University of Southampton

Monitoring Peatland Using the Internet of Things

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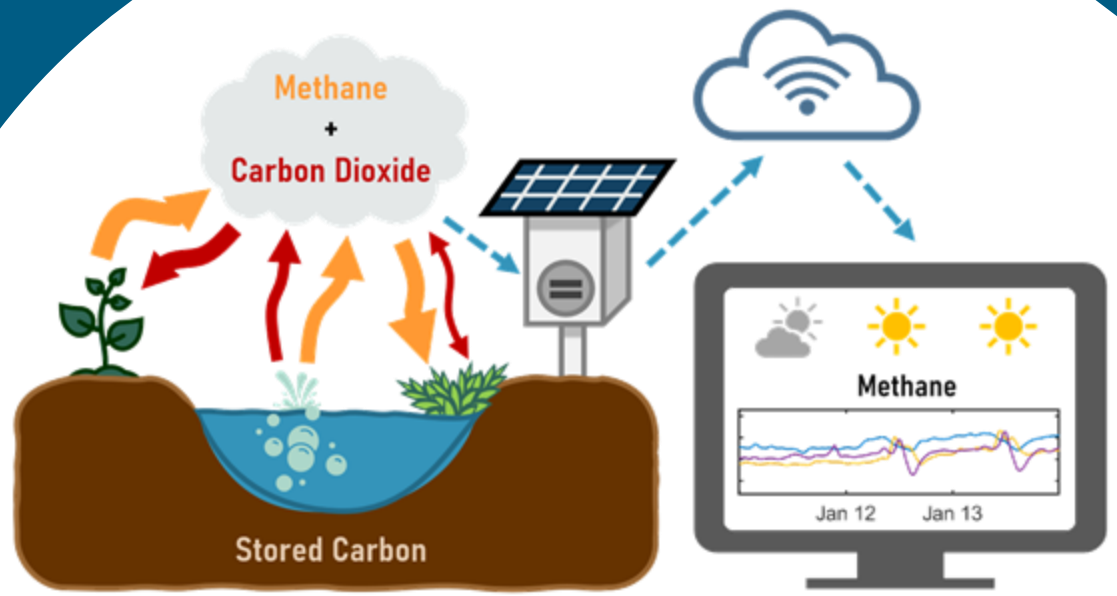
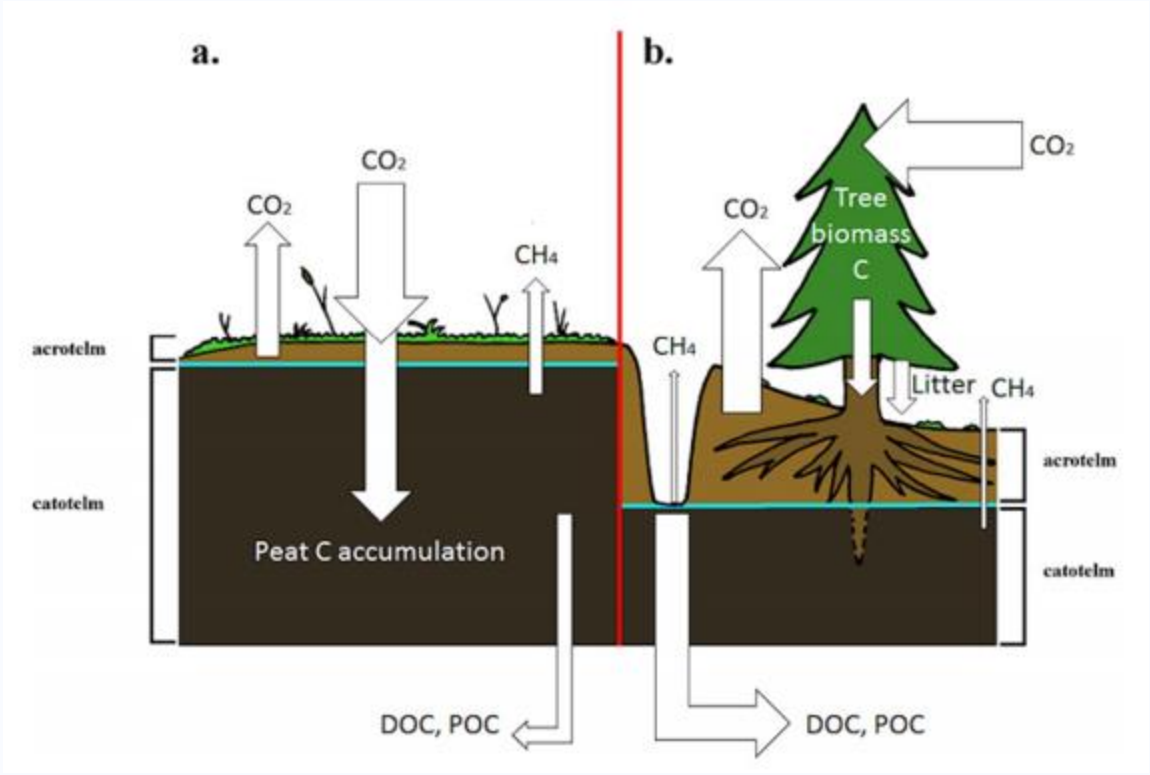


Background

- Healthy peatland steadily accumulates carbon
- Carbon fluxes are complicated
- Manually monitoring peatland conditions can be expensive, time-consuming and dangerous
- Maybe IoT can help..?



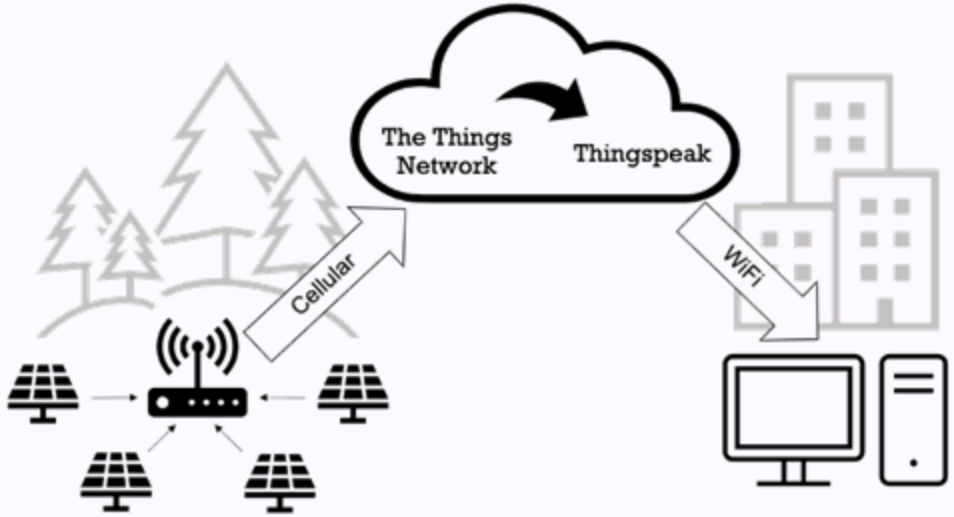
T. Sloan, R. J. Payne, A. R. Anderson, C. Bain, S. Chapman, N. Cowie, P. Gilbert, R. Lindsay, D. Mauquoy, A. Newton, et al., "Peatland afforestation in the uk and consequences for carbon storage," Mires and Peat, vol. 23, no. 1, pp. 1–17, 2018.

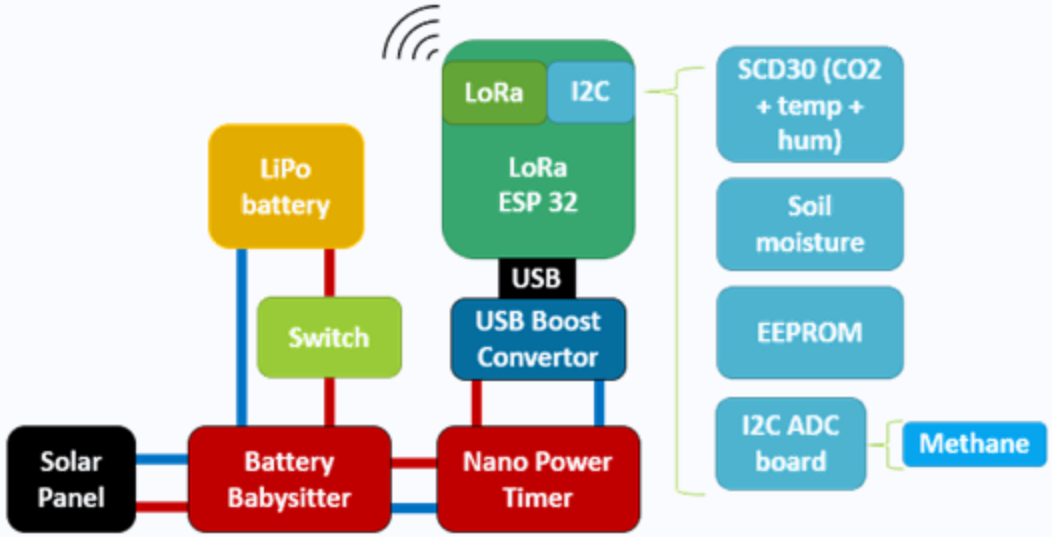
Design

- Sensor nodes collect local data:
  - Methane & CO2
  - Soil moisture
  - Temperature & humidity

- A gateway transmits this data to Cloud services

- Data can be viewed live and downloaded for further processing



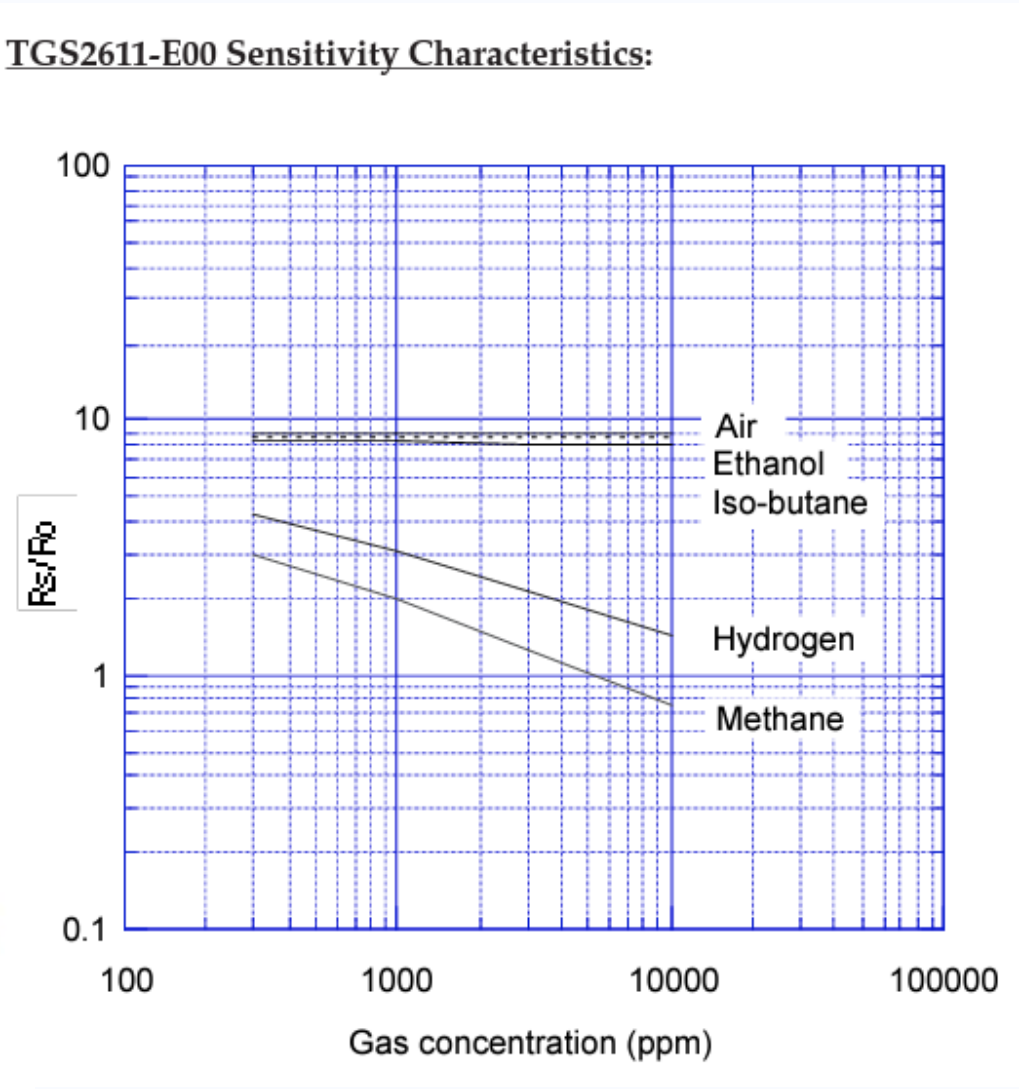


CO2 Sensor – SCD30

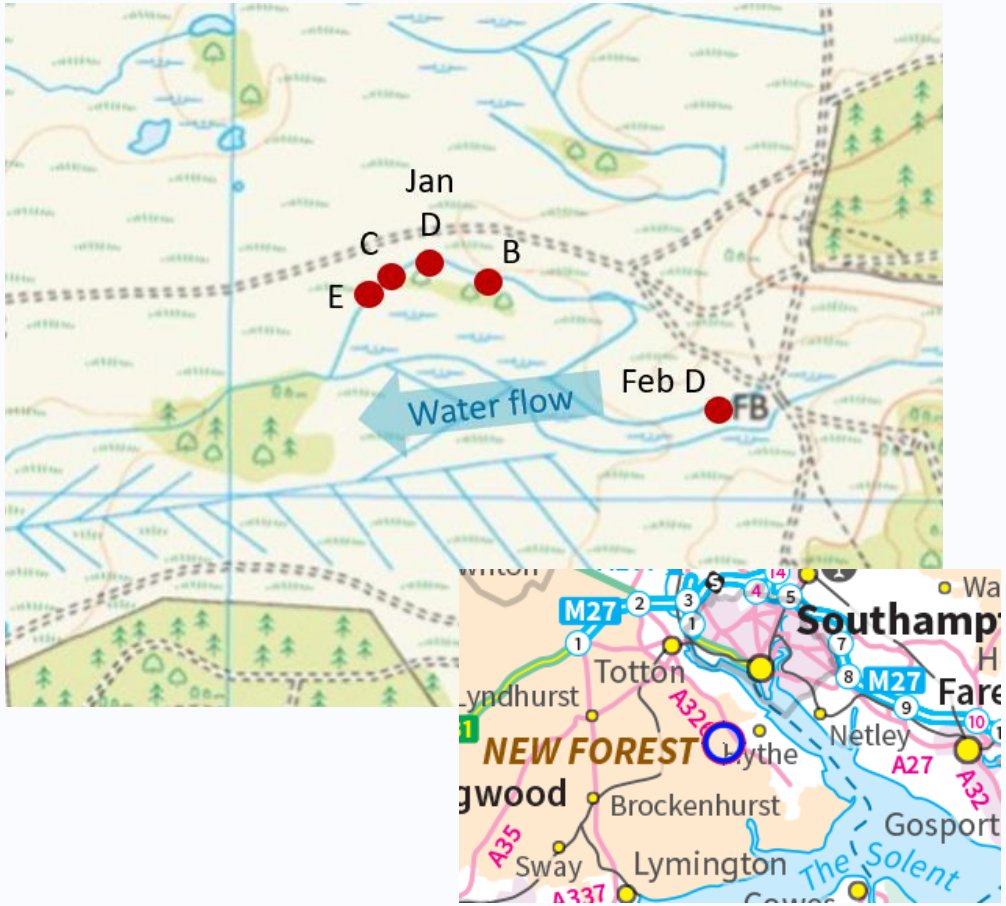
- NDIR CO2 sensor + temperature & humidity
- 0 – 10000 ppm CO2 but best in the 400+ range
- ±30ppm +3% accuracy

Methane Sensor - NGM2611-E13

- Resistive heating element
  - Resistance changes in the presence of methane
- Characterized down to 300 ppm
- Requires additional low-level calibration

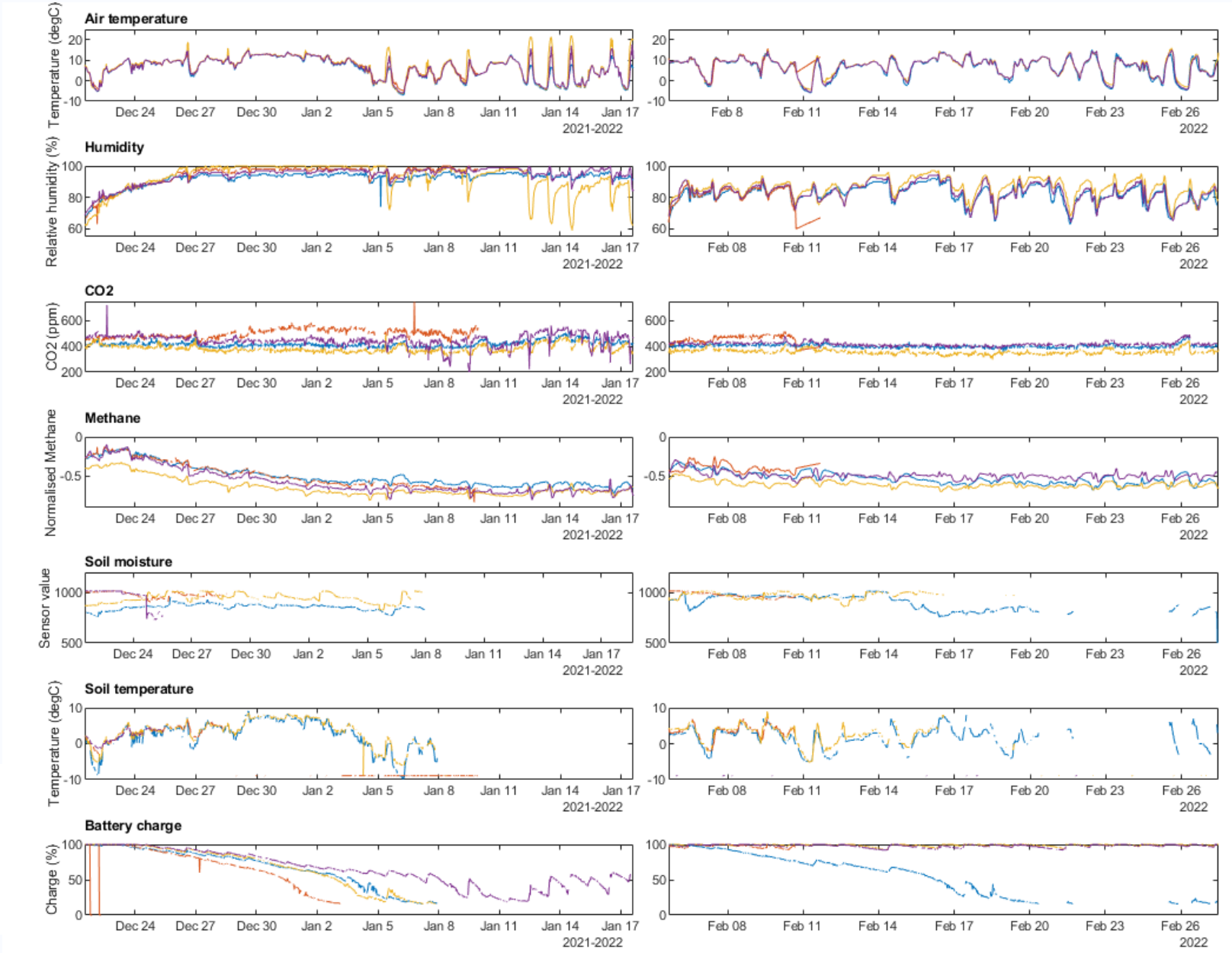


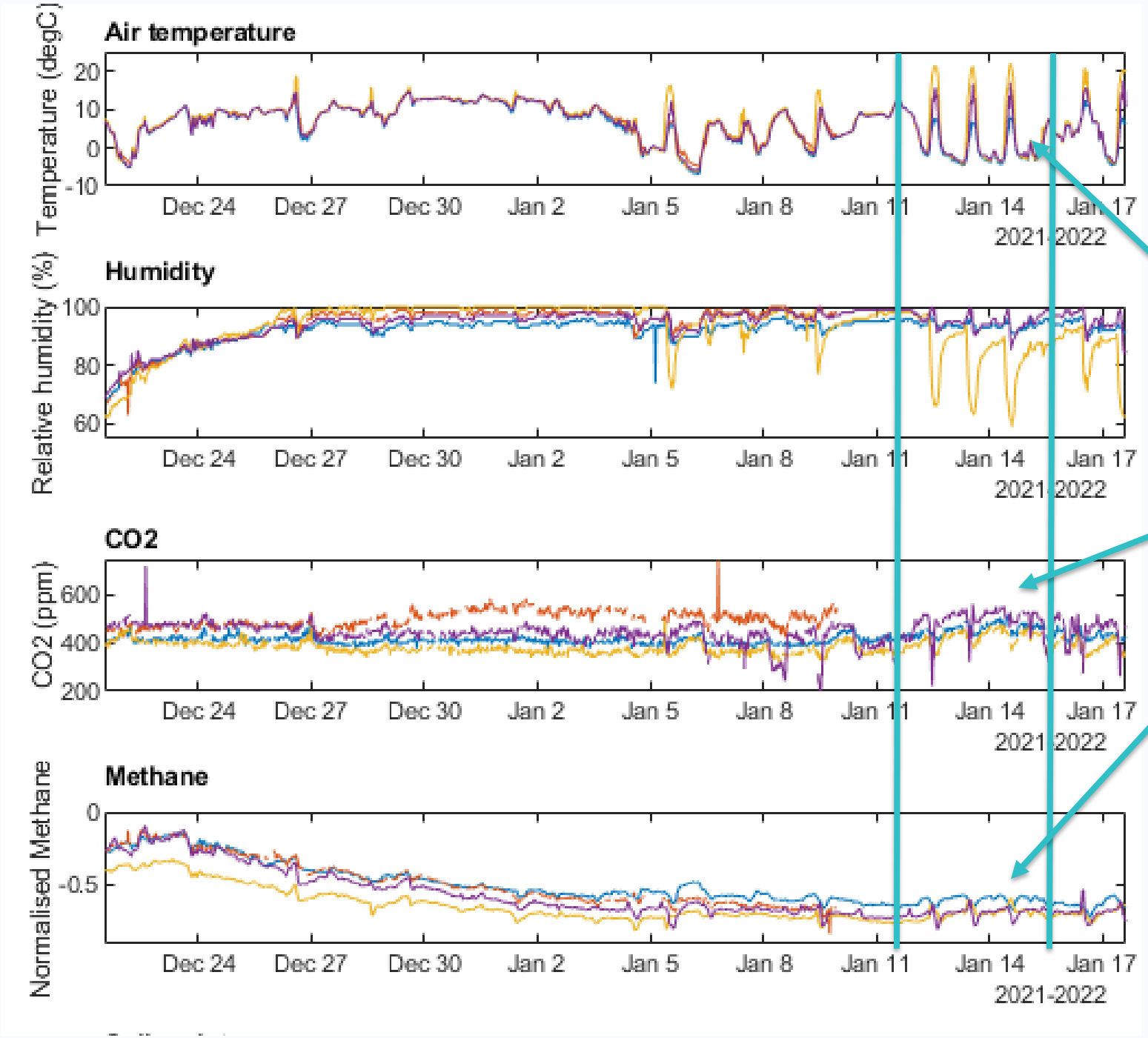
Deployment


Jan
D
C
B
E
Water flow
Feb D
FB
M27
Totton
NEW FOREST
Netley
A27
Brockenhurst
Gosport
Sway
Lymington
The Solent
A35

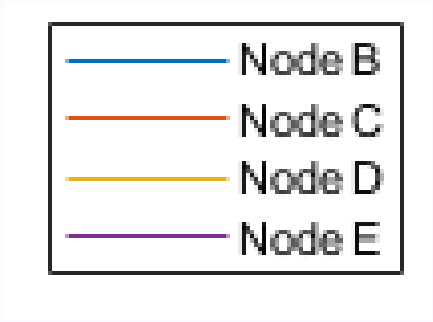
Results

- Over 7500 data points across 5 locations & 50 days




Air temperature
Temperature (degC)
20
10
0
-10
Dec 24
Dec 27
Dec 30
Jan 2
Jan 5
Jan 8
Jan 11
Jan 14
Jan 17
2021-2022
Humidity
Relative humidity (%)
100
80
60
CO2
CO2 (ppm)
600
400
200
Methane
Normalised Methane
0
-0.5

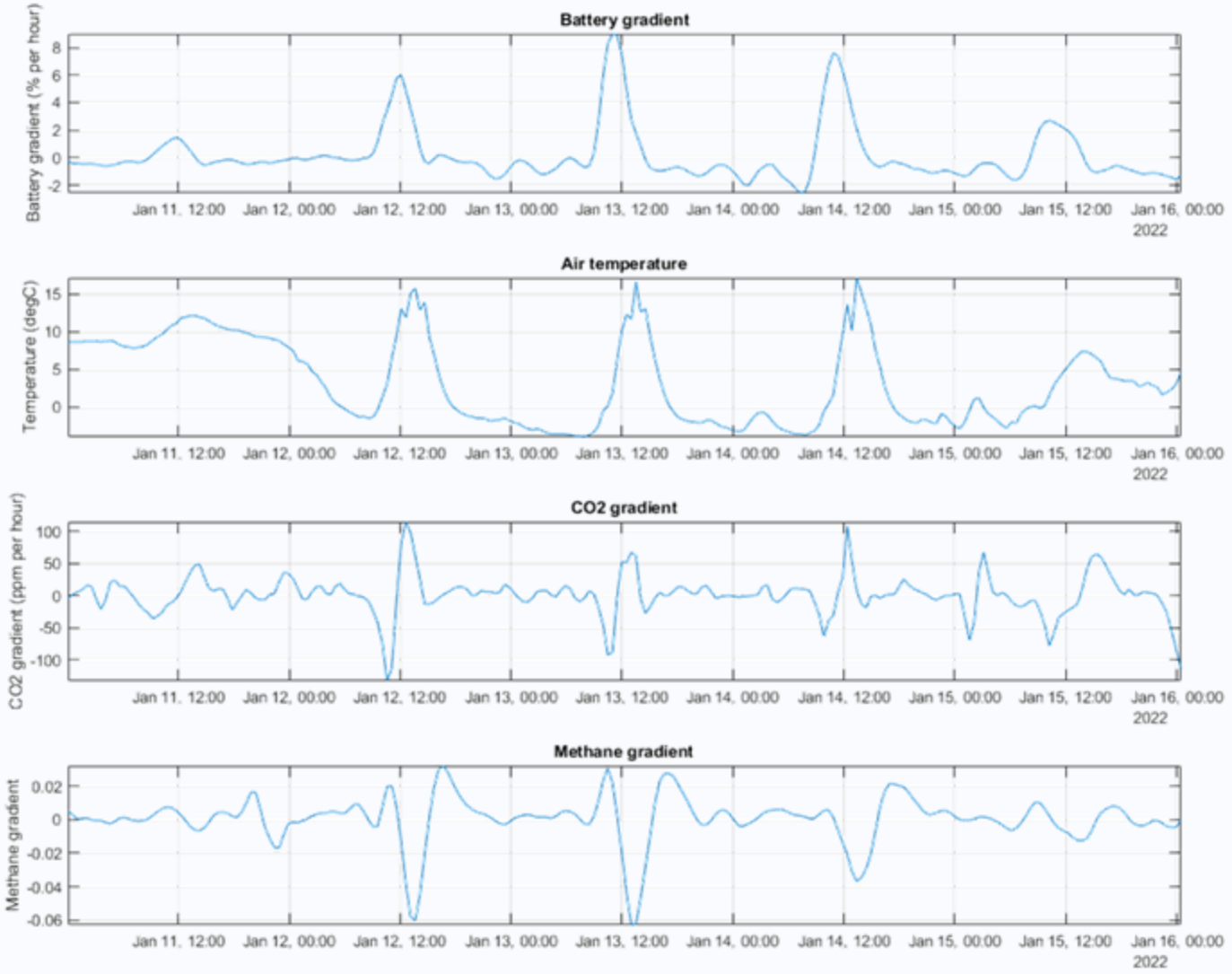
What's this??


Node B
Node C
Node D
Node E

On sunny days:

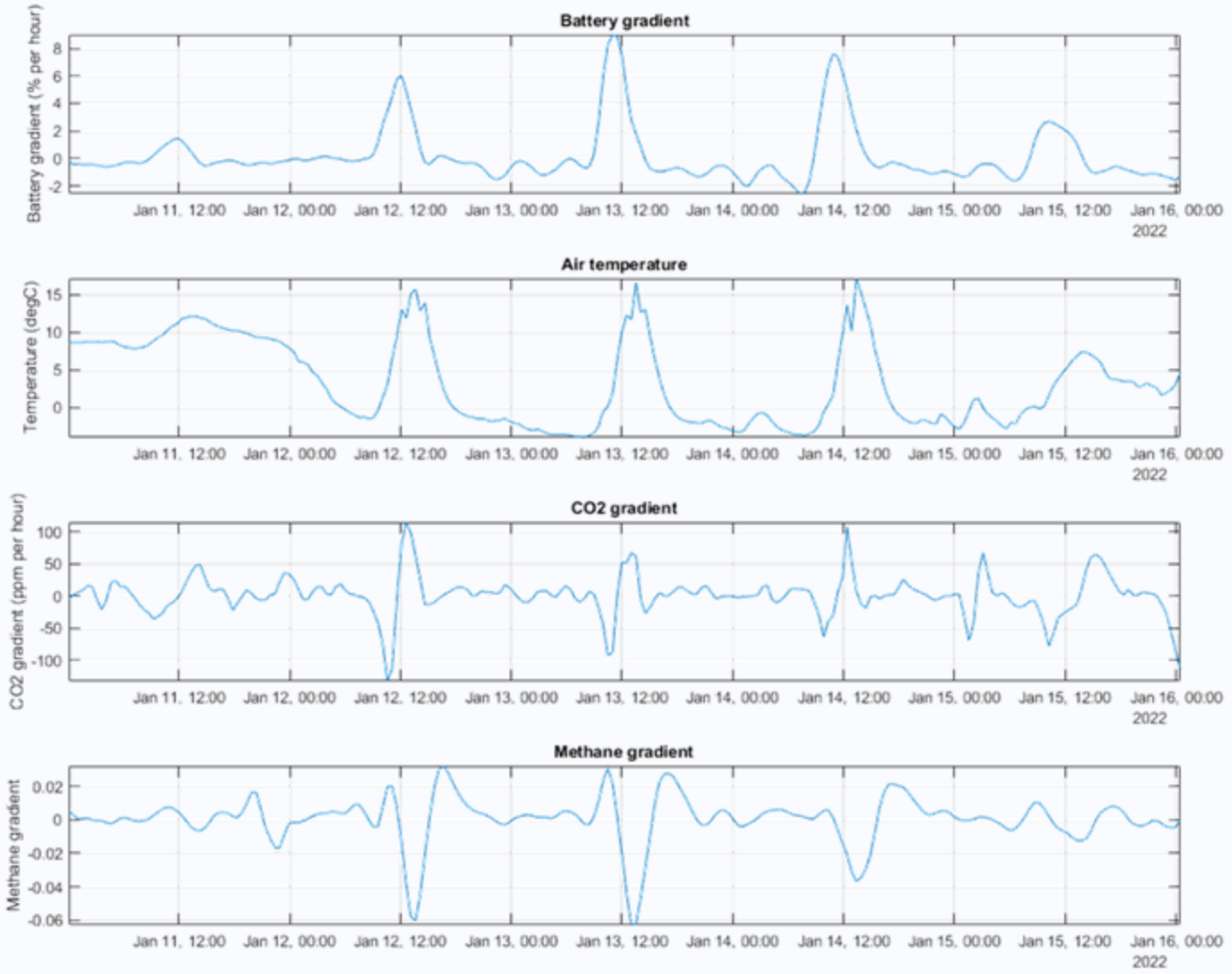
- CO2 production drops after sunrise, then increases after peak sunlight, returning to low rates overnight

- Methane production peaks in the morning, reaches a minimum after peak sunlight, then peaks again late in the afternoon



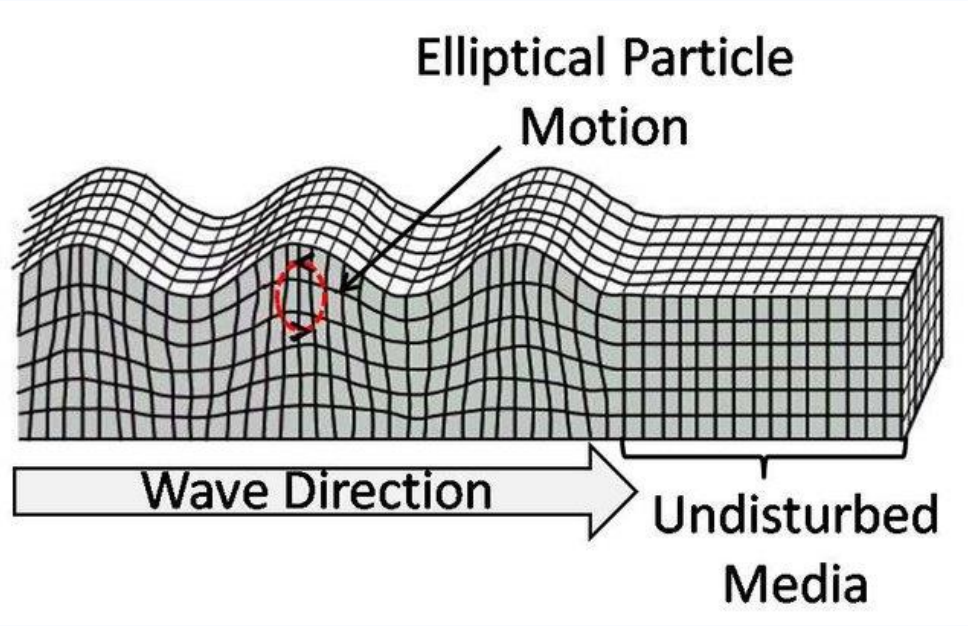
Current theories:

- Sunshine = photosynthesis, so CO2 drops at first
- Diffusion through vascular plants + warming of soil = initial methane release
- Methanotrophs become active and convert methane to CO2
- Subsurface temperature peaks later, causing 2nd methane peak



Future work

- Methane sensor calibration
- Adaptive sleep mode
  - Increase sleep duration in winter
- Better soil moisture sensors
  - Wider coverage
  - Quantitative data
  - Acoustic sensing?



https://www.researchgate.net/publication/303384382_Ground_vibration_from_underground_railways_how_simplifying_assumptions_limit_prediction_accuracy/figures?lo=1

Acknowledgements

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Thanks for listening!

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