Radiosonde System

User Manual & Operations Guide

TracerLab

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Contents

Safety & Regulatory Notice

Caution

Read this before you fly. Launching a free balloon puts hardware into shared airspace. **You, the operator, are solely responsible for conducting every flight safely and legally.**

Before and during every flight it is **your responsibility** to:

- **Know and follow all applicable laws and regulations** for your location — national aviation authority rules (e.g. in the United States, FAA regulations on unmanned free balloons), airspace restrictions, notification requirements, payload-weight limits, and any local ordinances.
- **Check the airspace** you will fly through and avoid controlled, restricted, or prohibited areas. Coordinate with or notify air-traffic authorities where required, and never launch near airports or active flight corridors.
- **Assess the conditions and recovery area** — weather, wind, predicted landing zone, terrain, people, property, roads, power lines and water — and launch only when it is safe to do so.
- **Handle the gas safely.** Helium and especially hydrogen require correct handling; hydrogen is flammable. Follow all gas-supplier and safety guidance.

Assumption of risk and no liability. The **PTHSonde** is provided *as is*, for research, educational, operational and hobby use. The designers, manufacturers, contributors and suppliers of the **PTHSonde** and this manual accept **no liability whatsoever** for any loss, damage, injury, regulatory violation or other consequence arising from its use. By building, launching or operating a **PTHSonde**, **you accept full responsibility** for doing so lawfully and safely, and you assume all associated risk. If you are unsure whether a flight is legal or safe, **do not launch.**

CHAPTER 1

System Overview

The **PTH**Sonde is a complete radiosonde system: a small, reusable weather-balloon payload that measures **P**ressure, **T**emperature and **H**umidity (plus wind, GPS position and battery health), streams it to the ground over a long-range 915 MHz LoRa link, and displays it live in a one-click desktop ground station that renders a full SHARPpy atmospheric sounding.

1.1 How the system fits together

The system has four parts: the sonde in the air, the radio link, the ground receiver, and the dashboard.

Figure 1.1: The **PTH**Sonde signal chain: the airborne sonde transmits telemetry over LoRa to a ground receiver, which forwards it over USB to the desktop dashboard.

1.2 Key features

- **Long-range LoRa** — Ebyte E22 at 22 dBm / 0.3 kbps air rate for maximum link margin.
- **Barometric flight data** — altitude, ascent rate and the sounding are derived directly from the pressure sensor.
- **SHARPpy analysis** — an SPC-style Skew-T and index panel rendered from each flight.
- **Reusable payload** — a rugged enclosure with a swappable battery; recover it and fly again.
- **Per-unit identity** — each sonde derives a stable hex ID from its chip, printed on its sticker.

Note

This guide covers the full operational workflow: preparing the sonde, pairing it with the ground station, filling the balloon, launching, and analysing the flight.

CHAPTER 2

The Sonde

The **PTHSonde** payload (shown on the cover) is a compact, reusable radiosonde carrying the full sensor suite and the radio, with a removable battery door and an exposed thermistor probe for true air temperature.

2.1 Measurement specifications

The **PTHSonde** measures the full **P**ressure / **T**emperature / **H**umidity state of the air, plus wind and position. The table below gives the rated performance of each measurement over the operating envelope.

Parameter	Range	Accuracy	Resolution	Response (τ_{63})
Air temperature	-70 to $+50$ °C	±0.3 °C	0.01 °C	< 2 s
Relative humidity	0–100 %RH	±1.8 %RH	0.1 %RH	~ 4 s
Barometric pressure	10–1200 hPa	±1.5 hPa	0.01 hPa	< 20 ms
Pressure altitude (derived)	0–31 km	±10 m	1 m	< 1 s
Wind speed (GPS-derived)	0–100 m/s	±0.5 m/s	0.1 m/s	3 s (downlink)
Wind direction	0–360°	±5°	1°	3 s (downlink)
GPS position	global	±2.5 m CEP	—	3 s (downlink)

Table 2.1: Rated measurement performance of the **PTHSonde** sensor suite.

Note

Operating envelope: surface to 12 km. The **PTHSonde** is rated from the ground through the boundary layer and into the lower and middle troposphere — the altitudes that matter for boundary-layer research, convective profiling, and lower/mid-tropospheric soundings. Temperature is measured by a fast, directly-exposed bead thermistor for true air temperature; humidity and pressure are sensed by dedicated digital sensors; wind is derived on the ground from the GPS track. All channels are sampled continuously (the sensors at 1 Hz internally) and the complete set is transmitted together once every **3 seconds** — the downlink rate. The values in the *Response* column are the sensors' physical τ_{63} time constants; GPS and wind refresh at the 3 s downlink rate (wind is a 5 s rolling average).

2.2 The flight train mass

The complete flight train — the **PTHSonde** in its enclosure, battery, sticker and the line hardware that connects it to the balloon — is designed to weigh about **80 grams** total. This is the payload mass used for all the balloon calculations in Chapter 5.

CHAPTER 3

Preparing the Sonde for Flight

Before every flight the sonde needs a fresh battery, the door secured, and the payload tied onto the flight line. The three steps below take about two minutes.

3.1 Step 1 — Insert the battery

Open the outer battery door and slide the cell into the holder, observing the polarity marked inside the bay. The board powers up immediately and begins its boot self-test.

Note

Recommended battery: Energizer Lithium CR123. This lithium cell is the right choice for the **PTHSonde** — it is light, holds a high energy density, and (critically) keeps delivering current in the extreme cold of the stratosphere, where ordinary alkaline cells sag and die. Always fly a fresh CR123.

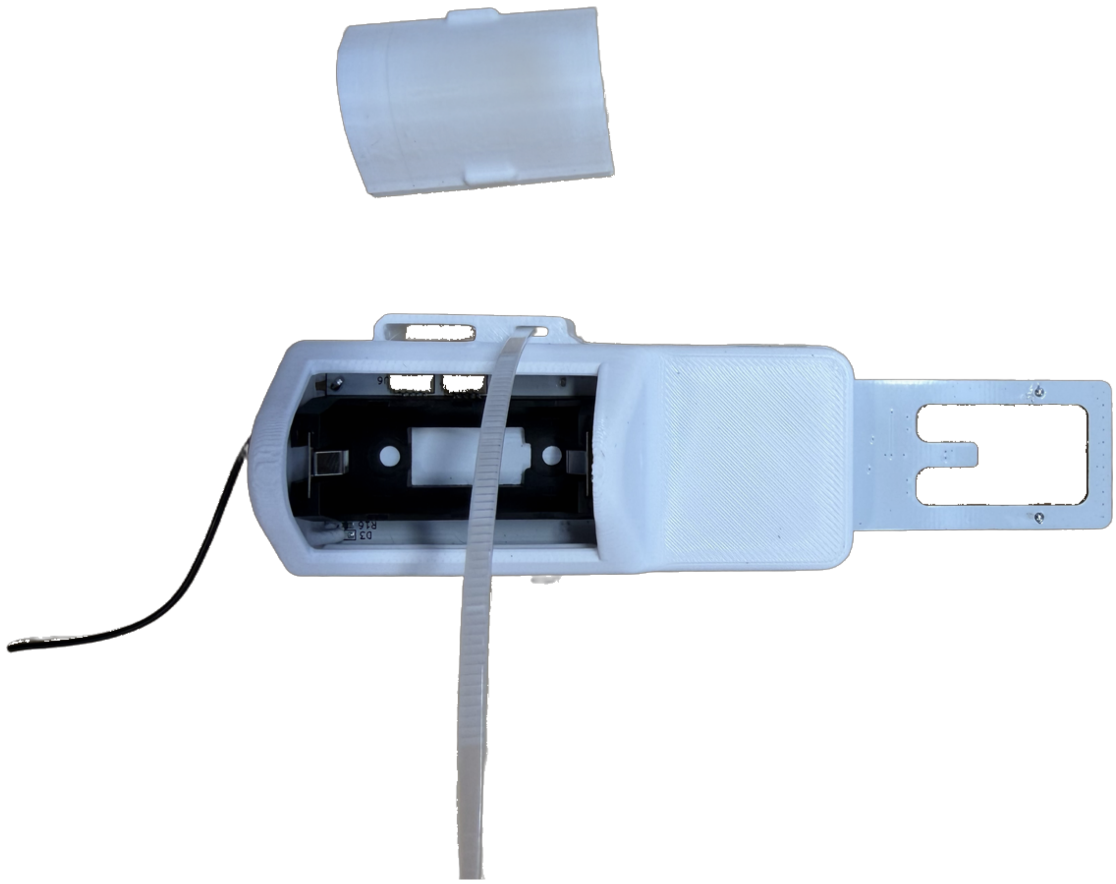


Figure 3.1: The open battery bay. Insert the cell into the holder (centre), minding polarity. The mounting bracket is on the right; the zip tie (left) will secure the outer door.

Tip

On power-up the status LED blinks while the radio and GPS initialise. On the dashboard, confirm the **Sonde ID** appears and every sensor dot reads green before you close it up.

3.2 Step 2 — Close and zip-tie the door

Refit the outer battery door and lock it down with a zip tie through the retaining slots. This keeps the battery seated through the launch and the landing.

Figure 3.2: The closed enclosure with the outer door zip-tied shut. The printed sticker carries the sonde's hex ID and the finder instructions.

3.3 Step 3 — Tie the sonde to the flight line

Thread the flight line through the bracket and tie it off so the payload hangs cleanly below the parachute. Use a strong, non-slip knot; this single line carries the payload for the whole flight.

Caution

Do not launch with a loose or frayed line. The knot at the bracket is the only thing holding your payload to the balloon — inspect it before every flight.

Figure 3.3: The finished sonde tied onto the flight line, ready to be attached below the parachute and balloon. Note the exposed thermistor board (left) that reads the true air temperature.

CHAPTER 4

The Ground Station & Dashboard

The ground station is a one-window desktop app. It owns the USB serial port to the receiver, records the flight, and draws everything live — telemetry, a Skew-T, a hodograph, time-series, a landing-prediction map, and the SHARPpy panel.

4.1 The ground receiver and antenna

The receiver is a small box with the same LoRa radio as the sonde, an SMA antenna connector, and a USB lead to your laptop. Like the sonde, each receiver carries its own hex ID on a printed sticker.

Figure 4.1: The ground station: the receiver box (here *Ground Station 0x74*), its magnetic-mount 915 MHz whip antenna, and the USB lead to the laptop.

> **Tip**
>
> **Antenna placement is the single biggest factor in your range.** Give the antenna a clear, unobstructed *view of the sky*, and mount it *as high as possible* — away from buildings, vehicles and metal, ideally on a mast, a rooftop, or a magnetic roof mount. The higher and clearer the antenna, the longer you hold the link as the balloon drifts toward the horizon.

4.2 Pairing the sonde with the ground station

1. Plug the ground receiver into your laptop over USB and launch the dashboard (the truck icon).
2. In the top bar, select the receiver's **COM port** and press **Connect**. The link indicator turns live and packets begin to count up.
3. Power on the sonde. Within a few seconds its **Sonde ID** appears in the left-hand LINK panel and the sensor dots at the bottom light green.
4. Use the channel controls to **stage** and, at launch, **lock** the sonde onto your flight frequency.

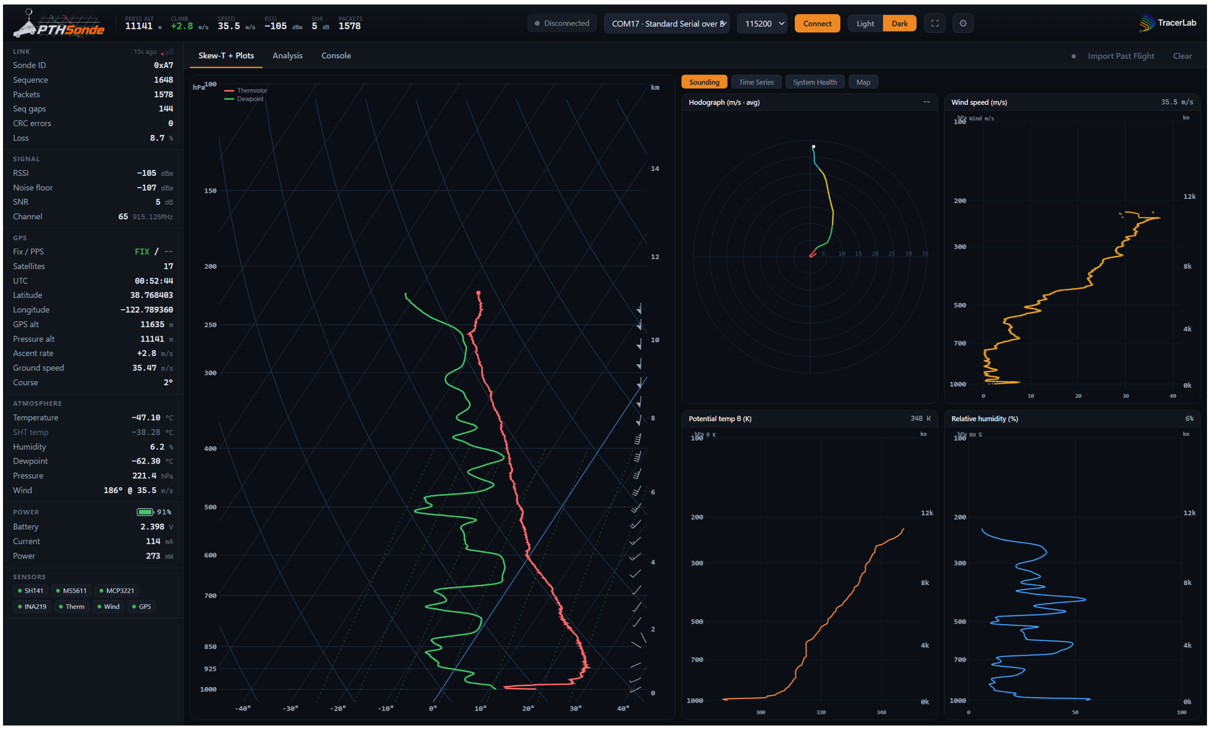


Figure 4.2: The live dashboard during a flight. Left: link, signal, GPS, atmosphere, power and per-sensor health. Centre: the Skew-T with the thermistor (red) and dewpoint (green) traces and wind barbs. Right: hodograph, wind-speed, potential-temperature and relative-humidity profiles.

> **Note**
>
> The header strip shows the headline numbers at a glance: pressure altitude, climb rate, ground speed, link RSSI/SNR and packet count. The connect controls and light/dark theme toggle live on the right.

4.3 Reading the panels

The right pane switches between four views.

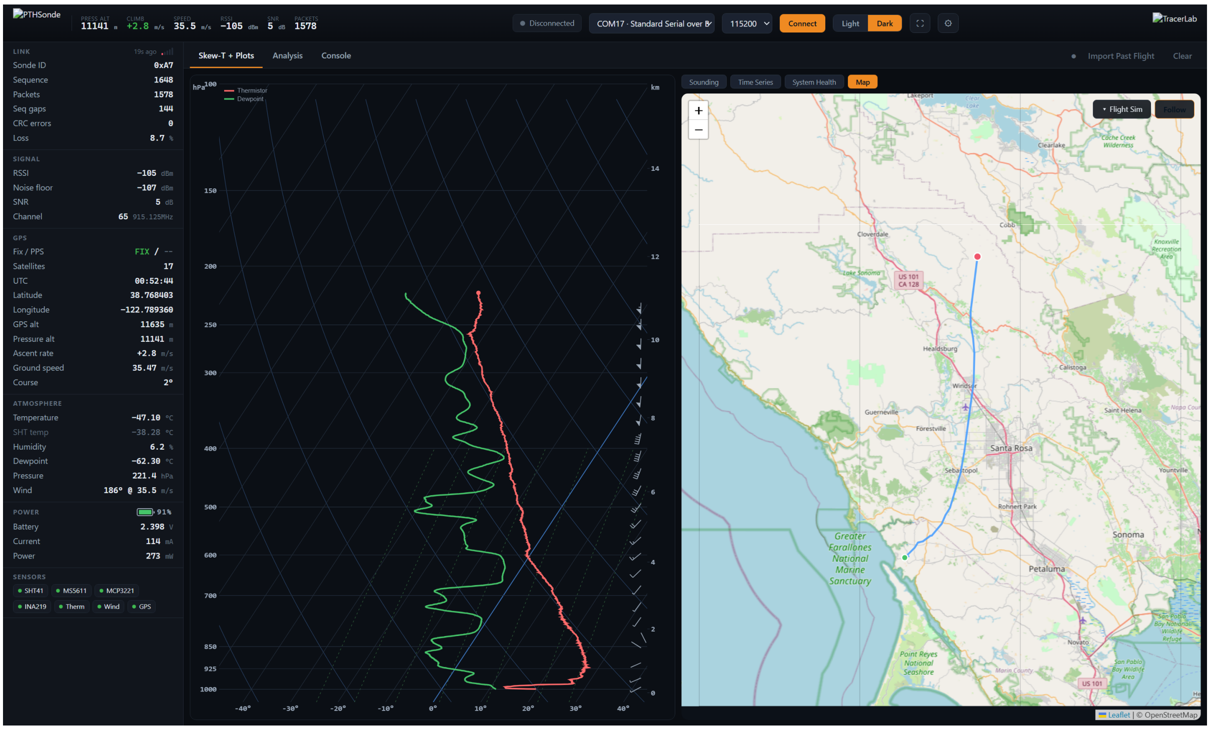


Figure 4.3: Map view — the live position and predicted landing overlaid on the terrain, so you can drive to the recovery point while the sonde is still flying.

4.4 The flight predictor

On the **Map** view, the **Flight Sim** button opens the landing predictor. It fetches winds-aloft from a public GFS model for your launch point and time, then flies a virtual balloon up and back down through those winds to estimate where the payload will land — *before* you launch, and continuously refined during the flight.

To run a prediction:

1. Set the **launch point** — type a latitude/longitude, press **Use sonde position**, or **Pick on map**. Set the launch time and elevation (elevation defaults to 0 m).
2. Enter the **balloon & payload** numbers: ascent rate, burst altitude, payload mass, parachute diameter and drag coefficient. If you used the Fill Calculator, **Send to Flight Predictor** fills these for you.
3. Press **Fetch GFS + Predict**. The map draws the trajectory and the panel reports the landing point, distance and bearing, burst altitude, time to burst, descent duration, total flight time and landing ETA.

Note

Leave **Auto-update in flight** on and the prediction sharpens continuously as the sonde flies — it substitutes your balloon's own measured winds for the model winds at every altitude you have already flown, so the landing estimate tightens on the way up.

Figure 4.4: **Time Series** view — every channel plotted against time for a quick sanity check of the whole flight.

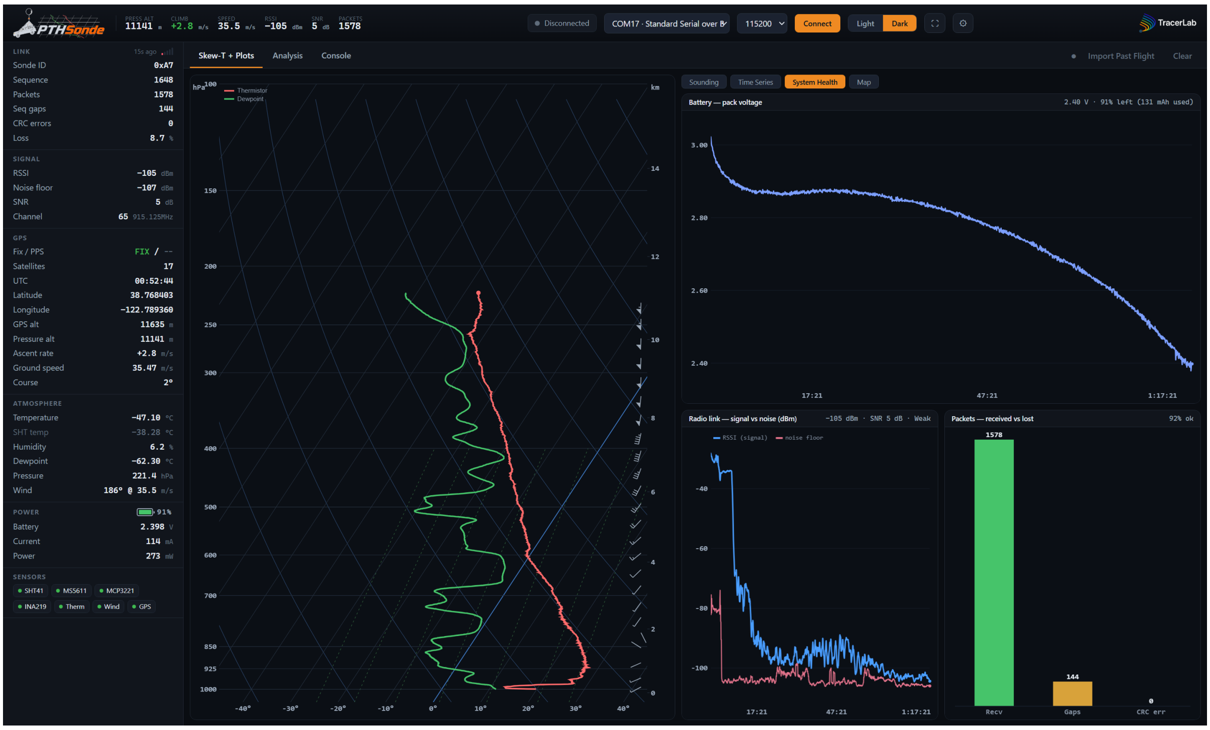


Figure 4.5: **System Health** view — engineering telemetry (battery, current, RSSI/SNR, sequence gaps) to confirm the payload is behaving.

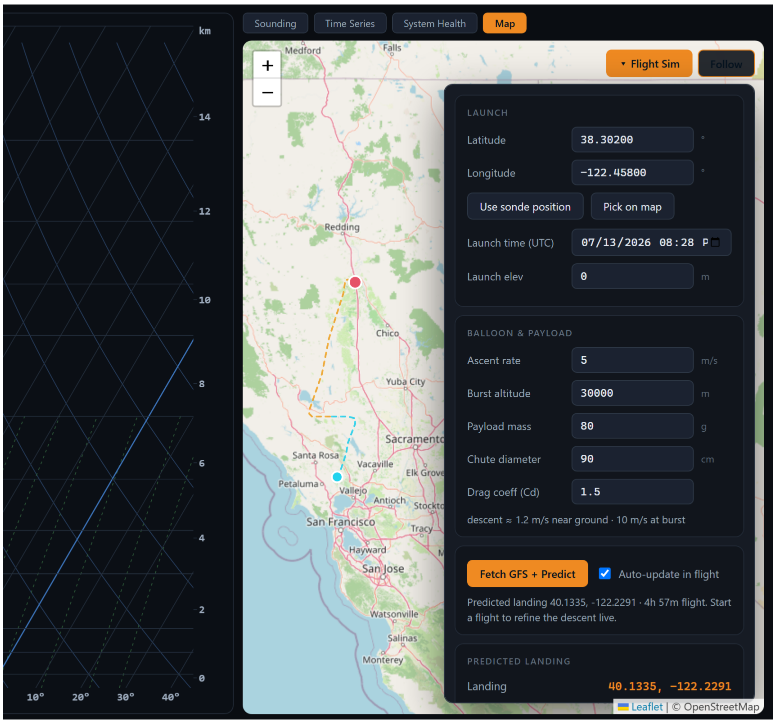


Figure 4.6: The flight predictor. Set the launch point (type it, use the sonde's position, or pick on the map) and your balloon numbers; the tool fetches GFS winds and draws the predicted ascent (cyan), descent (orange) and landing (red), with a full flight summary.

Tip

Start the prediction *before* you launch to make sure the forecast landing zone is safe, reachable and clear of hazards and controlled airspace. A prediction needs an internet connection to fetch the GFS winds.

CHAPTER 5

Filling & Preparing the Balloon

The balloon lifts the 80 g payload at a controlled rate to a controlled burst altitude. Two numbers set the flight: how much gas you put in (the *lift*) and which balloon you fly.

5.1 The physics of lift

A balloon floats because the helium inside weighs less than the air it displaces. At sea level, every litre of helium provides about

$$\text{net lift} = \rho_{\text{air}} - \rho_{\text{He}} = 1.225 - 0.179 \approx \mathbf{1.05} \text{ grams per litre.}$$

Three quantities matter when filling:

Gross lift
: the total upward buoyancy of the gas.

Neck (nozzle) lift
: gross lift minus the balloon's own weight — this is what you *measure* while filling, by hanging a known weight on the neck.

Free lift
: neck lift minus the payload — the net force that actually drives the ascent and sets the climb rate.

The standard target is a **5 m/s ascent**: fast enough for a predictable recovery window, slow enough for high-resolution data and a high burst.

5.2 Choosing the balloon and filling it

Two things set the flight: which balloon you fly, and how much gas you put in.

5.2.1 The two standard balloons

- **50 g balloon** — small, less gas. Bursts around 12 km. Good for a quick tropospheric profile and a nearby recovery.
- **150 g balloon** — reaches roughly 20 km, deep into the stratosphere, for a full sounding. Needs more gas and covers more ground before landing.

The fill table gives the numbers for both, assuming the 80 g **PTHSonde** train, a 5 m/s target ascent and a drag coefficient $C_d = 0.30$. **Fill until the balloon just lifts a weight equal to the neck lift**, then attach the payload. Hydrogen lifts a little more per litre, so it needs slightly less gas.

	50 g balloon		150 g balloon	
	Helium	Hydrogen	Helium	Hydrogen
Free lift	325 g	294 g	407 g	370 g
Neck (fill) lift	**405 g**	**374 g**	**487 g**	**450 g**
Gas volume	435 L	373 L	608 L	529 L
(cubic feet)	15 ft^3	13 ft^3	21 ft^3	19 ft^3
Launch diameter	0.9 m	0.9 m	1.05 m	1.0 m
Approx. burst altitude	12 km	13 km	20 km	21 km

Table 5.1: Recommended fill for the 80 g **PTHSonde** train, for helium and hydrogen. Burst altitudes assume typical burst diameters (1.5 m for the 50 g, 2.6 m for the 150 g) and vary with the actual balloon batch.

Note

Recommended balloons: Kaymont. Kaymont sounding balloons are a reliable, widely-available choice with consistent, well-documented burst diameters — fly the 50 g or 150 g size to match the profiles above.

Tip

How to measure neck lift. The cleanest method is a **spring scale** (a fishing or luggage scale): anchor it to the ground, clip the balloon neck to it, and add gas until the scale reads the neck-lift value from the table (e.g. 487 g for the 150 g balloon on helium). Alternatively, tie a small container to the neck and add water or weights until the total equals that value, then fill until the balloon *just* lifts the weight off the ground. Either way, you have exactly the right free lift once the 80 g payload replaces the weight.

Caution

Use **helium**, not hydrogen, unless you are trained and equipped for it. Fill outdoors or in a well-ventilated space, wear gloves, and never let the filled balloon contact the ground or rough surfaces — a nick becomes an early burst.

5.2.2 The Fill Calculator

For any other balloon, gas, payload or target altitude, the dashboard's **Fill Calculator** tab does the same physics interactively — using the same buoyancy-versus-drag model as the table above, so the numbers match.

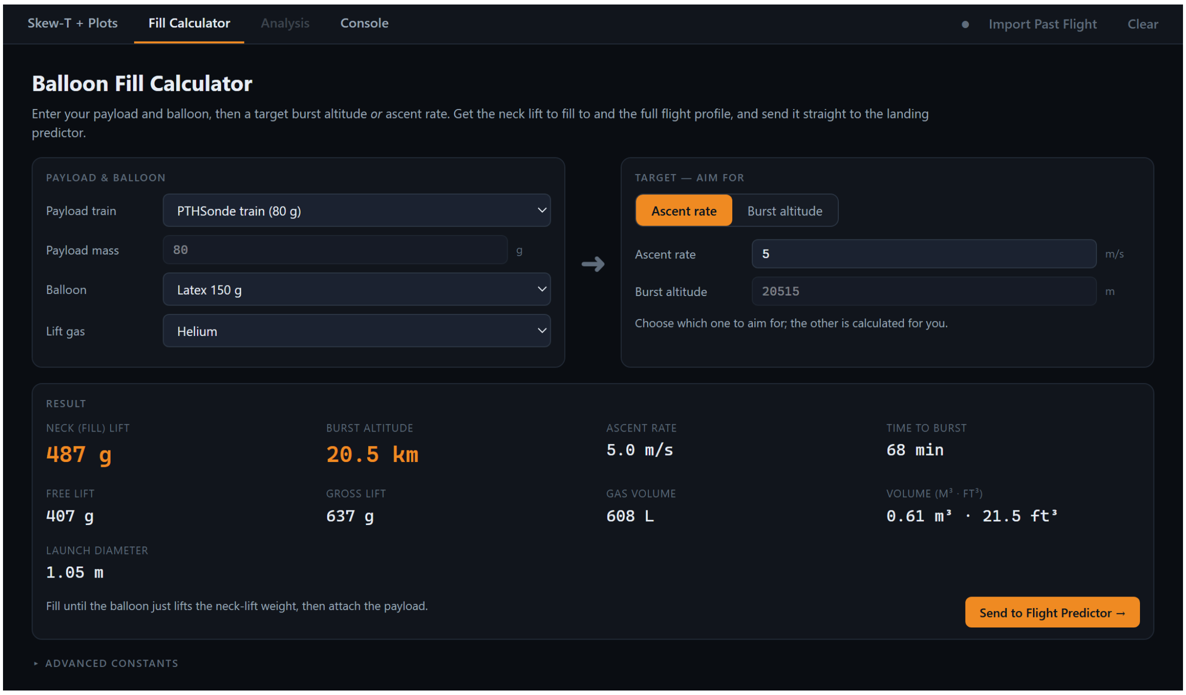


Figure 5.1: The Fill Calculator. Choose the payload train and balloon, pick your gas, and aim for either a target ascent rate or a target burst altitude — it returns the neck lift to fill to, the gas volume, launch diameter and the full flight profile.

To use it:

1. Pick the **payload train** — PTHSONDE TRAIN (80 G) locks the mass to the standard train, or choose CUSTOM to type your own.
2. Choose the **balloon** from the manufacturer list (Kaymont/Totex, Hwoyee, Pawan, or the **PTHSonde** 50 g / 150 g latex) and the **lift gas** (helium, hydrogen, and others). The balloon's mass and burst diameter fill in automatically; a CUSTOM balloon lets you set them under *Advanced constants*.
3. Under **Target**, choose whether to aim for an **ascent rate** or a **burst altitude**; the other is calculated for you.
4. Read off the **neck (fill) lift** — the weight to hang on the neck while filling — along with the gas volume, launch diameter, burst altitude and time to burst. **Send to Flight Predictor** carries these straight to the landing predictor (Chapter 4).

Note

Burst diameters in the balloon list are manufacturer nominal values and vary with batch, temperature and fill. Treat every result as a planning estimate and confirm your neck lift by measurement before launch.

5.3 Assembling the flight train

Rig the train top-to-bottom so everything hangs in a straight line below the balloon.

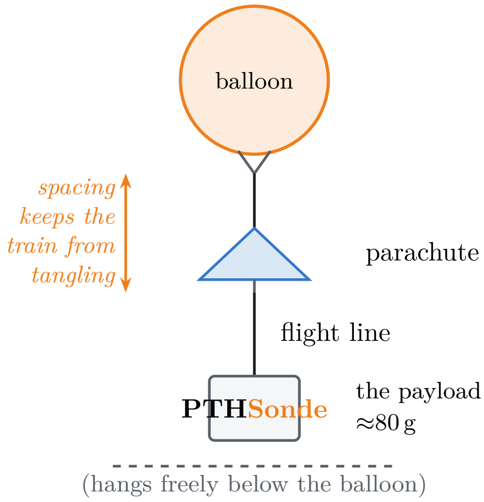


Figure 5.2: The flight train, top to bottom: balloon, parachute, flight line, and the **PTHSonde** payload. The parachute rides between the balloon and the payload so it deploys on burst.

CHAPTER 6

Launching

6.1 Pre-launch checklist

1. Sonde battery fresh; door zip-tied; all sensor dots green on the dashboard.
2. Sonde **locked** onto the flight channel; packets arriving with good RSSI.
3. GPS has a fix (satellite count climbing) with a clear view of the sky.
4. Balloon filled to the correct neck lift; neck tied off twice; parachute rigged.
5. Flight line knots inspected; payload hanging clean.
6. Recovery gear ready; landing-prediction map checked for a safe drift.

6.2 Release

Pick a moment with light, steady surface wind. Walk the payload downwind of the balloon so the train is stretched out, then release the balloon and let the line lift the payload smoothly out of your hand — never throw it.

Tip

The instant the sonde leaves the ground the dashboard's CLIMB number should jump to roughly +5 m/s and the pressure altitude should start rising. If it does not climb, you are under-filled — bring it back and add gas.

Figure 6.1: Release. Let the balloon lift the flight line and payload cleanly out of your hands; the dashboard should immediately show the climb rate go positive.

CHAPTER 7

In-Flight Operations & Data

7.1 Tracking the flight

Once airborne, the dashboard shows the complete flight picture:

- The **Skew-T** builds up in real time as the sonde climbs through the atmosphere.
- The **Map** shows the current position and the predicted landing point for recovery.
- The **header** tells you altitude, climb rate and link health at a glance.
- At burst the climb rate flips sharply negative; the parachute then controls the descent.

7.2 Recording & processing

The app records every packet to a flight folder on disk as it arrives. When the flight ends, one click processes the recording: it cleans the profile, and renders the SHARPpy sounding panel from your own data.

Note

Because altitude and ascent rate are derived from the barometric pressure sensor, the profile keeps building even after the GPS reaches its altitude ceiling — the sounding is complete all the way to burst.

CHAPTER 8

SHARPpy Sounding Analysis

The primary product of a flight is a SHARPpy SPC panel, rendered from the balloon's own temperature, humidity and wind profile. It turns raw telemetry into the same Skew-T / hodograph / index panel meteorologists use operationally.

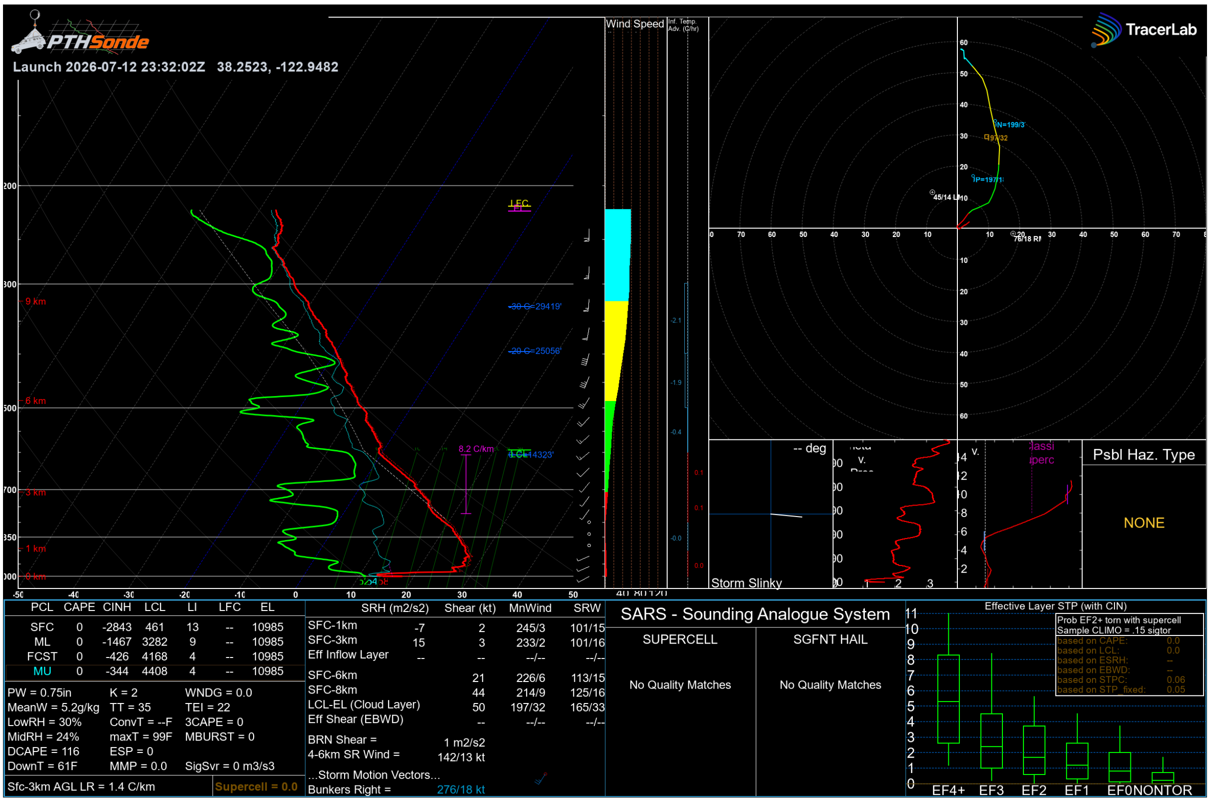


Figure 8.1: Example SHARPpy panel from a **PTHSonde** flight. The Skew-T (left) shows the temperature and dewpoint profile with the lifted parcel path; the hodograph (upper right) shows the wind with height; and the tables report the standard convective and kinematic indices.

8.1 Reading the panel — every value defined

The panel presents a complete severe-weather analysis in one view. Each quantity it reports is described below, grouped by what it tells you — and, for each index, gives its typical value *scale* and a representative *example* inline, so you can read a number and know immediately what it means. The examples are drawn from one coherent illustrative sounding: a moderately unstable, well-sheared spring afternoon — the classic supercell setup. A quiet day (like the calm flight shown earlier) would read near zero across the instability and severe indices; contrast the two to build intuition.

8.1.1 The plots

Skew-T log-P The environmental temperature (right curve) and dewpoint (left curve) versus pressure on skewed axes. The dashed line is the lifted-parcel path;

area where the parcel is warmer than the environment is CAPE, where cooler is CIN. Their left–right separation is the dryness of the air.

Hodograph The horizontal wind vector traced with height. Its length is the bulk shear; its curvature is the storm-relative helicity — both key to storm organisation.

Storm Slinky A 3-D cartoon of the modelled updraft's shape and tilt — a quick visual of how sheared the environment is.

Inferred Temp. Advection Warm- or cold-air advection through the column, inferred from how the wind veers (warm) or backs (cold) with height.

8.1.2 Lifted-parcel indices (the PCL table)

Each row lifts a different starting parcel: **SFC** (from the surface), **ML** (the average of the lowest 100 hPa, "mixed layer"), **FCST** (a forecast surface parcel at the expected afternoon high), and **MU** (the most-unstable parcel, highest θ_e). For each parcel:

CAPE Convective Available Potential Energy (J/kg) — the buoyant energy available to the parcel, the energy that drives updrafts. *Scale:* 0 none · <1000 weak · 1000–2500 moderate · 2500–4000 strong · >4000 extreme. *Example:* 2500 J/kg = strong instability.

CINH Convective Inhibition (J/kg) — the negative-buoyancy "cap" that must be overcome before free convection. *Scale:* 0 to -25 weak (easily broken) · -25 to -100 moderate · <-100 strong cap. *Example:* -45 = moderate, breakable by afternoon heating.

LCL Lifted Condensation Level (m) — the height cloud base forms. *Scale:* lower is more tornado-favorable; <1000 m low · >2000 m high/dry. *Example:* 900 m = low, favorable.

LFC Level of Free Convection (m) — the height above which the parcel is freely buoyant; the lower it is, the more readily storms initiate. *Example:* 1500 m.

EL Equilibrium Level (m) — where the parcel stops being buoyant, roughly the cloud/anvil top; higher means deeper storms. *Example:* 12000 m = deep convection.

LI Lifted Index (°C) — parcel-minus-environment temperature at 500 hPa; negative means an unstable, storm-prone airmass. *Scale:* >0 stable · 0 to -3 marginal · -3 to -6 moderate · -6 to -9 very unstable · <-9 extreme. *Example:* -7 °C = very unstable.

8.1.3 Thermodynamic & moisture indices

PW Precipitable Water (in) — total column water vapour. *Scale:* <0.5 very dry · 0.5–1.0 average · 1.0–1.5 moist · >1.5 heavy-rain potential. *Example:* 1.3 in = moist.

MeanW Mean water-vapour mixing ratio (g/kg) of the boundary layer; higher is moister. *Example:* 14 g/kg = a rich, moist boundary layer.

LowRH / MidRH Mean relative humidity (%) of the low and mid levels. Moist low over dry mid favours strong downdrafts. *Example:* 80%/45%.

K-Index Thunderstorm potential from mid-level temperature and moisture. *Scale:* < 20 unlikely · 20–25 isolated · 26–30 scattered · 31–35 numerous · > 35 likely/heavy. *Example:* 32 = numerous.

Total Totals Severe-storm index combining low-level moisture and the mid-level lapse rate. *Scale:* < 44 weak · 44–50 strong · 50–55 severe likely · > 55 intense. *Example:* 52 = severe likely.

Sfc–3km LR Temperature lapse rate over the lowest 3 km (°C/km); steeper is more unstable. ∼7–8 °C/km is steep. *Example:* 7.5 °C/km.

ConvT Convective Temperature — the surface temperature needed to break the cap; compare it to maxT to see if storms will fire. *Example:* 29 °C.

maxT Forecast daytime maximum temperature. *Example:* 31 °C (above ConvT — cap breaks).

3CAPE CAPE in the lowest 3 km — low-level updraft strength, relevant to tornadoes; > 100 J/kg is meaningful. *Example:* 120 J/kg.

DCAPE Downdraft CAPE (J/kg) — energy available to downdrafts; gust/outflow potential. *Scale:* < 500 weak · 500–1000 moderate gusts · > 1000 strong outflow / microburst. *Example:* 900 J/kg.

DownT Estimated downdraft (wet-bulb) surface temperature — the cool outflow. *Example:* 18 °C.

8.1.4 Kinematic (wind) indices

Shear Bulk wind difference across a layer (kt), e.g. SFC–1 km, SFC–6 km, SFC–8 km; organises storms. *0–6 km scale:* < 20 single-cell · 20–35 multicell / marginal supercell · 35–50 supercell · > 50 strong supercell. *Example:* 55 kt = strong deep-layer shear.

Eff Shear / EBWD
Effective Bulk Wind Difference — bulk shear over the storm's effective inflow layer; supercell range is ∼35–50+ kt. *Example:* 50 kt.

SRH Storm-Relative Helicity (m^2/s^2), 0–1 km and 0–3 km — the streamwise vorticity a storm can ingest; rotation/tornado potential. *0–1 km scale:* < 100 low · 100–150 supercell possible · 150–300 tornadic-favorable · > 300 strong. *Example:* 250 m^2/s^2.

SRW Storm-Relative Wind — the wind a moving storm "sees" in a given layer; stronger means better updraft ventilation. *Example:* 30 kt (0–2 km).

MnWind Mean wind over a layer — overall steering flow.

BRN Shear The shear term of the Bulk Richardson Number — pairs instability with shear.

Bunkers R / L
Predicted right- and left-moving supercell storm-motion vectors; use them to drive to the storm / recovery. *Example:* R at 240°/35 kt.

8.1.5 Composite severe-weather indices

SigSvr Significant Severe parameter (ML CAPE × 0–6 km shear); higher means more significant severe. *Example:* 60,000 = well into the significant-severe range.

Supercell Supercell Composite Parameter — CAPE, shear and helicity combined into a supercell likelihood. *Scale:* <1 non-supercell · 1–4 possible · >4 strong supercell. *Example:* $8 =$ strong.

STP Significant Tornado Parameter (effective-layer, CIN-weighted); the EF-scale bars show analogue tornado probabilities. *Scale:* <1 unlikely · 1–2 possible · >2 favorable for significant tornadoes. *Example:* 3.

WNDG Wind Damage Parameter — potential for damaging convective winds; >1 is elevated. *Example:* 1.5.

ESP Enhanced Stretching Potential — low-level stretching for landspout/weak-tornado potential. *Example:* 0.5.

MMP MCS Maintenance Probability (0–1) — whether an organised storm complex can sustain itself. *Example:* 0.6.

TEI Theta-E Index — mid-level dryness / downdraft potential; higher means drier aloft. *Example:* 30.

MBURST Microburst composite — wet/dry microburst potential. *Example:* 4.

SARS Sounding Analogue System — matches your profile to historical significant-hail and supercell soundings. *Example:* matches sig-hail / supercell analogues.

Poss. Hazard Type
SHARPpy's one-line overall verdict for the sounding — e.g. NONE, MRGL, or TOR on a tornado-capable day.

CHAPTER 9

Appendix

9.1 Downlink telemetry

Each transmission is a compact, CRC-checked binary packet sent a few times per minute. It carries the sonde ID and sequence, UTC time, GPS position and altitude, pressure, temperature, humidity, thermistor temperature, battery voltage/current, and status/validity flags. Wind is derived on the ground from successive GPS fixes.

9.2 Quick reference

Parameter	Typical value
Radio band	915 MHz ISM (LoRa)
Transmit power	22 dBm
Flight train mass	≈80 g
Target ascent rate	5 m/s
Neck lift, 50 g balloon (He)	≈405 g
Neck lift, 150 g balloon (He)	≈487 g
Burst altitude, 50 g / 150 g	≈12 km / ≈20 km
Helium net lift	≈1.05 g/L

Table 9.1: At-a-glance operating figures for the **PTHSonde** system.

9.2.1 Field quick-start card

The card below condenses the whole workflow — payload, fill figures for the two standard balloons, the launch sequence and troubleshooting — onto one page. **Print it at 100% scale** (it is sized 3.62 × 6.6 in) and cut it out to carry in the field.

PTHSonde

FIELD QUICK-START CARD

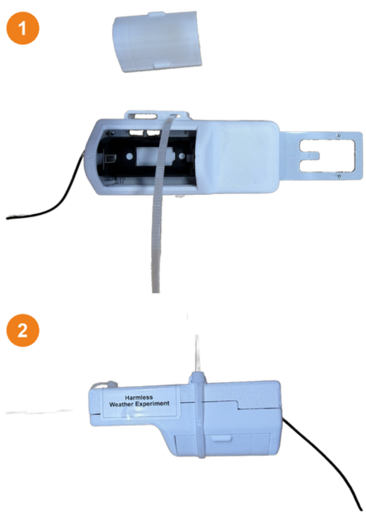
PAYLOAD	ASCENT	LINK
80 g	5 m/s	915MHz·3s

FILL — KAYMONT LATEX (HELIUM)

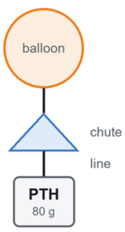
Balloon	Neck lift	Gas vol	Burst
50 g	405 g	435 L	~12 km
150 g	487 g	608 L	~20 km

Fill to the neck-lift weight (spring scale), then clip the payload.

1. **Battery**
   Fresh CR123 — sensor dots green.
2. **Close up**
   Refit the door, zip-tie it shut.
3. **Rig train**
   Balloon → chute → line → sonde (≈80 g).
4. **Ground station**
   USB in; open dashboard, pick COM.
5. **Power on**
   Sonde ID + green dots; LOCK channel.
6. **Fill**
   Fill to the neck lift; tie off twice.
7. **Release**
   Release downwind; climb ≈ +5 m/s.
8. **Track**
   Watch altitude, climb & the Map.
9. **Process**
   Flight over? Process → SHARPpy.



FLIGHT TRAIN



TracerLab

Follow local airspace rules.

Figure 9.1: Print-and-cut **PTHSonde** field quick-start card (3.62 × 6.6 in).

9.3 Inventory & stock tracker

Print or copy the following three pages to keep a running record of your hardware and consumables — one page each for sondes, balloons and lift-gas cylinders.

Sonde inventory

Sonde ID	Date flown	Notes

Balloon stock

Balloon (size / make)	In stock	Reorder at	Supplier	Notes

Lift-gas cylinders

Cylinder ID	Gas	Capacity	Level / PSI	Last filled	Notes