The Winter Precipitation Type Research Multi-scale Experiment (WINTRE-MIX) NRC W and X band (NAWX) airborne radar data

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Data level: 1
NAWX L1 netcdf file is generated for every binary radar data file. When an antenna is not active, data are replaced with filling values.

General notes

- These are the datasets acquired in Feb-Mar 2022 with two radar systems (W-band (NAW) 94.05 GHz, and X-band (NAX) 9.41 GHz during the WINTRE-MIX project
- The NAWX radar antenna subsystem (three W-band and three X-band antennas and a two-axis motorized reflector plate for one of the W-band antennas) is housed inside an un-pressurized blister radome on the right side of the aircraft fuselage (Fig. 1).
- In normal operational mode, NAWX data are available at nadir, zenith and side antennas. For WINTRE-MIX, the NAW aft antenna beam was often at a down-forward (30°) position for the dual-Doppler application. In those files, there will be no zenith data for NAW. Also, when the aircraft is flying at low altitude, nadir antennas (for both W- and X-band) are terminated to avoid damaging RF components.
- During WINTRE-MIX project, NAWX radars have a dedicated multiple Inertial Measurement Units (IMU) system installed at the radar rack.

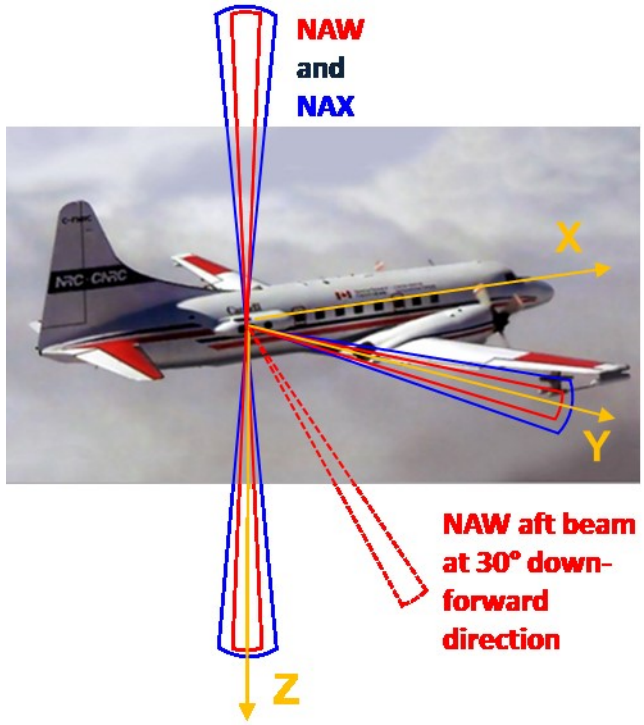

Figure 1: Location and direction of NAWX antenna beams and the aircraft reference system.

Data files

Format: The NAWX processed data are provided in a netCDF format. Detailed information about radar parameters are provided in the netCDF variables attributes.

Variables: The NAWX L1 data include radar equivalent reflectivity factor and Doppler velocity corrected for aircraft motion for each antenna. In addition, antenna beam pointing vector information are provided. The complementary measurements of aircraft state parameters that were recorded in real time by the NAWX data acquisition systems are included for reference only.

Processing: The reflectivity data are processed with noise subtraction. For NAW, different noise masks are available. For NAX, data are processed with noise subtraction and ground clutter filtering, also with a 2 dB above noise level mask applied. In addition to noise masks, there are masks for surface clutter, sub-surface, leak, etc. but those are for reference only. Accurate detection of surface gates is a challenging task because the surface return powers greatly depend on antenna beam incidence angles and surface types/condition which is unknown for most of the cases.

NRC preformed dedicated radar calibration maneuvers for both reflectivity as well as antenna beam pointing. In addition, cross-calibration (between antennas and W vs. X) was done to make sure that the data are consistent. The reflectivity values included in this release have accuracies of 1-1.5 dBZ for the W-band and 1-2 dBZ for the X-band and Doppler estimates have bias less than 0.5 ms^{-1} for the W-band and 1 ms^{-1} for the X-band. Basic information about the NAWX radar is given in Wolde and Pazmany (2005). A detailed descriptions of the NAWX data processing can be found in Nguyen et al. (2019).

Aircraft motion contribution at each antenna is estimated and subtracted from the measured Doppler velocity. For the NAW aft antenna at 30° down-forward position, Doppler after aircraft motion correction are folded into the Nyquist range.

Quicklooks: For each flight there could be multiple files, which correspond to the raw radar files as recorded by the NAWX Data Acquisition Systems. A new radar files are generated every time the radar configuration files changes during the flight, or when the size of the radar data reaches a certain size threshold. In order to aid the data users, quicklook files of vertical cross section and side reflectivity and Doppler velocity are provided in PNG format. When the NAW aft antenna was at down-forward position, the vertical cross section data include only the nadir antenna. In these quicklook files, the aircraft altitude is shown as a solid line (Fig. 2 and 3).

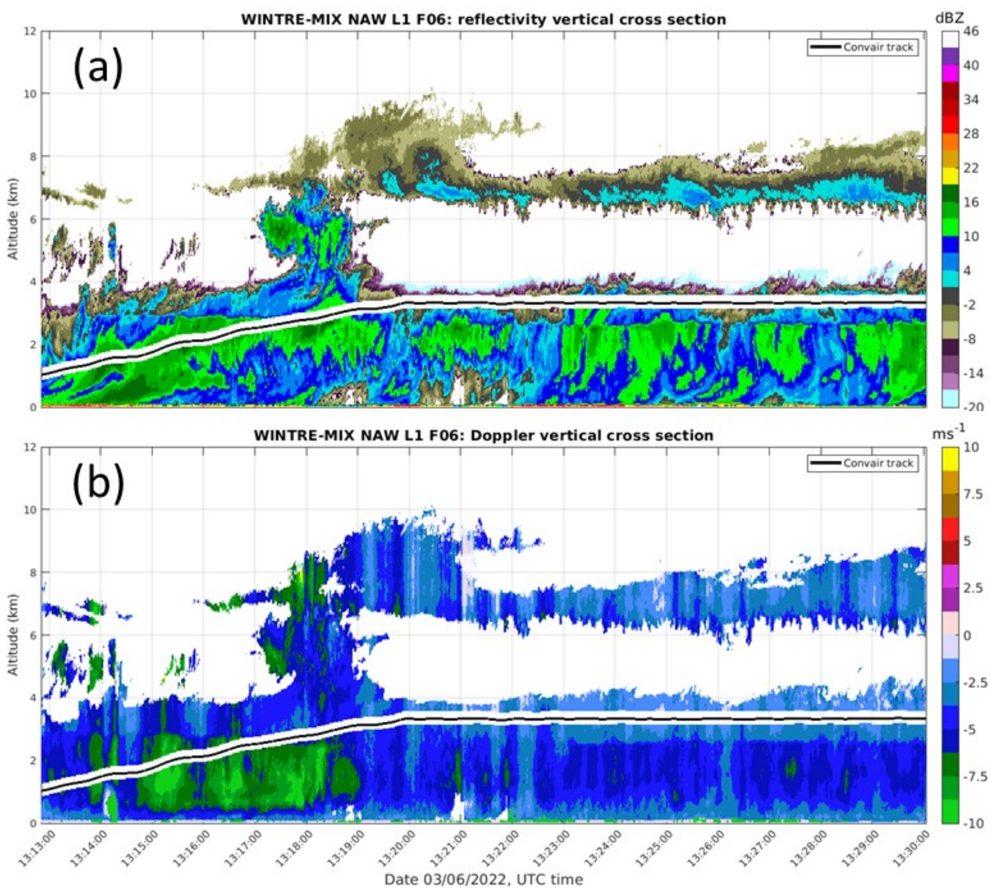

Figure 2: Example of NAW reflectivity (a) and velocity (b) quicklook for a segment of WINTRE-MIX flight 06 on 06 Mar, 2022.

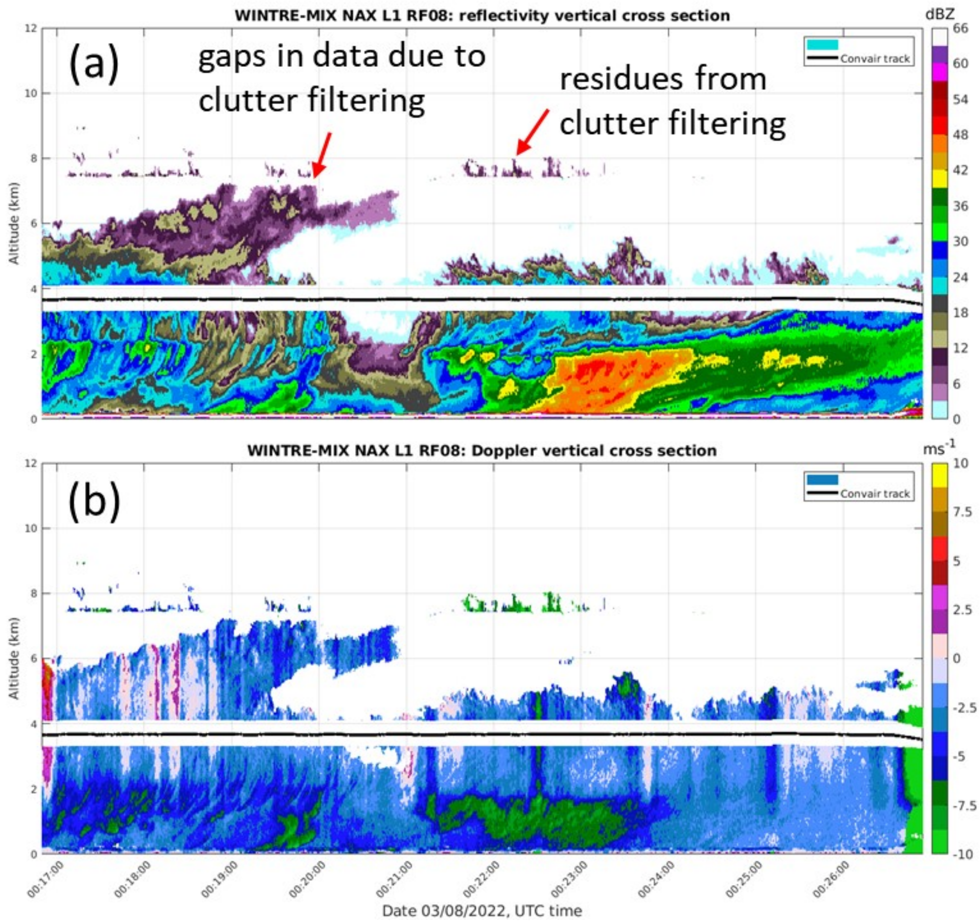

Figure 3: Same as in Fig. 2 but for NAX.

Data Quality: The NAW radar has excellent receiver isolation and good performance antennas providing high quality data. The NAX radar in contrast has lower circulators' isolation factor and poor sidelobe performance due to the limited antenna size. This results interference signals between the channels. In detail, a portion of the returned signal power from an antenna will leak into the other antenna's receiver (within a pair of nadir/zenith or side H/V) via the corresponding circulator and splitter. At zenith looking antenna, the leakage is most obvious at a range corresponding to the ground range of the nadir antenna or a range of strong precipitation target (melting layer, heavy rains …). For the side looking antenna, there's a strong sidelobes at ~90° and when they intercept targets with strong returns below the aircraft such as the earth surface or a storm melting layer, significant returns from the sidelobes will contaminate signals coming via the antenna's main lobe. In this release, those contaminating signals at the antennas are detected and masked out. If the interferences are strong, the filtering processing results in gaps in the data (Fig. 3).

References

Nguyen, C., Wolde, M., and Pazmany, A.: The NRC W- and Xband Airborne Radar Systems: Calibration and Signal Processing, 39th Conf. on Radar Meteorology, Iraka, Nara, Japan, 16–20 September 2019, Amer. Meteor. Soc., C000368, 2019.

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