Abstract
Dramatic motions were observed by instrumentation and a high definition video camera loaded in payloads attached to several Weber State University HARBOR (High Altitude Reconnaissance Balloon for Outreach and Research) near-spacecraft.

- Atmospheric turbulence, even when well clear of the jet stream, results in dramatic oscillations—including swinging the payload above the balloon and spinning (as in a barrel roll) of the entire package.
- Motions are being correlated with observed atmospheric conditions and addressing issues related to payload safety, mission tracking, and recovery.
- Also of interest are the dynamics of balloon rupture at low atmospheric pressure and the response of the parachute recovery system to that environment.

A Comparison of HARBOR August 2010 Flights—Observations by Onboard Video and Instrumentation
HARBOR flew 3 flights Aug. 18th-20th.
The first flight (18th) was fairly smooth. The 2nd two (19th & 20th) experienced dramatic turbulence.

Balloon size 1500 g. 3000 g.
Launch time 7 am 9 am
Length of leader line 6.5 m. 9 m.
Turbulence ascent/descent Low/Medium High/Medium

Conclusions—Large scale turbulence, comparable to microbursts near the ground, is occurring in the upper atmosphere in regions that are well clear of the expected turbulence at the edges of the jet stream. Any near-spacecraft that are designed to probe the stratosphere must be designed to handle dramatic rotational and oscillatory motions. These motions can generate forces exceeding 3 g's. Further work needs to be done to see if flight vehicle design can reduce these effects.

What is a typical HARBOR flight?
Scientific payloads are designed, constructed, and flown by students using weather balloons to reach the edge of space. These flights are similar to the hundreds of weather balloons launched by NOAA (National Oceanic and Atmospheric Administration) for which little is known about the flight dynamics. It is assumed by many atmospheric researchers that the balloon moves smoothly with the atmosphere. This is not true!