First experiences with low cost optical particle counters reveal emission in trees & woodlands

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Their usability in pollen & spore emission experiments

Skjøth, Carsten Ambelas[1]; Petch, Geoffrey[1]; Ottosen, Thor-Bjørn[2]; Hanson, Mary[1]; Frisk, Carl[1], Apangu, Godfrey[1] , Adams-Groom, Beverley[1], Crilley, Leigh R. [3] and Pope, Francis D.[3]

[1]School of Science & the Environment, University of Worcester, United Kingdom
[2]Department of Civil and Environmental Engineering, University of Surrey, United Kingdom
[3]School of Geography, Earth and Environmental Sciences, University of Birmingham, United Kingdom

Background

- Pollen spore counting is labour extensive
- Automated systems a solution – but expensive (both capital costs and running)
  - WIBS
  - Hund
  - Rapid-E
- Currently limited experience with automated low cost devices
- Purpose is to test the applicability of a modified low cost instrument from EUNetAir partner (COST network)[1]
  - Based on particle counter: Alphasense-N2 (£300)
  - Designed to compete with Grimm particle counter (~£14.500) and TSI 3330
  - Time resolution 1-10 sec
  - Modification:16 size bins, real time detection: 0.61µm – 40µm
- Three experiments:
  - Spore emission experiment in woodland
  - Pollen emission experiment in flowering tree
  - Test in reproducibility

**Figure 2 Particle size derivative comparison**
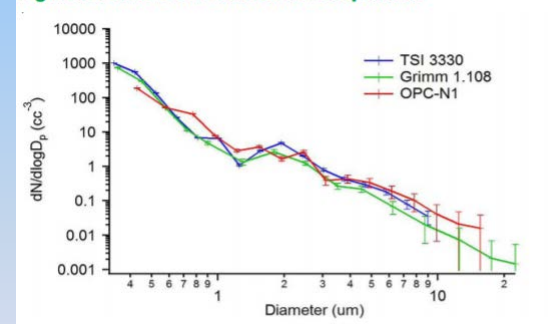
Specifications from standard OPC data sheet

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[1] Borego et al (2016)

Experiment 1: A woodland near Worcester

- **Observations**
  - Meteorological data 30 minute interval (not shown)
  - Burkard trap, 30 minute counts
  - 3 Particle counters 1m above spore source
  - 10 sec intervals, aggregated to 1h
 - Run by laptops + USB cable
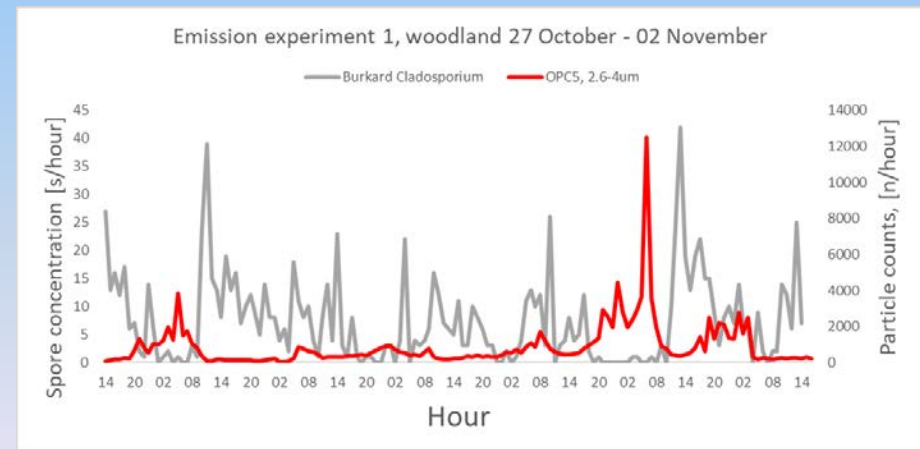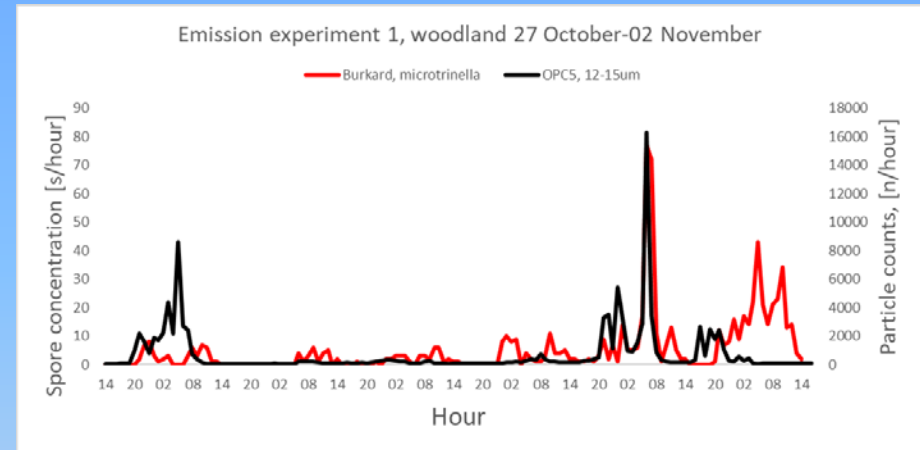
- **Initial conclusions**
  - New instrument working
  - Issues with relative humidity[2] for standard OPC-N2, affects beta-version?
  - A background reference is needed
  - Issue with "clogging up"

Emission experiment 1, woodland 27 October-02 November

Emission experiment 1, woodland 27 October - 02 November

[2] Crilley et al (2018)

Experiment 2: A birch tree Worcestershire

- **Observations**
  - Meteorological data 30 minute interval
  - 2 weekly phenological flowering registrations
  - 3 particle counters in pollen source (within tree), daytime
  - 1 particle counter in background area
  - 10 sec intervals, aggregated to 1 hour
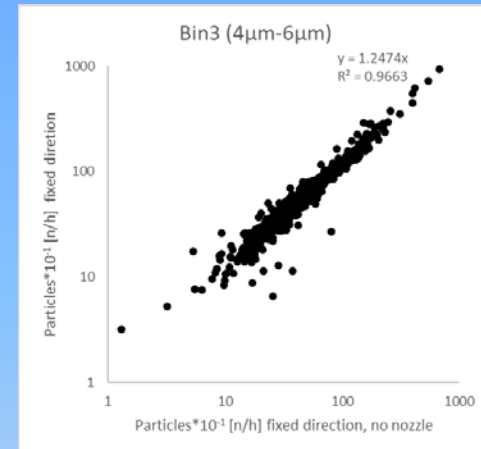 - Run by laptops + USB cable

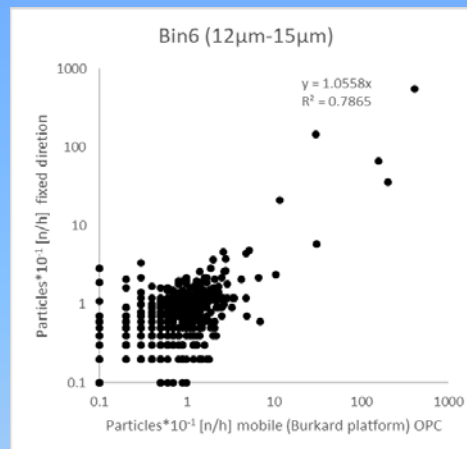Emission experiment 2, 20-25 April 2018
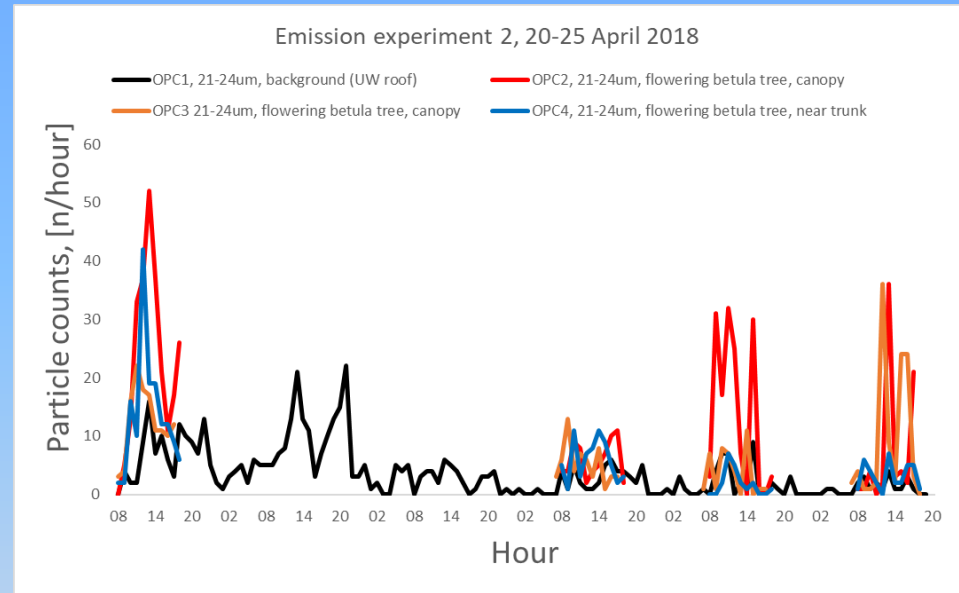
- **Initial conclusions**
  - Clear signal from flowering tree
  - Placement in emission zone critical
  - Problem with mobility (run by laptop)
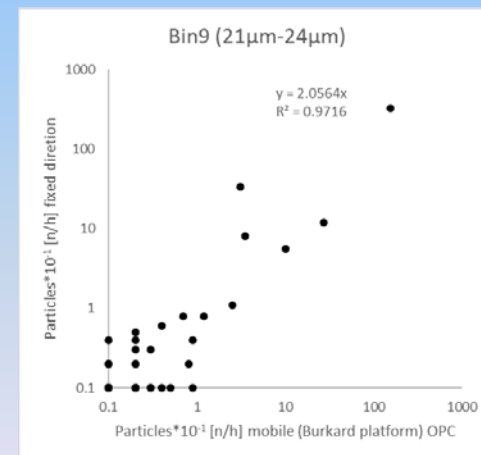 - Flowering clearly detected even most (lower) catkins appeared almost empty

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Experiment 3: Reproducability

- **Observations**
  - 3 particle counters
  - Rotating unit vs fixed unit (July-August)
  - 2 fixed units (April-June)
  - Background area
  - 10 sec intervals, aggregated to 1h
  - 3rd unit operated by Raspberry PI

- **Initial conclusions**
  - Counters reproduce each other
  - Effect of rotating method unclear
  - Correlations fall rapidly above 24 µm, fewer data
  - Effects of nozzle (inlet) unclear
  - Mobility solved by using Raspberry PI

Bin6 (12µm-15µm)

$y = 1.0558x$
$R^2 = 0.7865$

Particles*10^{-1} [n/h] fixed diretion

Particles*10^{-1} [n/h] mobile (Burkard platform) OPC

Bin3 (4µm-6µm)

$y = 1.2474x$
$R^2 = 0.9663$

Particles*10^{-1} [n/h] fixed diretion

Particles*10^{-1} [n/h] fixed direction, no nozzle

Setup showing rotating, fixed OPCs and ordinary Burkard trap

Bin9 (21µm-24µm)

$y = 2.0564x$
$R^2 = 0.9716$

Particles*10^{-1} [n/h] fixed diretion

Particles*10^{-1} [n/h] mobile (Burkard platform) OPC

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Conclusions

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Evaluation of low cost particle counter

- Can be used to detect potential emission in
  - Woodlands
  - Trees
- Issues
  - Particle count dependency on humidity
  - Efficiency
  - A background reference is needed
  - Placement in emission zone considered carefully
  - Correlations decrease above 24 µm
- Advantages
  - Highly mobile and "cheap"
  - Real-time data, mobile and designed dense data networks
  - Useful in specific experimental designs