

## OZONESONDE INSTRUCTIONS – ONE PAGE SUMMARY

1. Initial Ozonesonde Conditioning (3-7 days before flight).
  - A. Check pump pressure, vacuum, and pump current.
  - B. Run on **High O<sub>3</sub>** for 30 minutes.
  - C. Run on **NO O<sub>3</sub>** for 5 minutes.
  - D. Add 3.0 cc of cathode solution (wait 2 min).
  - E. Add 1.5 cc of anode solution
  - F. Run on **NO O<sub>3</sub>** for 20 minutes and record Background.
  - G. Short cell leads - add extra 2.5cc cathode - Store sonde in bag inside flight box.
  - H. Email group within 24-48 hours before launch (include Vaisala calibration file)
  
2. Day of Flight Preparation.
  - A. Change cathode and anode solutions.
  - B. Connect power and ECC sensor leads to ozone test unit for checkout procedure.
  - C. Run on **NO O<sub>3</sub>** for 5 minutes.
  - D. Record Background #1 (BG1).
  - E. Expose ozonesonde to 5 microamps ozone for 10 minutes,
  - F. Go to **NO O<sub>3</sub>** air – Measure 4 to 1.5 microamps decay time.
  - G. Measure T100 flow rate.
  - H. Test Vaisala radiosonde and set frequency
  - I. Attach Vaisala radiosonde to white Styrofoam box.
  - J. Position pump's battery next to sonde frame.
  - K. Connect radiosonde cable to ozonesonde
  - L. Compare computer's time to actual time
  - M. Start telemetry program (strato.exe).
  - N. Connect cell leads to board. Run for 5-10 minutes on filter.
  - O. Obtain final background – hit F9 to enter background into telemetry program.
  - P. Replace metal cover back on ozonesonde.
  - Q. Place ozonesonde inside Styrofoam box, and poke a hole in the side of the Styrofoam box.
  - R. Tape the lid on the box.
  - S. Open Vaisala battery compartment. Release radiosonde sensor tongue.
  - T. Activate wet battery by soaking in water for 3 min.
  - U. Connect power. Tape over connectors.
  - V. Run ozonesonde outside to obtain 5 minutes surface ozone measurement.
  - W. Attach to balloon train.
  - X. Check that Vaisala tongue is out. Antenna is down. Take balloon package outside.
  - Y. Hold for 1 minute at surface if conditions allow.
  - Z. Launch ozonesonde. Record GMT date and time of launch.
  - AA. Track data through ascent and on descent until signal fades.
  - BB. Back up data files on floppy disk.
  - CC. Condition ozonesonde for next flight.

### Reject Sonde if:

1. **Background is >0.10 microamps.**
2. **Background is negative (ex. -0.02 microamps).**
3. **T100 time is <25 seconds, or >34 seconds.**
4. **Vacuum is <14 inches of mercury.**
5. **Pump pressure is <8 psi.**
6. **Pump current is >120 milliamps.**

# OZONESONDE INSTRUCTIONS (ENSCI 2Z)

## INITIAL OZONESONDE CONDITIONING

3-7 days before flight.

1. Remove the ozonesonde from the white Styrofoam box. Connect all the ozonesonde tubing.
2. Place intake tube into **NO/LO** ozone port and connect ozonesonde power leads to the ozone test unit.
3. Turn on the ozone test unit air pump to start flow of filtered air.
4. Run the ozonesonde pump for 5 minutes on “**NO O<sub>3</sub>**” filtered air.
5. Go to Ozonesonde Checkout Sheet to enter checkout information in the “Initial Preparation 3-7 days before flight” section.
6. Disconnect intake tube and cathode sensor tube from pump. Use the vacuum/pressure gauge to measure pump head pressure and vacuum.
7. Record:

Pump current	(50-120 mA)	acceptable range
Pump pressure	(> 8 psi)	left side
Pump vacuum	(>15 inches of Hg vacuum)	
8. Reconnect tubing. Turn on the UV mercury lamp on the ozone test unit.
9. Pull out the silver UV shield. Turn the ozone test unit air pump switch off.
10. Place the sonde intake tube into the **High O<sub>3</sub>** port on the test unit.
11. Run “**High O<sub>3</sub>**” air through the ozonesonde for 30 minutes.
12. Move intake tube to **NO/LO O<sub>3</sub>** port. Turn off the UV mercury lamp. Push the UV shield back in.
13. Turn on air pump switch. Run on “**NO O<sub>3</sub>**” air for 5 minutes.
14. Turn off pump power.
15. Remove cathode and anode plugs (set plugs on Kimwipe or clean surface).
16. Add 3.0 cc of cathode solution to cathode cell. Replace cathode cell. Wait 2 minutes to allow solution to permeate the ion bridge before adding anode solution.
17. Add 1.5 cc of anode solution to anode cell. Replace anode plug.

**Notes:** *Use separate syringes for each solution.*

*Rinse solutions with distilled water after use.*

*Always add the cathode solution before the anode solution.*

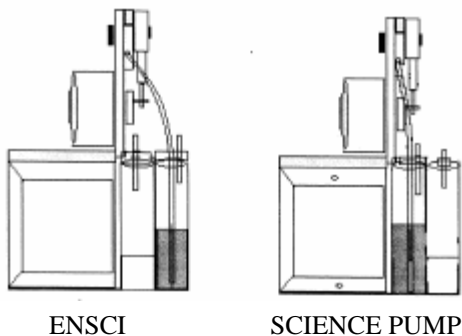
18. Run “**NO O<sub>3</sub>**” air through the ozonesonde for 20 minutes.
19. Record the cell current.
20. Shut power off and disconnect the ozonesonde from test unit and filter.
21. Add 2.5 additional cc's of cathode solution to the cathode cell.
22. Short the ECC sensor leads together with a shorting plug.
23. Place ozonesonde back into the plastic bag and into the Styrofoam box until the day of flight.
24. Email group within 24-48 hours before launch (include Vaisala calibration file)

## DAY OF FLIGHT PREPARATION & CHECKOUT

### Changing the cathode and anode solution:

1. Remove ozonesonde from Styrofoam box. Connect intake tube.
2. Inspect the cathode cap on the cell for KI salt crystals or white film. Rinse off these deposits with distilled water and wipe excess water with a clean Kimwipe before removing the cathode or anode caps.
3. Disconnect the cathode tubing from the exhaust side of the Teflon pump. Use the small pliers to remove the cathode cap from the cell. While holding the *outside* of the cathode tubing (only the section that is below the bottom of the cap, which will be inside the cathode chamber). Thoroughly shake off the excess rinse water.
4. Then check the length of the cathode tubing extending below the bottom of the cap. It should be  $5.2 \pm 0.2$  cm (usually never a problem with ENSCI sondes). Place cathode cap on clean Kimwipe or clean surface.
5. Add cathode solution to the cathode cell until it is full (this is done to rinse the cathode chamber with cathode solution). Then detach the anode cap and place it on the Kimwipe. Remove the anode solution (using the anode syringe) and then the cathode solution (using the cathode syringe). Add 3 cc of cathode solution to the cathode chamber. Put the cathode cap back on with the long tube fitting over the Teflon rod protruding up from the bottom of the cathode cell. **FIGURE 1** shows location of cells in ENSCI and SCIENCE PUMP sonde.
6. Add 1.5 cc of anode solution to the anode cell (Do not rinse the anode chamber with water or cathode solution). Place anode cap back on.
7. Flush the syringes with distilled water before storing.

--- The ozonesonde is now ready for checkout using the ozone test unit ---



**FIGURE 1. Ozonesonde with cathode (represented by blue) and anode (yellow) solutions.**

### **Connect Ozonesonde to Ozone Test Unit:**

9. Pull the labeled metal cover off of the ozonesonde to expose the V@C interface board (**FIGURE 2**).
10. Remove the ECC cell shorting plug and connect the sensor leads to the ozone test unit (cell microamp current leads)/
11. Connect power leads from the ozone test unit to the pump. Place the sonde intake tube about 2-4 cm into the NO-LO ozone port.  
**-- The sonde is now ready to be checked out on "NO O<sub>3</sub>" (filtered) air --**
12. Turn on the ozone test unit power and the air pump switch. The UV mercury lamp should be off. Now turn on the ozone/radiosonde power switch to start the ozonesonde pump. The microamp digital display will show a positive number. Allow the sonde to run on "NO O<sub>3</sub>" air for 5 minutes to allow the microamp background to stabilize. Then record the Background current (BG1) on the checkout sheet in microamp units.

### **Exposure to Ozone (FIGURE 3):**

13. Now give the ozonesonde ozonized air at the 5  $\mu$ amp level for 10 minutes by turning on the UV mercury lamp on the ozone test unit and pulling out the silver mercury lamp shield to generate ozone. Turn on the air pump switch to start the flow of ozonized air out the NO-LO ozone port. Start the 10 minute timing now. Adjust the control shield until you get a fairly stable 5  $\mu$ amps.

### **Response Time:**

14. Have a stopwatch ready. After the 10 minutes of ozone, measure the response time by pushing in the silver shield and switching the UV lamp off. The ozonesonde is now running on "NO O<sub>3</sub>" air. Record the time it takes the current to drop from 4.0  $\mu$ A to 1.5  $\mu$ A.

### **Flow Rate (T100 time) and Final Background Measurement:**

15. After the response test, continue running the instrument on "NO O<sub>3</sub>" air. Connect the soap bubble meter to the exit port on the cathode cell and measure the pump flow rate (**FIGURE 4**).
16. Record 5 flow-rate (T100) times, plus the room temperature and relative humidity on the checkout sheet.
17. After the flow rate measurements, enter the background in microamps "NO O<sub>3</sub>" "Background #2" (BG2=) on the checklist sheet.
18. Temporarily shut ozone/Vaisala power off. Then disconnect the sensor leads from the ozone test unit and plug into the V2C board (blue and white ports are marked in the lower right corner of the board).
19. Connect the multicolor Vaisala cable to the V2C board on the ozonesonde (make sure the multicolor cables are upward on the connector (see **FIGURE 2**). Connect the Vaisala power leads to the test unit (~18 volts).
20. Place sonde intake tube back into NO-LO ozone port. (Test unit air pump – on: UV lamp – off).

## **DRY versus HUMID FLOW RATE TEST:**

The T100 flow rate measured in the previous section needs to be corrected for evaporation of the soap bubble solution. This is done by measuring the flow rate of another ozonesonde pump running on filtered (dry) air followed by measuring the flow rate when the ozonesonde is sampling humidified air.

- A. Allow the dry/humid sonde to warm up on filtered air for 5 minutes.
- B. Make 2 T100 measurements – record on checkout sheet.
- C. Insert the intake tube into a plastic jug containing water ½ minute. Make 3 more T<sup>00</sup> measurements.
- D. Calculate the percentage difference  $100 * (\text{wet-dry}) / \text{dry}$  (If the air is fairly humid the percentage will only be around 0.5 to 1.5%. Very dry air, such as Boulder in the winter, will be around 3.0 to 3.5%).
- E. Record the room temp., RH, and the dry/humid correction on the checkout sheet. This will be entered in Strato.exe when entering the flight data.

## **Checking the Data on Strato.exe:**

21. Verify that the computer's clock is the same as actual time. If it is different, change the computer's clock to actual time.
22. Turn on the receiver and modem. The receiver settings are: -WFM mode, AFC on, Attenuation (ATT) – off. Modem in "FM" mode.
23. Turn the ozonesonde/Vaisala power back on for the Vaisala and ozonesonde pump. You should hear data coming through the receiver at around  $402.5 \pm 1$  MHz. The AFC will automatically tune to the strongest frequency.
24. After you hit enter (last step of telemetry program), data will begin running along the bottom of the screen.
25. A data summary list will appear in the upper left corner of the screen. It will show pressure, altitude, rise rate, temperatures, and ozone (**FIGURE 5**)

## **Record the final ozone background on Telemetry program:**

26. HIT the F9 key to enter new microamp background into the telemetry program. The microamp value will show up on the screen – hit enter to accept the value. Continue hitting F9 as often as you wish to get lower backgrounds. If you know the background should be lower than the value showing up on the screen, after hitting F9, then you can type the value in and hit enter instead of accepting the value shown on the screen. All backgrounds should be less than 0.12 microamps. The average background is  $0.05 \pm 0.03$  microamps. Record the background in the final 03 BACKGROUND in checkout sheet.

If data looks okay then go to the next section, otherwise see trouble shooting section.

## **Preparing the Ozonesonde for Launch:**

27. Turn off power and disconnect the Vaisala and ozonesonde from the test unit. Leave computer and telemetry program on.

28. Attach the Vaisala radiosonde to the side of the Styrofoam box that has a small tab (**FIGURE 6**). Use double stick tape and orange tape.
29. Place the pump battery in the battery compartment on the box. Place tape over the battery compartment.

**NOTE:** *If pump temperature at burst has been greater than 18 C Then:*

- A. Make one or two small ventilation holes (~1/2 cm diameter) in the side of the box.*
  - B. Try to keep the pump temperature between 25-35 C at launch.*
30. Reconnect the Vaisala multi color cable to the V2C board.
  31. Now place the ozonesonde pump inside the Styrofoam box (**FIGURE 7**). Connect the intake tube to the ozone filter before turning on power.
  32. Do a final look to be sure that the ozonesonde tubing is in place and pump power leads are out.
  33. Position the Styrofoam box lid so the tabs line up. Tape the lid on with 2 long strips of orange tape.
  34. Open the flap to expose the Vaisala tongue.

#### **Prepare the wet battery and tape lid on ozonesonde:**

35. Cut open the gold bag containing the wet battery. Position the battery power leads out of the bag so they don't get wet. Now add enough room temperature tap water to the bag to immerse the whole cell in water. Wait 3 minutes. Shake out excess water. Place the cell back in the bag. It may be helpful to trim off some excess on the gold bag so it will be easier to fit back into the Vaisala battery compartment.
36. Connect battery to the sonde. Place tape over the connector. Place wet battery (inside bag) in the battery compartment on the Vaisala radiosonde. Place the white Styrofoam cover over the battery compartment. Fold the crease on the flap inward – the Vaisala tongue will rest on top of the crease. Carefully lift the Vaisala tongue up at about a 45 degree angle and close the flap. Place a small piece of tape over flap to prevent it from opening during the flight.
37. Be sure the filter is on the intake tube. Then plug in pump batteries. Check data once more before taping over the battery leads.
38. If the ozone data shows all 9999's that means that the cell current has fallen below the previous "final background." Hit F9 again to accept the new lower background and enter on the checkout sheet.

**NOTES:** *In warm surface conditions: Once the lid is taped on, try to keep the pump running time to a minimum since the pump temperature will increase quickly at the warm surface. The ideal pump launch temperature should be around 25-30 C at the surface. No greater than 35 C if possible.*

39. Start the tape recorder.

### **Surface Ozone Measurement:**

40. Remove the ozone filter and take the sonde outside. Suspend the sonde about 1.5 meters above ground level (preferably pointing into the wind). Run for 5 minutes to record surface ozone (**FIGURE 10**).
41. Check the data once more. Bring the ozonesonde over to the balloon and tie the payout reel string to the ring on the lid of the Styrofoam box (**FIGURE 11**).

Ready for launch.

### **BE SURE THAT:**

1. **THE VAISALA ANTENNA IS POINTING DOWN.**
2. **THE VAISALA TONGUE (SENSOR) IS OUT.**

*When bringing the balloon and package out for launching – try to get a 1 minute surface measurement again before releasing the balloon. Disregard if it is very windy.*

### **LAUNCH BALLOON**

- Record local and GMT time of launch on checkout sheet.

**NOTE:** Check the data on the summary line while in flight – rise rate should range from 4 to 6 meters per second. If it is always greater than 5.5 m/s then try 100 grams less weight on the weighoff.

**NOTE:** Also check the internal temperature on the summary line (the pump temperature) when the balloon gets close to burst altitude. The pump temperature should be around 10-18 C at the end of the flight. If it is warmer than about 20 C then you may need to put in more ventilation holes in the side of the Styrofoam box.

### **END OF FLIGHT**

After the flight is completed (or no more signal . . . getting as much descent data as possible after burst). Then end the program by hitting F1 and entering “yes.” Now have a disk ready to insert into the floppy drive for backing up the flight data. The program will prompt you for the disk. Hit “enter” – The program will copy the TAxXX.raw TZxXX.de 1, TAxXX.mes, TAxXXASC.dat, TAxXXDSC.dat, and the Vxxxxxxx.cal files to the disk.

At the end of the month, send the disk with the backup files and copies of the flight checklist sheets to:

NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION  
CMDL, R/E/CG1  
ATTN: BRYAN JOHNSON  
325 BROADWAY  
BOULDER, COLORADO 80303-3328  
USA

## BALLOON TRAIN AND LAUNCHING

1. Lay out plastic tarp on floor. Open balloon box. Lay rubber balloon (which is inside a plastic bag) onto one end of the tarp. Slide balloon out of plastic bag. Invert the plastic bag over your hand so you can roll the balloon out onto the tarp (try not to touch the balloon with your bare hand; however you can handle the heavy rubber neck where the inflation hose attaches). Cut 3 pieces of string (short, medium, and long) = 40 cm, ~1-1.5 meters and ~1.8-2 meter pieces.
2. Attach CGA fitting end of garden hose to helium tank (each balloon flight uses about  $\frac{1}{2}$  -  $\frac{3}{4}$  tank of helium). Open the helium tank for a second or two to push out air in the hose. Then slide the filler end (aluminum or plastic nozzle) of hose into the heavy rubber neck of the balloon. Tie the 40 cm string around the neck on the nozzle so the nozzle will not slip out of the balloon while inflating.
3. Turn on helium tank, slowly at first.
4. Attach 1900 gram weight (weigh-off) to the nozzle. Also have an anchor weight attached to the 1900 weigh-off with a short string so the balloon does not continue rising once it lifts the 1900 gram weight. You can increase the helium flow once the balloon is suspended off the tarp. If the nozzle is plastic (lighter) then use about 2100-2200 gram weigh-off. If the rise rate is greater than 5.5 meters per second, try using 100 grams less in the weigh-off weight for the next flight.
5. Turn off helium flow once the 1900 gram weight starts to rise. Double up the 1.5 meter piece and tie off the balloon around the middle of the heavy rubber neck. Go around the neck about 4-5 times, using a simple slip knot after each loop, ending with any type of secure knot after the last loop. A closed loop of string should hang down from the neck. This is where the rest of the balloon train will be tied to. Now be very careful not to lose the balloon when you attached to loop to a heavy base weight and remove the hose nozzle. See **FIGURE 9**.
6. Fold the lower  $\frac{1}{3}$  to  $\frac{1}{2}$  of the heavy rubber neck up. And tie the 40 cm piece of string over the fold to hold in place. Once again tie several slip knots around the fold.
7. Open up the parachute by swinging it to catch air so the parachute is not sticking or clumping.
8. Double up the 2 meter piece of string. Attach it to the loop hanging from the balloon and to the top of the parachute. The payout reel is the next piece to be attached to the line.



9. Pull on the payout reel string to unwind the string wrapped around the axle. Run one loop around one of the bottom rods. This will slow the payout reel down on launch. Pull on the string to get a feeling for how fast the string will be letting out. Rewind string that you pulled out. Now attach the bottom strings from the parachute to the upper rod of the payout reel. The reel is orientated so it stays with the parachute and the string lets out the bottom of the reel. Tape excess string from the parachute-payout reel tie to prevent it from jamming the payout reel gear. See **FIGURE 8**.
  
10. Bring the ozonesonde in from the 5 minute surface ozone measurement (**FIGURE 10**) and set the ozonesonde on a stable box so the antenna can remain straight (**FIGURE 11**). Tie on the payout reel string to the ring at the top of the ozonesonde box. (Do not tip the ozonesonde on its side). Carry the ozonesonde and balloon train outside away from obstacles. For two person launch in windy conditions: try to line up with the balloon upwind from the sonde (so the balloon will come towards the sonde as it initially rises). One person should be holding the balloon close to the neck and the other holding the sonde and the dropper. If the winds are not too bad (less than 10-15 knots) then slowly let the balloon up until the other person has control of it. Make sure the line is fairly taut and the dropper is not snagged. Then release the balloon. Be careful not to catch the Vaisala tongue on your hands or arms. The balloon can be launched by one person when winds are less than about 15 knots. It is best to hold the rubber neck and the top of the parachute in one hand and the sonde and payout reel in the other. Slowly let the string and chute up until line is taut at the payout reel. If the wind is brisk you will have to run with the wind for a few meters than release it.

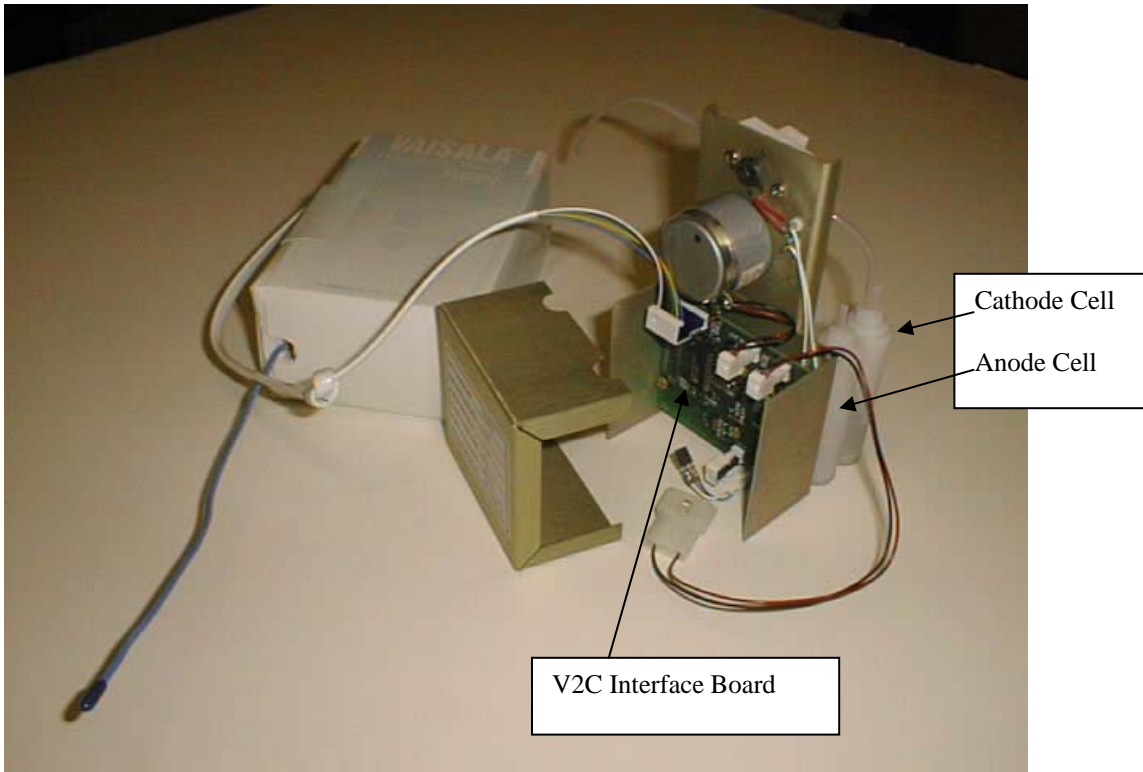


FIGURE 2. ENSCI 2Z OZONESONDE and VAISALA RADIOSONDE



FIGURE 3. OZONESONDE TEST UNIT : 2Z SONDE RUNNING ON 5 MICROAMPS OZONE

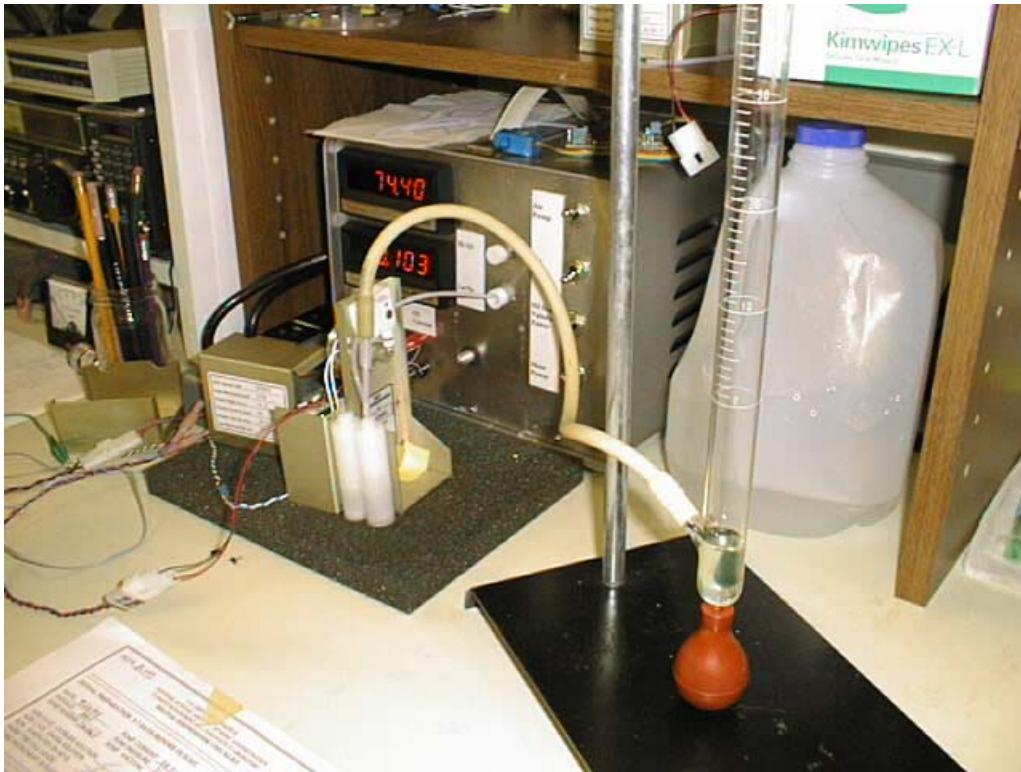


FIGURE 4. T100 FLOW RATE MEASUREMENT USING SOAP BUBBLE FLOW METER.

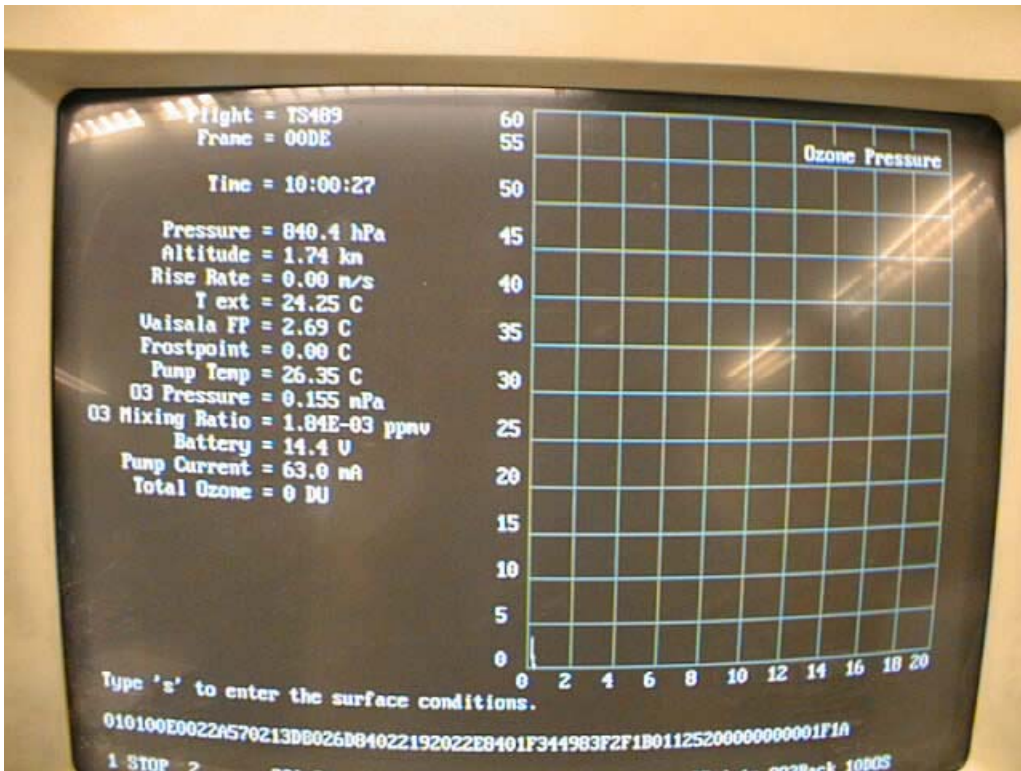


FIGURE 5. SUMMARY DATA SHOWN BY STRATO.EXE TELEMETRY PROGRAM.

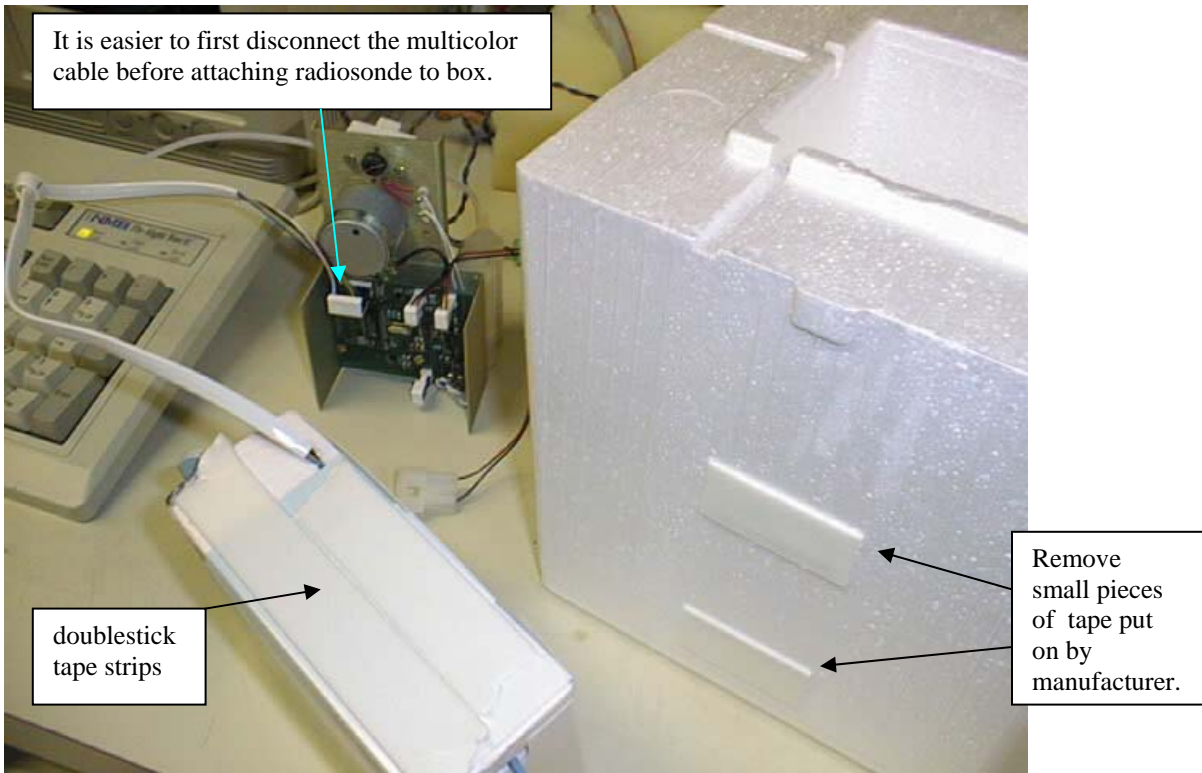


FIGURE 6. DOUBLESTICK TAPE USED TO ATTACH VAISALA TO OZONE BOX.



FIGURE 7. TOP VIEW OF OZONESONDE PLACED INSIDE BOX.



FIGURE 8. PAYOUT REEL ATTACHED TO PARACHUTE.

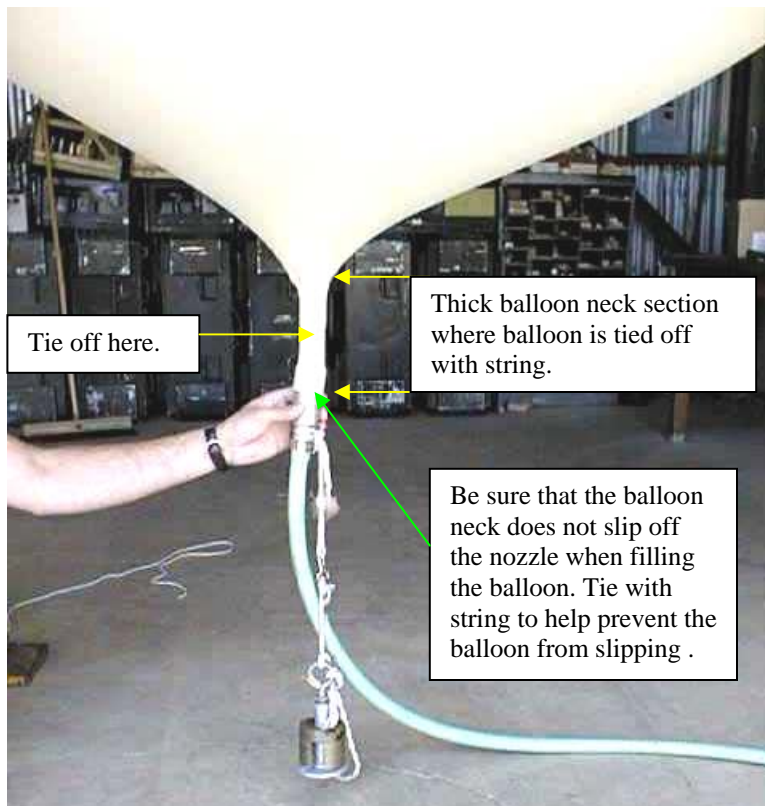


FIGURE 9. WEIGHOFF WEIGHT ATTACHED TO FILLED BALLOON.



FIGURE 10. OZONESONDE TAPED UP & SAMPLING SURFACE AIR FOR 5-10 MINUTES.

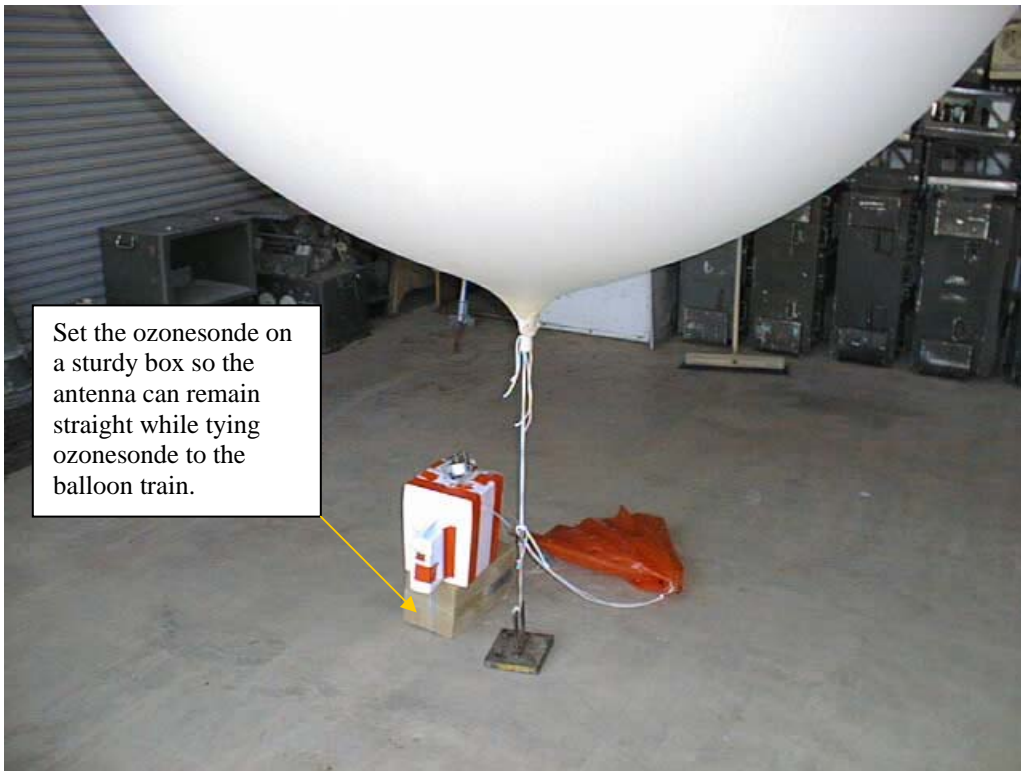


FIGURE 11. OZONESONDE TIED ON TO BALLOON – READY FOR LAUNCH.

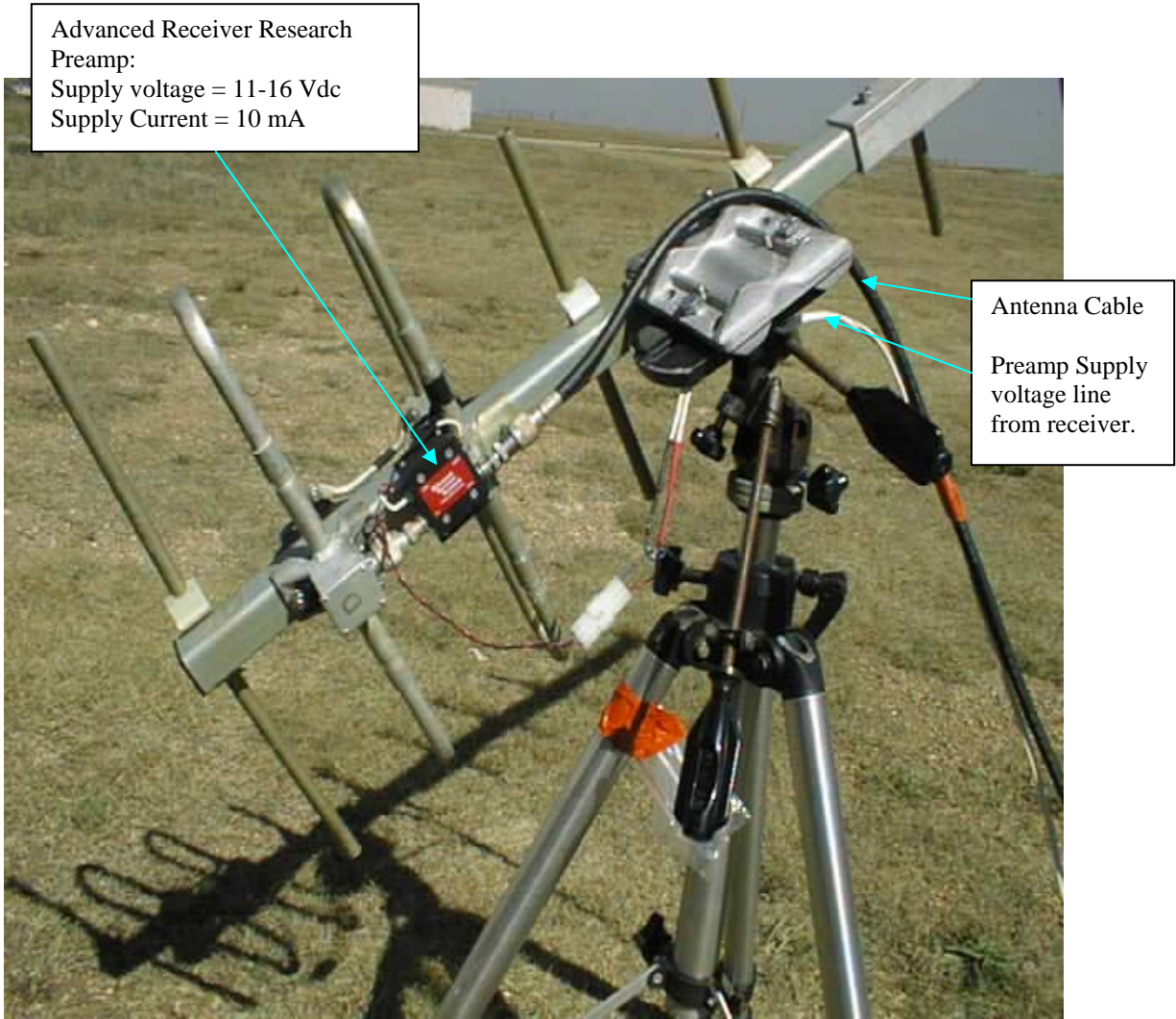
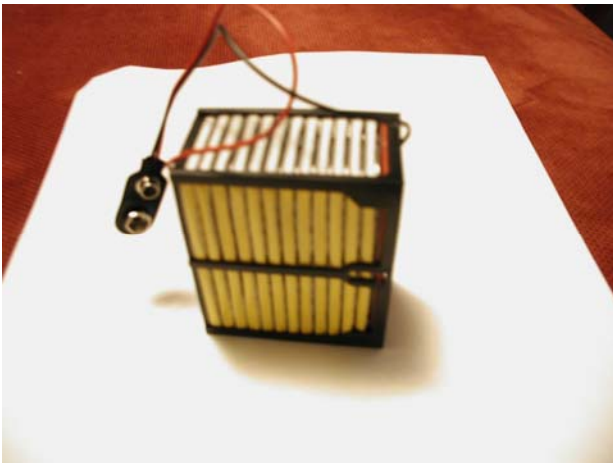


FIGURE 12. 403 MHZ YAGI ANTENNA MOUNTED ON A CAMERA TRIPOD.



Wet cell in upright position.

## Total weight of Ozonesonde when prepared for flight

Box including sonde and chemical battery:	0.50kg
Balloon:	1.19kg
Parachute:	0.06kg
Reel:	0.12kg
Battery for Vaisala:	0.08kg
Vaisala:	0.19kg
-----	
Total weight:	2.14kg