

**PBA****Home Archive Synopsis News/Updates**

THE PICO BALLOON ARCHIVE

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This website serves as the repository for the [Pico Balloon Archive \(PBA\)](#), designed to store, visualize, and ensure the quality of pico balloon data for the advancement of atmospheric science research.

Pico balloons are *ultra-lightweight*, party-sized, super pressure balloons that can float at altitudes between 9 to 15 km AMSL. Globally, they are launched by students, enthusiasts, and scientists, and can stay afloat for extended periods ranging from **months to years** after being launched. This data set encompasses pico balloons that have traversed all seven continents, accumulating hundreds of hours of flight data. **As such, it stands as the most extensive spatial data set for super pressure balloons to date!**

This website serves as the front end to the current data set. The 'Data Archive' tab features a chart outlining the [available data sets](#), complete with quicklook plots for various flights and options to download flight data files. The 'Synopsis' tab includes a [summary of all collected data](#). Additional details about the data sets can be found further down the page. The raw data and quicklook files can also be found at a AWS server at: <https://data.picoballoonarchive.org/data/>

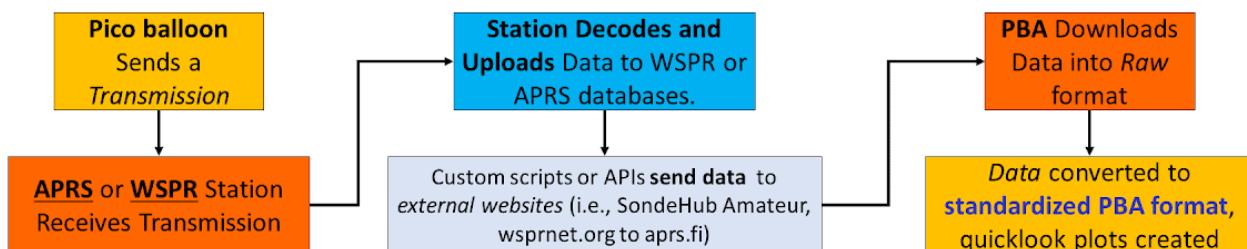




Pico balloons typically carry a **radio transmitter** that weights less than 50 grams that is solar powered. This allows for continuous daytime location tracking. Pico balloons frequently use amateur radio protocols, including APRS (Automatic Packet Reporting System) and WSPR (Weak Signal Propagation Reporter), to transmit telemetry information, encompassing GPS coordinates, altitude, temperature, and other relevant data. Both APRS and WSPR rely on **amateur radio infrastructure** to receive, decode, and upload balloon telemetry to publicly accessible websites like aprs.fi and wsprnet.org.

Pico balloons utilizing APRS can typically transmit a broader range of telemetry data due to the higher frequency radio band, which accommodates more information. However, a drawback is that APRS receiving frequencies often require line-of-sight, rendering balloons inaudible when they are over remote areas. In contrast, Pico balloons using WSPR can transmit signals over great distances, thanks to ionospheric signal propagation. The drawback is that the amount of data a balloon can transmit is limited, and it is frequently of lower resolution (see info farther below about quantifying errors).

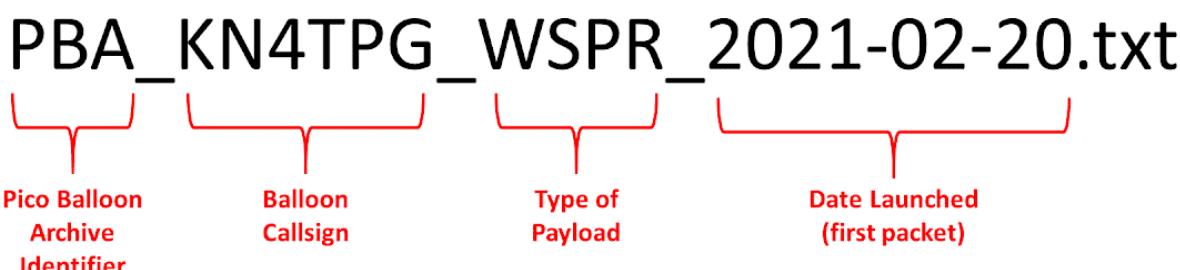
Once uploaded to aprs.fi or wsprnet.org, the data can be downloaded or visualized on alternative platforms like [SondeHub Amateur](#). The PBA aggregates information from both aprs.fi and [SondeHub Amateur](#), standardizing it into a unified format. A diagram illustrating this process can be found further below.



Data collection process for the Global Pico Balloon Dataset.



In the PBA, the **file structure** for a pico balloon flight is organized by its callsign, transmitter type, and launch date (year-month-day). An example of this naming convention is provided below.



Within a **PBA-formatted file**, the first 13 lines consist of **header information and data column labels** with respective units. These headers encapsulate a summary of the flight, similar to what is displayed in the 'Archive' tab table. Flight details include the callsign, date range, initial latitude and longitude coordinates, time spent airborne, total number of data points, and latitude range. Additionally, the headers feature labels for any *supplementary telemetry* that the trackers may provide. A 'Calculated Number of Circumnavigations' metric is also included, which tallies the instances where the balloon crosses its starting longitude. However, this value may not always be accurate, as balloons can occasionally reverse direction, which does not constitute a full circumnavigation. An [example file](#) is given below showing the first few lines.

All pico balloon flights in the GPBD come standard with GPS location and altitude, UTC time stamp in format year-month-day hour-minute-second, wind speed, wind direction, wind speed error, and wind direction error. If balloon has another sensors (pressure, temperature, etc...) it will show up in the telemetry columns. For WSPR pico balloon data, the size of the 6-digit WSPR grid squares varies with latitude. For instance, at a latitude of 45 degrees, a WSPR grid square measures roughly **4.6 kilometers** in height and **1.6 kilometers across**. The balloon's reported position corresponds to the latitude and longitude at the **center of this grid square**. Therefore, a error calculation of wind speed and direction calculation must be done.





```

First Latitude, Longitude: 34.6875, -86.45817
Time Aloft (days, hours, minutes, seconds): 107 days 03:30:00
Min and Max Latitude: 1.4375, 44.604
Calculated Number of Circumnavigations: 4
Index Number, Balloon Callsign, Time[UTC], Latitude[degrees], Longitude[degrees], Altitude[m - AMSL], Wind Speed[m/s], Wind Speed Error[+-m/s], Wind Direction[degrees], Wind Direction Error[+/-degrees], Vertical Motion [m/s], Telemetry 1[], Telemetry 2[], Telemetry 3[], Telemetry 4[], Telemetry 5[]

index,time,balloon_callsign,latitude,longitude,altitude,wind_speed,wind_speed_error,wind_direction,wind_direction_error,vertical_motion,telemetry_1,telemetry_2,telemetry_3,telemetry_4,telemetry_5

0,2021-02-20 17:06:00,KN4TPG,34.6875,-86.45817,2720.0,12.7,8.4,270.0,33.0,1.1,,,,,
1,2021-02-20 17:16:00,KN4TPG,34.64567,-86.375,3300.0,13.8,8.4,286.0,31.0,1.0,,,,,
2,2021-02-20 17:26:00,KN4TPG,34.60417,-86.20817,4000.0,18.1,8.4,286.0,27.0,1.1,,,,,
3,2021-02-20 17:36:00,KN4TPG,34.5625,-85.95817,4600.0,23.3,8.4,285.0,23.0,1.1,,,,,
4,2021-02-20 17:46:00,KN4TPG,34.52067,-85.79167,5300.0,23.9,8.4,285.0,22.0,1.1,,,,,
5,2021-02-20 18:06:00,KN4TPG,34.39567,-85.20817,6900.0,29.6,8.4,290.0,18.0,1.1,,,,,
6,2021-02-20 18:16:00,KN4TPG,34.35417,-84.875,7720.0,37.0,8.4,285.0,14.0,1.2,,,,,
7,2021-02-20 18:26:00,KN4TPG,34.3125,-84.625,8660.0,39.5,8.4,284.0,12.0,1.3,,,,,
8,2021-02-20 18:36:00,KN4TPG,34.27067,-84.29167,9660.0,42.0,8.4,283.0,12.0,1.4,,,,,
9,2021-02-20 18:56:00,KN4TPG,34.22917,-83.625,12060.0,46.9,7.5,281.0,9.0,1.6,,,,,

```

Example file for a PBA formatted pico balloon flight.

Archive and Synopsis Tab

To facilitate easier access to data, the 'Archive' section displays a chart summarizing the flights contained within the PBA. This table enables users to **download** pico balloon flight data in .txt format and also offers **quicklook visualizations** of the data.

The chart bears strong resemblance to the list of headers within each data file. Utilizing this table, users can identify pico balloons operating within **specific latitude or time domains**, or locate flights that are *currently airborne*. An example snippet of the table is list below. Data files can also be found at data.picoballoonarchive.org/data/processed/

Callsign	Payload Type	Flight Status	Date Range (UTC)	Total Data Points	First Latitude	First Longitude	Time Aloft	Min Latitude	Max Latitude	Telemetry 1	Telemetry 2	Telemetry 3	Telemetry 4	Telemetry 5
W5KUB-112 (Quicklook)	WSPR	Finished	2022-06-12 to 2023-04-06	3496	34.60417	-89.20817	297 days 16:10:00	7.47917	76.64583	None	None	None	None	None
NOB14 (Quicklook)	WSPR	Finished	2022-05-22 to 2023-02-13	7391	47.39583	10.45833	267 days 12:20:56	-67.22917	83.6875	None	None	None	None	None
BSS43 (Quicklook)	WSPR	In Progress	2022-04-29 to 2023-09-27	12439	74.0	-40.0	515 days 21:31:27	28.35417	89.60417	Temperature_degC	None	None	None	None

Click here for quicklook plot in new window

Click here to download data

If the flight has data within 7 days of the current time, it will say "In Progress"

Time Aloft is in format: days, hours:minutes:seconds

If the pico balloon has any other sensors, it will be listed here

E ⓘ The table from on the 'Archive' tab. Parts of the table are labeled.



float altitudes, and latitude. U and V are plotted as a histogram while other variables are vs. time. Additionally, a *textual summary* is provided in the top right corner of the graphical representation. To view one, a user can click on the 'Quicklook' tab in the Archive Table. Wind speed vs. time are plotted by day average scatter points and a 1 day rolling average. This is also done in the altitude vs. time plot. Using the 'Synopsis' tab, all pico balloon data can be viewed using **latitude bins and global maps**. These plots are **updated daily**. In addition, a map showing the location of the "In Progress" flights is shown.

Current Publications using the PBA

McKinney, Todd, et al. "Methodology, Deployment, and Performance of Pico Balloons in Antarctica." *Journal of Atmospheric and Oceanic Technology* 40.10 (2023): 1277-1290.

McKinney, Todd, et al. "Insights on polar day Antarctica radio propagation using amateur radio beacons on circumnavigating balloons." *Atmosphere* 14.7 (2023): 1118.

McKinney, Todd, et al. "Around the World They Go: Circumnavigating Balloon Satellites!" *Bulletin of the American Meteorological Society* 104.1 (2023): E192-E207.

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THE UNIVERSITY OF
ALABAMA IN HUNTSVILLE

**DEPARTMENT OF
ATMOSPHERIC & EARTH SCIENCE**





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