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Coupling Flux Towers and Networks with Proximal and Remote Sensing Data: New Tools to Collect and Share Time-Synchronized Hourly Fluxes

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Multiple hundreds of flux towers are presently operational as standalone projects and as parts of larger networks. However, the vast majority of these towers do not allow straight-forward coupling with satellite data, and even fewer have optical sensors for validation of satellite products and upscaling from field to regional levels.

In 2016, new tools to collect, process, and share time-synchronized flux data from multiple towers were developed and deployed globally. Originally designed to automate site and data management, these new tools can also be effective in coupling tower data with satellite data due to the following present capabilities:

- Fully automated FluxSuite system combines hardware, software and web-services, and does not require an expert to run it
- It can be incorporated into a new flux station or added to a present station, using weatherized remotely-accessible microcomputer, SmartFlux2
- It utilizes EddyPro software to calculate fully-processed fluxes and footprints in near-realtime, alongside radiation, optical, weather and soil data
- All site data are merged into a single quality-controlled file timed using PTP time protocol
- Data from optical sensors can be integrated into this complete dataset via compatible dataloggers
- Multiple stations can be linked into time-synchronized network with automated reports and email alerts visible to PIs in real-time
- Remote sensing researchers without stations can form "virtual networks" of stations by collaborating with tower PIs from different physical networks

The present system can then be utilized to couple ground data with satellite data via the following proposed concept:

- GPS-driven PTP protocol will synchronize instrumentation within the station, different stations with each other, and all of these to satellite data to precisely align optical and flux data in time
- Footprint size and coordinates computed and stored with flux data will help correctly align footprints and satellite motion to precisely align optical and flux data in space
- Current flux towers can be augmented with ground optical sensors and use standard routines to deliver continuous products (e.g. SIF, PRI, NDVI, etc.) based on automated field spectrometers (e.g., FloX and RoX, etc.) and other optical systems

- Schedule can be developed to point ground optical sensor into the footprint, or to run leaf chamber measurements in the footprint, at the same time with the satellite or UAV above the footprint
- Full snapshot of the satellite pixel can then be constructed including leaf-level, ground optical sensor, and flux measurements from the same footprint area closely coupled with the satellite measurements to help interpret satellite data, validate models, and improve upscaling

Several dozens of new towers already operational globally can be readily adapted for the proposed concept. In addition, over 500 active traditional towers can be updated to synchronize their data with satellite measurements. This presentation will show how FluxSuite system is used by major networks, and describe the concept of how this approach can be utilized to couple satellite and tower data.