Emission Sampling Using UAS

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Emission Sampling

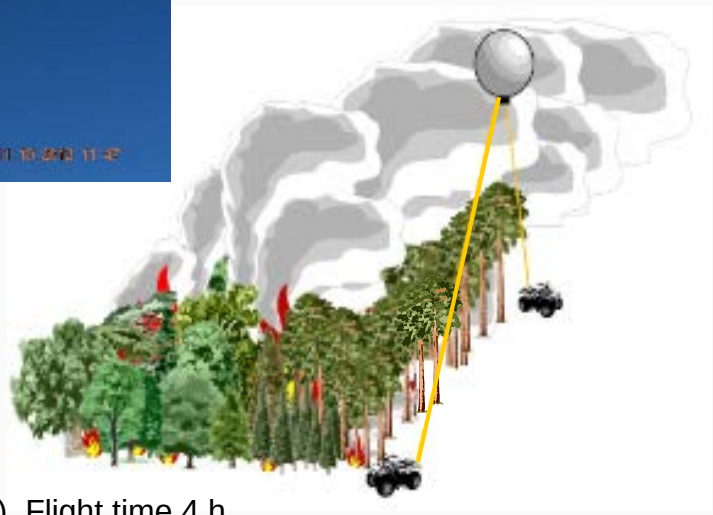
- open area sampling is becoming more important as
  - Industrial point sources are now more well-characterized
  - Open area sources are recognized for their importance to air shed pollution
    - Wildfires
    - Prescribed forest and agricultural fires
    - Oil and gas fields
    - Landfill and peat fires
    - Emergency response actions

Examples of Open Burning

How do we safely (people and equipment) sample these plumes?

Methods of Open Area Emission Sampling

The "Flyer": An unmanned, telemetry-controlled sampling system.



- Total weight ~ 21 kg (46 lb), Flight time 4 h
- Onboard computer with data transmission
- User-set CO_2 triggering of samplers
- GPS, CO_2, CO
- Semi-Volatile Organic Compounds (SVOCs)
- Volatile Organic Compounds (VOCs)
- Black carbon (BC)
- Brown carbon
- PM by filter ($PM_{2.5}$, PM_{10})
- Continuous $PM_{2.5}$, PM_{10}
- 3D-anemometer

Open Burning and Open Detonation

Limits on Current Method

Tethered aerostat sampling has worked well, but has constraints:

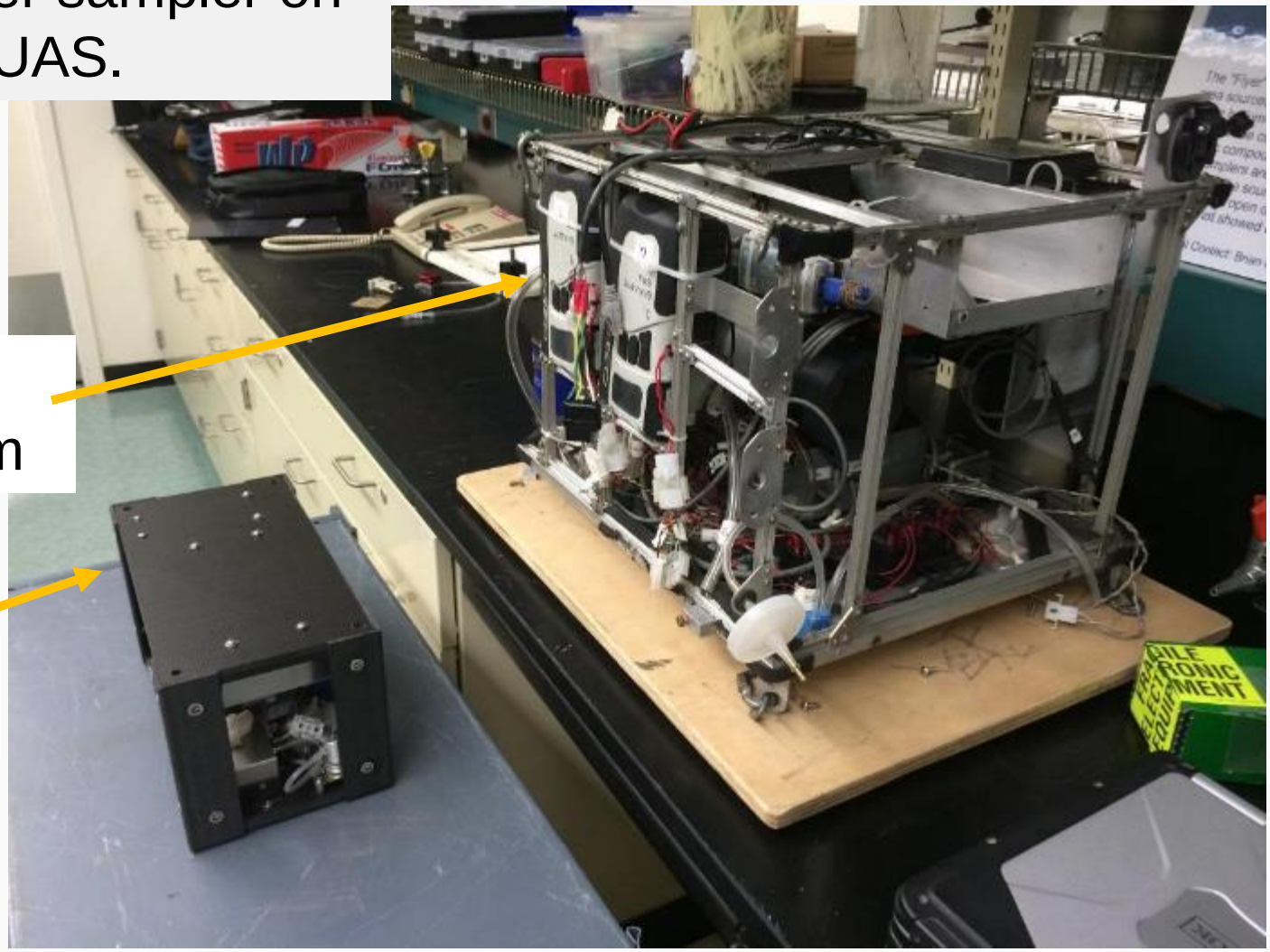
- Maneuverability.
  - Tethers (trees, power lines)
  - ATVs
  - Limited 3D range (wind shifts, plume drift)
  - Terrain and boundary limits
- Resource requirements.
  - Large team
  - Large equipment (and helium) Cost
- Response time is weeks+

Kolibri vs. Flyer

A smaller, lighter sampler on an untethered UAS.

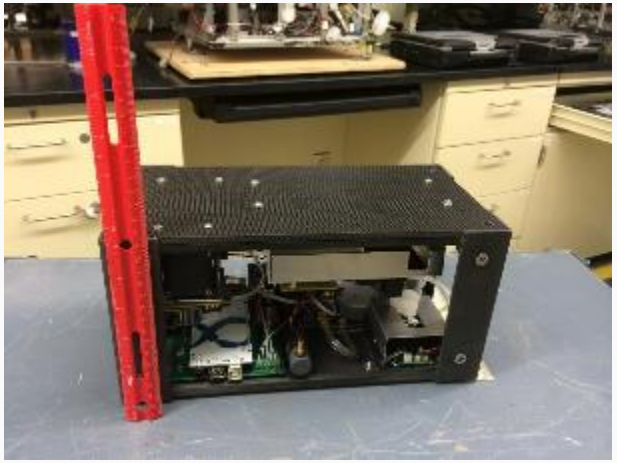
>21kg,
55 x 50 x 45 cm

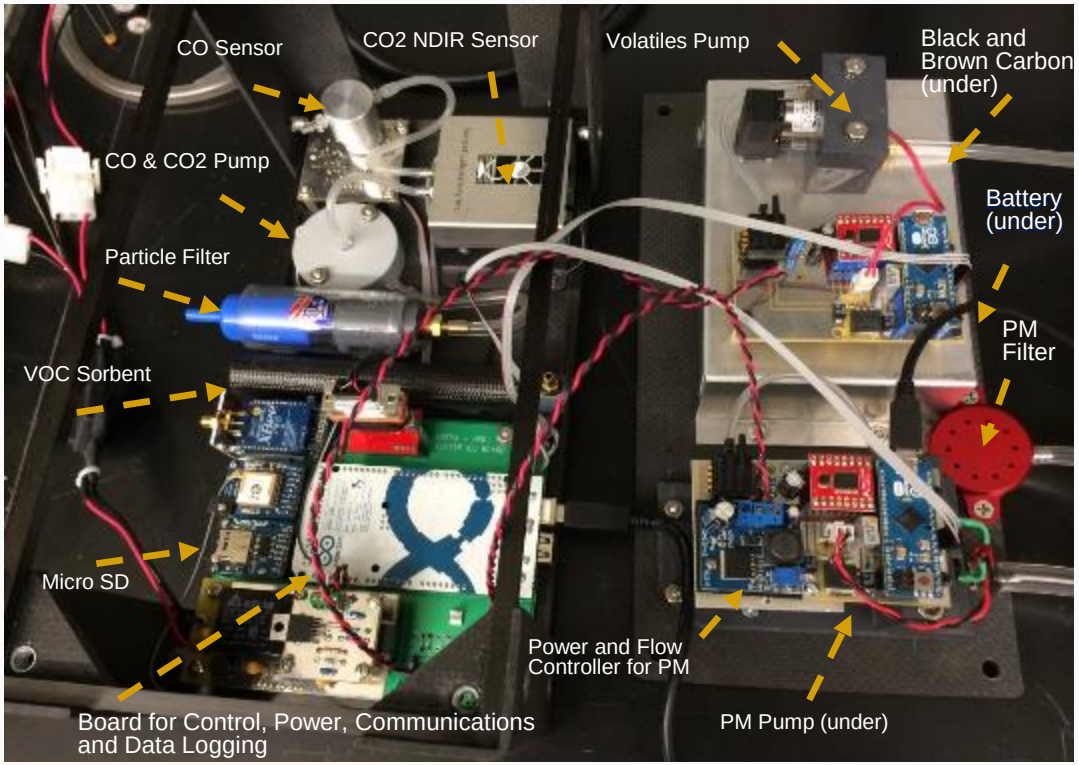
3.56 kg,
15 x 15 x 30 cm



Employing New, Low-cost, Small Sensors and Computers

The “Kolibri”





The Kolibri is 3.56 kg and measures

- CO2,
- CO,
- PM, metals, ions
- Volatile organics, carbonyls
- Black/brown Carbon
- PAHs, PCDDs/PCDFs, energetics

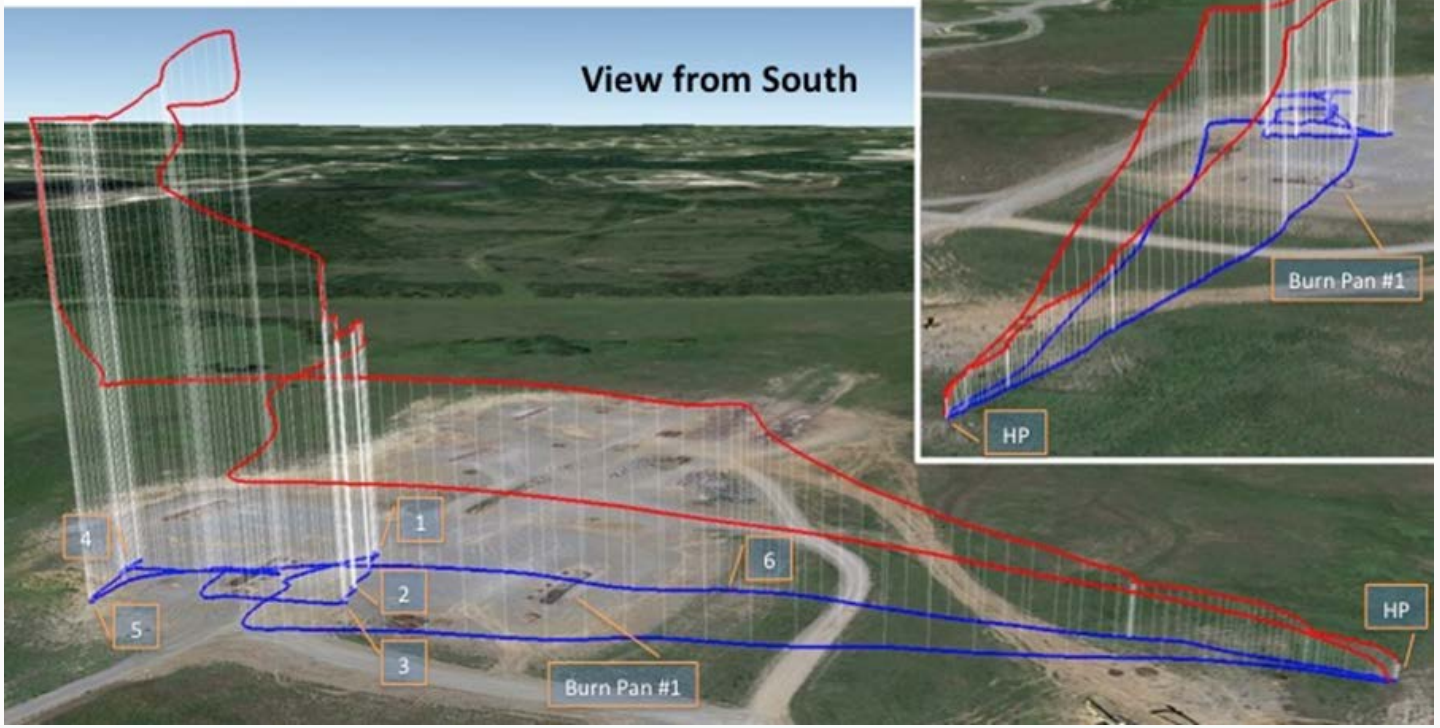
UASs

- Advances in GPS, carbon fiber, computer, and battery technologies have led to UAS development, particularly for multicopters.
- They are varied in size and capability; some as small as a dollar bill.
- They are operator controlled or fly programmed paths
- They have auto-return, boundary, and auto-land features
- Personnel are safely at a distance
- Recent designs can carry payloads of 5 kg for 15-20 minutes.
- They are portable (fold up) and fast to deploy
- They do not have a disturbance footprint
- Require only two people
- Costs range from $50 - $20K

View from the pilot's perspective – 250 m

Path of UAS/Kolibri During Open Burn Sampling

Mark [#]	Time [mm:ss]	Distance [m]	Height [m]	Battery [%]
1	00:30	187	36	96
2	01:00	179	41	94
3	01:30	177	56	92
4	02:00	231	80	90
5	02:30	227	61	88
6	03:00	112	30	86



Special thanks to the team!

UAS Applications in Emission Sampling

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