# Transformative Sensor Technologies and Smart Watersheds (TTSW)

## PROJECT SUMMARY

TTSW aims to develop, test, and deploy new technologies for monitoring water quality and quantity through collaboration with industry and government agencies. This includes field, drone, and airborne deployable sensors as well as physics and AI-based (machine learning/deep learning) algorithms for turning data from these sensors and those from recent/upcoming satellite missions into water-related products.

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## Innovative technologies for monitoring water quality and quantity at multiple scales

## Progress

- Development and deployment of **ground-based ultrasonic sensor** for measurements of water level and velocity, and snow depth.
- Development of **field deployable portable system with microwave sensor** capable of detecting lead in water.
- Development of **'Smart' sensor networks and** deployment of **transmitters** from observatories to satellites/across Canada.
- Development and deployment of **drone-based acoustic system (CHIONE)** for measurements of snow properties.
- Deployment of **drones with GNSS-R, hyperspectral, LiDAR and passive microwave systems** (ice/snow, soil moisture and water quality).
- Deployment of **CryoSAR airborne system (Ku and L-band)** for measurements of snow water equivalent (SWE) and near-surface soil moisture/freeze-thaw state.
- Design of **Microsatellite Water Mission concept** supported via deployment of airborne and current spaceborne hyperspectral and GNSS-R systems.
- Development of **physics and AI-based algorithms for the retrieval of water properties (liquid and solid phase)** from the abovementioned systems.
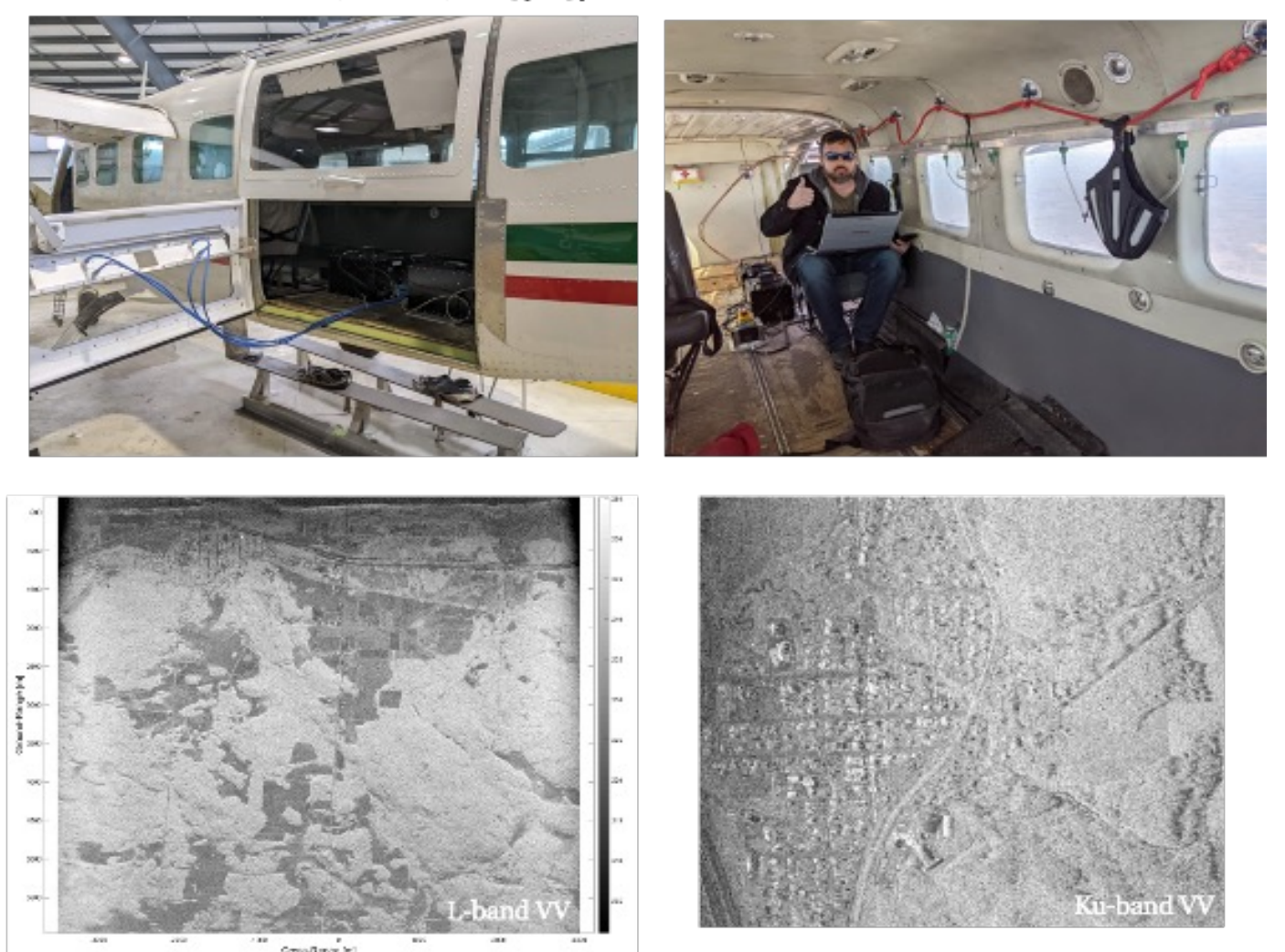
## Results (sample)

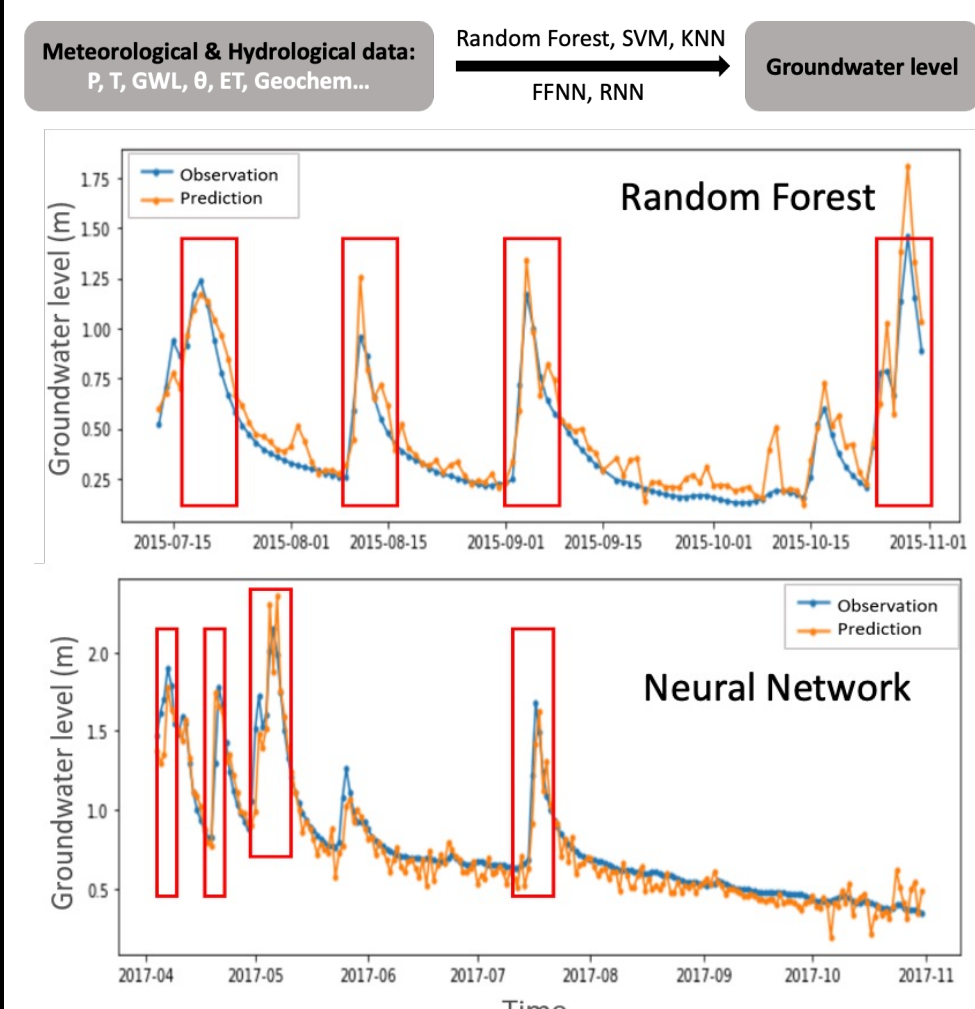### Microwave Sensor for Lead Detection in Water
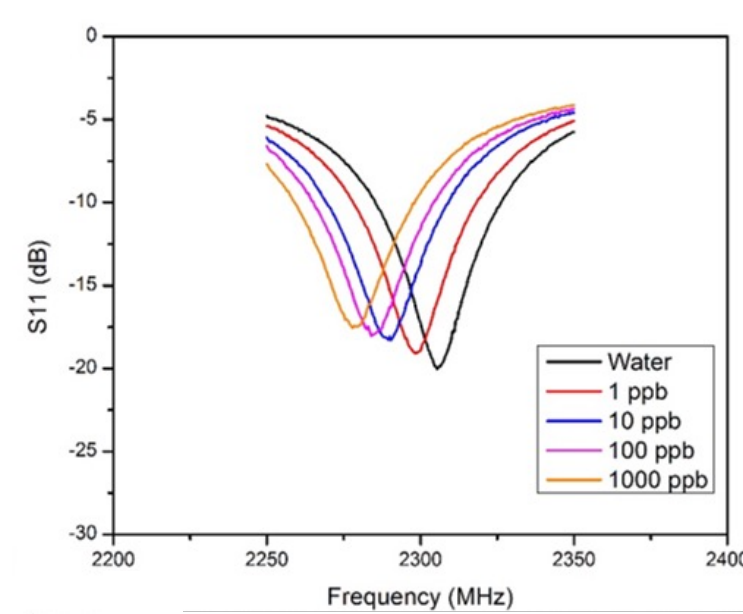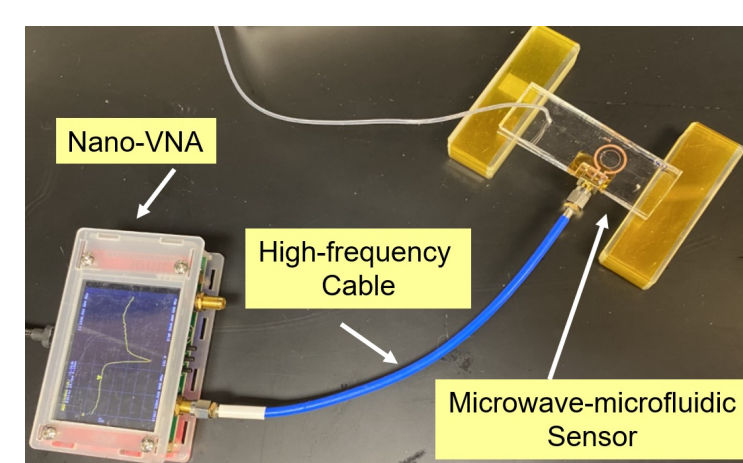


### CryoSAR Airborne System for Snow, Near-Surface Soil Moisture/Freeze-Thaw State
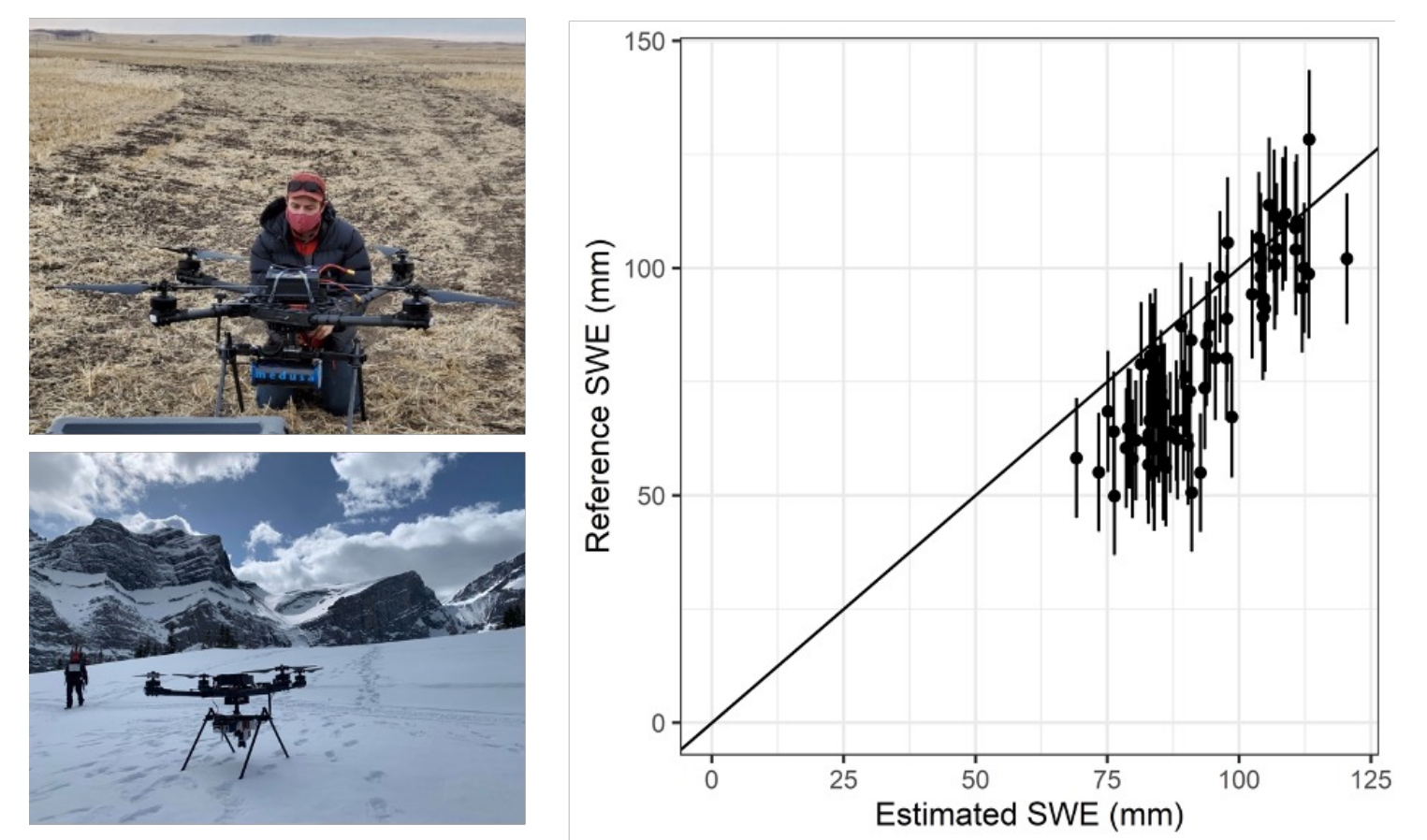
Powassan, ON, 14/4/2022 (uncalibrated data)



### Machine Learning Algorithms to Predict Groundwater Levels



### UAV-LiDAR/Gamma for Snow Depth/SWE Mapping



Gamma SWE vs lidar and snow survey

## User Engagement

TTSW is actively engaged with local communities, government agencies, industry and other GWF projects in the deployment and testing of new sensor technologies and the assessment of water-related products generated from algorithms developed by the research team.

Two examples: 1) Testing of L-band radiometer for deployment on UAVs developed by partner Skaha Remote Sensing; and 2) development of algorithms for the monitoring of lake ice, inundation and soil moisture from a GNSS constellation of nanosatellites (over 100) with global coverage, owned and operated by partner Spire.

## Outcomes and application uptake

- TTSW is informing both water quality and snow satellite mission concept studies for the Canadian Space Agency (WaterSat hyperspectral mission and Terrestrial Snow Mass Mission) led by project collaborators from Environment and Climate Change Canada (ECCC).
- AI-based (machine learning/deep learning) algorithms developed in the project and applied to multispectral and hyperspectral data from airborne and spaceborne sensors, in collaboration with ECCC, NRC, NASA and NOAA are being considered for the generation of cyanobacteria map products from future national and international satellite missions.
- Work on GNSS-R is informing industry (Spire) about the capabilities of this technology for the monitoring of lake ice, inundation and soil moisture.