High-Altitude Balloon Experiment

DESIGN GUIDELINES

NASA TECHRISE STUDENT CHALLENGE

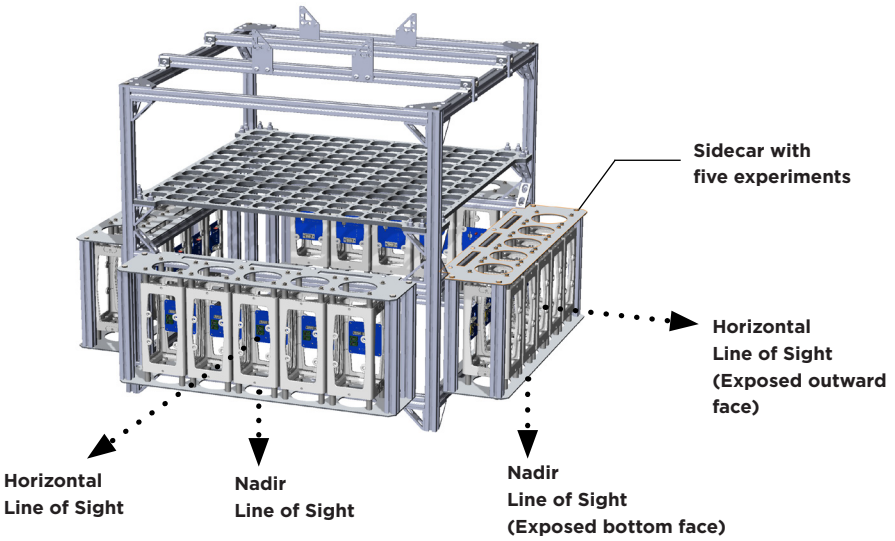
Below are guidelines to reference when developing your balloon experiment proposal. We encourage participation first and foremost, so remember that you won't be disqualified if your entry doesn't comply with every guideline. But if you do, your entry will score higher!

Experiment Cost

When developing your proposal, keep in mind that all purchased components to build your proposed experiment **should not exceed $1500**. The judges are not requesting a detailed budget nor will any team be disqualified based on cost, but proposals that require additional funding or outside sponsorship beyond the $1500 prize value will score lower.

How Balloon Experiments Will Fly

Below is an example mounting configuration with 20 balloon experiments aboard one NASA TechRise balloon flight. A gondola frame will hang from the balloon and there will be four "sidecars" with 5 experiments each. All experiments will have the opportunity to sense the atmosphere and capture images in two directions: 1) Nadir: looking down to Earth's surface and 2) Horizontal: looking out to the horizon. While the image below shows no foam, the sidecar surfaces will be covered with 1" foam insulation where possible due to the cold conditions. The bottom and outward faces can be fully exposed or insulated with cutouts for cameras/sensors. All experiments will plug into the main power/data source at the center of gondola and there will be no views to the interior. Also, the inflated balloon will block any upward views so there will be no zenith views. Inserts will also be placed between each flight box to isolate the experiments.



VEHICLE TELEMERY (DATA STREAM) SENT TO EXPERIMENTS

Time in UTC milliseconds
Latitude/Longitude
Altitude
Roll/Pitch/Yaw
Accel XYZ
Pressure
Course
Speed
Velocity XYZ

Flight Summary

For NASA TechRise, the balloon will launch and ascend to an altitude of approximately 70,000 feet, where it will float for at least four hours. The balloon will launch from Baltic, South Dakota and travel about 200-300 miles in the east/southeast direction. The flight crew will target a morning launch at 7am local time with the following launch conditions:

- Cloud cover less than 30%
- No rain at launch

The experiments can collect data during the balloon's ascent up to the float altitude and during the approximate four-hour float time. At the end of the float time, the power will be shut off, data collection will stop, and the experiments will parachute down to the ground.

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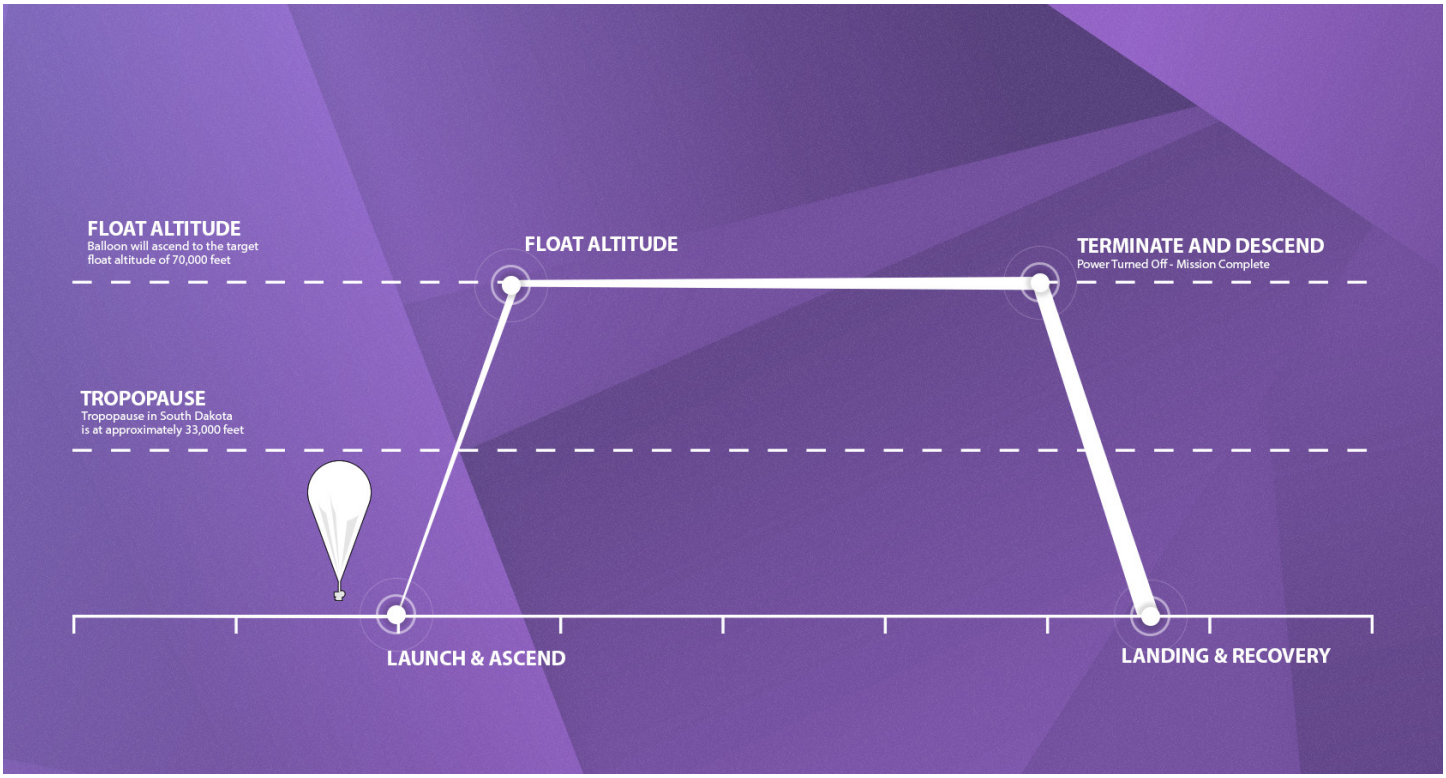
FLIGHT PROFILE & SIMULATOR



FLIGHT BOX

Winning teams assigned to high-altitude balloon flights will receive a 3D-printed Flight Box and a Technical Development Setup Guide.

FLIGHT PROFILE DETAIL

Pre-Launch	Flight experiments will be powered on and readied for flight.
Launch & Ascend	Target launch time is 7AM. Experiments will ascend through the troposphere into the stratosphere. During ascent, experiments will be operational and can collect data.
Float Altitude	After about 1 hour of ascent, the experiments will float at the target altitude of 70,000 feet for at least four hours.
Terminate and Descend	After 4-6 hours at float altitude, power will be shut off to the experiments, the balloon will be released, a parachute will be deployed, and the experiments will descend.
Landing & Recovery	The gondola will be tracked and best efforts will be made to recover the experiments and mail them back to each team.

RAVEN FLIGHT VIDEO

ABOUT HIGH-ALTITUDE BALLOONS

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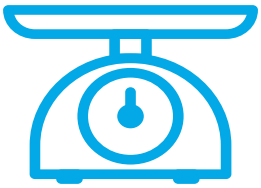
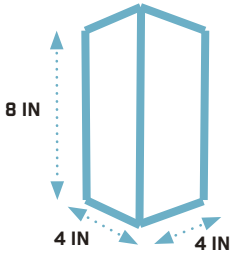


MASS

Your entire balloon experiment, including the 3D-printed box, screws, electronics, and all components inside can weigh no more than 1 kg or 2.2 pounds. The 3D-printed box will be provided to the winners and it will weigh between 130 - 180 grams. This means your team will have about 820 - 870 grams left for the rest of your experiment.

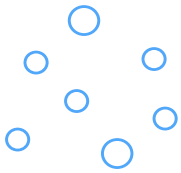


SIZE / VOLUME

Winners will be sent a 3D-printed box that is 4 inches x 4 inches x 8 inches in size. When brainstorming your design, it is important for your experiment idea to fit within this volume. The flight box will also have mounting points available on each side, which can be used to attach experiment components.

POWER & DATA

Your experiment will be plugged into the balloon for power and data. When designing your experiment, please remember that the experiment will receive 9V / 1.5 A of voltage and current from the balloon. This may limit the types of components you choose. Flight data will be sent in a serial byte format that can be received by a microcontroller through USB or UART and interpreted as strings of text and numeric data.



ATMOSPHERIC SENSING

Your experiment will be exposed to the ambient atmospheric temperature and pressure during flight. If using sensors to measure atmospheric conditions, it is recommended to mount sensors as close to the outer face of the experiment as possible.

VIEWS OF EARTH

Your experiment will be mounted onto a plate and then attached to the gondola frame. During flight, there will be views of Earth in two directions - down (Nadir) and out to the horizon (Horizontal).

TEMPERATURE

Temperatures during balloon flights could range between 5 degrees C and -82 degrees C. However, we don't advise designing for -82C! Please design for a cold flight, but also know that there is time to refine your component selections during the experiment build period. Future Engineers will help advise on insulation and temperature management strategies if selected as a winner.

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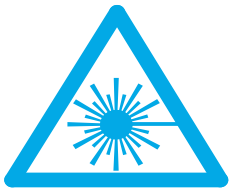
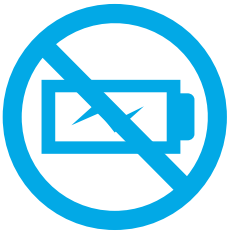


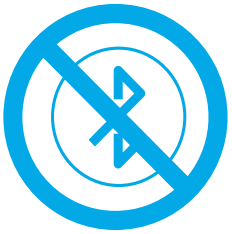
LASER SAFETY

Lasers are not allowed for NASA TechRise Balloon Experiments, which means that laser-transmitting technologies, such as LIDAR, are prohibited. However, exceptions will be made for internal sensors that use lasers to detect particles or other atmospheric data (i.e., PM or air quality sensors), so long as students are not directly interacting with the laser.



NO BATTERIES

Your experiment will be plugged into the balloon for power. Please design your experiment to operate solely using the balloon's power. By relying on balloon power there is less risk of a battery losing its charge before or during flight. If you want to use a component that is typically battery powered, we recommend hard wiring if possible.



NO BLUETOOTH / WIFI / RF

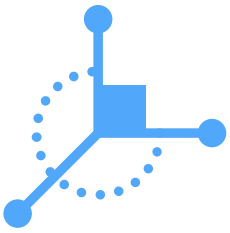
Radio frequency transmissions are NOT allowed on NASA TechRise experiments. This means no Bluetooth, WiFi, Cellular Phone, or RF Communications.

LIQUIDS

Experiments can have no more than 150 milliliters of non-hazardous liquid. If your team chooses to do an experiment with liquids, double containment is required. This means you need a container within a container to be extra sure that it doesn't leak.

NO BIOLOGY

Experiments that grow or monitor LIVE organisms are not allowed. All experiments will be stored in a dark place for many months, which means no plants, animal, or cellular focused experiments. (Unintentional bacteria/ germs are fine.) Exceptions are seeds on their own, or soils, or artificial soils for space farming-related experiments.



ACCELERATIONS

Your experiment should be designed to withstand 6-G in any direction. Balloons are generally known for their gentle, smooth rides, but there are two main points during flight to keep in mind when thinking about accelerations (or decelerations). First is when the parachute deploys. Second is when the gondola lands on the ground.

For more information, please refer to the Raven Tech Sheet **HERE**.