The Canadian Arctic Weather Science (CAWS) Iqaluit and Whitehorse Meteorological Supersites

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The goal of the Canadian Arctic Weather Science (CAWS) project is to conduct research into the future operational monitoring and forecasting programs of Environment and Climate Change Canada (ECCC) in the Arctic. ECCC commissioned two supersites located in Iqaluit, NU (64^{o}N, 69^{o}W) and Whitehorse, YT (61^{o}N, 135^{o}W), which are major transportation hubs that frequently experience severe weather conditions. A suite of instruments have been installed at these sites, including Ka- and X-Band radar, water vapor lidars (both in-house and commercial versions), multiple Doppler lidars, ceilometers, and radiation flux and precipitation sensors to provide automated and continuous observations of altitude-resolved winds, clouds and aerosols, visibility, radiation fluxes, turbulence, and precipitation. The benefit of integrated measurement systems at the CAWS supersites are being investigated to: 1) recommend the optimal cost-effective observing system for the Canadian Arctic that can complement existing radiosonde observations, 2) support satellite calibration and validation studies, and 3) provide enhanced meteorological observations during the World Meteorological Organization's Year of Polar Prediction (YOPP). In addition to the ground-based observations at the CAWS sites, numerical weather prediction (NWP) models have been specially configured for the Arctic and post-processed blizzard and low visibility products have been developed using artificial intelligence techniques. NWP model output at high frequency (on the order of model time-step) is also being provided from several modeling centres to enable comparisons with the CAWS supersites as part of YOPP. The full suite of instruments installed at the Iqaluit site are provided in the attached table (a similar suite of instruments has been operating at Whitehorse since 2017).

Preliminary results from the data collected at the CAWS sites show observations of unique Arctic meteorological features, including stratified layers of wind and water vapour, particularly within the boundary layer. The results clearly indicate that observational requirements for the Arctic will differ from other regions of North America. Besides the capacity to continuously monitor vertical structures in the atmosphere, the numerical model verification analysis for surface temperature indicate that turbulent flux and radiation measurements are needed to improve the quality of the local weather forecast. Processed data products from both sites are made available in near-real time to forecasters (Arctic Forecast Centres in Winnipeg and Vancouver) and other clients (Yukon Wildland Fire Management, Universities, and the general public) via the webpage ecpass.ca. Raw, unprocessed data files (ASCII or netcdf) are also available upon request.

Table: List of instruments operating at the Iqaluit supersite.

Instrument	Manufacturer	Date of Deployment	Operation	Measurement(s)	Temporal/geographic resolution
Precipitation Imaging Package (PIP)	NASA/ Wallops	Sept. 2014	380 frame/s grey-scale camera with back-lighting	Particle imagery, DSD, precip. rate and density estimation	1 min / surface obs. only
4 Cameras	Campbell Scientific	Sept. 2015	High-resolution images of the site	Ka-Radar, Lidar, and Sky-view images	5 min / 1080p
Ka-Band Radar	METEK	Sept. 2015	Scanning pulsed dual-polarization Doppler Radar	Line-of-sight wind speed and direction, cloud & fog backscatter, depolarization ratio	10 min / 10 m res. up to ~25 km range
Ceilometer CL31	VAISALA	Sept. 2015	Pulsed (8 kHz) diode laser Lidar	Cloud intensity, cloud octa and height, aerosol profiles, MLH	5 min / 5 m vert res. up to 7.5 km a.g.l.
PWD 52 Visibility Sensor (x2)	VAISALA	Sept. 2015	Forward-scatter measurement	Visibility, precipitation type	1 min / surface obs. only
Doppler Lidar	HALO	Sept. 2015	Pulsed (10 kHz) scanning at 1.5 µm (Mie scattering)	Line-of-sight wind speed and direction, aerosol backscatter, depolarization ratio	5 min / 3 m res. up to ~3 km range
Rosemount icing detector	Rosemount Engineering	Sept. 2015	Magnetostrictive oscillation probe with a sensing cylinder	Detects ice, frost	NA
Surface met obs.	Misc.	Ongoing	Misc.	Surface T, RH, pressure, winds, precipitation	1 min / surface obs. only
Radiosondes	VAISALA	Ongoing	Balloon-launched sonde	Profiles of T, RH, pressure, winds	12 hours / ~15 m res. up to ~30 km a.g.l.
4k Pantilt Camera	Axis	Oct. 2016	High-resolution images of the site	Automated pivoting camera provides images in all directions	5 min / 4k
Canadian Autonomous Arctic Aerosol Lidar (CAAAL)	ECCC	Oct. 2016	355/532/1064 nm transmitter & 6 ch. receiver	Aerosol and water vapour profiles; particle size and shape information	1 min / 3 m res. up to ~15 km a.g.l.
Doppler Lidar x2: Ridge (T121)	HALO	Oct. 2017	Pulsed (10 kHz) scanning at 1.5 µm (Mie scattering)	Line-of-sight wind speed and direction, aerosol backscatter, depolarization ratio	5 min / 3 m res. up to ~3 km range
Fog Measuring Device (FMD)	DMT	Sept 2018	Fog sensor	Fog intensity, water vapour at surface	1 min / NA
Far-IR Radiometer (FIRR)	LR Tech.	Sept 2018	Zenith/Nadir-viewing infrared radiometer	Downwelling IR radiation, cloud microphysics	2 min / NA
Surface radiation fluxes	Campbell Scientific	Sept 2018	Surface radiation sensors (diffuse and direct)	Short- and long-wave up, down, and horizontal radiation	1 min / NA
Water Vapour Lidar	VAISALA	Sept 2018	Pulsed DIAL lidar system	Profiles of aerosols, 24-hr water vapour profile	20 minutes / 5 m up to ~3 km agl (WV)