In-Cloud Icing and Large-Drop Experiment (ICICLE) 2019
AECL lidar data

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Data ver.: 1.0 (May 12, 2020)

Data level: 0 ("a reasonably complete data set of unspecified quality that consists of research products subjected to minimum processing in the field and/or in the laboratory by project staff")

Contents

General notes

- These are the datasets acquired between January and March 2019 with two AECL (Airborne Elastic Cloud Lidar) instruments during the ICICLE project based out of Rockford, Illinois (USA).
- The AECL primary output are the range-resolved 2D profiles of laser return at 355 nm as the laser pulses get backscattered by atmospheric constituents, including air molecules, aerosol particles and cloud droplets.
- The provided L0 data is range (R^2) and background corrected resulting in relative (uncalibrated) backscatter return and depolarization ratio values. No additional corrections or calibrations have been applied.
- The present datasets include data merged from two separate (albeit very similar) lidar systems that cover the zenith and nadir viewing geometries. Some inconsistencies between below and above aircraft data are therefore to be expected.
- The AECL processing follows the approach discussed in Baibakov et al, 2018 and Baibakov et al, 2019.

Instrument description and location

Airborne Elastic Cloud Lidar (Figure 1, top) built by Alpenglow, Inc. is a compact single wavelength airborne elastic lidar operating at 355nm used for the retrieval of vertical profiles of atmospheric properties, such as scattering and extinction properties of clouds and aerosols. The approximate locations of the two lidars are shown in Figure 1 (bottom).

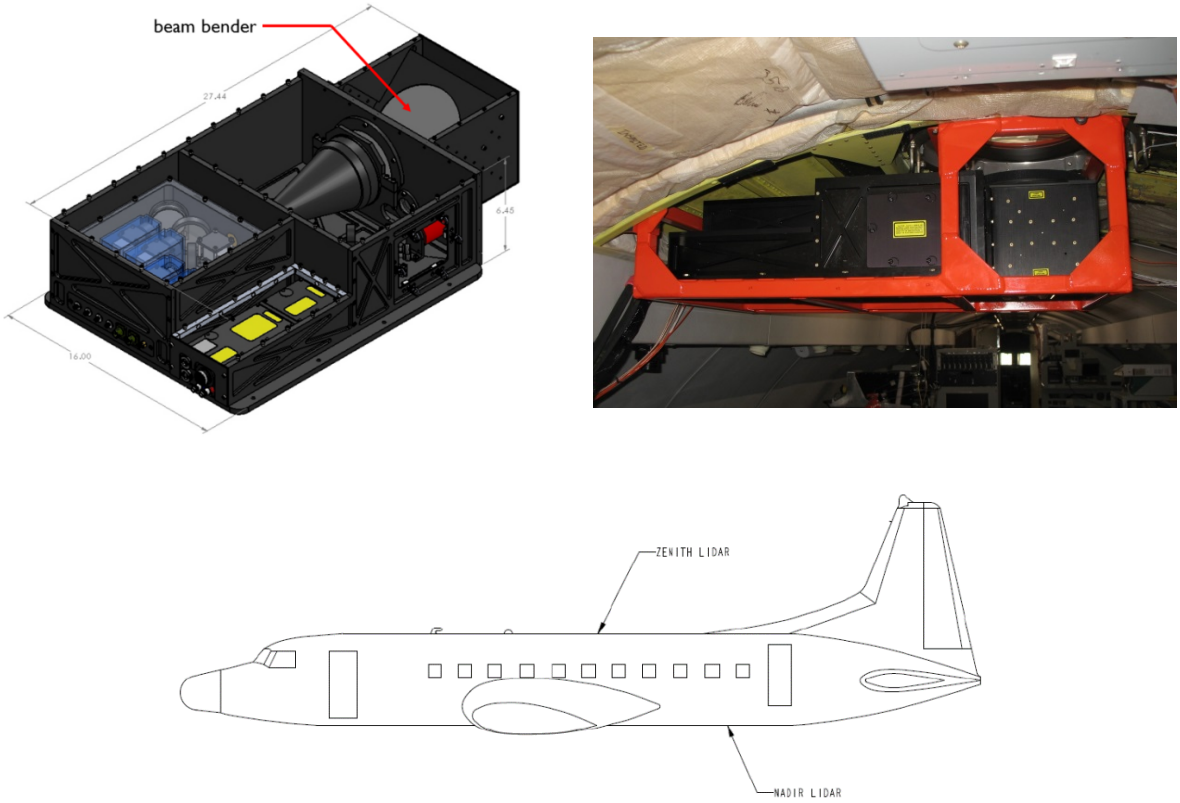

Figure 1. Top left: AECL CAD model with dimensions specified in inches. Top right: AECL when installed in zenith configuration on board the Convair-580 aircraft. Bottom: Approximate locations of the AECL zenith and nadir systems on board the Convair-580 aircraft.

AECL data acquisition statistics during ICICLE

Table 1 shows AECL data acquisition statistics during the ICICLE project.

Table 1. AECL data acquisition statistics during ICICLE. Coverage refers to the fraction of the flight (from takeoff to landing) during which the lidar data is available.

		Zenith				Nadir			
Flight	Date	From	To	Duration (h)	Coverage	From	To	Duration (h)	Coverage
1	18-Jan-19	19:21	20:45	1.4	47%	20:06	20:44	0.6	21%
2	27-Jan-19	17:53	21:24	3.5	99%	18:18	21:08	2.8	80%
3	28-Jan-19	20:13	23:11	3.0	74%	20:13	22:58	2.8	48%
4	29-Jan-19	17:40	21:51	4.2	91%	17:40	21:38	4.0	87%
5	31-Jan-19	16:34	20:09	3.6	88%	16:25	20:09	3.7	75%
6	4-Feb-19	12:31	16:28	4.0	97%	12:32	16:16	3.7	83%
7	5-Feb-19	17:37	22:10	4.6	97%	17:45	22:01	4.3	78%
8	6-Feb-19	18:47	22:59	4.2	96%	18:47	22:47	4.0	81%
9	7-Feb-19	18:04	22:03	4.0	100%	17:12	21:46	4.6	57%
10	8-Feb-19	14:23	16:40	2.3	80%	14:27	16:22	1.9	67%
11	11-Feb-19	15:07	18:57	3.8	99%	15:07	18:44	3.6	91%
12	12-Feb-19	11:13	15:11	4.0	87%	11:14	14:54	3.7	59%
13	12-Feb-19	16:56	19:50	2.9	98%	16:57	19:41	2.7	41%
14	14-Feb-19	16:20	20:37	4.3	98%	16:22	20:32	4.2	95%
15	15-Feb-19	19:24	0:00	4.6	98%	19:24	23:54	4.5	68%
16	16-Feb-19	1:14	5:32	4.3	84%	1:05	5:30	4.4	77%
17	17-Feb-19	12:06	16:07	4.0	98%	12:06	16:00	3.9	66%
18	17-Feb-19	16:57	20:11	3.2	88%	16:57	20:11	3.2	66%
19	22-Feb-19	16:27	20:54	4.5	87%	16:31	20:55	4.4	86%
20	23-Feb-19	12:04	16:17	4.2	94%	12:21	16:06	3.7	69%
21	24-Feb-19	11:59	16:59	5.0	100%	11:59	17:14	5.3	44%
22	24-Feb-19	17:08	20:11	3.0	61%	15:36	20:43	5.1	68%
23	26-Feb-19	17:26	20:52	3.4	98%	17:27	20:44	3.3	73%
24	26-Feb-19	22:33	2:45	4.2	90%	22:58	2:38	3.7	63%
25	28-Feb-19	17:51	21:58	4.1	73%	17:57	21:54	4.0	54%
26	2-Mar-19	10:28	14:51	4.4	99%	10:36	16:23	5.8	66%
27	2-Mar-19	16:02	18:40	2.6	59%	14:44	19:50	5.1	63%
28	5-Mar-19	11:55	16:25	4.5	98%	12:11	16:14	4.1	78%
29	7-Mar-19	16:10	21:07	4.9	102%	16:23	21:02	4.6	91%
30	8-Mar-19	16:06	18:04	2.0	65%	16:11	18:02	1.8	61%

Structure of data files

The data is provided in a netCDF format. The main AECL L0 products are the attenuated backscattered return (variable “CoPolHi”) and the depolarization ratio (“depol_ratio_Hi”), where “Hi” refers to the high gain channels. For a sample file structure see the accompanying “netcdf_structure.txt”.

Example of lidar measurements

Figure 2 shows an example of AECL measurements made between 19:38 and 20:00 during a pre-ICICLE flight on Nov. 22, 2018. As the aircraft descends into the cloud, the lidar data reveals a multi-layered structure with glaciated regions identified from high depolarization ratio (DR) values. The CPI particle imagery (not shown) indicates large crystal aggregates between 19:39 and 19:49. Also noticeable are distinct regions of low DR which we believe are aerosol layers (rather than liquid) because they are not detected by the NAWX radar and are not associated with a characteristic response in in-situ cloud probes. There is a marking transition immediately before 19:49 manifested by a significant increase in particle concentration (up to 13.5 cm^{-3}) and LWC (up to 0.17). Other sources of data indicate that at 19:49 the aircraft encountered mixed-phase conditions consisting of supercooled liquid drops and large ice aggregates. As the particle concentration increased, the lidar return was almost completely attenuated during the same time period.

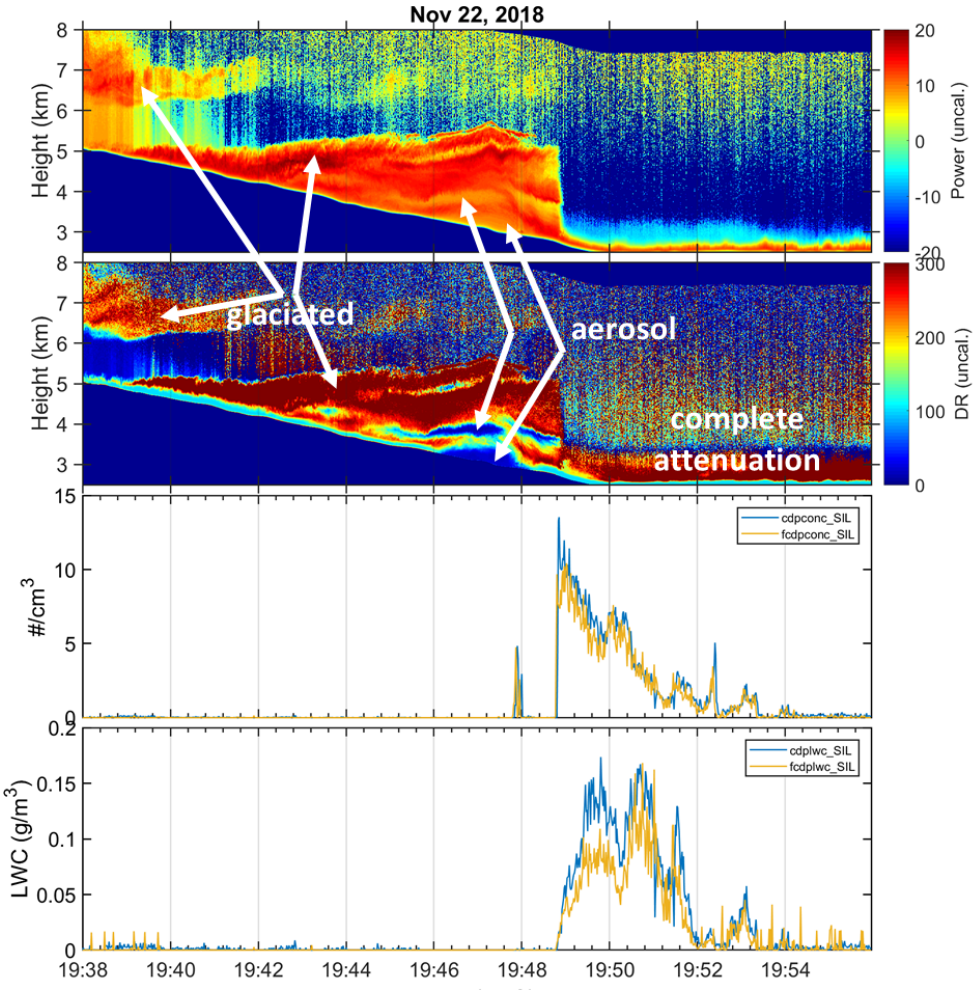

Figure 2. A flight fragment with AECL measurements on Nov. 22, 2018. From top to bottom: uncalibrated lidar (co-polarized) return, uncalibrated linear depolarization ratio, total particle concentration (#/cm^3) and liquid water content (g/m^3), derived from the CDP and FCDP in-situ probes.

Distribution and Publication

Preliminary data distribution and data use for publications follow the data policy agreed upon by the NRC, ECCC and FAA. We request that the NRC is notified for any data distribution to 3rd parties before the public release.

References

Baibakov, K., Wolde, M., Nguyen, C., Korolev, A., Heckman, I., (2018), Retrievals of ice-water content from an airborne elastic lidar in tropical convective clouds, ILRC 28 proceedings, June 25-30, 2017, Bucharest, Romania, EPJ Web Conf., Vol. 176 (2018) 05051.

Baibakov, K., Wolde, M., Nguyen, C. and Korolev, A., (2019), Airborne elastic cloud lidar for ice-water content retrievals during the HAIC-HIWC 2015 campaign, NRC technical report, 58 p., doi: 10.5281/zenodo.3585578