



ISFS Measurements

Fluxes Over Snow Surfaces, Phase II (FLOSSII)



Looking east toward Medicine Bow mountains from FLOSS site.



Measurement challenges due to rime.

INTRODUCTION

FLOSSII is the second phase of the [FLOSS](#) project, studying the surface meteorology of snow-covered rangeland in the North Park region of Colorado, near Walden.

This document is a standard product of [NCAR/EOL](#) which gives an overview of the measurements taken using the [Integrated Surface Flux Facility \(ISFF\)](#) and conditions during the FLOSSII field experiment.

FLOSS II will operate in conjunction with the NASA [Cold Land Processes Field Experiment \(CLPX\)](#).

NEWS

- September 22nd, 2003 - High-rate data is available [here](#).
- December 18th, 2003 - Quality-controlled statistics are available [here](#).

LINKS TO OTHER FLOSS PARTIPANTS

- [CLPX main WWW site](#)
- [National Snow and Ice Data Center](#) -- see CLPX links
- [Oregon State University](#)
- [NOAA Polarimetric Scanning Radiometer Data \(CLPX02 & CLPX03\)](#)

- [NCAR MMM Report](#)
- [NCAR MMM Summary](#)

LOCATION

Near Walden, Colorado, in the Arapahoe Wildlife Refuge near the former Case Ranch. We thank the [Refuge](#) for their generous use of this location.

The Refuge also has supplied us with an [aerial photo](#) of the area around our site from a few years ago, which I've [anotated](#) with approximate locations of the FLOSS and FLOSS II sites.

We've produced a [map](#); using Topo of the site, with tower locations for FLOSSI and FLOSSII indicated with red dots. Note that the labels are to the NE of the corresponding dot -- not necessarily the closest.

I have written a set of [driving directions](#) for the convenience of the many visitors which also includes a list of contact info.

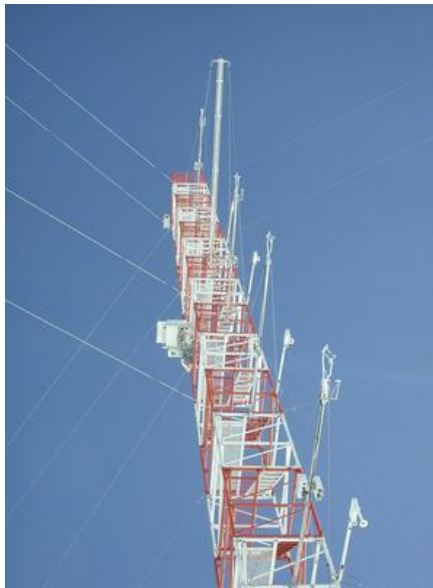
CHRONOLOGY

- October 1st - 4th, 2002: Tower extended to 34m; most tower infrastructure installed; PAM stations online; soil probes installed
- October 10th: Fixes to soil probes; added sensors to PAM
- November 18th - 22nd: Install base trailer; 34m tower data system and sensors; reconfigure PAM
- December 1st: Official start of operations
- December 4th: Visit to fix a few problems (grassland soil sensor cable, lake pyrgeometer, 2m T/RH at main).
- December 16th - 18th: Service visit: install pyrgeometers, CO2, TP01 sensors.
- December 20th: CSU performed snow depth survey near tower, including near radiometer stand at "grass"
- January 2nd, 2003: CSU performed snow depth survey near tower, including near radiometer stand at "grass" -- future surveys avoided this area.
- January 6th - 8th: Service visit -- reboot cosmos, fix sage and lake TP01, add CO2 HiCal, 25m rads
- January 27th - 28th: Service visit -- fixed 25m radiometer wiring, grass TP01, T/RHs
- January 31st: Bill Massman restarts our LI6251
- February 19th - 27th: CLPX Dry IOP, site staffed February 18th - March 6th
- March 25th - April 2nd: CLPX Wet IOP
- March 26th - 27th: Visit to investigate Sage site with thermal camera
- April 3rd - 7th: Teardown, phase I: PAM stations, main tower sensors, base trailer
- April 4th - 18th: FLAB Rooftop T/RH intercomparison (in 2 groups)
- April 18th - May 31st: FLAB Rooftop Pyrgeometer intercomparison (cleaned week of May 12th)
- May: Teardown, phase II: main tower, power, grass sensors

Between the periods of staffed observations, data will be taken in a minimal maintainance mode, with short service visits and remote data monitoring.

MEASUREMENT SITES

34 Meter Walkup Tower (Stations 0 and 1)



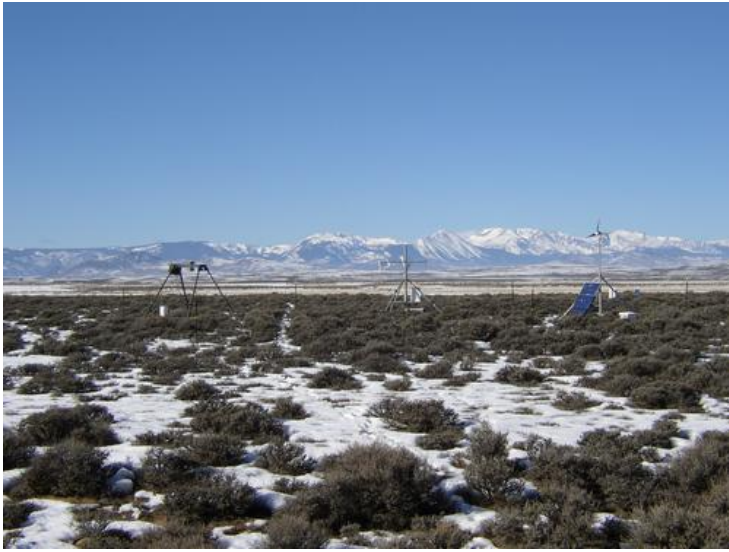
NCAR ISFF sensors were installed at three sites during FLOSSII:

- profiles of mean air temperature and RH at 0.5, 1, 2, 5, 10, 15, 20, and 30 meters
- profiles of three-component wind at 1, 2, 5, 10, 15, 20 and 30 meters
- fast-response hygrometers (for water vapor fluxes) at 2, 10, 20 and 30 meters.
- fast CO₂ sensor at 2 meters (to be installed in December).
- barometer
- up-and-down-looking longwave radiometers at 25m ([photo with only one radiometer mounted](#)).
- nearby radiation stand with up-and-down-looking longwave radiometers at 4m and down-looking longwave radiometer at 1.5m over a bare surface ([photo](#)).
- nearby radiation stand with up-and-down-looking long and short wave radiometers and net radiation sensor over a grass surface ([photo](#)).
- nearby radiation stand with a down-looking longwave radiometer over greasewood bushes ([photo](#)).
- 3 soil temperature profiles, each with sensors at 2.5, 5 and 10 centimeter depths
- 3 soil moisture profiles, with sensors at 5 and 10 cm depths
- 3 soil heat flux plates
- 1 soil thermal properties probe
- ETI weighing precipitation and Campbell Scientific ultrasonic snow depth gauges

Station numbering:

In the data files, and on the plots, sensors on the tower or the nearby radiation stands are designated as either station #0 or station #1. Sensors which are unique to the tower are regarded as being at station 0. Sensors which correspond to similar sensors at the lake and sage sites, like the T/RH, sonic and fast hygrometer at 2 meters, and the radiation and soil sensors at the grass site, are designated as station 1.

Sagebrush Site (Station 2)



- mean air temperature and RH at 2 meters
 - barometer
 - one level of eddy correlation sensors (sonic anemometer, fast water vapor) at 2 meters
 - 4 component radiation stand and soil sensors like the tower.
-

Lake Site (Station 3)



- mean air temperature and RH at 2 meters
 - barometer
 - one level of eddy correlation sensors (sonic anemometer, fast water vapor) at 2 meters
 - 4 component radiation stand and soil sensors like the tower.
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Site Locations:

site	Latitude (N)	Longitude (W)	Elevation [approx, from map](m)
34m tower	40° 39' 32"	106° 19' 26"	2476.5
sagebrush	40° 40' 04"	106° 19' 08"	2475.5
lake	40° 39' 50"	106° 19' 40"	2474.5
Base trailer	40° 39' 39"	106° 19' 18"	-

SENSORS

Here is the plan for the [sensor array](#).

SONIC ANEMOMETERS

CSAT3 sonic anemometers were used all wind sensing for FLOSSII. Overall, their performance was excellent, with occasional spikes probably due to precipitation in the path or accumulating on the path. Sage and Lake sonics sampled at 20 samp/s, main tower sonics were at 60 samp/s. During the pre-operations phase, the (sage and lake) sonics were in "grab sample" mode. They later were changed to average 3 samples at 60 samp/s.

Specific notes:

- Sage, October 3rd: CSAT deployed
- Lake, October 4th: CSAT deployed
- Sage, November 18th: CSAT changed to oversample mode (from single-sample)
- Lake, November 19th: CSAT changed to oversample mode (from single-sample)
- Main, November 20th: CSATs deployed. Data from csat.15m briefly came in as csat.30m ~15:00 [these values will be deleted in the data]
- Main, December 18th: csat.10m misleveled during krypton cleaning. The bracket broke and was replaced on January 6th. Both level and boom angle may have changed slightly.
- Main: Boom angles that were shot on November 21st show little variation, but wind direction profiles show differences on the order of 2 degrees. Angles were spot checked on January 7th and found to have differences, but were impossible to measure accurately with the hand-held compass. Apparently, it wasn't possible to reshoot these angles with a theodolite later in the project(?).

Sonic tilt angles have been evaluated using all the data:

- Data from 10m have been split into three sections due to the problems mentioned above. Note that the angles are quite close before and after the problems with this sensor.
- It appeared to be necessary to break the tilt plots of the 15m data about the time of a site visit on February 18th, though no action was noted that should have affected this sensor.
- Both the 1m and 2m data on the tower show strange variations at an azimuth of about -60 degrees (relative to the sonic centerline) -- perhaps this is flow interference between these two sensors?

FLOSS II Sonic Tilt Angles

Sensor	w-bias (m/s)	Lean (deg)	LeanAz (deg)	Plot
1m	-0.028	0.8	122.7	plot
2m	-0.018	0.4	-154.1	plot
5m	-0.024	0.4	114.6	plot
10m: Before December 18th	-0.014	1.2	132.2	plot
10m: December 18th - January 6th	-0.034	2.1	-155.2	plot
10m: After January 6th	-0.034	1.2	142.2	plot
15m: Before February 18th	-0.004	1.4	58.1	plot
15m: After February 18th	-0.025	2.7	23.8	plot
20m	-0.001	1.5	155.2	plot
30m	0.035	1.3	122.5	plot
sage	0.014	0.3	95.8	plot
lake	0.009	1.6	-85.5	plot

We attempted to level all of these sensors during installation by using an electronic level to adjust (boom) guy wire tension and then attaching the anemometer. This should have been accurate to about 0.2 deg. Thus, we assume that these above "tilts" actually indicate real air motion due to local topography. Thus, none of these tilts have been removed from the data. If the user is interested in applying our rotation procedure, see our [tilt correction page](#).

KRYPTON HYGROMETERS

These were our only sensors for measuring water vapor fluxes, but they did not perform well. The Lake and Sage sensors were connected (using the PMB-version serializers) on October 10th. On November 18th at sage, November 19th at lake, and all the time (after about November 20th), all kryptons (but one) were set to a pathlength of 2.6cm, following guidance from Arian van Dyke's paper. Previously, all ISFF kryptons had pathlengths of about 1.2cm.

Here is a list of serial numbers:

2m	1389 (2.6cm)
10m	1391 (2.6cm)
20m	1392 (2.6cm) changed to 1390 (2.0cm) on 6 Jan
30m	1394 (2.6cm)
sage	1133 (1.2cm) changed to 1395 (2.6cm) on 18 Nov
lake	1393 (1.242cm) changed to 1397 (2.6cm) on 18 Nov

All kryptons had extensive periods of bad data, especially on cold (below -15 C) nights. We now suspect that the cause of this is fog. To test the theory that this was due to frost build-up, we attached a hot-air blower to main.2m on December 16th (not operational until December 18th), which helped a bit on December 22nd - 24th, but not as much as expected. The pump on this blower seized up the next day. On the morning of January 7th, this problem recurred and was observed to be related to the presence of ice fog. Whether fog was always the reason is still unknown. (The fog on January 7th was accompanied by extensive "feather" rime which was visible on the Axis camera images, but the camera didn't show this rime during other bad krypton events.) Tests of 3 kryptons (both head and electronics) in the lab showed normal operation down to -40 C, so this problem is not simply a failure from low temperatures.

We will have removed the majority of obviously bad data by using the criteria: $|kh_2o-H_2O| > 1.8 \text{ g/m}^3$ or $kh_2oV < 50\text{mV}$. Some bad data will slip through this filter -- especially during the transitions between rimed and ice-free conditions.

Also, the 20m krypton showed a diurnal variation not seen by other kryptons. The onset appears to be related to incoming short-wave radiation, but this problem continues into darkness. We saw a hint of similar behavior in FLOSS01 that appeared to be caused by corrosion in the electronics box that was fixed during IHOP02. The 20m sensor was replaced on January 6th.

CARBON DIOXIDE

We deployed our LiCor 6251 (closed-path IRGA) with an inlet at 2m at the main tower to measure CO₂ fluxes close to the surface. It was installed December 16th, and valve control (for the gas calibration system) started December 18th. Only a Lo-Cal cylinder was attached initially, since one gas regulator was bad. We installed a new regulator January 6th and got Hi-Cal working. On January 7th, we swapped Lo-cal cylinders since the pressure was somewhat low. On January 8th, the calibration cycles were shortened to 30 seconds (down from 2 minutes) to extend the life of the calibration gases. Due to an apparent slight leak in the LoCal plumbing, it was necessary to change the LoCal cylinder 3 times during the experiment, whereas only one HiCal cylinder was used throughout (see [plot](#)).

For the first time, we monitored pressure in the line close to the sample cell. It read about 10% lower than ambient pressure, a value which probably is typical of most of our deployments -- certainly FLOSS01. However, on January 6th the inlet flow rate was changed from 6 to 7 lpm, which caused this pressure sensor to go offscale. We lowered the flow rate back to 6 on the next visit. During the period when it ran offscale, Plicor appeared to be approximately 82% of P, so we will synthesize a corrected Plicor from P at stn1 (itself a derived quantity that implements a correction for sensor temperature -- see "Barometer" below). (The top and bottom magenta lines in this [plot](#) show the uncorrected and corrected Plicor values.)

We have investigated data from the calibration periods and find that most of the data are well fit by voltage linearly related to CO₂ density, computed using the calibration gas mixing ratio and the sample cell temperature and pressure (see [plot](#)). The data from the first 3 weeks (before the Hi-Cal regulator was installed) appear to have an offset from the rest of the data. Also, the Lo-Cal data at the end of the program are more scattered -- even from earlier data using the same Lo-Cal cylinder. The cause of both of these effects is as yet unknown. Thus, we have applied the regression from the middle 2 months (January 7th - March 21st) to the entire period, noting that only the sensor gain is important for the flux measurements desired for FLOSS.

To obtain a slightly reduced residual, we added an extra term to the fit: $V \sim a_1 + a_2 * m * \rho + a_3 * P$. With this fit, we compute CO₂ mixing ratios during the calibration periods. Our [plot](#) of the mixing ratios thus computed versus those of the cylinders shows that there still is a disturbing amount of scatter. However, the barely-discernable horizontal lines on this plot indicate that the first and third quartiles are generally within a range of +/-2 ppmV of the calibration cylinder values (except for those from the 323.26 ppmV cylinder used at the beginning).

As a further check of these calibrations, we show data from "supplementary calibrations" done on February 20th and 27th. During these calibrations, gas from other CO2 calibration cylinders were introduced to the Li6251 at the inlet, rather than at the analyzer. Both of these calibrations were performed (on purpose?) at the time of automatic calibration cycles. A [plot](#) of these supplementary calibrations shows rather poor absolute values. (In this plot, the horizontal lines represent the value of the automatic calibration cylinders, the dots are the value of the supplementary calibration cylinder and indicate the supplementary calibration time, and the black line is the LiCor output calibrated using the fit described above.) The February 20th case shows that the above calibration produces values which are about 9ppmV lower than the supplementary calcs but also about 5-7ppmV higher than the automatic calcs. However, the February 27th case shows the supplementary calcs now 12ppmV lower, with the automatic calcs nearly matched. For such differences to exist between automatic and supplemental calcs, there must be a response of our system to pressure or perhaps temperature variations that we have not characterized. (Even though the automatic calcs themselves go through a wide range of pressures and temperatures.) Clearly, it will take more work to interpret the usefulness of these supplemental calcs!

CO2 data have NOT yet been included in the final data.

T/RH

These generally worked, though main tower profiles were often not strictly monotonic. Some of these differences may be real (since fetch changes with height), however at least one swapping test showed a sensor problem. Nevertheless, all sensors agreed with the laboratory reference to better than 0.1 C in post-calibrations, suggesting a sensor exposure problem. We ran a side-by-side intercomparison for 2 weeks on the FLAB roof immediately following the field phase to investigate these difference further (see table below). As with the lab tests, these showed differences of at most 0.1 C, and more typically 0.03 C. (RH differences were 2.5% max, 1% typical.) All sensors were operated as they had been at the time of tear-down, except for the replacement of a bad fan on the 20m sensor. Many inlet bells also were noted as being broken (due to ice during operations). Thus, the obvious potential problems of poor fan aspiration and dirty Gortex filters wouldn't appear to have caused these differences, though the fans [could] have had less electrical power on the tower. The laboratory-determined differences listed in the below table have been removed from the data.

Note also that these sensors ingested ice crystals during riming events (and possibly snow) -- see logbook, e.g., comments [169](#) and [173](#) and [photos](#). No attempt will be made to eliminate these data.

There were several cases that fans were noted as not working (see below). During the days before these times, temperatures could be higher than ambient during the day and lower than ambient at night, due to radiative heat transfer -- especially in light winds. These cases sometimes are apparent in the temperature profiles or in comparisons with tc from a nearby sonic anemometer. We have filtered these data by removing data with $|Tc(z)-tc(z)| > 0.5C$ during the period when the fans were logged as having problems (Tc is the acoustic virtual temperature computed from T, RH, and P). Note that this is a pretty liberal criteria which probably retains some bad data, though it also could reject good data when the sonic data are bad.

Specific problems:

- Sage, November 18th: Replaced T/RH (newer calcs?)
- Lake, November 19th: Replaced T/RH (newer calcs?)
- Main, November 21st: T/RH.25m swapped due to RH 3% high
- Main, December 4th: T/RH.2m fan was bad, new sensors installed
- Main, December 16th: T/RH.2m swapped due to T 0.2 C high, but didn't change
- Main, January 1st: T/RH.5m fan died, changed January 6th
- Main, January 4th: T/RH.30m fan died, changed January 6th
- Main, March 17th: T/RH.20m fan died, not replaced
- Main, tear-down: one boom was folded against the tower, presumably due to earlier wind.

Roof-top test results:

TestID	S/N	50Y	FLOSS beg	Location end	Roof:dT degC	Bath:dT degC	Roof:dRH %	Bath:dRH %	Notes
ic_trh:									
a	001	T3510005	-	0.5	+0.059	+0.10	-1.6	-3.0	bell broken
b	206	R4910001	0.5	1	-REF-	+0.01	-REF-	0.0	bell broken
c	104	T1140031	-	2	-0.006	+0.07	-1.0	-2.0	bell broken
d	701	T3510004	-	5	-0.112	-0.05	-1.2	-1.5	bell broken
e	702	T2620019	5	10	-0.060	-0.07	-0.1	0.0	
f	007	T0820012	15	same	+0.011	+0.03v	-0.3	-0.5	
g	704	09N001	20	same	+0.024	+0.00	-0.4	-1.5	new fan
h	008	U5020029	25	same	+0.051	0.00	0.0	-0.5	
i	003	T1130007	30	same	-0.008	+0.03	+0.2	0.0	
j	101	P1110024	sage	same	-	-	-	-	no inlet
k	502	R4910005	lake	same	-	-	-	-	no inlet
l	703	P1110027	1	-	+0.007	-0.02	-0.6	-0.5	
m	004	U5020030	2	-	-0.012	0.00	-2.3	-3.5	bell broken dur:
n	204	P4920040	10	-	-0.034	+0.01v	+1.0	0.0	

```

ic_rad:
i      003      T1130007      30      same                               bad until end
j      206      R4910001      0.5      1      -REF- +0.01 -REF- 0.0
k      101      P1110024      sage     same +0.015 +0.01 -0.2 0.0
l      502      R4910005      lake     same -0.025 -0.01 -1.0 -1.5
-      005      P1110023      spare   spare -      +0.01 -      -1.0

```

RADIOMETERS

There were a lot of radiometers, since this experiment tried to repeat (and extend) the longwave-radiative flux divergence study first done during CASES99, in addition to measuring all 4 components to know the surface energy balance at each site.

All upward-looking sensors were set up for forced ventilation, though it was discovered that electrical noise from the fans caused noise in the Tsoil measurements (same problem as in IHOP02). Thus, the fans were unplugged December 4th? - December 18th at Lake and Sage (The fans were left on at the main tower site). While they were unplugged, snow could [and did at least sometime] accumulate to cover the domes. This problem was "fixed" on December 13th - 18th by both reprogramming the loggers to delay before sampling the Tsoil probes and by adding a capacitor in parallel with the fans to reduce the amount of electrical noise. After these fixes, Tsoil looked okay at Lake and Sage, though the tower sensors still show a slight amount of noise.

Net radiometers were used at all 3 sites. They were the only radiometers at Lake and Sage from October 11th - November 18th. However, during this period, a logger program problem prevented data from being acquired until November 18th - 19th. All Rnet values should be normal [albeit, sometimes with ice cover] after then.

Upward and downward pyranometers were deployed at all 3 sites starting November 18th - 20th using Kipp and Zonen radiometers. All appear to have operated normally.

Upward and downward pyrgeometers were deployed at all 3 sites starting November 18th -20th using Epply sensors. In addition, downward-looking pyrgeometers were deployed over two other surface types (mostly bare ground on December 17th and greasewood on January 7th) near the main tower to extend the lower sampling. An upward and a downward-looking sensor were mounted at 4m over this bare patch (also December 17th) as a second level in the flux-divergence array. A pair (for redundancy) of upward and downward-looking sensors were mounted at 25m (December 17th, though trolley not extended until December 18th) as the third level of the flux divergence array.

Note that the "bare" site was approximately north of the main tower and thus was shaded by it from direct sun about noon every day. This wasn't considered a problem since the long-wave flux divergence sub-experiment only needs data at night.

All of these pyrgeometers were carefully calibrated in our oil bath, so that accuracies of <1 W/m2 could be obtained. However, Tdome-Tcase from the 25m and 4m.in.bare pyrgeometers were odd after setup. A wiring problem in the logger was discovered and fixed on January 27th. This cable swap also caused the wrong calibration coefficients to be applied to these signals. Our S-functions dat.Tdome and dat.Tcase have been changed to correct this problem. The 4m.in.bare "problem" appears to have corrected itself by January.

FLOSSII Pyrgeometers

Variable Name	Station	S/N	B * (lab)	B * (roof)	f(%) * (roof)	Notes
Rlw.in	1 (grass site)	26416	2.9	2.4	0.9	
Rlw.in	2 (sage)	26417	2.6	2.1	1.3	
Rlw.in	3 (lake)	29137	1.7	-	-	Faulty case temperature (Tcase). Removed December 4th
Rlw.out	1 (grass site)	29260	3.4	2.9	1.1	
Rlw.out	2 (sage)	27907	3.5	2.5	0.2	
Rlw.out	3 (lake)	29136	2.3	1.8	1.9	
Rlw.in.4m	0 (bare site)	31981	3.6	2.1	1.1	Installed December 17th
Rlw.out.4m	0 (bare site)	31980	3.9	1.9	1.2	Installed December 17th

Rlw.out.bare	0 (bare)	31976	3.0	2.5	0.5	Installed December 17th
Rlw.out.grease	0 (greasewood)	31978	3.5	3.0	0.9	Connected January 7th
Rlw.in.a.25m	0 (tower)	31975	2.9	2.4	0.7	Installed December 17th
Rlw.in.b.25m	0 (tower)	31979	3.2	2.7	0.8	Installed December 17th Removed January 7th, to check questionable case and dome temps. Reinstalled January 27th, 15:30 MST
Rlw.out.a.25m	0 (tower)	31974	3.1	2.6	0.5	Installed December 17th Removed January 7th, to check questionable case and dome temps. Reinstalled January 27th, 15:30 MST
Rlw.out.b.25m	0 (tower)	31977	2.4	1.9	1.2	Installed December 17th

* The above B and f values are used in the calculation of the long wave radiation (R_{lw}) from the pyrgeometer thermopile value (R_{pile}) and the case and dome temperatures:

Where SB is the Stefan-Boltzmann constant which is

$$SB = 5.6704 * 10^{-8} \text{Wm}^{-2}\text{K}^{-4}$$

$$R_{lw} = R_{pile} + SB * (T_{case}^4 + B * (T_{case}^4 - T_{dome}^4)) + f * R_{sw}$$

At the end of the project, we ran a side-by-side comparison of all of the pyrgeometers on the roof of FLAB. During this comparison, we made a set of shading tests to evaluate the response to short-wave radiation. Several of the short-wave tests did not make sense (show an inverse top-hat response when shaded) using the above (laboratory-derived) B values. It was possible to obtain top-hat response for all sensors by making the B values smaller. However, using the set of B and f values thus obtained, there still are differences of up to 5 (typically 2) W/m². (We note that even larger differences were seen during periods when the sensors weren't cleaned daily.) The QC-corrected data use the coefficients from the rooftop tests. We will leave any additional corrections to the user.

SOIL

There were lots of soil measurements for FLOSSII because we wanted to sample the heterogeneous surface. Each of the 3 main sites had 3 subplots with a complete set of sensors (see [diagram](#)). Each subplot had a 3-level temperature profile (2.5, 5, and 10cm), 2-level moisture profile (5 and 10cm), and 1 heat flux measurement (10cm). All of these sites were installed October 4th - 5th to give them time to settle in. (They were "set" by pouring water over the site after installation.) In addition, each of the main sites had one thermal properties probe installed December 16th - 18th to determine heat capacity and thermal conductivity. Many of the sensors to implement this spatial sampling have been provided by the NCAR Hydrometeorological Land and Water Initiative (see [here](#) for more information). Note that the installation in October was in normal soil, but the December installations were in frozen ground. It appears that the TP01 sensors installed in the frozen ground did not couple well to the soil until a thaw that occurred January 14th.

The soil temperature measurements were good, with the exception of the fan noise problem noted above in the radiometer section. Also, Tsoil.a.2.5cm at Sage had extreme variations. This could have been due to the sensor being exposed to air. However, subplot "a" was

directly underneath a sage bush, so the dirt around this sensor could have been heated by the plant material (which is black). We decided to leave this sensor alone and its data have been retained in the final data set.

The soil heat flux probes were mostly okay, with the following notes:

- Gsoil.a.10cm was installed upside-down at Lake. Its data have been multiplied by -1. Its cable was cut on October 27th and repaired on December 18th.
- Gsoil.b.10cm was installed upside-down at Lake. The cables were swapped in the logger box to correct this on November 20th and the data multiplied by -1 before then.
- The data from Gsoil.c.10cm at Lake only look reasonable from December 17th - 28th. We chose not to fix the frayed cable in the frozen ground.
- Gsoil.c.10cm at Sage became bad on December 18th, due to our activity. We failed to fix it January 7th.

All of the bad data due to these cable and sensor problems has been deleted.

The soil moisture probes (Ech2o) all reported values, with the following notes:

- Qsoil.c.10cm at Lake failed on December 3rd, due to a bad cable. We determined that repair (or replacement) of this probe would disturb the other soil measurements in this subplot, so it remained bad for the rest of the experiment.
- From October 4th - 10th, the sensors at Lake and Sage were installed horizontally, rather than vertically. Due to a logger programming problem, none of these values are available anyway.

However, an e-mail exchange that we had with the manufacturer after the project explained that these probes (and others that depend on the electrical properties of the soil, including our CS615 and TRIME probes) do not detect frozen water. Thus, **MOST OF OUR SOIL MOISTURE MEASUREMENTS ARE NOT VALID**. The data have been edited to remove all Qsoil measurements when the corresponding Tsoil is below zero. This removes all but the last few weeks (spring thaw) of data at the Sage and Lake sites. (The grass cover at Grass insulated the soil so it remained frozen through the end of the project.) We made a few gravimetric measurements at each subplot which also should be valid. A [plot](#) shows all of the good soil moisture measurements. In this plot, rows correspond to the grass, sage, and lake sites (from top to bottom) and subplots a, b, and c (left to right); Ech2o measurements are lines (blue is 10cm while magenta is 5cm) and gravimetric samples are dots, colored to correspond to the Ech2o locations when appropriate. Obviously, not much data remain. It should be possible to correlate the TP01 heat capacity values (see below) with soil moisture, though these measurements were not made in the same subplots. (The TP01 values are shown in the above plot as green lines.) This task will be left to the user.

In addition, we deployed a soil thermal property probe (Hukseflux TP01) at each site. This is a new measurement for ISFF, but should provide a better estimate of soil heat capacity than we have made for earlier studies (using mass-weighted bulk thermal properties and crude estimates of soil composition). Also, these probes measure the soil thermal conductivity, which is needed to correct our soil heat flux measurements. Unfortunately, we did not obtain these probes until the soil was frozen and we also had some wiring errors (though little data were lost because of the wiring since the probes took a long time to settle). Thus, a complete data set is not available until January 27th. It appears that these probes needed to settle in the frozen ground -- they were installed with a slight (<1mm) air gap with the soil. The data appear to show that none of the probes were really settled until a soil warming period at the end of January (see [plot](#)). Additionally, the signals from the probes at lake and sage had significant noise, caused by the voltage controller of the PAM station. We fixed this noise with a voltage regulator on February 22nd, though the data before appears to be usable.

BAROMETERS

These worked as expected. Main site's PTB100 had a second-order temperature effect, causing errors on the order of 4mb in the cold temperatures. (See logbook comment [44](#).) This has been corrected in the data using the fit: $Perr(mb) = 3.4 - 0.126 * T_{box.cosmos}(C)$, where these coefficients were calculated using the data from the Sage site, adjusted by -0.1mb to account for the 1m height difference. Hoses between the pressure ports and sensor were not connected at Lake and Sage until October 10th. Data from this period have not been removed since a slightly bad pressure should be more useful than no pressure.

PRECIPITATION

There was a weighing precipitation gauge and an ultrasonic snow depth gauge at the main tower site (near grass radiation stand). Both were installed on the November 21st visit. The weighing gauge did not report values between November 21st and December 15th for an unknown reason. It appeared to work later. Its response was tested on January 7th and it was only one "tip" off (43 reported of 44 expected), so the data should be okay. These tips have been removed from the data.

The snow depth gauge was noisy since it was deployed, similar to its behavior during FLOSS01. Thus, the data probably are useless, even though the mean value is nearly correct. We moved it on 1/6 to a location which shouldn't see interference from the radiometer stand legs, but the noise didn't change. Nevertheless, these data are included in the final data set since they appear to be a reasonable indication of when it was snowing (when the signal has large variations and often goes to zero)!

As mentioned above, the krypton hygrometers appear to be a good indicator of fog!

DATA SYSTEM EFFECTS

The October and November data were gathered exclusively through the GOES satellites. Our recent experience with data taken this way is that about 10% of the data have errors. We have eliminated the data when checksums were not correct.

FLOSSII FIELD LOGBOOK

A computer-readable [field logbook](#) of comments noted by NCAR and other personnel is available in read-only html form and updated every day.

PHOTOGRAPHS

Main Tower:

- October 1st, 2002
- November 20th, 2002
- November 21st, 2002
- December 4th, 2002
- January 27th, 2003
- IOP: February 17th - March 7th, 2003
- Ice Detectors

Sage Site:

- October 10th, 2002
- November 20th, 2002
- January 7th, 2003
- January 27th, 2003
- IOP: February 17th - March 7th, 2003
- TCAM test: March 26th - 27th, 2003

Lake Site:

- October 10th, 2002
- November 20th, 2002
- December 4th, 2002
- January 27th, 2003
- IOP: February 17th - March 7th, 2003

Other:

- University of Wyoming King Air
- Wildlife
- Misc.

PHOTOS FROM TOWER

An Axis 2420 network camera is installed on the tower at about 28 meters, looking west. Photos of VGA resolution (704x480) were saved in JPEG form every 15 minutes from 05:00 to 20:00 local time (MST=GMT-7). Contact ISFF for these data. [Photos at 08:00, 12:00 and 16:00 local time](#) each day are available online.

Note that the exposures of these images varies considerably -- even between the 15-minute shots. We highly recommend examining the entire set for any serious use of these images.

DAILY QC PLOTS

[Preliminary time series, profile and spectra plots](#) are available for review of data quality. The time series plots are of the 5-minute statistics, covering 48 hours, centered on local noon of each day. Hourly profiles from the 30 meter tower are plotted from 5-minute or 30-minute means, as labeled. Spectra plots are made from 30-minute periods of high-rate sensor data, starting at the stated time.

FLOSSII DATA ACCESS

The NCAR FLOSSII data is available for download in the following forms:

- [5-minute statistics in NetCDF form](#)
- [High rate data in ASCII or NetCDF](#) (via a Java application)

[More information about this event...](#)



PROJECT WEBSITES

[ISFF Project Page](#)

CONTACT INFORMATION

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