New York State Mesonet: Implementation of an Eddy Covariance Flux Sub-network


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The New York State Mesonet (NYS Mesonet)

The NYS Mesonet is an integral component of the New York State Early Warning Weather Detection System that was established by the Department of Homeland Security in January 2014 to improve weather monitoring and forecasting in New York State. It is currently the largest Mesonet in the United States, consisting of 126 standard weather stations, spaced approximately 19 miles apart, and three advanced sub-networks (sub-nets) including:

- Flux system is wired, tested, and prepped at the Atmospheric Sciences Research Center (ASRC) for transport into field and installation.
- Flux system shipped by NYS Mesonet truck to the field site.
- Net radiometer, IRSA, and sonic are leveled using bottom of the tower as reference.
- Instruments and enclosure are mounted on the tower at their respective heights using Campbell Scientific tower mounting kit pin. CM210, U-bolts, and 6 ft long aluminum round tube.
- Enclosure is affixed to a custom square stock tower mount.
- Cables and tubes run down the tower to the enclosure
- System is field tested, connected remotely to Mesonet servers, and data transmission is initiated.
- Data is monitored, datalogger program tweaked (ongoing process)

About the Flux Sub-network

The NYS Mesonet Flux Sub-net consists of seventeen closed-path eddy covariance flux systems mounted on seventeen existing NYS Mesonet towers throughout New York State (NYS). Most instrumentation is as-included with the commercially available Campbell Scientific, CPECO2 flux system, though the Mesonet’s system is customized (in house) to meet our specific needs and limitations. The objective of the flux sub-net is to provide a platform for research to improve numerical weather prediction in NYS thereby serving the economic, societal, and safety needs of NYS stakeholders. The design, siting, and implementation of the Flux sub-net reflects the desire for it to be utilized for a variety of other research purposes as well including but not limited to agriculturally, carbon budget studies, boundary layer-land surface research, model and satellite validation, and instrument R&D. Those interested in using data from or collaborating with the NYS Mesonet Flux Sub-net are encouraged to contact the authors below via http://nysmesonet.org.

Flux Sub-network By the Numbers

- 17 Fluxes installed at Veiloo, VA
- 11 months to fully deploy network (less automated calibrations)
- 9 m AGL measurement height (wind, radiation, gas)
- 15 Watts (steady state power draw 13 W winter running mode)
- 330 days of data at Veiloo, VA site
- $750 K initial investment
- $530 K annual operating budget

Power and Data Management

- Flux system relies on Mesonet solar power system entirely
- Power consumption:
  - 3 W (net radiation, soil heat flux only)
  - 6 W (net radiation, soil heat flux, and wind only)
  - 15 W (full power mode, all data collected)
  - 30 W (full power mode + net radiometer heaters on)
- 15 W, full time operation only possible between late April and early October given solar power system limitations

Other considerations for siting

- Co-location with other NYS Mesonet Sub-nets
- Representativeness of 9 m AGL flux measurement at each site
- Flow distortion potential from obstructions nearby to tower
- Uniqueness of land cover/use surroundings
- Potentially impactful terrain features
- Predominant wind direction (land cover/use in fetch)
- Meteorologically interesting areas (e.g. Tug Hill Plateau)
- Site host interest

Siting Strategy

Targeted Site Types for Potential Research Areas

- Infrastructure - waterways/water front (water/energy balance)
- Emergency management - urban sites (dispersion)
- Economic - agricultural sites
- Numerical Weather Prediction (NWP) - all sites
- Climate change/ecological - all sites (carbon balance, land use/land cover change)

Installation Process

- Phase 1 (December 2016 – June 2017)
  1. Flux system is wired, tested, and propped at the Atmospheric Sciences Research Center (ASRC) for transport into field and installation.
  2. Flux system shipped by NYS Mesonet truck to the field site.
  3. Net radiometer, IRSA, and sonic are leveled using bottom of the tower as reference.
  4. Instruments and enclosure are mounted on the tower at their respective heights using Campbell Scientific tower mounting kit pin. CM210, U-bolts, and 6 ft long aluminum round tube.
  5. Enclosure is affixed to a custom square stock tower mount.
  6. Cables and tubes run down the tower to the enclosure
  7. System is field tested, connected remotely to Mesonet servers, and data transmission is initiated.
  8. Data is monitored, datalogger program tweaked (ongoing process)

- Phase 2 (June 2017 – November 2017)
  9. Trenches dug and conduit laid for calibration tubes and soil heat flux cables
  10. Soil heat flux plates inserted gently into the soil profile 6 cm subsurface
  11. Cables and gas tubing routed through conduit
  12. Calibration tank enclosure mounted to Mesonet tower box
  13. Locations of burned plates are recorded using coordinate system

- Phase 3 (Underway)
  13. Calibration tank concentrations verified in the lab before shipment to flux site
  14. Calibration tanks shipped to site and installed
  15. Automatic calibration procedure initiated on a schedule

Calibrations

- Frequent calibrations of the EC115 infrared gas analyzer are necessary to ensure accuracy of the CO₂ and H₂O concentration measurements due to the sensitivity of the instrument to changes in ambient weather. We plan to perform automated calibrations of the EC115’s CO₂ signal once or twice daily using two reference gas concentrations stored on site in 44 inch cylinders. The two reference gases (around 0 and 420 ppm CO₂) are procured from a local gas supplier. The cylinder concentrations are verified using a Picaarro G4303 cavity ring-down spectrometer (CRDS) that is calibrated prior to every use by two high quality NOAA standard gases. The EasyFlux DL program runs a calibration process whereby reference gases are sent periodically to the EC115 for calibration using the CPECO2’s optional 4 valve module. The H₂O signal must be manually calibrated manually using a dew point generator. This is performed in the fall and spring with regular maintenance of the flux system.

Ongoing & Future Projects

- Optimize power management during winter months
- Improved leveling of the net radiometer on the folding tower
- Improve current and develop new methods for automated quality control
- Evaluate representativeness of each flux site (i.e. footprint modeling)
- Evaluation of EasyFlux DL and CPECO2 performance
- Improvement of boundary layer-surface parameterizations in NWP
- Identification of trends and data phenomena that suggest a need for further study

Contacts

- Poster, technical, data questions: covert@albany.edu
- Collaborative opportunities: smiller@albany.edu
- NYS Mesonet Project Manager: dintrigo@albany.edu
- Data requests: http://nysmesonet.org/Data/requestsdata

Acknowledgements

This research is made possible by the New York State (NYS) Mesonet. Original funding for the NYS Mesonet was provided by Federal Emergency Management Agency grant FEMA-2858-CR-NY, with the continued support of the NYS Division of Homeland Security & Emergency Services; the state of New York; The Research Foundation for the State University of New York (SUNY); the University at Albany, SUNY; the Atmospheric Sciences Research Center (ASRC) at SUNY Albany; and the Department of Atmospheric and Environmental Sciences (DAES) at SUNY Albany. Appreciation is extended to all those who assisted in procurement, development, assembly, installation, data quality control and maintenance of the flux network over the last two years.