

Automated Observation of a “remote” UK upland catchment

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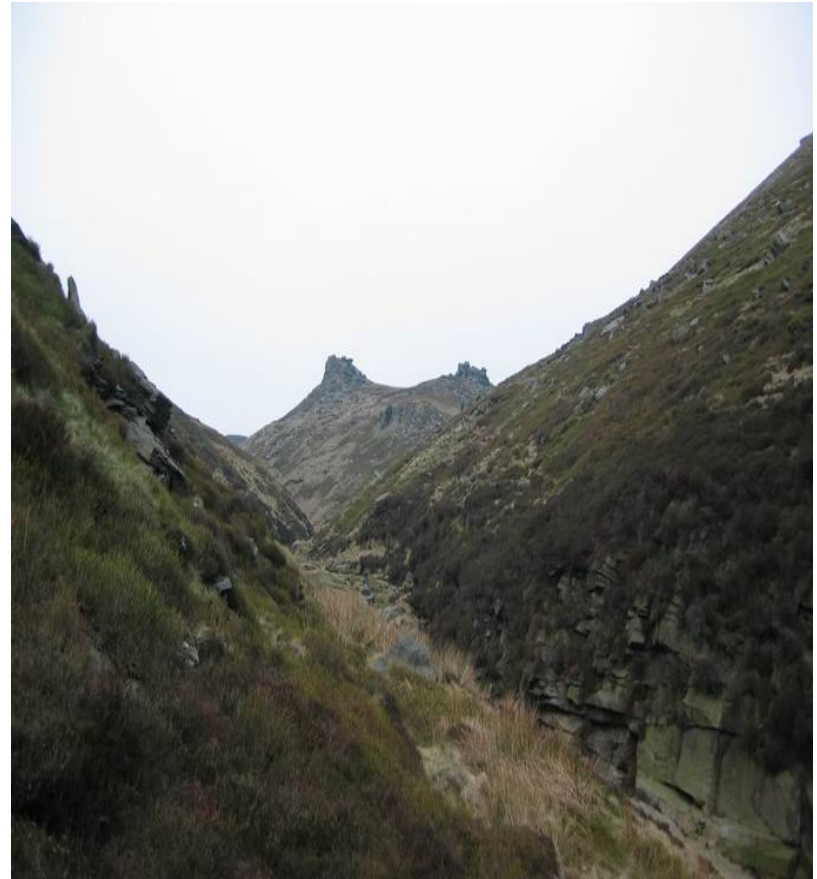
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Terry Parr, Rob Rose (CEH Lancaster)

Crowden Great Brook

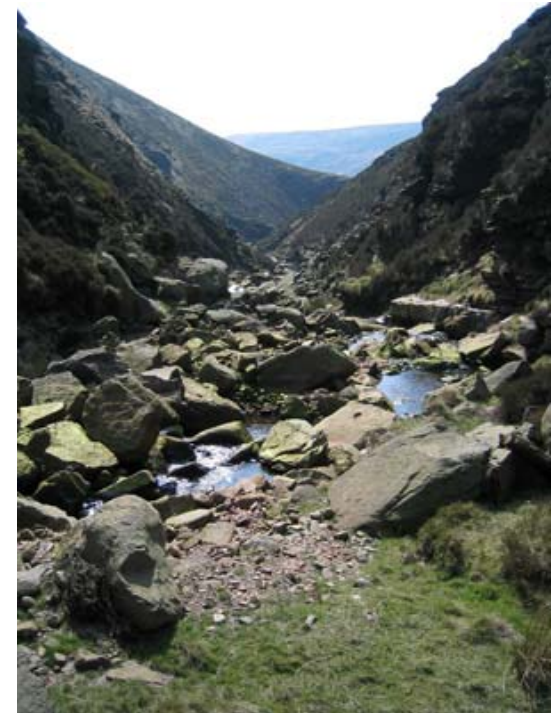
- Aim to characterise inputs and outputs of a “system” in the peak district.
 - Precipitation, Solar, Aeolian, Biological
 - Hydro, clastic, ET, solute, biological
- Enable better understanding of complex events
 - Peat erosion
 - Mass wasting
 - Bedload movement
 - Human Impacts
- Extract Climate change signals
- Current deployment consists of seven nodes, one of which is a base-station with a GSM modem to communicate alarm events back.
- Four nodes measure temperature (internal and soil), battery voltage and soil moisture. Additionally there are two rain gauges and three additional nodes (currently with no radio) measuring stream parameters.
- Summer 2008 will add a second transect, and radiation sensors, extra stream sensors (piezo, pressure, flow, EC, turbidity), cameras (visible and thermal)



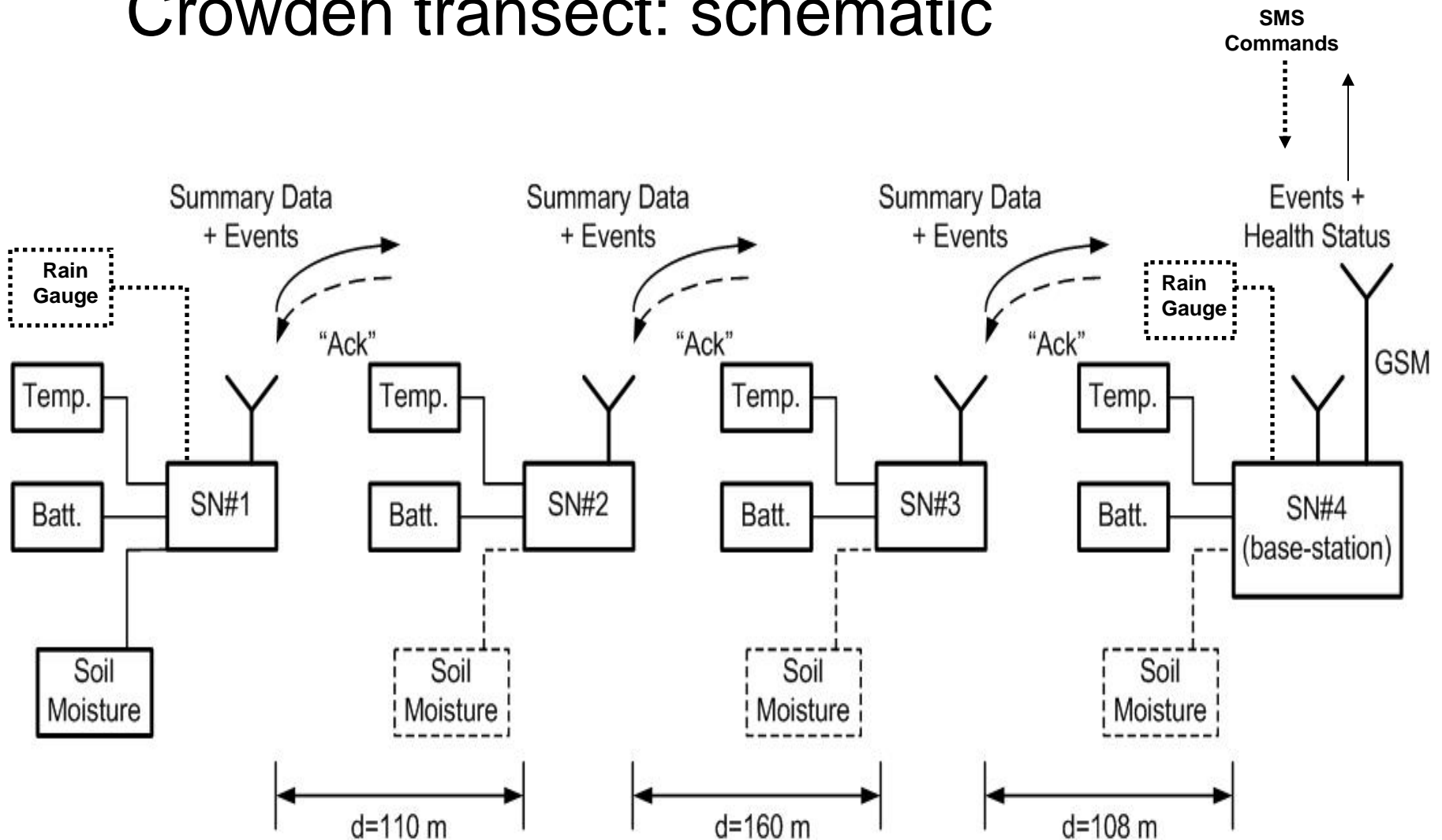
Crowden Great Brook



The Stream



Crowden transect: schematic



— Phase 1 test
 Phase 2 (currently deployed)

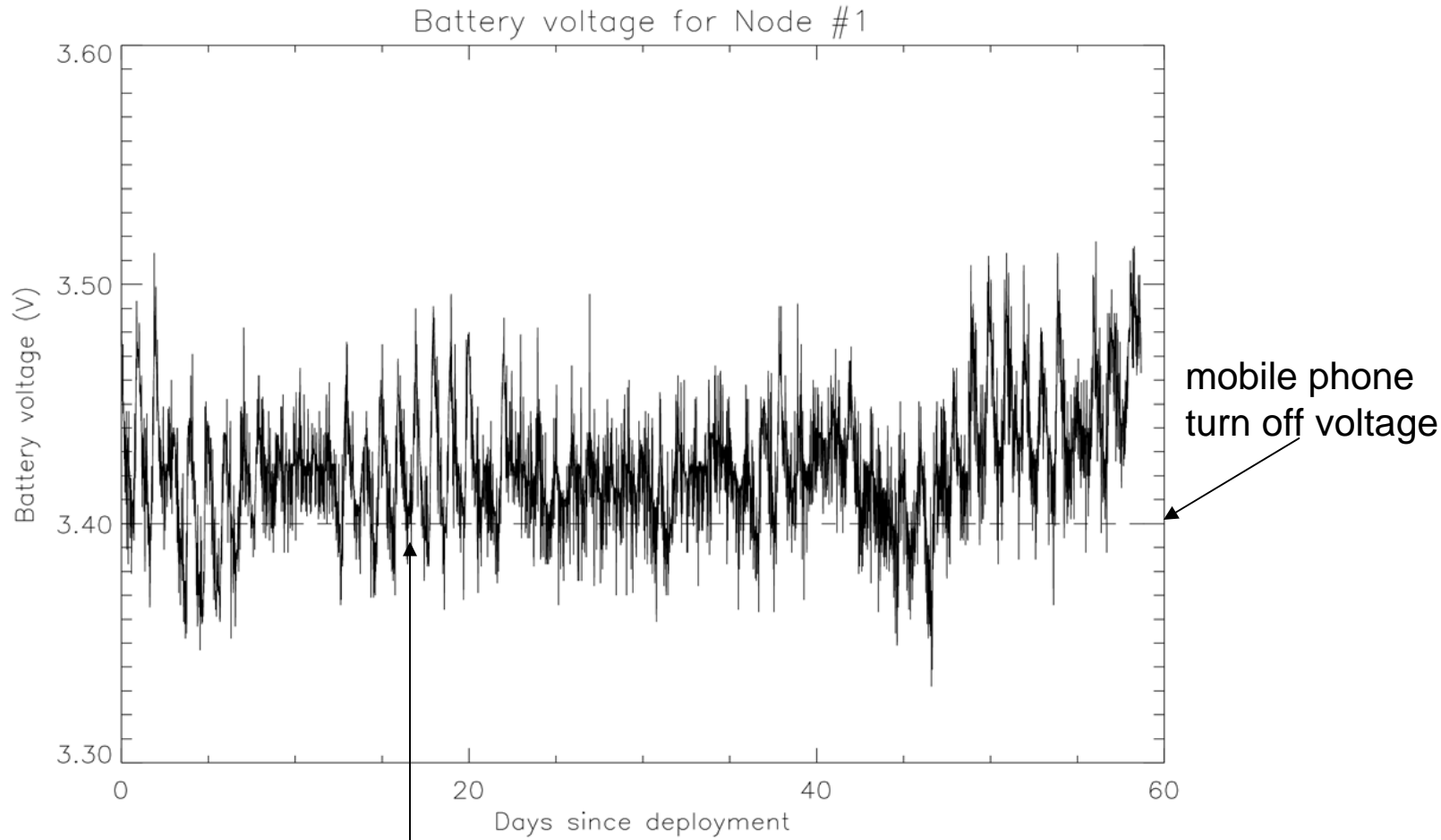
Operation.

- Only alarms and data samples (for off-line diagnostics) are sent real-time, as specified by a table of control rules
- Data is retrieved on each field visit (every 2 months or when repair needed)
- Each data recovery is used to update the control rules
 - comms, data sampling, data analysis, sensor diagnostics, alarm conditions, etc.
- There is a policy based management system and a simple command & real-time query interface
 - automated generation of prioritised alarms
 - automated conflict resolution between needs of users, builders and maintainers
 - best effort, high priority first (i.e. no node model!)

Remote WSN commands via SMS.

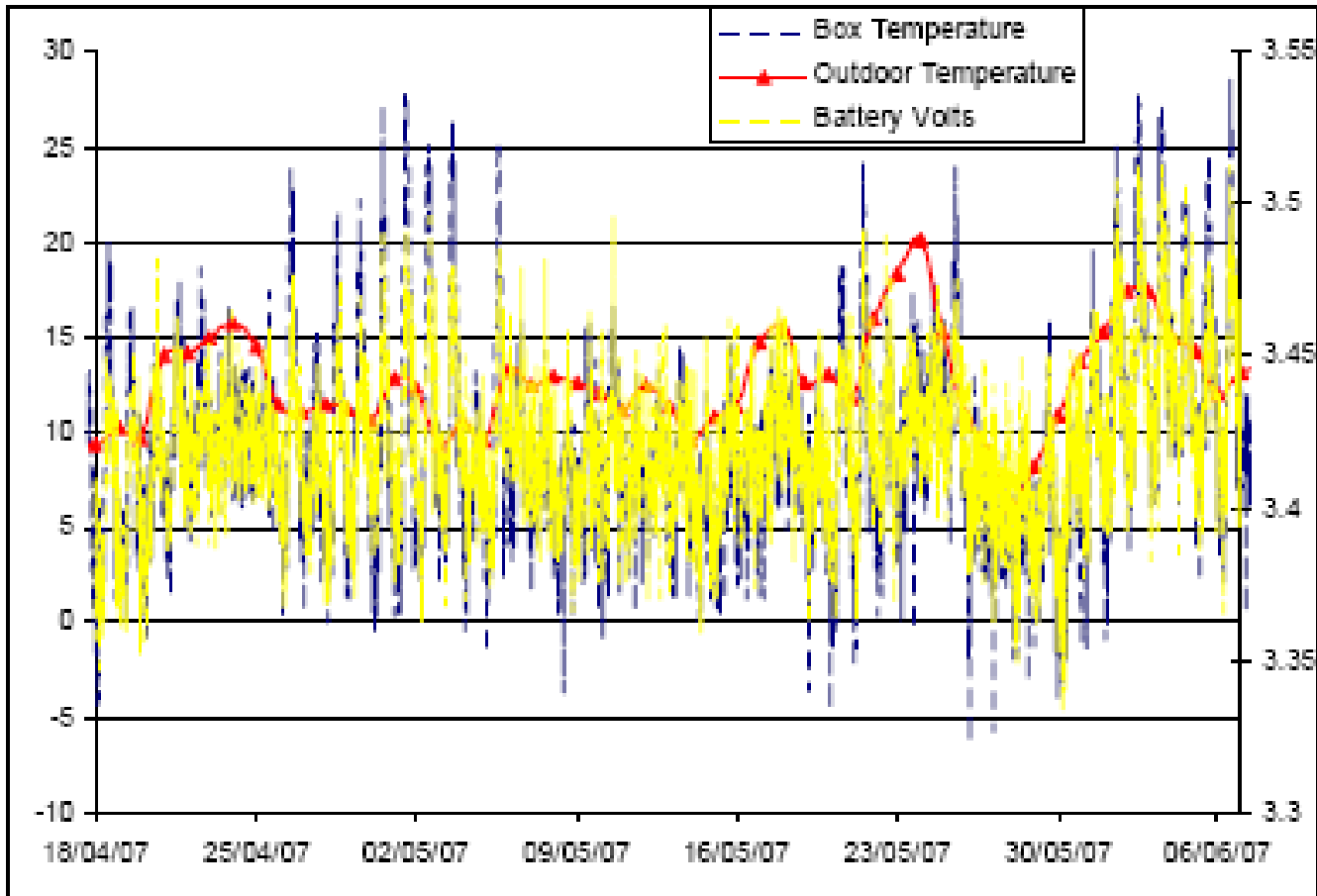
- Have implemented (and tested) a simple command language so that we can remotely (via SMS):
 - Read the last temperature, soil moisture, rain and/or battery level (“?T?”, “?TS?”, “?TSV?” etc.).
 - Switch off/on individual sensors (“?X?”= OFF, or “?Y?” = ON).
 - change the sampling schedule
 - Change the alarm reporting schedule (“?R1?” = every hour, “?R2?” every two hours etc.).
- Priority driven alarm resends (ie. A “low batt” alarm is given a high priority and is re-sent)
- Have also built in a timed function, so that certain future functions can be switched on/off at certain times: e.g. to switch on a blue-tooth device at 7 AM we’d send “?BY07?”
- This will be extended in the summer so that we can modify event conditions, change alarm priorities etc.

Example data: simple threshold.

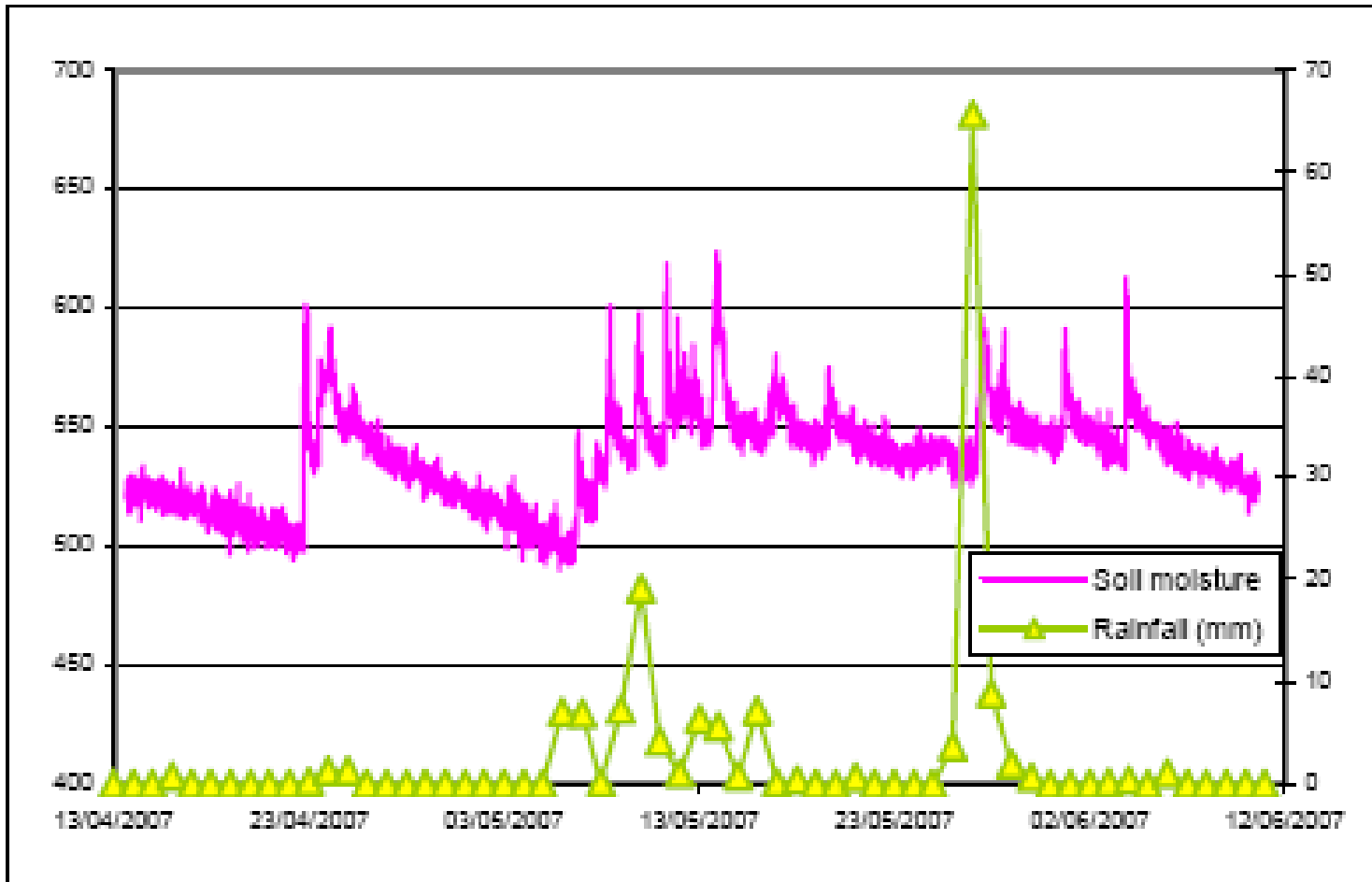


Problem: Fixed threshold here generated too many “low batt” alarms (diurnal fluctuations, $V_{\text{batt}} \approx T$).

Correlation

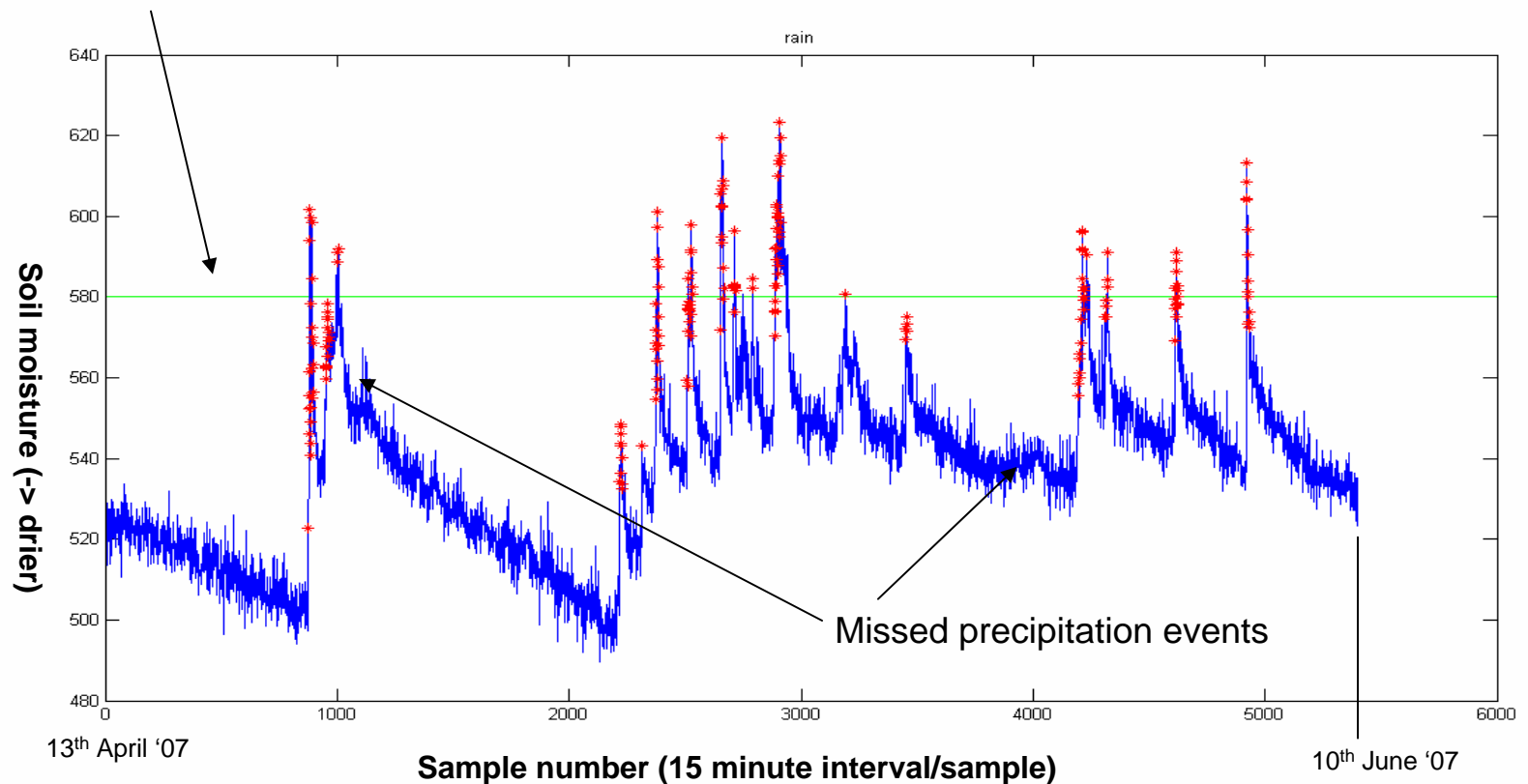


Cross-correlative triggers?



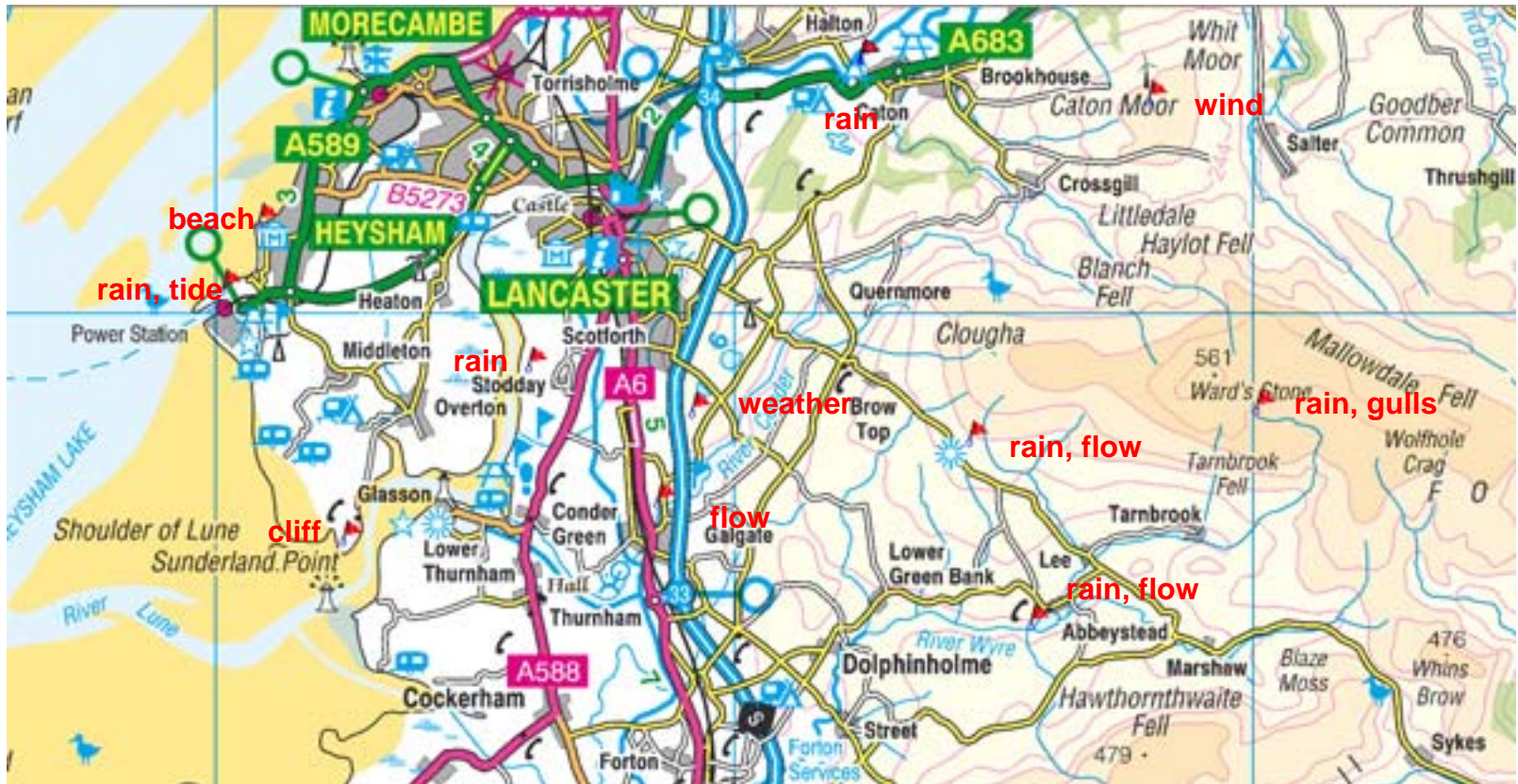
Example data: Change Threshold.

Simple, static, threshold level (Phase 1)



* = "It's raining!" alarm. New, adaptive, alarm algorithm

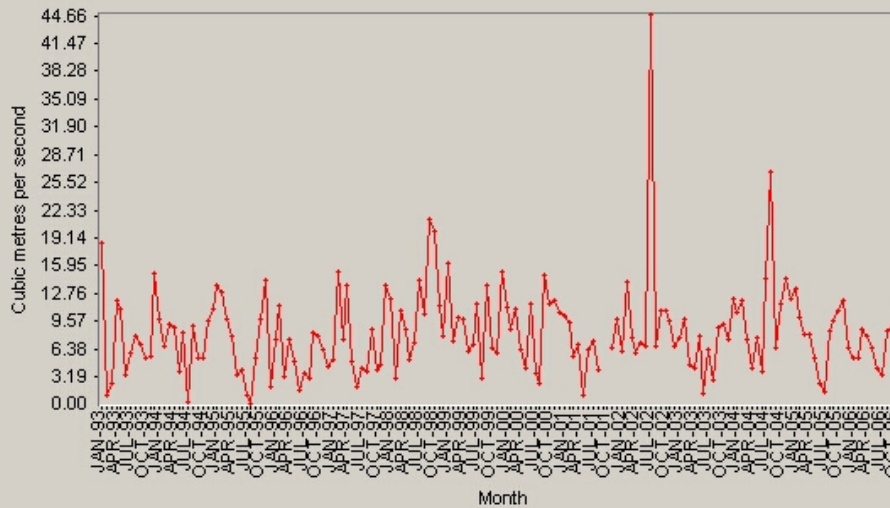
Lancaster Observations



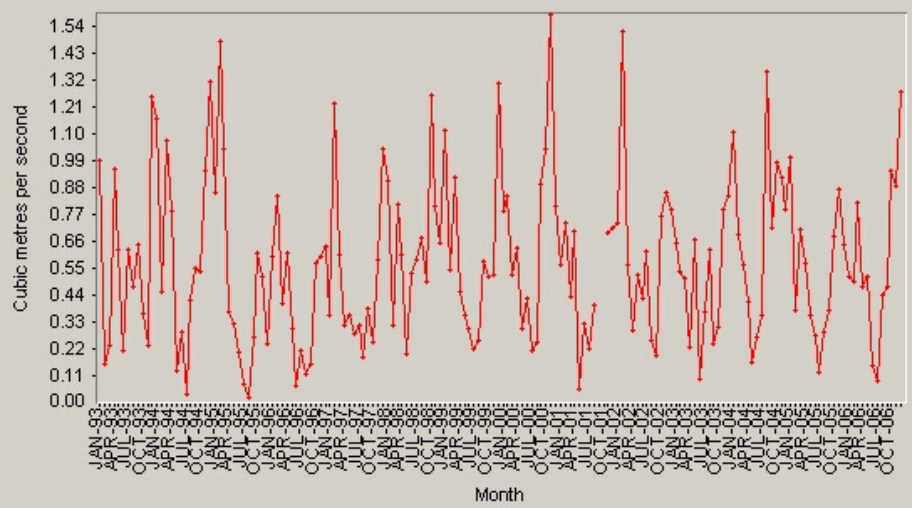
ECN Sites



Moor House (CEH ECN)



MOO



MOO



Conclusions.

- “Sensor network” technology is maturing to the point where it can assist with new science
- Hardware can be reused, but a modular approach is needed to allow specialisation of sensors and radios
- Available technology can support many useful adaptive behaviours, but software must be customised for each site
- During each development phase we learn more, and we are evolving our observatory in a progressive, step-wise fashion
- The next generation network will use more heterogeneous hardware, but hopefully a common control interface
- Findings will be replicated at two other UK upland sites