METADATA
Senator Beck Study Plot

Senator Beck Study Plot (SBSP) data: http://snowstudies.org/data1.html
Senator Beck Basin Study Area (SBBSA), Red Mountain Pass, San Juan Mountains
Center for Snow and Avalanche Studies (CSAS)

I. Senator Beck Study Plot (SBSP)

1) Type of Site
   a) Study Plot: this study site is located on a generally level bench above treeline, in alpine tundra typical of the western San Juan Mountains, and is strongly influenced by wind. The site is situated away from steep slopes, near the centroid of Senator Beck Basin, and experiences no mid-day shading from adjacent terrain. Snow cover is conserved, undisturbed, within a 12m x 36m plot located northwest of and adjacent to the instrumentation. This snow pit plot, with its comparatively uniform depth snowcover, is used for a time series of snowpack profiles throughout the snow season and by researchers requiring undisturbed snowcover for their projects. See our archived data for SASP snow profiles, by season.

2) Site Datum
   a) Location: August 2008 GPS: Lat 37° 54' 24.77918", Lon -107° 43' 34.55556"
      i) Originally estimated as Lat 37° 54' 25" N, Lon 107° 43' 30" W; per USGS Ironton, Colorado quadrangle 1955, NAD 1927
   b) Elevation: August 2008 GPS: 12,185.57 feet (3719 meters)
      i) Originally estimated as 12,200 feet (3368 meters) per USGS Ironton, Colorado quadrangle 1955, NAD 1927
   c) Aspect & Slope: study plot generally slopes 3 degrees NNE
   d) Soils: generally very shallow or absent altogether (exposing bare bedrock), with small pockets of deeper soils in terrain depressions where an 'O' horizon has formed under denser grasses
   e) Vegetation: alpine tundra plant community; no shrubs, no krummholz within study plot
   f) Ownership: SBSP is located on public lands and authorized by the Uncompahgre National Forest under a Special Use Permit issued to the CSAS
   g) Changes to site: no changes to ground surface
   h) Photographs: see CSAS website at http://snowstudies.org/sbsp1.html

3) System Operation
   a) SBSP began operating in Winter 2003/2004, at 1200 hrs on October 29, 2003 (Julian Day 302)
   b) SBSP performs continuous collection of 'Winter' and 'Summer' datasets spanning the 'Water Year' (October 1 through September 30)
      i) 'Winter' datasets begin October 1 (start of 'Water Year') through midnight of the last day of Spring (through the day before summer solstice)
      ii) 'Summer' datasets extend from Summer Solstice through September 30 (through the day before start of new 'Water Year')

c) Data Arrays
   i) 1 hour data arrays: *Flag* field = 201
   ii) 3 hour data arrays: *Flag* field = 203
   iii) Solar Noon arrays: *Flag* field = 212 (2 minute arrays through solar noon period)
   iv) 24 hour data arrays: *Flag* field = 224

d) All data are collected on Mountain Standard Time, by day-of-year (DOY)
   i) Datalogger clocks are *not* switched from/to Mountain Daylight Time
   ii) 24 hour summary datasets (*Flag* = 224) are calendar day, ending at midnight.

4) System Operation Notes (see also Sensor History notes for individual sensors):

a) Notable changes in operations (additions of sensors, recalibrations, etc.), or sensor or system malfunctions with extended periods of missing data, are listed below. Other, brief periods of missing data exist.

Year	Date(s)	Day of Year	Note
2017	Feb. 9	40	The SR50 snow depth sensor functioned sporadically November thru Jan. During this time, there were hourly values reported that seemed reasonable and accurate, daily snow depth estimates could likely be estimated from these data. On February 9, 2017 it was replaced and has operated fine since.
2016	Aug 4 – Sept 9	217-253	All pyranometers and pyrgeometer removed for recalibration. Down looking unfiltered pyranometer and down looking unfiltered pyranometer removed Aug 4. All others removed Aug 5. Restored to service on Sept 19, 2016 (DOY 253).
2014-2015	Dec 21 - Jan 5	355-5	Low Wind monitor damaged between 1400-1500 hrs Dec 21, 2014 (DOY 355) during Storm #5; no valid data until new instrument installed Jan 5, 2015 (DOY 5) between 1400-1500 hrs and data resumed.
2012	Aug 4 – Sep 15	217-259	All pyranometers and pyrgeometer removed for recalibration; restored to service on Sept 16, 2012 (DOY 260).
2012	Sept 7	251	SBSP battery bank replaced (4 batteries); System lost power between 0800 and 0900 hours; no data for 201 or 203 arrays for 0900 hours; 224 array for this day is calculated from 23 hours of data.
2012	Jul 17 – Sep 24	199-268	Frequent episodes of missing Soil Surface Temperature data throughout the summer; other soil temperature data OK
2012	Feb 17	48	Loggernet 2.1c program measurement execution interval changed from 5 seconds to 6 seconds to prevent “table overrun” errors on primary datalogger and to match SASP execution interval (also changed to 6 seconds on the same day.
2011	Aug 9 - Sep 7	221-250	Pyranometer intercalibration from 1100 hrs August 9, 2011 (DOY 221) through 1100 hrs September 7, (DOY 250); down-looking pyranometer arm rotated and aimed upward during this period; shadow array arm removed; no valid shadow array or down-looking pyranometer data for this period; no interruption to pyrgeometer operation
2011	Aug 9 - Sep 13	221-256	Lower Wind sensor removed for servicing on August 9, 2011 (DOY 221); replaced with refurbished sensor on September 13,

			2011 (DOY 256). No Lower Wind data for those 36 days.
2010	Jun 19	170	Soil temperature data restored
2010	May 3 – Jun 13	123-164	Episodic bad Lower RH data during overnight hours
2010	Apr 27 - SAG	117-161	Extensive missing snow and soil temperature data

Table continues next page

Year	Date(s)	Day of Year	Note
2010	Mar 30 – Apr 9	89-99	System power failure caused by short in Upper Air Temp/RH sensor cable; sensor removed and power restored; no SBSP data during this period
2009	Aug 10 – Sep 2	222-245	Pyranometer intercalibrations; shadow array arm removed; all pyranometers mounted up-looking at top of mast; no valid shadow array or down-looking pyranometer data for this period; no interruption to pyrgeometer operation
2007	Oct 1-7	274-280	SR50 snow depth sensor malfunction; sensor replaced for Winter 0708 with loaner; no lost snowcover data
2007	Aug 21 – Sep 30	233-274	All pyranometers recalibrated by AccuFlux, in multi-step process, with periods of missing data, by sensor
2007	Jun 28 – Jul 4	179-185	Pyrgeometer intercalibrated to new unit; no missing data
2006	Aug 28 – Sep 5	240-248	Pyranometer intercalibrations; shadow array arm removed; all pyranometers mounted up-looking at top of mast; no valid shadow array or down-looking pyranometer data for this period; no interruption to pyrgeometer operation
2005	Sep 19-26	262-269	Pyranometer intercalibrations; shadow array arm removed; all pyranometers mounted up-looking at top of mast; no valid shadow array or down-looking pyranometer data for this period; no interruption to pyrgeometer operation
2005	Jul 16	197	Soil temperature, volumetric water content, heat flux sensors installed
2005	Jan 20-25	20-25	Lower Wind, all radiometers, snow temperature sensors installed; missing hourly and 24-hour summary data during re-programming
2004	Oct 8	278	Site resumes operation with Upper Wind, Lower Air Temp/RH data only
2004	Jun 20	172	Winter 03/04 dataset completed; site shut down for major tower modifications over Summer 2004; no data until Oct 8, 2004
2003	Oct 29	302	SBSP startup; Winter 03/04 dataset includes Upper Wind, Lower Air Temp/RH only

5) Power
   a) Solar powered by 40 watt photovoltaic panel providing regulated charge to four 12V gel DC batteries. Battery bank has total 320 amp hours nominal capacity.
      i) 320 amp hour battery bank installed Fall 2004
         (a) Entire battery bank replaced (four new batteries) September, 2012
   b) October 2003 through October 2004: Solar powered by 10 watt photovoltaic panel providing a charge to a 12 amp hour lead acid battery; DC power. Battery charge regulated by Campbell Scientific CH12R regulator

6) Measurements and Sensors
   a) Upper Wind Speed and Direction
      i) Properties
         (a) Make: RM Young

(b) Model: #05103-5
(c) Serial Number: see table below
(d) Type: Wind Monitor
(e) Specifications: CSI_RMYoung_WindMonitor_05103_manual.pdf

ii) Installation
(a) Height above ground: 9.6 m
(i) Refer to Sensor Status Workbooks, by winter season, for sensor height above snowpack surface
(b) Distance from tower or obstacle: 0.6 m
(c) Data begin: October 29, 2003 (DOY 302), noon
(d) Comments: mounted to arm extending north from mast.
(e) Comments: Data recorded on secondary Campbell Scientific CR-10 datalogger (Ser. #14652, recalibrated December 2004), SDI-12 linked to the SASP primary datalogger.
(f) Comments: Sensor initially programmed to collect only scalar average wind speed; programming was changed at noon on Jan 20, 2005 (DOY 20) to calculate both scalar and resultant average speed (and resultant direction) data; see table of programming instructions at end of metadata.

iii) Sensor History:

Serial #	Date	Action	Condition
61998	Aug 24, 2011	Installed as SBSP Upper, replacing WM22659; no interruption of data	Refurbished by Campbell Scientific, Inc (CSI), summer 2011.
22659	Aug 24, 2011	Removed for refurbishing by CSI	In good condition upon inspection
22659	Oct 3, 2004	Reinstalled at SBSP	Refurbished by CSI July 2004
22659	Summer 2004	Removed, serviced by CSI	In good condition upon inspection
22659	Oct 29, 2003	Installed	Used, operating normally

b) Lower Wind Speed and Direction
i) Properties
(a) Make: RM Young
(b) Model: #05103-5
(c) Serial Number: 61653
(d) Type: Wind Monitor
(e) Specifications: CSI_RMYoung_WindMonitor_05103_manual.pdf

ii) Installation
(a) Height above ground: 4.0 m above ground
(i) Refer to Sensor Status Workbooks, by winter season, for sensor height above snowpack surface
(b) Distance from tower or obstacle: 0.9 m
(c) Comments: mounted to arm extending west from mast
(d) Data begin: Oct 17, 2004

(e) Comments: programed on Jan 20, 2005 to calculate both scalar and resultant average speed (and resultant direction) data; see table of programming instructions at end of metadata.

iii) Sensor History:

Serial #	Date	Action	Condition
136358	Jan 5, 2015	Installed as SBSP Lower Wind, replacing #61653	New instrument
61653	Jan 5, 2015	Removed for repair	Speed components completely missing
61653	Dec 21, 2014	Speed function failed	Damaged during Storm #5
61653	Sept 13, 2011	Installed as SBSP Lower Wind, replacing #61998	Refurbished by CSI, summer 2011; no lost data
no sensor installed 8/9/2011 to 9/13/2011 – data gap			
61998	Aug 9, 2011	Removed for servicing	Good upon inspection
61998	Oct 17, 2004	Installed at SBSP	New, RMY cal July 2004

c) Lower Air Temperature and Humidity

i) Properties

(a) Make: Campbell Scientific

(b) Model: HMP-50YA (replaced CS500 #Z184003)

(i) Oct 16, 2004 – April 14, 2010: Campbell Scientific/Vaisala CE humiter 50YC, Model CS500-U, Serial #Z184003

(ii) Oct 29, 2003 – Oct 16, 2004: Campbell Scientific/Vaisala CE humiter 50YC, Model CS500-U, Serial #P4810054

(c) Serial Number: F1510119

(d) Type: Platinum resistance temp detector (PRT) and capacitive RH sensor.

(e) Specifications: CSI_hmp50_manual.pdf

ii) Installation

(a) Height above ground: 3.8 m above ground

(i) Refer to Sensor Status Workbooks, by winter season, for sensor height above snowpack surface

(b) Distance from tower or obstacle: 0.6 m

(c) Data begin: October 29, 2003

(d) Comments: mounted on arm extending east from mast.

iii) Sensor History:

Serial #	Date	Action	Condition
HMP50 F1510119	Aug 14, 2010	Installed, replaced CS500 #Z184003	New instrument when installed; no lost data
Z184003	May 3 – June 13, 2010	RH sensor malfunction	missing 1-hour data, 3-hour, and 24-hour summary data, on DOYs 123, 124, 126, 127, 128, 130, 131, 135, 136, 150, and 164
Z184003	Oct 25, 2004	Tested by CSI	Met specs
CS500 Z184003	Oct 3, 2004	Installed, replaced CS500 #P4810054	New instrument

P4810054	Summer 2004	Removed from site, tested by CSI, relocated to SASP	Replaced RH chip
CS500 P4810054	Oct 29, 2003	Installed	Used, operating normally

d) Upper Air Temperature and Humidity
   i) Properties
      (a) Make: Campbell Scientific
      (b) Model: HMP-50YA
      (c) Serial Number: A4210021
      (d) Type: platinum resistance temp detector (PRT) and capacitive RH sensor
      (e) Specifications: CSI_hmp50_manual.pdf
   ii) Installation
      (a) Height above ground: 8.7 m above ground
         (i) Refer to Sensor Status Workbooks, by winter season, for sensor height above snowpack surface
      (b) Distance from tower or obstacle: 0.15 m
      (c) Data begin: February 6, 2006
      (d) Comments: property of NSIDC.
   iii) Sensor History:

Serial #	Date	Action	Condition
A4210021	July 1, 2010	Reinstalled	Sensor cable repaired by CSI
A4210021	March 30 – July 1, 2010	Malfunction; sensor removed	Sensor's cable failed causing system wide power failure; no valid data collected
A4210021	Feb 6, 2006	Installed	New instrument

e) Snowpack Depth
   i) Properties
      (a) Make: Campbell Scientific
      (b) Model: SR50
      (c) Serial Number: C3853
      (d) Type: ultrasonic depth sensor
      (e) Specifications: CSI_sr50_manual.pdf
   ii) Installation
      (a) Height above ground: 3.55 m above ground
      (b) Distance from tower or obstacle: 1.6 m
      (c) Data begin: Jan 20, 2005
      (d) Comments: wherever possible, bad data for short intervals (1-3 hours) are corrected by interpolation (for all interpolated data since fall 2011 see our Data Notes). When bad data occur over longer time periods no interpolation is performed and bad data are removed resulting in missing data.

iii) Sensor History:

Serial #	Date	Action	Condition
C3853	Nov, 2016-Jan, 2017	Nov, 2016-Jan, 2017, operated sporadically. Replaced transducer on Feb. 9, 2017. Day of year 40	New transducer installed. Hourly data Nov-Jan did report occasional reasonable and seemingly accurate.
C3853	Jan 24-Feb4, 2011	Temporarily replaced by loaner	New transducer installed by CSI, returned to service
C3853	Oct 1, 2008	Reinstalled	New transducer by CSI
C3853	Oct 7, 2007	#3853 malfunctioning and removed for repair; #4396 loaner installed for remainder Winter 07/08	No lost data after #4396 installed; loaner operating normally; no lost snowcover depth data
C3853	Summer 2007	New transducer installed by CSAS, reinstalled	Erratic data continued after transducer replacement
C3853	Summer 2007	Sensor mount position moved from end of W arm to end of south arm	
C3853	March 23, 2005	Returned to service using a 'sample' versus 'maximize' instruction	Serviced by CSI
C3853	Feb 26, 2005	Sensor malfunctions; replaced with UDG01 #C1374, loaner SR50 (CSI)	#C1374 and loaner SR50 operating normally; no lost data
C3853	Jan 20, 2005	Installed	New sensor

iv) Spring date of "snow all gone" (SAG), by winter season

(a) Data begin ~October 1 each season, regardless of presence of snow on the ground, and may reflect plant heights until snow cover begins to accumulate. Early season snowfalls may melt and reveal bare ground or plants until persistent snow cover develops.

(b) Date of SAG refers to total loss of snowcover directly under sensor in spring; snowpack depth data are discontinued thereafter and sensor is removed for summer, then reinstalled in early fall.

Winter	Date of Spring SAG	DOY
2016/2017	June 17, 2017	168
2015/2016	June 20, 2016	172
2014/2015	June 22, 2015	173
2013/2014	June 12, 2014	163
2012/2013	June 1, 2013	152
2011/2012	May 21, 2012	142
2010/2011	June 27, 2011	178
2009/2010	June 9, 2010	160
2008/2009	May 21, 2009	141
2007/2008	June 18, 2008	170

2006/2007	June 21, 2007	172
2005/2006	June 9, 2006	160
2004/2005	July 1, 2005	182

f) Solar Flux & Albedo Sensors (six total)
  i) Properties
    (a) Make: all units Kipp & Zonen
    (b) Model: CM21 (all five pyranometers) and CG4 (pyrgeometer)
    (c) Serial Numbers, by unit/location:
      (i) Up-looking broad band CM21 pyranometer: Ser. #041366
      (ii) Up-looking 'NIR to SWIR' CM21-RG695 filtered pyranometer: Ser. #041351
      (iii) Up-looking shadowed broad band CM21 pyranometer: Ser. #041367
      (iv) Up-looking CG4 pyrgeometer: Ser. #040744
      (v) Down-looking broad band CM21 pyranometer: Ser. #041365
      (vi) Down-looking 'NIR to SWIR' CM21-RG695 filtered pyranometer: Ser. #041352
    (d) Type: spectral response, by types:
      (i) Broad band CM21 pyranometer: 305-2800 nm (50% points)
      (ii) 'NIR to SWIR' CM21-RG695 pyranometer: 780-2800 nm (50% points)
      (iii) CG4 pyrgeometer: 4.5-42 µm (50% points)
    (e) Specifications
      (i) CM21 (including RG695): Kipp_Zonen_cm21_pyranometer.pdf
      (ii) CG4: Kipp_Zonen_cg4_pyrgeometer_manual.pdf
  ii) Installation
    (a) Height above ground:
      (i) Up-looking array: 9.4 m
      (ii) Down-looking array: 3.55 m
    (b) Distance from tower or obstacle:
      (i) Up-looking array: 0.5 - 0.6 m
      (ii) Down-looking array: 1.3 - 1.5 m
    (c) Data begin: January 19, 2005 (DOY 19)
    (d) Comments: snow surface albedo calculations are influenced by the slope and aspect of the reflective (snow) surface. In order to monitor the slope and aspect of the snowpack surface within the domain of the SBSP downlooking pyranometers, arrays of manually observed, 3m “height of snow” (HS) stakes are installed around the SBSP tower, as described in a separate HS Stake Array Metadata document. SBSP HS Stake Array data are contained in Sensor Status Workbooks, by winter season.
    (e) Comments: no ventilation units installed; up-looking sensors rarely covered by fresh snow due to winds at site. Up-looking 'shadowed' CM21 pyranometer deployed in Swiss ASRB-style array for aprox. 5 minutes of shadowing at/about solar noon each day.

iii) Sensor History:

(i) Contact CSAS for intercalibration and recalibration results.

(ii) Recalibrations by AccuFlux per Annex A.3.1 of the ISO-9847 Standard

Sensors	Date	DOY	Action
All	August 4 – Sept 9, 2016	217-253	All pyranometers and pyrgeometer removed for recalibration. Down looking unfiltered pyranometer and down looking unfiltered pyranometer removed Aug 4. All others removed Aug 5. Restored to service on Sept 19, 2016 (DOY 253).
Pyrgeometer	October 26, 2012	300	Applied revised CG4 sensitivity from Accuflux; new sensitivity value set at 11.37 µV/W m^2, or 94.59% of the August 2012 recalibrated sensitivity of 12.02 µV/W m^2; data from DOY 259 to DOY 300 are *not* revised
All	Sep 15, 2012	259	Reinstalled; 24hr data resume following day (DOY 260)
All	Aug 4 – Sep 14, 2012	217-258	All radiometers removed for recalibration by Accuflux; no radiation data during this period
table continued below			
Pyranometers	Aug 9-Sep 7, 2011	221-250	Intercalibrated in-situ, on mast; no valid down-looking or shadow array data for this period
Pyranometers	Aug 10-Sept 2, 2009	222-245	Intercalibrated in-situ, on mast; no valid down-looking or shadow array data for this period
Pyranometers	Aug 21 – Oct 1 2007	233-274	All units recalibrated by Accuflux; periods of missing data, by sensor
Pyrgeometer	Jun 28 – Jul 4, 2007	179-185	Intercalibrated, in-situ, to new CG4; no missing data
Pyranometers	Aug-Sep 2006	240-248	Intercalibrated in-situ, on mast; no valid down-looking or shadow array data for this period
Pyranometers	Sep 19-26, 2005	262-269	Intercalibrated in-situ, on mast; no valid down-looking or shadow array data for this period
All	Jan 19, 2005	25	All units installed, new
All	Nov 2004		Original calibration by K&Z

a) Infrared Snow Surface Temperature

i) Properties

(a) Make: AlpuG GmbH

(b) Model: SnowSurf IR Thermometer (replaced suspect Everest sensor)
  (i) Winter 2004/2005 Everest snow surface temperatures retained but suspect
(c) Serial Number: #4004
(d) Type: millivolt output type
(e) Specifications: AlpuG_SnowSurf_manual.pdf

ii) Installation
(a) Height above ground: 3.5 m
  (i) Refer to Sensor Status Workbooks, by winter season, for sensor height above snowpack surface
(b) Distance from tower or obstacle: 1 m
(c) Date originally installed at SBSP: December 12, 2005 (DOY 346)
(d) Service/calibration dates: new equipment, calibrated November 26, 2005.
(e) Comments: emissivity value = fixed at 0.98 for snow surfaces only, and not adjustable for soil or plant ground cover. Operating range -40 C to +80 C. Instrument is removed for summer season to reduce wear and tear.

Winter	End of Valid Spring Data	DOY
2015/2016	Remained in Operation	
2014/2015	June 21, 2015	172
2013/2014	June 10, 2014	161
2012/2013	May 26, 2013	146
2011/2012	May 21, 2012	142
2010/2011	June 24, 2011	175
2009/2010	June 8, 2010	159
2008/2009	May 19, 2009	139
2007/2008	June 15, 2008	167
2006/2007	June 17, 2007	168
2005/2006	June 3, 2006	154

(f) Sensor History:

Serial #	Date	Action	Condition
4004	Dec 12, 2005	Installed	New, AlpuG cal Nov 2005

b) Snow Temperature (five sensors)
i) Properties
(a) Make: Campbell Scientific
(b) Model: #107 (five sensor array)
(c) Serial Number: na
(d) Type: thermistor
(e) Specifications: CSI_107_temp_probe_manual.pdf

ii) Installation
(a) Height above ground, not including any downward displacement caused by settlement of the overlying snowcover (unknown).
  (i) SnoT Lo sensor at the ground surface
  (ii) SnoT 2Lo sensor 10 cm above the ground
  (iii) SnoT Ctr sensor 20 cm above the ground
  (iv) SnoT 2Hi sensor 30 cm above the ground

(v) SnoT Hi sensor 40 cm above the ground
(b) During the first four winters (2004/2005 – 2007/2008), sensor deployed relative to snowpack surface was observed during field sessions. Contact CSAS for array's "floating" position within the snowpack for those seasons.
(c) Distance from tower or obstacle: approximately 4 m.
(d) Date originally installed at SASP: January 20, 2005 (DOY 20)
(e) Comments: all measurements corrected with small offsets calibrating the sensors to isothermal snow at 0.0 C. Values above 0.0 C occur during exposure of sensors to air during early winter, prior to full burial of the array, and during spring snowmelt as array becomes exposed to air.
(f) Comments: Sensor array stored on mast for summer.
(g) Sensor History:

Serial #	Date	Action	Condition
na	January 2005	Installed	New Sensors

c) Soil Heat Flux
i) Properties
(a) Make: REBS (Campbell Scientific)
(b) Model: HFT-3.1
(c) Serial Number: Serial Number: H043139
(d) Type: thermopile
(e) Specifications: CSI_REBS_hft-3.1_manual.pdf
ii) Installation
(a) Height below ground surface (below "A" horizon; several cm "O" horizon present): 3 cm
(b) Distance from tower or obstacle: approximately 4 m
(c) Date originally installed at SBSP: July 16, 2005
(d) Service/calibration dates: new unit upon installation; original calibration October 7, 2004
(e) Comments: none

iii) Sensor History:

Serial #	Date	Action	Condition
H043139	Jul 16, 2005	Installed	New, REBS cal Oct 2004

d) Soil Temperature (four sensors)
i) Properties
(a) Make: Campbell Scientific
(b) Model: #107
(c) Serial Number: na (none)
(d) Type: thermistor
(e) Specifications: CSI_107_temp_probe_manual.pdf
ii) Installation

(a) Height *below* ground surface (below O/A horizon boundary): at O/A horizon boundary , -10 cm, -20 cm, -25 cm
(b) Distance from tower or obstacle: approximately 4 m
(c) Date originally installed at SBSP: July 16, 2005
(d) Service/calibration dates: new units upon installation; sensors not serviceable

e) Soil Volumetric Water Content
   i) Properties
      (a) Make: Campbell Scientific
      (b) Model: CS616
      (c) Serial Number: na (none)
      (d) Type: water content reflectometer
      (e) Specifications: CSI_cs616_manual.pdf
   ii) Installation
      (a) Height below ground surface (below O/A horizon boundary): -10 cm
      (b) Distance from tower or obstacle: approximately 4 m
      (c) Date originally installed at SBSP: July 16, 2005
      (d) Service/calibration dates: new units upon installation; sensors not serviceable;
      (e) Comments: the sensor is horizontally deployed, with both tines at the same level below, and parallel with, the ground surface. Non-rocky soil enabled utilization of Campbell Scientific installation jig resulting in minimal soil disturbance during installation.

f) Ground/Snowpack Interface Moisture Content
   i) Properties
      (a) Make: Campbell Scientific
      (b) Model: CS616
      (c) Serial Number: na (none)
      (d) Type: water content reflectometer
   ii) Experimental data begun in Winter 2007/2008 and **discontinued Winter 2011/2012**; contact CSAS

g) Mid-Snowpack Moisture Content
   i) Properties
      (a) Make: Campbell Scientific
      (b) Model: CS616
      (c) Serial Number: na (none)
      (d) Type: water content reflectometer
   ii) Experimental data begun in Winter 2007/2008 and **discontinued Winter 2010/2011**; contact CSAS

2) Primary Datalogger
   a) Make: Campbell Scientific
   b) Model: CR10X
   c) Serial Number: 3884
   d) Type: fully programmable measurement and control system with ring memory
   e) Specifications: CSI_cr10x_specs.pdf

f) Comments: none
g) Sensor History:

Serial #	Date	Action	Condition
CR10X 3884	July 15, 2004	Recal by CSI, with certif	Operating normally
CR10X 3884	Oct 29, 2003	Installed	Used, operating normally; original calibration 1996

3) 'Slave' Datalogger
   a) Make: Campbell Scientific
   b) Model: CR10X
   c) Serial Number: 46843
   d) Type: fully programmable measurement and control system with ring memory
   e) Specifications: CSI_cr10x_specs.pdf
   f) Comments: 'slave' datalogger required for input channels for experimental snow moisture sensors Winters 2007/2008 through 2010/2011; connected to primary datalogger using SDI-12 link. Used during CG4 pyrgeometer intercalibrations.
   g) Sensor History:

Serial #	Date	Action	Condition
CR10X 46843	Nov 3, 2006	Installed	New, orig calib Oct 2006

4) Multiplexer
   a) Make: Campbell Scientific
   b) Model: AM16/32
   c) Serial Number: 6694
   d) Type: relay
   e) Specifications: CSI_am16-32a_manual.pdf
   f) Comments: housed in own enclosure.
   g) Sensor History:

Serial #	Date	Action	Condition
6694	Oct 16, 2004	Installed	New

5) Data Retrieval
   a) RF Station ID = 2
   b) Radio telemetry using phone-to-RF base station; no repeater utilized
      i) Campbell Scientific model RF 310M modem; serial #2224
      ii) Model RF310 Maxon SD-125 V2 VHF radio: serial #030604892
      iii) Cellwave PS1121-3 dipole antenna

6) Software
   a) Campbell Scientific LoggerNet 2.1c
   b) Contact CSAS for specific Winter or Summer season Loggernet programming

7) Observer Contact Information
   a) Name: Chris Landry - Executive Director

b) Organization: Center for Snow and Avalanche Studies
c) Address: PO Box 190, Silverton, CO, USA 81433
d) Telephone: (970) 387-5080
e) Email: clandry@snowstudies.org
f) Website: http://www.snowstudies.org

8) Data processing and output methods:
   a) Loggernet program execution interval: initially set at 5 seconds from original 2003 startup until February 17, 2012, when interval was increased to 6 seconds. This change was required to reduce increasing volume of "table overrun" errors triggered by the recent addition of experimental snow moisture sensors. Data processing for those sensors often exceeded the 5 second allowance, effectively resulting in a doubling of the 5 second execution interval to 10 seconds. Discontinuing those measurements and increasing the execution interval for the remaining sensors to 6 seconds in February 2012 effectively eliminated table overrun errors.
   b) Revised measurements of snow depth: instruction P73 (Maximize) used during early Winter 2004/2005 changed to P70 (Sample) in March 2005, sampling once at the end of all arrays to minimize bad data caused by blowing snow
   c) Measurements and Loggernet instructions: see table on following page
      (1) Location # in the table below refers to position in data file string (within a given array) as well as column number in relevant Excel spreadsheet header

Data processing and output methods (data points as labeled in Excel workbooks):

Spreadsheet Labels (some abbreviations expanded)	*Loc'n #*	*LoggerNet 2.1c Instruction*	*Type of Measurement*	*Notes*
ArrayID	1	P80	na	201 = 1 hour array 203 = 3 hour array 212 = solar noon array 224 = 24 hour array
Year	2	P77	Na	Calendar year
DOY	3	P77	na	Sequential day of calendar year
Hour	4	P77	na	Mountain Standard Time at end of array period, in military time; previous day at midnight, 2400 at midnight
LoAir_Min_C LoAir_Min_Time	5 6	P74	Minimize	Lower air temperature (C) sensor array minimum, time of minimum
LoAir_Max_C LoAir_Max_Time	7 8	P73	Maximize	Lower air temperature (C) sensor array maximum, time of maximum
Lo_RH	9	P70	Sample	Lower RH sensor; samples relative humidity (%) once at end of array
Upper Wind Monitor UpWind_PGust_MS UpWind_PGust_Time UpWind_SAvg_MS UpWind_Uavg_MS UpWind_Dir_Uavg UpWind_Dir_StDev	 10 11 12 13 14 15	 P73 P69	 Maximize Wind vector	P69 output option '2': scalar mean horizontal wind speed S; resultant mean wind speed U; resultant mean wind direction; standard deviation wind direction using Campbell Scientific algorithm.
Lower Wind Monitor LoWind_PGust_MS LoWind_PGust_Time LoWind_SAvg_MS LoWind_Uavg_MS LoWind_Dir_Uavg LoWind_Dir_StDev	 16 17 18 19 20 21	 P73 P69	 Maximize Wind vector	P69 output option '2': scalar mean horizontal wind speed S (ms); resultant mean wind speed U (ms); resultant mean wind direction; standard deviation wind direction using Campbell Scientific algorithm.
PyDwn_Unfilt_W	22	P71	Average	Down-looking broadband pyranometer, in average watts/m^2
PyDwn_Filt_W	23	P71	Average	Down-looking NIR & SWIR filtered pyranometer, in average watts/m^2 *(see Note 2 below)*
PyUp_Unfilt_W	24	P71	Average	Up-looking broadband pyranometer, in average watts/m^2
PyUp_Filt_W	25	P71	Average	Up-looking NIR & SWIR filtered pyranometer, in average watts/m^2
PyUp_Shad_W	26	P71	Average	Up-looking shadowed broadband pyranometer, in average watts/m^2
Pyrgeom_W	27	P71	Average	Up-looking pyrgeometer, in average watts/m^2
Sno_IR_C	28	P71	Average	Average infra-red temperature of snow surface (degrees C)
Sno_Gd_C	29	P71	Average	Mean temperature (C) of lowest snow temperature sensor in five-sensor array
Sno_10cm_C	30	P71	Average	Mean temperature (C) of 2nd lowest snow temperature sensor in five-sensor array
Sno_20cm_C	31	P71	Average	Mean temperature (C) of center snow temperature sensor in five-sensor array
Sno_30cm_C	32	P71	Average	Mean temperature (C) of 2nd highest snow temperature sensor in five-sensor array
Sno_40cm_C	33	P71	Average	Mean temperature (C) of highest snow temperature sensor in five-sensor array

Table continued next page

Spreadsheet Labels (some abbreviations expanded)	*Loc'n #*	*LoggerNet 2.1c Instruction*	*Type of Measurement*	*Notes*
Sno_Height_M	34	P70	Sample	Height-of-snow sampled once at end of array
Sys_Volts	35	P70	Sample	Voltage at datalogger (prior to regulation) sampled once at end of array
LoAir_Avg_C	36	P71	Average	Averages all measurements of air temperature collected during a day, from 0000 hrs through 2400 hrs
Soil_Flux_W	37	P71	Average	Average heat flux (watts) entering or exiting soil
Soil_Surf_C	38	P71	Average	Average temperature (C) at soil/air interface (sensor exposed to direct light)
Soil_10cm_C	39	P71	Average	Average temperature (C) at 10 cm below ground surface
Soil_20cm_C	40	P71	Average	Average temperature (C) at 20 cm below ground surface
Soil_25cm_C	41	P71	Average	Average temperature (C) at 25 cm below ground surface
Soil_VWC	42	P71	Average	Volumetric water content (scale 0.0 to 1.0) of soil at 10 cm below ground surface
UpAir_Min_C UpAir_Min_Time	43 44	P74	Minimize	Upper air temperature (C) sensor array minimum, time of minimum
UpAir_Max_C UpAir_Max_Time	45 46	P73	Maximize	Upper air temperature (C) sensor array maximum, time of maximum
Up_RH	47	P70	Sample	Upper RH sensor; samples relative humidity (%) once at end of array
UpAir_Avg_C	48	P71	Average	Averages all measurements of air temperature collected during a day, from 0000 hrs through 2400 hrs
Ground-Snow Moisture	49	P71	Average	'Period' measurement of moisture at ground/snowpack interface **DISCONTINUED 2/17/2012** *Experimental data collected Winters 2006/2007 to Feb 17, 2012 only; contact CSAS*
Mid-Pack Snow Moisture	50	P71	Average	'Period' measurement of moisture at mid-snowpack **DISCONTINUED 5/18/2010** *Experimental data collected Winters 2006/2007 to May 18, 2010 only; contact CSAS*
See also: **Table of variables, CF standard names and attributes:** snowstudies.org/data/metadata/SBSP_Variable_Table.xlsx				

Web Links for CSAS Metadata and Supplemental Documents:

- CF Standard Name Table for each variable measured:
  http://snowstudies.org/data/metadata/PTSP_Variable_Table.xlsx

- Archived Datasets by Season, Snow Profiles, and Storm Reports:
  http://snowstudies.org/data1.html

- Metadata for all CSAS Study Plots:
  Swamp Angel Study Plot: http://snowstudies.org/data/metadata/SASP.pdf
  Senator Beck Study Plot: http://snowstudies.org/data/metadata/SBSP.pdf
  Putney Study Plot: http://snowstudies.org/data/metadata/PTSP.pdf
  Senator Beck Stream Gauge: http://snowstudies.org/data/metadata/SBSG.pdf

- Photographs of all Study Plots:
  Swamp Angel Study Plot: http://snowstudies.org/sasp1.html
  Senator Beck Study Plot: pthttp://snowstudies.org/sbsp1.html
  Putney Study Plot: http://snowstudies.org/sasp1.html
  Senator Beck Stream Gauge: http://snowstudies.org/sbsg1.html

- Height of Snow (HS) Stake Array Metadata:
  http://snowstudies.org/data/metadata/HS_Stake_Array_Metadata.pdf

- Sensor Status Workbooks:
  http://snowstudies.org/data/metadata/SensorStatusWorkbooks/

- Instrument Manuals: http://snowstudies.org/data/metadata/InstrumentManuals/

- Interpolated Data Notes (Winter 2011/2012 and onward) for all CSAS Study Plots:
  http://snowstudies.org/data/metadata/DataNotes.xls