Stratofox Aerospace Tracking Team

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Carter Observatory & Planetarium
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About Stratofox

- We're an amateur group which performs aerospace tracking services for high altitude rocket balloon launches
- Our team has familiarity with the Black Rock Desert region, a launch site in Northern Nevada
- Members have experience in high-power rocketry, Ham Radio, 4x4, amateur astronomy, search & rescue, wilderness first responder, etc
- Our goal is to get invitations to “all the cool launches” for our members and help the alternate aerospace industry get off the ground

Claims to fame

- On May 18, 2004 Stratofox found the CSXT amateur space rocket's nose cone & avionics, 1 day after it was launched from the Black Rock Desert, Nevada.
- The CSXT booster was not as easily found because it lost its transmitter. Stratofox recovered it in a Winter 4x4 expedition on November 26, 2004
- Stratofox has performed space launch Range Safety several times. We're the only non-government organization that has.

Stratofox Timeline
Formation 2001-2002

- Some of the team started tracking rockets and balloons for JP Aerospace of Sacramento since 1998, most since 2001
- JPA tracking coordinator Tim Sargent (passed away in 2003) encouraged us to recruit Ham friends in Silicon Valley in 2001
- “JPA South Bay Team” grew during 2001-2002, brought as many as 6 4x4 vehicles at a time to JPA missions in Nevada
- JPA got an Air Force research contract in late 2002 that limited opportunities to volunteer
- So our Silicon Valley group cast a wider net for opportunities

Stratofox Timeline

Forming its identity – late 2002

- 8 team members camped at Black Rock anyway when a JPA balloon launch was postponed. We called it “Stratofox 1”.
- Some of our members helped at CSXT's Space Shot 2002 amateur space launch attempts
- The CSXT 2002 attempt ended in failure – the rocket exploded shortly after liftoff - we helped pick up the pieces

Stratofox Timeline
First year - 2003

- Feb 1 - space shuttle accident got interest in helping search for shuttle debris
- June 14 – Stratofox finds Paragon Dragoon I rocket 15 minutes after touchdown
- Aug 22-24 - “Stratofox 2” camping trip was training for upcoming CSXT and Paragon space launches
- Sept 14-18 – Paragon Dragoon II space launch -first attempt

Stratofox Timeline
Into the Spotlight - 2004

- April 8-11 – initial scouting for Debris 6 Hunt
- May 17-18 – CSXT Space Shot 2004, Stratofox recovers payload/avionics after space flight
- June 7 – Para gon Dragoon II space launch, 2nd attempt
- June 21, Sept 29, Oct 4 – Stratofox attends SpaceShipOne as spectators
- Aug 14-15, 20 – search for CSXT booster
- Nov 26 – CSXT space booster recovered

2005: The Season of Hard Knocks

- Following 2004 season with first amateur space launch success, Stratofox recovered CSXT space rocket payload and booster
- As we all know, pushing the envelope has risk
- All the high-altitude launches at Black Rock in 2005 ended in “shovel recoveries”
- If you're not familiar with the term, you will be soon

AeroPAC To100K

- Aero-PAC is the Association of Experimental Rocketry of the Pacific, the TRA high-power rocketry regional group for northern CA/NV including the Black Rock Desert
- To100K is a club project to set a 100,000ft altitude record for a high-power rocket (under NFPA 1127 regulations)
- Because 100K feet waivers available at Black Rock
- Stratofox coordinated searches following the Aug 5 & Sept 24 launches

AeroPAC To100K – 2005

- Aug 5 launch
  - booster (1st stage) OK
  - sustainer (2nd stage) didn't deploy drogue chute
  - sustainer broke up on main chute deployment
- Sept 24 launch
  - Booster (1st stage) OK, reused from Aug 5
  - Sustainer didn't light due to computer failure
  - Shovel recovery – sustainer pieces recovered from underground

Paragon Dragoon I
June 2003

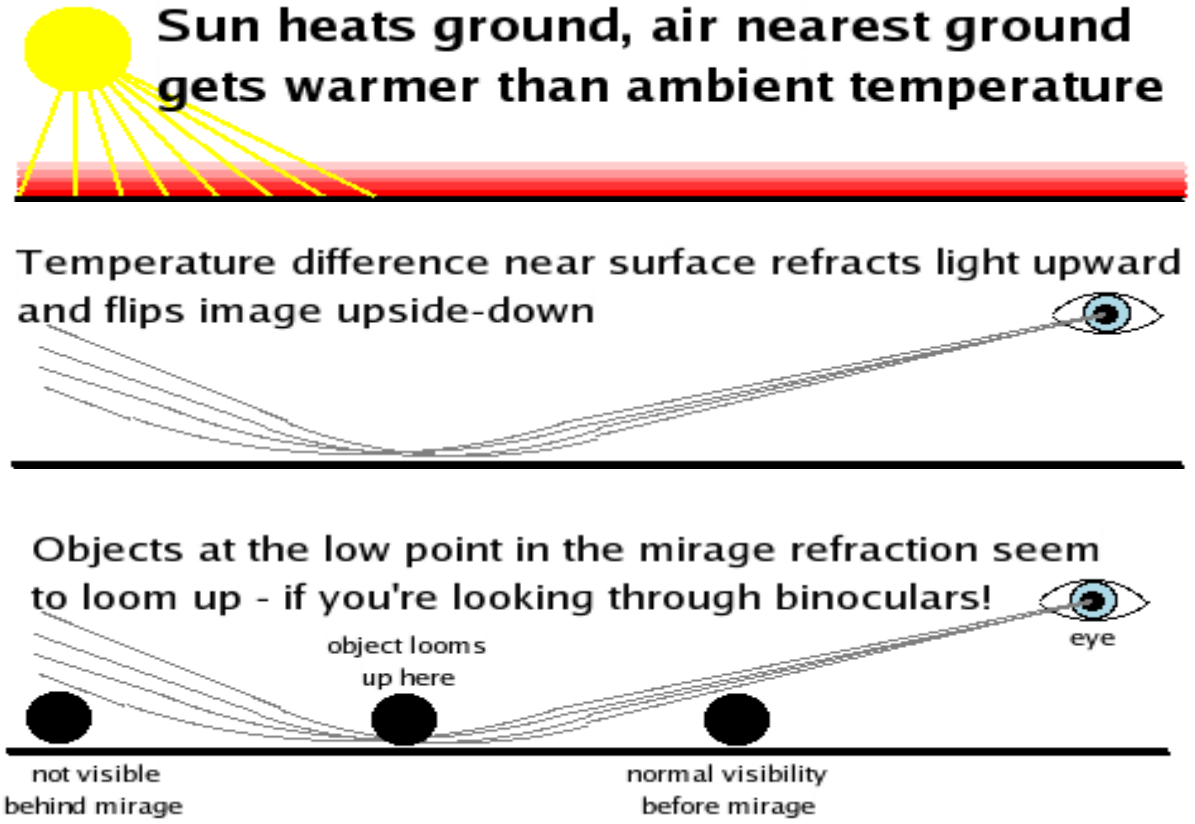
Stratofox's first find

Paragon Dragoon I – June 2003

- More difficult than usual – we were still unknown and no one knew who could give us the transmitter frequency. So we didn't have it!
- Everyone set out looking for it – we were 1 of 8 vehicles
- Teamwork: I did the driving and headed downwind from the rocket's observed direction of flight
- Bryan KF6ZEO did continuous binocular sweeps telling me where to turn whenever he saw anything
- This trick used the desert mirage to our benefit...

Searching in a Desert Mirage: What is a mirage?

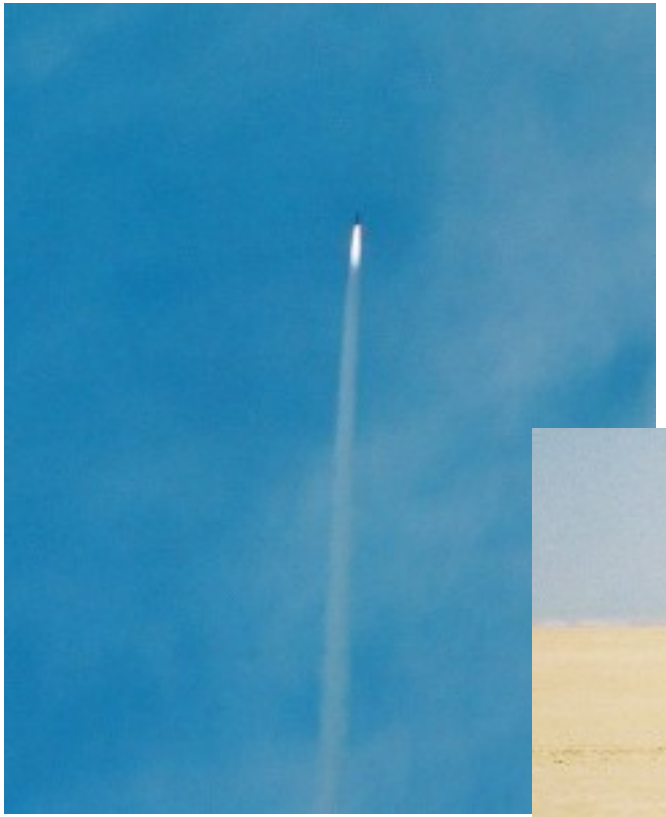
- "Inferior Mirage" caused by heating decreases visibility



Effects of a Desert Mirage

- Driving at highway speeds, if your passenger is making binocular sweeps, you can cover large areas quickly as objects loom up. The Dragoon I booster loomed up in Bryan's binoculars.
- You can move the mirage refraction distance further away with every inch off the ground – stop and stand on your vehicle if you need to. From the booster, Bryan found the nose cone this way.
- By our observations we think mirages affect radio propagation similar to light waves – maybe a form of the Tropospheric Ducting effect. Antenna height is needed to make beyond-line-of-sight surface contacts even on a flat lakebed during mirage conditions.
- People with handheld radios lose contact beyond the mirage.

Paragon Dragoon I –J une 2003



Debris 6 Hunt

A needle in a haystack...
which might never be found

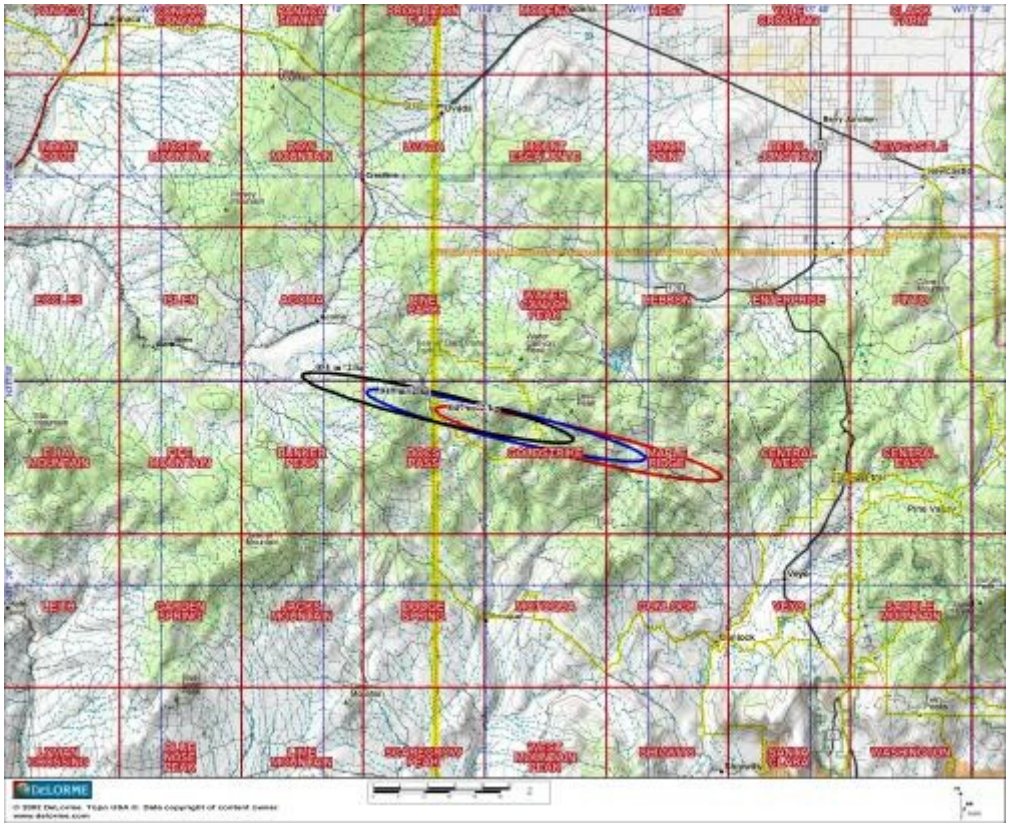
Forum for STS-107 eyewitnesses

- Stratofox organized a meeting for space shuttle Columbia eyewitnesses on 1st anniversary of accident (Feb 1, 2004)
- We ended up getting a new group of members who were interested in what we're doing
- They also brought new skills (astronomy, ballistics, etc) to the team
- After this meeting, we adopted a new project: searching for "Debri s 6" from STS-107
- Second eyewitnesses meeting was Jan 29, 2005

Search for STS-107's Debris 6

- There was enough eyewitness video of Debris 6 to estimate an impact area. NASA canceled its search after 2 weeks.

  - Stratofox found possible match between ballistic estimate and eyewitness account of falling debris
  - Good enough to look
  - Initial scouting of area was April 8-11, 2004
  - Brief searches in July 2005 and Sept 2006



CSXT Space Shot – May 2004

First amateur launch to space (100km)

CSXT Space Shot 2004
first amateur launch to space

- We were prepared to attempt a launch every day all week
- Stratofox assisted with radio communications, clearing the area
- Launched during first launch window, 11:12AM on Mon, May 17
- Downlink telemetry failed because antennas were damaged by Mach 5.5 heating –o therwise it could have told us where it was
- We initially knew it reached space because it took 8 minutes to fall back to Earth, when we heard the re-entry booms
- A chartered helicopter got beacon near mountains 25 miles away, winds were too rough to get in the mountains
- Then it was up to Stratofox to go find it

CSXT Space Shot 2004 Geographic spread of teams

- Avionics built in Connecticut near ARRL HQ by an all-Ham team led by Eric Knight KB1EHE
- Rocket body built in Minneapolis, led by Ky Michaelson
- Motor built in Denver area, with some participants from Miami, led by Jerry Larson
- The tracking team (Stratofox) from Northern California & Nevada

CSXT Space Shot 2004
Stratofox recovers the spacecraft

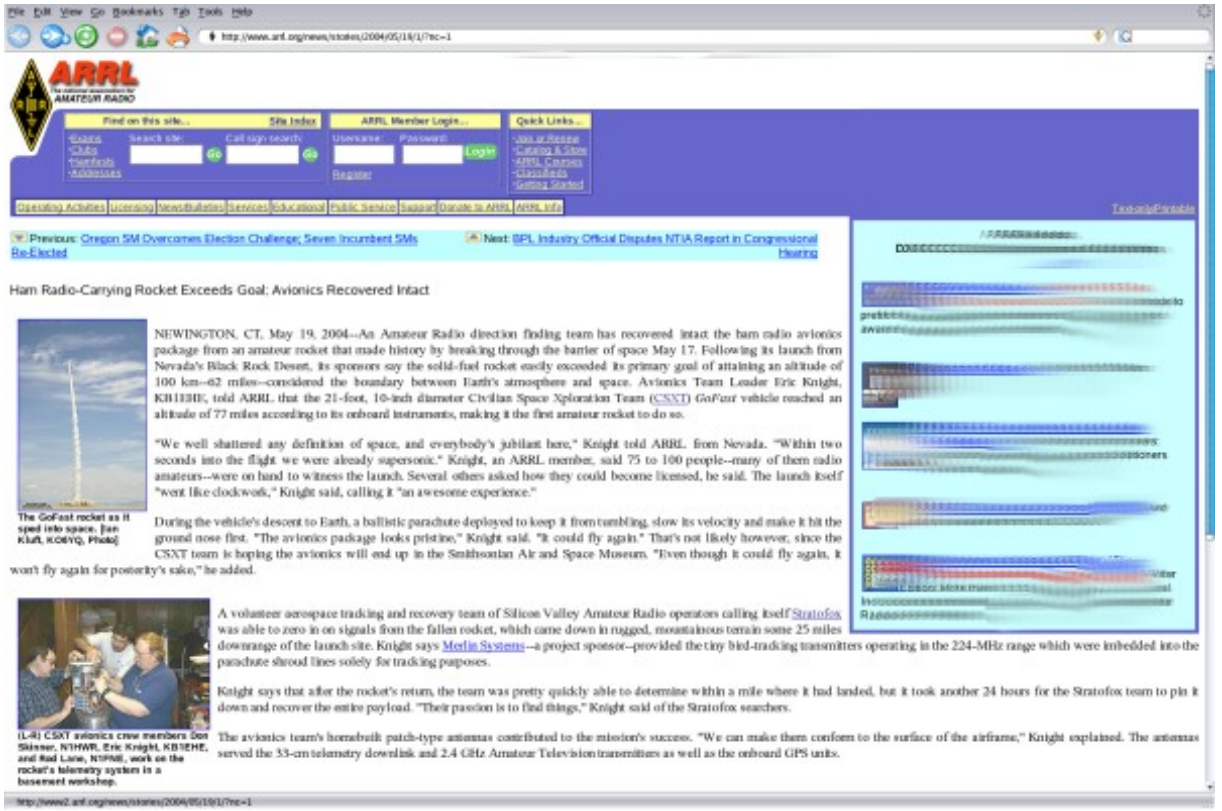
- Used radio direction finding for secondary beacon attached to parachute
- almost got there on first day – had to get everyone off mountain before dark
- rescued two spectators who were also trying to look for it and broke down
- found it at 6100' elevation after very strenuous hike around noon on May 18

Stratofox group picture: Will Galloway AE6EY, Ian Kluft KO6YQ, Jeremy Cooper KE6JJJ, Sean Lynch KG6CVV, Randy Palmer WA6LCD, Steve Palmer KA6DHU and Rob Palmer. Not shown: Diane Palmer KC6HVP, Christian Void KF6IHU, Colleen Brennan and Jay Lawson.

ARRL news gets attention for Stratofox

- ARRL news article got a lot of attention among Hams for Stratofox

When some of us went to Mojave to SpaceShipOne, on all three trips strangers saw our signs and said, "H ey! Stratofox! I know you." We met some nice Hams each time.



ARRL

Ham Radio-Carrying Rocket Exceeds Goal; Avionics Recovered Intact

NEWINGTON, CT, May 19, 2004--An Amateur Radio direction finding team has recovered intact the ham radio avionics package from an amateur rocket that made history by breaking through the barrier of space May 17. Following its launch from Nevada's Black Rock Desert, its sponsors say the solid-fuel rocket easily exceeded its primary goal of attaining an altitude of 100 km--62 miles--considered the boundary between Earth's atmosphere and space. Avionics Team Leader Eric Knight, KB1IHE, told ARRL that the 21-foot, 10-inch diameter Civilian Space Xploration Team (CSXT) *GoFast* vehicle reached an altitude of 77 miles according to its onboard instruments, making it the first amateur rocket to do so.

"We well shattered any definition of space, and everybody's jubilant here," Knight told ARRL from Nevada. "Within two seconds into the flight we were already supersonic." Knight, an ARRL member, said 75 to 100 people--many of them radio amateurs--were on hand to witness the launch. Several others asked how they could become licensed, he said. The launch itself "went like clockwork," Knight said, calling it "an awesome experience."

The GoFast rocket as it sped into space. [Jan Kluft, KC6YQ, Photo]

During the vehicle's descent to Earth, a ballistic parachute deployed to keep it from tumbling, slow its velocity and make it hit the ground nose first. "The avionics package looks pristine," Knight said. "It could fly again." That's not likely however, since the CSXT team is hoping the avionics will end up in the Smithsonian Air and Space Museum. "Even though it could fly again, it won't fly again for posterity's sake," he added.

A volunteer aerospace tracking and recovery team of Silicon Valley Amateur Radio operators calling itself Stratofox was able to zero in on signals from the fallen rocket, which came down in rugged, mountainous terrain some 25 miles downrange of the launch site. Knight says Merlin Systems--a project sponsor--provided the tiny bird-tracking transmitters operating in the 224-MHz range which were imbedded into the parachute shroud lines solely for tracking purposes.

(L-R) CSXT avionics crew members Don Skinner, N1HWR, Eric Knight, KB1IHE, and Rod Lane, N1PNR, work on the rocket's telemetry system in a basement workshop.

Knight says that after the rocket's return, the team was pretty quickly able to determine within a mile where it had landed, but it took another 24 hours for the Stratofox team to pin it down and recover the entire payload. "Their passion is to find things," Knight said of the Stratofox searchers.

The avionics team's homebuilt patch-type antennas contributed to the mission's success. "We can make them conform to the surface of the airframe," Knight explained. The antennas served the 33-cm telemetry downlink and 2.4 GHz Amateur Television transmitters as well as the onboard GPS units.

Search for missing CSXT booster

- No signals heard from the booster after descent
- In July 2004, CSXT analysis of Stratofox recordings of the sonic boom indicated that the booster's parachute was deployed.
- Ground searches were done in August.

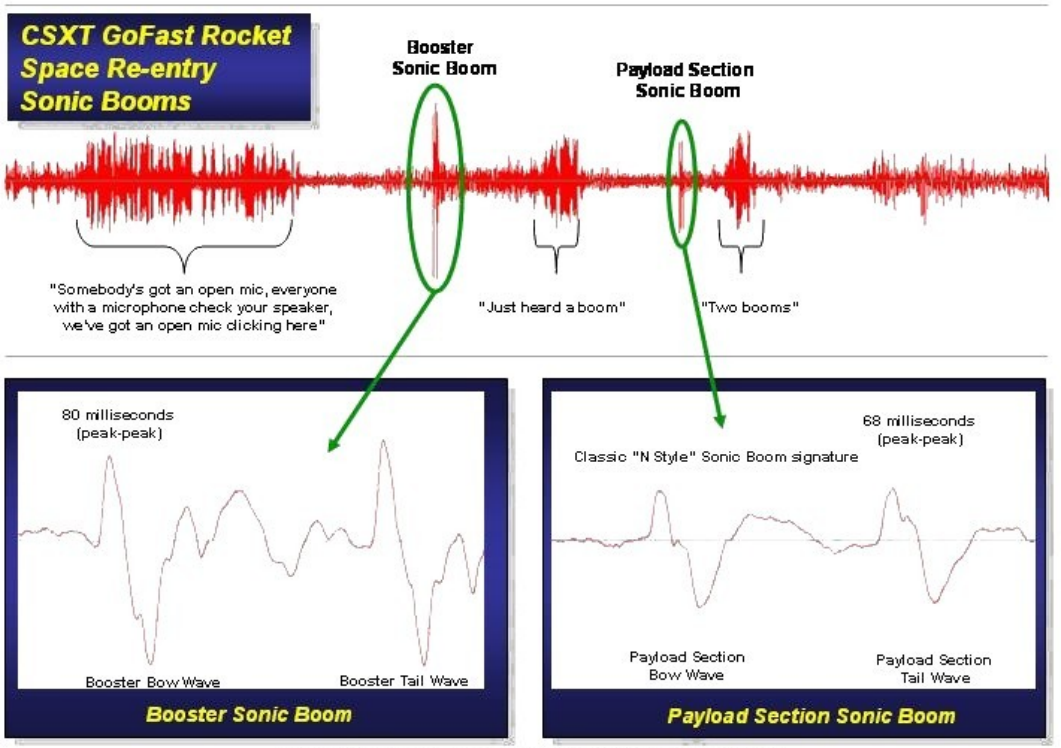


Image courtesy of Jerry Larson, Civilian Space eXploration Team (CSXT)
http://www.civilianspace.com/

Missing CSXT booster recovered November 2004

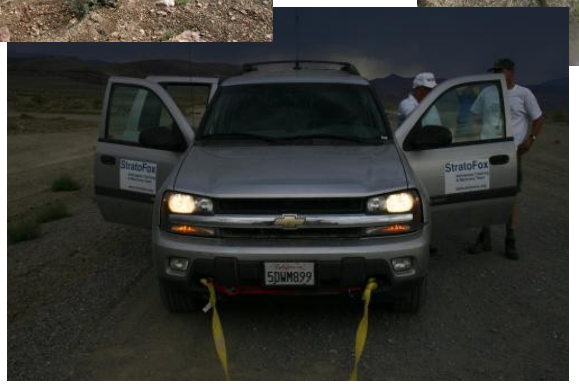
- Nov 10 - BLM chartered helicopter doing survey of wild horses finds the booster near where we had searched in August
- Nov 15 - BLM notifies CSXT and Stratofox
- Nov 26 – Stra tofox 4x4 expedition in mud/snow recovers the booster hours before a snowstorm

What happened to the booster?

- Parachute deployed successfully for high-drag re-entry
- booster went subsonic above 100,000'
- Parachute detached around or below 50,000'
- booster accelerated back up to 500 mph at impact
- forward 3 ft shattered, leaving 12 ft
- fin canister broke loose of all its bolts and slid to forward end
- now looks like the fins are on backwards – but they're really on the wrong end!

4x4ing, Search & Rescue close calls in 2004

- Stratofox tries to bring enough Search & Rescue capability for self-rescue if needed - it was needed 5 times in 2004
- We also rescue stranded people anywhere we find them
- 5 members are from El Dorado County Search & Rescue



2005 – "Season of Hard Knocks"

Some accomplishments come the hard way

2005: The Season of Hard Knocks

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AeroPAC To100K

Paragon Dragoon IIB

- Paragon Astronautics is from Denver CO
- Developing suborbital payload launch capability
- Dragoon IIB launch was under FAA/AST space launch permit
- Launch occurred Sept 27, 2005
- Airframe failure and premature payload separation during flight
- Booster continued to fly without payload

Paragon Dragoon IIB

- Stratofox cleared the downrange areas with air/ground surveillance
- Stratofox is the only amateur group who has performed space launch Range Safety* to the FAA's satisfaction. All others are government organizations.

* Range Safety in this case means clearing downrange areas of people

Paragon Dragoon IIB

Stratofox injury accident

- Stratofox member was in a rollover accident
- badly broken arm necessitated helicopter evac
- prompted more members to get emergency medical training

2006: Plans unfinished

- Planned to support UP Aerospace launch at New Mexico Spaceport in March, then delayed to August, then delayed to September, then volunteer badges canceled by spaceport at last minute
- Supported To100K at AeroPAC launch meet at Black Rock in August
- Began plans to install WiFi data link between Reno and Stratofox repeater site at Black Rock

2007: Stanford Biolaunch Balloon

- Stratofox tracked and recovered Stanford University's BioLaunch balloon on its flight to 72,000 ft on March 10, 2007
- Launch from Mt Hamilton (location of University of California's Lick Observatory) east of San Jose/Silicon Valley
- Landed in Henry Coe State Park on top of a tree
- Stratofox was credited with making same-day recovery possible
- Stanford built good equipment that had enough redundancy to overcome problems, easy to track

Stanford Biolaunch Balloon

- Where it was found
- Sometimes you aren't done when you've found it!

Making an Amateur Space Program

- Even a weather balloon can photograph the curvature of the Earth from 60,000' or above
- In USA, we can get approval from the Federal Aviation Administration to fly a balloon by using the same reporting procedures as the National Weather Service uses for its daily weather instrument launches
- In NZ, you'd have to find out how to get those approvals
- You also have more concern about losing a balloon over the ocean here.
- Whatever you do, make sure to keep it legal
- Can be frustrating but persistence is worthwhile