From field notes to data portal – An operational QA/QC framework for tower networks

Cove Sturtevant, Skyler Hackley, Timothy Meehan, Joshua Roberti, Greg Holling, and Santiago Bonarrigo

National Ecological Observatory Network, Boulder, Colorado, USA

Introduction

Tower networks such as Ameriflux, ICOS, and NEON grow in size and sophistication, yet tools have lagged for robust, efficient, scalable quality assurance and quality control (QA/QC). Even with automated tests, QA/QC remains a largely manual process due to:

- Heavy reliance on visual inspection of *all* data
- No explicit link between field notes of visible problems and data flagging
- These are complicated by a separation of duties - different personnel manage different sites or steps in the data flow

As such, an increase in network size requires a proportional increase in personnel devoted to QA/QC, quickly stressing the human resources available.

Here we present a scalable QA/QC framework that combines:
- the efficiency and standardization of automated tests
- the power and flexibility of visual checks
- an efficient communication pathway from field personnel to data processors to end users
- standardization in field records and monitoring

Tools in development

- Fulcrum mobile application template for tower maintenance
  - customizable
  - standardized records
  - offline data entry
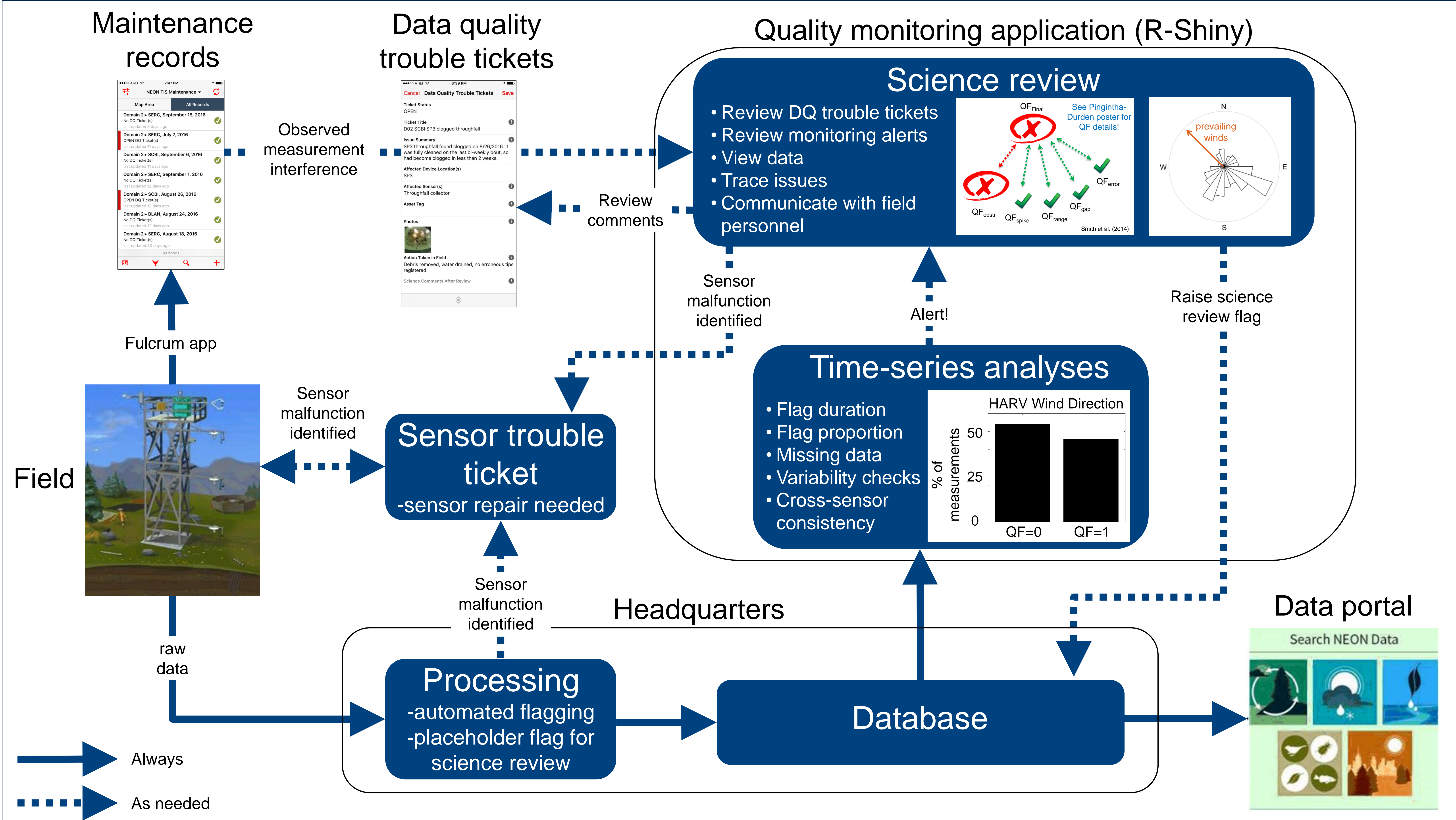 - cloud-based record storage
  - API access
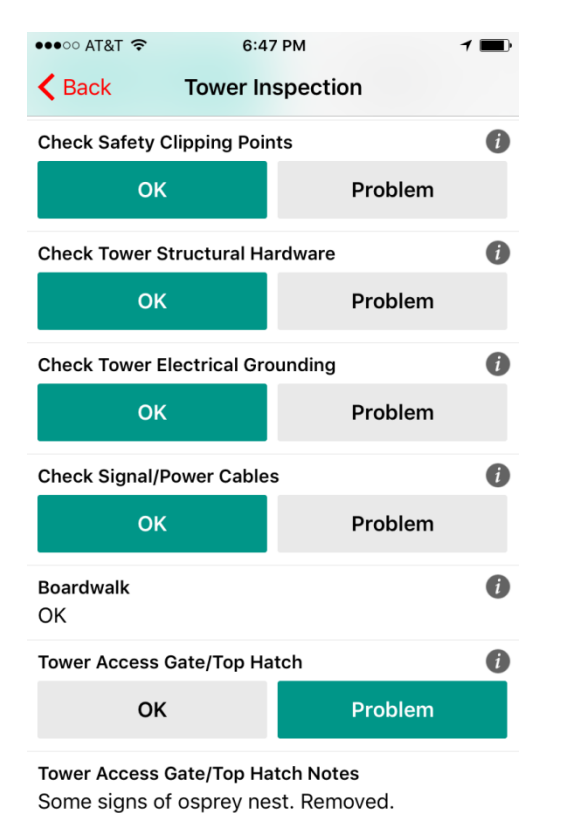
- Open-source R-shiny application for monitoring data quality
  - Docker-packaged scalable deployment
  - Review data quality trouble tickets & time-series alerts
  - View data (raw & processed)
    - Random "Plot of the Day"

- Open-source R package with monitoring algorithms
  - Quality flag duration/proportion
  - Time-frequency analysis:
    - Changes in data frequency
    - Changes in variability (e.g. diel & seasonal patterns)
    - Other common issues in Pastorello et al. (2014)
  - Cross-sensor consistency checks

Operational QA/QC framework

Maintenance records — Data quality trouble tickets — Quality monitoring application (R-Shiny)

Observed measurement interference

Science review
- Review DQ trouble tickets
- Review monitoring alerts
- View data
- Trace issues
- Communicate with field personnel

See Pingintha-Durden poster for QF details!

QF_{Final}
QF_{error}
QF_{obstr} QF_{spike} QF_{range} QF_{gap}
Smith et al. (2014)

prevailing winds

Review comments

Sensor malfunction identified

Raise science review flag

Fulcrum app

Field

raw data

Sensor malfunction identified

Sensor trouble ticket
-sensor repair needed

Sensor malfunction identified

Alert!

Time-series analyses
- Flag duration
- Flag proportion
- Missing data
- Variability checks
- Cross-sensor consistency

HARV Wind Direction

% of measurements — 50, 25, 0 — QF=0, QF=1

Data portal

Search NEON Data

Headquarters

Processing
-automated flagging
-placeholder flag for science review

Database

→ Always
⇢ As needed

Have feedback or ideas? Please contact us! CSturtevant@BattelleEcology.org