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Near Space

The shore of our new ocean...

Copyright - JPAerospace
The view from a high altitude balloon launched by JP Aerospace, an advance amateur ballooning and rocketry group.

John F. Kennedy in his famous Rice University speech referred to space as our *New Ocean*. And just as an ocean possesses a shore, so do we find a shore above us at the transition from earth to space.

This space shore is often referred to as Near Space.

The realm of Near Space officially lies between 75,000 feet (~23km) and and 62.5 miles (100km) according to the International Aeronautical Federation (FAI). Here we consider a wider range that extends up to 200km or so where it becomes safe for satellites to remain in orbit without immediately becoming dragged down by friction with the residual atmosphere.

The vehicles that traverse this high altitude domain are called **nearcraft**. These include sub-orbital rockets, which make quick jumps into and out of near space, and high-altitude balloons that can loiter there for extended periods.

> Weather balloons routinely go to 27km (~90k ft). Scientific balloons go to 42 km (137k ft or 26mi) and remain at high altitudes for several days. The world record altitude reached by an unmanned balloon is 51.82km (170k ft or 32.2mi).
>
> The record for altitude reached by a crewed balloon was set by Malcom D. Ross and Victor A. Prather who flew to 34.668km (113,740ft or 21.54mi) on April 5, 1961.

Compared to orbital flights and journey's to the Moon and Mars, Near Space may seem of little interest, only an interlude on the way to more exciting places. In fact, Near Space offers numerous exciting benefits and applications.

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Here is a list of some possible benefits of utilizing Near Space:

- **Cheaper and quicker access** to space-like conditions are offered by nearcraft as compared to getting a launch to orbit. See the Ballooning and Sub-orbital rocket entries below.
- **Amateur groups are participating** in more and more activities there. Ham radio enthusiasts, students, and amateur scientists carry out high altitude experiments in astronomy and atmospheric studies, taking high altitude pictures, and testing equipment that will be used on satellites.
- **High altitude cameras** can see for several hundred miles farther than with aerial photography and access to a given area is more flexible than with the infrequent fly-overs by remote sensing satellite.
- **Development of sub-orbital RLVs** will be much quicker and cheaper than orbital vehicles. The technology, operations techniques, etc. learned from sub-orbital systems will then be applicable to second generation vehicles intended for orbit. See the article **Sub-orbital Rockets to Space: The Next Logical Step?**
- **Sub-orbital space tourism** packages will offer trips that may last in total only half an hour or so. Yet, at the top of 100km trajectory one will see the curvature of the earth below and a dark starry sky above and one will experience the accelerating thrill of riding a rocket and then feel a few minutes of microgravity. Many people may actually prefer this kind of brief initial space experience over a full blown stay in orbit for several days. See the Sub-orbital Space Tourism section

Copyright TVNSP
Image of a lake taken from +100k ft by a camera on an amateur high altitude balloon. Cameras can see the horizon out to several hundred miles from Near Space.

So just as there are those who prefer the sea shore for such activities as swimming and fishing rather than sailing out into the open sea, so there will be many people who prefer the Near Space shore over voyages into open space.

Note: This section was inspired by a suggestion from near space enthusiast Paul Verhage

News & Events

- Into thin air: Early in 2005, champion skydiver Cheryl Stearns will make the highest free-fall jump in history from the edge of space. - New Scientist - Dec.19.03

- It's Not Your (Great Grand) Fathers Airship (Two) - Rocket Man Blog - Nov.10.03
- The poor man's space program by L. Paul Verhage - The Space Review - Oct.27.03
- US Air Force eyes 'near space' vehicle - Jane's - Sept.19.03
- Countdown to record balloon attempt - BBC - Sept.1.03
- Brits with altitude prepare to float into space in a giant balloon - Guardian - July.11.03
- Balloonists' rehearsal for record bid - BBC - July.10.03
- Lightning Jets Blow Sky High - Wired - June.25.03
- Strato-plane looks skyward - BBC - June.24.03
- U.K. pair to ride balloon into 'space' - CNN.com - June.23.03
- Instant Glider: Just add Light - Science@NASA - May.2.03
- JP Aerospace Busy in Near Space - Space Log - Dec.14.02
- Light Shows: The Science and Scenes of Near Space - Space.com - Oct.29.02
- First Global Space League Event Lofts Rocketcam and Student Space Experiments Over Oklahoma - Spaceref/Takeoff Tech PR - Oct.4.02
- PongSats Ready For Spaceport Sendoff - Space.com - Oct.4.02
- Ecliptic RocketCam™ Supports Global Space League Event in Oklahoma - Ecliptic - Oct.2.02
- QinetiQ 1 balloonists now look to next year to launch their balloon for the edge of space - QinetiQ 1 PR - Sept.24.02
- Frenchman ready for daredevil dive - BBC - Sept.6.02
- NASA's Ultra Long Duration Balloon To Try Again To Circumnavigate Globe - Aviation Week - Aug.29.02
- British Balloonists to Attempt Record Flight to Edge of Space - Space.com - Aug.28.02
- NASA Scientific Balloon Sets World Record - NASA - Aug.26.02
- The Man Who Will Fall to Earth - Wired - July.29.02
- Stratospheric Platform Serves As Satellite - Space.com - July.24.02
- Fossett ready for glider challenge - BBC - July.21.02
- Balloon adventurers eye weather - BBC - July.9.02
- Balloonist's Next Try: How High - Wired - July.9.02
- Stratospheric Satellites: a New Technology for Monitoring Global Disasters - Yahoo /Global Aerospace PR - July.3.02
- Amateur Radio-carrying balloon launches are a success -ARRL - June.27.02
- Weather balloons to plug wireless gaps - CNN.com - June.22.02
- Billionaire seeks to glide to edge of space - CNN.com - May.9.02 - Steve Fossett will ride the wind to nearly 19km:

Events

- Next Pongsat balloon flight is Oct.5, 2002 - JP Aerospace
- Upcoming Flights - EOSS
- High Altitude Balloon Launch Information Center

Discussions

- Yahoo! Groups : Ballooning
- Yahoo! Groups: tvnsp · Treasure Valley Near Space Project

Amateur & Student High Altitude Ballooning

A *near space stack* consists of a helium balloon, recovery parachute, and nearcraft, and can reach fifty feet (~17m) in length. Such a stack can fly to over 100,000ft (~33km) in altitude yet costs only a few hundred dollars. The balloon expands as the stack rises and will eventually burst. The payload then parachutes to earth and is tracked with GPS data sent via telemetry on amateur radio .

The cost to launch anything to orbit is usually quite high - thousands of dollars per kilogram. Even a free piggyback ride on someone else's launcher can require long delays.

Sounding rocket flights are not so cheap either and the flights last for only a brief time.

An alternative is to put a payload on a high altitude balloon, which can cost only a few hundred dollars to fly. A balloon can reach as high as 25km and remain aloft for days. At such altitudes the payloads are above much of the atmosphere, they see the black canopy of space, and view clearly a big swath of the earth with a curved horizon out to several hundred miles.

Balloons can be good alternative for educational projects in which students usually only have a year or so to participate.

So it's not surprising that amateur high altitude ballooning has become a growing activity that involves ham radio enthusiasts and educators looking for low cost but exciting science projects for their students.

Below are some resources in this exciting field.

Introductory Materials

- Amateur Near Space Exploration Brochure - TVNSP
- Ham Ballooning FAQ at EOSS
- Balloons in Space: Amateur Balloonists Reach into the Stratosphere - Weatherwise Magazine - Nov/Dec 01

Other Resources

- **AMSAT & High Altitude Balloons**
- **Edge of Space Sciences** - An educational program that lets students, both K-12 and university levels, in Colorado build "satellites" for flights on high-altitude balloons. These broadcast data from on board experiments to student receivers.

    - Balloon to Carry CU Student "Mini Satellites" to Edge of Space - Univ. of Colorado at Boulder PR - Aug.24.01
    - Colorado Space Grant Consortium
    - Citizen Explorer:Welcome to CX-1
- **Borealis** - Montana Space Grant Consortium's High Altitude Balloon Program
    - Classroom projects - balloons, GPS, space science, etc.
- **CAPSAT** - Coordinated Algebra (II) & Physics Simulated Satellite - high school project that sent amateur radio transceivers on a balloon.
- High Altitude Balloon Launch Information Center
- **HighShips** - "low-cost provider of scientific and civic event unmanned ballooning services. We are developing a unique service to keep up to 2 pounds of payload up at 90,000+ feet for two to seven days."
- TVNSP: Treasure Valley Near Space Project
- HABITAT: SkyLab Research Balloon
- Nebraska Stratospheric Amateur Radio (NSTAR)
- Project Traveler - subgroup of RCKARA radio club in Hutchinson, KS.
- Kansas Near Space Project
- Arizona Near Space Research
- Balloon v1.0
- Ralph Wallio, WØRP
    - Amateur Ballooning Records
    - **Ballooning Links** - lots of links to amateur high-alt ballooning sites
- FreeSpace - Terence Bordelon
    - Shadow-2 High Altitude Balloon Launched Glider

Other High Altitude Resources

- **QinetiQ 1** - attempt to break balloon high altitude record and ascend to 132,000 feet - almost 40km high (25 miles).
    - Brits with altitude prepare to float into space in a giant balloon - Guardian - July.11.03
    - Balloonists' rehearsal for record bid - BBC - July.10.03
    - Ballooning 25 Miles High - In Depth [about the QinetQ 1 mission] - BBC NEWS
    - U.K. pair to ride balloon into 'space' - CNN.com - June.23.03
    - QinetiQ 1 balloonists now look to next year to launch their balloon for the edge of space - QinetiQ 1 PR - Sept.24.02
    - Space balloonists helped by Gagarin's team - BBC - June.5.02
    - Andy Elson - "Record breaker, Engineer and intrepid Explorer"
- FAI Ballooning Commission - official world ballooning organization
    - World Records for crewed balloons & airships
- Solo Spirit - History of Ballooning
- NASA Balloon Program Office
- National Scientific Balloon Facility (NSBF)
    - Scientific Ballooning Links
- Balloon links at the Laboratory for High Energy Astrophysics (LHEA)
- All About Ballooning - NASA GSFC
- Weather Balloon - Infoplease
- Graphic showing relatives sizes of a science balloon and Washington Monument
- *The Pre-Astronauts : Manned Ballooning on the Threshold of Space* (Amazon commission link) by Craig Ryan, 1995.
- The Perlan Project ---- Soaring to the top of the World...
    - Fossett's next great adventure - BBC - July.10.02
    - Balloonist's Next Try: How High - Wired - July.9.02
    - Billionaire seeks to glide to edge of space - CNN.com - May.9.02 - Steve Fossett will ride the wind to nearly 19km
- Airship & Blimp Resources
    - Experimental Ballooning Links
- Big Blue - student project at Univ. of Kentucky to study Mars glider by releasing prototypes at high altitudes where atmosphere density similar to that on Mars.
    - Instant Glider: Just add Light - Science@NASA - May.2.03
- High Altitude Glider Project - project by Art Vanden Berg involving a "small, self-guided glider, designed to fly at very high altitudes. The glider is carried up by its tail with a helium weather balloon to altitudes of up to 85,000 feet above sea level, and then released to fly back to the launch point."

- **Altitude Records**:
  - 29.4km (96,500 ft) - solar-powered, unmanned Helios in 2001 reached - highest for a non-rocket powered aircraft. Built by Aerovironment with NASA funding.
  - 34.668km (113,740ft or 21.54mi) - highest altitude for a crewed balloon - April 5, 1961 by Malcom D. Ross and Victor A. Prather
  - 51.82km (170,000 ft. or 32.2mi) - highest altitude for unmanned research balloon - launched from Chico, California in 1972.
  - 107.990km (354,300 ft) - X-15 in 1963 - highest altitude for a piloted rocket powered aircraft - (Space shuttle not counted here since it goes to orbit.)
- **High Altitude Aerial platforms:** these commercial projects seek to place platforms at high altitude to provide services such as cell phone and broadband communications relays for urban areas, carry scientific instruments for weather and atmospheric measurements, remote sensing, etc.. (With the recession in telecommunications, most if not all of the telecom balloon projects are on hold.)
  - Angel Technologies - Scaled Composites' Proteus piloted, fan jet powered aircraft, that reached 19.1km (62,786 ft) in November 2000. Flying in 8 hour shifts, 3 planes would provide 24hour coverage.
  - Global Aerospace Corp. - developing "guided stratospheric balloons" under a NASA contract.
    - StratoSail - a sail hung on a tether from the balloon.
    - Stratospheric Satellites: a New Technology for Monitoring Global Disasters - Yahoo /Global Aerospace PR - July.3.02
  - Sky Station International - airships at 21 km (70,000 ft)
  - SkyTower [Last update: 11/12/01] - will use the ultra-lightweight solar powered Helios vehicle from Aerovironment as its platform
    - Solar-Powered Aircraft Delivers Wireless Broadband - Newsfactor - July.24.02
  - Space Data Corporation
    - Weather balloons to plug wireless gaps - CNN.com - June.22.02
  - Stratospheric Platforms Project - Japan Nat'l Aerospace Lab
  - Stratos - company intending to provide "high altitude telecommunications in South Africa and Sub-Saharan Africa"
  - Even Lower Earth Orbit - Beyond 2000 - Mar.31.00
  - Boeing and CargoLifter to Explore Stratospheric Airship Concepts - Boeing - July.30.02

Rockoons

JP Aerospace releases the Advanced Platform structure in a Jan.30, 2002 flight test.

The technique of carrying a rocket by a balloon to a high altitude for launch has been around since the 1940's. Such combo systems came to be called *rockoons*. Not only does a balloon give a rocket a head start in altitude, but by launching the rocket above much of the atmosphere it saves the fuel needed to punch through a lot of air when launched from the ground..

However, there are drawbacks in that the balloon does not provide a very stable platform. (JP Aerospace is attempting to build more elaborate balloon borne structures to provide greater stability and flexibility.) Rockoons are obviously affected by the wind and other weather conditions and so launches often get delayed.

Some recent rocket projects, especially amateur groups seeking to break rocket altitude records, have resurrected the rockoon approach and have made launches with them. Here are some groups working with balloon launched rockets:

- JP Aerospace - intends to be the first amateur organization to put a payload into space. Following a systematic step-by-step approach, they've developed increasingly complex balloon launch systems for their rockets. Initially, the rocket hung far below a balloon but now they are developing balloon platforms from which rocket launches can take place and also can carry oher payloads such as scientific instruments.
  - **Pongsat** - a split table tennis ball is used to hold simple experiments created by school kids for flights on high altitude balloons and sub-orbital rockets.
  - Next Pongsat balloon flight is Oct.5, 2002 - JP Aerospace
  - PongSats Ready For Spaceport Sendoff - Space.com - Oct.4.02
  - Pongsat Mission II - High altitude balloon to 31km on May.11.2002
- Huntsville Alabama L5 Society -- HAL5 - Project HALO
- da Vinci Project - X Prize competitor uses a balloon to reach high altitude before firing its rocket.
- Rockoon - Astronautix history and timeline for rockoons

Sub-orbital Rockets

- **Advance Amateur Rocketry Projects**
- **Sounding Rockets - Launch & Propulsion Section**
- **X-Prize** and other suborbital RLV projects - **RLV Countdown Section**
- **Sub-orbital Space Tourism**
- **Sub-orbital Rockets to Space: The Next Logical Step?** by Clark S. Lindsey. Reprint of an article in NSS Ad Astra - March-April 2002

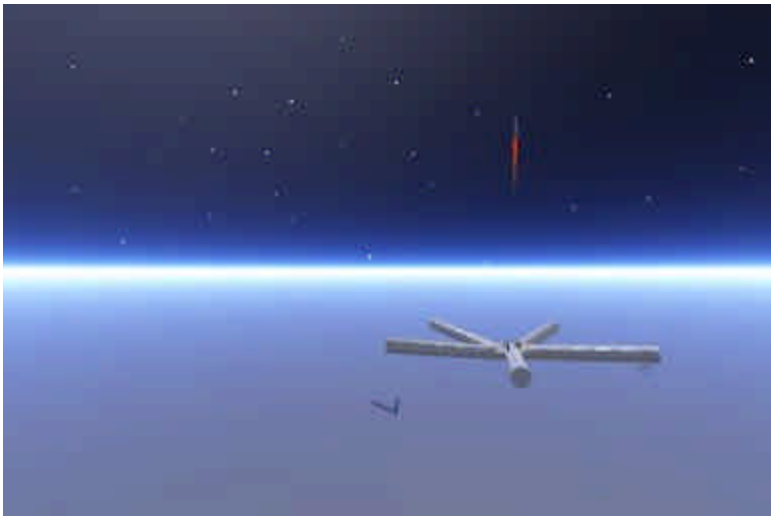
Other Near Space Topics

- **Meteor Observation - Visible & Radio - Space Science**
- **Natural Radio - Space Radio** - EM signals from storms, meteors, auroral effects, etc.
- **Aurora/Magnetosphere Projects - Space Science**
- **Satellite Building** - amateur and student satellite projects share many features with Near Space efforts including a low cost approach and building robuts systems that can survive the rigors of a high vacuum environment.
- **Space Radio** - Ham radio enthusiasts have long led the way in amateur involement with space including communication with satellites, building of satellites, and now Near Space projects.

Advanced Concepts

Here we scan some concepts involving Near Space that are particularly exciting .

Floating Platforms



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JP Aerospace's Stratostation concept for a "manned sub-orbital space station. Floating at 140,000 feet this structure will serve as a launch platform, research facility and

tourism destination. At over a mile across, it will be supported by multiple Helium lift cells."

The floating city in the sky has long been a staple of science fiction. City sized platforms such as those in Star Trek or Star Wars require technology far beyond our current capabilties (e.g. anti-gravity systems that violate fundamental physics laws as we currently understand them.)

However, it's quite within our capabilities to float a platform at very high altitudes that is big enough to hold, say, living quarters for a few people and a substantial amount of equipment.

For example, JP Aerospace is proposing to build the Stratostation (see figure above.) It would offer a facility useful for a number of applications such as a place for atmospheric and space scientists to place sensors and observatories. It could also be useful for launching rockets. Vee Airships would provide access to the station.

> Note that launching at high altitudes removes the fuel penalty that a ground launched vehicle must pay to punch through the atmosphere. Also, to perform efficiently, rocket nozzles must either compensate for atmospheric pressure (e.g. use an extensible mechanism or the aerospike approach) or the vehicle must use a multi-stage system in which the first stage engine nozzles are optimized for low altitudes and the second and third stages set for low air pressure and vacuum regions.

Space Diving

Project Excelsior at the Air Force Museum
Captan Joseph Kittinger jumping from a balloon gondola at 102,800 ft. ((19.5mi or 31.3km).

In 1960 Air Force Captan Joseph Kittinger dived from a balloon that he had flown up to 31km altitude. He nearly reached **supersonic speed** before releasing his parachute. He was testing whether pilots of high altitude aircraft like the U2 spyplane could survive if they had to bail out.

Could similar jumps from high altitudes and even from orbit become the **ultimate extreme sport**?

In the 1960's there were several US projects that investigated whether astronauts could rescue themselves from disabled spacecraft by "bailing out" in various types of personal protection outfits. These included General Electric's MOOSE (Manned Orbital Operations Safety Equipment) scheme in which the astronaut lay in an injection-seat type of pod with a heat shield and small rocket to initiate re-entry.

These and other schemes may some day lead to *space diving* and *space surfing* as the ultimate in space thrills!

- **Spacediving - Canadian Arrow** - lots of links at this X Prize project site. They believe spacediving will become a popular application of sub-orbital RLV vehicles.
- **StratoQuest** - Cheryl Stearns' project to break the current skydiving altitude record of 102,800 feet (19.5mi or 31.3km).
  - History of Kittinger's Dive - lots of nice photos
- **The Super Jump** by Michel Fournier
  - The Man Who Will Fall to Earth - Wired - July.29.02
- USAF Museum
  - Col. Joseph Kittinger, Jr
  - Project Excelsior
- **Audio/Videos**
  - August 16, 1960: The Man Who Parachuved from Outer Space - RealAudio history report from Discovery Online about Kittinger. (note the piece begins on another subject.)
  - To the Edge of Space: Project Manhigh - videotape at the History Channel store.
- **Articles**
  - Into thin air: Early in 2005, champion skydiver Cheryl Stearns will make the highest free-fall jump in history from the edge of space. - New Scientist - Dec.19.03
  - Frenchman ready for daredevil dive - BBC - Sept.6.02
  - Russian Text Pilot Says a Man Can Jump from Space without Parachute - RIA Novosti - June.28.02
  - The highest human freefall from the stratosphere - SpaceRef - Apr.17.02
  - Taking the Plunge - Scientific American - November 2001
  - Australian Ex-Commando to Conduct Record-Breaking Space Jump - Spacedaily - March.5.01
  - Space Parachuting: Skydiving from the Edge - Space.com - June.8.01
  - Loose Moose: One Way to Bail Out of Orbit - Space.com - Sept.23.00
  - Skydiver aims for high-altitude mark - BBC - March.5.01
  - Space Diving - Space.com - Jan.12.0

SkyHooks

The possibility of an orbital system that somehow grabs a vehicle from high altitudes and brings it up to orbit is one of those hand waving kind of concepts that is often proposed but seldom makes sense.

However, with the development of space tethers and high stength fibers, practical proposals have begun to appear:

- **HASTOL** - a concept at Tethers Unlimited in which the end of a rotating tether will rendevous with a rocketplane at 100km and pick up a payload to take to orbit.

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Editor: Clark S. Lindsey
Contact: clarklindsey@hobbyspace.com