Cloud Sensor User's Manual

2006-01-19

Serial # _____

V004G for firmware version 0x35 and above, and Clarity version 1.58 and above.

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1. Warnings

a) **THIS DEVICE IS PRIMARILY INTENDED FOR OBSERVATION PLANNING. While it can be used to trigger the closure of an observatory under adverse weather conditions, it is NOT intended as the primary or sole protection against rain or snow entering the observatory. Under certain meteorological conditions it is possible for rain to occur without clouds being detected by the sensor. Significant rainfall or snowfall may occur before the wetness detector triggers. Improper installation or adjustment may impair detection of adverse weather conditions. Operator vigilance and the use of multiple weather information sources are essential when operating an observatory remotely.**

b) **THE METAL SENSOR HEAD AT THE TOP END OF THE CLOUD SENSOR UNIT CAN GET HOT (70°C or 158°F).** Do not touch it carelessly even if you think that it should not be hot. An unlikely failure of the wetness sensor could cause it to heat unexpectedly.

c) The emergency dome closure connector (see section 11) may call for a dome closure at any time. **IF YOU ARE WORKING ON THE DOME, TURN OFF THE POWER TO THE DOME.**

d) Please do not adjust the 7 screws around the outside of the cloud sensor unit. On some versions of the Cloud Sensor they are supposed to stick out a bit.

e) When correctly installed, the Cloud Sensor Unit is rain-proof. Never immerse the unit in water. Also, the power supply and adaptor box are for indoor use only.

f) At the cable connector end of the Cloud Sensor Unit there is a small temperature sensor. It is fairly well protected from mechanical damage but, if you really try, you could break it.

g) The mini-DIN connector on one end of the cable can be plugged into your PC and other devices. Do not do that. It is ONLY to be plugged into the supplied adaptor box.

h) We strongly suggest that you try the Cloud Sensor Unit indoors as explained in section 4 before doing the final installation.

2. Introduction

The Cloud Sensor senses how clear the sky is, measures the ambient air temperature, and detects wetness (snow and rain). It must be mounted out of doors in a location that provides a clear view of the sky. A cable runs from the sensor unit to the indoors, and connects to the supplied adaptor box. This adaptor box has a wall plug power supply connector, a DB-9 serial port for connection to a computer, and another connector which is used to request an emergency dome closure. The supplied "Clarity" software operates with Windows 98 and later, and provides a visible and audible interface. It has a single line file and a COM (ActiveX) interface to allow the Cloud Sensor to input to observatory automation software.

Here are some of the intended uses of the Cloud Sensor and Clarity software:

a.   Identify sky conditions before starting an observing session or opening a remote observatory;
b.   Warn the user who is indoors, when the skies become clear so the user knows that observing could start or resume;
c.   Warn the user that conditions have changed from clear to cloudy and that further imaging will not succeed;
d.   Warn the user that conditions have become very cloudy and that the observatory should be closed soon;
e.   Warn the user that conditions have become wet and the observatory should be closed immediately;
f.   Automatically close an observatory when conditions become very cloudy or wet, even if the user is not at the computer to see the warning, or the computer is not functioning;
g.   Provide the Cloud Sensor's data via a COM (ActiveX) or file interface, to other software.

3. Operating Principles

The Cloud Sensor detects the presence of clouds in an indirect manner. What it really does is measure the sky temperature by sensing the infrared radiation from the sky in the 8 to 14 micron wavelength range. It uses a thermopile to do this. It then compares this reading to the ambient temperature at the bottom of the Cloud Sensor Unit. A clear sky is at least 20°C (36°F) colder than the ambient temperature near the ground. A fully overcast sky with low clouds (the kind that rain usually comes from) usually will be close to the same temperature as the ambient temperature.
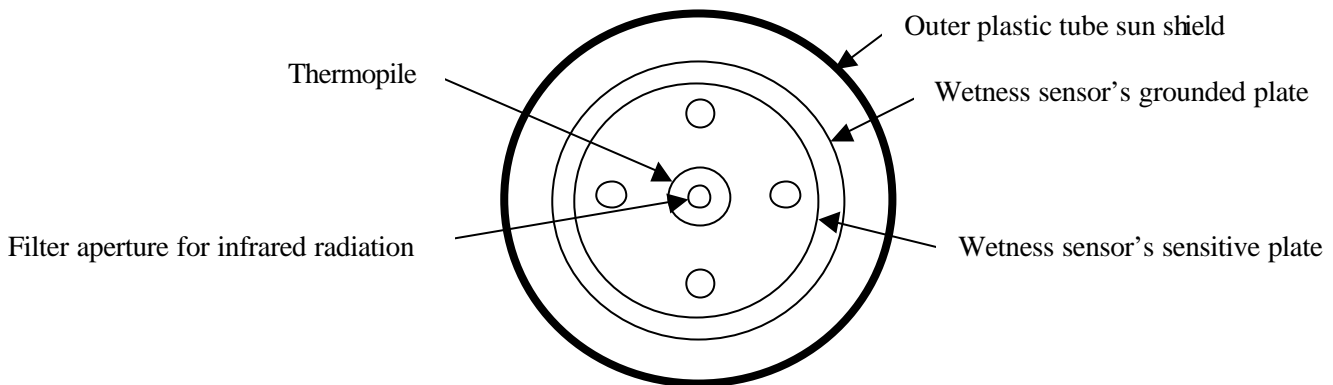
Very high thin clouds composed of ice crystals (cirrus) are by nature quite cold and therefore may not be detected by the Cloud Sensor. Unfortunately, this might fool you into thinking that you can observe when you cannot. This might waste a bit of your time but on the positive side these clouds do not contain rain.

There are some unusual meteorological situations where rain clouds can be high above ground and therefore cold. If so there will be a warning only after the rain begins to fall.
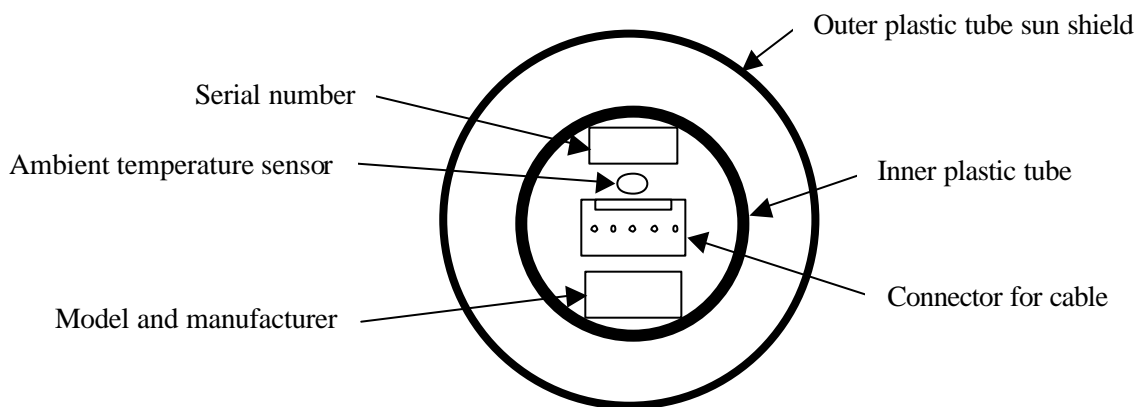
While these limitations due to the physics of the atmosphere are unfortunate, you should find the Cloud Sensor a very useful adjunct to your astronomical observing, just as we do.

The thermopile for measuring sky temperature is inside the little round can (a TO-5 transistor case actually) on the sky end of the Cloud Sensor Unit. You can see the filter aperture that lets the infrared radiation enter the device. This device also contains a thermistor which is used to measure the temperature of the case around the thermopile. At the other end of the Cloud Sensor Unit, near the cable connector, is a thermistor which measures the ambient temperature. The Cloud Sensor Unit should be

Sky End View (shows the sensor head)

Thermopile

Outer plastic tube sun shield

Wetness sensor's grounded plate

Filter aperture for infrared radiation

Wetness sensor's sensitive plate

Ground End View

Outer plastic tube sun shield

Serial number

Ambient temperature sensor

Inner plastic tube

Model and manufacturer

Connector for cable

Note that the 7 screws which support the inner plastic tube and lock the circuit board in place have been omitted for clarity.

Figure 1 - Ends of the Cloud Sensor Unit

positioned so that this ambient-measuring thermistor will actually be at a temperature near that of the ambient ground temperature.

Around the thermopile device there are two concentric stainless steel disks, the top one being a little smaller than the one beneath. These two disks are electrically insulated from each other and together they form the wetness detector. If a drop of water bridges the two disks, a slight electric current flows between them signaling the presence of moisture. This sensor is also able to detect snow and ice because usually it is heated sufficiently to melt them.

The thermopile cannot see through any form of water. This means that any wetness must be removed quickly. This is done by three methods. First, the sky end of the Cloud Sensor Unit is normally heated to 4°C (7°F) or more above the ambient temperature to prevent the formation dew or frost. Second, when it

is wet, the sensor head is heated to 70°C (158°F) until it is dry. Third, the Cloud Sensor Unit is installed at a tilt from the vertical position so water runs off of the sensor head.

The double tube configuration provides a solar shield for the sensor unit – especially for the ambient thermistor. The Cloud Sensor is primarily designed for use just before and during the night. It is not well enough shielded to give fully accurate ambient temperature readings in full sun, especially if mounted over a hot roof rather than on a pole over vegetation.
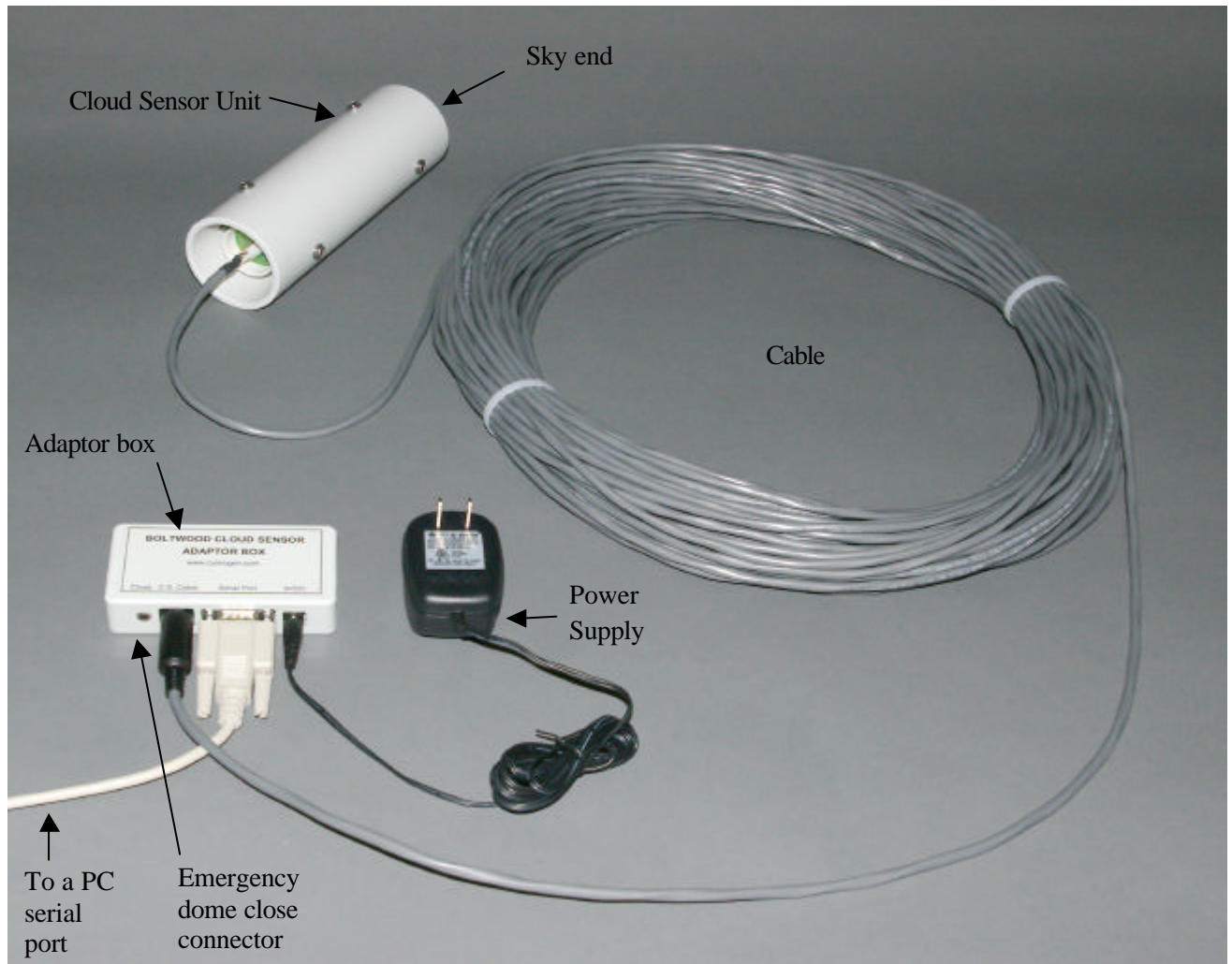

Figure 2 – Cloud Sensor system with the hardware parts interconnected

4. Software Installation and Cloud Sensor Familiarization

The CDROM supplied contains the Clarity software, this manual, and the program TestClarity. TestClarity is discussed in section 13.

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Please follow these steps to install the software and test the Cloud Sensor:

1. Install the Clarity software from the supplied CDROM, or from a more recent version you have found on the web site. When you insert the CDROM into your computer, the install program should start automatically. Just follow its on-screen instructions. If it does not start automatically, please browse the contents of the CDROM and run the program called "SetupClarity.exe".

   You might wish to add the Clarity program to your startup menu so that Clarity is always running when your computer is running.

2. Next, try the system indoors before installing the Cloud Sensor Unit outdoors, by following these steps:

   a. Do not plug in the wall plug power supply yet. This precaution is necessary in case you misregister the rectangular connector at the rear of the Cloud Sensor Unit. Connect the cable to both the Cloud Sensor Unit and to the adaptor box. The cable is supplied in a coil held together with white cable ties. Enough slack has been left at each end so that you probably do not need to cut the ties.

   b. Connect the adaptor box to one of the computer's serial ports using the supplied DB9 extension cable. Note which COM port number you have used. Check that the line voltage marked on the power supply matches your line voltage. Then plug in the power supply to the adaptor box and to the building power. The "audio" jack on the adaptor box is not used at this time. If the Cloud Sensor Unit is not yet near room temperature, leave it until it is. It does not matter in what order you plug things together or run the software, except as concerns the registration of connectors noted above.

   c. Run the Clarity software. You may get the message, "Could not find any previous settings in registry - using defaults. This is normal if Clarity has never been run before". Just click OK.

   d. Enter your COM port number into the "COM Port" field. If all is well, after less than 30 seconds the circle just to the left of the COM port field will flash green every 3 seconds meaning that the computer is receiving signals from the Cloud Sensor Unit. If the circle remains red or you get "No Msg's" continuously, check all of the Cloud Sensor hardware connections and make sure that you have the COM port number correct.

   e. Familiarize yourself with the software, and the various readings and alerts. After a few seconds, the three fields at the top of the window should contain numbers. Aim the unit at something that is at room temperature and the left hand number should be near zero. If it reads 999.9, wait a couple of minutes for the sensor to heat up a bit and try again. Aim it at your skin and the number should read either a few degrees positive or 999.9 (it won't show your true temperature because it quickly saturates for positive temperatures, indicating 999.9). Aim it at something taken from your freezer and the number should be quite negative.

   During all of this, the top middle number field should be showing the air temperature in the room. The "% heat" box should be above zero all of the time (indicating that heat is being applied to the sensor's case) dropping to a low (but non-zero) value when the sensor's case has been warmed to about 4°C (7°F) above the ambient temperature.

After a few minutes the top right number field should indicate a temperature that is about 4°C (7°F) above the Ambient Temp. If this is true, slightly dampen your finger and touch across the sky end stainless steel disks (CARE – an unlikely fault could cause these to be hot). The junction between them is the rain sensor. By bridging it you are simulating rain. The "wet" square should turn blue and the stainless steel disks should get warm to the touch in a minute or so. If you wish to, you can simulate some "rain" with a sprinkle of water. The sensor head should then heat until the water on the junction between the stainless steel disks evaporates. The heater will then shut off until the sensor head cools. NOTE that the sensor head could heat up to a HOT 70°C (158°F).

Take a look at section 9.1 of this manual and try out the Alert For and Alert Type check boxes, and the Clear/Cloudy/Very Cloudy (V.C.) thresholds. Become familiar with the various alerts.

5. Cloud Sensor Unit Installation

The Cloud Sensor Unit must be installed out of doors in a location where it has an unobstructed view of the sky. It will not work through a glass window. Its field of view is in the shape of a cone with an included angle of approximately 80°. There is some sensitivity out to 120°. Any substantial obstruction in that field of view will reduce the sensitivity and accuracy of the unit.
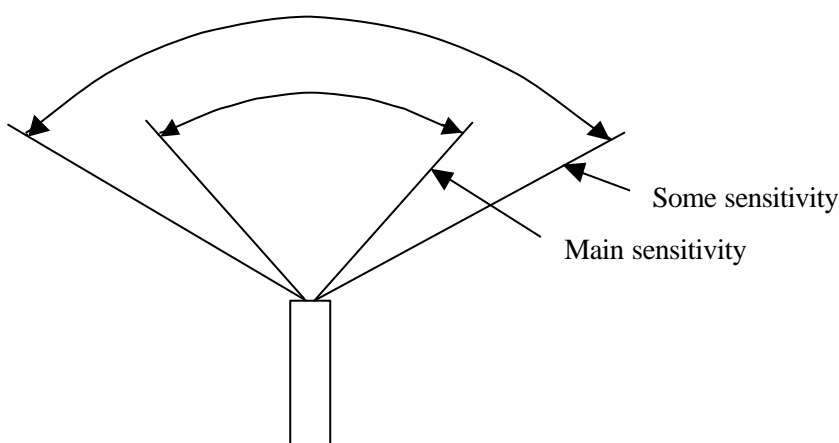

Some sensitivity

Main sensitivity

Figure 3 - Cloud Sensor sky angular coverage

The unit is installed with a tilt of 10°, or a bit more, from the vertical. This tilt allows water to run off of the surface of the stainless steel disks. Otherwise it would take a lot of heating to evaporate that water.

It would be better to lean 10° into the direction from which the prevailing winds blow. This will allow, in most situations, the Cloud Sensor Unit to detect a change in the weather slightly earlier than otherwise.

The Cloud Sensor is quite robust but it must not be installed in a highly polluted or corrosive environment. Normally you would not locate an observatory in such a place.

Because the Cloud Sensor head can get very hot (70°C or 158°F), locate the Cloud Sensor Unit such that no one can casually touch it.
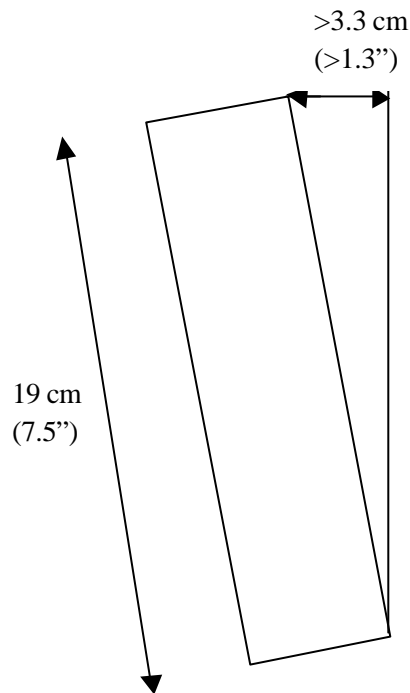
>3.3 cm
(>1.3")

19 cm
(7.5")

Figure 4 - Tilting Cloud Sensor to allow the rain to run off

The Cloud Sensor Unit does not come with a mounting bracket because we expect everyone's situation to be different. One way to mount it would be to fasten a piece of aluminum channel or angle to the edge of your roof and tilted at the requisite 10°. An even better location would be on a pole or post positioned over vegetation. In this way the ambient temperature sensor would not be affected by the heat from your roof or driveway during and after a hot, sunny day.

Prepare to fasten the Cloud Sensor Unit to your bracket using two of the longer cable ties. You may need to put small notches in your bracket where the ties will go around it so as to avoid having the Cloud Sensor Unit slip down (especially with temperature changes). Place each tie against a ring of 3 screws around the 6 cm (2.4") tube, with the ties on the middle side of the screws. Position the Cloud Sensor Unit near the top of the bracket such that the thermopile cannot see the bracket. Make the bracket long enough to keep the Cloud Sensor Unit above any snow drifts – if you get any.

Figures 5, 6, and 7 show a sample installation. 2 cm (¾") aluminum angle 1.5 mm (.060") thick was used along with some 2.5 cm (1") square aluminum tubing with a 1.3 mm (.050") wall thickness.

The cable has been sent to you in a coil without twists in it. To keep it that way you need to cut the two white cable ties and then unroll the cable instead of just holding the bundle and pulling at one end.

For those who do not already have a convenient hole through an exterior wall for the cable, drill a 15 or 16 mm (5/8") diameter hole through the wall, making very sure not to drill through any electrical wires or plumbing pipes. To thread the cable, it usually is easier to start with the cable inside. Push a straightened out metal coat hanger with the hook at the outside end, from outside to inside. Tape the rectangular connector and 10 cm (4") of cable to the coat hanger. Pull on the coat hanger. You might need a second person inside to unroll the cable and to make sure that the cable does not snarl. If you are alone, unroll the cable inside first before pulling it through the wall. Note that the end of the cable with the rectangular connector goes to the Cloud Sensor Unit.

If you must use a smaller hole (large enough for the cable itself but without the connector), you can disassemble the rectangular connector using a very small screwdriver and a lot of care. First push the 5 wires into the connector slightly. This disengages the retaining tabs on the clips. Then you depress the retaining tab of the clip for each pin. They are visible in each of the rectangular small holes on the longer side. With the retaining tab depressed you gently pull on the wire and the clip will come out.

Before reassembling the connector you might need to use a small knife to bend each retaining tab upward slightly. The pinout for the rectangular connector is:

Pin Number	Wire	Signal
1	black	Data Out
2	white	Data Return
3	red	+9V Return
4	green	+9V
5	brown	/ITSWET

Note that the "1" (for pin 1) molded into the rectangular connector housing is hard to see. It is right beside one of the side slots at the edge of the connector. Pin 5 has "2695" molded in over it.

Another possibility for those with some electronic assembly skills, is to cut the cable at a point that will be well indoors when you are finished. Then thread the outdoor portion though the wall. Now cut back the covering on both sides of the cut. Slip large heat shrink tubing over one end of the cable. Strip the wires and slip heat shrink over each wire on one side. Solder the wires together matching the colors. Insulate the joints with the heat shrink and shrink it. Slip the large heat shrink over the entire joint and shrink it.

Do not have the wall plug power supply plugged in when doing the next step. This precaution is necessary in case you accidentally misregister the rectangular connector at the rear of the Cloud Sensor Unit. Plug the rectangular connector on the cable into the bottom end of the Cloud Sensor Unit. Use one of the cable ties to strain-relieve the cable on something below and close to the unit. Tie the cable against a flat or convex surface - not the inside of an angle or U channel.

Fasten the cable to the building using the cable ties that are supplied. The ties that have a hole at the end allow you to screw them to a wall. If you need extra ties you should be able to find them in the electrical section of a hardware store. Use the black version (which should be labeled UV light resistant).

Support the cable well enough so that it will not flex in the wind – especially if the temperatures might go below -20°C (-4°F). The cable is inflexible when very cold and may crack if flexed or handled. Put a drip loop into the cable before entering the building so that water running down the cable cannot run into the hole in the wall.

Bring the cable indoors to near your computer. Plug the Cloud Sensor cable into the adaptor box and you are done.

6. Reliability

The Cloud Sensor is built to good commercial standards and failures should be very rare. It should give satisfactory service for many years. Its most essential detector as far as observatory safety is concerned, is the wetness detector. If it does give an erroneous reading, it is more likely to show wetness when it is

Figure 5 - Typical roof installation (note the tilt)

Figure 6 - Showing the aluminum square tubing that allows the aluminum angle to clear the roof edge

Figure 7 - Showing notches in the aluminum angle

actually dry, rather than the other way around. However the Cloud Sensor is not ultra-reliable with multiple redundancy, etc. Please do not use it as the only protection for expensive equipment.

Wind and rain can cause serious damage to observatory equipment. The Cloud Sensor is not intended as safety equipment, nor is it intended to be a substitute for due care and vigilance in operating your observatory. It can provide an extra level of security by being set up to automatically close the observatory whenever thick clouds or rain are detected. However, significant rain may already have fallen by the time the observatory closes – this should only be considered a "last resort" protection system. We strongly recommend that you maintain watch on local satellite and radar images, forecasts, and observe local weather conditions.

7. Birds

A couple of customers have had problems with birds perching on the Cloud Sensor thus blocking the sensor. The birds also used it as a toilet. A possible solution is to find some galvanized welded wire fencing with a grid of 1/2" to 1" (1.5 to 2.5 cm) mesh size. Cut a piece long enough to wrap around the Cloud Sensor (about 8" or 20 cm) and about 2" (5 cm) wide. Do the cutting such that on one side it is all sharp ends as long as the grid size allows. Wrap this around the plastic tube at the top and hold it on with a stainless steel plumber's gear clamp. This won't interfere much with the IR sensor and should be a pain for the birds.

(Un)fortunately we do not have this problem at the factory so we have been unable to test this. Please report any experiences to us.

8. Lightning

Unfortunately many good mounting locations will also attract lightning. The Cloud Sensor has lightning protection in the Cloud Sensor Unit and in the adaptor box. These should protect against the surge from nearby lightning hits. They will not protect against a direct hit (nothing simple or inexpensive will). We do not warranty the unit against lightning damage, nor damage to your building or other equipment due to lightning that the cable might conduct inside, because it is beyond our control. In high frequency lightning areas an optical isolation device on the RS-232 interface between the adaptor box and the computer is strongly recommended.

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If the unit is vulnerable, place a properly grounded lightning rod nearby. Also provide a heavy grounding wire from the metal bracket you mount the unit on directly down to a ground rod. The typical roof installation pictured in figures 5 and 6 has such a grounding wire. A few loops in the cable near to the cable entrance to the building will also help keep a direct stroke of lightning out of the building.

9. Clarity Software

This software package runs on your Windows PC and interprets the measurements from the Cloud Sensor Unit. It also allows you to control which events will cause alerts and what those alerts will be. It is named "Clarity" because it indirectly displays the clarity of the sky above the sensor. The following is a field by field description of the window:

9.1 Window

The caption of the Clarity window gives the version number of the Clarity software. The Clarity window shows the latest data from the Cloud Sensor Unit on the top row. Below that is a square that contain a flag which changes color if the Cloud Sensor Unit is wet (blue), or shows the same color as the window background. To the right is the heater power as a percentage.

The Clarity window displays temperatures in either degrees Celsius (°C) or degrees Fahrenheit (°F). The choice is yours, and you set it using the °C and °F buttons. Some fields display actual temperature. In the top left hand example in figure 8, Ambient Temp. is 25.1°C. Other fields contain temperature differences. In the same example, Sky-Amb. Temp. is –31.4°C.

The other fields are operator settable and control how the Cloud Sensor data is used. Some combinations which would not make sense are prohibited. Some seemingly unusual ones do make sense, such as alerting for clear, very cloudy and wet. You might wish to make such a selection when your observatory is open but some clouds came in preventing observing, and you expect they will disappear soon.

In detail:

Sky-Amb. Temp.   Sky temperature minus ambient temperature. This is near zero for a fully overcast sky and, say, –25°C (-45°F) or more negative for a clear sky.

Note that this value may be quite erratic when the sensor is wet. This occurs because of a varying amount of water over the thermopile window, and effects from the operation of the heater while it tries to evaporate off the water.

This might saturate to 999.9 if the unit is pointed at something that is warmer than ambient. It might saturate in the other direction to –999.9 when it is pointed at something that is very cold relative to the thermopile case. Some thermopiles will saturate at –60°C. If this happens, be thankful that you have such skies!

Ambient Temp.   Ambient temperature (from the sensor located at the bottom end of the Cloud Sensor Unit). This serves as an approximation for the near ground temperature.

Sensor Temp.   Temperature of the case of the thermopile.

Sensor Is:

wet — When this is blue, it is raining (snowing) or has just finished raining (snowing). This condition is also possible under extreme dewing or frosting conditions.

% heat — This shows how much of the available heater power is being applied to the sensor head.

Thresholds:

Clear/Cloudy — User settable. When the Sky-Amb. temperature is more negative than this value, Clarity declares the sky to be "clear". When it is more positive than this, the sky is "cloudy". The default value is -25°C (-45°F). As you gain experience with using Clarity you may wish to adjust this number to better suit local conditions and the current season.

Cloudy/V.C. — User settable. V.C. stands for "Very Cloudy". When the Sky-Amb. temperature is more negative than this value, Clarity declares the sky to be "cloudy" (or "clear" – see above). When it is more positive than this, the sky is "very cloudy". The default value is -10°C (-18°F). As you gain experience with using Clarity you may wish to adjust this number to better suit local conditions and the current season. Very cloudy skies are the kind which can quickly degrade into raining skies, and there is no point in trying to observe when it is that cloudy.

Alert For (user settable):

Clear — Alerts if the Sky-Amb. Temp. is more negative than the Clear/Cloudy Temp.
Cloudy — Alerts if the Sky-Amb. Temp. is more positive than the Clear/Cloudy Temp.
V.Cloudy — Alerts if the Sky-Amb. Temp. is more positive than the Cloudy/V.C. Temp.
Wet — Alerts when it is raining or snowing.

Alert Type (user settable):

Visual — The bottom field in the window shows the current weather status, normally colored green. If this box is checked and there is an alert, the text will be shown as light green, pink or red depending upon the importance, and it will flash.

Beeper — Your computer's built in speaker is used for alerts. Three different sounds are used. The first is for a normal alert. A stronger sound is used if it is very cloudy. An even stronger alert is given if it is raining. Note that Windows 98 uses the "System Beep" which will not differ between alert types, and on some computers might be barely audible.

Sound — Your computer's sound card is used to generate the alerts. A rain alert is emphatic.

COM Port — User settable. This allows you to inform Clarity as to which serial port the Cloud Sensor is connected to. The small circle to the left of the number should color every 3 seconds. This means that a message has arrived from the Cloud Sensor.

Logging: — User settable. Clarity can create a log file in your computer and record the information from the Cloud Sensor Unit. The log file is located where you choose (Log File button explained below) and new data is appended to it as requested below. The file is normally kept closed so you can view it with an editor while Clarity is running. The user may set:

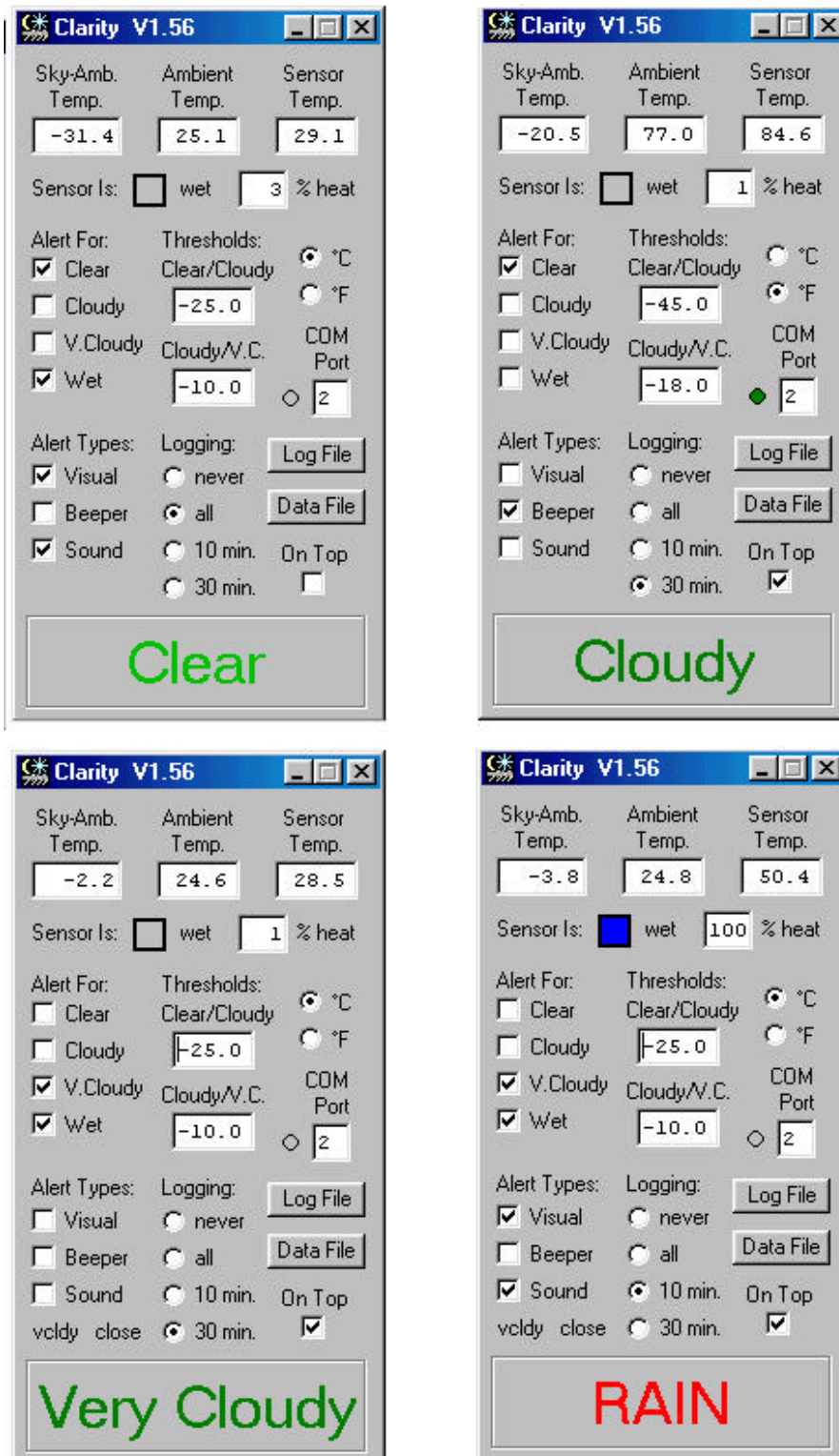never — The log file is not to be used.

Figure 8 – Sample screen captures of the Clarity window

all	All messages go to the log. This is used if you have a problem with the Cloud Sensor Unit and want to send us a detailed report about it.
10 min.	These create a file that you might use to record observing conditions for some further analysis.
30 min.	

Log File — A command button that calls up a Windows Open File dialog box to allow you to set a log file path and name. Until this is done, you cannot request any logging.

Data File — A command button that calls up a Windows Open File dialog box to allow you to set a data file path and name. See Section 10.1.

On Top — User settable. If this is checked the Clarity window will stay "on top" and not be hidden by other windows. If it is on top and then minimized, the minimization will occur. If this was checked, the window had been minimized, and a visual alert occurs, the window will be immediately displayed on top. To stop this behavior uncheck the visual alert.

vcldy — may appear on the left just above the big status field at the bottom. It means that the Cloud Sensor internally has determined that it is very cloudy using a fixed threshold of approximately 10°C (-18°F). This internal flag is used as part of the "contact closure for emergency observatory shutdown" decision (see section 11) as well as part of the heater control algorithm.

close — may appear on the left just above the big status field at the bottom. It means that the "contact closure for emergency observatory shutdown" (see section 11) has been closed.

9.2 Log File

The optional log file keeps a record of the Cloud Sensor's observations which you can use to see what your long term trends are. The log is invaluable to us if you are having any problems. We recommend that you set a log file path and you choose "10 min." as your default setting. Please copy and paste the relevant section of the log file to the end of the "problem" section in the support form at http://www.cyanogen.com/support/tech_main.htm if you report a problem. If you send a log file in an email, please do it as an attachment – it is too hard to read if it is inside an email. Use the "all" setting if you are expecting a problem to occur.

The log file is cumulative from run to run. If you use the "all" a lot, the file can get quite large and you might wish to edit it or delete it.

The data that might be useful to a user is:

```
Date        Time     U SkyRl Ambnt Sensr Block Hea KD32 1CVW  Fvr ... Cvr
2005-01-17 11:20:01 C -43.9 -13.4   3.1 999.9  22 0100 0000  054 ... 1.56
2005-01-17 11:30:02 C -40.7 -12.8   3.1 999.9  21 0100 0000  054 ... 1.56
```

```
Date          local date
Time          local time
```

U	temperature units (C or F). The lines with other letters are for factory use.
SkyRl	Sky-Amb. Temp. field from the Clarity window
Ambnt	Ambient Temp. field from the Clarity window
Sensr	Sensor Temp. field from the Clarity window
Block	for manufacturer use only
Hea	sensor head heater power setting in percent
KD32 1CVW	these are flag bits. The ones possibly useful to the user are:

       K   the "emergency observatory shutdown contact" is closed or has closed since the last log line was generated if this is =1

       V   the sensor head has detected "very cloudy". This is a fixed threshold determination independent of the threshold in the Clarity window. It is used as part of the emergency observatory shutdown determination

       W   the sensor head is wet., or has been wet at least once since the last log line was generated.

Fvr	sensor head firmware version number in decimal (the DIP IC is marked in hexadecimal)
Cvr	Clarity version number.

As well as this, the log records include internal data that will be important for us if you are having problems.

9.3 Registry

Every time the Clarity program is closed or a field is changed, it preserves the following information in the registry:

- location of the window on the screen
- COM port number
- Clear/Cloudy and Cloudy/V.C. threshold temperatures
- Alert For and Alert Types check boxes
- On top setting
- logging setting
- log file path and name
- data file path and name
- temperature unit.

These values are reinstated next time Clarity is run.

10. Remote Operation

The Clarity program has no special awareness of remote computing. It does however have some features that will help:

- The COM or ActiveX interface detailed in section 13. To use this you would have to run suitable software in the same computer that Clarity is running in (and to which the Cloud Sensor is physically connected). This is software that you would write, or possibly from a third party.
- The single line data file facility described next.

10.1 Single Line Data File Facility

A one line file for current sky data may be written by Clarity. This file may be accessed across networks by using file sharing. Use the "Data File" button to set the file used, as is shown in section 9.1. The file is written by Clarity for each message received from the Cloud Sensor (3 seconds apart). The format is:

```
Date        Time      U   SkyT   AmbT   SenT Hea W Since   Now() Day's S
2005-06-03 02:07:23 C  -28.5   18.7   22.5    3 0 00004 038506.08846 1
```
The immediately above line is an example of the only line in the file.

The fields mean:

Date	local date yyyy-mm-dd
Time	local time hh:mm:ss (24 hour clock)
U	temperature units, 'C' for Celsius or 'F' for Fahrenheit
SkyT	sky-ambient temperature
AmbT	ambient temperature
SenT	sensor case temperature
Hea	heater setting in %
W	wet flag, =0 for dry, =1 for wet
Since	seconds since last valid data
Now() Day's	VB6 Now() function result (in days)
S	SkyCondition (see the SkyCond enum in section 13).

Your software may parse this line either by using the fixed number of columns for each field, or by sensing the spaces between the fields. The intention is to maintain this format in future revisions by placing any changes as extra fields at the end of the line.

Clarity (written in Microsoft Visual Basic 6) opens the file with "Output Lock Write", writes the line, and then closes the file. This might mean that occasionally your open to read the file will fail. To read in VB, open this file for "Input", read the line with "Line Input", and then close the file. When opening this file you MUST check for errors.

In your own software, check that "Now" is advancing (or that the date/time is recent). This confirms that the file is being updated by Clarity. Check "Since" to confirm that Clarity is communicating with the Cloud Sensor. If you do not do both checks, you might be badly misled.

This data file should be placed where Clarity is sure to have access to it at all times. If you put the file on a different computer across a network from where Clarity is running, all will be well until either the computer with the file or the network fails. Then Clarity will report continuous errors because it cannot open the file.

When run, TestClarity (section 13) shows the contents of this one line file each time TestClarity does a poll.

10.2 Potential Remoting Problems

If you operate the computer that Clarity is running on via some form of remote console software from another computer, there can be problems. The Clarity executable has to be run in order to give alarms

when needed. The operating system might not allow Clarity any CPU cycles when the operating system or a privileged program crashes, or when the remote console software is waiting for the Internet link to update the remote computer.

To see if you have the latter problem, set logging to "all" and then after a few minutes look at the log. There should be a log line every 3 seconds (firmware 35H plus) or so. If there are large gaps and then sudden bursts, you have the problem. Clarity attempts to alleviate this problem by reading Cloud Sensor messages much faster (every .25 seconds) than the messages are produced. Thus Clarity can "catch up".

This is a safety problem for your observatory but I am afraid that it is beyond the scope of the Cloud Sensor to fix it. The emergency contact closure (section 11) will still function – this problem is part of why that function is completely PC independent.

11. Contact Closure For Emergency Observatory Shutdown

The 3.5mm mono audio jack on the adaptor unit provides a way of performing an emergency observatory shutdown even if your computer has failed. If the Cloud Sensor Unit is seeing a very cloudy sky or it is wet, the inner conductor of the jack is shorted to the outer shell. This contact closure can be used indirectly to activate shutter motors, etc. At all other times when there is power, the inner conductor is floating electrically. For a time after a loss of power to the adaptor box, and just after power on, the contact closure might be open or closed.

To use this facility you need to have some knowledge of electronics in order to connect it properly to your dome/roof hardware.

The outer shell of the jack is connected to the ground pin of the DB9 RS232 connector – and that will be connected to your computer's ground, and to the building's power ground when the DB9 is plugged into your computer's serial port. Your circuit must put between 0V and +30V on the inner conductor of the jack – there is a 33V transorb across the jack. Your circuit must not allow more than 150 mA of current to flow when the contact closes. Note that if you grossly exceed this current limit, you will burn out a transistor inside the Cloud Sensor Unit – there is no protection against this.

When the Cloud Sensor is wet, the short across the jack is continuous. When it is "very cloudy" the short is interrupted for 3 msec. every 3 seconds. This is done for internal reasons and probably will not be a problem for your dome electronics. The "very cloudy" threshold is not the same as the one you set in the Clarity software (which is in the possibly crashed computer!). Instead it is a computer independent threshold of about -10°C (-18°F) that is built into the Cloud Sensor Unit itself.

After the rain has ended, the contact closure may not occur for "very cloudy" until the Cloud Sensor Unit has evaporated any remaining moisture and partially cooled off. The observatory has already been closed so this does not matter.

12. Error Messages

The error messages should be self explanatory. Some will appear in a message box, some in the large text field in the Clarity window, and some that are of concern to the factory only appear in the log file. Clarity will recover from almost all errors.

If you plug/unplug things while Clarity is running, you often will get various communications errors. Clarity will recover from these.

13. COM Interfacing

Note that this has nothing to do with the serial COM port. COM Automation is also referred to as ActiveX. Thank Microsoft for the confusion in terminology.

This allows other software programs (including ones you write) to gather data from the Cloud Sensor. For instance, you may want a program to park your telescope and close your observatory's dome/roof if very cloudy or rain is detected. The following are the properties available in the CloudSensor class. Note that all temperatures are always in Celsius here. SecondsSinceGoodData provides a way to check that the computer is communicating with the Cloud Sensor properly.

Please be sure that you know how to use COM before you try it with Clarity, especially if your program is multithreaded. Obscure problems arise that look like Cloud Sensor failures but aren't, if you break the rule that an object must be created, used, and deleted on the same thread.

TestClarity (which is installed along with Clarity) is a simple Microsoft Visual Basic 6 program that uses this COM facility. The source code as well as an executable is provided, and these are installed into …\Program Files\BoltwoodSystems\Clarity\TestClarity. This is meant to be just an example and it might not be a fully robust program.

Please do use: Set cloud = CreateObject("Clarity.CloudSensor")
as shown in TestClarity and not New to create the object. If you use New, your executable might not work with the next version of Clarity because VB6 might change the class ID when we recompile Clarity here. At the Cloud Sensor's low data rates, there is no efficiency needn to use New.

The ActiveX Visual Basic 6 property declarations:

```
Public Enum SkyCond
     skyUnknown = 0
     skyClear = 1
     skyCloudy = 2
     skyVeryCloudy = 3
     skyWet = 4
End Enum

Public Property Get SkyCondition() As SkyCond
```
        is derived from the rawer properties below.

```
Public Property Get RelSkyT() As Double
```
        is the Clarity window Sky-Amb. Temp. field in Celsius.

```
Public Property Get AmbientT() As Double
```
        is the Clarity window Ambient Temp. field in Celsius.

```
Public Property Get SensorT() As Double
```
        is the Clarity window Sensor Temp. field in Celsius.

```
Public Property Get WetF() As Boolean
```
is true if the Clarity window square "wet" is blue.

```
Public Property Get HeaterPercent() As Double
```
is the sensor head heater power setting in percent.

```
Public Property Get CloudyThreshT() As Double
```
is the value in the Clear/Cloudy threshold field in the Clarity window in Celsius.

```
Public Property Get VCloudyThreshT() As Double
```
is the value in the Cloudy/V.C. threshold field in the Clarity window in Celsius.

```
Public Property Get Fahrenheit() As Boolean
```
is true if °F was used in the Clarity window.

```
Public Property Get SecondsSinceGoodData() As Long
```
allows you to see if data is arriving properly from the Cloud Sensor Unit. There is data about every 3 seconds so allow, say, 15 seconds in order to not report a failure due to bad messages from lightning, etc.

14. Warranty

Boltwood Systems Corporation warranties the Cloud Sensor against manufacturing defects for one year from the date of purchase. This warranty does not cover damage due to improper installation, exposure to heavily polluted or corrosive atmospheres, intentional damage or tampering, lightning, or extreme weather conditions. If you have a problem, please contact us before you ship the unit to us.

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15. Contacting Us

For assistance with the Cloud Sensor, please contact us through our exclusive distributor, Diffraction Limited. Go to http://www.cyanogen.com/support/tech_main.htm, or call (613) 225-2732.   If you are reporting a problem be sure to include a log file (see section 9.2) in your report if it is possibly relevant.

For further information on the Cloud Sensor, demo software, upgrades, or a copy of the manual, go to http://www.cyanogen.com/products/cloud_main.htm.