Wood Buffalo Environmental Association

Program Description

Regional Meteorological Network (MET)

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Program Overview

The Regional Meteorological Network (MET) is a part of a collection of integrated monitoring programs operated by the WBEA Deposition (DEP) monitoring group (formerly the Terrestrial Environmental Effects Monitoring [TEEM] group). This program provides continuous, hourly measurements of meteorological conditions in remote areas around Regional Municipality of Wood Buffalo. The monitoring network was established to provide high-quality data for use in air quality and deposition modeling, cumulative effects monitoring, and evaluation of ecosystem responses.

The MET program aims to address specific monitoring questions:

- What is the interaction between inter-annual weather patterns and forest response to industrial air emissions?
- How accurate are deposition calculations provided by the dispersion models?
- Can meteorological data reduce the bias in the model predictions?

(adapted from Prasad & Dann, 2015)

Additional meteorological monitoring is conducted by the WBEA AAM program at each Air Monitoring Station (AMS) and may be added to different focus studies as needed.

History

Below is a timeline of major network developments.

- 2008 - Tower installation at site 1004
- 2009 - Tripod installation at site 2054 and upgrade at site 1004 (Stantec)
- 2010 - Tower installation at site 2001 (Stantec)
- 2011 - Power system upgrades at sites 1004 and 2001 (solar tower added). Tower installations at sites 1007 and 2013. Conducted by BioSynch with the assistance of WBEA staff.
- 2012 - Tower installation at site 3016.
- 2013 - Tower installation at site 3011
- 2014 - Tripod installations at sites 3083, 3086, 3088, 3092, 3096.
- 2018 - All tripod stations rebuilt with telemetry and dual power systems
- 2022 – Tripods removed at sites 3083, 3086, 3088, 3092, 3096.
- 2023 – Meteorology measurements added to towers 1002, 1023, 2005, 3009.
- 2024 – Meteorology measurements added to tripod 4913
- 2025 – Tower installation at site 3017.

Station Descriptions

Most 30-m MET tower stations are located within a jack pine ecosystem with a Forest Health Monitoring (FHM) interior site. It is typically situated at the highest elevation in the forest stand. Parameters measured by tower stations include air temperature, relative humidity, wind speed, wind direction, and solar radiation. Some MET towers have these sensors at four levels within and above the jack pine canopy, while some MET towers only have these sensors at canopy height (to support Denuder flow calculations). Precipitation and barometric pressure are measured near ground level. Below ground measurements may include soil temperature, volumetric water content, and electrical conductivity within the forest soil.

The supporting infrastructure at these stations includes one or two towers, solar power systems, and wildlife exclusion fencing. The primary tower is a 30-meter steel tower with cross arms at four heights for situating sensors in a vertical profile. Weatherproof enclosures are mounted at the base of the primary tower and house the datalogger and peripherals, telemetry hardware, and power system components. At some sites, there is an adjacent 15-meter aluminum tower that supports the solar arrays for the station power systems. Battery banks are sheltered in three large chest coolers buried in the ground. Electrified wildlife exclusion fencing is installed around the perimeter of the station area - encircling both towers, the precipitation gauge, and battery banks.

Figure 2 - A low-angle aerial photo of the MET tower at site 2013 (facing northwest), situated in a jack pine upland forest.

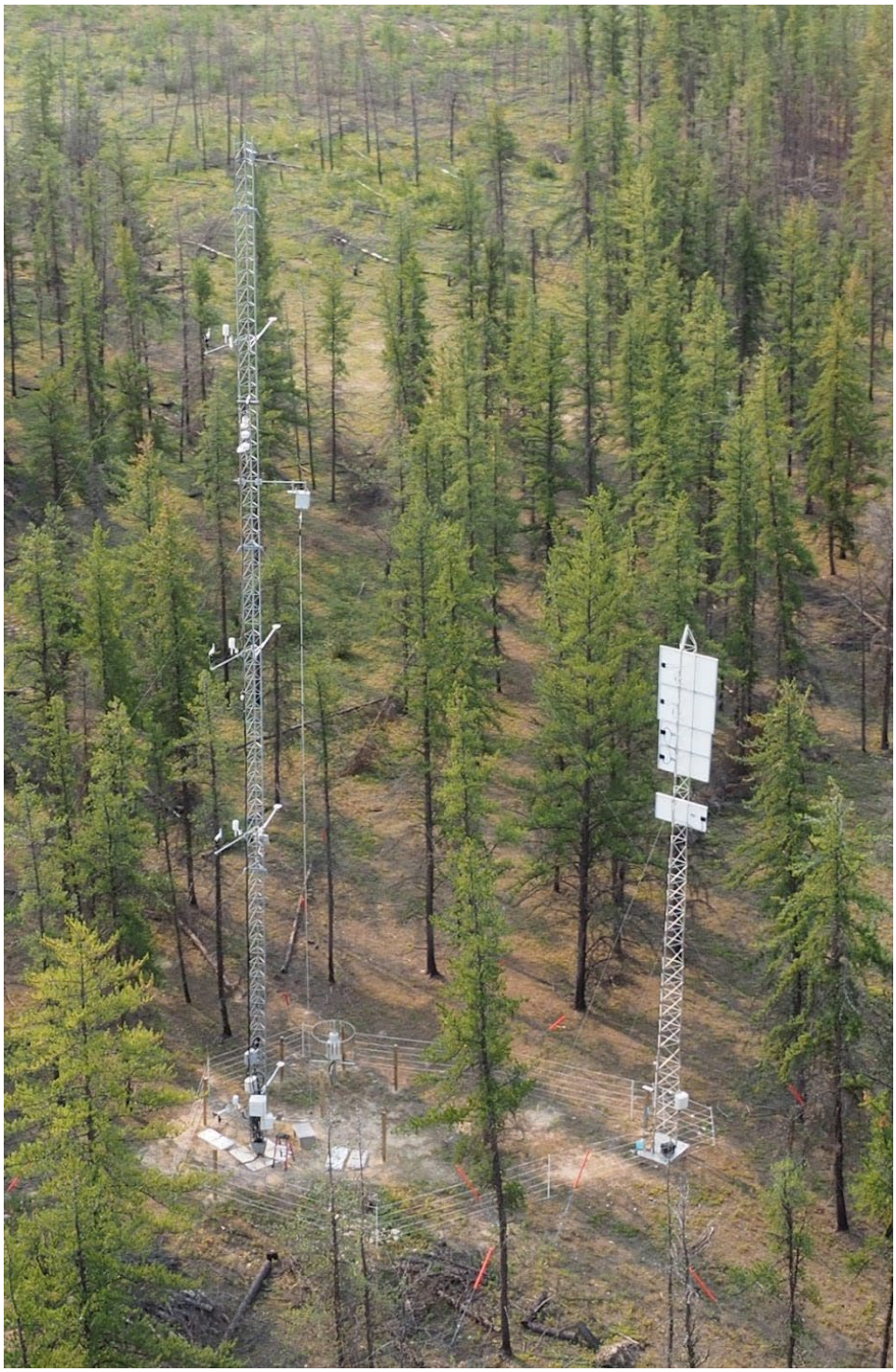

Figure 3 - A high-angle aerial photo of the MET tower at site 2013 (facing southeast). The 30-meter tower on the left is instrumented at four heights. The 15-meter tower on the right supports the solar panel arrays. The Denuder sampler is visible on the right (west) side of the tower. The rain gauge, battery enclosures, and wildlife exclusion fencing at ground level are also visible.

Equipment Details

Monitoring Parameters and sensor details

Table 2 - MET monitoring parameters and sensor details

Parameter	Abbreviation	Sensor Make and Model	Maintenance Frequency	Maintenance Details
Air Temperature	AT	Vaisala HMP155	12 months	Recalibration completed by WBEA staff at WBEA Centre
Relative Humidity	RH			
Wind Speed	WS	RMYoung 05103	12 months	Sensor head bearing replacement (2 bearings in each) by WBEA with parts from Campbell Scientific
Wind Direction	WD			
Photosynthetically Active Radiation (PAR)	PAR	LI-COR Li-190 Quantum	24 months	Recalibration by LI-COR
Global Solar Radiation	SR	LI-COR Li-200 Pyranometer	24 months	Recalibration by LI-COR
Barometric Pressure	BP, Pressure	Vaisala PTB110 (CS106 if sold by Campbell Scientific)	24 months	Recalibrated by Campbell Scientific
Precipitation	Precip	OTT Pluvio2 200	12 months	Guided Accuracy and Drip Test
Soil Temperature	SoilT	Campbell Scientific CS650	None	Regular maintenance not required
Soil Water Content	VWC, Moist			
Soil Electrical Conductivity	EC			

Sensor Heights

All sensors on MET tripod stations are positioned at 2 meters above the ground surface. At some MET tower stations, atmospheric sensors are installed at four levels within and above the jack pine canopy. The four levels are referenced in two different ways by WBEA data systems.

Within the Campbell Scientific programs (i.e., CRBasic datalogger programming and RTMC data viewer) sensor positions are referenced in relation to the jack pine canopy height at the time of tower installation with sensors at:

- ground level plus 2 meters
- canopy height minus 3 meters

- canopy height plus 2 meters
- canopy height plus 10 meters

At some MET towers, soil sensors are positioned at two depths–10 cm and 50 cm below the surface–in three separate pits adjacent to the tower base.

Data Collection and Transfer

The data logger and telemetry components are housed within large (14”x16” or 16”x18”) weatherproof enclosures at the base of each station. Table 4 provides a breakdown of the specific model of datalogger, and modem used in each monitoring station.

Dataloggers

MET stations are equipped with Campbell Scientific dataloggers that control sensors and peripherals and collate data received from the sensors. MET towers use CR3000 model dataloggers.

Telemetry

MET tower stations are integrated with either cellular modems (Microhard BulletPlus) or satellite modems (Hughes 9502) which allows for automated data retrieval on scheduled intervals using the Campbell Scientific LoggerNet Connect program running on the WBEA server. Power to the modem is controlled by the station datalogger via a solid-state relay, allowing the modem to be turned on and off programmatically or remotely through LoggerNet Connect.

MET tower stations are programmed to have telemetry powered continually and the solar power systems have been sized to meet these power requirements. Since telemetry is powered continually, the station can be connected at any time of day. The LoggerNet server is scheduled to connect and download data hourly from tower stations.

The dataloggers are programmed to switch telemetry power off (or leave the power off) if the telemetry power system has low voltage (below 12 VDC).

Power Systems

Monitoring locations are not typically situated close to grid power, so each MET monitoring station operates on solar power systems (nominal 12 VDC) consisting of battery banks for power storage, solar arrays to recharge the battery bank, and solar charge controllers to safely regulate battery bank charging and supply power to the equipment.

All stations have, at minimum, two separate power systems: one that powers the datalogger and sensors and a second that powers the telemetry system. Separate power systems ensure data continuity through periods of low solar charging.

Tower stations have a third power system for the denuder and filter pack samplers, which rely on the tower structure to position the sampler above the forest canopy and the station telemetry system for data transfer.

Timeline of Annual Activities

All year

- Data checks - ideally 2 times per week
- Monthly site visits - ideally concurrent with other monitoring activities
    - Confirm the sensors, equipment, and other infrastructures have not been disturbed by the wildlife and that the wildlife exclusion fencing is operational and in good repair
    - Clear sensors of any accumulated dirt or debris
    - Confirm the station is operating properly before and after completing any work
- Submit detailed notes from data checks and site visits
- Purchasing to replace used inventory or retired equipment and components

Summer Season

- Arrange to have tower structures inspected by a tower installation company - each instrumented tower should be inspected every year

July/August

- Send sensors for factory recalibration in preparation for annual maintenance
    - Confirm the number of sensors that require upcoming changeout
    - Prepare spare sensors for shipment, update sensor and equipment locations in the WBEA stock management system (AQMData2)
    - Contact the service center to obtain RMA and relevant paperwork
        - Equipment sent to Campbell Scientific in Edmonton:
            - PTB110/CS106
            - Dataloggers: CR1000, CR3000
        - Equipment sent to LI-COR in Lincoln, Nebraska:
            - Li-190
            - Li-200
- Confirm inventory of RMYoung 05103 flange bearings for annual changeout and order more from Campbell Scientific, if needed

September

- Annual sensor maintenance campaign – concurrent with denuder/passive sample changeout
    - Replace existing HMP155 sensors with recalibrated sensors every 12 months
    - Replace bearings in RMYoung 05103 sensor heads every 12 months
    - Replace Li-190 and Li-200 sensors with recalibrated units every 24 months
    - Update datalogger programs with sensor-specific multipliers