CLPX Snow Pit Measurements

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1 ABOUT CLPX SNOW PIT MEASUREMENTS

Snow pit data were collected during various Cold Land Processes Experiment (CLPX) investigations in northern Colorado and southern Wyoming, USA. Snow pit data are presented in their respective CLPX data sets, and this document describes the data format and spatial/temporal coverage of all the snow pit measurements. All CLPX snow pit data followed the same general sampling protocol. There are four groups of snow pit data: Intensive Observation Period (IOP) pit data, Local-Scale Observation Site (LSOS) pit data, meteorological station pit data, and Ground-based Passive Microwave Radiometer (GBMR) pit data.

The NASA Cold Land Processes Experiment (CLPX) was a multi-sensor, multi-scale experiment that focuses on extending a local-scale understanding of water fluxes, storage, and transformations to regional and global scales. Within a framework of nested study areas in the central Rocky Mountains of the western United States, ranging from 1-ha to 160,000 km^2, intensive ground, airborne, and spaceborne observations were collected. Data collection focused on two seasons: mid-winter, when conditions are generally frozen and dry, and early spring, a transitional period when both frozen and thawed, dry and wet conditions are widespread.

2 DETAILED DATA DESCRIPTION

2.1 Format

All CLPX snow pit data followed the general sampling protocol. There are four groups of snow pit data: Intensive Observation Period (IOP) pit data, Local-Scale Observation Site (LSOS) pit data, meteorological station pit data, and Ground-based Passive Microwave Radiometer (GBMR) pit data:

1. IOP pit data: These data represent the bulk of the pits sampled during the experiment. They were measured with the strictest levels of quality control, including QC performed in the field, usually within a day of the measurement. They include the so-called "gamma pits" taken along roadsides in the North Park MSA, to coincide with simultaneous airborne gamma overflights.
2. LSOS pit data: These pits were sampled at the LSOS, during each of the IOPs.
3. Met Station pit data: These snow pits were sampled very close to each of the nine Main ISA Meteorological Towers, and the tower at the Fraser Experimental Forest Headquarters (near the LSOS). Each of these pits were sampled once in the months of December 2002, and January, February, March, May, and June 2003.
4. GBMR pit data: Snow pits were sampled near the GBMR-7 instrument periodically (usually coincident with GBMR-7 experiments) during the course of the winter from November 2002 to March 2003.

Snow pit data are available in comma-separated ASCII text files, with a file extension of .csv, and in shapefile spatial data format, with various file extensions.

- For each group of pits (LSOS, Met, GBMR and each of the the four IOPs), there are four ASCII files, containing summary, density profile, temperature profile, and stratigraphic profile information.
- For each group of pits (LSOS, Met, GBMR and the combined IOPs), there are six shapefiles (with various extensions) for summary, density profile, temperature profile, and stratigraphic profile data. Shapefiles contain everything included in the text files, except for general pit comments, which were too verbose for import into shape format.

During all IOPs, extra pits were dug across the entire North Park MSA, to coincide with simultaneous airborne gamma measurements. These pits have non-standard pit IDs.

Missing data in the ASCII files are identified by "-999". In the shapefiles, missing dates are designated 9999-99-99, missing text fields are designated "NoData", and missing numeric fields are designated -999.

2.1.1 Snow Pit Summary Files

Snow pit summary files contain one record per pit, with the following fields:

```
Column 1: PIT NAME (MIsp##)
        M = 1-letter code for MSA:
            f = Fraser
            n = North Park
            r = Rabbit Ears
        I = 1-letter code for ISA:
            a = Alpine
            b = Buffalo Pass
            f = Fool Creek
            i = Illinois River
            m = Michigan River
            p = Potter Creek
            s = Spring Creek (if MSA Code = r) or
                St. Louis Creek (if MSA Code = f)
            w = Walton Creek
        sp## = snow pit ("sp") and 2-digit pit number (##)
Column 2: IOP - IOPx (x = 1-4)
Column 3: SECTOR - sector name (alpha, bravo, charlie, delta)
Column 4: DATE - yyyymmdd
Column 5: TIME - hhmm
Column 6: UTME - UTM Easting (m)
Column 7: UTMN - UTM Northing (m)
Column 8: SWET - surface wetness:
           d = Dry
           m = Moist
           w = Wet
           vw = Very Wet
Column 9: SRUF - surface roughness photo taken (Y or N)
Column 10: SL-A - soil sample A (Y or N; in later pits, depth of sample in cm)
Column 11: SL-B - soil sample B (Y or N; in later pits, depth of sample in cm)
Column 12: CNPY - canopy
           c = Coniferous
           cs = Snow-covered Coniferous
           f = Deciduous
           ds = Snow-covered Deciduous
           g = Grass (only in North Park)
           s = Sage (only in North Park)
           n = No Canopy
Column 13: CNHT - approximate canopy height (cm); only used in North Park (missing for IOP1)
Column 14: DEPTH - measured snow depth (cm)
Column 15: SWE - calculated snow water equivalent (mm)
Column 16: DNS_LYRS - number of density profile layers [set to 1 if SIPRE tube was used
        instead of density cutter]
Column 17: DNS_AVG - pit average density (kg/m^3)
Column 18: DNS_MAX - pit maximum density (kg/m^3)
Column 19: DNS_MIN - pit minimum density (kg/m^3)
Column 20: T_MEAN - pit average temperature (C)
Column 21: T_MAX - pit maximum temperature (C)
Column 22: T_MIN - pit minimum temperature (C)
Column 23: T_SFC - pit surface temperature (C)
Column 24: T_BASE - pit base temperature (C)
Column 25: STR_LYRS - number of stratigraphy layers
Column 26: SMGR_AVG - pit small grain average (average of [SmallShort*SmallLong]) (mm^2)
Column 27: SMGR_MAX - pit maximum small grain (mm^2)
Column 28: SMGR_MIN - pit minimum small grain (mm^2)
Column 29: MDGR_AVG - pit med grain average (average of [MedShort*MedLong]) (mm^2)
Column 30: MDGR_MAX - pit maximum medium grain (mm^2)
Column 31: MDGR_MIN - pit minimum medium grain (mm^2)
Column 32: LGGR_AVG - pit large grain average (average of [LgShort*LgLong]) (mm^2)
Column 33: LGGR_MAX - pit maximum large grain (mm^2)
Column 34: LGGR_MIN - pit minimum large grain (mm^2)
Column 35: MJ_SHAPE - majority grain shape (New, Round, Mixed, Faceted)
Column 36: SURVEYOR - surveyor names
Column 37: QC - list of QC codes for this pit (see the Quality Assessment section of this
        document, below)
```

Figure 1. Snow Pit Summary File Fields

2.1.2 Snow Pit IDs

```
IOP Pit IDs: MIsp##

            M = 1-letter code for MSA:
                f = Fraser
                n = North Park
                r = Rabbit Ears
            I = 1-letter code for ISA:
                a = Alpine
                b = Buffalo Pass
                f = Fool Creek
                i = Illinois River
                m = Michigan River
                p = Potter Creek
                s = Spring Creek (if MSA Code = r) or
                    St. Louis Creek (if MSA Code = f)
                w = Walton Creek
            sp## = snow pit ("sp") and 2-digit pit number (##)

"Gamma" Overflight Pit IDs: surveyor##
             surveyor = first surveyor's last name
             ## = 2-digit pit number, gamma pit numbers have no
                  significance, sometimes they indicate
                  sequence of data collection, but
                  sometimes 2 teams of surveyors
                  leap-frogged along the same road, with
                  1st team using odd numbers and second
                  team using even numbers

GBMR Pit IDs: gbmr##x
            gbmr = pit taken near GBMR instrument
            ## = 2-digit pit number, indicates same location throughout the winter
            x = letter {a,b,c, etc} indicating sequence of pit
                measurements throughout the winter

LSOS Pit IDs: LABEL##x
            LABEL = snow (iop1);  lsos (iop2-4)
            ## = 2-digit pit number
            x = letter {a,b,c, etc.}

Met Pit IDs: MImet##{x}
        M = MSA code (see standard IOP pit IDs for MSA codes)
        I = ISA code (see standard IOP pit IDs for ISA codes)
            met = indicates a met station pit
            ## = 2-digit pit number (numbers are sequential through the winter), thus:
                 01 = December, 2002
                 02 = January, 2003
                 03 = February, 2003
                 04 = March, 2003
                 05 = May, 2003
                 06 = June, 2003
            x = optional letter, {a or b}, only used in North Park in
                December 2002
```

Figure 2. Snow Pit IDs

2.1.3 Sample Snow Pit Summary Data File:

When a snow pit summary file is opened in a spreadsheet program, such as Excel, the file appears as:

PIT	IOP	SECTOR	DATE	TIME	UTME	UTMN	SWET	.....
fasp01	iop1	alpha	9999-99-99	-999	425983	4410879	-999	.....
fasp02	iop1	alpha	2/20/2002	1400	426038	4411259	d	.....
fasp03	iop1	bravo	2/20/2002	1150	426024	4411419	d	.....

Figure 3. Snow Pit Summary Data File

2.1.4 Snow Pit Density Profile Files

Snow pit density profile files contain one record per density layer measured, with the following fields:

```
Column 1: PIT_NAME - pit ID, (see PIT field in summary records, above)
Column 2: IOP - iopx (x = 1-4)
Column 3: DATE - yyyy-mm-dd
Column 4: TIME - hhmm
Column 5: UTME - UTM Easting (m)
Column 6: UTMN - UTM Northing (m)
Column 7: TYPE - instrument used [C(utter) or T(ube)]
Column 8: TOP - layer top height (cm)
Column 9: BOT - layer bottom height (cm)
Column 10: DNS_A - first density measurement (kg/m^3)
Column 11: DNS_B - second density measurement (kg/m^3)
Column 12: DNS_AVG - average of DENSITY-A and DENSITY-B
Column 13: QC - list of QC codes for this density layer
```

Figure 4. Snow Pit Density Profile Files

2.1.5 Sample Snow Pit Density Data File

When a snow pit density file is opened in a spreadsheet program, such as Excel, the file appears as:

PIT_NAME	IOP	DATE	TIME	UTME	UTMN	TYPE	TOP	BOT	DNS_A	DNS_B	DNS_AVG	QC
fasp02	iop1	2/20/2002	1400	426038	4411259	C	122	112	111	128	119.5	QC(000)
fasp02	iop1	2/20/2002	1400	426038	4411259	C	112	102	100	92	96	QC(000)
fasp02	iop1	2/20/2002	1400	426038	4411259	C	102	92	192	190	191	QC(000)

Figure 5. Snow Pit Density Data File

2.1.6 Snow Pit Temperature Profile Files

Snow pit temperature profile files contain one record per temperature layer measured, with the following fields:

```
Column 1: PIT_NAME - pit ID, (see PIT field in summary records, above)
Column 2: IOP - iopx (x = 1-4)
Column 3: DATE - yyyy-mm-dd
Column 4: TIME - hhmm
Column 5: UTME - UTM Easting (m)
Column 6: UTMN - UTM Northing (m)
Column 7: HEIGHT - height (cm)
Column 8: TEMP - temperature (C)
Column 9: QC - list of QC codes for this temperature layer
```

Figure 6. Snow Pit Temperature Profile Files

2.1.7 Snow Pit Temperature Data Files

When a snow pit temperature file is opened in a spreadsheet program, such as Excel, the file appears as:

PIT_NAME	IOP	DATE	TIME	UTME	UTMN	HEIGHT	TEMP	QC
fasp02	iop1	2/20/2002	1400	426038	4411259	121	-9	QC(000)
fasp02	iop1	2/20/2002	1400	426038	4411259	111	-9	QC(000)
fasp02	iop1	2/20/2002	1400	426038	4411259	101	-9	QC(000)

Figure 7. Snow Pit Temperature Data File

2.1.8 Snow Pit Stratigraphy Profile Files

Snow pit stratigraphic profile files contain one record per stratigraphic layer measured, with the following fields:

```
Column 1: PIT_NAME - pit ID, (see PIT field in summary records, above)
Column 2: IOP - iopx (x = 1-4)
Column 3: DATE - yyyy-mm-dd
Column 4: TIME - hhmm
Column 5: UTME - UTM Easting (m)
Column 6: UTMN - UTM Northing (m)
Column 7: TOP - layer top height (cm)
Column 8: BOT - layer bottom height (cm)
Column 9: SM_SHT - representative Small grain, Short dimension (mm)
Column 10: MD_SHT - representative Medium grain, Short dimension (mm)
Column 11: LG_SHT - representative Large grain, Short dimension (mm)
Column 12: SM_LNG - representative Small grain, Long dimension (mm)
Column 13: MD_LNG - representative Medium grain, Long dimension (mm)
Column 14: LG_LNG - representative Large grain, Long dimension (mm)
Column 15: GRN_TYPE - grain type (New, Round, Mixed, Faceted)
Column 16: QC  - list of QC codes for this stratigraphy layer
Column 17: COMMENT - surveyor's comments
```

Figure 8. Snow Pit Stratigraphic Profile Files

2.1.9 Snow Pit Stratigraphy Data File

When a snow pit stratigraphy file is opened in a spreadsheet program, such as Excel, the file appears as:

PIT_NAME	IOP	DATE	TIME	UTME	UTMN	TOP	BOT	SM_SHT	MD_SHT	LG_SHT	SM_LNG	MD_LNG	LG_LNG	GRN_TYPE	QC	COMMENT
fasp02	iop1	2/20/2002	1400	426038	4411259	122	110	0.2	0.2	0.2	0.5	0.5	0.8	n	QC(000)	new snow, wind
fasp02	iop1	2/20/2002	1400	426038	4411259	110	96	0.2	0.5	0.5	0.3	1	1	n	QC(000)	2/19/02 event
fasp02	iop1	2/20/2002	1400	426038	4411259	96	90	0.1	0.1	0.1	0.2	0.2	0.2	r	QC(000)	wind slab

Figure 9. Snow Pit Stratigraphic Data File

2.2 File and Directory Structure

Each group of pit files (IOP, LSOS, Met, and GBMR) is available in a compressed (tarred and zipped) file that will extract into two directories: "ascii/" contains the .csv version of the data, and "shape_files/" contains the GIS-compatible shapefiles.

2.3 File Naming Convention

The following codes are used in filenames (and for site names in the raw data):

```
MSA Code
      F = Fraser
      N = North Park
      R = Rabbit Ears

ISA Code
      A = Alpine
      B = Buffalo Pass
      F = Fool Creek
      I = Illinois River
      M = Michigan River
      P = Potter Creek
      S = Spring Creek (if MSA Code = R) or
            St. Louis Creek (if MSA Code = F)
      W = Walton Creek

ISA Sector
      A = Lower Left Quadrant - SW
      B = Upper Left Quadrant - NW
      C = Upper Right Quadrant - NE
      D = Lower Right Quadrant - SE
```

Figure 10. Site Names and Raw Data Naming

ASCII filenames are named pit_GROUP_v#_DATA.csv, where:

pit = indicates snow pit data
GROUP = pit group (iop1, iop2, iop3, iop4, lsos, met, or gbmr)
v# = Data release number (e.g., version 2) (note: see the Data Set Version History section of this document)
DATA = type of data in the file: "summary," "density," "temperature," or "strat"
.csv = comma-separated value text file

Shapefile names are pit_GROUP_v#_DATA.ext, where:

pit = indicates snow pit data
GROUP = pit group (iop, lsos, met, or gbmr) *note that all IOP pits are included in a single shapefile
v# = Data release number (e.g., version 2)
DATA = type of data in the file: "summary," "density," "temperature," or "strat"
.ext = shape file extensions {.dbf, .prj, .sbn, .sbx, .shp, .shx}

2.4 File Size

ASCII file sizes range from 20 to 300 KB. shapefile sizes range from 1 to 8 MB.

2.5 Spatial Coverage

Snow pits were sampled in Fraser, North Park, and Rabbit Ears MSAs in northern Colorado, USA.

See the About CLPX Snow Pit Data Technical Reference for more information.

- Schematic diagram of the nested study areas for the CPLX
- Study area map
- Location of MSAs
- Location and characteristics of ISAs

2.5.1 IOP Snow Pits

Table 1. IOP1 Snow Pits Measured

MSA	Planned number of pits	Actual number of pits
Fraser	48	47
North Park	48	48 plus 118 "gamma" pits
Rabbit Ears	48	48

Table 2. IOP2 Snow Pits Measured

MSA	Planned number of pits	Actual number of pits
Fraser	48	48
North Park	48	48 plus 160 "gamma" pits
Rabbit Ears	48	48

Table 3. IOP3 Snow Pits Measured

MSA	Planned number of pits	Actual number of pits
Fraser	48	48
North Park	48	48 plus 92 "gamma" pits
Rabbit Ears	48	18

Table 4. IOP4 Snow Pits Measured

MSA	Planned number of pits	Actual number of pits
Fraser	48	48
North Park	48	48 plus 43 "gamma" pits
Rabbit Ears	48	44

2.5.2 LSOS Snow Pits

LSOS snow pit locations changed between 2002 and 2003. Please refer to the two location diagrams in the CLPX LSOS snow pit documentation for pit locations. No UTM locations were recorded for the 2002 LSOS snow pits. Instead, a general location of 424492 E, 4417690 N was used for all IOP1 and IOP2 pits. For the 2003 snow pits, a GPS location was recorded for each individual pit, but because of GPS inaccuracy, the location of snow pits shown on the maps is more accurate than the GPS data.

2.5.3 Met Snow Pits

Met snow pits were sampled at or near each of the nine Main ISA Meteorological Towers, and at the tower at the Fraser Experimental Forest Headquarters (near the LSOS). Please refer to the ISA Main Meteorological Data document for pit locations. Met snow pit locations (UTME and UTMN coordinates) are not exact. Surveyors were not equipped with GPS receivers, so the recorded pit locations are locations of the corresponding met station towers.

2.5.4 GBMR Snow Pits

GBMR snow pit measurements were taken near the GBMR-7 instrument (please see the CLPX GBMR-7 documentation for more information about the GBMR spatial coverage).

2.6 Temporal Coverage

2.6.1 IOP Snow Pits

IOP Snow pits were measured during IOPs 1, 2, 3, and 4.

- IOP1 took place 19-24 February 2002.
- IOP2 took place 25-30 March 2002.
- IOP3 took place 20-25 February 2003.
- IOP4 took place 26-31 March 2003.

2.6.2 LSOS Snow Pits

LSOS pits were measured during the four IOPs. On each of the following days in 2002, three snow pits were sampled:

- 19 February – Pits 1, 3, and 5
- 20 February – Pits 2, 4, and 6
- 21 February – Pits 1, 3, and 5
- 22 February – Pits 2, 4, and 6
- 23 February – Pits 1, 3, and 5
- 24 February – Pits 2, 4, and 6
- 25 March – Pits 2, 4, and 6
- 26 March – Pits 1, 3, and 5
- 27 March – Pits 2, 4, and 6
- 28 March – Pits 1, 3, and 5.
- 29 March – Pits 2, 4, and 6
- 30 March – Pits 1, 3, and 5

On each of the following days in 2003, three LSOS snow pits were sampled:

- 19 February – Pits 2, 4, and 6
- 20 February – Pits 1, 3, and 5
- 21 February – Pits 2, 4, and 6
- 22 February – Pits 1, 3, and 5
- 23 February – Pits 2, 4, and 6,
- 24 February – Pits 1, 3, and 5
- March5 – Pits 2, 4, and 6
- 26 March – Pits 1, 3, and 5
- March7 – Pits 2, 4, and 6
- 28 March – Pits 1, 3, and 5.
- 29 March – Pits 2, 4, and 6
- 30 March – Pits 1, 3, and 5

2.6.3 Met Snow Pits

Met pits were measured once each month in December 2002, and January, February, March, May, and June 2003. Precise dates are indicated in the data files.

2.6.4 GBMR Snow Pits

GBMR pits were measured periodically from November 2002 to March 2003. Measurement dates are indicated in the data files.

Because of the general lack of snow in North Park, all pit data were collected on the first day of ground observations. The second day, teams collected data at sites across the entire MSA to coincide with the gamma overflights.

2.7 Parameter or Variable

Parameters include snow density, snow temperature, snow stratigraphic, snow grain size, and snow water equivalent. Snow wetness and surface roughness were also measured at the IOP snow pits.

For a complete description of parameters and measurements, please refer to the Measurements section of the CLPX Plan.

3 DATA SET VERSION HISTORY

The latest release of snow pit data is Version 2 (v2 in all filenames), current as of 1 June 2004. Previously released copies of files with filenames that do not include "_v2" are obsolete and should be replaced with the v2 copies.

Differences between Version 1 (v1) and Version 2 (v2) files are:

1. IOP1 Pits: some errors leading to erroneous 950 QC codes at North Park were eliminated
2. IOP2 Pits: erroneous 950 QC codes at North Park were corrected
3. IOP3 Pits: erroneous 950 QC codes at North Park were corrected, and during a new QC, a different dominant snow grain type was chosen when two snow grain types were equally present in one snow pit
4. LSOS Pits: IOP2 pits underwent a new QC, and a different dominant snow grain type was chosen when two snow grain types were equally present in one snow pit
5. GBMR Pits: typo in UTME location of pit 4b was corrected
6. All Pits: v2 density, temperature, and stratigraphic profiles contain fields for date, time, and UTM coordinates for every record (these fields were not included in v1 files); v2 files have QC fields in a separate column (in v1 files, the QC values were included at the beginning of the record comment field).

4 QUALITY ASSESSMENT

The IOP pit data were collected with the strictest levels of quality control, including QC performed in the field, usually within a day of the measurement (this included the so-called "gamma pits" taken along roadsides in North Park, to coincide with simultaneous airborne gamma overflights).

Snow pit data from other investigations (e.g., LSOS, GBMR) were submitted to NSIDC at a later date, and in some cases were not QC'd and edited until a year after data collection. Although every effort was made to ensure the same quality in measurements, some QC questions remain unanswered.

Sources of measurement error in the snow pit density data include debris/vegetative matter embedded in the snow pit wall, particularly at or near the bottom of the snow pit, and the practice of "carrying down" the last measured density to the bottom of the pit, when the density cutter could not be used for the lowest measurements. This usually affected the last 10 cm or so, but could affect more, and is indicated in the density profile records with QC code "001". Surveyors did their best to avoid debris in the density cutters, but this situation was not always avoidable, and, where possible, was noted in the surveyors' comments.

4.1.1 Detailed Explanations of Snow Pit QC Codes

Table 5. General Code Values

Code	QC Performed On
001-099	snow density measurements
100-199	snow mass measurements ("shallow" pits)
200-299	snow temperature measurements
300-399	snow stratigraphic measurements
400-899	unused

Code	QC Performed On
900-999	general pit information, i.e., header values

Table 6. Code and Description

Code	Description (what was reset/set/estimated: the reason why)
000	QC OK: all tests passed
001	Density value estimated: Surveyor did not measure densities to the ground.
002	Density value calculated from sipre mass: Surveyor used sipre tube instead of density cutter.
003	Reset recorded layer top heights: recorded layer overlapped with layer above.
004	Interpolated layer density: gap in recorded densities.
005	Surveyor entered trace, will be treated as measurement of 0.
105	Surveyor entered trace, will be treated as measurement of 0.
301	Reordered grain sizes from LargeMedSmall: Relative grain sizes appeared out of expected order.
302	Reordered grain sizes from LargeSmallMed: Relative grain sizes appeared out of expected order.
303	Reordered grain sizes from MedSmallLarge: Relative grain sizes appeared out of expected order.
304	Reordered grain sizes from MedLargeSmall: Relative grain sizes appeared out of expected order.
305	Reordered grain sizes from SmallLargeMed: Relative grain sizes appeared out of expected order.
310	3Reordered grain dimensions from LongShort: Relative dimensions appeared out of expected order.
311	Reordered grain dims/sizes from LongShort and LargeMedSmall: Relative grains appeared out of expected order.
312	Reordered grain dims/sizes from LongShort and LargeSmallMed: Relative grains appeared out of expected order.
313	Reordered grain dims/sizes from LongShort and MedSmallLarge: Relative grains appeared out of expected order.
314	Reordered grain dims/sizes from LongShort and MedLargeSmall: Relative grains appeared out of expected order.
315	Reordered grain dims/sizes from LongShort and SmallLargeMed: Relative grains appeared out of expected order.
320	Grain dims/sizes are ambiguous.
901	Snow pit depth estimated from first density measurement: Surveyor did not enter pit depth.
902	Snow pit depth estimated from mass measurement depths: Surveyor did not enter pit depth.

Code	Description (what was reset/set/estimated: the reason why)
903	Snow pit depth estimated from first stratigraphic depth: Surveyor did not enter pit depth.
904	Snow pit depth set to 0: Surveyor did not enter pit depth, no snow measurement taken, but soil samples taken.
905	Warning: Snow pit depth does not match top of density profile.
906	Warning: Snow pit depth does not match top of temperature profile.
907	Warning: Snow pit depth does not match top of stratigraphic profile.
914	Canopy reset to missing value: Snow depth is 0.
915	Surface roughness reset to n: Snow depth is 0.
916	Surface wetness reset to missing value: Snow depth is 0.
917	Canopy height reset to missing value: Snow depth is 0.
950	Warning: Shallow pit form used, but pit depth > 15 cm.
951	Warning: Deep pit form used, but pit depth < 15 cm.
990	Warning: One or both UTM coordinates are missing.
991	Warning: Missing date and/or time field.
999	No data collected for this pit.

4.2 Additional Details:

000 QC OK: all tests passed; No problems were detected; values have not been changed from the original forms.

4.3 Density QC codes

001 Density value estimated: Surveyor did not measure densities to the ground. The density cutter was 10 cm high, so the final density profile was generally not measured all the way to the ground, especially in cases where vegetation was present. This density measurement was estimated by carrying the last actual measurement to the ground.

002 Density value calculated from sipre tube mass: Surveyor used sipre tube instead of density cutter. In some cases, the surveyor used the density profile sheet (normally used for density cutter measurements) to record SIPRE tube (mass) measurements. The original measurement is assumed to be a mass and was used to calculate this density.

003 Reset recorded layer top heights: recorded layer overlapped with layer above. The recorded density layer overlapped with the layer above it. In order to assure non-overlapping measurements

for pit average density and SWE, the top height of this layer was reset to the bottom height of the layer above it.

004 Interpolated layer density: gap in recorded densities. There was a gap in the recorded density layers. In order to assure a continuous set of density measurements for pit average density and SWE, this layer was inserted, with a density interpolated from the densities of the immediately surrounding layers.

005 Surveyor entered trace, treated as measurement of 0. During IOP3 and IOP4, snow on the ground that was not measurable was recorded as a trace, and trace values were included in calculated values as zeroes.

4.4 Mass QC codes

105 Surveyor entered trace, treated as measurement of 0. During IOP3 and IOP4, snow in the ground that was not measurable was recorded as a trace, and trace values were included in calculated values as zeroes.

4.5 Stratigraphy QC codes

301 Reordered grain sizes from LargeMedSmall: Relative grain sizes appeared out of expected order. The expected order of grain dimensions was short dimension Small, Medium, Large followed by long dimension Small, Medium, Large. However, when the QC software compared the areas (i.e. ShortSmall times LongSmall, etc.) the original values in this stratigraphic layer appeared to be reversed (Large, Medium, Small) and have been reordered.

302 Reordered grain sizes from LargeSmallMed: Relative grain sizes appeared out of expected order. The expected order of grain dimensions was short dimension Small, Medium, Large followed by long dimension Small, Medium, Large. However, when the QC software compared the areas (i.e. ShortSmall times LongSmall, etc.) the original values in this stratigraphic layer appeared to be out of order (Large, Small, Medium) and have been reordered.

303 Reordered grain sizes from MedSmallLarge: Relative grain sizes appeared out of expected order. The expected order of grain dimensions was short dimension Small, Medium, Large followed by long dimension Small, Medium, Large. However, when the QC software compared the areas (i.e. ShortSmall times LongSmall, etc.) the original values in this stratigraphic layer appeared to be out of order (Medium, Small, Large) and have been reordered.

304 Reordered grain sizes from MedLargeSmall: Relative grain sizes appeared out of expected order. The expected order of grain dimensions was short dimension Small, Medium, Large followed

by long dimension Small, Medium, Large. However, when the QC software compared the areas (i.e. ShortSmall times LongSmall, etc.) the original values in this stratigraphic layer appeared to be out of order (Medium, Large, Small) and have been reordered.

305 Reordered grain sizes from SmallLargeMed: Relative grain sizes appeared out of expected order. The expected order of grain dimensions was short dimension Small, Medium, Large followed by long dimension Small, Medium, Large. However, when the QC software compared the areas (i.e. ShortSmall times LongSmall, etc.) the original values in this stratigraphic layer appeared to be out of order (Small, Large, Medium) and have been reordered.

310 Reordered grain dimensions from LongShort: Relative dimensions appeared out of expected order. The expected order of grain dimensions was 3 short dimensions followed by 3 long dimensions, however, original values in this stratigraphic layer appeared swapped, and have been reordered.

311 Reordered grain dims/sizes from LongShort and LargeMedSmall: Relative grains appeared out of expected order. A combination of 301 and 310.

312 Reordered grain dims/sizes from LongShort and LargeSmallMed: Relative grains appeared out of expected order. A combination of 302 and 310.

313 Reordered grain dims/sizes from LongShort and MedSmallLarge: Relative grains appeared out of expected order. A combination of 303 and 310.

314 Reordered grain dims/sizes from LongShort and MedLargeSmall: Relative grains appeared out of expected order. A combination of 304 and 310.

315 Reordered grain dims/sizes from LongShort and SmallLargeMed: Relative grains appeared out of expected order. A combination of 305 and 310.

320 Grain dims/sizes are ambiguous. The combination of dimensions and grain sizes was ambiguous. These grain sizes were left in the order that they were recorded, but should probably be treated with care before assuming dimension and or size order.

4.6 Pit Summary (general mismatches across various fields) QC codes

901 Snow pit depth estimated from first density measurement: Surveyor did not enter pit depth. The pit depth field on the original data sheet was left blank. It was estimated using the top height of the uppermost density measurement.

902 Snow pit depth estimated from mass measurement depths: Surveyor did not enter pit depth. The pit depth field on the original data sheet was left blank, and there was no density or stratigraphic profile information. The pit depth was estimated using the maximum height of the mass measurements taken.

903 Snow pit depth estimated from first stratigraphic depth: Surveyor did not enter pit depth. The pit depth field on the original data sheet was left blank, and there was no density profile information. The pit depth was estimated using the top height of the uppermost stratigraphic measurement.

904 Snow pit depth set to 0: Surveyor did not enter pit depth, no snow measurement taken, but soil samples taken. The pit depth field on the original data sheet was left blank, and there was no density, temperature or stratigraphic profile information, but soil samples were taken. The location is assumed to have no snow, and depth was set to 0.

905 Warning: Snow pit depth does not match top of density profile. The pit depth value on the original data sheet is different from the top height of the density profile.

906 Warning: Snow pit depth does not match top of temperature profile. The pit depth value on the original data sheet is different from the top height of the temperature profile.

907 Warning: Snow pit depth does not match top of stratigraphic profile. The pit depth value on the original data sheet is different from the top height of the stratigraphic profile.

914 Canopy reset to missing value: Snow depth is 0. Measurement protocol was to record canopy only when snow depth was greater than 0. In this case a recorded canopy was reset to missing because the snow depth was 0.

915 Surface roughness reset to n: Snow depth is 0. Measurement protocol was to take a surface roughness photo only when snow depth was greater than 0. In this case a photo was taken, but this field was reset to "n" (no) because the snow depth was 0. The roughness photograph at this pit was not deleted, however.

916 Surface wetness reset to missing value: Snow depth is 0. Measurement protocol was to record surface wetness only when snow depth was greater than 0. In this case a recorded surface wetness was reset to missing because the snow depth was 0.

917 Canopy height reset to missing value: Snow depth is 0. Canopy height field was introduced (in North Park only) during IOP2. Measurement protocol was to record canopy height only when snow depth was greater than 0. In this case a recorded canopy height was reset to missing because the snow depth was 0.

950 Warning: Shallow pit form used, but pit depth > 15 cm. Measurement protocol was to use the "shallow" pit form when the snow depth was less than 15 cm.

951 Warning: Deep pit form used, but pit depth < 15 cm. Measurement protocol was to use the "deep" pit form when the snow depth was more than 15 cm.

990 Warning: One or both UTM coordinates are missing. Pit coordinates are incomplete or missing.

991 Warning: Missing date and/or time field. Date and/or time field are missing.

999 No data collected for this pit. Data were not collected at this pit location, due to safety hazard, weather conditions, or lack of time.

4.7 Data Acquisition and Processing

For complete information about the snow pit data sampling protocol, please see the Cold Land Processes Field Experiment Plan Sampling Protocols.

5 DOCUMENT INFORMATION

5.1 List of Acronyms

- CLPX = NASA Cold Land Processes Experiment
- GBMR = Ground-based Passive Microwave Radiometer
- IOP = Intensive Observation Period
- ISA = Intensive Study Area
- LRSA = Large Regional Study Area
- LSOS = Local Scale Observation Site
- MSA = Meso-cell Study Area
- UTME = Universal Transverse Mercator Coordinates in the Easting Direction
- UTMN = Universal Transverse Mercator Coordinates in the Northing Direction

5.2 Publication Date

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5.3 Date Last Updated

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