High Altitude Ballooning

High-altitude balloons used at St. Catherine University are typically flown around 100,000 ft. This places the balloon in the stratosphere, which is considered to be in "near-space" conditions. High-altitude ballooning is used for furthering research concerning the atmosphere as a way to test equipment used in outer space and also as a recreational hobby. The balloon is filled with enough helium to lift student-built experiment payloads up into the stratosphere (figure 1 and 2a).

All payloads are equipped with one or more tracking devices so that the balloon can be tracked during flight and found after landing (figure 2b). Some systems commonly used in high altitude ballooning are: Automatic Packet Reporting System (APRS – ham radio), StratoStar (900MHz radio GPS tracking), Geiger counters, accelerometers, cameras, temperature and relative humidity sensors, and pressure sensors just to name a few. Some of these systems can be flown on their own, while others have to be placed within a payload box.

Our thermal wake boom was comprised of two main components.

A) Carbon fiber rods — the rods allow for attachment of temperature sensors. Data sensors are attached to the rods at selected locations in attempt to resolve the spatial extent of the wake. HOBO temperature sensors used were cylindrical sensors (5.1 X 33mm).

B) Payload box — the box holds all of the instrumentation used to collect the temperature data. We have used HOBO data loggers, but we have also explored the use of Arduino Uno loggers this fall. Pink foam insulation is the primary structural element — this is covered by white duct tape. Attachment points are also setup to allow connection to other payloads.

The wake data collection device is typically located 2.5 meters or less from the neck of the balloon, which is well within the theoretical extent of the wake predicted by reference 1.

We present data characterizing the thermal wake that trails below ascending high-altitude balloons (AKA weather balloons) as they ascend into the stratosphere. This wake, which is warmer than the ambient air during the day but colder during night flights, is reported to be significant within 25 feet of the base of the balloon (see Ref 1). We have built and flown a "wake boom" that hangs below latex weather balloons with a 1-D array of temperature sensors that extends horizontally from directly beneath the balloon to outside of the predicted width of the thermal wake. We present analysis of the temperature profiles collected utilizing this apparatus.

Data Collection

Data typically show a variation of typically no more than +/- 1.5 degrees Fahrenheit for data collected in the troposphere and for data collected post balloon burst. The temperature difference created by the thermal wake is more substantial for the daytime wake as compared to the nighttime wake.

Future Steps

A) More thorough cross-calibration of the temperature sensors and the use of other types of temperature sensors.

B) Build and fly a two-dimensional X-shaped wake boom to investigate a potential warm side of the wake (sun side of the balloon).

C) Use upward-oriented video of the balloon to assist in determining the size of the balloon and characterize the orientation of the wake boom with respect to the sun side of the wake.

D) Higher data logging rates to investigate pendulum motion effect.

References


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