AURORA Concept of Operations

Requirements:

- Vehicle must be reusable
- Vehicle must follow FAA guidelines for radiosondes
- Vehicle must be capable of transmitting real time weather data to the ground
- Vehicle must be capable of functioning up to (75,000) feet ASL
- Vehicle must be capable of maintaining at least an 7:1 average glide ratio for the duration of the descent

Constraints:

- Vehicle must not weigh more than (500) grams.
- New system must not require extensive infrastructure changes to use
- Vehicle must not be “prohibitively expensive”.

Stakeholders:

- National Weather Service – Launch 70,000 weather balloons every year
- Lockheed-Martin, InterMet Systems, Vaisala, others– Radiosonde Manufacturers
- Military (for fire control systems)
- World Meteorological Organization

Flight Profile:

Prelaunch:

The Radiosonde should be easy to setup and calibrate with common tools and instructions, preferably with minimal updates to current tools in use. The inflation of the balloon as well as getting permission from the FAA to launch should not change from current protocols. The radiosonde is attached to the balloon.

Launch:

The balloon is brought outside and released at the proper time.

Climb:

Data will be collected and transmitted for the duration of the ascent. Real time data reporting is a requirement for correct forecasting and timely publishing of weather reports. The data will also be collected onboard, most importantly the winds, altitude, temperature, and humidity data. For the ascent the autopilot computer will be off to conserve power.

Release:

Release will be a critical time for the system. Current designs make no effort to protect the radiosonde from the popping of the balloon. For the success of AURORA it will be necessary to protect the radiosonde from becoming entangled in the bursting balloon. This can be accomplished by a number of means. Ideally the radiosonde would be protected from the balloon popping by passive measures, such as a long cable or a shield. There should be no reason to separate from the balloon before burst.

Initial Free Flight:

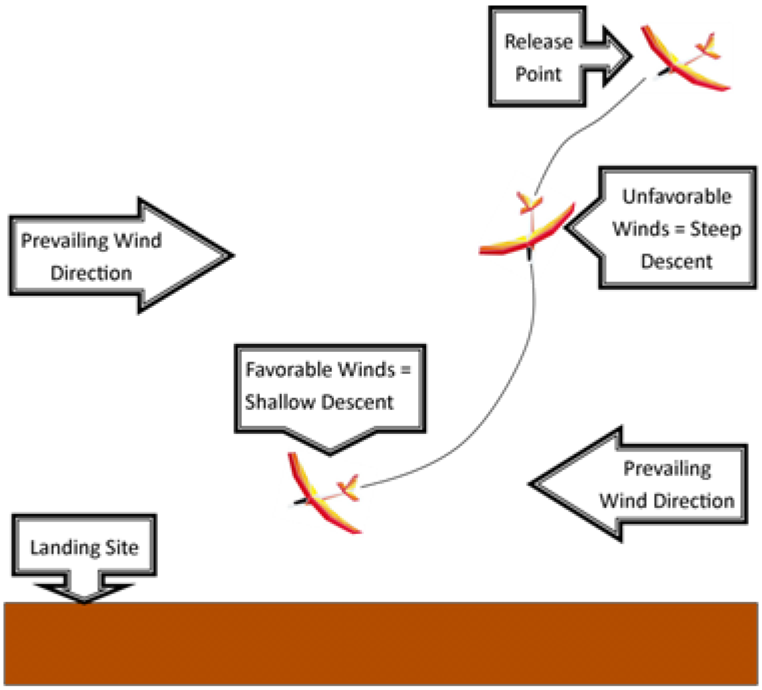
Post-Release Stabilization:

Immediately after release the flight computer will start and take control. To prevent spin entry or other dangerous aerodynamic conditions the controller will actively prevent excessive roll during acceleration to best glide speed. The navigation computer will then locate the nearest landing site and command the flight computer to turn to the appropriate heading for that target.

Calculation of Initial Flight Plans:

Direct to Land:

For flights where the machine is not loaded with waypoints to hit on descent, the navigation computer will now perform calculations to come up with a flight path to the best landing site based on data collected during the ascent phase. Important data for these calculations includes temperature, humidity, winds-at-altitude, and vertical speed. Flight paths would be adjusted to descend more slowly in regions where the winds are favorable, and to descend quickly through areas where forward progress would not be made.



Temperature and humidity data can be used to determine regions with possible icing risk, so that time in these regions can be minimized.

Additionally, geocoded minimums data preloaded onto the machine is referenced for ensuring that the craft will not penetrate any prohibited airspace during the descent. An optimized flight path is generated based on this data. It is likely that the navigation computer will calculate more than one possible flight plan and choose the one that gives the greatest arrival altitude over the landing zone.

Heading Following Descent:

The vast majority of the descent portion of the flight will have the craft flying along the calculated heading to the chosen landing site. During this time the APRS unit can still be transmitting to give the absolute best chance of finding the craft should it fail during this phase. The vast majority of this phase will be out of the range of cell towers, so there is no point in activating the GSM module. The navigation computer will be recalculating the heading to the target

Final Approach:

Once the craft has arrived over the landing site, the final descent profile is initiated.

Altitude Burn-off:

If the craft arrives over the landing site will excessive remaining altitude, the navigation computer will instruct the flight computer to spiral downward over the location until the GPS altitude indicates it is within the correct distance to initiate an approach.

Positioning for Approach:

Given the strict weight requirements for this vehicle, a final parachute descent is not likely reasonable. Because landing sites are preprogrammed, it is likely that some reference point, altitude, heading, and ground height will be given for the approach. If equipped with devices for landing approach modification, these would be deployed at this point. Finally, a transmission will be made to record the entering of approach to ease recovery efforts.

Landing:

The approach will be made based on GPS and airspeed. Once the GPS indicates that the craft is low enough, a landing transmission will be made prior to touchdown so that the final location can be recorded in the event that the craft flips, or is otherwise unable to transmit its final coordinates after touchdown. Immediately after touchdown, the craft would shut down all unnecessary systems, such as the flight and navigation computers, to save battery power for recovery.

Recovery:

After touchdown, the craft will enter a recovery mode and activate any equipment to assist in exact location by recovery teams. Depending on battery level, if the craft is not recovered within a certain time window, it will enter a low power mode where homing transmissions will be made at increasingly sparse, but regular intervals. These transmissions would be timed to a clock so that recovery crews would know when to be listening for homing transmissions.