

# *Stratofox*

## *Aerospace Tracking Team*

*Presented by Ian Klufft KO6YQ*  
*Pacificon 2008*  
*ARRL Pacific Division Convention*  
*San Ramon, California*  
*October 19, 2008*

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# *About Stratofox*



# *About Stratofox*

- We're an amateur group which performs tracking services for high altitude rocket and balloon flights
  - Our team has familiarity with the Black Rock Desert region, a rocket 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 civilian entrepreneurial aerospace industry get off the ground
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# *What does Stratofox's name mean?*

- It stands for “Stratospheric foxhunt”.
- The Stratosphere is the layer of the atmosphere from 40,000' to 120,000'.
- A foxhunt is a search for a hidden transmitter
- The most challenging type of transmitter hunt is one where the transmitter fell from the sky.
- So no one can tell you where they hid it.
- That's what we do.



# *Quick History*

- Founded in late 2002
  - First high-altitude rocket recovery in June 2003 – Paragon Dragoon I (mid-altitude systems test) altitude 16 miles, found 6 miles away
  - Recovered first amateur rocket launched to space, CSXT Space Shot in May 2004 altitude 72 miles, found 25 miles away
  - Recovered 8 high-altitude balloons for Stanford University and NASA Ames in 2007 & 2008 altitudes up to 20 miles, found up to 80 miles away
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# *Whose launches has Stratofox supported?*

In chronological order by first launch supported...

- Paragon Astronautics
- Civilian Space eXploration Team
- Association of Experimental Rocketry of the Pacific “AeroPac”
- Stanford University & NASA Ames



# *Other potential upcoming launch support*

- UP Aerospace  
space launch business formed following success of CSXT Space Shot 2004
  - Masten Space Systems  
ground crew for X-Prize's Lunar Lander Challenge
  - SpeedUp  
ground crew for X-Prize's Lunar Lander Challenge
  - Sugar Shot 2 Space  
seeking first amateur launch to space using amateur propellants
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# *Highlights of recoveries*



# *Paragon Dragoon I – June 2003*

- Difficult... we were unknown. 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 in the mirage
- Using the desert mirage to our advantage, we were able to make very effective 1-mile diameter binocular sweeps
- With some intuition about the wind drift direction, we found it on the first search pass in less than 15 minutes.



# *CSXT Space Shot 2004*

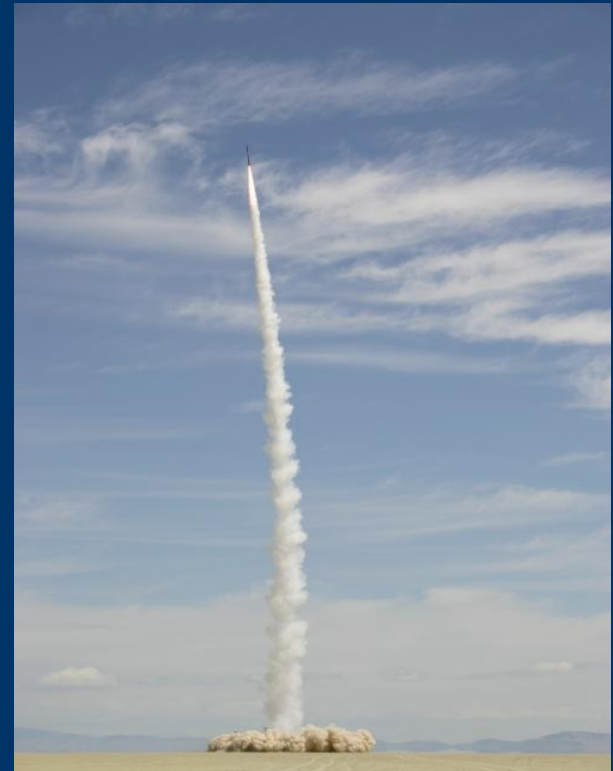
## *first amateur launch to space*

- We were prepared to attempt a launch every day all week
  - Stratofox assisted with communications & clearing area
  - Launched during first window, 11:12AM on Mon, May 17
  - APRS telemetry failed because antennas were damaged by Mach 5.5 heating – otherwise we'd have had GPS data
  - We initially knew it reached space because it took 8 minutes to hear the atmospheric 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
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# *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 designed in Denver, built in 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 Klufft 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

Later in 2004 when some of us went to Mojave to see SpaceShipOne, on all three trips strangers saw our signs and said, “Hey! Stratofox! I know you.” We met some nice Hams each time.

The screenshot shows a web browser window displaying an ARRL website article. The browser's address bar shows the URL: <http://www.arrl.org/news/stories/2004/05/19/17ac-1>. The page features the ARRL logo and navigation menus. The main article is titled "Ham Radio-Carrying Rocket Exceeds Goal: Avionics Recovered Intact" and is dated May 19, 2004. It reports on the successful launch of the Stratoflex rocket from Nevada's Black Rock Desert, which reached an altitude of 100 km (62 miles) and recovered its avionics package intact. The article includes a photograph of the rocket launch and a sidebar with a radio spectrum plot. The text describes the rocket's performance, the recovery of the avionics package, and the role of the Stratoflex team in tracking and recovering the payload.

**Ham Radio-Carrying Rocket Exceeds Goal: Avionics Recovered Intact**

NEWINGTON, CT, May 19, 2004—An Amateur Radio direction finding team has recovered intact 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, KB1HRE, told ARRL that the 21-foot, 10-inch diameter Civilian Space Exploration Team (CSSET) GoFour 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 jubilation 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."

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 CSSET 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.

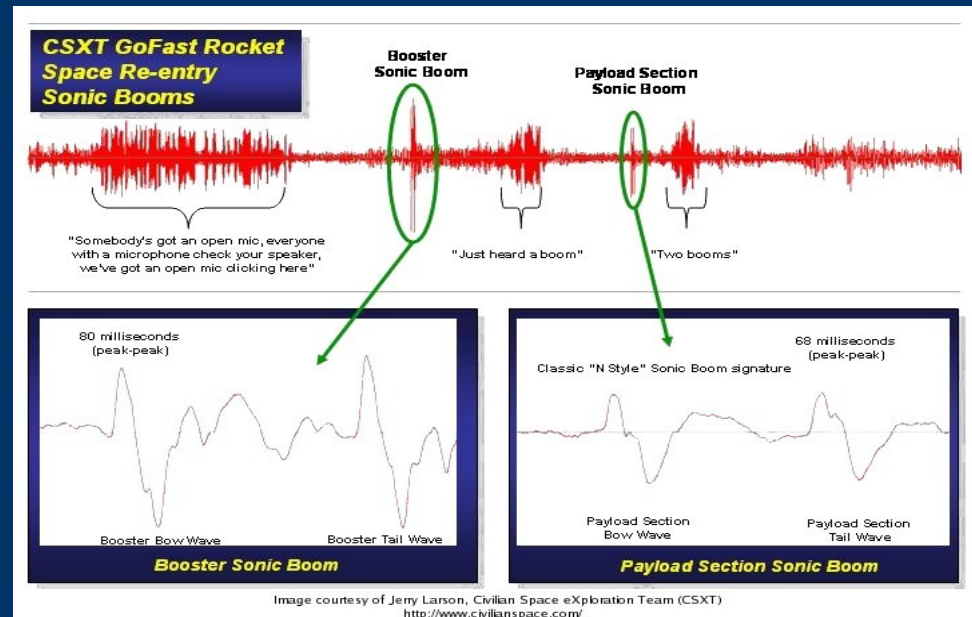
A volunteer aerospace tracking and recovery team of Silicon Valley Amateur Radio operators calling itself Stratoflex was able to zero in on signals from the fallen rocket, which came down in rugged, mountainous terrain some 25 miles downrange of the launch site. Knight says Merlin Systems—a project sponsor—provided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

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 Stratoflex team to pin it down and recover the entire payload. "Their passion is to find things," Knight said of the Stratoflex searchers.

The avionics team's homemade 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-m 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 and was presumed lost
- In July 2004, CSXT analysis of Stratofox audio recording of the sonic boom indicated that booster's parachute was deployed.
- Ground searches were done in August.



# *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 – Stratofox 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 (1m) shattered, leaving 12 ft (4m)
  - 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!
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# *Stratofox recovers the booster*



# 4x4ing, Search & Rescue close calls in 2004

- We try 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
- some members are from El Dorado County Search & Rescue



# *4x4ing, Search & Rescue why show the close calls?*

- Stratofox recruits for participants
- At an event, there's no room for spectators
- We don't hide this because we want to scare away anyone who isn't really interested in participating
- We take safety very seriously
- But you have to accept some risk
- More to scare spectators coming up...



# *2004-2005 Paragon space launch attempts*

- Dragoon II  
June 7, 2004 launch in 1<sup>st</sup> day's window  
nozzle failure at liftoff, rocket impacted 3 miles away
- Dragoon IIB  
Sept 27, 2005 launch in 2<sup>nd</sup> day's window  
payload separation in flight, booster impacted  $\frac{3}{4}$  mile away



# *2004-2005 Paragon space launch attempts*



## *2005-2006 AeroPac “To100K”*

- Rocket club effort to build a rocket to exceed 100,000' with commercially-available solid motors
  - 3 attempts spanning 2005 and 2006
  - First stage (booster) always worked
  - Different failure every time for the 2nd stage
  - Currently in redesign
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# *2005-2006 AeroPac "To100K"*



# *Stratofox injury accident*

- Stratofox member was in a rollover accident
- Badly broken arm necessitated helicopter evac (he fully recovered)
- Prompted more members to get emergency medical training
- We recruit for these skills and can arrange training



# *2007 BioLaunch research balloons – Stanford/NASA*

- “BioLaunch” name comes from primary research, exposing DNA samples to solar radiation at altitude
- Stanford Aerospace Engineering students also fly satellite electronics to test in near vacuum
- K12 student experiments on some flights



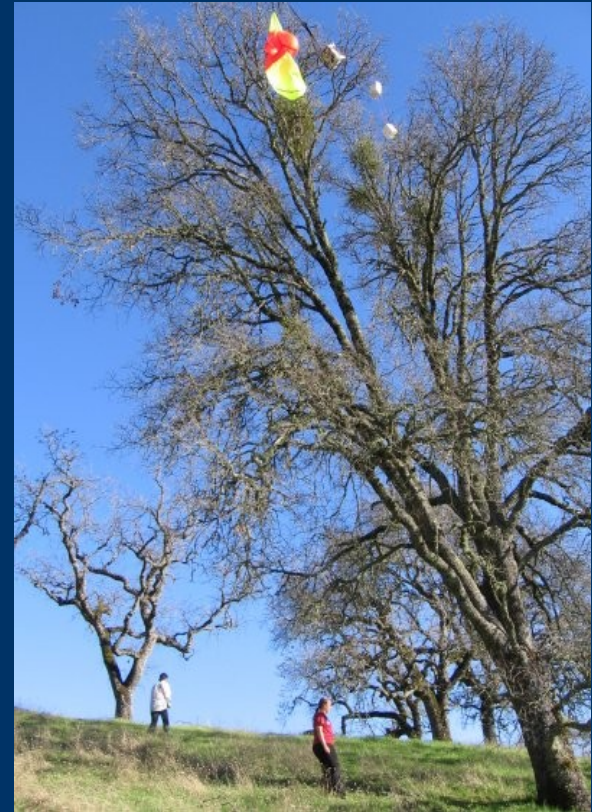
# *2007 BioLaunch research balloons – Stanford/NASA*

- BioLaunch B07A – March 10, 2007  
launched from Mt Hamilton  
landed in Henry Coe State Park
- Landed on top of a tree
- Successful same-day recovery enabled Stanford to present results to NASA promptly, which enabled further research funding



# *2007 BioLaunch research balloons – Stanford/NASA*

- Sometimes when you find it, you aren't done yet

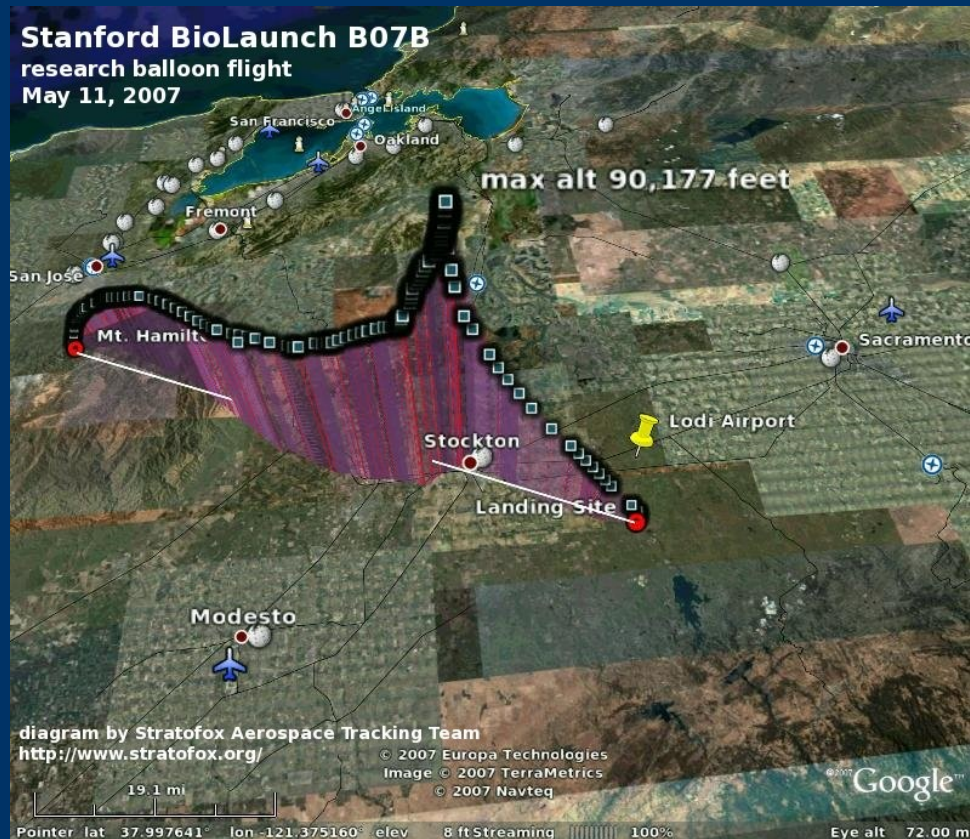


# *2007 BioLaunch research balloons – Stanford/NASA*

- BioLaunch B07B – May 11, 2007  
launched from Mt Hamilton  
landed NE of Lodi
- Landed on top of a tree again  
(Stanford's mascot is a tree)
- Stratofox chase plane crew found payloads within  
10 minutes of payload touchdown



# 2007 BioLaunch research balloons – Stanford/NASA



# *2007 BioLaunch research balloons – Stanford/NASA*

- BioLaunch B07C – June 9, 2007  
launched from Galt (south of Sacramento)  
landed north of Tracy in San Joaquin Delta
- Landed in corn field right down the furrow
- Stratoflex chase plane crew found it within 15 minutes of payload touchdown



# *2007 BioLaunch research balloons – Stanford/NASA*

- Again, the plane found it in minutes where ground search might have taken hours
- APRS telemetry received by air and ground crews
- Plane crew “talked in” the ground crews to the site



# *2007 BioLaunch research balloons – Stanford/NASA*

- BioLaunch B07D – Aug 4, 2007  
launched from Casa de Fruta (E of Gilroy)
- Part of payload separated and landed in mountains
- Remainder landed in San Joaquin Valley orchard
- All day+evening search, both parts recovered



# *2007 BioLaunch research balloons – Stanford/NASA*

- BioLaunch B07E & B07F – Dec 15, 2007 launched from Casa de Fruta
- B07E flew to 95,000', landed SW of Los Banos
- B07F aborted at 30,000' by Stanford landed near junction of I-5 and SR 165
- Both recovered in time for lunch
- Plane grounded in San Jose due to fog arrived 3 minutes after B07E recovery



# *BioLaunch B08A – March 2008*

- BioLaunch B08A & B08B – Mar 8, 2008 launched from Galt (south of Sacramento)
- 3 Stratofox teams started at the launch site
- 3 started at the Madera Airport (north of Fresno)
- Both balloons landed near Merced
- Both recovered in time for lunch (again!)
- B08A flew to 107,000'
- B08B flew to 68,000' (as high as planned)



# *Stratofox at the Fossett search*



Bob Verish, Brad Douglas KB8UYR, Greg Retkowski KI4NQF, Ian Klufft KO6YQ and Bernhard Hailer AE6YN with Greg's plane at the Minden NV Airport on Sept 8, 2007.  
(Yes it's normal for a Long-EZ to park with the nose gear stowed.)

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# *Stratofox at the Fossett Search*

- Stratofox is not a Search & Rescue organization
- But we have search & rescue expertise for our own crews' safety and anyone we find who needs help
- During Fossett search, Stratofox had numerous tips which we passed to CAP
- In 4 different cases, we were in positions to help and members stepped up to the task
- Amateur Radio used to track safety of our members



# *Stratofox at the Fossett search September 2007*

- Sept 3 – Fossett reported missing
  - Sept 4 – CAP begins search
  - Sept 7-8 – Stratofox aerial search near Eureka NV
  - Sept 7-8 – Stratofox ground search Minden NV to Mono Lake CA
  - Sept 11 – Stratofox aerial search near Topaz CA
  - Sept 13 – ELT heard near Mammoth/Mono Lake
  - Sept 14 – Stratofox ground search at Mammoth
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## *Sept 8-9: Eureka NV search*

- Sept 5: Eureka County NV Sheriff received report that a geologist heard an “aircraft in distress” on 9/3
  - No way to know if it was Fossett or another aircraft
  - CAP too overwhelmed to help Eureka County
  - Sept 7-8: Stratofox member Greg Retkowski KI4NQG flew to Eureka to help with grid search
  - No plane found - determined to be false alarm
  - Thunderstorm turbulence at time of report probably refracted sounds of US 50 traffic back to ground
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## *Sept 7-8: Minden to Mono Lake*

- CAP accepted when we offered to help search
  - Stratofox ground crew arrived in Minden Sept 7
  - Pilot Greg KI4NQG arrived from Eureka Sept 8
  - CAP withdrew offer for concern of collision risk, wanted CAP-trained pilots only
  - Asked us to search on ground only – we complied
  - Stratofox members heard from friend of Fossett that he was headed “south along 395”
  - binocular searches from Minden to Mono Lake
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# *Sept 7-8 search participants*

- David Brock N6DCB – point of contact
- Brad Douglas KB8UYR
- Bernhard Hailer AE6YN (\*)
- Ian Klufft KO6YQ
- Greg Retkowski KI4NQF – pilot/plane owner
- Bob Verish (\*)

(\*) indicates participation in this event qualified for Stratofox membership

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# *Sept 10, 2007: plane in sat photo*

**Before**

**After**



**That's an airplane – and the right size  
found by Internet volunteer Drew Smith**

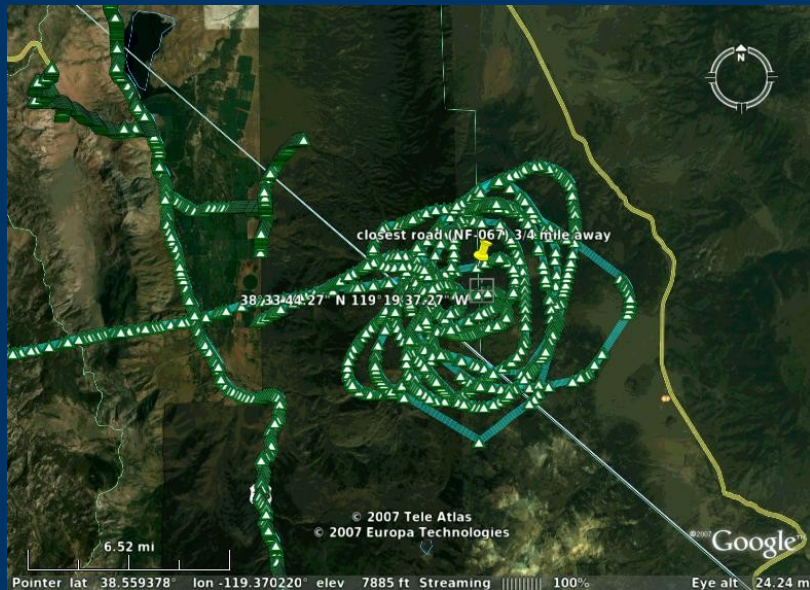
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# Sept 11, 2007: aerial search

GPS: 9/8 ground and 9/11 aerial

Definitely no airplane there



We determined the plane in the sat photo was in flight at the time

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## *Sept 11, 2007 participants*

- Brad Douglas KB8UYR – point of contact
- Ian Klufft KO6YQ
- Ben Woodard KG6FNK – pilot/plane owner



## *Sept 13: ELT heard near Mono Lake*

- Stratofox member Steve Rubin AE6CH, not involved in but aware of the search, heard an Emergency Locator Transmitter (ELT)
  - He was flying a Cessna 210 from Santa Monica to Reno west of the crest of the Sierras
  - ELT reported “25 mi west to south of Mono Lake”
  - He reported it to Air Traffic Control and to the Stratofox team
  - Stratofox forwarded report to Fossett family & CAP
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# *Sept 14: ground search from Mono Lake to Mammoth Lakes*

- Based on previous evening's ELT report
- Ground search by Ian Klufft KO6YQ monitored for ELT from Mono Lake to Mammoth Lakes
- No ELT heard
- Deep-freeze nights left no hope of finding survivor
- Now after the wreckage was found we know...
  - Ridge would have blocked ELT signal
  - At nearest this was 8 miles from crash site



# *Stratofox at the Fossett search*

- Needle in a haystack search
  - Odd circumstances with CAP overwhelmed by reports from the public, unable to sort them quickly
  - When Stratofox had info, we always forwarded it
  - We also checked for ourselves if we could help
  - Normally we're not an S&R organization
  - The thought at the time was that Fossett might be waiting for a rescue
  - Now we know it was too late before searches started
  - Team members still feel proud of our efforts
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# *Training and Recreation*



# *Camping and Exploration*

- Stratofox tries to schedule a recreational camping and exploration trip to the Black Rock Desert each year
- It helps train new members about the area
- It gives us a chance to explore areas related to upcoming events without pressure
- We always use Amateur Radio for safety
- Nearest cell coverage is 80 miles south



# *Recreational trips to the Black Rock Desert*

- Stratofox 1 – Sept 2002  
founding event of Stratofox
  - Stratofox 2 – Aug 2003  
training for CSXT and Paragon space shots
  - Stratofox 3 – Sept 2006  
exploring after busy years w/ space launches
  - Stratofox 4 – Aug 2007  
hiking in Black Rock Range
  - Stratofox 5 – Sept 2008  
hiking, desert navigation, AHPRA rocket launch
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# *Volunteering for Stratofox*



# *If you're interested in Stratofox*

- Stratofox is admittedly picky about new membership
  - We have to keep the group trustworthy because some of our partner organizations have considered each other competitors before and others probably will again
  - We have to be trusted by all parties
  - There is no room for spectators out in the deep desert – everyone has to “carry their own weight” out there
  - Potential new members need to have a useful skill – an Amateur Radio license qualifies because we need communications in desert areas with no cell coverage
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# *If you're interested in Stratofox*

- You may be referred as a potential new member by any team member who thinks you have what it takes
  - This puts you on “invitee” status
  - Invitees can earn full membership by participating in an event
  - After participating, you can be voted onto the team
    - How well did you do your part?
    - How well did you help the team achieve its goals?
    - How well did you get along with the team?
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# *Useful skills for membership*

Any of these, the more the better:

- Amateur Radio license
- Navigation, GPS & maps
- 4x4/off-roading
- High-power rocketry certification
- Private Pilot license or better
- Own an airplane

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# *Useful skills for membership*

(continued)

- Electronics or Aerospace Engineering
- Astronomy
- Search & Rescue
- Emergency medical training
  - First Aid/CPR is minimal
  - Wilderness First Responder
  - EMT
- Logistical planning



# *Who's on the team?*

- 52 members with an impressive array of skills from...
  - Northern California
    - Silicon Valley, East Bay, North Bay, El Dorado, Chico
  - Southern California
    - Tehachapi/Mojave, LA Basin, San Diego
  - Nevada
    - Reno
  - Colorado
  - Virginia



# *Useful equipment for Hams*

- APRS receiver: 2m/70cm radio, GPS
- Laptop with APRS mapping software (i.e. Xastir)
- Separate band or radio for UHF voice comms
- Yagi or other directional antenna + attenuator



*If you don't have a Ham license*

Please see  
<http://radioexam.org/>  
for practice FCC exams  
and studying advice



# *Upcoming Events*



# *BioLaunch balloon flights*

- Usually in Central California
  - Maybe some at Black Rock
  - Launch site determined within days before flight
    - Winds aloft forecast 1-2 days before launch
    - Work back from desired landing area
      - not in the ocean
      - not in a metro area
  - Volunteers accepted
  - Participation qualifies invitees for membership
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# *Launches at Black Rock Desert*

- Located 2 hours north of Reno
- None during the wet season – lakebed is not dry
- Many groups may ask for assistance
  - AeroPAC To100K or other high-power rocket
  - Sugar Shot 2 Space or other space launch
  - Stanford balloons
  - Others as they invite Stratofox to help



# *Lunar Lander Challenge 2009*

- Probably to be held at Las Cruces, NM
  - Remains to be seen if any prizes are won in 2008
  - Stratofox may assist with ground operations for some Lunar Lander Challenge teams
    - Masten Space Systems
    - Paragon Astronautics
    - SpeedUp
  - Teams competing for up to \$1M for two rocket hover flight between two landing pads
  - Prizes won't cover teams' development costs
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# *Out of pocket expenses*

- Historically, all Stratofox volunteers have handled their expenses out of pocket
- Stratofox's parent/umbrella corporation was granted 501(c)3 status in August 2007
- Volunteer expenses are now tax-deductible
  - Record your mileage and keep your receipts
- Donations are now tax-deductible
- Some situations may arise where we can reimburse volunteers for expenses – but don't count on that



## *For more information...*

- Web site: <http://www.stratofox.org/>
- Talk mail list – public aerospace discussion
- Announce-only mail list – if you only want announcements

