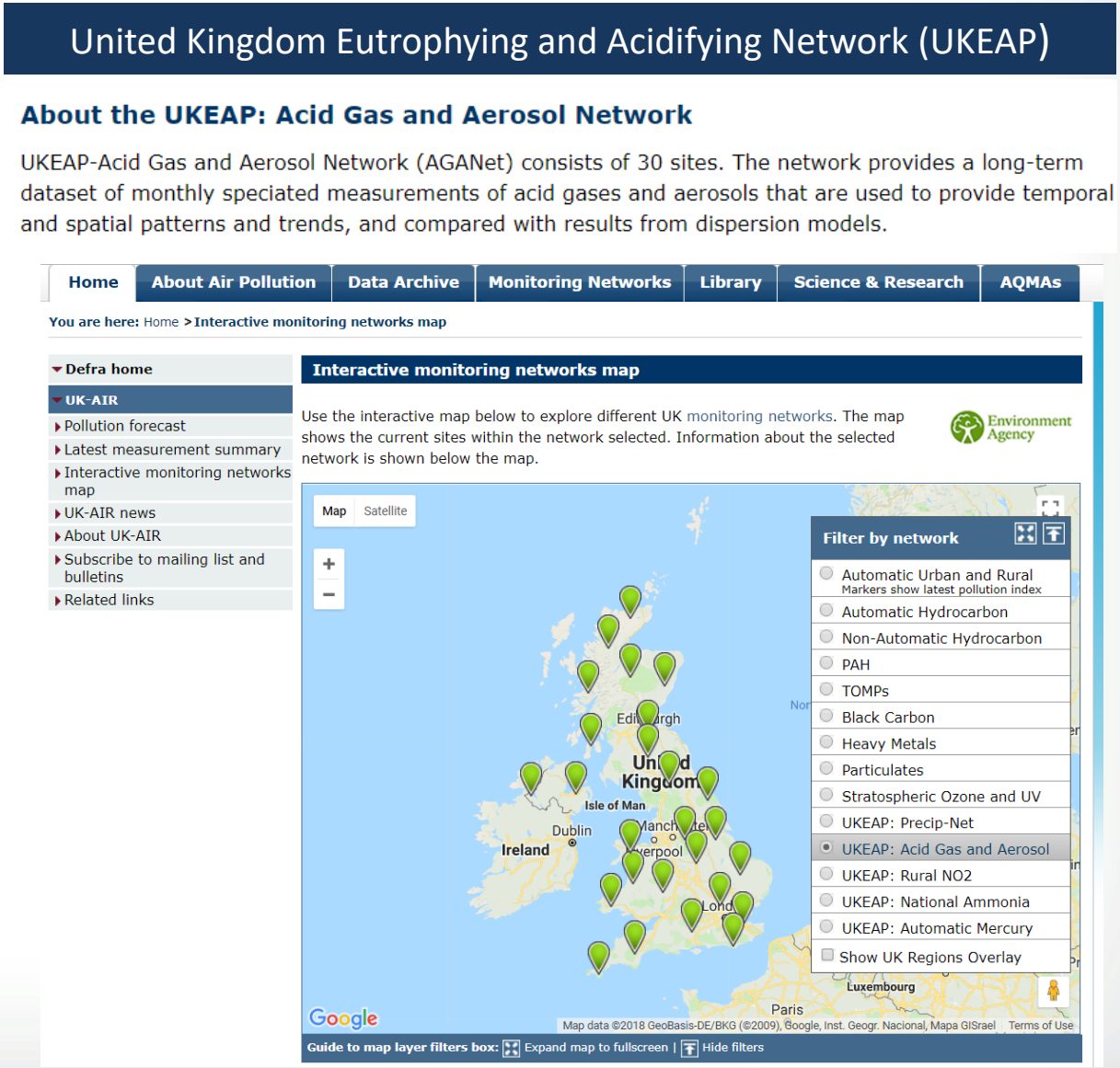


Schematic of two-height conditional gradient sampling system

- 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

- **DE**nuder for **L**ong **T**erm **A**tmospheric 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



https://uk-air.defra.gov.uk/networks/network-info?view=ukeap

Gas and particulate measurements

Glass denuder
Single bore
10 cm length

4 denuders in series
X 4 sets per sample box

Three stage filter pack
25 mm diameter

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 ~ 100 X 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)