Conference on Advancing MLT Atmospheric Studies through Commercial Suborbital Vehicles

February 27-28, 2025

Final Report
NSF Award ID 2432335

Dr. Dianne DeTurris
Professor, Aerospace Engineering, Cal Poly

Dustin DeBrum
Director Operations, Cal Poly Digital Transformation Hub

May 1, 2025

Table of Contents

Table of Figures

Introduction

This project aimed to explore the potential of commercial reusable suborbital vehicles to enable unprecedented access to the mesosphere lower thermosphere (MLT) region of the Earth's atmosphere for in-situ measurements and observations.

The increase in low-cost access to near space presented by these vehicles enables game-changing opportunities with respect to research and education. A suborbital research vehicle will not only grant scientists much more frequent access to in situ investigations in near-Earth space but also allow students at all levels to gain hands-on access to space science and engineering.

One can envision a model where students can conduct complete end-to-end projects to design, build, fly, and analyze data from individual research projects for thousands of dollars instead of hundreds of thousands. Such a paradigm will also strengthen ties between university researchers, funding agencies and commercial spacecraft companies.

The MLT is a critically important but poorly understood region that plays a crucial role in space weather, climate, atmospheric change, and Earth systems modeling. Commercial reusable suborbital vehicles and a centralized facility to access them could significantly augment current balloons and sounding rocket study of the MLT.

The primary objectives of this effort were to bring together scientists, engineers, educators, and commercial operators to discuss missions and instruments that can take advantage of frequent, low-cost suborbital vehicle flights to the MLT—supporting new research programs, data collection, technology development, and educational opportunities at universities and research institutions across the United States.

Conference Team

Dr. Dianne DeTurris

Dr. DeTurris is a professor in the Aerospace Engineering Department. Dr. DeTurris has degrees in Aerospace Engineering from Georgia Tech, Penn State, and Virginia Tech, with PhD research in experimental hypersonic airbreathing propulsion. Before joining Cal Poly in 1998, Dr. DeTurris was a research faculty member at the College of William & Mary. She also held the position of a Post-Doctoral Fellow for the National Research Council at NASA Langley Research Center and worked on fighter performance analysis for General Dynamics Fort Worth Division. Since coming to Cal Poly, Dr. DeTurris has been interim Co-Chair of the Aerospace Engineering Department, Director of Global Technical Education Initiatives, and an advocate for DEI in the College of Engineering. Her teaching includes jet and rocket propulsion, aerothermodynamics, hypersonics, systems thinking, and launch vehicle design. Dr. DeTurris is a faculty advisor for two student rocket development clubs. Her current research is in managing complexity in large engineered systems.

Dustin DeBrum

Dustin DeBrum is the Director Operations for Digital Transformation Hub (DxHub), California Cybersecurity Institute, and 5G Innovation Lab at Cal Poly, where he supports cyber education initiatives and outreach to build a skilled cyber workforce capable of navigating today's complex threat landscape. His higher-education career spans over 24 years at Cal Poly, supporting university commercial operations and enterprise technology services. Before Cal Poly, DeBrum worked for multiple dot-com companies in Silicon Valley. In addition to his experience, DeBrum has presented and hosted workshops, conferences, and online webinars on space cybersecurity, technology disability policy, credit card security, and cloud deployment. DeBrum holds a bachelor's degree in Twentieth-Century Science & Technology History from San Jose State University and a Master's in Educational Leadership and Administration from Cal Poly.

Dr. Kurt Colvin

Dr. Kurt Colvin is a retired professor of industrial engineering from Cal Poly, San Luis Obispo. His professional interests encompass a range of technical fields, including systems engineering, data analytics, data acquisition, cloud computing, and aircraft flight test engineering. Dr. Colvin possesses over 25 years of industrial and research experience. His career has included work at organizations such as NASA (Ames and JPL), the Air Force Test Pilot School, The Boeing Company, Systems Integrators, Inc., Ameridata, Festo, and Frito-Lay, Inc. Throughout his career in education, he has taught a diverse array of subjects. These include systems engineering, mechanical design, manufacturing processes, industrial automation, systems simulation, manufacturing systems integration, flight test engineering, and data analytics. Beyond his professional endeavors, Dr. Colvin is a parent and spouse and demonstrates a commitment to lifelong learning. His personal interests are varied and active; he is a pilot, bicyclist, sailor, and an enthusiastic builder of projects undertaken purely for enjoyment.

Anmol Sharma

Anmol Sharma is a fourth-year Aerospace Engineering student at Cal Poly and has been involved in the aerospace industry through internships and projects during her university career. Sharma served as a Spacecraft Integration Engineering Intern for SpaceX, Mechanical Design Intern for Payload Integration for NASA, and Systems Engineer Intern for the Paso Robles Airport. Sharma will receive her BS in Aerospace Engineering in June 2025.

Conference Summary

The Conference on Atmospheric Research Using Suborbital Vehicles was hosted at the Allegretto Vineyard Resort, February 27-28, 2025. Planning for the event began in 2024, focusing on bringing together education, government, and commercial partners to discuss how commercial suborbital vehicles are being used to support research, now and into the future. Figure 1 shows the conference opening by Cal Poly President Jeffrey Armstrong.

Figure 1 - Opening welcome from Cal Poly President Jeffrey D. Armstrong

Seventeen sessions were spread over 1.5 days and provided participants with time for interaction and sharing. Sessions included the state of MLT and atmospheric research, existing methodologies for suborbital research (e.g., balloon, drone, sounding rockets, etc.), new horizontal lift systems, early student engagement in space research, and community support for educational access to space and spaceport development.

The Science of the Mesosphere-Lower Thermosphere (MLT)

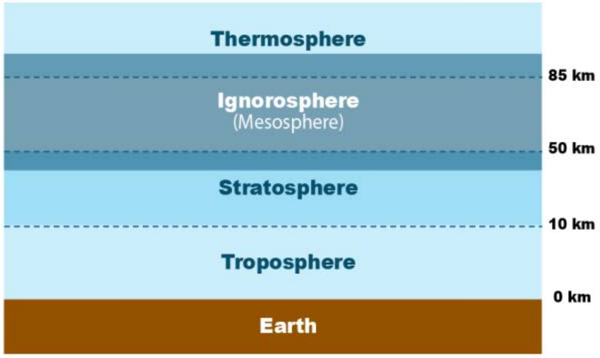


Figure 2 – Range of the 'Ignorosphere'

Dr. Todd Smith from JHU-APL set the stage for the conference by providing an overview of the mesosphere-lower thermosphere-ionosphere (MLT-I) region (see Appendix C1), which poses unique research challenges due to its inaccessibility. Too low for satellites and too high for balloons, with sounding rockets providing only expensive, brief data collection opportunities.

The MLT, shown in Figure 2, comprises several layers: the mesosphere (50-85km), where meteors burn up and temperatures reach -90°C; the thermosphere above it with dramatically increasing temperatures (200-2000°C) that marks the boundary to space at 62 miles and features solar UV/X-ray breakdown and aurora formation; and the ionosphere (extending to 1000km) with its three layers (D, E, F) of charged particles that vary with sunspot cycles and can disrupt power grids.

Dr. Smith highlighted the "Catch-22" that experiments need space-testing before deployment and advocated for frequent, low-cost flights offering reusable platforms and microgravity research opportunities. These would enable crucial studies in multiple areas including the global radiation budget (affected by clouds, aerosols, and greenhouse gases), atmospheric composition, ionosphere plasma, auroras, electron content mapping for improved GPS accuracy, negative ions found on Titan, noctilucent clouds, upper atmosphere lightning, and meteors.

Space to Grow

According to Stan Shull (see Appendix C2), global satellite infrastructure now exceeds 11,000 craft, with 90% in Low Earth Orbit (LEO, 200-2000 km). This distribution is particularly significant for Mesosphere-Lower Thermosphere (MLT) research, as the lower boundary of LEO satellites operates in the upper reaches of the MLT region that Dr. Smith described as critically important yet challenging to study.

The $300 billion global space economy, with $75 billion from the US alone, is driving technological innovations like CubeSats, reusable rockets, and high-volume satellite production that could revolutionize MLT research. The shift from "exquisite" production models (5-10 years of government-led development) to "standard" models (under 2 years of commercial development) aligns perfectly with Smith's call for frequent, low-cost flights to overcome the "Catch-22" of space testing. These technological and economic developments create new possibilities for deploying specialized instruments to study the MLT region and the vehicles needed to support a rapid flight cadence.

Shull's recommendation that an educationally focused spaceport specializing in suborbital testing represents a direct opportunity to advance MLT research. Such testing platforms could enable studies of the global radiation budget, atmospheric composition variability, ionosphere plasma, and other phenomena identified as crucial research areas. The expanding capabilities in communications and data services could also enhance real-time monitoring of the ionosphere's D, E, and F layers, improving our understanding of how sunspot cycles affect their structures and densities. This convergence of atmospheric science and satellite technology offers promising pathways to expand our limited knowledge of this critical atmospheric region that influences everything from global warming to space weather and communications.

The Next Generation of Suborbital Vehicles

Building on the discussions of MLT science and satellite technology, Khaki Rodway presented Dawn Aerospace's development of next-generation suborbital vehicles (see Appendix C3), which offer promising new platforms for researching the difficult-to-access atmospheric region. These rocket-powered aircraft, shown in Figure 3, are designed specifically for frequent suborbital research missions, reaching the Karman line at 100km (62 miles). Dawn's approach directly addresses the need for frequent, affordable access to the MLT region that Smith emphasized is "too low for satellites and too high for balloons."

Suborbital flight history has evolved from the 1961 Mercury Redstone launch and the 1963 X-15 flights above the Karman line to commercial milestones like SpaceShip One in 2004 and Blue Origin's New Shepard in 2015. Dawn Aerospace is positioning itself as a more cost-effective alternative at approximately $100,000 per flight, significantly less than traditional sounding rockets. It offers advantages in turnaround time, risk reduction, and targeted testing capabilities. Their current Mk-II Aurora vehicle can reach hypersonic speeds past Mach 3.5 with a goal of just 90 minutes between flights, potentially revolutionizing the frequency of MLT data collection compared to the "rare, expensive, and not reliable" sounding rockets that Smith described.

Dawn's suborbital vehicles provide an ideal platform for rapid prototyping and testing of both

Figure 3 - Dawn Aerospace Mk-II and Mk-III size comparison (see Appendix C3)

science packages and satellite systems. The remarkably quick 90-minute turnaround between flights directly addresses Smith's "Catch-22" dilemma, where experiments need space-testing before deployment. This rapid cadence allows researchers to iterate quickly on instrument designs, test components in actual space conditions, identify problems, implement fixes, and retest—all potentially within the same day. For satellite developers, this capability dramatically accelerates the testing cycle for critical subsystems like sensors, communications equipment, and environmental monitoring tools before committing to full orbital deployment.

With 40-minute flight durations providing exposure to the extreme conditions of the upper atmosphere and space boundary, Dawn's vehicles enable realistic testing at a fraction of the cost and time required for traditional space validation, potentially transforming how the industry approaches both scientific instrument development and satellite systems engineering for the expanding commercial space sector that Shull described.

Rocket Engine Testing

Continuing the discussion on rapid prototyping, Ryan Meisberger presented Stellar Exploration's rocket testing operations at their Paso Robles Hypergolic Test Site at the future Paso Robles Spaceport (see Appendix C4). This facility specializes in building, testing, and loading chemical propulsion systems, including work on NASA's Capstone mission. Their capabilities directly complement the satellite technology ecosystem described earlier and provide the critical testing infrastructure that supports both "exquisite" and "standard" satellite production models.

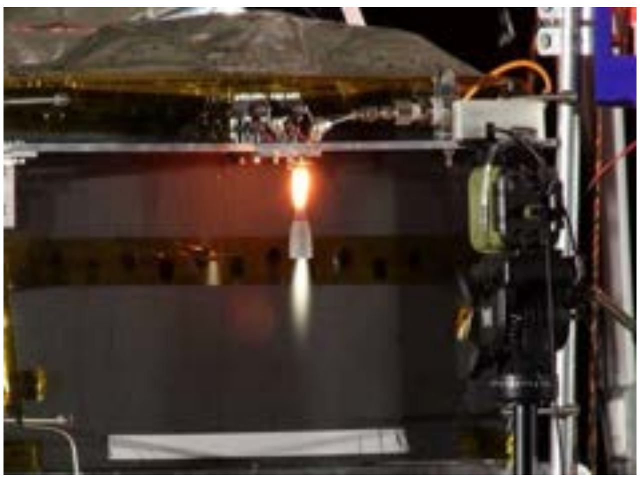


Figure 4 - Stellar Explorations Nano Satellite propulsion test (source https://www.stellar-exploration.com/)

The company maintains 14 certified SCAPE (Self-Contained Atmospheric Protective Ensemble) handlers who safely work with dangerous hypergolic propellants—specifically hydrazine and dinitrogen tetroxide—commonly used in rocket systems. This infrastructure enables comprehensive testing of small satellite propulsion systems essential for positioning and maneuvering satellites in various orbits, including VLEO.

The facility tests (see Figure 4) monopropellant thrusters producing 0.25N to 0.5N of thrust (up to 24 thrusters per test) and 5N bipropellant thrusters (up to 8 per test). Their services include qualification unit hot-fire tests, water hammer testing, catalyst testing, and hypergolic load tests—all critical validation steps for ensuring reliable operation in space. With 30 engineers and an annual development cycle for new thrusters, Stellar Exploration demonstrates the specialized aerospace testing capacity that Shull identified as a potential focus area for a research-aligned Spaceport, while leveraging Dawn Aerospace's capabilities of providing the propulsion system verification that satellites need before deployment.

Paso Robles Spaceport

Building on the foundation of MLT science needs, Dawn Aerospace's suborbital capabilities, and Stellar Exploration's rocket testing operations, a panel featuring Bill Britton, Dr. Kurt Colvin, and Paul Sloan presented a vision for the Paso Robles Spaceport focused on educational access to space (see Appendix C5). Britton, the Executive Director for Cal Poly Solano Campus and Maritime Academy Initiatives and a City of Paso Robles Airport Commissioner, identified a common problem within the space industry: the lengthy wait times and high costs associated with securing launch opportunities. The proposed spaceport, shown in Figure 5, would address this by providing *assured educational access to space* for testing, fostering education, connecting university programs with workforce needs, and promoting scientific curiosity among students and the public.

Dr. Kurt Colvin introduced the Spaceport Training and Research Center (STRC), which would provide hands-on experience and bridge commercial space opportunities with education, research, and development. The facility would provide state-of-the-art capabilities and offer

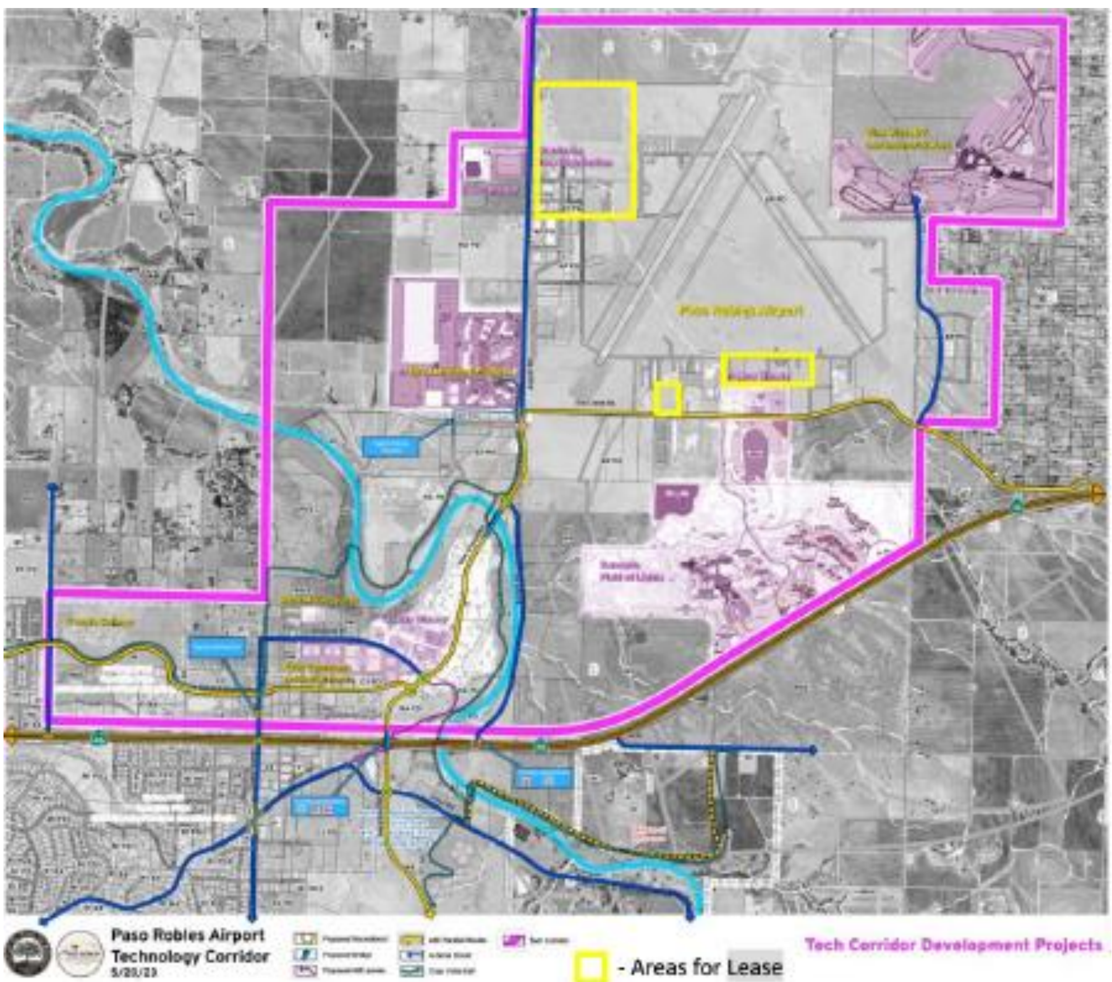


Figure 5 - Paso Robles Spaceport and Technology Corridor (see Appendix C5)

training at both university and professional levels. Unlike other spaceports, this initiative would specifically focus on education and research, creating opportunities for middle school, high school, and college students to build, design, and launch projects while still in school.

City of Paso Robles Economic Development Manager Paul Sloan addressed economic development aspects of the spaceport initiative, noting that while agriculture, tourism, and business currently drive the economy in San Luis Obispo and Santa Barbara counties, a spaceport would bring significant additional economic benefits. The city of Paso Robles has developed a strategic plan incorporating space tech, with the spaceport envisioned as part of a broader *Space Innovation and Technology Park*. The proposed site would leverage the Paso Robles airport, a former military facility with existing infrastructure advantages. Sloan, Britton, and Colvin emphasized that the educational focus positions the project uniquely among spaceports, addressing gap issues mentioned by the previous speakers that would have a positive impact on space research.

MLT Research Case Study

Following his previous presentation, Dr. Todd Smith provided a research case study from Johns Hopkins University's Applied Physics Laboratory (JHU-APL) commercial suborbital program (see Appendix C6), showcasing how private companies are transforming suborbital spacecraft development. Figure 6 shows one example of how commercial space has changed dramatically in the last 20 years.

Figure 6 – Blue Origin New Shepard lifts off from launch site one during NS-31 (April 14, 2025) (source - https://www.blueorigin.com/news/gallery)

Their JANUS platform, a self-contained portable system that standardizes power, data storage, and instrument control, has completed nine flight tests demonstrating the crucial ability to conduct repeated experiments. The program has partnered with the Commercial Spaceflight Federation, Blue Origin, and Virgin Galactic over ten years, securing NASA Flight Opportunities funding for five low-cost missions while involving numerous students working with small payloads. This case study directly supports the Paso Robles Spaceport vision by providing a proven model for educational space access.

Beginning with Blue Origin launches (see Figure 6) before moving to Virgin Galactic for vibration and electromagnetic environment studies; the JANUS program has evolved through both successes and failures. Their experience emphasizes how rapid launch access benefits agile prototyping and how standardized platforms for development could be leveraged at the proposed Spaceport Training and Research Center, particularly by using Dawn Aerospace's quick-turnaround vehicles.

The JHU-APL program validates the need for an educationally focused spaceport, showing how NASA partnerships can support ongoing research, how meaningful student involvement enhances outcomes, and how proper infrastructure enables economically viable space research. This working model confirms that the spaceport's approach to bridging commercial space opportunities with education and research can address the gaps in MLT region understanding while providing valuable hands-on experience for students at all levels.

Engaging Students in Space Technology Research

Cal Poly Aerospace Engineering professor and the conference PI, Dr. Dianne DeTurris (see Figure 7), presented her work engaging students in space technology research focused on a propulsion curriculum (see Appendix C7). Under her guidance, Cal Poly has developed comprehensive rocket technology projects for undergraduate, graduate, and club participants. These initiatives provide hands-on experience in rocket development while maintaining rigorous safety standards throughout all activities.


Figure 7 - Dr. Dianne DeTurris speaking to attendees

Cal Poly's rocket development uses an agile approach and has followed a progressive evolution in complexity and capability. The initial focus has been building solid motor rockets for competitions, obtaining Tripoli Rocketry Association certifications, and working with solid rocket motors up to class M. DeTurris’ students later advanced to hybrid testing using nitrous oxide and HTPB (rubber), which offered advantages in performance and technology. Most recently, they've developed sophisticated liquid rocket engines using ethanol and nitrous oxide, achieving remarkable success in competitions, including the extremely challenging feat of throttling a thruster from 100% to 35% and back up again - something only one other student team worldwide has managed to achieve.

DeTurris' work directly connects to the previous sessions by demonstrating practical educational applications that could benefit from access to an educational Spaceport and Dawn Aerospace's rapid-turnaround suborbital vehicles. The Collegiate Propulsive Lander

Challenge[1], she highlighted, with plans for a hovering and landing vehicle, represents the kind of iterative testing that Smith advocated for in his MLT research case study.

Space IOT Research Case Study

Cal Poly Electrical Engineering department professors Dr. Dennis Derickson and Steve Dunton, along with Cal Poly Space Systems lead Jack Ryan, presented a compelling case study on suborbital Internet of Things (IoT) research that continued to build on the themes of previous sessions (see Appendix C8). Their work focuses on LoRa (Long Range) wireless communication technology, which, despite its low bandwidth, offers significant advantages for space research applications due to its long-range capabilities and low cost (see Figure 8).

According to Derickson, LoRa uses a distinctive chirped waveform modulation technique that shifts from low to high frequency, enabling low-bandwidth communication between ground stations and low-orbit to suborbital payloads.

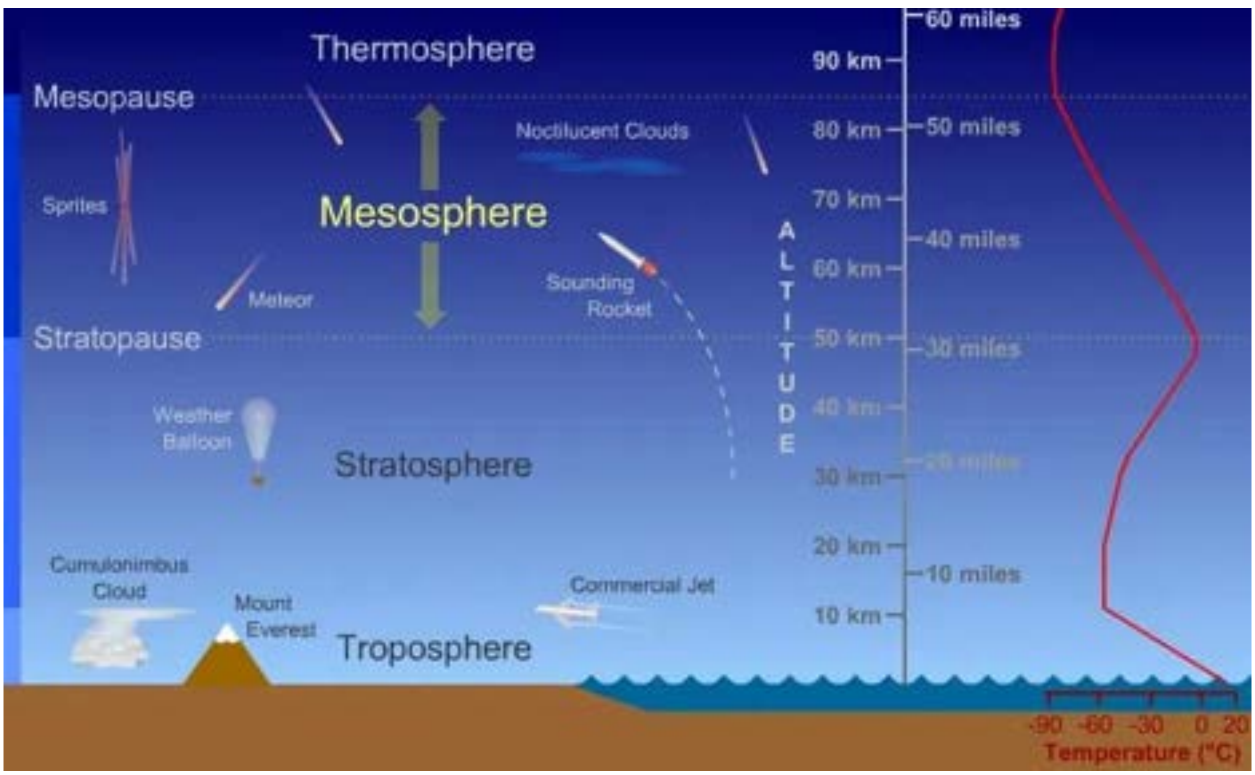


Figure 8 – Long-term Mesospheric Research Goal: Suborbital mission into the Mesosphere to leverage developed LoRa payloads for targeted research (see Appendix C8; source - https://scied.ucar.edu/image/atmosphere-layers-diagram).

[1] https://landerchallenge.space/

The team collaborates with OWL Integration[2], which develops low-cost, Size, Weight, and Power (SWAP) radios. Professor Dunton described how these systems can function effectively with low-gain antennas on the ground and in space, making them particularly suitable for MLT research applications. The project incorporates a "Clusterduck Mesh Network"[3] with custom electronics and payloads featuring various components that work together in a mesh configuration. This technology has multiple possible use cases, both terrestrial and orbital. It could directly impact MLT research, offering a potential low-cost solution for data collection in these difficult-to-access atmospheric regions.

Local Community STEM

The first day of the conference concluded with a panel moderated by local science teacher Evan Johnston from Paso Robles High School, featuring three students with aerospace aspirations (see Appendix C9). The panel discussed their interest in space research and engineering projects, including collaborations to build a five-foot suborbital testing rocket that reaches 5,000 feet. Their stories underscored both the enthusiasm among local students and the need for more accessible aerospace education opportunities, which is precisely what the proposed Paso Robles Spaceport aims to provide. This session demonstrated the importance of STEM education, highlighting why bridging academic research and commercial space applications is crucial for developing the next generation of aerospace professionals who will contribute to future MLT research and suborbital vehicle development.

From the Ground Up to Middle Out

Kicking off day two, Dr. Jamey Jacob from Oklahoma State University's Oklahoma Aerospace Institute for Research and Education (OAIRE)[4] presented "From the Ground Up to Middle Out: Drones and Balloons for Assistive Suborbital Observations." His work addresses the in-situ data gap in the Planetary Boundary Layer (PBL) through a comprehensive approach using multiple vehicle types (see Figure 9). This has evolved from performing Mars aircraft testing at high altitudes to the NSF-funded Cloud-Map project, which helped develop regulatory approval processes and expand partner relationships. More recently, Jacob's team has focused on advanced air mobility funded by NASA, supporting emerging technologies and air traffic control by gathering wind data across various boundary layers in urban and rural environments (see Appendix C10).

Dr. Jacob described OAIRE's innovative use of multiple platforms to conduct atmospheric research. Their solar balloons, which can reach 60,000-90,000 feet, provide an inexpensive platform for student projects and team-building exercises. Having launched approximately 200 balloons with a nearly 100% payload recovery rate, they've expanded to *Meteogliders*

[2] https://www.owlintegrations.com/
[3] https://clusterduckprotocol.org/
[4] https://go.okstate.edu/aerospace/

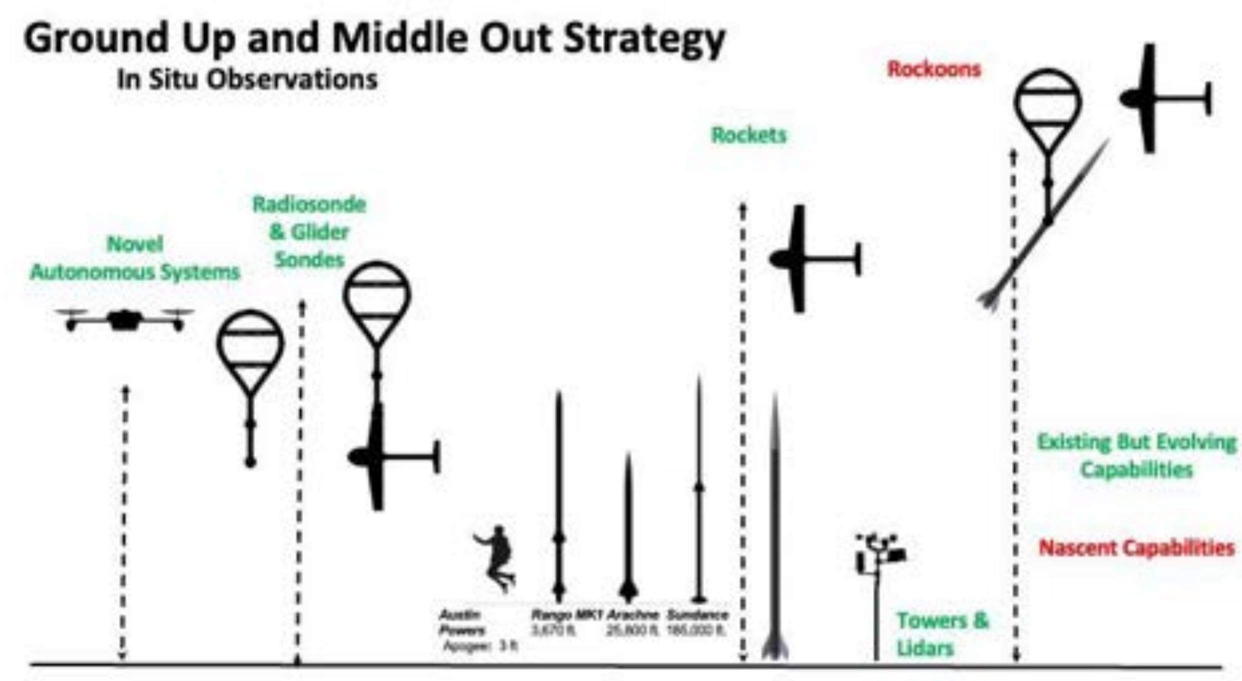


Figure 9 - Ground Up and Middle Out Strategy for In Situ observations as outlined by Oklahoma Aerospace Institute for Research and Education (see Appendix C10).

that offer controlled descent paths, unlike conventional balloons. Their most impressive development is a deployable glider payload launched from a small 4-inch diameter rocket with an N-sized motor, capable of reaching 40,000 feet before deployment. The team is also working on plans for a *Rockoon* (rocket launched from a balloon) that could be conducted at Oklahoma Air and Spaceport, located in Burns Flat, which has extensive testing capabilities.

The presentation demonstrated another approach to accessing the difficult-to-study atmospheric regions discussed the previous day by Dr. Todd Smith, and like Cal Poly's rocket programs and the LoRa communications research, OAIRE's multi-platform approach offers complementary data collection methods that could benefit from the educational spaceport model proposed for Paso Robles. Jacob's strategy represents another model for bridging the gap between academia and industry while developing practical solutions for atmospheric research—precisely the kind of collaborative work that could thrive at an education-focused spaceport facility.

PolySat Program

Jess Bleakley, a Cal Poly third-year aerospace engineering student and PolySat[5] lab manager, presented an overview of the university's student-run small satellite research and development laboratory that established the CubeSat standard in collaboration with

[5] https://www.polysat.org/

Stanford University (see Appendix C11). Founded in 1999, the program initially focused on student projects but has evolved into a significant contributor to small satellite development. The program is currently working on three missions (SAL-E, AMDROHP, and GENESys) scheduled for upcoming launch.

Bleakley emphasized how access to a suborbital launch facility would provide affordable opportunities with fast turnaround times, enabling more iterative testing processes ideal for agile prototyping. Aligning with the earlier calls for frequent, low-cost flights to advance MLT research and the use of multi-platform strategies.

Overall, the PolySat program gives students hands-on experience with real space hardware (see Figure 10), a key part of research and learning success addressed in previous sessions, creating a robust educational ecosystem that bridges academic research with commercial space applications while providing valuable learning opportunities for students at all levels.

Figure 10 - Cal Poly students developing and testing a new CubeSat (source - https://www.polysat.org/).

Cal Poly AMSAT Project

As a follow-up to the PolySat program, space cybersecurity educator Henry Danielson and Cal Poly computer science student Isaac Rudnick provided a short overview of a project leveraging the Association of Amateur Radio Satellite Organizations (AMSAT)[6] development standard, which uses a $400, 3D-printed 1U CubeSat simulator to teach systems integration and satellite communications.

Though not space worthy, this plastic model incorporates all the components of a real orbital or suborbital payload, allowing students to learn ground control communications and practice using telemetry to determine rotation rates. This cost-effective educational tool, with its open-source instructions and month-long build timeline, provides valuable hands-on experience in radio telecommunications and CubeSat design fundamentals, demonstrating how accessible technologies can bridge theoretical knowledge and practical space applications.

Paso Robles Air and Spaceport Licensing Update

Given the discussion a potential educationally focused spaceport could have for research and development, Mark Scandalis, the Paso Robles Airport Manager, presented an update

[6] https://www.amsat.org/

on the city's licensing process (see Appendix C12). Following a preliminary technical review in 2022, which confirmed the project's feasibility, the city partnered with Cal Poly to develop the license application. The site includes 296 acres available for development and already incorporates two static engine testing sites in its explosive site plan.

Significant progress has been made with the spaceport operations procedures, records management plan, and initial documentation already submitted to the FAA. The city council also secured an FAA grant to update the airport master plan to include the spaceport concept. The remaining steps include completing the launch site location review, hazard analysis, environmental assessment, and finalizing agreements with local agencies. According to Scandalis, the project aims to connect the educational and research initiatives discussed throughout the conference to the concrete infrastructure and regulatory framework necessary to make the vision of an educationally focused spaceport a reality.

In support of Scandalis' update presentation, Cheree Kiernan, President and CEO of Integrated Launch Solutions (ILS), outlined the licensing process to assist other participants working on similar programs. She explained the difference between FAA Part 420 (spaceport licensing) and the more stringent Part 450 (launch vehicle operator licensing).

Bridging the Gap

The final conference session (see Appendices C13 and 14) featured a panel discussion on "Bridging the Gap" between industry, academia, and government for spaceport operations, with participants Cheree Kiernan, Robert Meyer, David Sanchez, Bob Crockett, and Mike Mierau (see Figure 11). The purpose of this conversation was to explore key challenges facing

Figure 11 - Cheree Kiernan, Robert Meyer, David Sanchez, Bob Crockett, and Mike Mierau, discuss bridging the gap between industry, academia, and government for spaceport operations.

space research and innovation facilities, including keeping talented workers in the local community, securing adequate funding, developing a supportive ecosystem, and ensuring sufficient facility utilization.

Robert Meyer from the Employment Training Panel (ETP) in the governor's office discussed workforce development funding, noting they've already provided $400,000 to support Cuesta Community College and have $100 million available for training programs. David Sanchez shared his experience growing a small aerospace business from 2 to 15 employees, emphasizing the importance of clear value propositions and affordable facilities for startups. Bob Crockett highlighted that while the spaceport wouldn't change Cal Poly's curriculum, it would dramatically expand opportunities for the university's 80 engineering clubs and research initiatives through government and industry contracts. Mike Mierau from Premier Valley Bank discussed financing options for startups and suggested that educational institutions could be the first tenants to attract industry partners.

The panel concluded with actionable recommendations: create accessible entry points for small companies with limited resources; implement "baby steps" with safe pilot programs to achieve early, inexpensive wins; broaden pathways for students to develop skills needed in the aerospace economy; advocate for support during California Aerospace Day in Sacramento; and consider innovative approaches to facility design that could generate more revenue while accommodating FAA limitations. This final session effectively tied together the conference's themes of educational opportunity, economic development, and collaborative partnerships while providing practical next steps toward realizing the Paso Robles Spaceport vision.

Conclusions and Next Steps

Accomplishments

- The conference successfully convened a diverse group of stakeholders, including scientists, engineers, educators, and commercial space operators.
- It fostered discussions on leveraging commercial suborbital vehicles for unprecedented access to the Mesosphere-Lower Thermosphere (MLT) region.
- The event explored the potential of low-cost suborbital flights to support new research programs, data collection, technology development, and educational opportunities.
- It showcased advancements in suborbital vehicle technology, highlighting reusable platforms and rapid prototyping capabilities.
- The conference saw over 100 registrations from across academia, government, and the private sector for the 1.5-day event, with 67 participants on Thursday and 47 participants on Friday.
- Over 25 students registered from college to high school for the event to listen and to present projects.
- The event saw five universities register, including San Jose State University, San Diego State University, Cal Poly Pomona, and presentations from Cal Poly San Luis Obispo, Johns Hopkins University, and Oklahoma State University.
- State and Federal representatives attended to convey support, understand need and impact, and highlight student excellence.
- 15 commercial companies, including launch providers (Dawn, SpaceLaunch, SpaceX, Blue Origin) registered for the event.
- Case studies demonstrated the feasibility of conducting repeated experiments and the benefits of standardized platforms for development.
- The conference addressed the importance of creating accessible pathways for students and researchers, emphasizing hands-on experience and collaboration between academia, industry, and government.
- It advanced the Paso Robles Spaceport vision, focusing on its potential to provide assured educational access to space, foster STEM education, and drive economic development in the region.
- The conference facilitated crucial conversations on licensing processes, infrastructure development, and strategies for bridging the gap between industry, academia, and government to support spaceport operations and the growth of the aerospace sector.
- The conference included a "Working Backwards" exercise that generated actionable themes such as the establishment of a multi-university educational consortium, stakeholder communication strategies, integrated educational pathways, and phased infrastructure development plans.

What was the impact

The culminating activity of the conference consisted of a structured *Working Backwards* exercise in which conference attendees were divided into five discussion groups to synthesize insights and formulate strategic action items.

Working Backwards is a project planning methodology used extensively by Cal Poly's Digital Transformation Hub (DxHub) powered by AWS[7], to understand customer goals and validate the viability of a product or strategy. For this event, participants were put into groups and provided with four questions:

1. Describe a challenge or opportunity in atmospheric research or space science.
2. How could commercial, academic, and government partners collaborate to address the challenge or opportunity?
3. Describe how you might be able to better address the challenge or opportunity if a solution were implemented.
4. Describe what the end result looks like.

The conversations produced several interconnected themes, such as the establishment of a multi-university educational consortium with shared access to suborbital vehicle opportunities, the development of comprehensive stakeholder communication strategies, the creation of integrated educational pathways spanning from middle school through university research programs, and the implementation of phased infrastructure development plans to support innovation. Furthermore, participants emphasized the critical importance of strategic alliance-building in securing regulatory approvals and community support to ensure long-term impact on research and education.

Another important factor identified was the time requirements for successfully implementing the outlined goals, with the agreement that a crawl, walk, run framework encompassing immediate, intermediate, and long-term objectives be leveraged.

The groups also recognized that the convergence of educational institutions, governmental agencies, and commercial entities is essential for establishing the operational capabilities necessary to address the research gaps and needs discussed during the conference and to support a more effective agile development methodology.

Intellectual Merit of the Event

The conference demonstrated significant intellectual merit by:

- Addressing Critical Research Gaps: It focused on the mesosphere-lower thermosphere (MLT), a scientifically vital but poorly understood atmospheric region,

[7] https://dxhub.calpoly.edu/

highlighting challenges like its inaccessibility and the limitations of current research methods.

- Convening Diverse Expertise: The event successfully brought together scientists, engineers, educators, students, and commercial space operators from academia, government, and the private sector to share knowledge and foster interdisciplinary dialogue.
- Showcasing Technological Innovation: Presentations featured advancements in commercial reusable suborbital vehicles, rocket testing, satellite technology (like CubeSats and LoRa communication), and alternative atmospheric observation platforms (drones, balloons, gliders), emphasizing capabilities like rapid prototyping, frequent low-cost access, and iterative testing.
- Promoting Collaborative Solutions: The conference facilitated crucial discussions on bridging the gap between industry, academia, and government, exploring collaborative models for research, infrastructure development (like the Paso Robles Spaceport), workforce training, and funding.
- Integrating Education and Research: A strong emphasis was placed on the educational potential of suborbital research, showcasing models for engaging students at all levels (K-12 through university) in hands-on projects, fostering STEM pathways, and developing the future workforce.
- Generating Actionable Outcomes: The event included structured exercises that led to concrete themes and next steps, such as the potential formation of a multi-university educational consortium and phased development plans, indicating a commitment to translating discussion into tangible progress.

Overall, the conference significantly contributed to advancing the understanding of MLT science and the application of commercial suborbital vehicles, fostering innovation and collaboration across multiple sectors.

Conclusions

The Conference on Atmospheric Research Using Suborbital Vehicles successfully convened stakeholders from diverse sectors to address the challenges and opportunities in Mesosphere-Lower Thermosphere (MLT) research. The event fostered discussions on leveraging commercial suborbital vehicles for scientific exploration, technological development, and educational advancement. Participants explored the potential of low-cost suborbital flights to support research programs, data collection, and hands-on educational opportunities, while also addressing the advancements in suborbital vehicle technology and the feasibility of repeated experiments using standardized platforms.

A key focus of the conference was on the development of the Paso Robles Spaceport vision, emphasizing its potential to provide assured educational access to space, promote STEM education, and stimulate regional economic development. Strategic discussions addressed licensing processes, infrastructure development, and the importance of collaboration between industry, academia, and government to support spaceport operations and the growth of the aerospace sector.

The conference culminated in a "Working Backwards" exercise that generated actionable themes such as the establishment of a multi-university educational consortium, stakeholder communication strategies, integrated educational pathways, and phased infrastructure development plans. Participants recognized the need for strategic alliances, regulatory approvals, community support, and a phased implementation approach to achieve long-term impact on research and education. The conference underscored the importance of collaboration between educational institutions, government agencies, and commercial entities to establish operational capabilities, address research gaps, and support agile development methodologies in the field.

When participants were asked about what new idea resonated with them, the top two phrases were collaboration and rapid prototyping, highlighted in Figure 7, both of which align with key points raised during the Working Backwards exercise. The proposed consortium model would leverage collective resources to provide unprecedented access to suborbital research opportunities, with the added benefit of addressing workforce development needs through integrated educational pipelines. At the same time, assured educational access to facilities and suborbital platforms could change the paradigm for research and development. These approaches align with the conference's overarching theme of democratizing access to space research through commercial suborbital vehicles, particularly for educational institutions and early-career scientists.

Next Steps

Continued Discussion—Communication and collaboration were key themes of the event, with many participants eager to share ideas and collaborate on innovative ways to support MLT research and systems development. As such, the conference provided a great opportunity for networking and discussion.

We recommend a cadence of follow-up in-person or online events for academic, commercial, and governmental participants to allow research teams to share projects and hardware needs or innovations, commercial partners to share new platforms and capabilities, and government agencies to provide updates on funding opportunities or infrastructure development plans.

Educational Consortium Development—The establishment of a multi-university educational consortium with shared access to suborbital vehicle opportunities was an innovative idea generated from the event, and multiple attendees expressed their interest in participating. Furthermore, Dawn Aerospace has indicated its interest in partnering in such a consortium and the potential for a ‘wet lease’ model to provide regional launch capabilities.

We recommend creating a working group including the conference participants (academic and commercial) to develop integrated educational pathways from middle school through university research programs to foster interest and expertise in the field.

Assured Educational Access to Space—Access to facilities and suborbital platforms from a dedicated educational facility near an applied research university could change the game for suborbital testing, research, and development. It can also be the catalyst for early education and operational training programs. Establishing the Paso Robles Spaceport Training and Research Center (STRC) addresses these needs.

We recommend implementing a phased infrastructure development plan to support innovation and growth in a sustainable manner. This plan should include a "crawl, walk, run" framework with immediate, intermediate, and long-term objectives to manage the time requirements for successfully implementing the outlined goals.

We think it is important to continue to foster the convergence of educational institutions, governmental agencies, and commercial entities to establish the operational capabilities needed to address research gaps and support agile development methodologies

With commercial and governmental partners already in line to support this initiative and the potential for turnkey resources, the problem of the *ignorosphere* can be solved.

Appendix A – List of Registered Participants

Name	Company/School	Email	Att
Jennifer Acevedo	AgWest	jennifer.acevedo@agwestfc.com	✓
Grant Acevedo	Paso Robles High School	granttacevedo@gmail.com	✓
Jeffrey Armstrong	Cal Poly, San Luis Obispo	jarmstro@calpoly.edu	✓
Yotam Barr	Cal Poly, San Luis Obispo	ybarr@calpoly.edu	
Chris Bausch	City of Paso Robles	CBausch@prcity.com	✓
Kris Beal	City of Paso Robles	kbeal@prcity.com	✓
Steven Beck	Loma Seca Vineyards	steven@lomaseca.com	✓
Neil Bedagkar	Cal Poly, San Luis Obispo	nbedagka@calpoly.edu	
John Bellardo	Cal Poly, San Luis Obispo	bellardo@calpoly.edu	
Logan Bishopric	San Luis Obispo Propulsion Technologies	lbishopric@hotmail.com	
William Britton	Cal Poly, San Luis Obispo	bibritto@calpoly.edu	✓
Olivia Carey	Cal Poly, San Luis Obispo	carey.d.olivia@gmail.com	✓
Alex Castellar	Cal Poly CubeSat Laboratory	acaste42@calpoly.edu	
Subhash Chellappan	Launch On Demand	subash.chellappan@launchondemand.space	
Dan Ciccateri	All Points, LLC	dciccateri@allpointsllc.com	✓
Cameron Coleman	Cal Poly	cjmcclur@calpoly.edu	✓
Kurt Colvin	Cal Poly, San Luis Obispo	kcolvin@calpoly.edu	✓
Henry Danielson	Cal Poly, San Luis Obispo	hdaniels@calpoly.edu	✓
Kyle Dart	Paso Robles High School	Kyledart314@gmail.com	✓
Bruce DeBruhl	Noyce School of Applied Computing	bdebruhl@calpoly.edu	✓
Dustin DeBrum	Cal Poly, San Luis Obispo	ddebrum@calpoly.edu	✓
Dennis Derickson	California Polytechnic State University	ddericks@calpoly.edu	✓
Dianne DeTurris	Cal Poly, San Luis Obispo	ddeturri@calpoly.edu	✓
Aadi Dhanda	Cal Poly, San Luis Obispo	aadidhanda@gmail.com	
Connor Doherty	Cal Poly, San Luis Obispo	cmdohert@calpoly.edu	
John Donaldson	JD4Homes	john@jd4homes.com	✓
Liam Duckworth	Cal Poly	liduckwo@calpoly.edu	✓
Madi Dulisse	ICEYE US	Madeline.dulisse@iceye.us	✓
Steve Dunton	Cal Poly, San Luis Obispo	sdunton@calpoly.edu	✓
Tom Erskine	Country Real Estate, Inc.	gwen@countryrealestate.com	✓
Gwen Erskine	Country Real Estate, Inc.	gwen@countryrealestate.com	✓
Calvin Fong	Cal Poly SLO, Cal Poly Space Systems	cfong28@calpoly.edu	
Michael Foote	REACH	mfoote@reachcentralcoast.org	✓
Brenna Fowler	ChangeAerial	byfowler@gmail.com	
Rocky Garcia	SpaceX	Rocky.Garcia@spacex.com	
Steve Gregory	City of Paso Robles	msponhaltz@prcity.com	✓

Elizabeth Gross	Cal Poly CubeSat Laboratory	lgross04@calpoly.edu	
Jonathan Holly	Cal Poly, San Luis Obispo	Jcholly@calpoly.edu	✓
Madeleine Hott	Cal Poly, San Luis Obispo	mhott@calpoly.edu	✓
Chris Huot	City of Paso Robles	CHuot@prcity.com	✓
Jim Irving	JimIrving.com	jim@jimirving.com	✓
Ibisia Jack	San Diego State University	pjack1220@sdsu.edu	
Jamey Jacob	OAIRE - Oklahoma State University	jdjacob@okstate.edu	✓
Glenn Johnson	Paso Robles Pilots Association	Glenn805@icloud.com	✓
Evan Johnston	Paso Robles High School	ewjohnston@pasoschools.org	✓
Tom Jones	Aerospace Museum of California	Director@AerospaceCA.org	✓
Karen Jones	Aerospace Museum of California	Advancement@AerospaceCA.org	✓
Paul Jurasin	EmPathIze Innovation and Foresight	paulj@empathizeif.com	✓
Eric Kemp	USSF SLD30/DTO	eric.kemp.5@spaceforce.mil	
Rudra Khakhar	Cal Poly, San Luis Obispo	rkhakhar@calpoly.edu	
Cheree Kiernan	Integrated Launch Solutions, Inc.	cheree.kiernan@ilscorporation.com	✓
Jim Klo	SRI International	jim.klo@sri.com	✓
Scott Knuckles	EduCyber Solutions	scott@knuckles.today	
Justin Kopcinski	Cal Poly, San Luis Obispo	jkopcin@gmail.com	✓
Maneesh Kumar	Cal Poly, San Luis Obispo	mkumar05@calpoly.edu	✓
Katherine Legg	San Jose State University	Katherine.legg@sjsu.edu	
Todd Lindner	RS&H	Todd.Lindner@rsandh.com	✓
Jennifer Loftus	Paso Robles Joint Unified School District	jloftus@pasoschools.org	✓
Warren Long	Optimum Growth Group	wlong1234@gmail.com	✓
Jeff Long	Broad Horizon Media	Jeffdirect1@gmail.com	✓
John Lozano	IHM Outdoors	Johnlozano@yahoo.com	
Marcy Mabry	SpaceLaunch	marcy.mabry@spacelaunch.space	
Dale Magee	Catalyst Consulting	Dale@catalystconsulting.biz	✓
Jared Malapit	Precision Construction Services	jared@precision.services	✓
Ryan Meisberger	Stellar Exploration	ryan.meisberger@stellar-exploration.com	✓
Robert Meyer	California Employment Training Panel	Robert.Meyer@etp.ca.gov	✓
Markus Mieritz	Cal Poly, San Luis Obispo	markuskm26@gmail.com	✓
Victoria Natalie	OAIRE - Oklahoma State University	victoria.natalie@okstate.edu	✓
Kali Nowakowski	Cal Poly Partners	kgwagner@calpoly.edu	✓
Sedat Ozer	Cal Poly, Pomona	sozer@cpp.edu	✓
Lorenzo Pedroza	Cal Poly CubeSat Laboratory/Cal Poly SLO Student	lapedroz@calpoly.edu	✓
Julie Pruniski	REACH	julie@reachcentralcoast.org	✓
Robert Randle III	Cal Poly, San Luis Obispo	rbrandle@calpoly.edu	✓
Erin Reilly	San Diego State University	ereilly0150@sdsu.edu	✓
Quinn Ricci	Cal Poly, San Luis Obispo	qricci@calpoly.edu	

Emili Rios	United States Space Force	emili.rios@spaceforce.mil	✓
Sharen Roden	City of Paso Robles	sroden24@yahoo.com	✓
Khaki Rodway	Dawn Aerospace	khaki@dawnaerospace.com	✓
Isaac Rudnick	Cal Poly, San Luis Obispo	irudnick@calpoly.edu	✓
Jack Ryan	Cal Poly, San Luis Obispo	jryan39@calpoly.edu	✓
Toby Sagi	SLO Propulsion Technologies	tsagi@calpoly.edu	
David Sanchez	Streamline Aero	david@streamline.aero	✓
Mark Scandalis	Paso Robles Airprot	mscandalis@prcity.com	✓
Kyle Schumacher	Cal Poly, San Luis Obispo	kschum01@calpoly.edu	✓
Anmol Sharma	Cal Poly, San Luis Obispo	asharm77@calpoly.edu	✓
Stan Shull	Alliance Velocity, LLC	stan@alliancevelocity.com	✓
Paul Sloan	City of Paso Robles	psloan@prcity.com	✓
Todd Smith	Johns Hopkins University	H.Todd.Smith@jhuapl.edu	✓
Tyler Sova	SLO Propulsion Technologies	tsova@calpoly.edu	
Curtis Streeter	Deep Blue Integration, Inc.	Curtis@deepblueintegration.com	✓
Tomas Svitek	Stellar Exploration	tomas@stellar-exploration.com	
Winnie Trinh	Cal Poly, San Luis Obispo	witrinh@calpoly.edu	✓
Laki Vlachos	Blue Origin	avlachos@blueorigin.com	✓
Anthony Williams	Paso Robles High School	antdwill47@gmail.com	✓
Kara Woodruff	Office of California State Senator John Laird	kara.woodruff@sen.ca.gov	✓
Calla Woodruff Lyons	Cal Poly, San Luis Obispo	cawoodru@calpoly.edu	✓
Erik Wright	Precision Construction Services	erik@precision.services	✓
Diane Zannotti	Office of Congressman Jimmy Panetta	Diane.Zannotti@mail.house.gov	✓
Zackery Zounes	United States Air Force	zackeryzounes@att.net	

Appendix B – Agenda

CONFERENCE ON ATMOSPHERIC RESEARCH USING COMMERCIAL SUBORBITAL VEHICLES

February 27-28, 2025

Allegretto Vinyard Resort, Paso Robles

Thursday, February 27, 2025		
7:30 a.m. – 3 p.m.	Registration	
7:30 – 8:30 a.m.	Breakfast Bar	
8:30 – 8:40 a.m.	Jeff Armstrong	Welcome from Cal Poly President
8:40 – 8:45 a.m.	Dustin DeBrum	Conference Overview & Logistics
8:45 – 9:30 a.m.	Todd Smith	The Science of the Mesosphere-Lower Thermosphere (MLT)
9:30 – 10:30 a.m.	Stan Shull	Keynote speaker: Space to Grow
10:30 – 11 a.m.	Morning Break	
11 – 11:30 a.m.	Khaki Rodway	Dawn Aerospace: Next Generation of Suborbital Vehicles
11:30 a.m. – 12 p.m.	Ryan Meisberger	Stellar Exploration: Rocket Testing Operations
12 – 1:30 p.m.	Lunch Buffet	
1:30 – 1:40 p.m.	Kara Woodruff	Remarks from Senator Laird's Office
1:40 – 2:20 p.m.	Bill Britton/Kurt Colvin/ Paul Sloan	Paso Robles Spaceport Vision, Educational Programs and Opportunities
2:20 – 2:50 p.m.	Todd Smith	MLT Research Case Study
2:50 – 3:10 p.m.	Dianne DeTurris	Engaging Students in Space Technology Research
3:10 – 3:40 p.m.	Dennis Derickson	Space IoT Research Case Study
3:40 – 3:50 p.m.	Afternoon Break	
3:50 – 4:20 p.m.	Evan Johnston (moderator)	Panel: Local Community STEM Showcase and Spaceport Interest Panelists: Grant Acevedo, Kyle Dart, Anthony Williams
4:20 – 4:30 p.m.	Dustin DeBrum	Reflections and Summary for the Day
4:30 – 6 p.m.	Happy Hour Reception (Sponsored by JUSTIN)	

THIS WORK IS SUPPORTED BY

the U.S. National Science Foundation under Award No. 2432335

U.S. National Science Foundation

AND

PASO ROBLES

CAL POLY

DIGITAL TRANSFORMATION HUB

CALIFORNIA CYBERSECURITY INSTITUTE

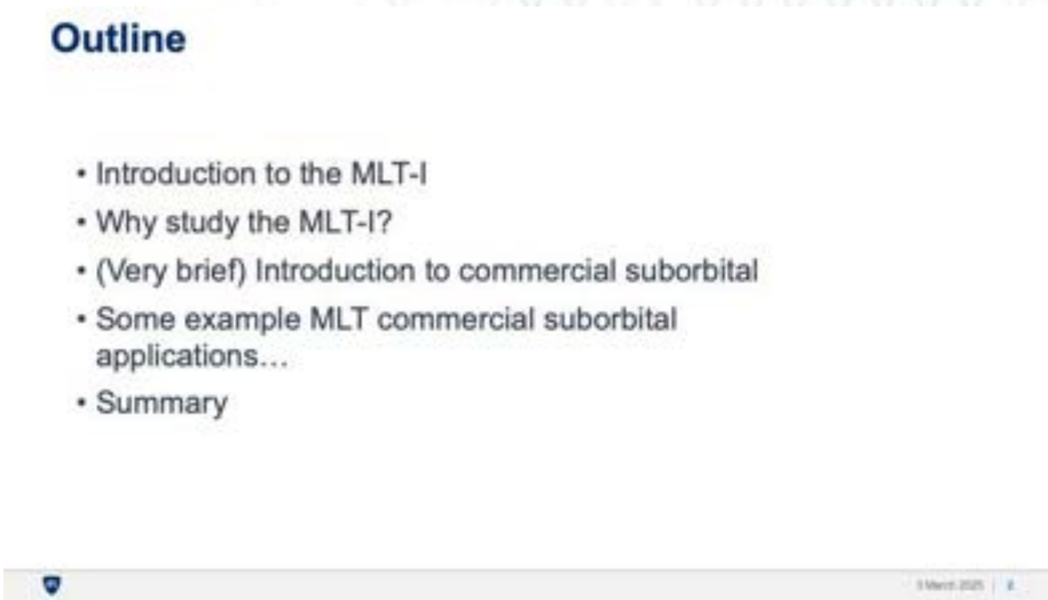
CITY OF EL PASO DE ROBLES

ETP Employment Training Panel

Friday, February 28, 2025		
7:30 – 8:30 a.m.	Breakfast Bar	
8:30 – 8:50 a.m.	Jamey Jacob	From the Ground Up to Middle-Out: Drones and Balloons for Assistive Suborbital Observations
8:50 – 9:10 a.m.	Jess Bleakley	PolySat Program
9:10 – 9:20 a.m.	Henry Danielson/ Isaac Rudnick	Cal Poly AMSAT Project
9:20 – 9:40 a.m.	Mark Scandalis	Paso Robles Air and Spaceport Licensing Update
9:40 – 10 a.m.	Cheree Kiernan ILS	Understanding Spaceport, Vehicle, and Payload Licensing
10 – 10:20 a.m.	Morning Break / Panel Setup	
10:20 – 11 a.m.	Paul Sloan (moderator)	Panel: Bridging The Gap: Collaboration between Industry, Academia and Government for Spaceport Operations. Panelists: Robert Meyer (ETP), David Sanchez (Streamline Aerospace), Bob Crockett (Cal Poly), Mike Mierau (Premiere Valley Bank)
11 – 11:30 a.m.	Dustin DeBrum	Workshop Closure and Next Steps Informal Discussion - Open to All
11:30 a.m. – 1 p.m.	Boxed Lunches	

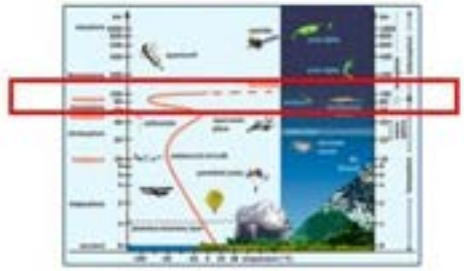
Appendix C - Presentations

C1 - The Science of the Mesosphere-Lower Thermosphere (MLT) –Smith



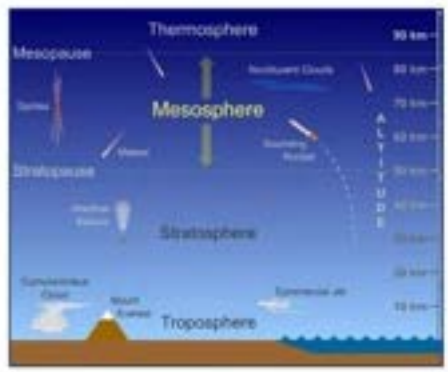
Introduction to the Mesosphere-Lower Thermosphere-Ionosphere (MLT-I)

- Earth's atmosphere generally considered from the surface to altitude of ~1000 km
- Divided into 5 main layers
  - Troposphere (~0-10 km): ~75% of atmosphere
  - Stratosphere (~10-50 km): contains most of ozone
  - Mesosphere (~50-85 km): temperatures decrease
  - Thermosphere (~85-400 km): temperatures increase
  - Exosphere (>400 km): mainly oxygen & hydrogen
- Within exosphere, particles likely escape to space
- The Ionosphere overlaps at ~60-500 km
- Commercial suborbital vehicles offer game-changing access to the Mesosphere & Lower Thermosphere ("MLT") & Ionosphere



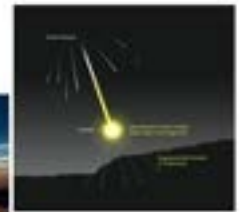
More about the Mesosphere (Part 1)

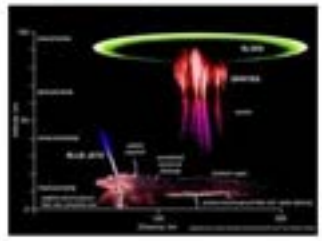
- Directly above the Stratosphere @ ~50-85 km (~31-53 miles)
- Considered "middle atmosphere" (along with Stratosphere)
- Temperatures decrease with altitude
- Coldest atmospheric temperature ~-90° C
- Stratopause: lower boundary with Stratosphere
- Mesopause: upper boundary with Thermosphere
- Difficult to directly study
  - Too low for satellites/too high for balloons and aircraft
  - Mainly studied with brief, infrequent sounding rockets
  - Still much to learn about the mesosphere



More about the Mesosphere (Part 2)

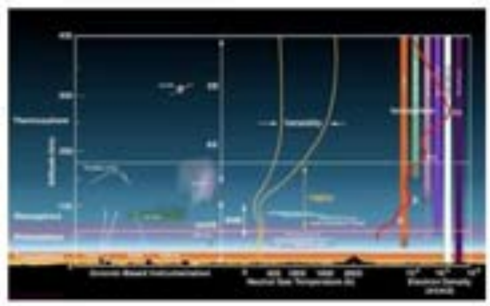
- Gas molecules & atoms are thoroughly mixed
- Most meteors vaporize in this layer
  - Relative high concentration of iron & other metals
- Surprising "Noctilucent Clouds" or "Polar Mesospheric Clouds" sometimes near the poles
  - Much higher than 'normal' clouds
  - Form in a much drier environment (than Troposphere)
- Odd electrical discharges akin to lightning, called "sprites" and "ELVES"
- Various waves and tides carry energy from below into the Mesosphere
  - Drives most global circulation





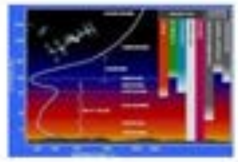
More about the Thermosphere (Part 1)

- Directly above the Mesosphere @ ~90-500 km (~55-600 miles)
- Contains traditional boundary to space @~100 km (~62 miles)
- Temperatures increase with altitude
  - Climb sharply up to ~200-300 km and then levels off
  - Upper Thermosphere can exceed 2000° C
- Solar activity strongly influences temperature
  - Typically ~200° C (hotter in daytime)
  - ~500° C when Sun is very active
- Thermosphere: upper boundary with Exosphere
- Lower Thermosphere also difficult to directly study
  - Too low for satellites/too high for balloons and aircraft
  - Mainly studied with brief, infrequent sounding rockets



More about the Thermosphere (Part 2)

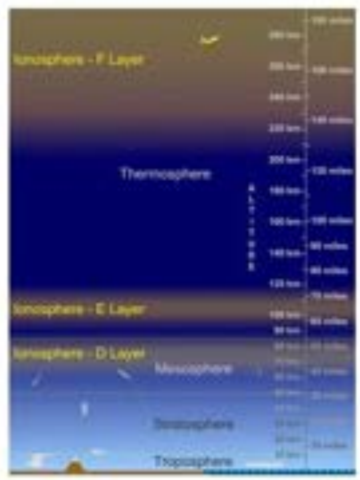
- Critical transition region from collisional to non-collisional
  - Energetic Solar UV and X-ray photons break apart molecules
  - Upper thermosphere main components: Oxygen (O), Nitrogen (N), and Helium (He)
- Most solar X-ray and UV radiation absorbed in this layer
  - Thermosphere gets hotter and expands when the Sun is active
- Wave and tides drive overall circulation
- Aurora primarily occurs in this layer
  - High energy solar photons ionize neutral gas
  - Production of ions that populated the ionosphere



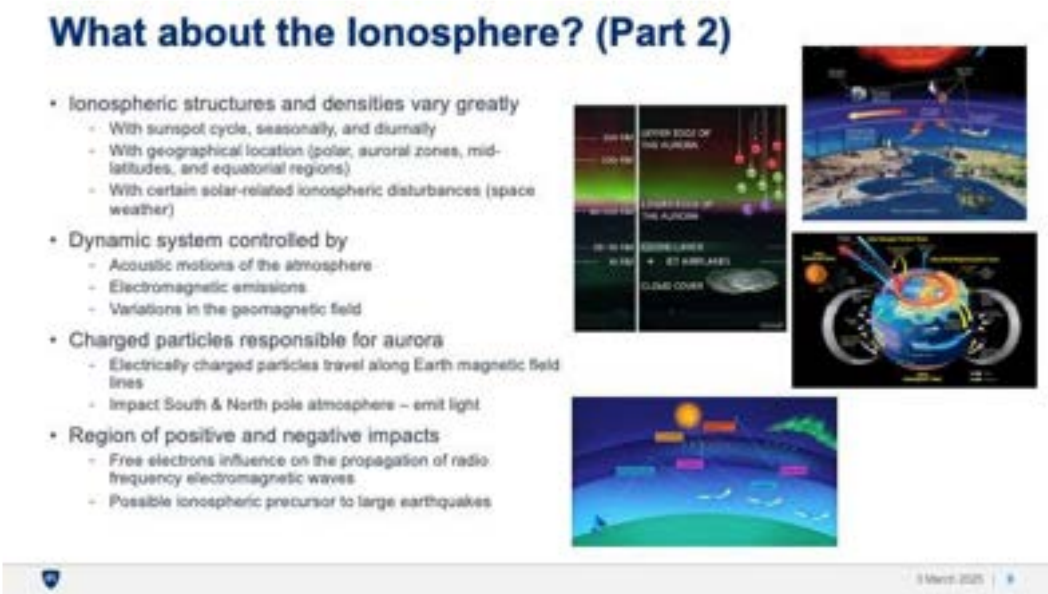
3 March 2025 | 7

What about the Ionosphere? (Part 1)

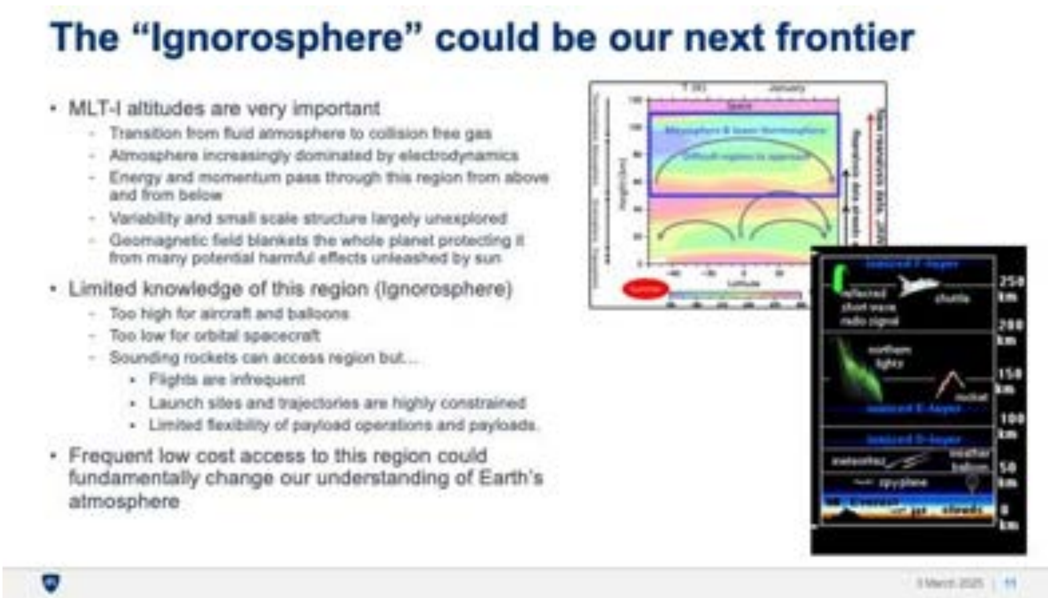
- Overlaps the MLT @ ~60km to >300 km (~37 to >190 miles)
- Produced by electrons, ions and photons from space
  - Ionization primarily depends on solar activity (i.e. "Space Weather")
  - Ionization processes release excess energy (photons producing aurora)
- Divided into 3 regions
  - D layer (~60-90 km) – lowest, densest layer in Mesosphere
  - E layer (~90-150 km) – typically in lower Thermosphere
  - F layer (~150-500 km) – typically in upper hermosphere
- Ionization increases in daytime

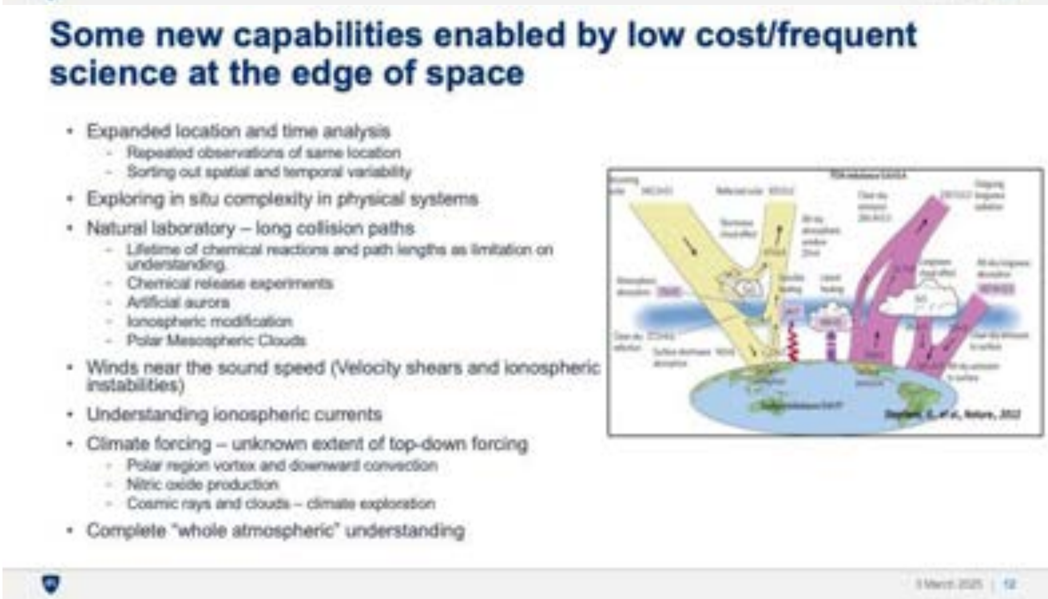


3 March 2025 | 8


What about the Ionosphere? (Part 2)
Ionospheric structures and densities vary greatly
With sunspot cycle, seasonally, and diurnally
With geographical location (polar, auroral zones, mid-latitudes, and equatorial regions)
With certain solar-related ionospheric disturbances (space weather)
Dynamic system controlled by
Acoustic motions of the atmosphere
Electromagnetic emissions
Variations in the geomagnetic field
Charged particles responsible for aurora
Electrically charged particles travel along Earth magnetic field lines
Impact South & North pole atmosphere – emit light
Region of positive and negative impacts
Free electrons influence on the propagation of radio frequency electromagnetic waves
Possible ionospheric precursor to large earthquakes
UPPER EDGE OF THE AURORA
LOWER EDGE OF THE AURORA
OZONE LAYER
JET AIRPLANES
CLOUD COVER


Why study the MLT-I?
In situ observations are traditionally difficult
Many questions still exist about the MLT-I
Sometimes referred to as the "Ignorosphere"
Suborbital region not well understood
How can we truly understand our atmosphere with this hole in our knowledge (modeling, prediction, how it formed, why it is here, what may happen in the future…example of Mars)
Global warming
Impacts of space weather (communications, power grid impacts, etc.)
Global energy budget
Meteor input to our atmosphere
Geomagnetic field blankets the whole planet protecting it from many potential harmful effects unleashed by sun
The region filters out the shortest wavelengths of ultraviolet energy from the sun before it reaches the surface of earth
What else goes on near 100km:
Noctilucent Clouds
Gravity Wave Breaking
Turbopause
Transitional and Transformational Region
Thermosphère
Mésosphère
Stratosphère
Troposphère
Terre
85 km
50 km
10 km
Exosphere
Thermosphere
Mesosphere
Stratosphere
Troposphere

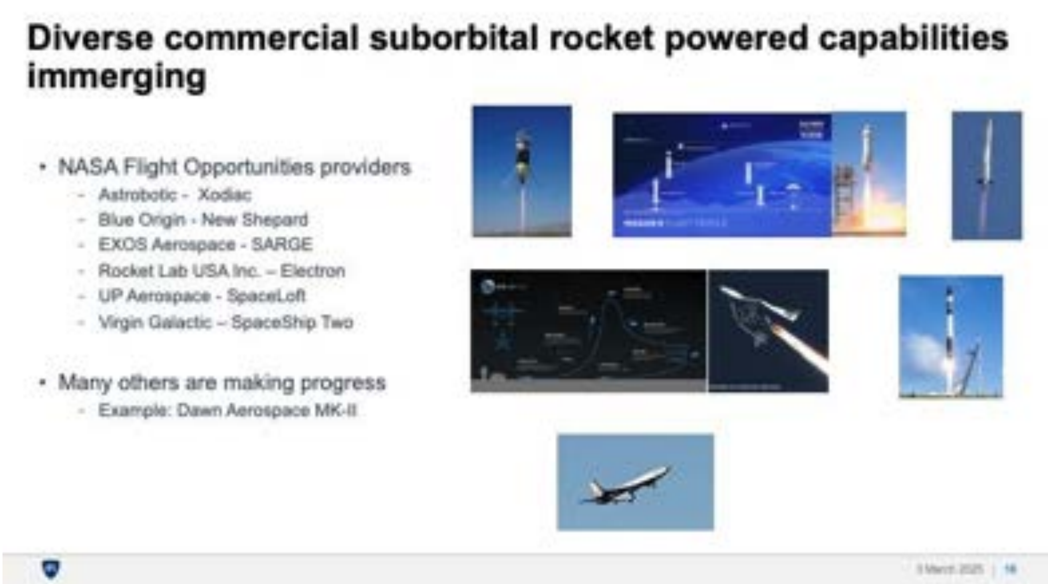

The "Ignorosphere" could be our next frontier
• MLT-I altitudes are very important
- Transition from fluid atmosphere to collision free gas
- Atmosphere increasingly dominated by electrodynamics
- Energy and momentum pass through this region from above and from below
- Variability and small scale structure largely unexplored
- Geomagnetic field blankets the whole planet protecting it from many potential harmful effects unleashed by sun
• Limited knowledge of this region (Ignorosphere)
- Too high for aircraft and balloons
- Too low for orbital spacecraft
- Sounding rockets can access region but…
• Flights are infrequent
• Launch sites and trajectories are highly constrained
• Limited flexibility of payload operations and payloads.
• Frequent low cost access to this region could fundamentally change our understanding of Earth's atmosphere


Some new capabilities enabled by low cost/frequent science at the edge of space
• Expanded location and time analysis
- Repeated observations of same location
- Sorting out spatial and temporal variability
• Exploring in situ complexity in physical systems
• Natural laboratory – long collision paths
- Lifetime of chemical reactions and path lengths as limitation on understanding.
- Chemical release experiments
- Artificial aurora
- Ionospheric modification
- Polar Mesospheric Clouds
• Winds near the sound speed (Velocity shears and Ionospheric instabilities)
• Understanding ionospheric currents
• Climate forcing – unknown extent of top-down forcing
- Polar region vortex and downward convection
- Nitric oxide production
- Cosmic rays and clouds – climate exploration
• Complete "whole atmospheric" understanding

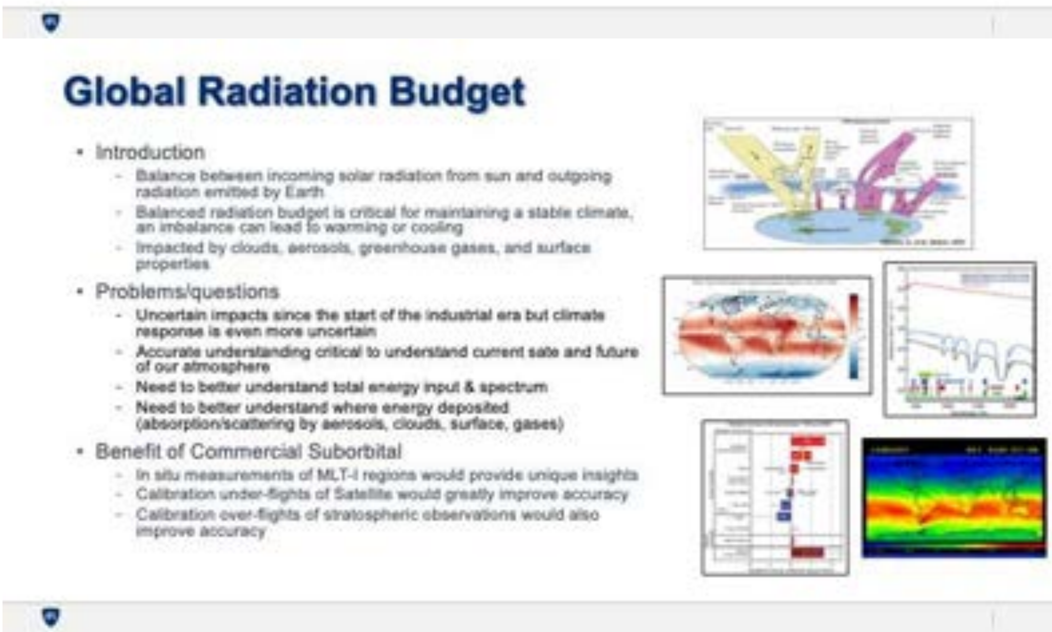

Where could expanded exploration of the MLT-I lead?
We explore the upper atmosphere because it is interesting – it also has practical value.
Understanding
Prediction
Mitigation
Security
Education
Exploration
A more complete understanding of our atmosphere
Past, present and future of the Earth
Planets in general (i.e. exoplanets)
What controls the evolution a planet?
What maintains the conditions for life?
How "special" are these conditions?

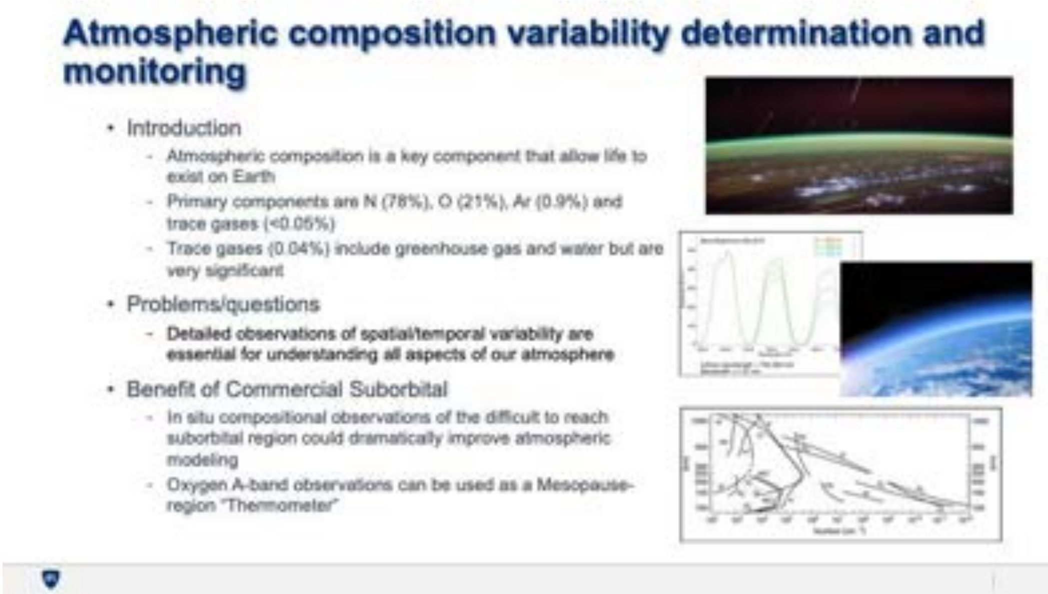

Additional benefit - More rapid advancement of instrument technology
"Catch-22"
Large mission instrumentation requires maturity but how do you acquire this without mission experience
Technology Readiness Level "valley of death"
Personal experience - Europa Clipper example
Low-cost frequent flights provide excellent method of rabidly developing and testing new technology
Return of payload – opportunity to fly prototypes/engineering models
Human tended mission offer opportunity to move lab environment up to the edge of space
May not provide the exact required environment but still provides opportunity to improve TRL

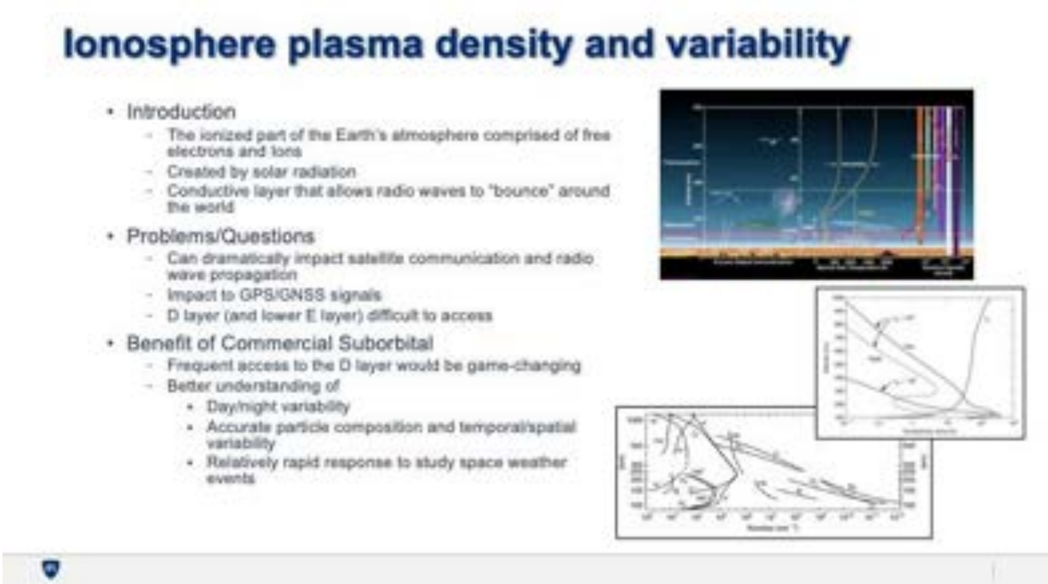

But what do we mean by "commercial suborbital"?
• Private companies developing revolutionary suborbital spacecraft with novel scientific and engineering applications Routine access to the 'ignorosphere'
- The establishment of a commercial space fleet (Kelly Act of 1925 analogy)
• Revolutionary suborbital spacecraft – game-changing attributes
- 1-2 orders of magnitude cheaper than traditional costs
- Human tended and untended
- Relatively large payload capacity
- Fully reusable with rapid turn around
- Access to ~>100 km
- Guaranteed safe return of payload
- Up to 3 minutes of micro-gravity
• Large potential for applications beyond space tourism
- Direct research of the suborbital region
- Technology development and flight testing
- Low cost, frequent flight tests -> cost and schedule reductions
- STEM education and motivation


Diverse commercial suborbital rocket powered capabilities immerging
• NASA Flight Opportunities providers
- Astrobotic - Xodiac
- Blue Origin - New Shepard
- EXOS Aerospace - SARGE
- Rocket Lab USA Inc. – Electron
- UP Aerospace - SpaceLoft
- Virgin Galactic – SpaceShip Two
• Many others are making progress
- Example: Dawn Aerospace MK-II

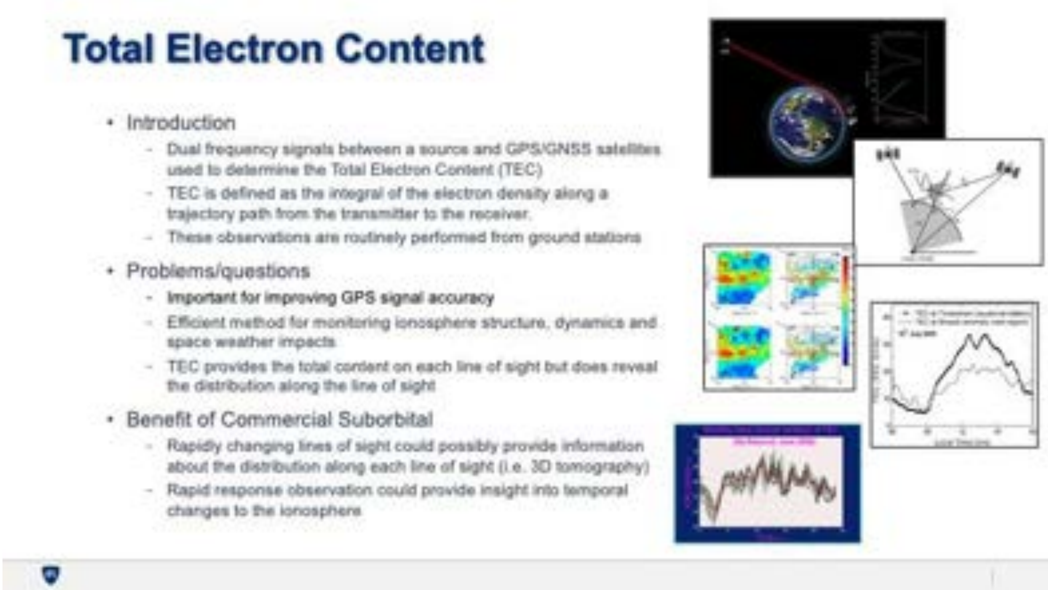
Some examples of the significant range of MLT-I commercial suborbital applications…




Atmospheric composition variability determination and monitoring
Introduction
Atmospheric composition is a key component that allow life to exist on Earth
Primary components are N (78%), O (21%), Ar (0.9%) and trace gases (<0.05%)
Trace gases (0.04%) include greenhouse gas and water but are very significant
Problems/questions
Detailed observations of spatial/temporal variability are essential for understanding all aspects of our atmosphere
Benefit of Commercial Suborbital
In situ compositional observations of the difficult to reach suborbital region could dramatically improve atmospheric modeling
Oxygen A-band observations can be used as a Mesopause-region "Thermometer"


Ionosphere plasma density and variability
Introduction
The ionized part of the Earth's atmosphere comprised of free electrons and ions
Created by solar radiation
Conductive layer that allows radio waves to "bounce" around the world
Problems/Questions
Can dramatically impact satellite communication and radio wave propagation
Impact to GPS/GNSS signals
D layer (and lower E layer) difficult to access
Benefit of Commercial Suborbital
Frequent access to the D layer would be game-changing
Better understanding of
Day/night variability
Accurate particle composition and temporal/spatial variability
Relatively rapid response to study space weather events


Aurora & Auroral Currents
• Introduction
- Aurora are produced by solar wind interaction with the Earth's magnetic field
• Charged particle travel along the magnetic field lines until they interact with atmospheric particles (usually near the north or south poles)
• Particle interaction produce light emissions
• Colors (wavelength) are dependent on atmospheric species and solar wind particle energy
- Observed at multiple planets
• Problems/questions
- Improved understanding helps improve knowledge of atmospheric and interactions
• Benefit of Commercial Suborbital
- Opportunity to study ionosphere at lower altitudes (but must launch at higher & lower latitudes)
- Responsive in situ observations of aurora and currents could provide game-changing insight
Sun

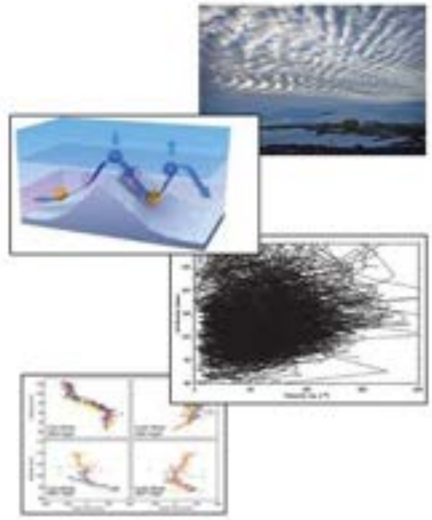

Total Electron Content
• Introduction
- Dual frequency signals between a source and GPS/GNSS satellites used to determine the Total Electron Content (TEC)
- TEC is defined as the integral of the electron density along a trajectory path from the transmitter to the receiver.
- These observations are routinely performed from ground stations
• Problems/questions
- Important for improving GPS signal accuracy
- Efficient method for monitoring ionosphere structure, dynamics and space weather impacts
- TEC provides the total content on each line of sight but does reveal the distribution along the line of sight
• Benefit of Commercial Suborbital
- Rapidly changing lines of sight could possibly provide information about the distribution along each line of sight (i.e. 3D tomography)
- Rapid response observation could provide insight into temporal changes to the ionosphere


Negative ions – connection to other worlds
• Introduction
- NASA Cassini Mission spent 13 (2004-2017) years at Saturn and dramatically increased our planetary knowledge
- Saturn's largest moon, Titan (larger than Mercury), has an extremely dense atmosphere that may represent an primordial version of Earth's atmosphere.
- Negative ions unexpectedly discovered at Titan
- Data at Earth suggests significant day/night variability in composition and density of negative ions in the D-region
• Problems/questions
- Negative ions are extremely important for driving atmospheric chemistry and present in Earth's atmosphere at suborbital altitudes
- Far more negative ion observations at Titan than Earth (211 vs. ~20)
• Benefit of Commercial Suborbital
- Commercial suborbital vehicles of this difficult to reach region offer the possibility of dramatically increasing out knowledge off negative ions in Earth's atmosphere
- Opportunity to measure negative ion composition multiple times per day and/or night will provide new insight into the microphysics and chemistry of this region and allow us to test existing chemical models.
- Offers the potential to fundamentally improve our understanding of atmospheric chemistry, dynamics and predictive modeling


Noctilucent clouds (NLCs)
• Introduction
- Rare, wispy, blue or silvery clouds that appear in upper atmosphere during summer
- Also known as polar mesospheric clouds
- Only visible at latitudes between 45° and 80° (too faint to be seen in daylight)
- Composed of tiny ice crystals
- Exist at ~76 km to ~85 km altitudes
• Problems/questions
- Data suggests NLCs require water vapor, dust, and very cold temperatures to form but sources of this dust and vapor are not known with certainty
• Benefit of Commercial Suborbital
- More frequent in situ observations NLCs could dramatically improve understanding of them, how they are formed and their impact on the atmosphere
- Help confirm the dust and vapor sources

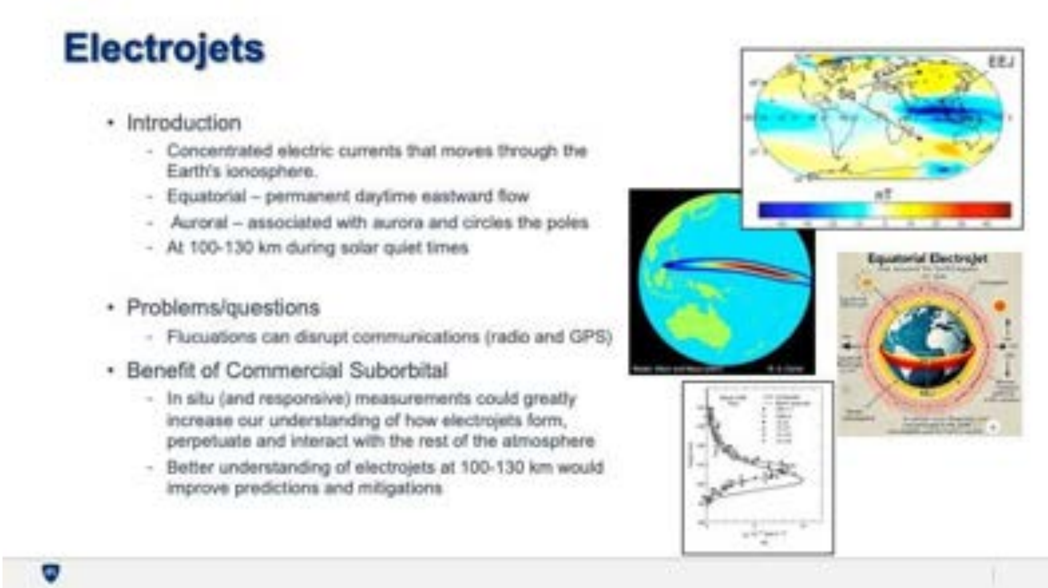
Gravity waves

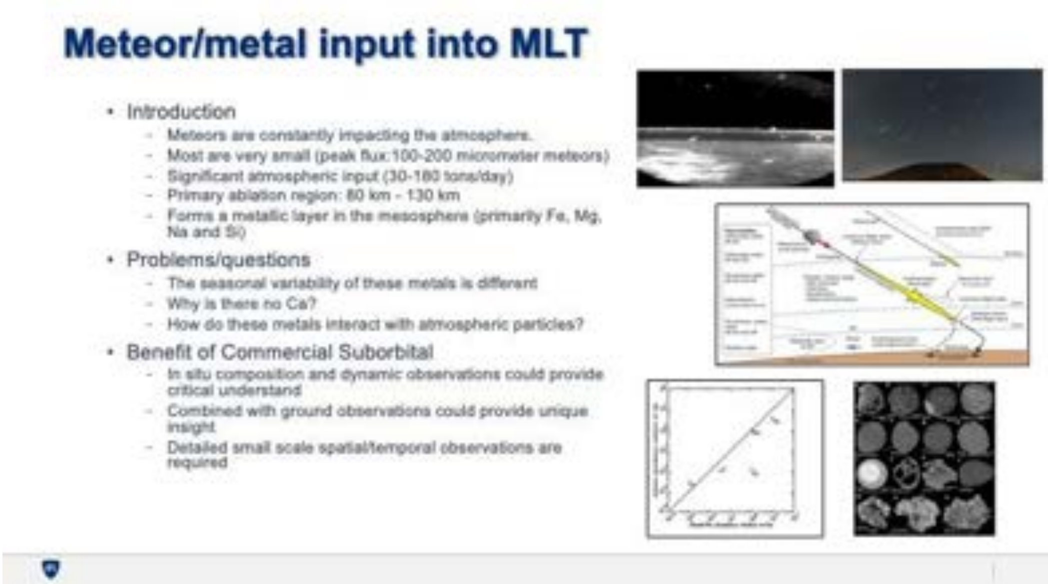
- Introduction
  - Ripples or wave-like disturbances in the atmosphere
  - Rise and fall in a wave-like pattern
- Problems/questions
  - Can play a crucial role in transferring energy and momentum between atmospheric layers layers
  - Gravity waves that reach ionosphere cause traveling ionosphere disturbances
  - Provide a good mechanism for studying greatly varying wind velocities
- Benefit of Commercial Suborbital
  - Gravity waves can be observed from space and ground but coincident in situ observations provide great insight into particle interactions and dynamics caused by these features

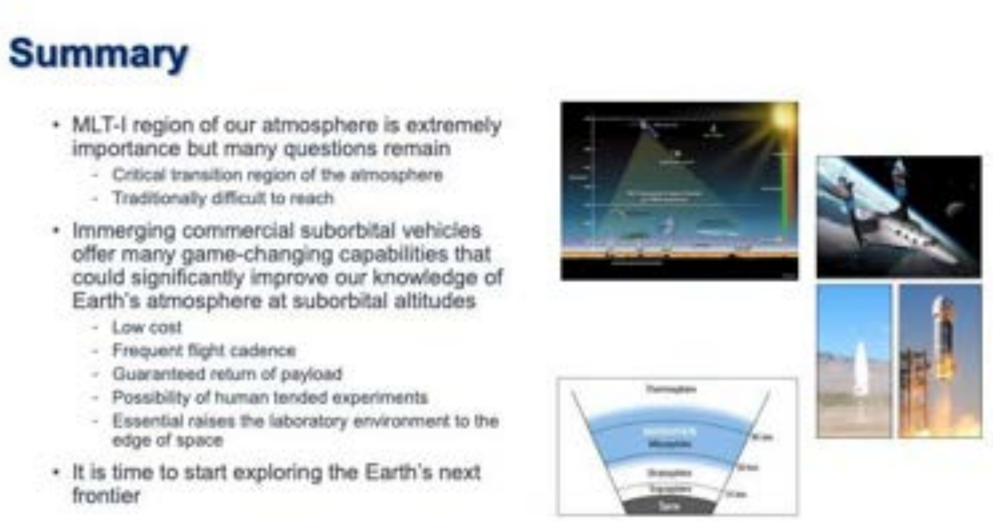


Upper Atmosphere (Ionospheric) Lightning

- Introduction
  - Short-lived (milli-2 seconds) electric breakdown above normal lightning
  - Thought produced by luminous plasma interaction (TLE: Transient Luminous Events)
  - Generally bright emission above storms
  - Many types: sprites, sprite halos, ghosts, blue jets, gigantic jets, pixies, gnomes, trolls, blue starters, and ELVESs
  - Theorized in 1920's but 1st video was in1989
  - Observed at other worlds (such as Jupiter)
- Problems/questions
  - Unusual phenomena that are not well understood
  - May dramatically alter chemical and electrical MLT-I properties
- Benefit of Commercial Suborbital
  - In situ observations of the near regions can provide insight into formation
  - Responsive, coordinated (with ground and satellite) observations could help us understand these fascinating phenomena

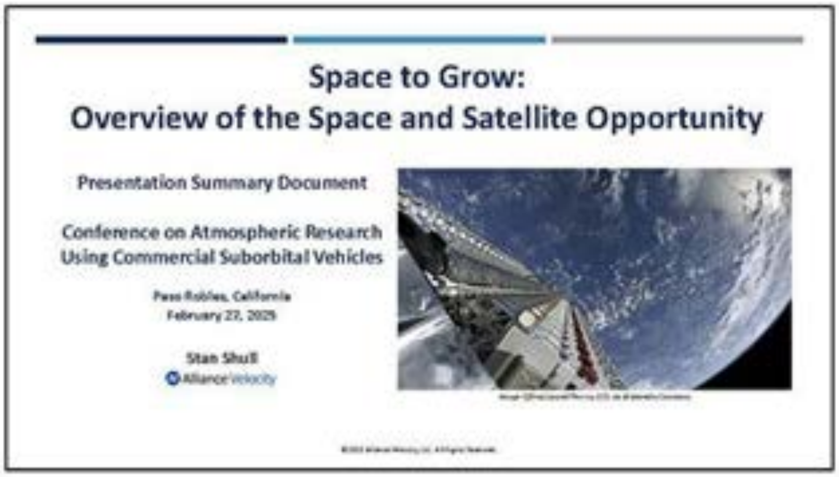

Electrojets
Introduction
Concentrated electric currents that moves through the Earth's ionosphere.
Equatorial – permanent daytime eastward flow
Auroral – associated with aurora and circles the poles
At 100-130 km during solar quiet times
Problems/questions
Flucuations can disrupt communications (radio and GPS)
Benefit of Commercial Suborbital
In situ (and responsive) measurements could greatly increase our understanding of how electrojets form, perpetuate and interact with the rest of the atmosphere
Better understanding of electrojets at 100-130 km would improve predictions and mitigations
EEJ
Equatorial Electrojet


Meteor/metal input into MLT
Introduction
Meteors are constantly impacting the atmosphere.
Most are very small (peak flux:100-200 micrometer meteors)
Significant atmospheric input (30-180 tons/day)
Primary ablation region: 80 km - 130 km
Forms a metallic layer in the mesosphere (primarily Fe, Mg, Na and Si)
Problems/questions
The seasonal variability of these metals is different
Why is there no Ca?
How do these metals interact with atmospheric particles?
Benefit of Commercial Suborbital
In situ composition and dynamic observations could provide critical understand
Combined with ground observations could provide unique insight
Detailed small scale spatial/temporal observations are required


Summary
MLT-I region of our atmosphere is extremely importance but many questions remain
Critical transition region of the atmosphere
Traditionally difficult to reach
Immerging commercial suborbital vehicles offer many game-changing capabilities that could significantly improve our knowledge of Earth's atmosphere at suborbital altitudes
Low cost
Frequent flight cadence
Guaranteed return of payload
Possibility of human tended experiments
Essential raises the laboratory environment to the edge of space
It is time to start exploring the Earth's next frontier

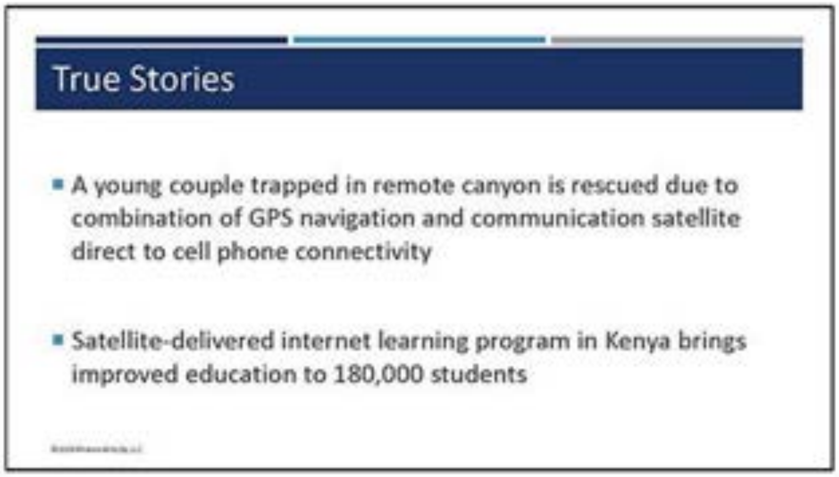

APL
JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

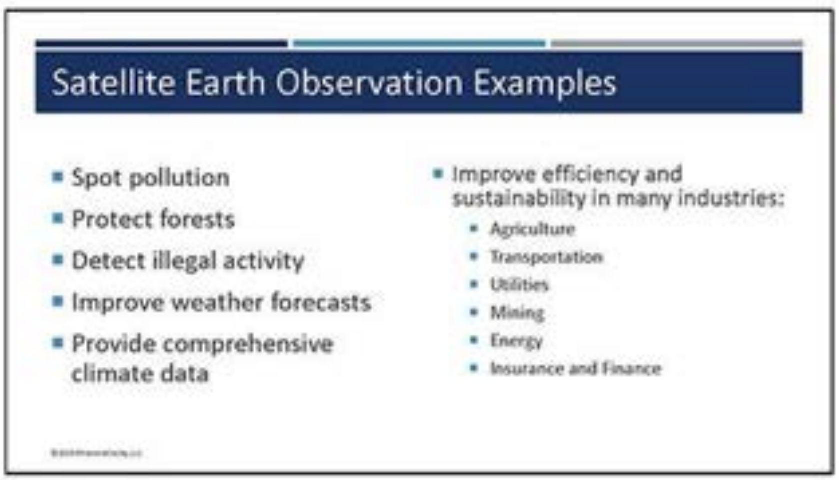
C2 - Space to Grow – Shull

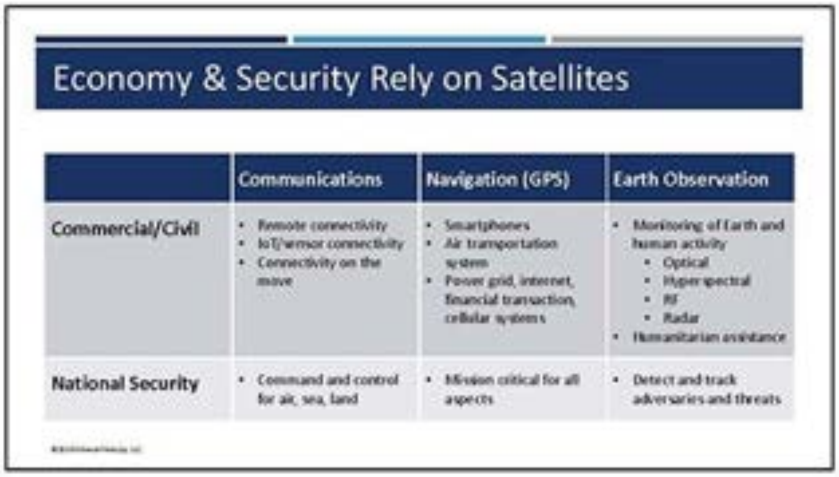


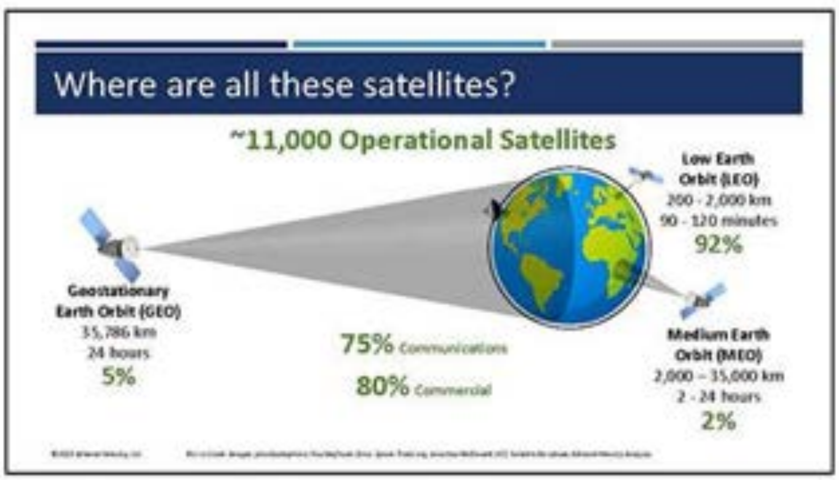

Topics
Introduction to Satellites
Global Space Economy
Future Space Opportunities


Topics
Introduction to Satellites
Global Space Economy
Future Space Opportunities


True Stories
A young couple trapped in remote canyon is rescued due to combination of GPS navigation and communication satellite direct to cell phone connectivity
Satellite-delivered internet learning program in Kenya brings improved education to 180,000 students

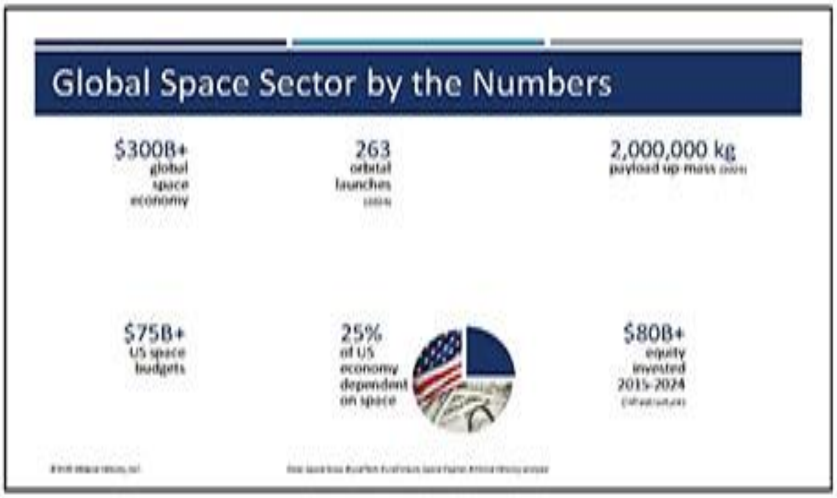

Satellite Earth Observation Examples
Spot pollution
Protect forests
Detect illegal activity
Improve weather forecasts
Provide comprehensive climate data
Improve efficiency and sustainability in many industries:
Agriculture
Transportation
Utilities
Mining
Energy
Insurance and Finance

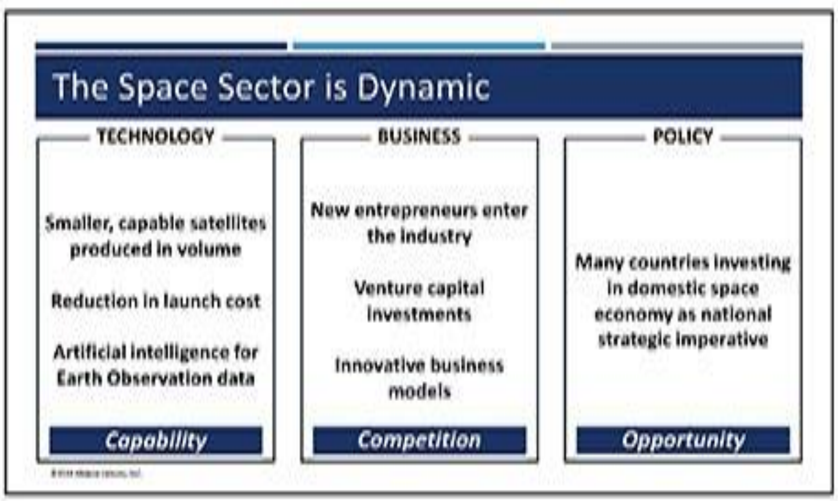

Economy & Security Rely on Satellites
Communications
Navigation (GPS)
Earth Observation
Commercial/Civil
• Remote connectivity
• IoT/sensor connectivity
• Connectivity on the move
• Smartphones
• Air transportation system
• Power grid, internet, financial transaction, cellular systems
• Monitoring of Earth and human activity
• Optical
• Hyperspectral
• RF
• Radar
• Humanitarian assistance
National Security
• Command and control for air, sea, land
• Mission critical for all aspects
• Detect and track adversaries and threats


Where are all these satellites?
~11,000 Operational Satellites
Low Earth Orbit (LEO)
200 - 2,000 km
90 - 120 minutes
92%
Geostationary Earth Orbit (GEO)
35,786 km
24 hours
5%
75% Communications
80% Commercial
Medium Earth Orbit (MEO)
2,000 – 35,000 km
2 - 24 hours
2%

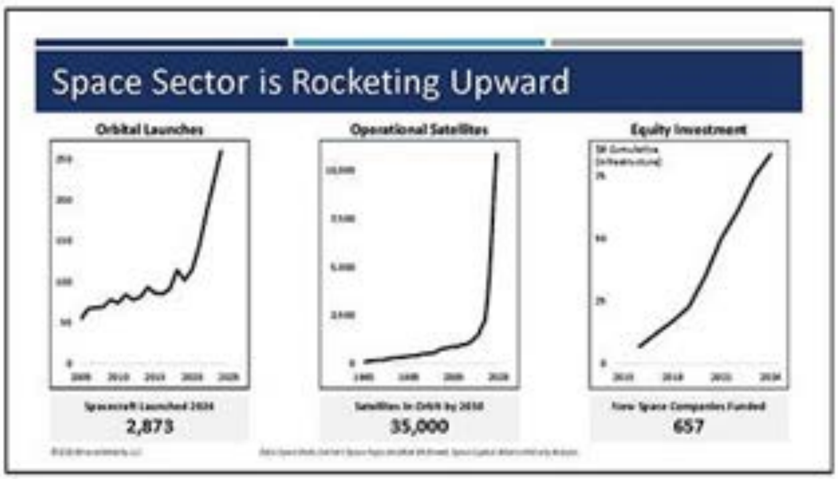

Topics
Introduction to Satellites
Global Space Economy
Future Space Opportunities


The Modern Space Sector
CUSTOMER
Business
Consumer
Government
Military
Academia
APPLICATIONS
Data & Connectivity
Earth Observation
Navigation
Mobility
Analytics & Cloud
Human Spaceflight
Internet of Things
Weather & Climate
Science & Exploration
INFRASTRUCTURE
Launch
Satellites
Ground Services
Software
In-Space Operations
Debris & Traffic
Insurance & Financing
Policy & Law
Resource Utilization

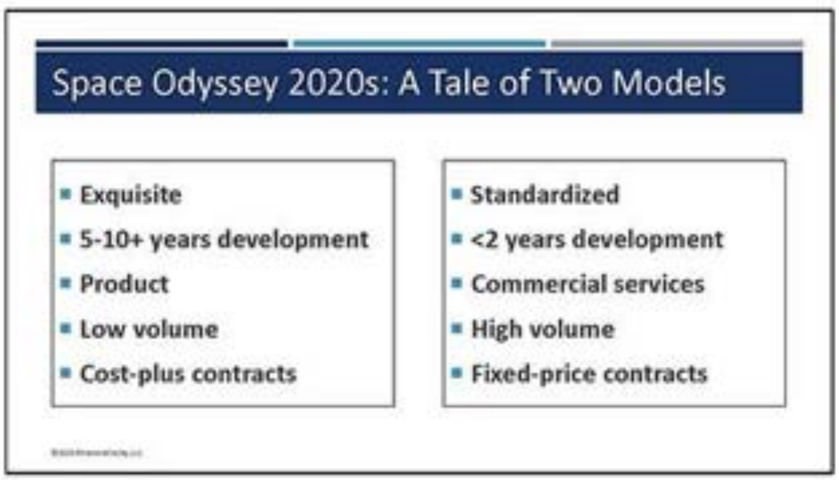

Global Space Sector by the Numbers
$300B+ global space economy
263 orbital launches
2,000,000 kg payload up-mass
$75B+ US space budgets
25% of US economy dependent on space
$80B+ equity invested 2015-2024


The Space Sector is Dynamic
TECHNOLOGY
Smaller, capable satellites produced in volume
Reduction in launch cost
Artificial intelligence for Earth Observation data
Capability
BUSINESS
New entrepreneurs enter the industry
Venture capital investments
Innovative business models
Competition
POLICY
Many countries investing in domestic space economy as national strategic imperative
Opportunity


Space is a Contested Domain
Moscow Threatens U.S. Satellites
China and US Satellites Play Dangerous 'Cat and Mouse'
Satellite Warfare Is a Distinct Possibility


Space Sector is Rocketing Upward
Orbital Launches
Operational Satellites
Equity Investment
Spacecraft Launched 2024
2,873
Satellites in Orbit by 2030
35,000
New Space Companies Funded
657

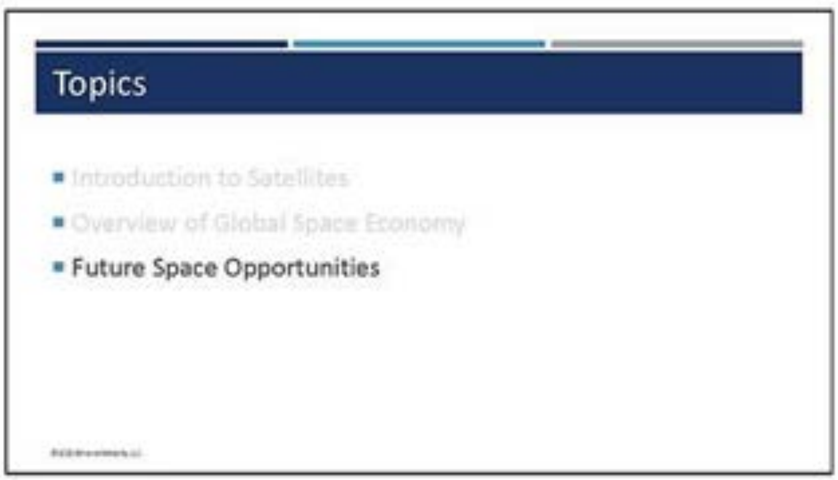

SpaceX & New Space Leaders
SpaceX
Driver of innovation & change
Leading launch provider
Top satellite manufacturer & operator
Big supplier to NASA/DoD
Dominant position
Other new space leaders coming on strong
Blue Origin
Amazon Project Kuiper
Rocket Lab
Firefly Aerospace
Sierra Space
Others
Driving space commercialization growth globally

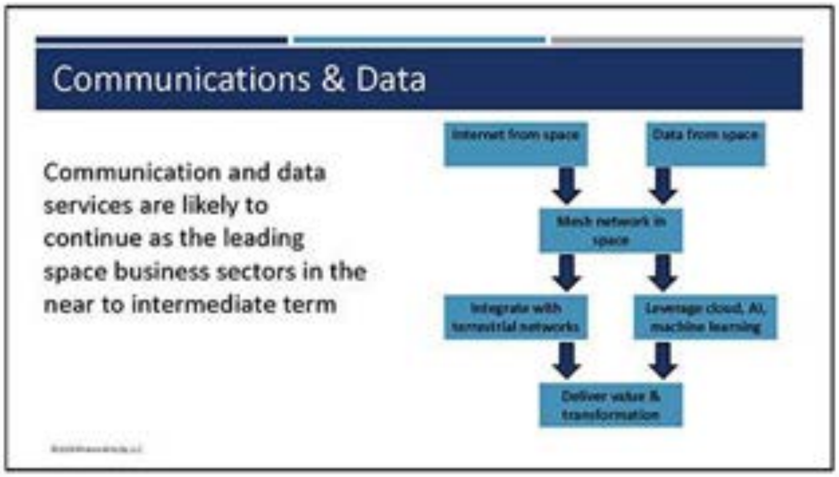

Space Odyssey 2020s: A Tale of Two Models
Exquisite
5-10+ years development
Product
Low volume
Cost-plus contracts
Standardized
<2 years development
Commercial services
High volume
Fixed-price contracts


The New Commercial Space Race
Why Deere thinks satellites are the next big technology to invest in
Eli Lilly heads to space to explore next frontier of drug development
Microsoft takes on Amazon in the data space race with Azure Orbital
Swiss Re Forms Strategic Partnership with Satellite Operator for Flood Monitoring
Exxon Mobil Partnership to Deploy Satellite Technology For Global Emissions Mitigation
DHL expands its global logistics operation to include outer space missions


The New Commercial Space Race
Space Force wraps initial plan for building 'hybrid' commercial/military 'outernet'
Spy agency awards 'historic' contracts to commercial satellite firms
Pentagon's commercial satellite internet services program soars to $13 billion
SES to Buy Intelsat in $3.1 Billion Bid to Rival Musk's Starlink
Lockheed Martin completes acquisition of smallsat manufacturer Terran Orbital
Boeing Explores Sale of Space Business


The New Commercial Space Race
Verizon Jumps Into Satellite-to-Cell Market With AST SpaceMobile
AT&T deal will make every phone a satellite phone
T-Mobile Takes Coverage Above and Beyond With SpaceX
Lynk Successfully Deploys Two More Orbital 'Cell Phone Towers in Space'
Globalstar soars on Apple's $1.7 billion satellite investment


Topics
Introduction to Satellites
Overview of Global Space Economy
Future Space Opportunities


Communications & Data
Communication and data services are likely to continue as the leading space business sectors in the near to intermediate term
Internet from space
Data from space
Mesh network in space
Integrate with terrestrial networks
Leverage cloud, AI, machine learning
Deliver value & transformation


US National Security: Key Space Themes
• Space Domain Awareness
• Dynamic Space Operations
• Proliferated Architectures
• Tactically Responsive Space
• Commercial Engagement & Services
Defining Threat: China

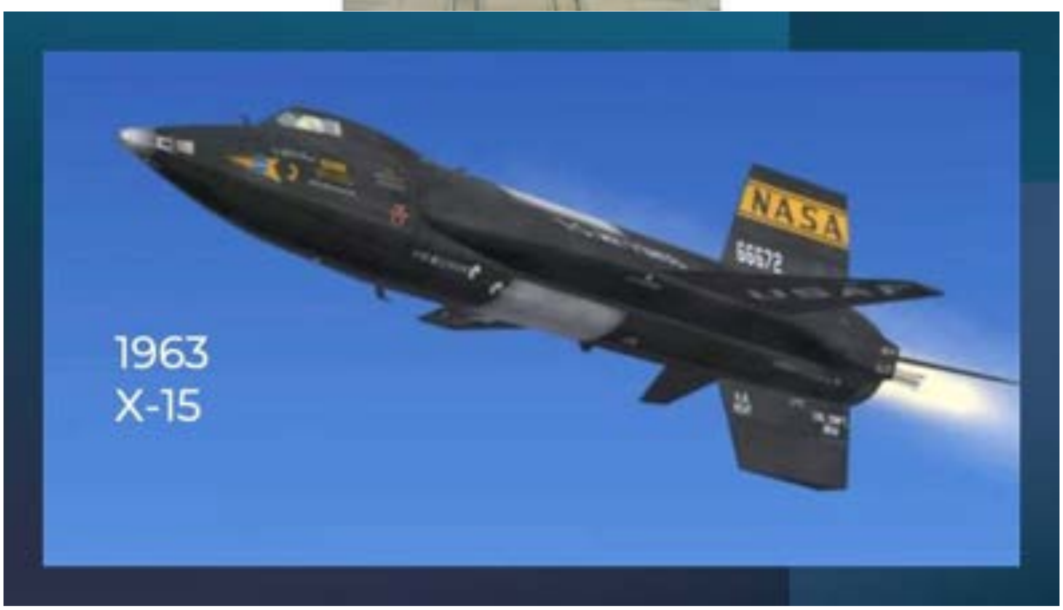

Other Sectors & Business Opportunities
Space science and exploration
Human spaceflight
Commercial private
Moon goal: US & China
International competition
Private space stations
Satellite servicing
Assembly & manufacturing
Lunar economy
Energy and mining


Thank You
Stan Shull
Alliance Velocity

C3 - Dawn Aerospace: Next Generation of Suborbital Vehicles – Rodway

EXAMPLES OF SUBORBITAL VEHICLES

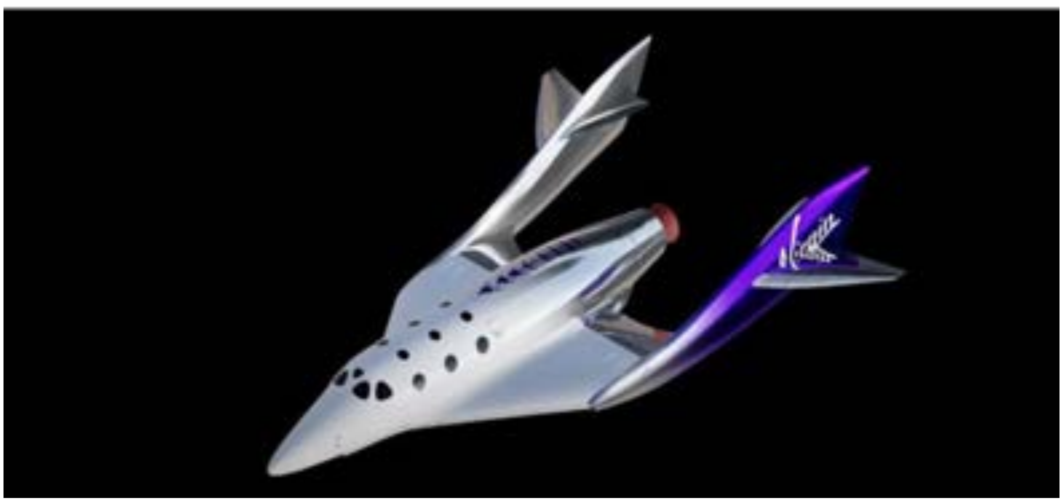
1961
Mercury
Redstone



2004 SpaceShipOne X-Prize Flights

2015
New
Shepard

2026 Virgin Galactic Delta Class

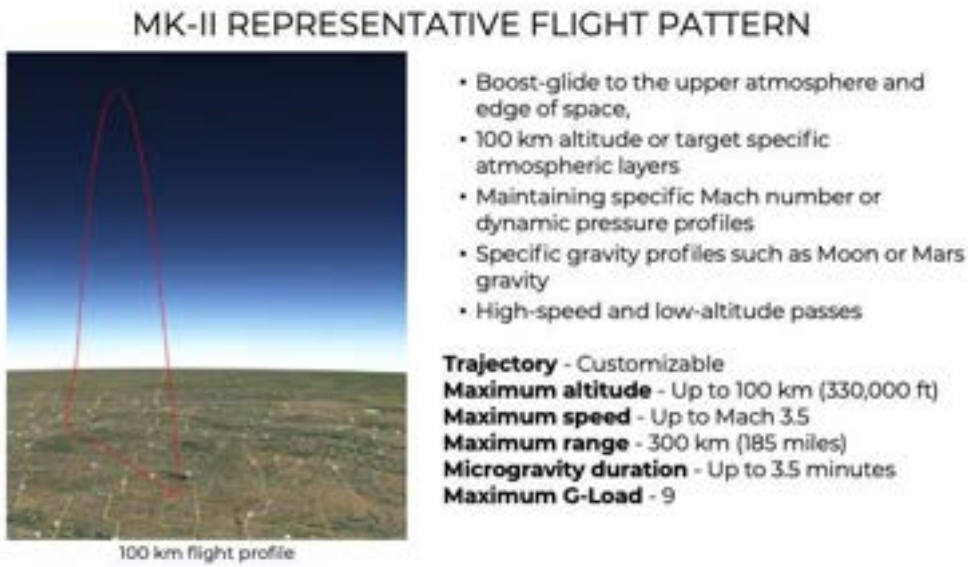


COMMERCIAL SUBORBITAL VEHICLES IN 2025

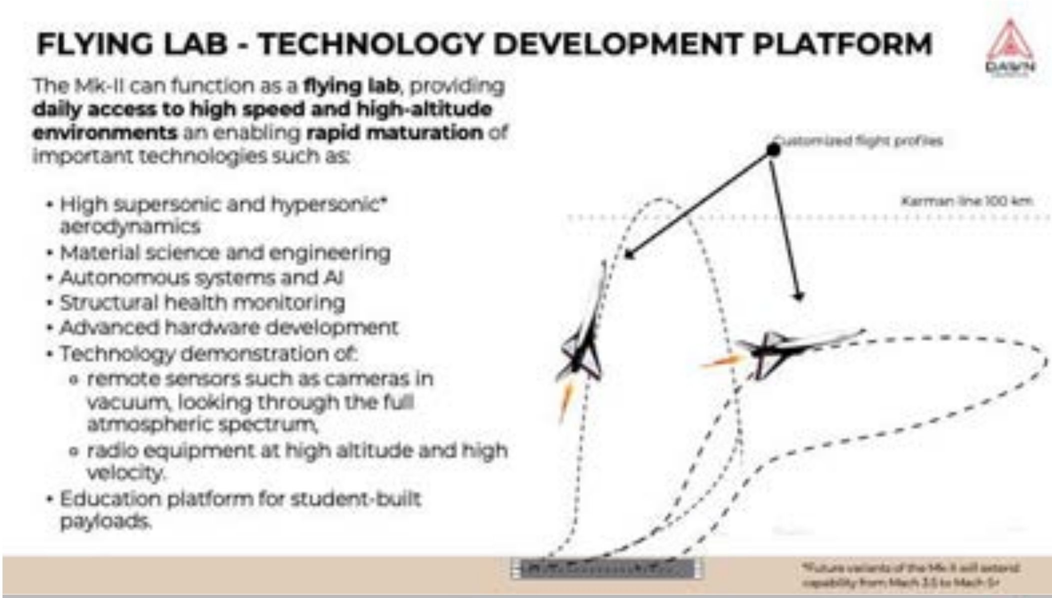
Vehicle	Number of Flights	Max Altitude	Period of Activity
Virgin Galactic SpaceShip One	17	112 km	2003 - 2004
Virgin Galactic VSS Unity / Galactic #	12 (above 50 km)	89 km	2018 - 2024
Blue Origin New Shepard	29 + 1 planned	118 km	2012 - present
Dawn Aerospace Mk-IIA Aurora	58 + 4 planned	82,500 ft (25 km)	2021 - present

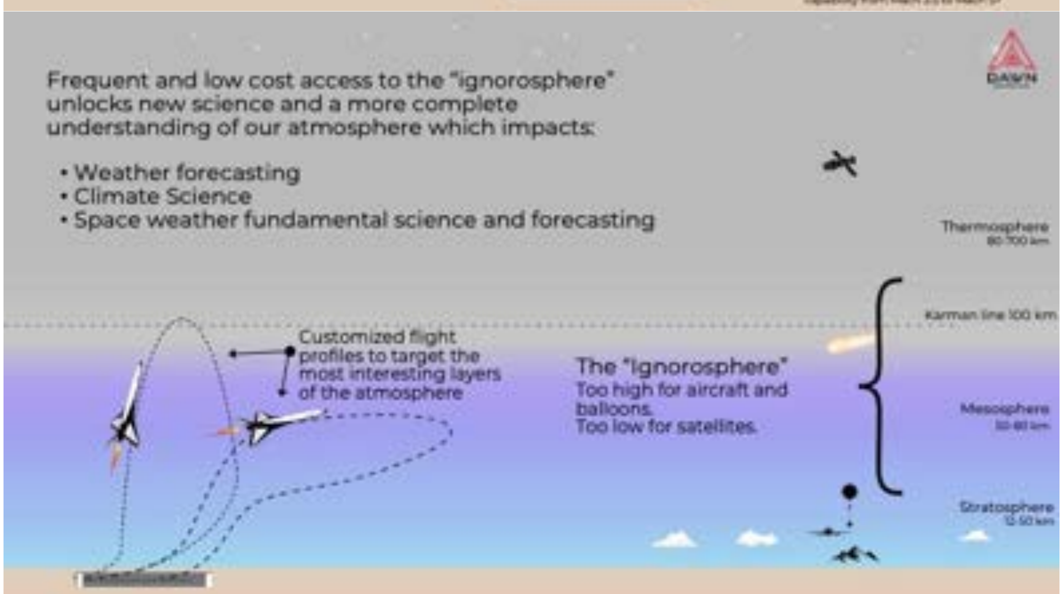

DAWN AEROSPACE IN NUMBERS
110
Headcount
Established 2017
4
Locations - NZ, NL, FR & USA
Christchurch, NZ headquarters
Infrastructure required for USA operations
115
Thrusters in space
25 different spacecraft
2 thrust classes
17
Rideshare launches
On Falcon 9, IM, Vega, and Soyuz-2
58
Mk-II Flights
Same vehicle in Operational Environment (TRL 8)
47 jet power. 10 rocket power
25+
Customers
North America, Europe, Asia, & Oceania


THE MK-II AURORA
A SUPERSONIC UNCREWED SUBORBITAL AIRCRAFT
Core Features
• Rocket-powered suborbital aircraft
• Highly reusable - within 3 hours
• Mission-dedicated payload bay
• Fully self-contained and responsive operations
• Remotely-piloted
Size
• 4.8m long x 2.4 m wing tip to wing tip
• 400kg MTOW
Performance
• up to 100+ km
• Up to Mach 3.5
• 2900 m/s deltaV
Runway
• Rapidly deployable to/from any 1000m runway
• Horizontal takeoff and landing


MK-II REPRESENTATIVE FLIGHT PATTERN
• Boost-glide to the upper atmosphere and edge of space,
• 100 km altitude or target specific atmospheric layers
• Maintaining specific Mach number or dynamic pressure profiles
• Specific gravity profiles such as Moon or Mars gravity
• High-speed and low-altitude passes
Trajectory - Customizable
Maximum altitude - Up to 100 km (330,000 ft)
Maximum speed - Up to Mach 3.5
Maximum range - 300 km (185 miles)
Microgravity duration - Up to 3.5 minutes
Maximum G-Load - 9
100 km flight profile


MK-II OPERATIONS SCENARIOS
Flight Operations
• Rapid space access
• High flight cadence in fast timeframe
• Operational altitudes: 20 to 100+ km
• Maneuverable
• Downrange capability
Payload Operations
• Payload dedicated flights
• Instrument external access
• Optical window in payload bay
• Payload deployment possible (Mk-IIB)
• No human-tended experiments

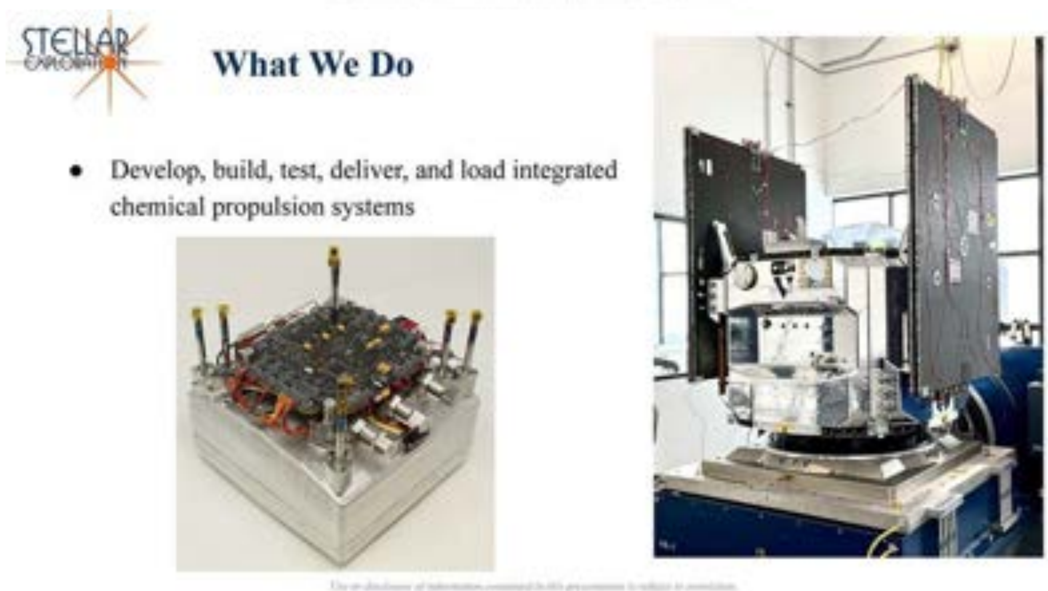

FLYING LAB - TECHNOLOGY DEVELOPMENT PLATFORM
DAWN
The Mk-II can function as a **flying lab**, providing **daily access to high speed and high-altitude environments** an enabling **rapid maturation** of important technologies such as:
• High supersonic and hypersonic* aerodynamics
• Material science and engineering
• Autonomous systems and AI
• Structural health monitoring
• Advanced hardware development
• Technology demonstration of:
◦ remote sensors such as cameras in vacuum, looking through the full atmospheric spectrum,
◦ radio equipment at high altitude and high velocity.
• Education platform for student-built payloads.
Customized flight profiles
Karman line 100 km
*Future variants of the Mk-II will extend capability from Mach 3.5 to Mach 5+


DAWN
Frequent and low cost access to the "ignorosphere" unlocks new science and a more complete understanding of our atmosphere which impacts:
• Weather forecasting
• Climate Science
• Space weather fundamental science and forecasting
Thermosphere
80-700 km
Karman line 100 km
Customized flight profiles to target the most interesting layers of the atmosphere
The "Ignorosphere"
Too high for aircraft and balloons.
Too low for satellites.
Mesosphere
50-80 km
Stratosphere
12-50 km


SUBORBITAL RESEARCH AND TECHNOLOGY DEVELOPMENT
Existing Rocket-Powered Suborbital Vehicles and Sounding Rocket Payload Opportunities
Dawn Mk-II Aurora
New Shepard
SpaceShipTwo
Sounding Rockets
Stratospheric Balloons
Price per flight: $100,000 / flight | $ >750K | $ >750K | $ 1 - 5M | $50k - $2M per flight
Max altitude: 100+ km | ~105 km | ~85 km | 1,500 km | 40km
Avg flight duration: 40 minutes | 11 minutes | 2.5 hours | 20 minutes | days/weeks
Trajectory: fully customizable | vertical | parabolic | parabolic | limited control
Max payload mass: 30 kg (trade) | ~420 kg | 450+ kg | 450 kg | 3,600 kg
Microgravity time: ~3 minutes | ~3 minutes | >2 minutes | 5 - 15 minutes | N/A
Avg wait time to flight: <1 month | >6 months | >5 years | > 2 years | > 1 year
Seeking collaborators with payloads to conduct research, technology development, and STEM education flights on Mk-II
Mission Opportunities
• Earth observation
• Low/microgravity experiments
• In-situ atmospheric measurements
• Technology development
• National security
• Customized aerodynamic profile flights
• STEM education
• Disaster response and recovery
Come fly with us!
DAWN


DAWN
AEROSPACE
Khaki Rodway
Spaceplane Sales & Operations
khaki@dawnaerospace.com
THANK YOU

C4 - Stellar Exploration: Rocket Testing Operations – Meisberger



Where We Began

- Began testing in 2017
- Mobile test infrastructure
  - Pack it in, pack it out

Where We Are Now

- High-cadence ambient testing capabilities
- 14 Certified SCAPE Handlers
- Passive and active propellant monitoring
- Shipping containers contain house critical permanent infrastructure

Monopropellant Test Capabilities

- Thrust
  - 0.25N-5N
- Capable of testing 24x thrusters per day

Bipropellant Test Capabilities

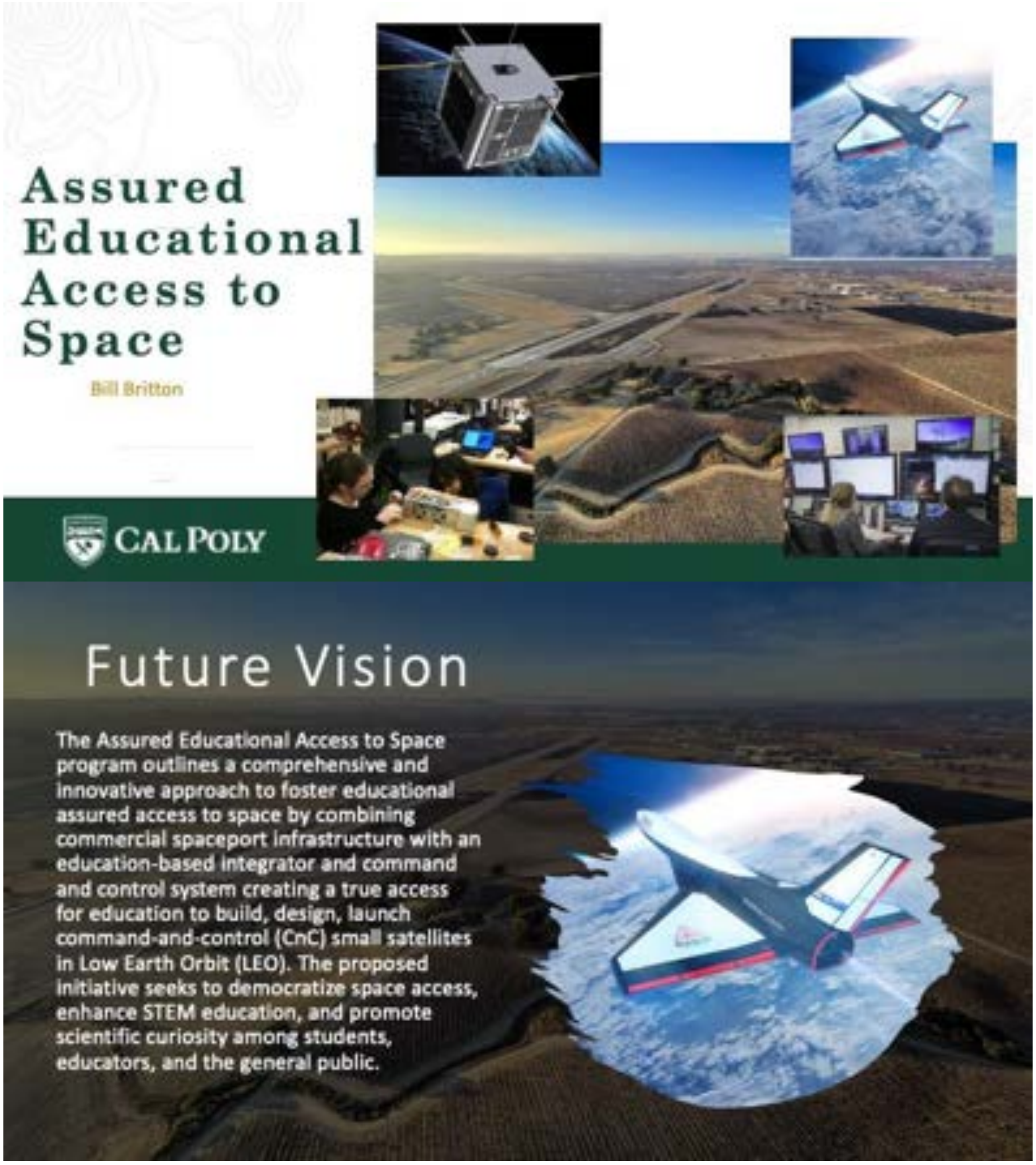
- Thrust
  - 5N (440N in development)
- Capable of testing 8x thrusters per day

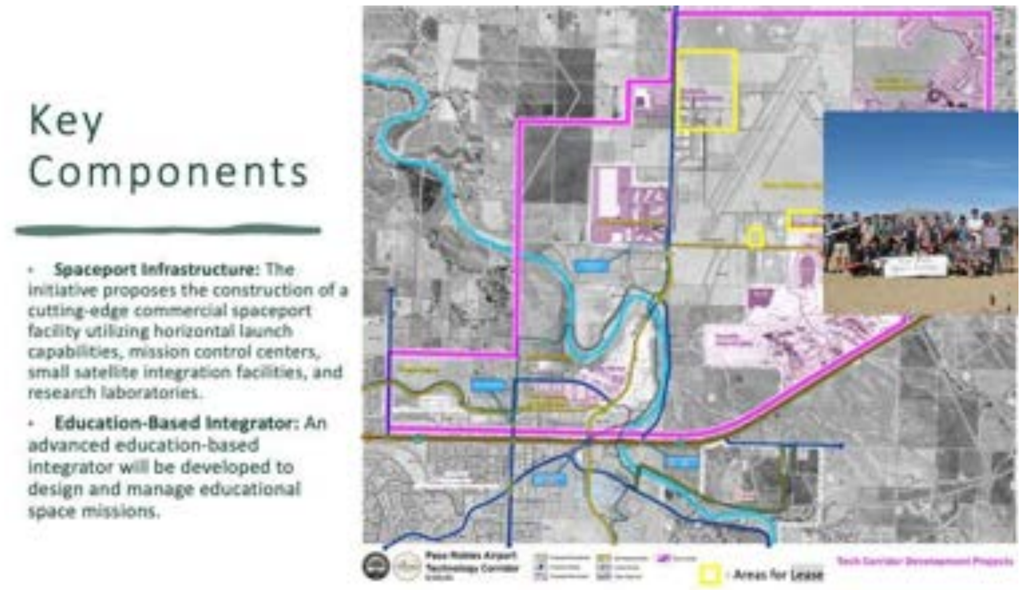
Additional Test Capabilities

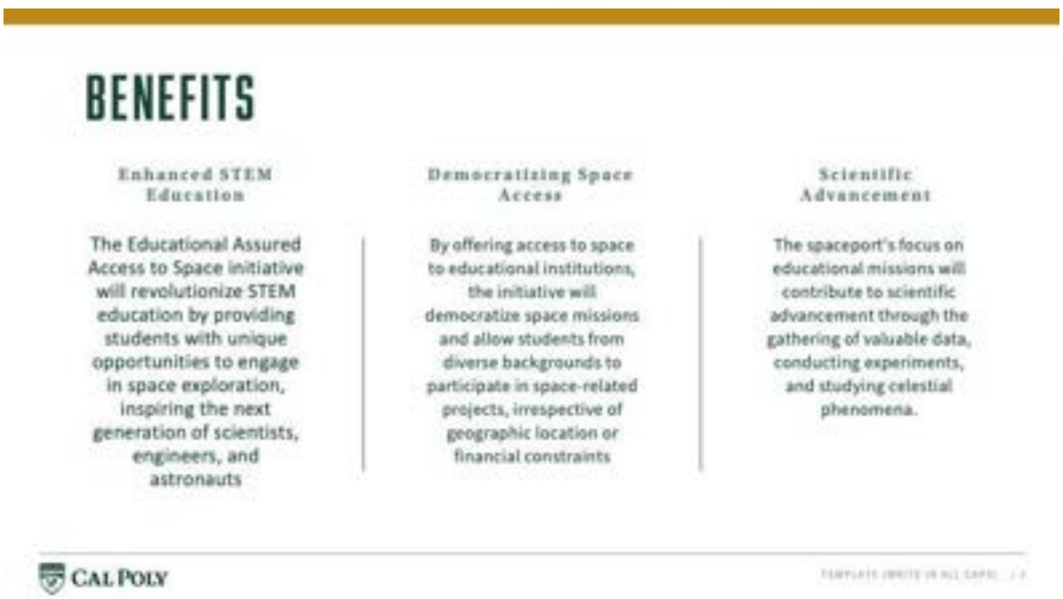
- End to End Qualification Unit Hotfire
- Hydrazine Water Hammer Testing for SLS EUS
- Prototype Monopropellant Catalyst for JPL
- Disassembly of Hypergolic Loading
- SCAPE Handler Training and Certification

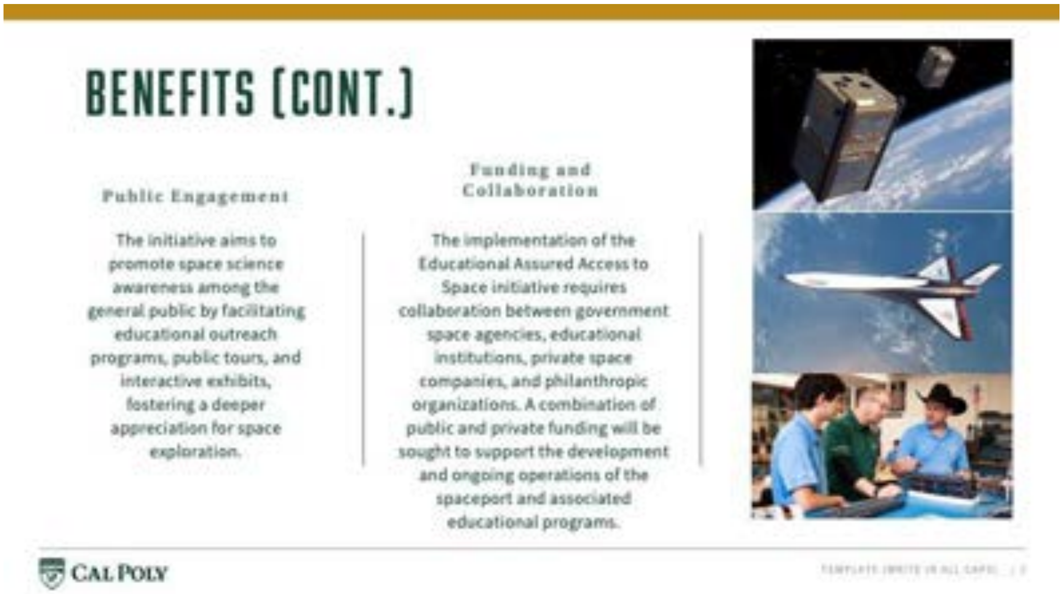
Questions?

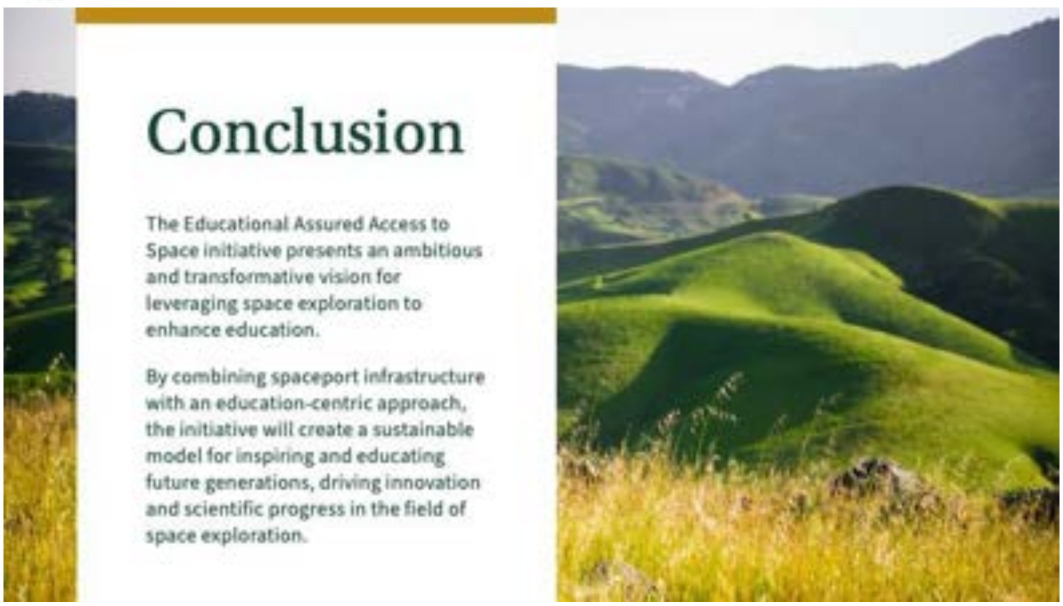
C5 - Paso Robles Spaceport Vision, Educational Programs, & Opportunities – Britton, Sloan, & Colvin

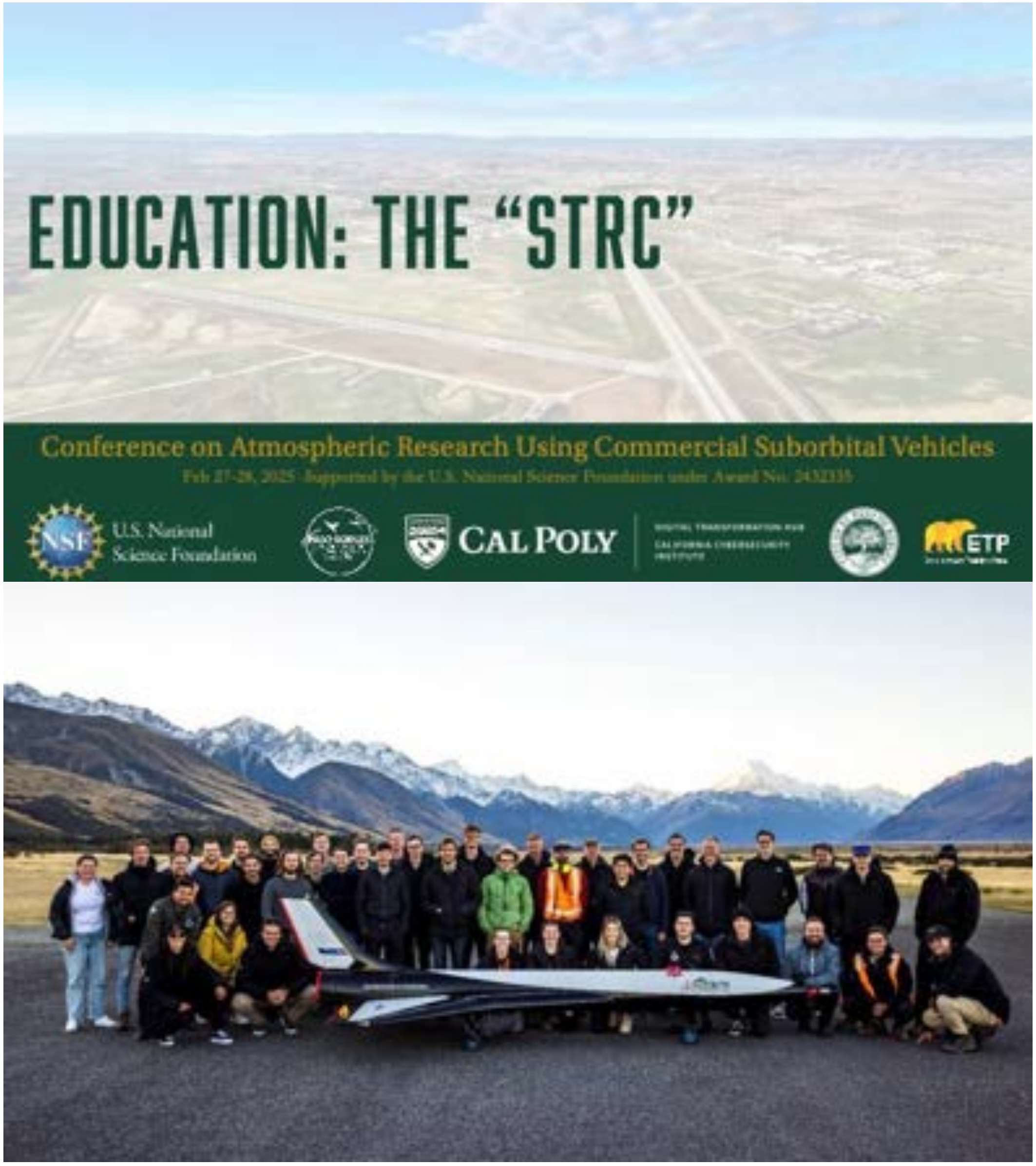



Key Components
Spaceport Infrastructure: The initiative proposes the construction of a cutting-edge commercial spaceport facility utilizing horizontal launch capabilities, mission control centers, small satellite integration facilities, and research laboratories.
Education-Based Integrator: An advanced education-based integrator will be developed to design and manage educational space missions.
Paso Robles Airport Technology Corridor
Areas for Lease
Tech Corridor Development Projects


BENEFITS
Enhanced STEM Education
The Educational Assured Access to Space initiative will revolutionize STEM education by providing students with unique opportunities to engage in space exploration, inspiring the next generation of scientists, engineers, and astronauts
Democratizing Space Access
By offering access to space to educational institutions, the initiative will democratize space missions and allow students from diverse backgrounds to participate in space-related projects, irrespective of geographic location or financial constraints
Scientific Advancement
The spaceport's focus on educational missions will contribute to scientific advancement through the gathering of valuable data, conducting experiments, and studying celestial phenomena.
CAL POLY


BENEFITS (CONT.)
Public Engagement
The initiative aims to promote space science awareness among the general public by facilitating educational outreach programs, public tours, and interactive exhibits, fostering a deeper appreciation for space exploration.
Funding and Collaboration
The implementation of the Educational Assured Access to Space initiative requires collaboration between government space agencies, educational institutions, private space companies, and philanthropic organizations. A combination of public and private funding will be sought to support the development and ongoing operations of the spaceport and associated educational programs.
CAL POLY


Conclusion
The Educational Assured Access to Space initiative presents an ambitious and transformative vision for leveraging space exploration to enhance education.
By combining spaceport infrastructure with an education-centric approach, the initiative will create a sustainable model for inspiring and educating future generations, driving innovation and scientific progress in the field of space exploration.

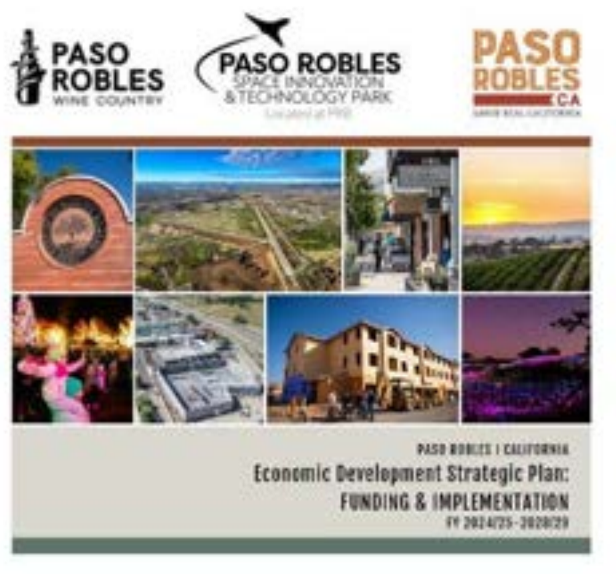

EDUCATION: THE "STRC"
Conference on Atmospheric Research Using Commercial Suborbital Vehicles
Feb 27-28, 2025 -Supported by the U.S. National Science Foundation under Award No. 2432335
NSF
U.S. National
Science Foundation
CAL POLY
ETP

Spaceport Training and Research Center

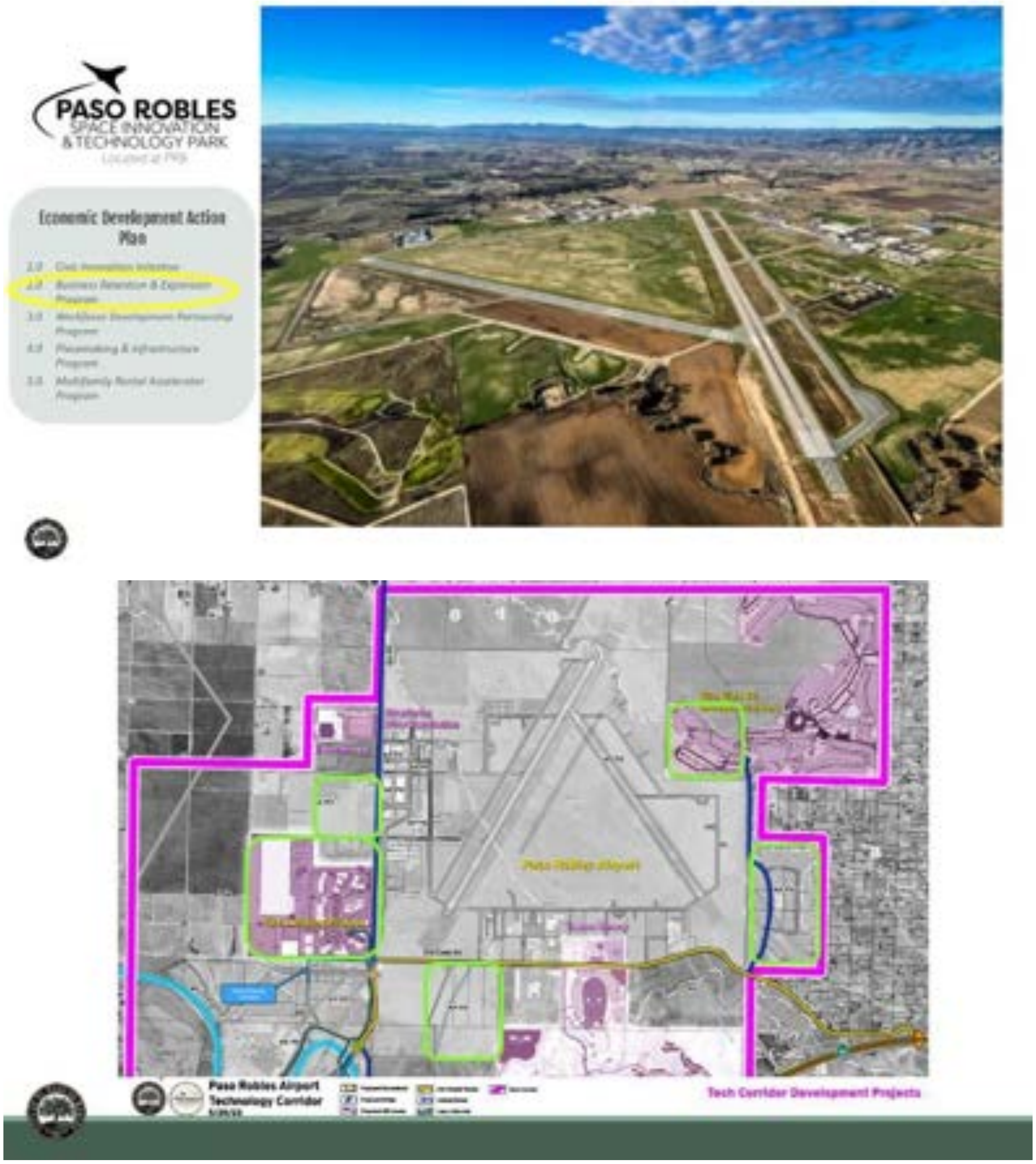
PASO ROBLES SPACE INNOVATION & TECHNOLOGY PARK


Spaceport Training and Research Center
University Students
University Research
Vocational Training
K-12 STEM Education
Professional Development
What's Next?
• Initial Curriculum Development
• Start an Astronaut Scholars Program
• Align with the GSA Educational Efforts
• Collaborate with The International Space University
• Develop The Engine Test Facility
• Identify Collaborators
• Seek Seed Funding for the STRC


CITY OF EL PASO DE ROBLES
Economic Development
February 27, 2025


PASO ROBLES WINE COUNTRY
PASO ROBLES SPACE INNOVATION & TECHNOLOGY PARK
PASO ROBLES CA
PASO ROBLES | CALIFORNIA
Economic Development Strategic Plan:
FUNDING & IMPLEMENTATION
FY 2024/25-2028/29


Economic Development Action Plan
Key Initiatives & Implementation Partners
City of Paso Robles Economic Development Partners
REACH
CAL POLY
WORKFORCE
SBDC
SLO PARTNERS
eckerd connects
Action Plan*
1.0 Civic Innovation Initiative
2.0 Business Retention & Expansion Program
3.0 Workforce Development Partnership Program
4.0 Placemaking & Infrastructure Program
5.0 Multifamily Rental Accelerator Program
*75+ Specific Action Items in the Action Plan


PASO ROBLES
SPACE INNOVATION
& TECHNOLOGY PARK
Economic Development Action Plan
Paso Robles Airport
Technology Corridor
Tech Corridor Development Projects

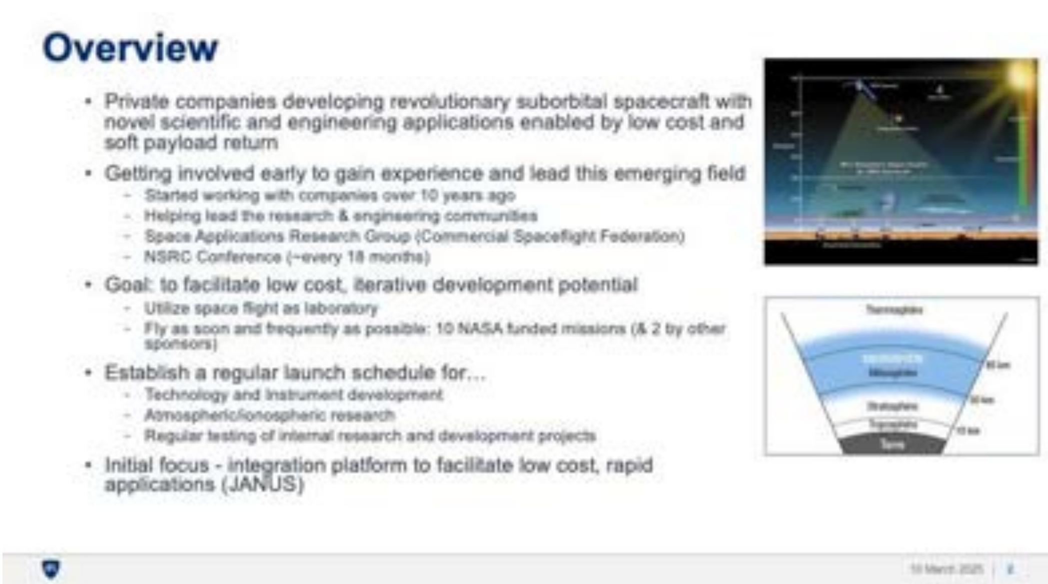

PASO ROBLES
SPACE INNOVATION
& TECHNOLOGY PARK


STELLAR
EXPLORATION
SPACENEWS
Stellar Exploration propels EchoStar nanosatellite to valuable slot

Economic Development Strategic Plan

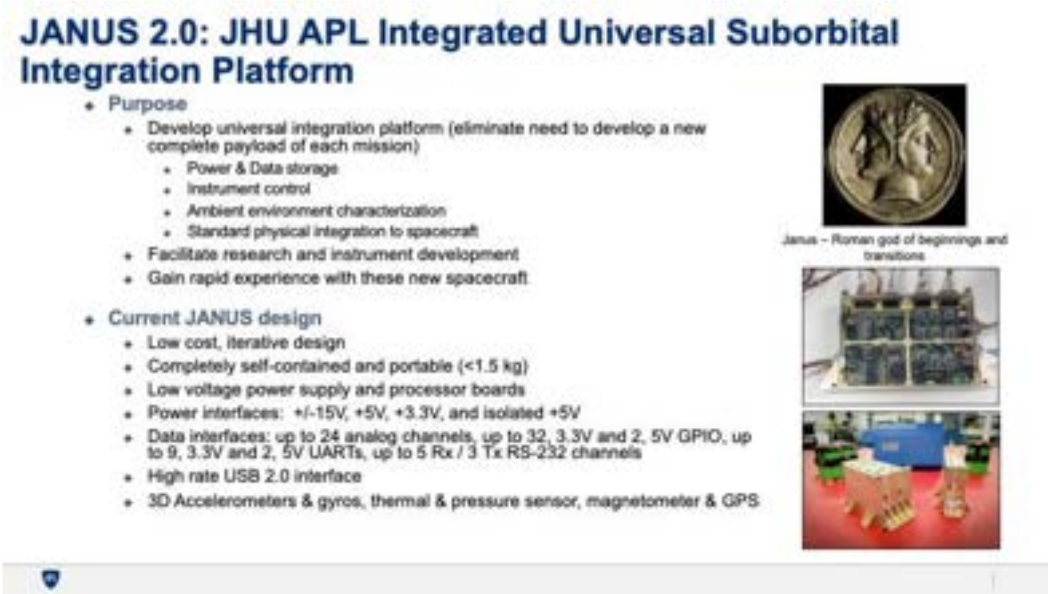
"EDSP"

C6 - MLT Research Case Study – Smith



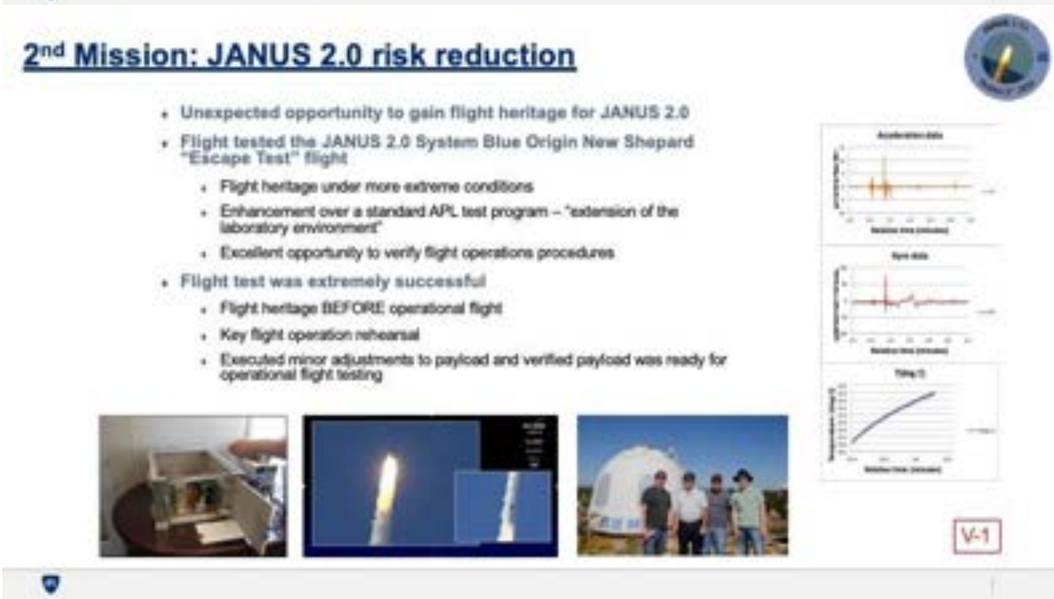

Commercial Suborbital Spacecraft…in general
Revolutionary suborbital spacecraft – key attributes for APL purposes
1-2 orders of magnitude cheaper than current costs
Manned & unmanned, relatively large payload capacity
Fully reusable with rapid turn around
Access to ~100 km
Guaranteed safe return of payload
Up to 3 minutes of micro-gravity
Large potential for applications beyond space tourism
Direct research of the suborbital region
Technology development and flight testing
Low cost, frequent flight tests -> cost and schedule reductions

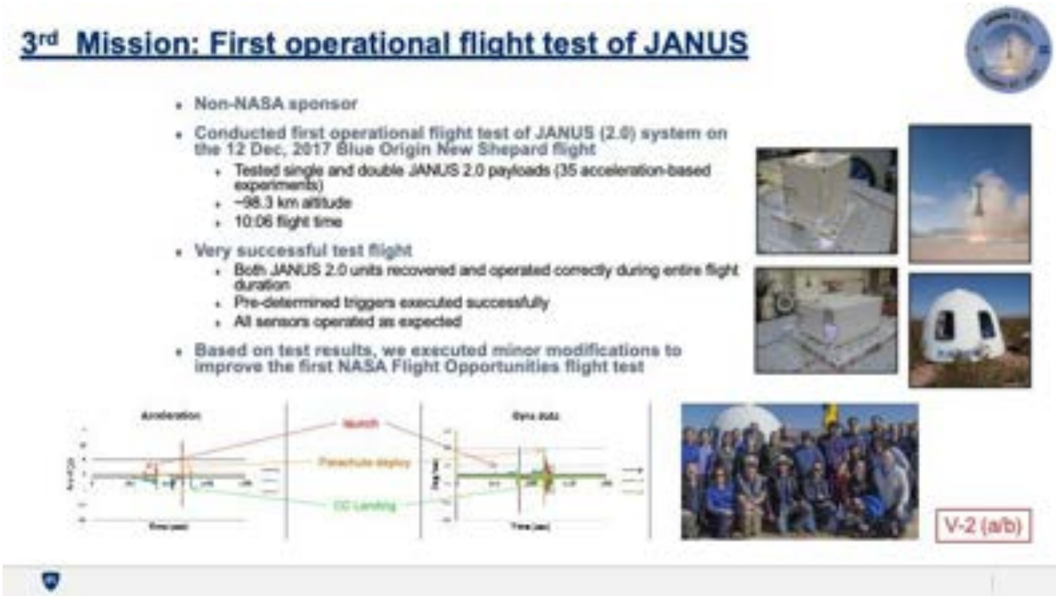

Most APL flights have been on Blue Origin and Virgin Galactic – very different designs
Blue Origin New Shepard
A Jeff Bezos company – launches out of West Texas
Crew Capsule (carries up to 6 people) – lands via parachute & retro rocket
Propulsion Module lands autonomously under power on landing pad
Virgin Galactic Spaceship 2 (VSS Unity)
Started by Richard Branson – Launches out of Spaceport America, NM
White Knight 2 aircraft carries spaceship up to ~50,000 ft
Spaceship 2 (6 passengers + 2 pilots) lands on a runway

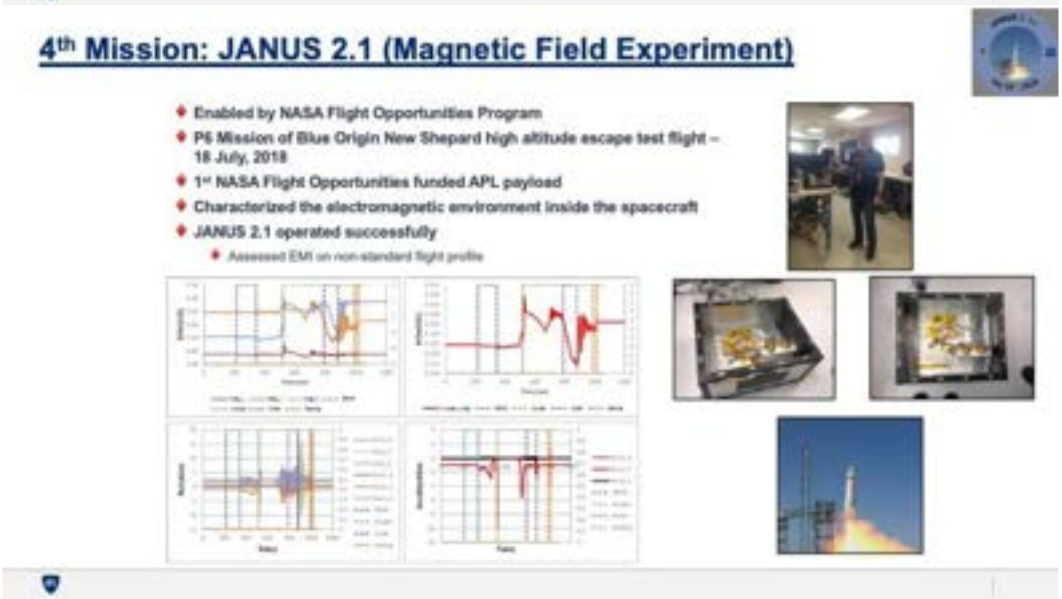

JANUS 2.0: JHU APL Integrated Universal Suborbital Integration Platform
Purpose
Develop universal integration platform (eliminate need to develop a new complete payload of each mission)
Power & Data storage
Instrument control
Ambient environment characterization
Standard physical integration to spacecraft
Facilitate research and instrument development
Gain rapid experience with these new spacecraft
Current JANUS design
Low cost, iterative design
Completely self-contained and portable (<1.5 kg)
Low voltage power supply and processor boards
Power interfaces: +/-15V, +5V, +3.3V, and isolated +5V
Data interfaces: up to 24 analog channels, up to 32, 3.3V and 2, 5V GPIO, up to 9, 3.3V and 2, 5V UARTs, up to 5 Rx / 3 Tx RS-232 channels
High rate USB 2.0 interface
3D Accelerometers & gyros, thermal & pressure sensor, magnetometer & GPS
Janus – Roman god of beginnings and transitions

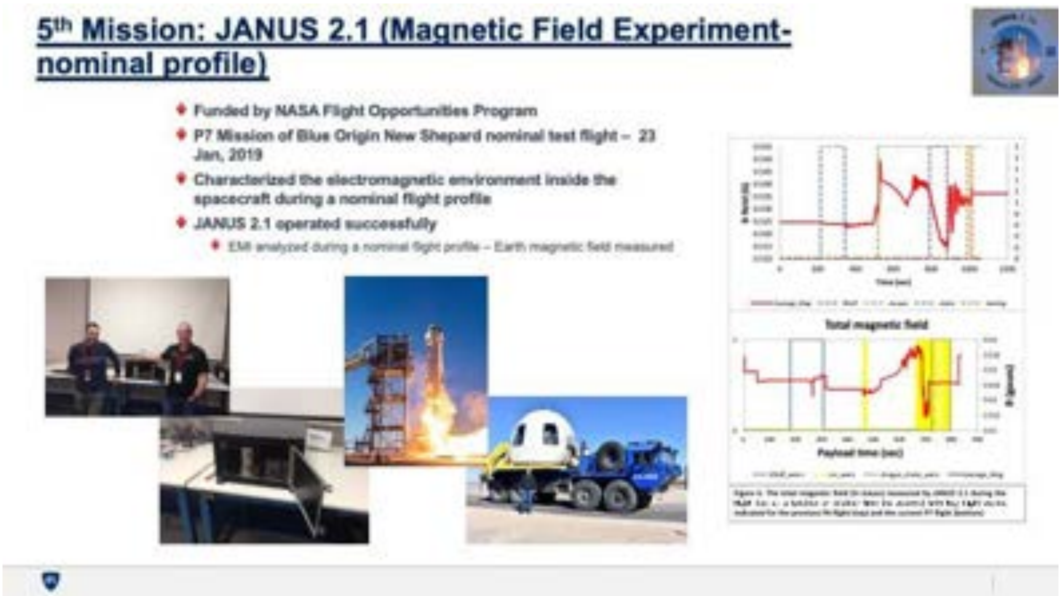

Eight successfully completed flight tests so far
2 Nov, 2016 – Masten Space Systems Xombie launch vehicle
Low altitude NASA reduction flight for first JANUS flight
5 Oct, 2016 – Blue Origin New Shepard Spacecraft
Low altitude 'escape test' preflight for AOS Sponsor mission
12 Dec, 2017 - Blue Origin New Shepard Spacecraft
Operational flight for AOS Sponsor mission (35 experiments)
18 Jul, 2018 - Blue Origin New Shepard Spacecraft
1st NASA funded experiment (high altitude escape test) – Env. char
23 Jan, 2019 - Blue Origin New Shepard Spacecraft
2nd NASA funded experiment (nominal altitude test) – Env. char
22 Feb, 2019 – Virgin Galactic Spaceship 2
3rd NASA funded experiment – Env. char
13 Oct, 2020 – Blue Origin New Shepard Spacecraft
4th NASA funded experiment – JANUS 2.1 (magnetometer & GPS/IMU)
22 May, 2021 – Virgin Galactic Spaceship 2
5th NASA funded experiment – JANUS 2.1 (magnetometer & GPS/IMU)

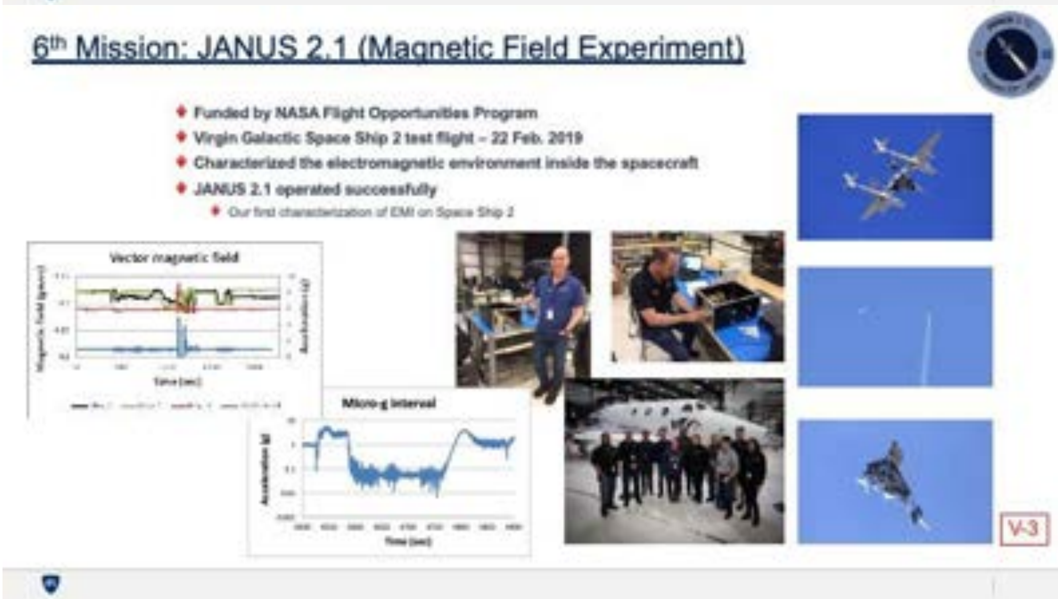

1st Mission: Flight Opportunities Risk reduction flight
While awaiting our first operational flight, NASA Flight Opportunities conducted a low altitude Risk Reduction flight on Nov 2nd, 2016
Masten Space Systems Xodiac launch vehicle
~0.5 km altitude, ~1:17 flight duration
Provided critical initial flight assessment of the JANUS 1.0 prototype system
Validated the pressure and thermal detections systems, however, identified the need for accelerometer and magnetometer upgrades
Facilitated improved design (JANUS 2.0)
More compact and durable
Improved operational mission probability of success: model for future approach to low cost access to space

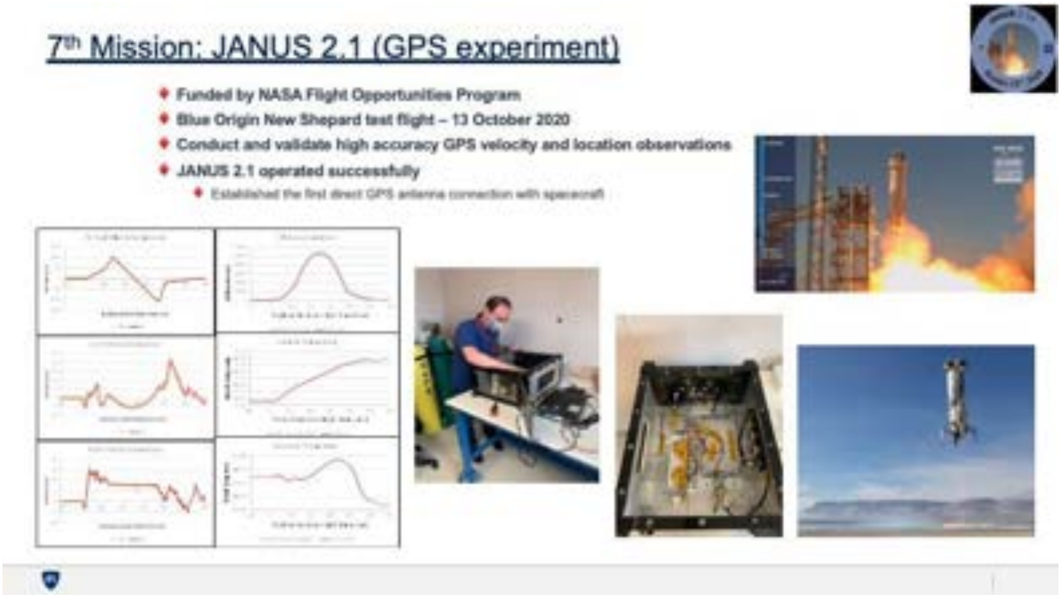

2nd Mission: JANUS 2.0 risk reduction
Unexpected opportunity to gain flight heritage for JANUS 2.0
Flight tested the JANUS 2.0 System Blue Origin New Shepard "Escape Test" flight
Flight heritage under more extreme conditions
Enhancement over a standard APL test program – "extension of the laboratory environment"
Excellent opportunity to verify flight operations procedures
Flight test was extremely successful
Flight heritage BEFORE operational flight
Key flight operation rehearsal
Executed minor adjustments to payload and verified payload was ready for operational flight testing
Acceleration data
Gyro data
V-1

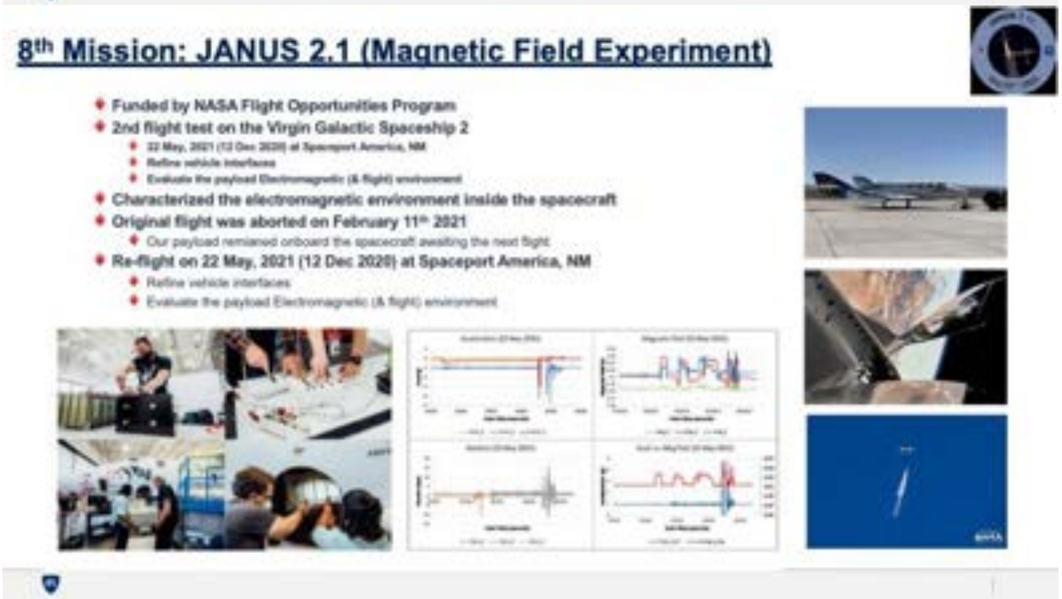

3rd Mission: First operational flight test of JANUS
Non-NASA sponsor
Conducted first operational flight test of JANUS (2.0) system on the 12 Dec, 2017 Blue Origin New Shepard flight
Tested single and double JANUS 2.0 payloads (35 acceleration-based experiments)
~98.3 km altitude
10:06 flight time
Very successful test flight
Both JANUS 2.0 units recovered and operated correctly during entire flight duration
Pre-determined triggers executed successfully
All sensors operated as expected
Based on test results, we executed minor modifications to improve the first NASA Flight Opportunities flight test
Acceleration
Launch
Parachute deploy
CC Landing
Time (sec)
V-2 (a/b)

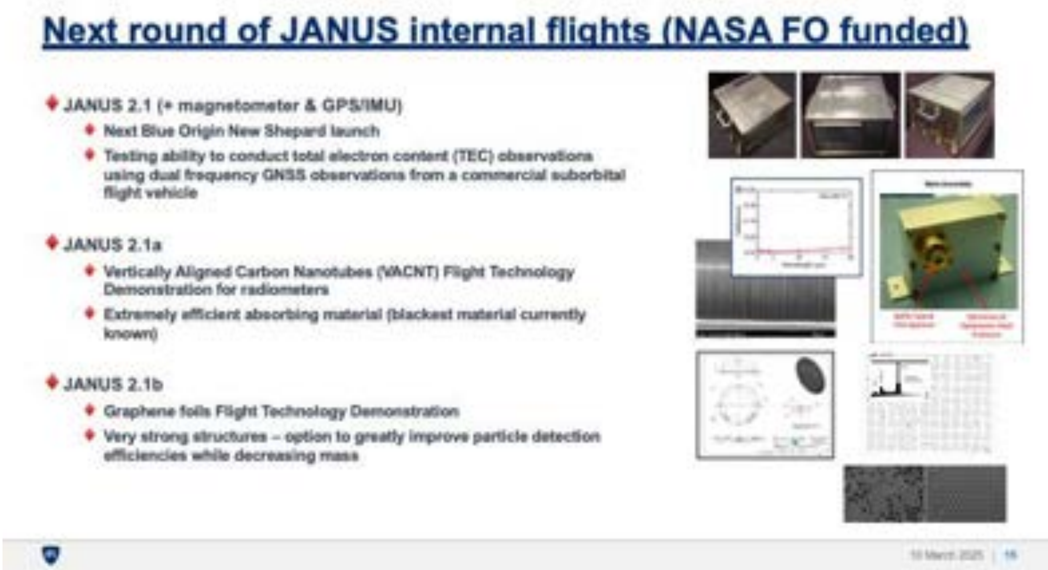

4th Mission: JANUS 2.1 (Magnetic Field Experiment)
Enabled by NASA Flight Opportunities Program
P6 Mission of Blue Origin New Shepard high altitude escape test flight – 18 July, 2018
1st NASA Flight Opportunities funded APL payload
Characterized the electromagnetic environment inside the spacecraft
JANUS 2.1 operated successfully
Assessed EMI on non-standard flight profile


5th Mission: JANUS 2.1 (Magnetic Field Experiment-nominal profile)
Funded by NASA Flight Opportunities Program
P7 Mission of Blue Origin New Shepard nominal test flight – 23 Jan, 2019
Characterized the electromagnetic environment inside the spacecraft during a nominal flight profile
JANUS 2.1 operated successfully
EMI analyzed during a nominal flight profile – Earth magnetic field measured
Total magnetic field
Payload time (sec)


6th Mission: JANUS 2.1 (Magnetic Field Experiment)
Funded by NASA Flight Opportunities Program
Virgin Galactic Space Ship 2 test flight – 22 Feb. 2019
Characterized the electromagnetic environment inside the spacecraft
JANUS 2.1 operated successfully
Our first characterization of EMI on Space Ship 2
Vector magnetic field
Micro-g interval
Acceleration (g)
Time (sec)
V-3


7th Mission: JANUS 2.1 (GPS experiment)
Funded by NASA Flight Opportunities Program
Blue Origin New Shepard test flight – 13 October 2020
Conduct and validate high accuracy GPS velocity and location observations
JANUS 2.1 operated successfully
Established the first direct GPS antenna connection with spacecraft


8th Mission: JANUS 2.1 (Magnetic Field Experiment)
Funded by NASA Flight Opportunities Program
2nd flight test on the Virgin Galactic Spaceship 2
22 May, 2021 (12 Dec 2020) at Spaceport America, NM
Refine vehicle interfaces
Evaluate the payload Electromagnetic (& flight) environment
Characterized the electromagnetic environment inside the spacecraft
Original flight was aborted on February 11th 2021
Our payload remianed onboard the spacecraft awaiting the next flight
Re-flight on 22 May, 2021 (12 Dec 2020) at Spaceport America, NM
Refine vehicle interfaces
Evaluate the payload Electromagnetic (& flight) environment

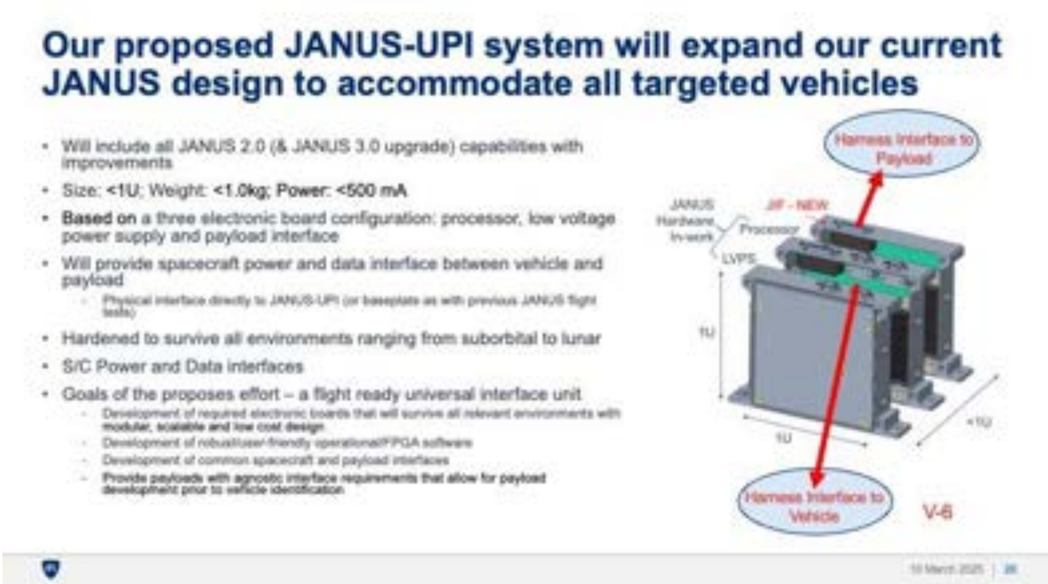

Next round of JANUS internal flights (NASA FO funded)
JANUS 2.1 (+ magnetometer & GPS/IMU)
Next Blue Origin New Shepard launch
Testing ability to conduct total electron content (TEC) observations using dual frequency GNSS observations from a commercial suborbital flight vehicle
JANUS 2.1a
Vertically Aligned Carbon Nanotubes (VACNT) Flight Technology Demonstration for radiometers
Extremely efficient absorbing material (blackest material currently known)
JANUS 2.1b
Graphene foils Flight Technology Demonstration
Very strong structures – option to greatly improve particle detection efficiencies while decreasing mass


APL will soon fly externally (NASA FO funded also)
JANUS 3.0
1st external environment access (Blue Origin New Shepard launch)
Will enable much more expanded research and technology demonstration
Location on top of the Propulsion Module
JANUS 3.0a
Applying Europa Clipper technology
Plasma Instrument for Magnetic Sounding (PIMS)
Charged particle detection at suborbital altitudes on commercial suborbital flights (finally!)
Will focus on negative ion observations on this flight (tied to observations of Saturn's moon Titan)
JANUS 3.0b
Collaboration with Cornell University
ChipSat dispersion and recovery
Very small satellites – 2-4 gm
Enabling technology for novel applications
1st deployable attempt
V-4

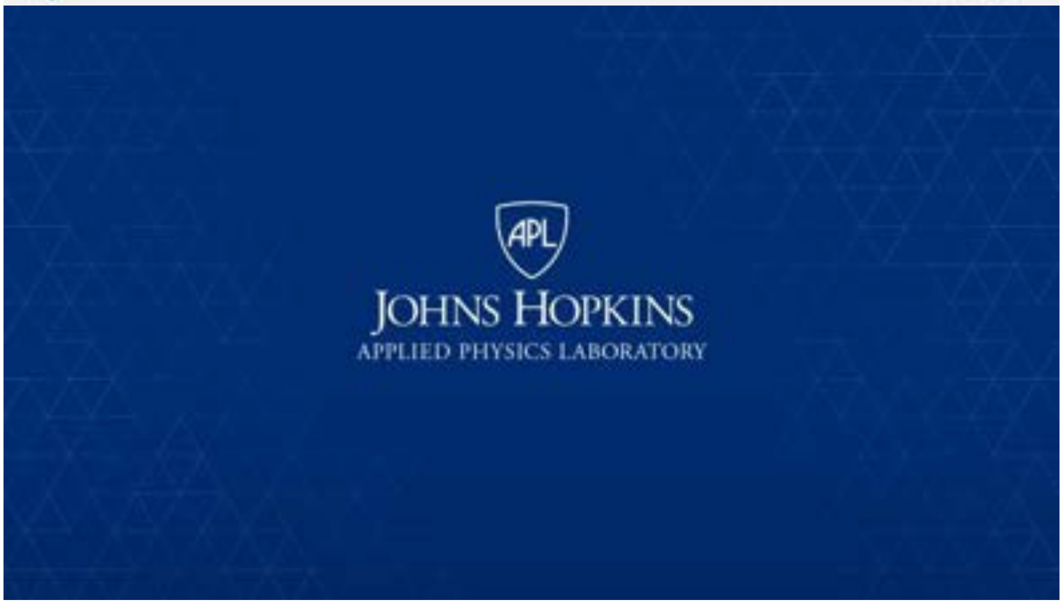

9th Mission ☹
First external APL test!
Just before max Q, propulsion module experienced an anomaly
Crew Capsule did just was it was supposed to do – shut down the PM and ignited escape motor
CC landed safely with payloads (all would have survived)
Unfortunately, PM (and JANUS 2.0) was lost
Currently building new, improved JANUS and hope to conduct re-flight later this year
T+ 00
V-5 (-6:40)


Something good still happened on our 9th mission
APL/Blue Origin team mentoring an elementary school project to conduct a scientific experiment on the Blue Origin New Shepard rocket
Funded by the AGU Celebrate100 Grant program
Engaging the entire PS 185 (Brooklyn, NY) Elementary School
Intended to provide unique and exciting education opportunity that will hopefully inspire many students to pursue STEM career fields
Focus on scientific method and engineering design process
Students were very excited/motivated (V-7)
Students ideas were very interesting
Selected experiment - "Mass on a spring with fine grain particles"
Students will predict and observe how the length of a spring will change (& how the small particles move) under differing gravitational environments
Originally flew on our 9th mission
Payload survived escape motor firing
Re-flew (successfully in Dec, 2023) (V-8)
Mass on a spring
Camera
Small Particles

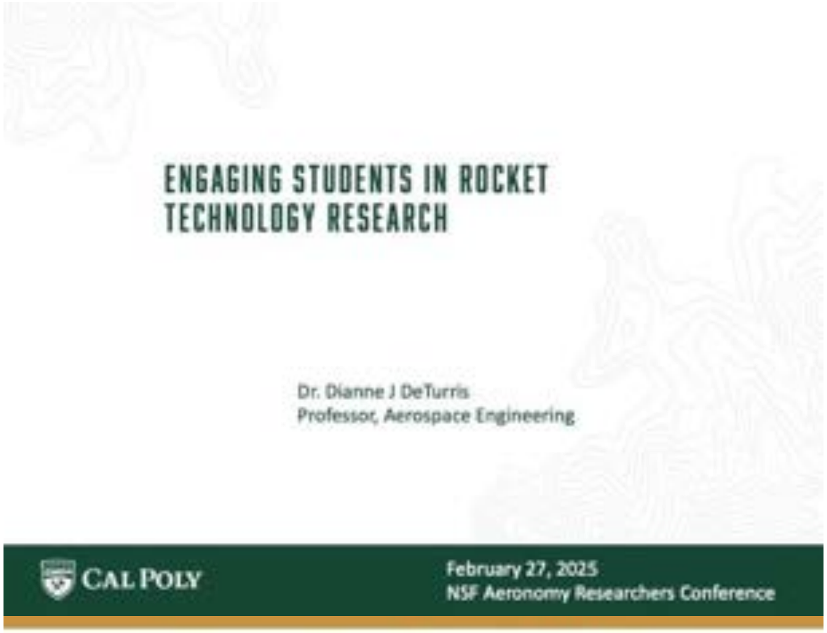

JOHNS HOPKINS
APPLIED PHYSICS LABORATORY
JANUS-UPI:
Next Step for Commercial Suborbital and Beyond
Proposed interface system to accommodate ALL NASA Flight Opportunities supported commercial vehicles and hosted payloads(+ CubeSats, lunar & other SMD missions)
JANUS-UPI is an evolution of existing JANUS design used on Blue Origin and Virgin Galactic payload flights
JANUS-UPI all providing all Minimum (and Example Additional) Interface Capabilities including:
Electrical/physical interface
Distribute, switch, convert and regulate power with grounding
Modular, flexible, low-cost and rapid payload accommodation
Pass commands, acknowledgements, vehicle telemetry & onboard data storage (possible communication system)
Allow easy interface access to payload
Support early payload development before vehicle is identified
Parabolic
High Altitude Balloons
Hosted Payloads
Small-sat
Moon – surface or orbit
Beyond?
Leveraging existing interface experience
To develop a truly universal payload interface system

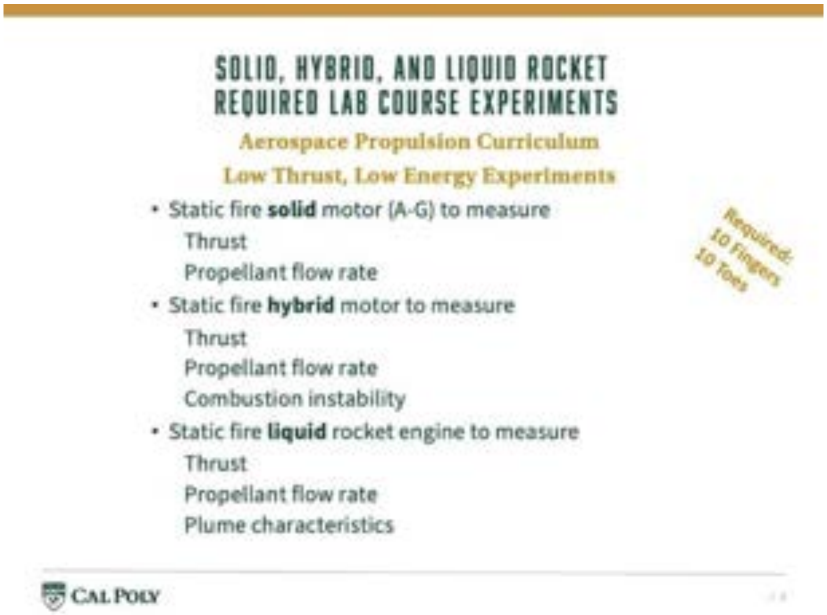

Our proposed JANUS-UPI system will expand our current JANUS design to accommodate all targeted vehicles
Will include all JANUS 2.0 (& JANUS 3.0 upgrade) capabilities with improvements
Size: <1U; Weight: <1.0kg; Power: <500 mA
Based on a three electronic board configuration: processor, low voltage power supply and payload interface
Will provide spacecraft power and data interface between vehicle and payload
Physical interface directly to JANUS-UPI (or baseplate as with previous JANUS flight tests)
Hardened to survive all environments ranging from suborbital to lunar
S/C Power and Data interfaces
Goals of the proposes effort – a flight ready universal interface unit
Development of required electronic boards that will survive all relevant environments with modular, scalable and low cost design
Development of robust/user-friendly operational/FPGA software
Development of common spacecraft and payload interfaces
Provide payloads with agnostic interface requirements that allow for payload development prior to vehicle identification
Harness Interface to Payload
JANUS Hardware In-work
JIF - NEW
Processor
LVPS
1U
<1U
Harness Interface to Vehicle
V-6


Summary, next steps and future strategy
• Current APL program has been successful
– Positioned to utilize vehicles as they become available
– Creating effective relationships with commercial providers
– Program expanding (2 PIs and 10 funded missions) – more APL PI's starting to propose
• JANUS interface system
– Provides standardized physical & electrical interface
– Processor/FPGA, data storage, LVPS, environmental monitoring (comms?)
– Eliminates need to develop entire payload (cost/schedule reduction)
– Low cost IRAD flight testing
• Leveraging current successes to expand current commercial vehicle applications
– All commercial suborbital platforms/vehicles
– Orbital and lunar/cislunar


APL
JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

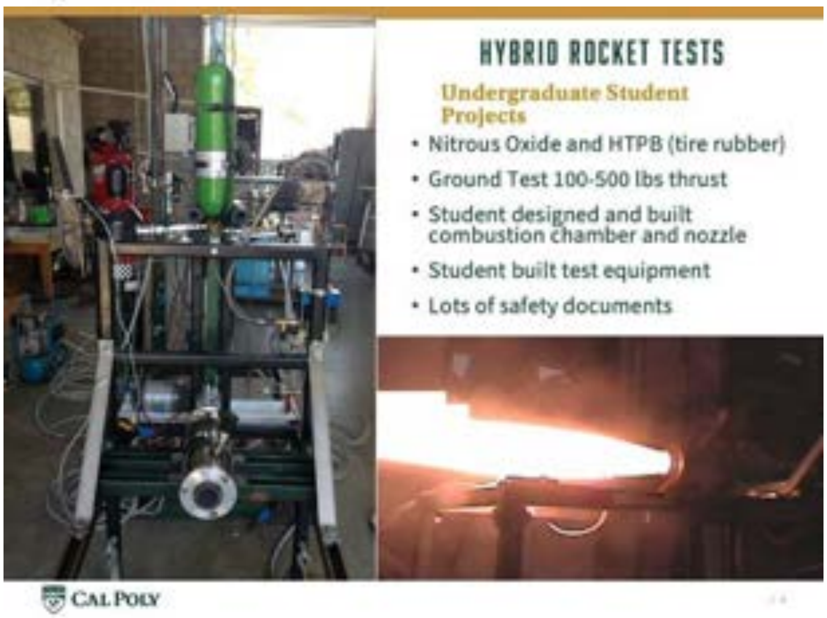
C7 - Engaging Students in Space Technology Research – DeTurris

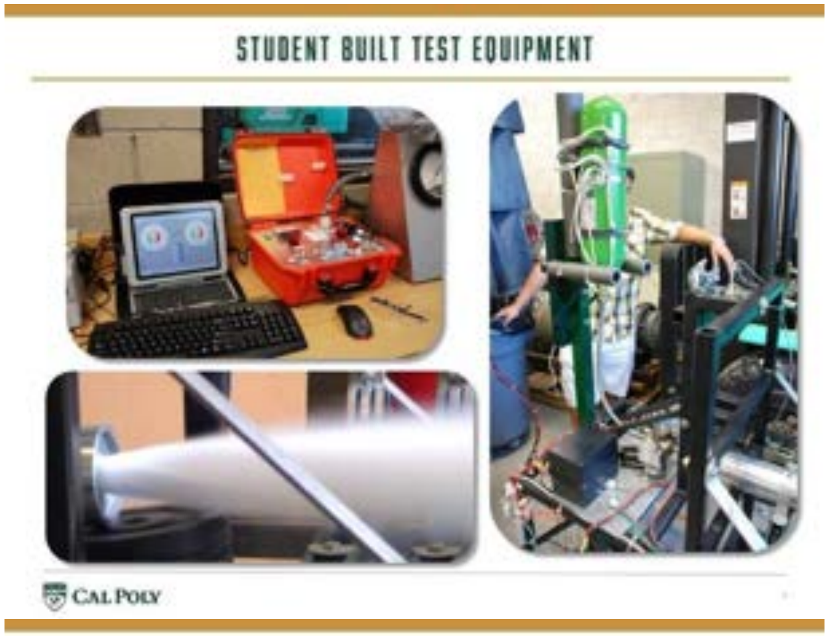



SOLID, HYBRID, AND LIQUID ROCKET REQUIRED LAB COURSE EXPERIMENTS
Aerospace Propulsion Curriculum
Low Thrust, Low Energy Experiments
• Static fire solid motor (A-G) to measure
Thrust
Propellant flow rate
• Static fire hybrid motor to measure
Thrust
Propellant flow rate
Combustion instability
• Static fire liquid rocket engine to measure
Thrust
Propellant flow rate
Plume characteristics
Required: 10 Fingers 10 Toes
CAL POLY


UNDERGRADUATE STUDENT ROCKET PROJECTS
University Rocketry Competitions
• Tripoli Rocketry Association Certification
• Build One and Two Stage Rockets
o Carbon fiber and fiberglas structure
o Test Rocket Recovery Before Flight
• Commercial Solid Motors Up to M
CAL POLY

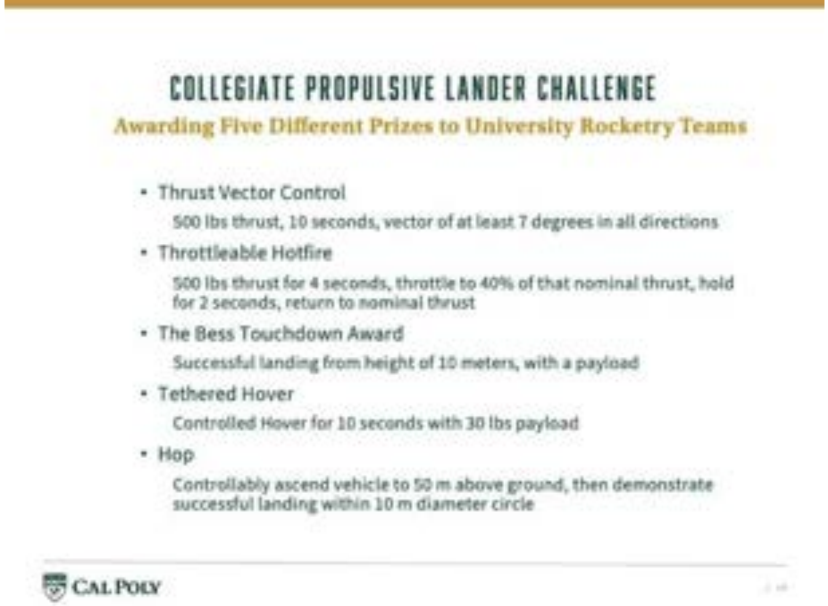

2014
2018
2009
CAL POLY

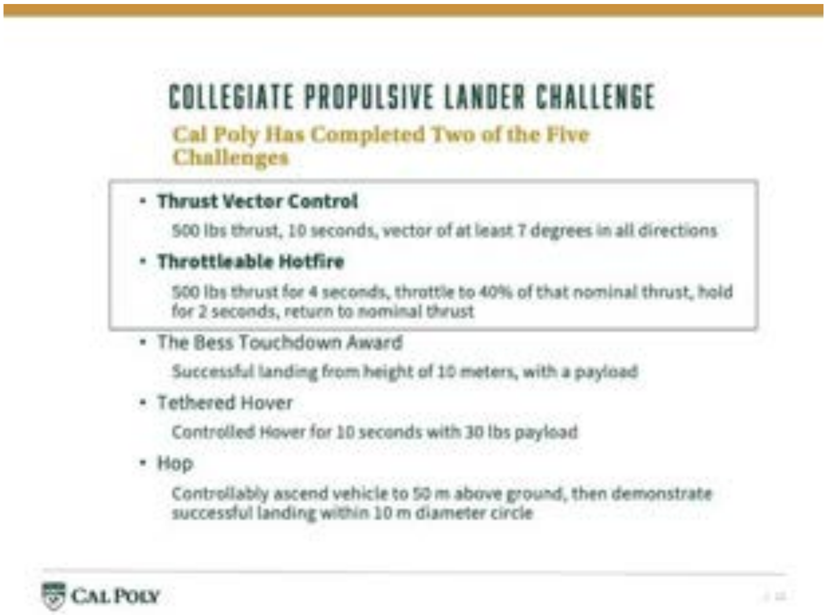

HYBRID ROCKET TESTS
Undergraduate Student Projects
• Nitrous Oxide and HTPB (tire rubber)
• Ground Test 100-500 lbs thrust
• Student designed and built combustion chamber and nozzle
• Student built test equipment
• Lots of safety documents
CAL POLY


STUDENT BUILT TEST EQUIPMENT
CAL POLY

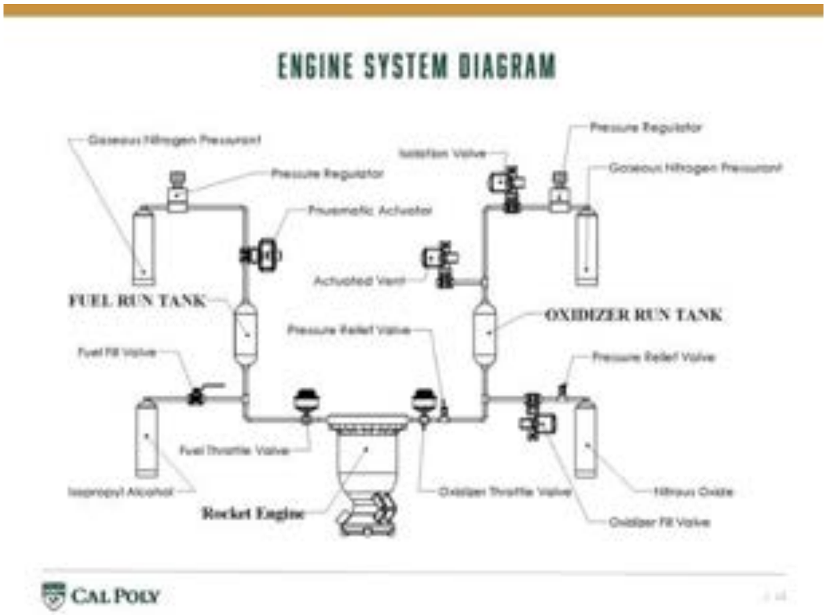

FLIGHT TESTING HYBRID ROCKETS
Nitrous Oxide and HTPB
• After Successful Ground Test, Flight Vehicle was Designed
o Student mixed HTPB propellant grain
o Student designed combustor and nozzle
o Student built rocket
• Fly at Friends of Amateur Rocketry in Mojave
CAL POLY


GROUND TESTING LIQUID ROCKETS
Developed test stands for 10 lbs and 500 lbs thrust
• Ethanol and oxygen liquid rocket engine
• Instrumentation for thrust, mass flows, pressures and temperatures
• Create knowledge transfer structure
CAL POLY


COLLEGIATE PROPULSIVE LANDER CHALLENGE
Awarding Five Different Prizes to University Rocketry Teams
• Thrust Vector Control
500 lbs thrust, 10 seconds, vector of at least 7 degrees in all directions
• Throttleable Hotfire
500 lbs thrust for 4 seconds, throttle to 40% of that nominal thrust, hold for 2 seconds, return to nominal thrust
• The Bess Touchdown Award
Successful landing from height of 10 meters, with a payload
• Tethered Hover
Controlled Hover for 10 seconds with 30 lbs payload
• Hop
Controllably ascend vehicle to 50 m above ground, then demonstrate successful landing within 10 m diameter circle
CAL POLY


COLLEGIATE PROPULSIVE LANDER CHALLENGE
Cal Poly Has Completed Two of the Five Challenges
Thrust Vector Control
500 lbs thrust, 10 seconds, vector of at least 7 degrees in all directions
Throttleable Hotfire
500 lbs thrust for 4 seconds, throttle to 40% of that nominal thrust, hold for 2 seconds, return to nominal thrust
The Bess Touchdown Award
Successful landing from height of 10 meters, with a payload
Tethered Hover
Controlled Hover for 10 seconds with 30 lbs payload
Hop
Controllably ascend vehicle to 50 m above ground, then demonstrate successful landing within 10 m diameter circle
CAL POLY

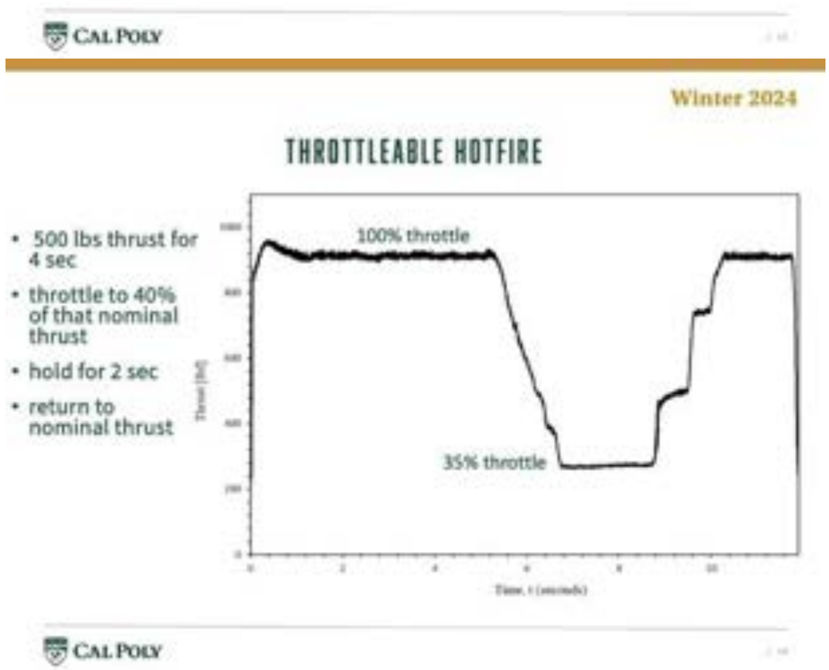

PROPULSIVE LANDER CHALLENGE TEST UP
Isopropyl Alcohol and Nitrous Oxide Liquid Rocket Engine
Feed system sized for 1000 lbs thrust
Hot fire duration sized for 20 seconds
Unlike doublet impinging injectors
Ablative phenolic combustor and nozzle
Custom control system includes real time monitoring of pressure, temperature, and thrust
CAL POLY

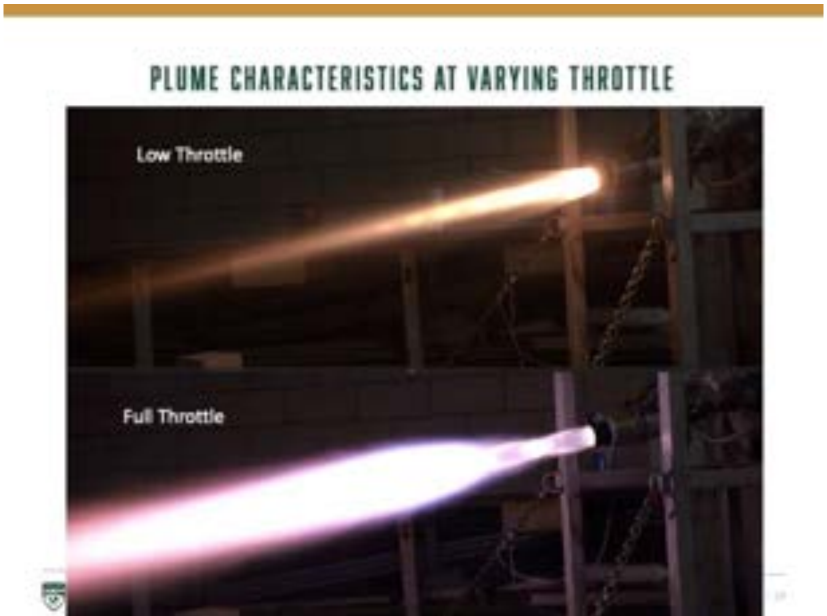

ENGINE SYSTEM DIAGRAM
Gaseous Nitrogen Pressurant
Pressure Regulator
Pnuematic Activator
Isolation Valve
Pressure Regulator
Gaseous Nitrogen Pressurant
Actuated Vent
FUEL RUN TANK
OXIDIZER RUN TANK
Pressure Relief Valve
Fuel Fill Valve
Pressure Relief Valve
Fuel Throttle Valve
Isopropyl Alcohol
Rocket Engine
Oxidizer Throttle Valve
Nitrous Oxide
Oxidizer Fill Valve
CAL POLY


Fall 2023
THRUST VECTOR CONTROL
• 500 lbs thrust
• 10 seconds
• vector of at least 7 degrees in all directions

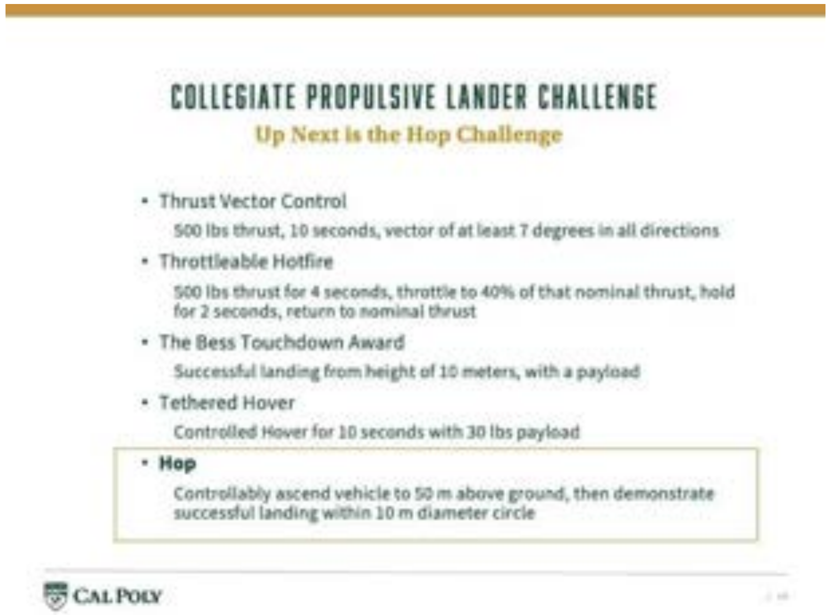
SPT

Presents:




PLUME CHARACTERISTICS AT VARYING THROTTLE
Low Throttle
Full Throttle


SPT
Presents:
CAL POLY


COLLEGIATE PROPULSIVE LANDER CHALLENGE
Up Next is the Hop Challenge
• Thrust Vector Control
500 lbs thrust, 10 seconds, vector of at least 7 degrees in all directions
• Throttleable Hotfire
500 lbs thrust for 4 seconds, throttle to 40% of that nominal thrust, hold for 2 seconds, return to nominal thrust
• The Bess Touchdown Award
Successful landing from height of 10 meters, with a payload
• Tethered Hover
Controlled Hover for 10 seconds with 30 lbs payload
• Hop
Controllably ascend vehicle to 50 m above ground, then demonstrate successful landing within 10 m diameter circle
CAL POLY


FUTURE STATIC FIRE TESTING
Rockets Producing More Than 500 lbs Thrust
• Create a large test stand for liquid rocket testing
o Different engine configurations
o Different materials
o Different manufacturing techniques
o Different control configurations
• Create a large test stand for hybrid rocket testing
• Develop infrastructure for cryogenic propellants
CAL POLY

C8 - Space IOT Research Case Study – Derickson

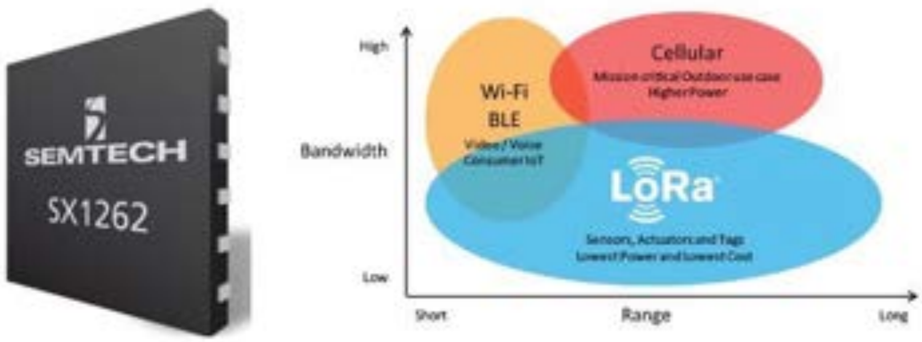
Wireless Communication using LoRa modulation and the Cluster Duck Protocol; Ground-to-Space links in the License-Free 915 MHz ISM Frequency Band

Dennis Derickson ddericks@calpoly.edu
Steve Dunton sdunton@calpoly.edu
Cameron Mcclure-Coleman (cjmcclur@calpoly.edu)
Jack Ryan jryan39@calpoly.edu
Kevin Nottberg knottber@calpoly.edu
Sammy Brunton sbrunton@calpoly.edu
Bryan Knouse bryan@owlintegrations.com

Presentation Outline

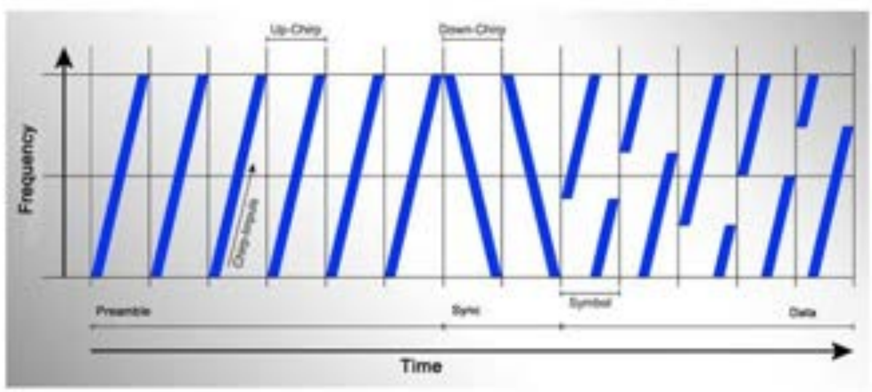
- What is the LoRa Wireless technology created by SEMTEC Inc?
- Partnership between OWL Integrations and Cal Poly
- Application to Today's Conference
  - Cal Poly Developed LoRa/CDP Hardware and Software
  - Cube Sat with LoRa Link Project
  - Cal Poly Space Systems LoRa Link Project
  - Cal Poly/Lacuna Space LoRa Link Project
- Summary and Conclusions

LoRa as a low data rate, long distance com link.



https://www.semtech.com/lora

LoRa (Long Range) Chirped –Waveform Modulation Technique pioneered by SEMTEC



LoRa Receiver Sensitivity at -135 dBm. LoRa TX power at 20 dBm.

700 km LEO Link to 700 km (145 dB path loss)

Link Loss capability of 150 dB with Low gain antennas

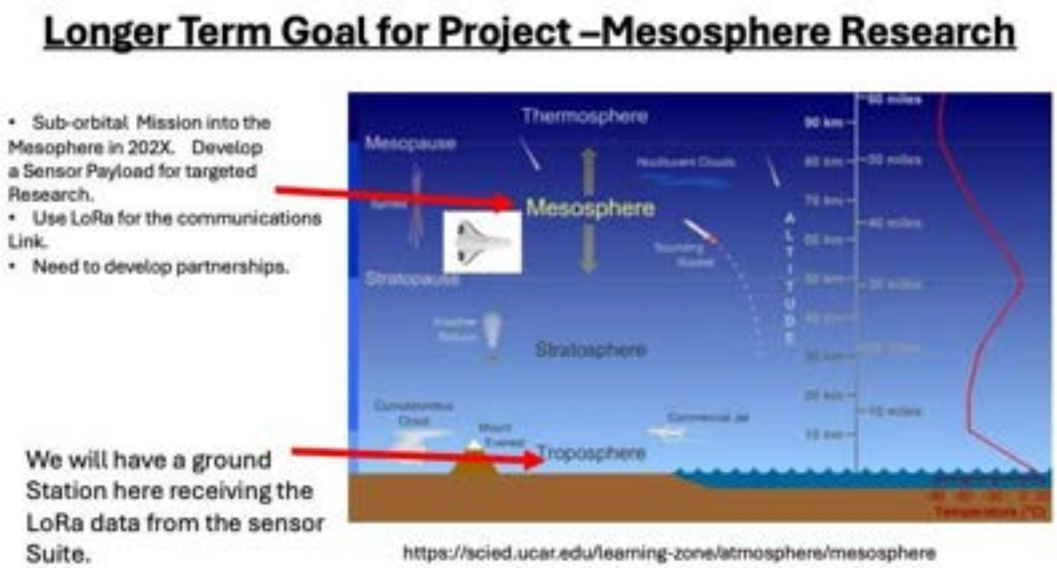
70 km Mesosphere Link to (125 dB path loss)


OWL Integrations / Cal Poly Collaboration
The ClusterDuck Mesh Network
DuckLink devices are deployed on land, water, or in the air and sync with nearby network nodes in clusters to form the ClusterDuck sensor and communications network.
DATA
DATA
API
to external systems
Hardware
Ducklink
MamaDuck
PapaDuck
Owl
Start-up Technology Company Focused on Making Connections
OWL
CAL POLY/OWL HARDWARE/SOFTWARE CREATIONS
Kevin Nottberg Grad Student
Space Quacker Advanced Development (SQUAD) Cube Sat Module Field Test
Squad Board At 101 Cuesta Grade Ridge
RC1 Beacon Near Morro Bay
QUAD RC1 Board Field Test

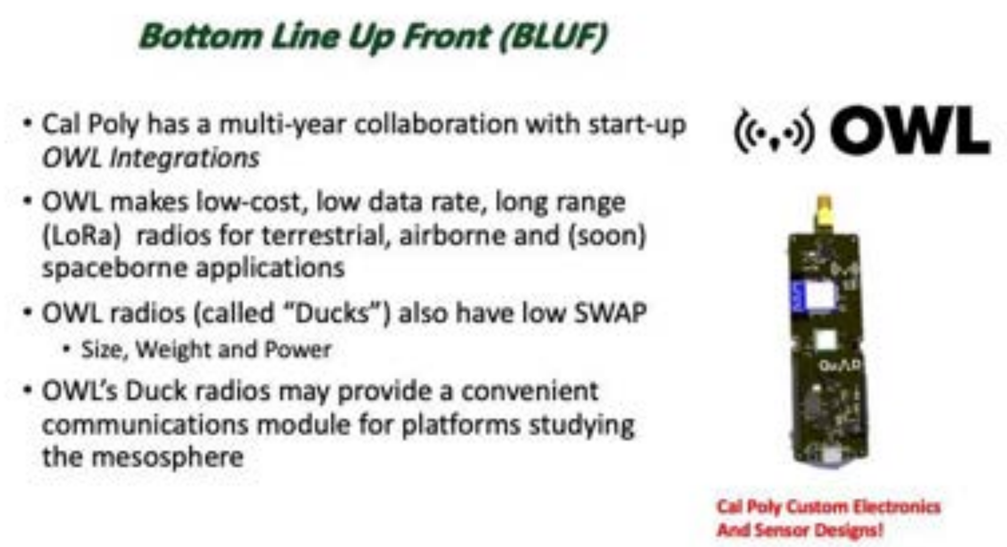
Link Conclusion from Lora/CDP Link Field Testing:

1. **Mesosphere Links** can be completed with Low-Gain Antennas for Both ground station and space vehicle antennas.

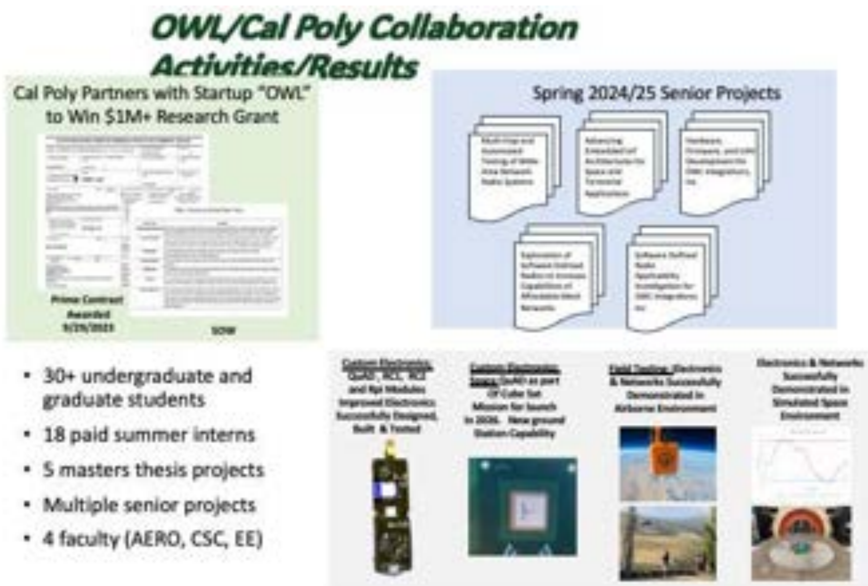
2. **Low Earth Orbit Links** will need High Gain antennas to complete the link.


Longer Term Goal for Project –Mesosphere Research
• Sub-orbital Mission into the Mesophere in 202X. Develop a Sensor Payload for targeted Research.
• Use LoRa for the communications Link.
• Need to develop partnerships.
We will have a ground Station here receiving the LoRa data from the sensor Suite.
Thermosphere
Mesopause
Mesosphere
Stratopause
Stratosphere
Troposphere
ALTITUDE
90 km
https://scied.ucar.edu/learning-zone/atmosphere/mesosphere


Ducks in Space:
Cal Poly's "Learn By Doing" Approach to Mature "Duck" Radios for Future Space Flight & Possible Mesosphere Science
High altitude (91,000 feet) balloon test of Duck Radio, June 2024. In Nov. '24 we did testing in a airplane environment.
CAL POLY
www.calpoly.edu
OWL
www.project-owl.com
AFWERX
afwerx.com


Bottom Line Up Front (BLUF)
• Cal Poly has a multi-year collaboration with start-up OWL Integrations
• OWL makes low-cost, low data rate, long range (LoRa) radios for terrestrial, airborne and (soon) spaceborne applications
• OWL radios (called "Ducks") also have low SWAP
• Size, Weight and Power
• OWL's Duck radios may provide a convenient communications module for platforms studying the mesosphere
OWL
Cal Poly Custom Electronics
And Sensor Designs!


California Polytechnic State University
A Number of Reasons Why
LEARN BY DOING IS DIFFERENT
#1
95%
#1
CAL POLY
• Cal Poly is a top-ranked public university in San Luis Obispo, California (USA)
• We implement "Learn By Doing" as a deliberate process where students acquire knowledge and skills through active engagement in research and development projects projects
• Example
• Cal Poly co-created the Cubesat satellite standard
• Our student-led space program "PolySat" has been spacefaring since 2006
• We prioritize teaching and use research to support student learning
REQUIRED MAJOR COURSES
50% LAB HOURS
Research Institute in Need of Partners (Funding)


OWL/Cal Poly Collaboration Activities/Results
Cal Poly Partners with Startup "OWL" to Win $1M+ Research Grant
Prime Contract Awarded
SOW
Spring 2024/25 Senior Projects
30+ undergraduate and graduate students
18 paid summer interns
5 masters thesis projects
Multiple senior projects
4 faculty (AERO, CSC, EE)


OWL-Cal Poly Roadmap
Developing & demonstrating a space capable product assures a robust platform for airborne and disadvantaged users
CubeSat Launch SAL-E 2025
Space Feasibility
Improvements & Lab Tests
ADDED!
2024 Progress Resulted in Duck Radio Payload Now Baselined for 2025 Cubesat Launch on SAL-E


Results
Balloon Launch Retrieval
SpaceDucks 4.0 Team – Balloon Launch
And Space Ducks 4.5 - Airplane Launch
PolySat Team
Connecting…Partnering…Empowering…Securing Funding
We're Going into Space…Working Together


Summary – New Electronics
and Space –Oriented Missions
• Cal Poly has a multi-year collaboration with start-up OWL Integrations
• OWL makes low-cost, low data rate, long range (LoRa) radios for terrestrial, airborne and (soon) spaceborne applications
• OWL radios (called "Ducks") also have low SWAP
• Size, Weight and Power
• OWL's Duck radios may provide a convenient communications module for platforms studying the mesosphere
OWL
We can design custom electronics
and sensors for your needs too!

Cal Poly Space Systems (CPSS);
Custom LoRa-based Sensor Suite Projects

Club Biography

- Club is in existence since 1983
- Currently has 70 membership (many different majors)
- Meets twice weekly; Always Design, Building, Testing and Learning.
- Initially the club was formed as a group in the 1970s working on a " NASA Getaway Special" with the Space-Shuttle Program.

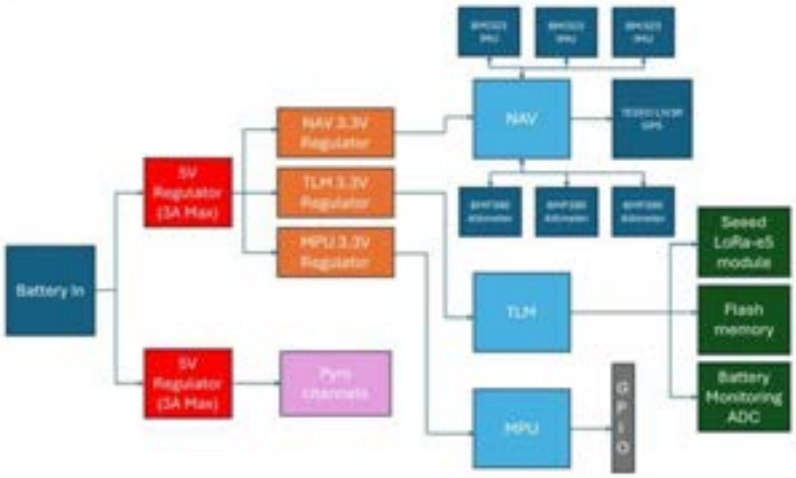
Key Coms Module using LoRa Link: Telemetry and Operations Manager (TOM)

- General-purpose flight computer for wide variety of future CPSS missions
- Will be running on both CPSS projects launching this year
- Main objectives/advantages:
  - Easy implementation
  - Cost-effectiveness
  - Modularity

TOM Artwork Fall 2024

Block Diagram of the Sensor Suite:

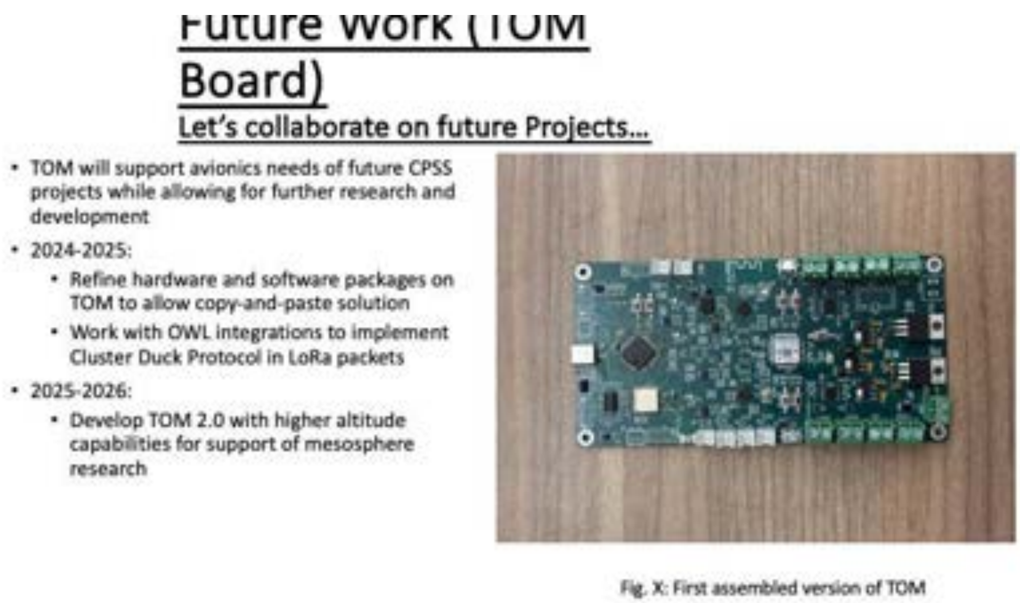
Telemetry and Operations Manager (TOM) Electronics

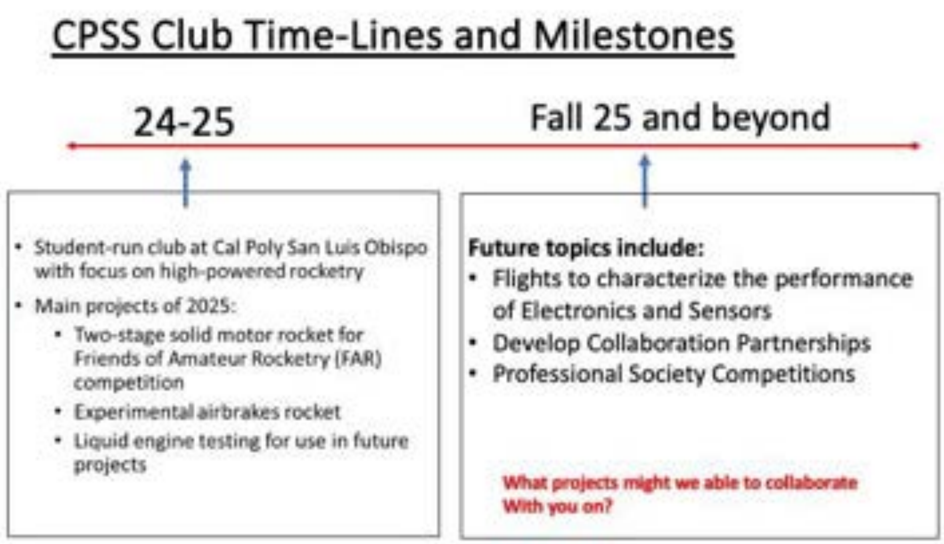


Features:

Telemetry and Operations Manager (TOM) Electronics

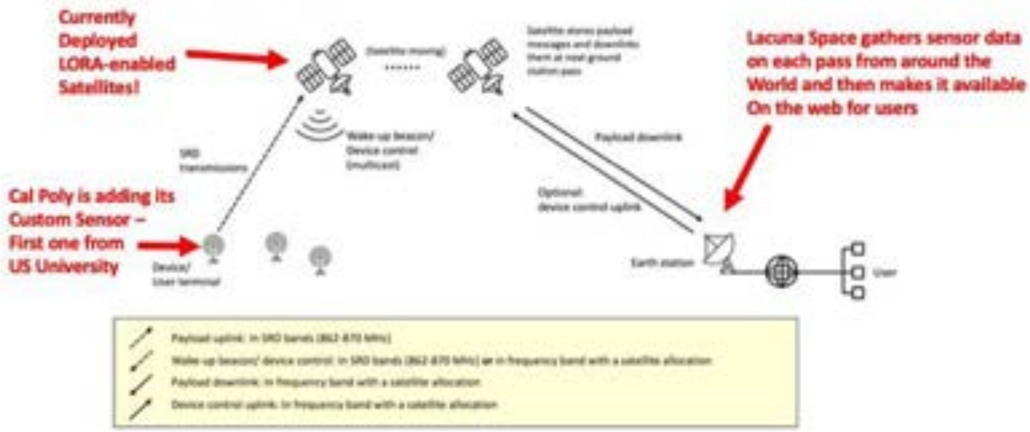
- On-board sensors:
  - u-blox Neo-M8 GPS
  - 3 BMP390 barometric altimeters
  - 3 BMI323 IMU's
- Telemetry broadcasted to ground station using Wio-e5 LoRa module
  - Embedded SemTech SX1262 LoRa transceiver and STM32WLE5JC
- STM32F7 microcontroller for other control system/mission-specific needs


Future Work (TOM Board)
Let's collaborate on future Projects...
• TOM will support avionics needs of future CPSS projects while allowing for further research and development
• 2024-2025:
• Refine hardware and software packages on TOM to allow copy-and-paste solution
• Work with OWL integrations to implement Cluster Duck Protocol in LoRa packets
• 2025-2026:
• Develop TOM 2.0 with higher altitude capabilities for support of mesosphere research
Fig. X: First assembled version of TOM


CPSS Club Time-Lines and Milestones
24-25
Fall 25 and beyond
• Student-run club at Cal Poly San Luis Obispo with focus on high-powered rocketry
• Main projects of 2025:
• Two-stage solid motor rocket for Friends of Amateur Rocketry (FAR) competition
• Experimental airbrakes rocket
• Liquid engine testing for use in future projects
Future topics include:
• Flights to characterize the performance of Electronics and Sensors
• Develop Collaboration Partnerships
• Professional Society Competitions
What projects might we able to collaborate With you on?

Lacuna Space/Cal Poly LoRa Low Earth Orbit Project

2.2 OPERATIONAL CONCEPTS



Lacuna Space/Cal Poly LoRa Low Earth Orbit Project

Lacuna Space LoRa ground station module
Model 300915 (915 MHz for North America)

Many different kinds of sensor can be used to link
To the Lacuna Space LoRa Link based satellite system

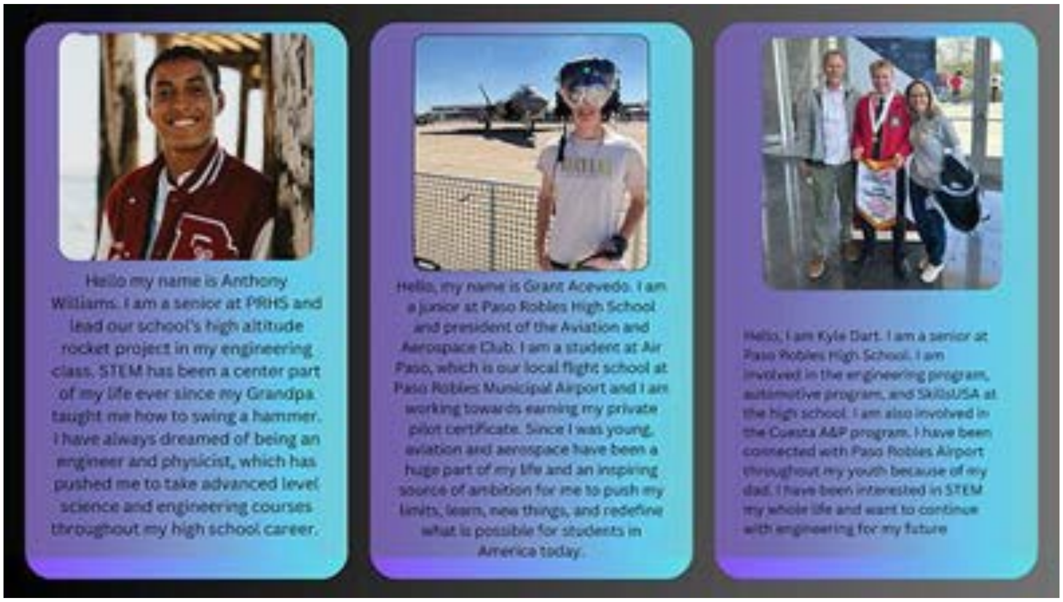
Summary:

1. **LoRa/CDP 915 MHz Communication Links are Versatile, License-Free and capable of Mesosphere and LEO paths.**
2. **Cal Poly / OWL Integrations partnership has developed new custom LoRa/CDP Link hardware/software and associated expertise.**
3. **Would like to leverage Cal Poly/OWL integration solutions to solve Space-Based Communication Applications – HOW CAN WE HELP?**

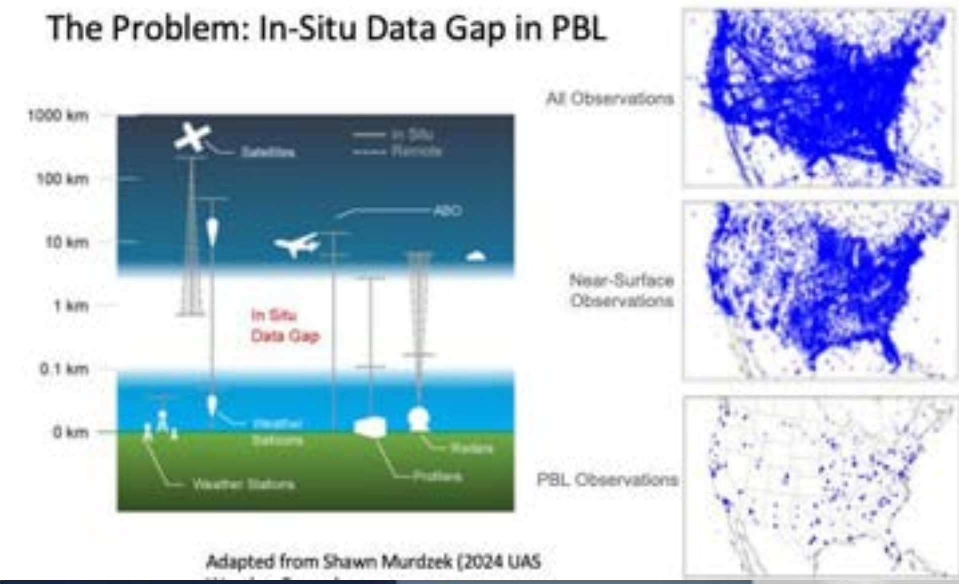
CAL POLY

OWL

C9 - Local Community STEM Showcase & Interest – Johnston, Acevedo, Dart, & Williams

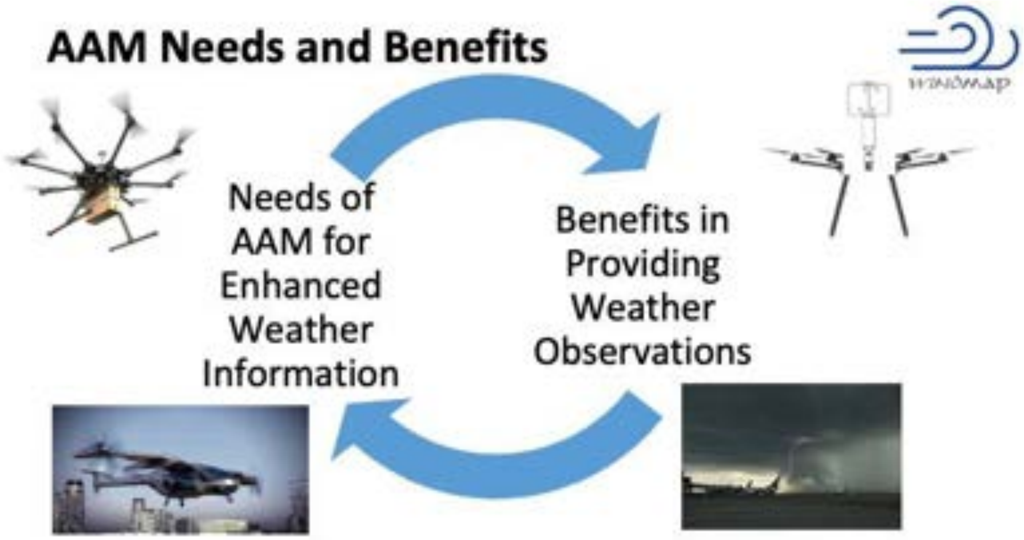


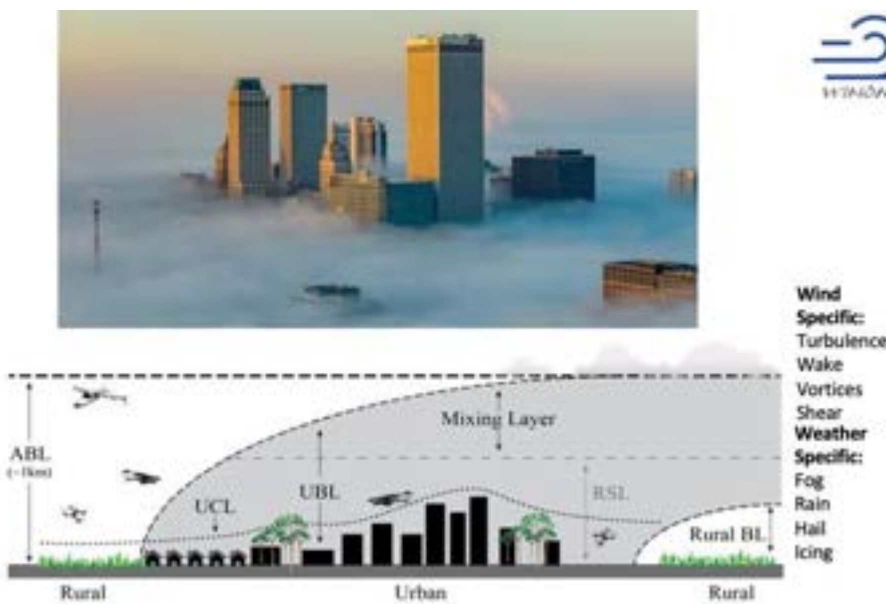
C10 - From the Ground Up to Middle Out: Drones & Balloons for Assistive Suborbital Observations – Jacob

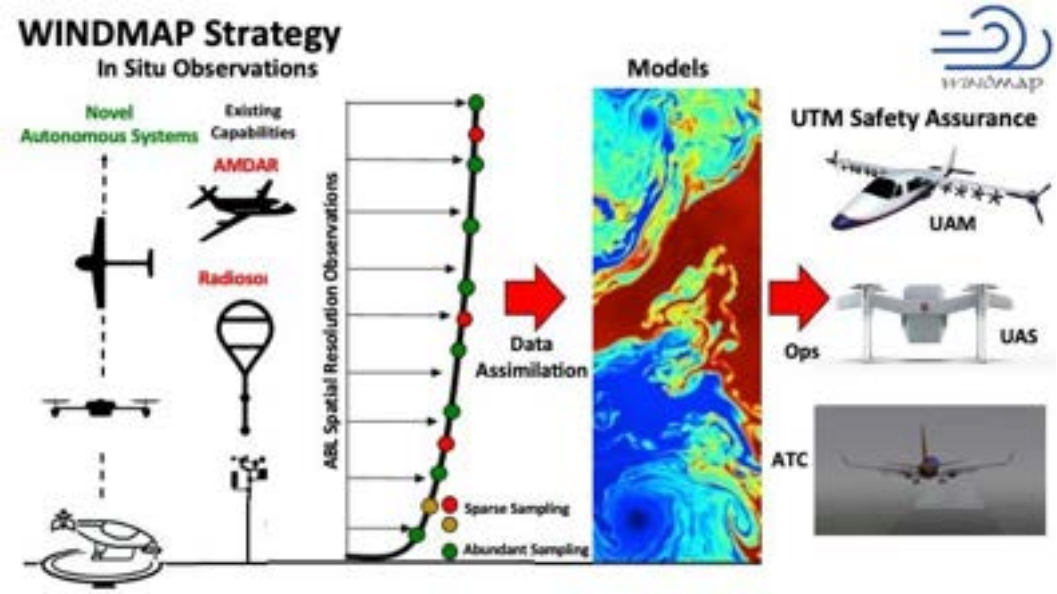

The Problem: In-Situ Data Gap in PBL
1000 km
100 km
10 km
1 km
0.1 km
0 km
In Situ
Remote
Satellites
ABO
In Situ
Data Gap
Weather Balloons
Radars
Weather Stations
Profilers
All Observations
Near-Surface Observations
PBL Observations
Adapted from Shawn Murdzek (2024 UAS

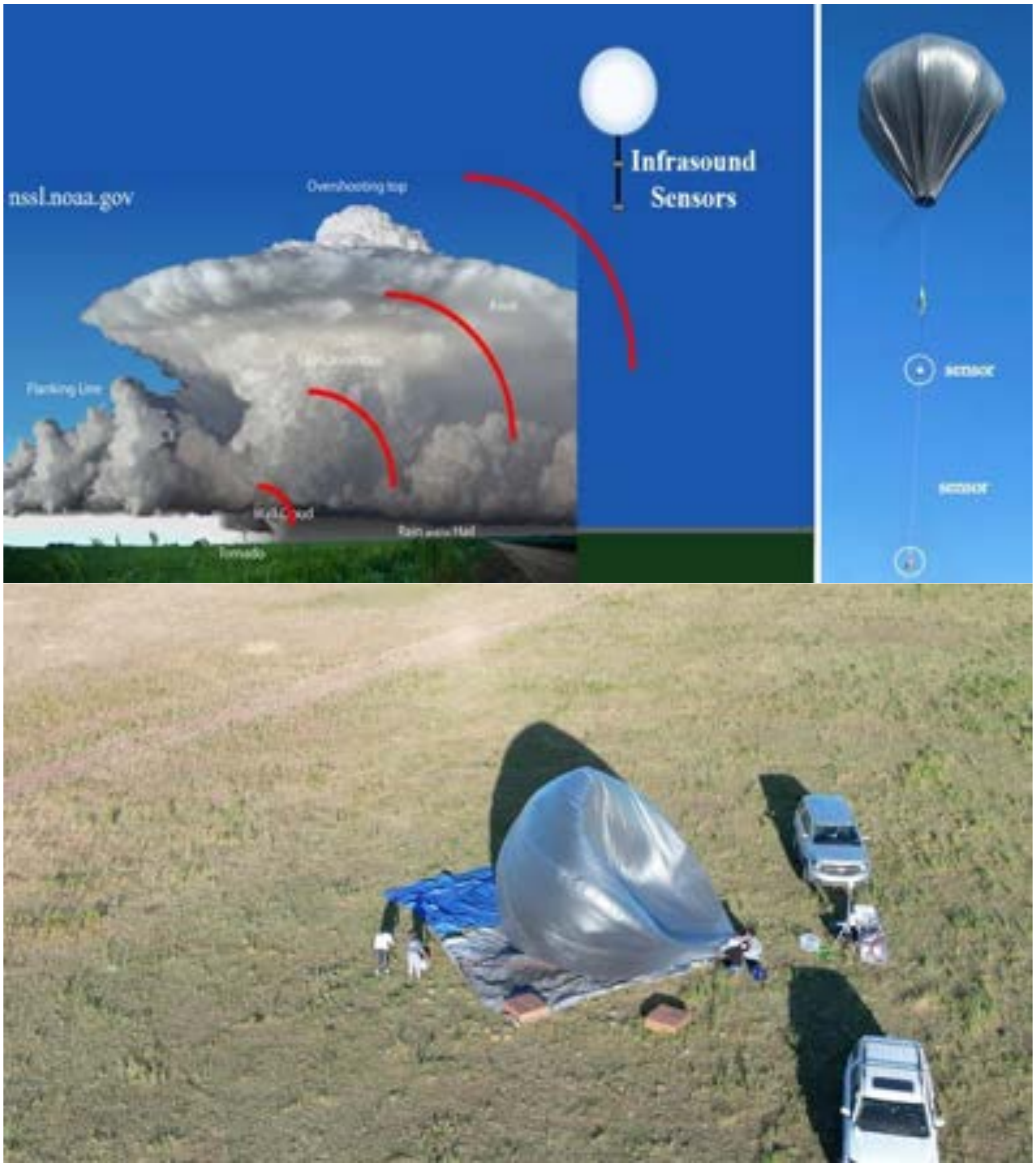

Origins: Mars Aircraft
NASA

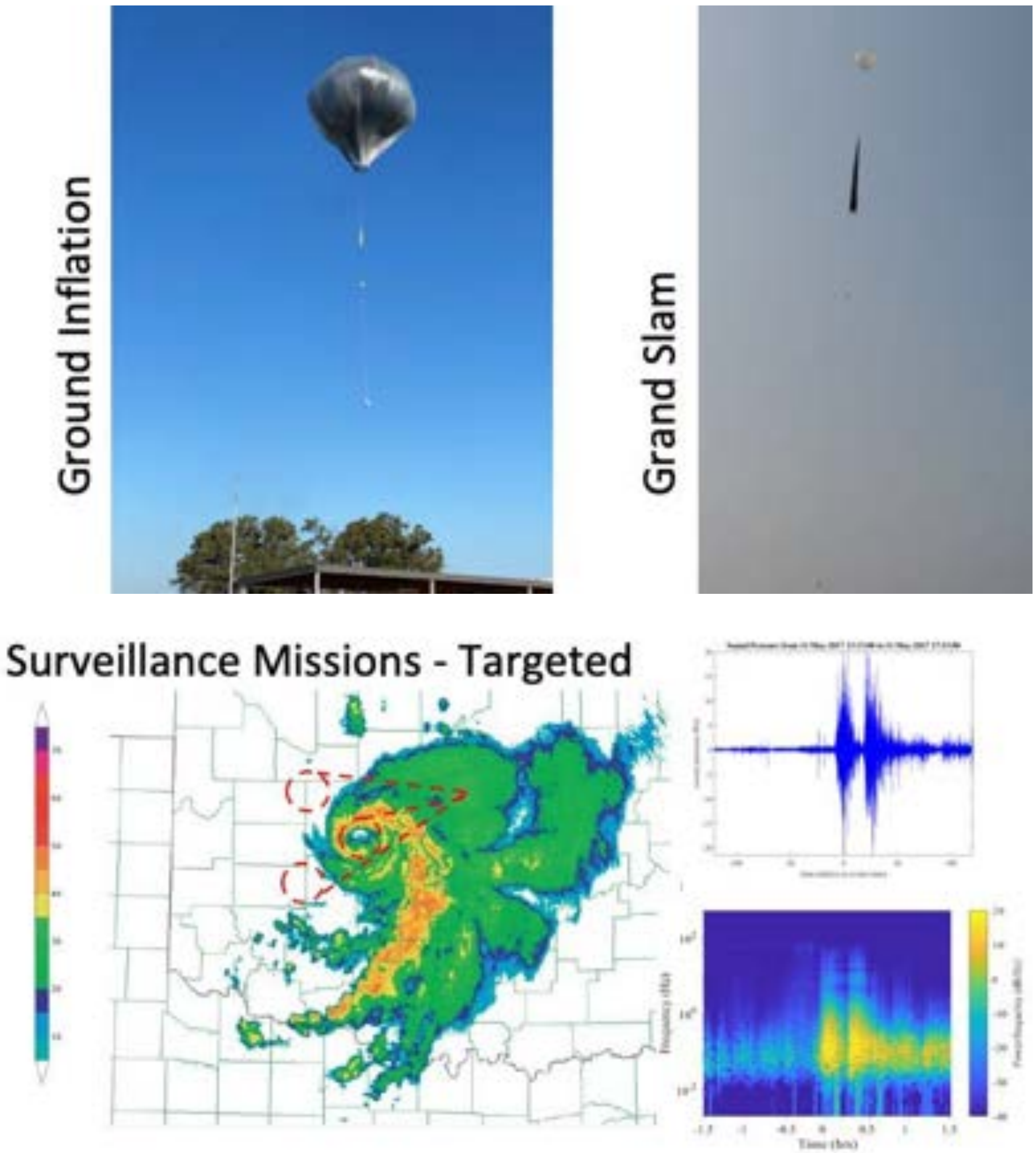

Mars Aircraft High Altitude Tests
NASA LaRC
OSU and UK
CLOUD-MAP
Collaboration Leading Operation UAS Development for Meteorology and Atmospheric Physics
CLOUDMAP
Small Unmanned Aircraft for Atmospheric Boundary Layer Research
Nebraska
Lincoln
UK
KENTUCKY


AAM Needs and Benefits
Needs of AAM for Enhanced Weather Information
Benefits in Providing Weather Observations

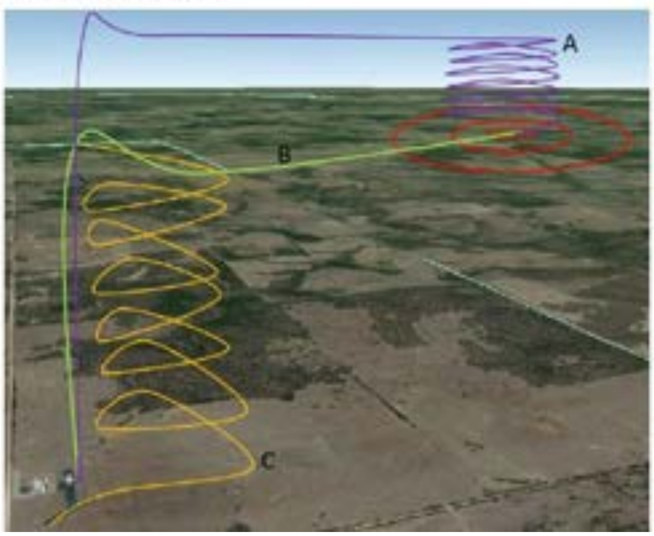

Wind Specific:
Turbulence
Wake
Vortices
Shear
Weather Specific:
Fog
Rain
Hail
Icing
ABL
Mixing Layer
UCL
UBL
RSL
Rural BL
Rural
Urban
Rural


WINDMAP Strategy
In Situ Observations
Novel Autonomous Systems
Existing Capabilities
AMDAR
Radioso
ABL Spatial Resolution Observations
Sparse Sampling
Abundant Sampling
Data Assimilation
Models
UTM Safety Assurance
UAM
Ops
UAS
ATC

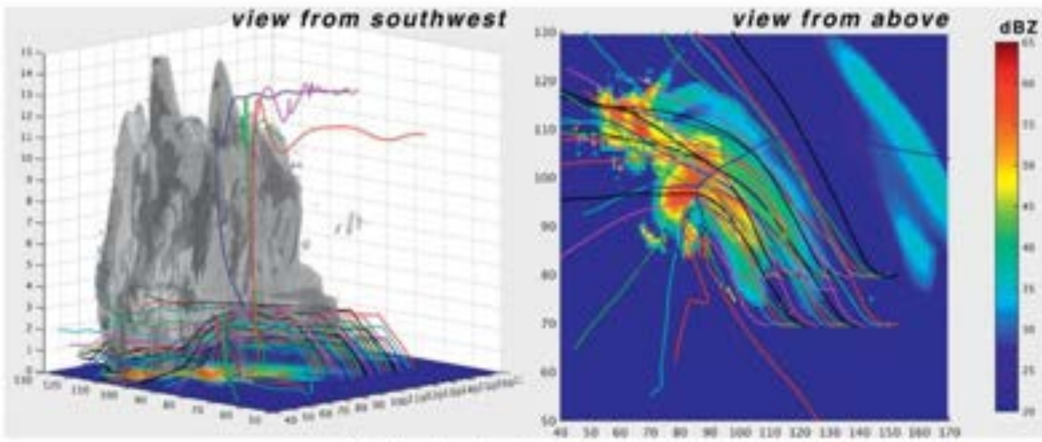

Infrasound
Sensors
nssl.noaa.gov
Overshooting top
Flanking Line
Tornado
sensor
sensor


Ground Inflation
Grand Slam
Surveillance Missions - Targeted

Mission Selection



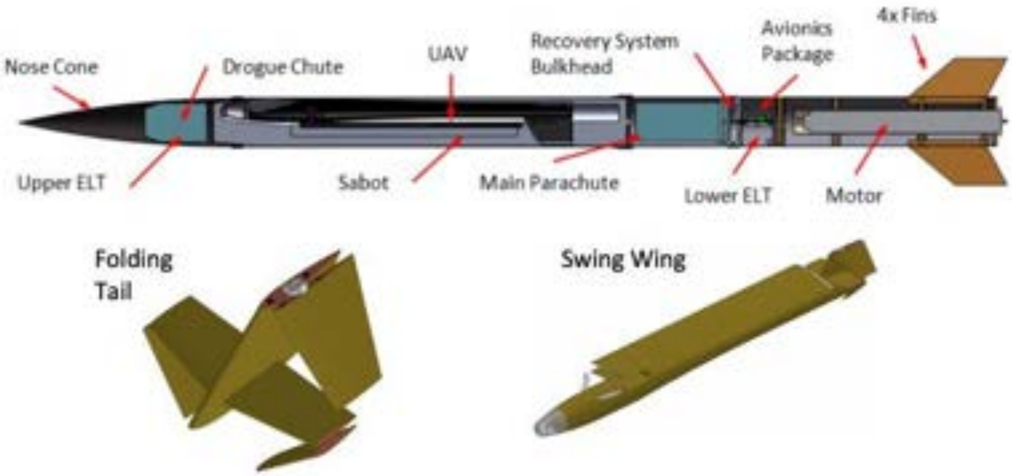
Balloonborne Pseudo-Lagrangian Drifter Probes

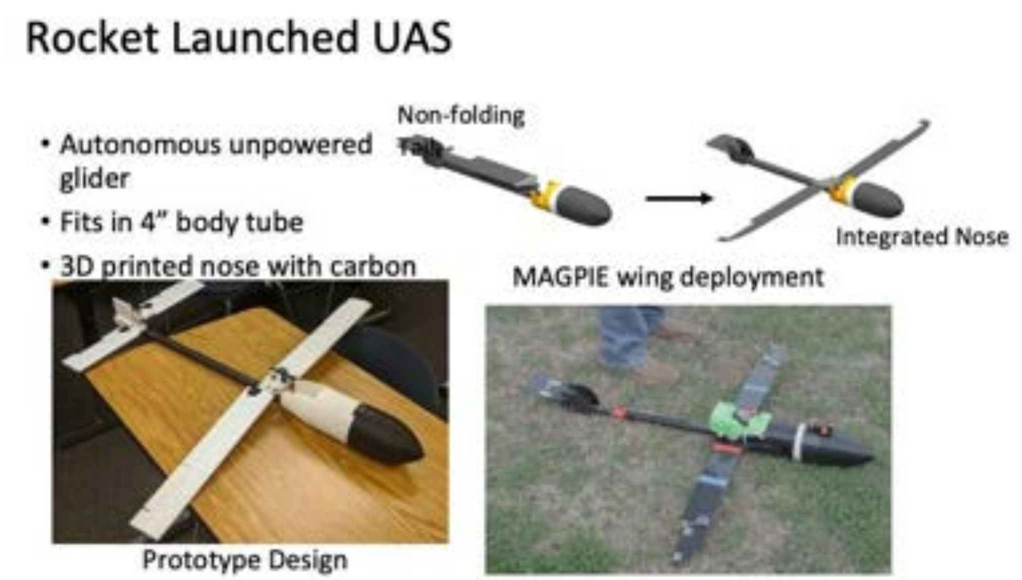


https://journals.ametsoc.org/view/journals/bams/99/4/bams-d-17-0204.1.xml?tab_body=pdf

Foundations in 2012

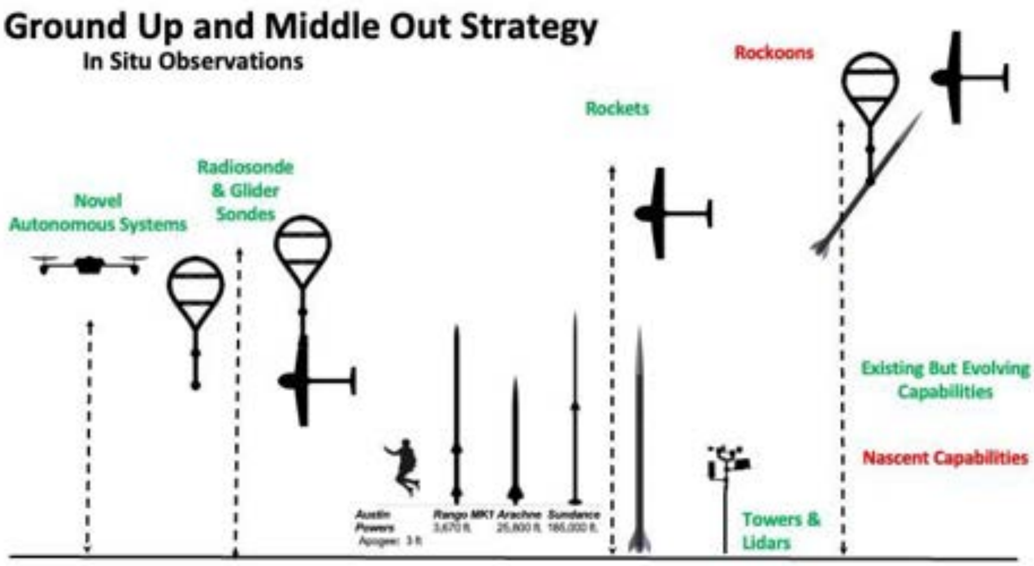
Rocket Launched UAS

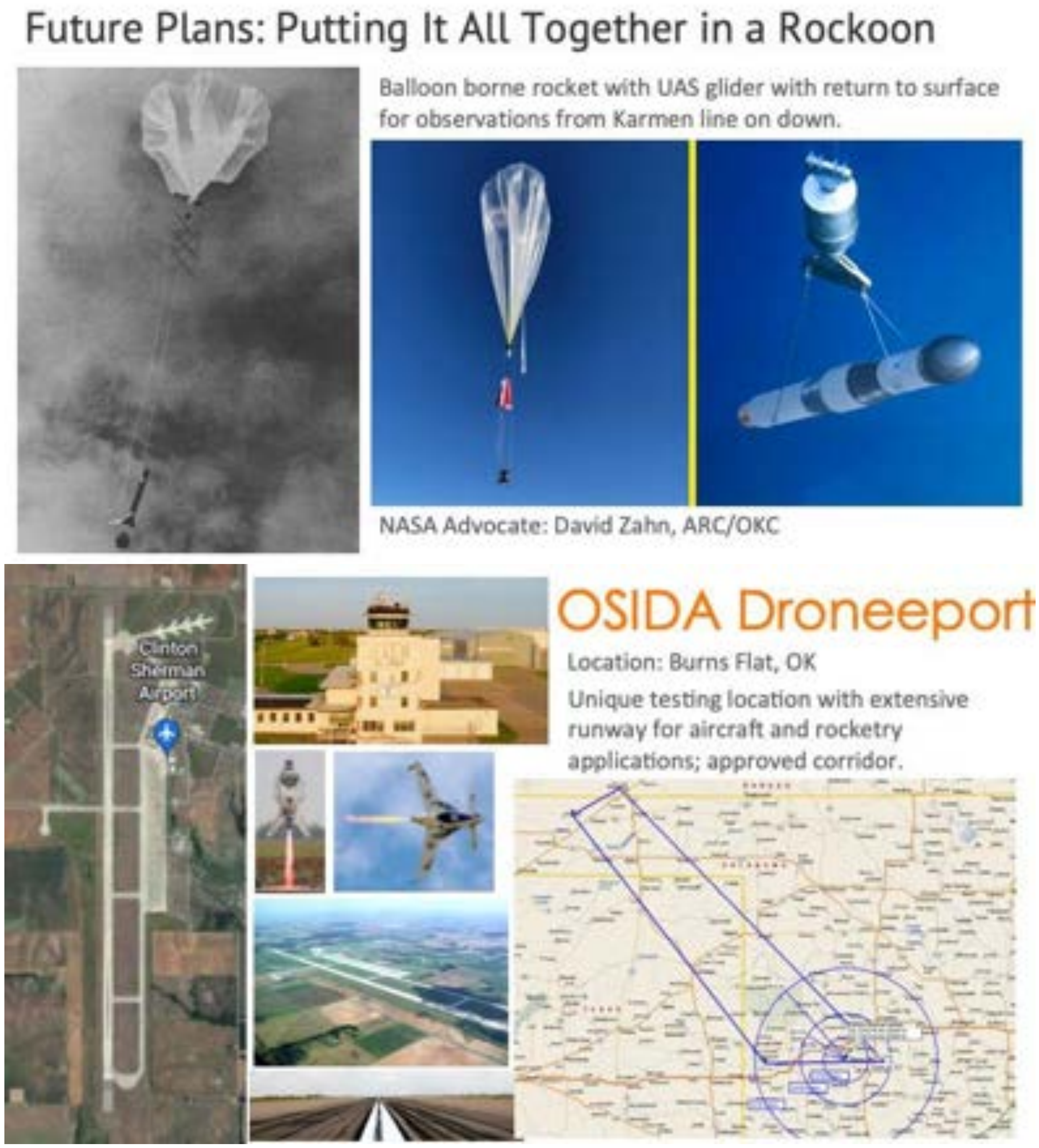


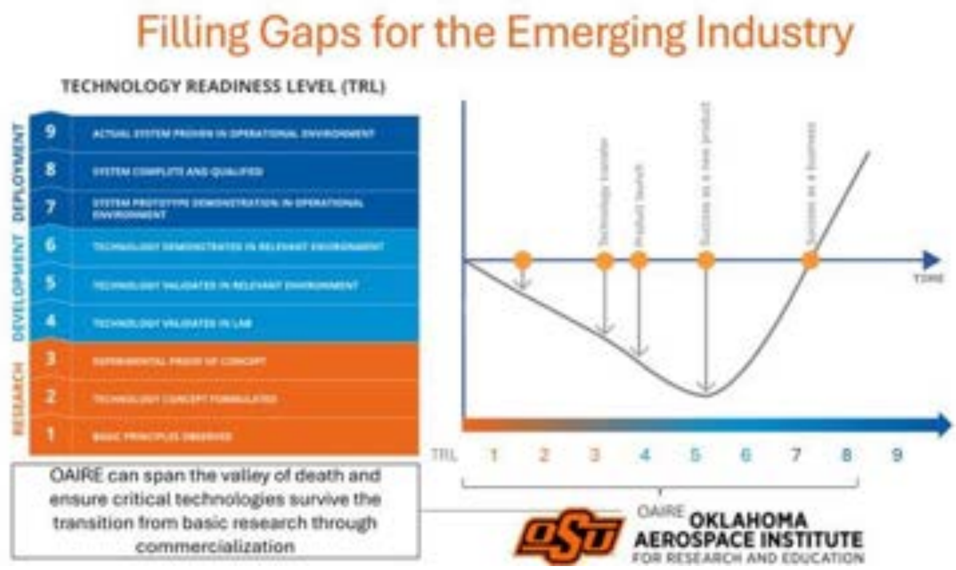

Rocket Launched UAS
• Autonomous unpowered glider
• Fits in 4" body tube
• 3D printed nose with carbon
Non-folding Tail
Integrated Nose
MAGPIE wing deployment
Prototype Design


Rocket Launched UAS
Folding Flat Plate Wings
Ailerons
Elevator
Recovery Chute
Nosecone w/ Payload
• Rocket Launched to 40,000 ft
• L/D 5-10 allows glide distances from 40 to 80 miles from deployment
• Smaller systems for swarming deployment (e.g., NRL Cicada)

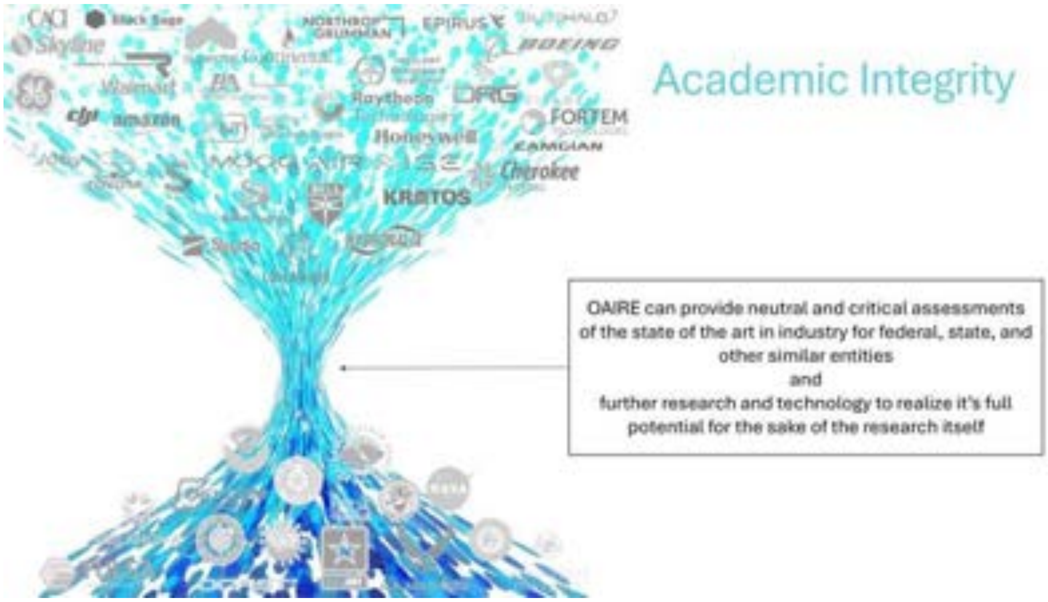
Launch Tests 2022




Future Plans: Putting It All Together in a Rockoon
Balloon borne rocket with UAS glider with return to surface for observations from Karmen line on down.
NASA Advocate: David Zahn, ARC/OKC
Clinton Sherman Airport
OSIDA Droneeport
Location: Burns Flat, OK
Unique testing location with extensive runway for aircraft and rocketry applications; approved corridor.


Filling Gaps for the Emerging Industry
TECHNOLOGY READINESS LEVEL (TRL)
DEPLOYMENT
DEVELOPMENT
RESEARCH
9
8
7
6
5
4
3
2
1
TIME
TRL 1 2 3 4 5 6 7 8 9
OAIRE can span the valley of death and ensure critical technologies survive the transition from basic research through commercialization
OAIRE
OKLAHOMA AEROSPACE INSTITUTE
FOR RESEARCH AND EDUCATION

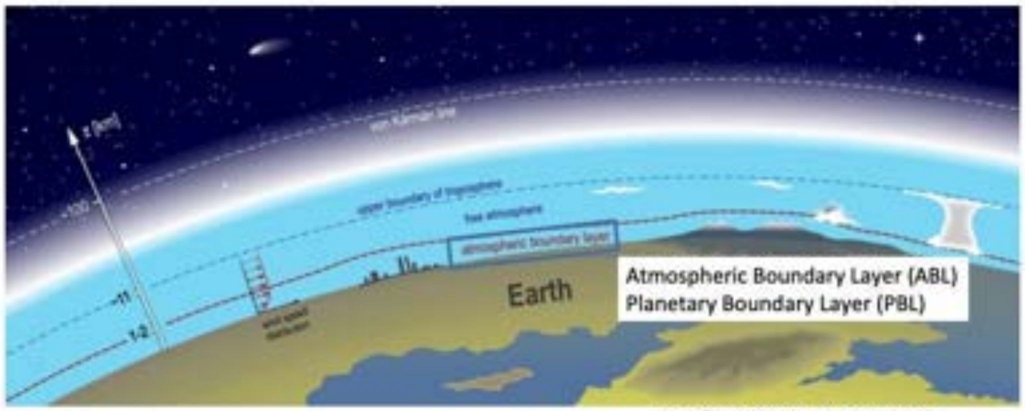

Filling Gaps for the Established Industry
OAIRE can fill critical gaps in the aerospace supply chain and provide support to the established industry without seeking immediate profitability


Academic Integrity
OAIRE can provide neutral and critical assessments of the state of the art in industry for federal, state, and other similar entities
and
further research and technology to realize it's full potential for the sake of the research itself

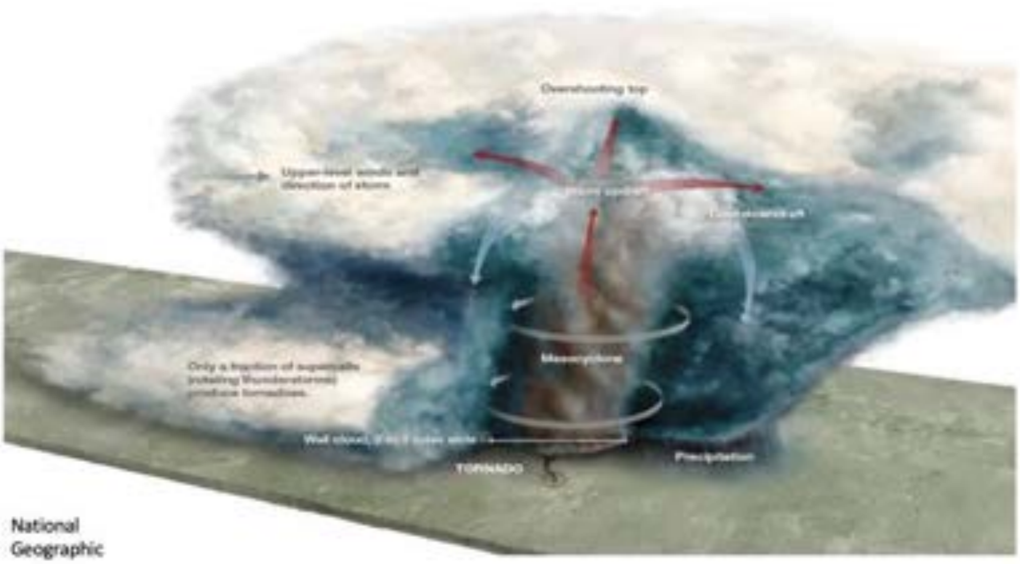

The strategy:
The organization must have multiple and varied income streams
The organization must be able manufacture professional quality components and prototypes in small batches
The organization must be able to produce professional level engineering documentation and deliverables similar to aerospace industry standards
Supporting Academic Research
Supporting Established Industry
Supporting Emerging Industry
OKLAHOMA AEROSPACE INSTITUTE FOR RESEARCH AND EDUCATION

OAIRE & Oklahoma Assets

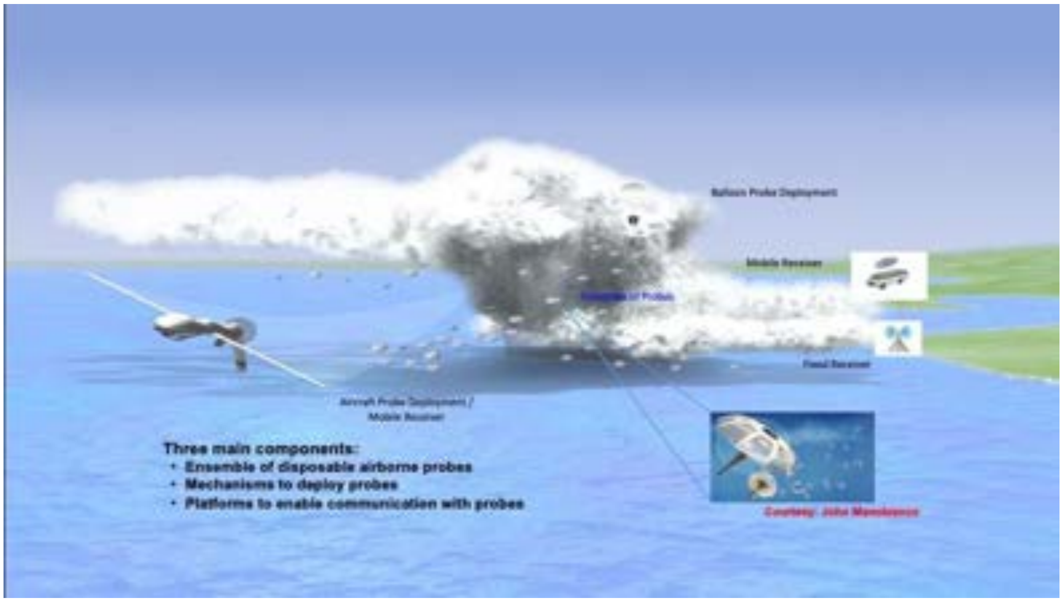
Structure of the Earth's Atmosphere



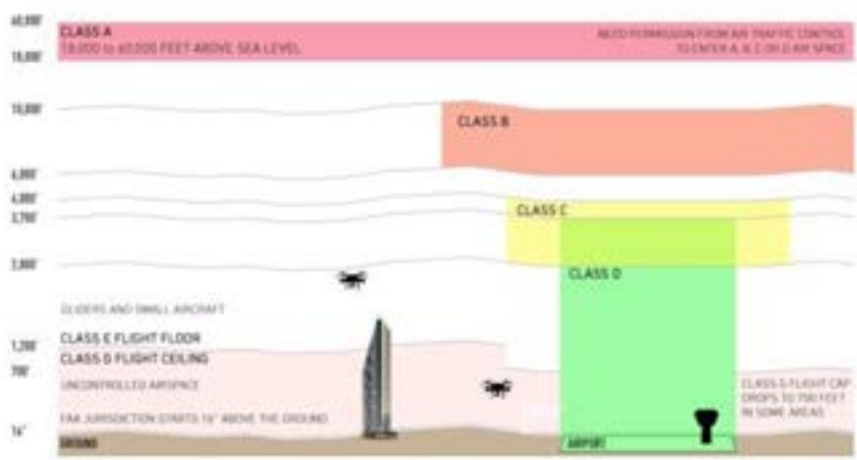
https://bmeafl.com/the-project-proposal/

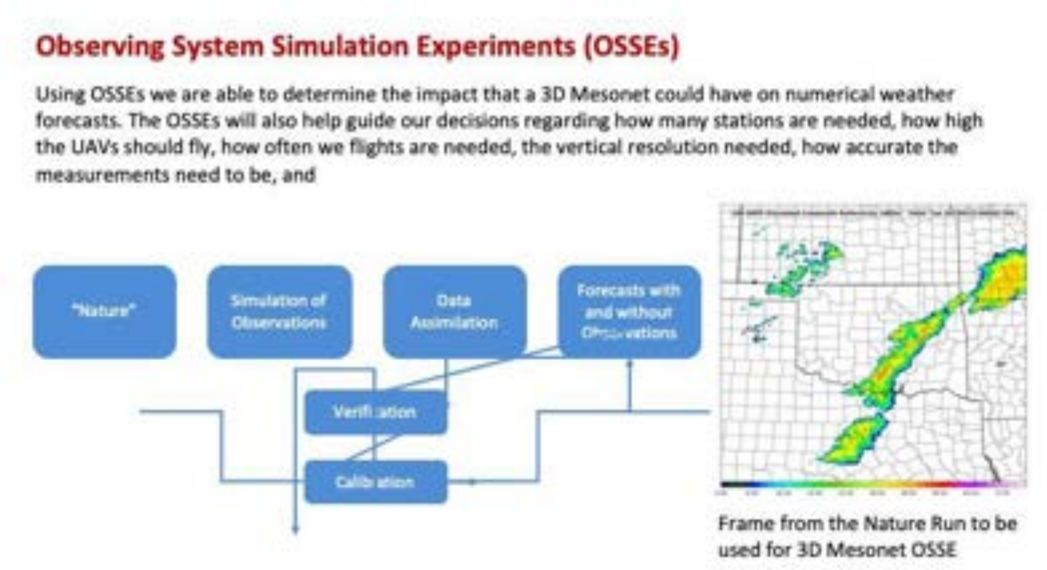


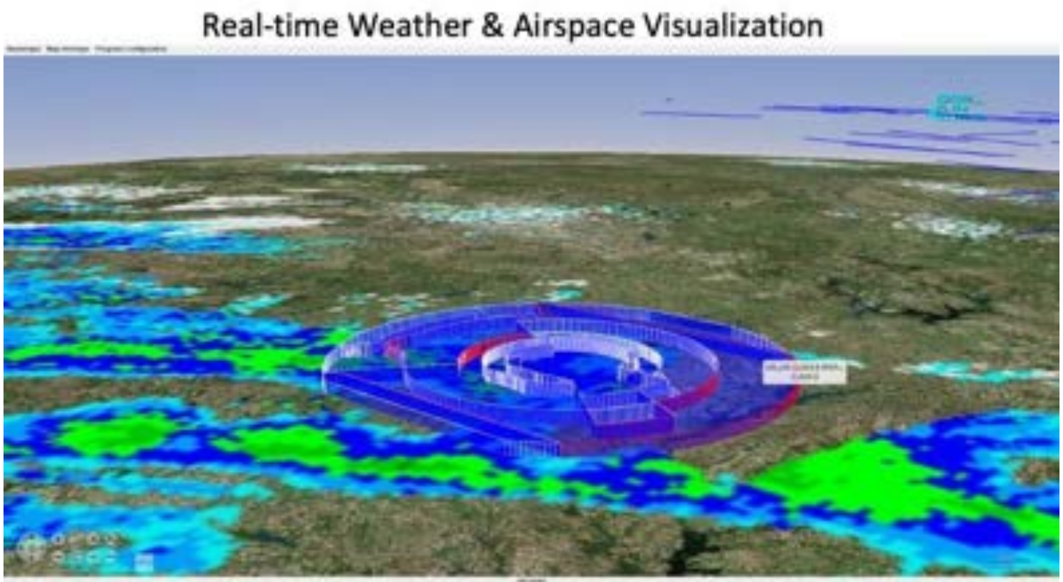
National Geographic



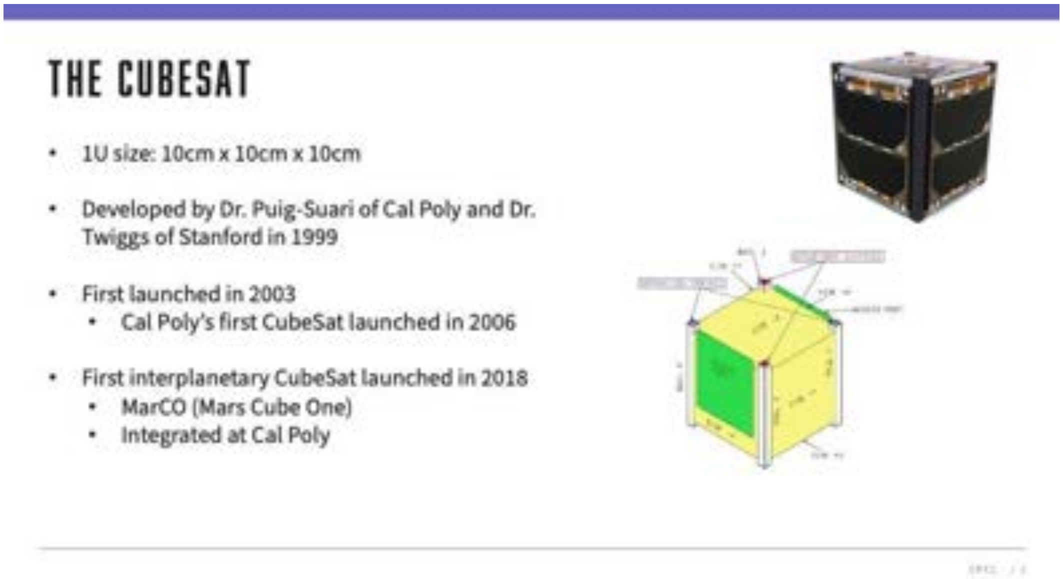
Airspace regulation

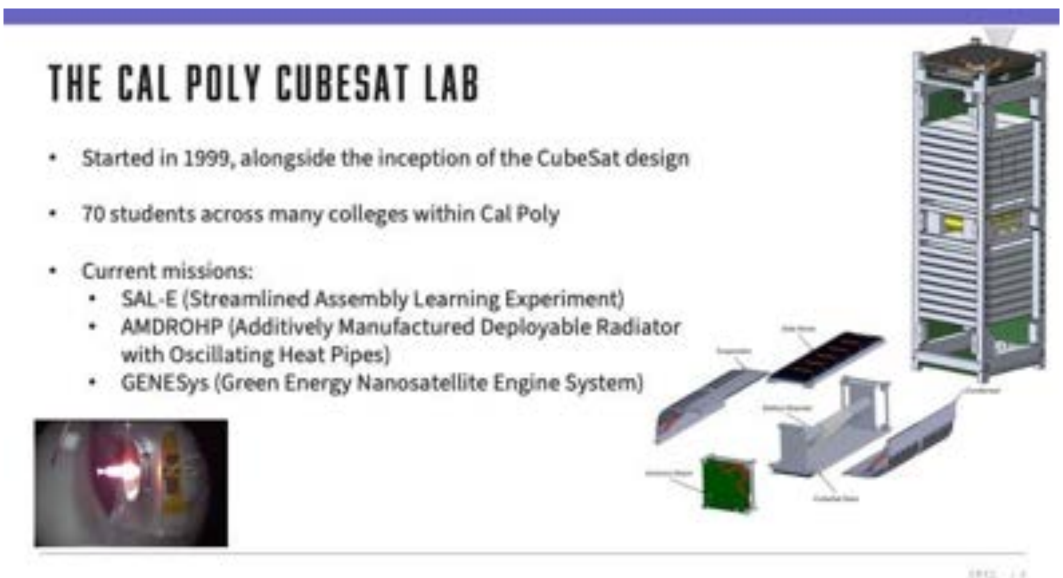



Observing System Simulation Experiments (OSSEs)
Using OSSEs we are able to determine the impact that a 3D Mesonet could have on numerical weather forecasts. The OSSEs will also help guide our decisions regarding how many stations are needed, how high the UAVs should fly, how often we flights are needed, the vertical resolution needed, how accurate the measurements need to be, and
"Nature"
Simulation of Observations
Data Assimilation
Forecasts with and without
Verification
Calibration
Frame from the Nature Run to be used for 3D Mesonet OSSE


Real-time Weather & Airspace Visualization

C11 - Polysat Program – Bleakley


THE CUBESAT
1U size: 10cm x 10cm x 10cm
Developed by Dr. Puig-Suari of Cal Poly and Dr. Twiggs of Stanford in 1999
First launched in 2003
Cal Poly's first CubeSat launched in 2006
First interplanetary CubeSat launched in 2018
MarCO (Mars Cube One)
Integrated at Cal Poly


THE CAL POLY CUBESAT LAB
Started in 1999, alongside the inception of the CubeSat design
70 students across many colleges within Cal Poly
Current missions:
SAL-E (Streamlined Assembly Learning Experiment)
AMDROHP (Additively Manufactured Deployable Radiator with Oscillating Heat Pipes)
GENESys (Green Energy Nanosatellite Engine System)

SPACEPORT APPLICATIONS

- Evaluate Performance
  - Dragsail deployment mechanisms
- Obtain Data
  - Increase TRL
- Refine Experiments
  - Implement lessons learned to enhance future prototypes and mission success
- Provide Opportunities
  - Hands-on research and development experience for students

TESTING APPLICATIONS

- IPEX Balloon Test (2012)
  - Over 100,000ft altitude
- Balloon tests can be unreliable and not as expansive as launches from spaceports
- Suborbital advantages:
  - Affordable
  - Recover the CubeSat
  - Controlled testing environment
  - Fast turnaround time

WORKFORCE CONTRIBUTIONS

- Student Engagement and Internships
- Partnerships with Industry
- Hands-On Learning Opportunities
- Workforce Pipeline Development
- Supporting the Growth of the Space Industry
- Enhancing Diversity and Inclusion

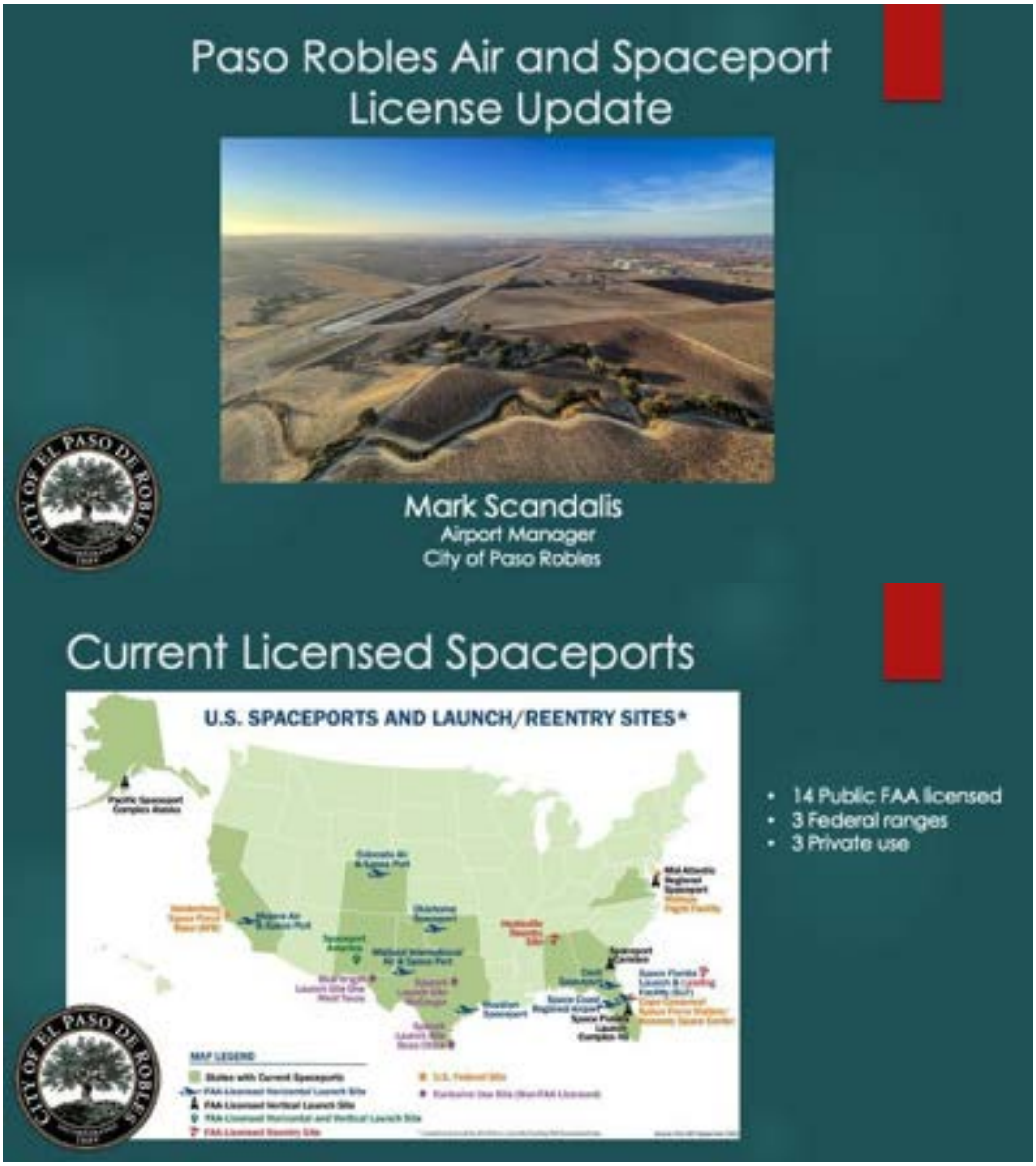
CUBESAT DEVELOPERS WORKSHOP

- Annual CubeSat Conference held at Cal Poly
- April 22-24, 2025
- Unites industry experts, researchers, and students to drive innovation in small satellite technology
- Synergy between local spaceports, industry, and educational institutions

NASA
MILLENNIUM SPACE SYSTEMS
A Boeing Company
ULA


FIND OUT MORE!
CubeSat Workshop
PolySat Website
CUBESAT

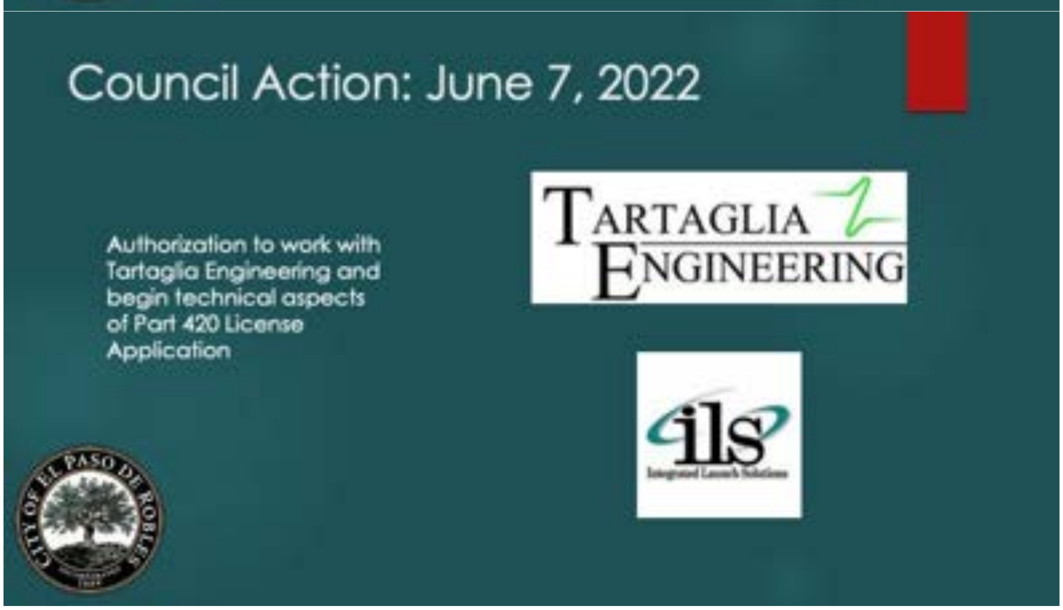
C12 - Paso Robles Air and Spaceport Licensing Update – Scandalis



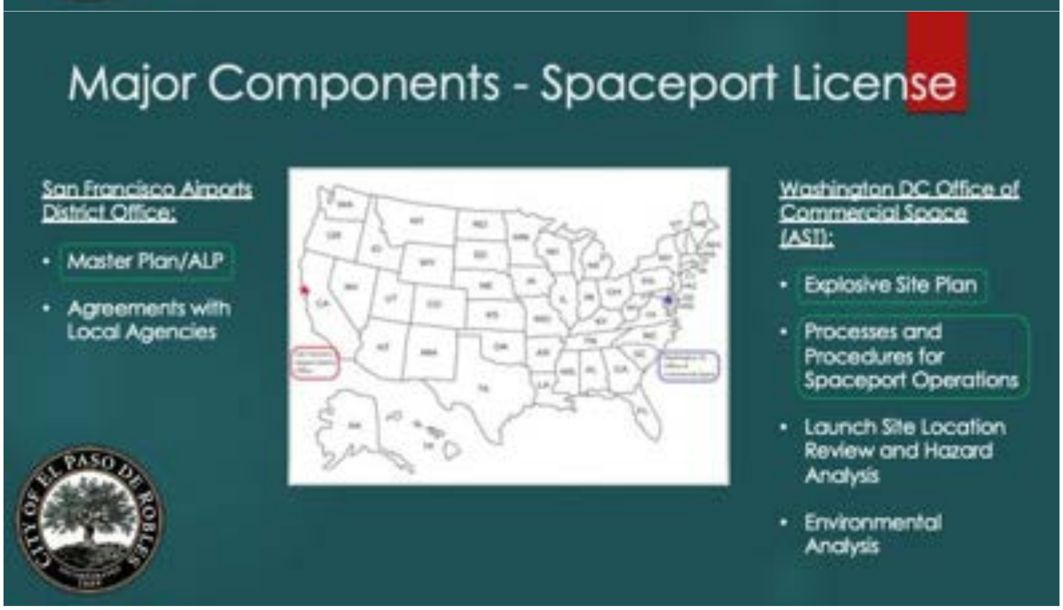

Council Action: August 3, 2021
Authorization to start Preapplication for Spaceport License
THE TRIBUNE
Spaceport in Paso Robles? City wants to turn its airport into horizontal launch facility
Mayor Steve Martin


Council Action: February 28, 2022
Preliminary Technical Review by Tartaglia Engineering and S.O. Witt and Associates LLC
Paso Robles
Spaceport
Preliminary Technical Review


Preliminary Technical Review
CITY OF EL PASO DE ROBLES


Council Action: June 7, 2022
Authorization to work with Tartaglia Engineering and begin technical aspects of Part 420 License Application
TARTAGLIA ENGINEERING
ils
Integrated Launch Solutions
CITY OF EL PASO DE ROBLES

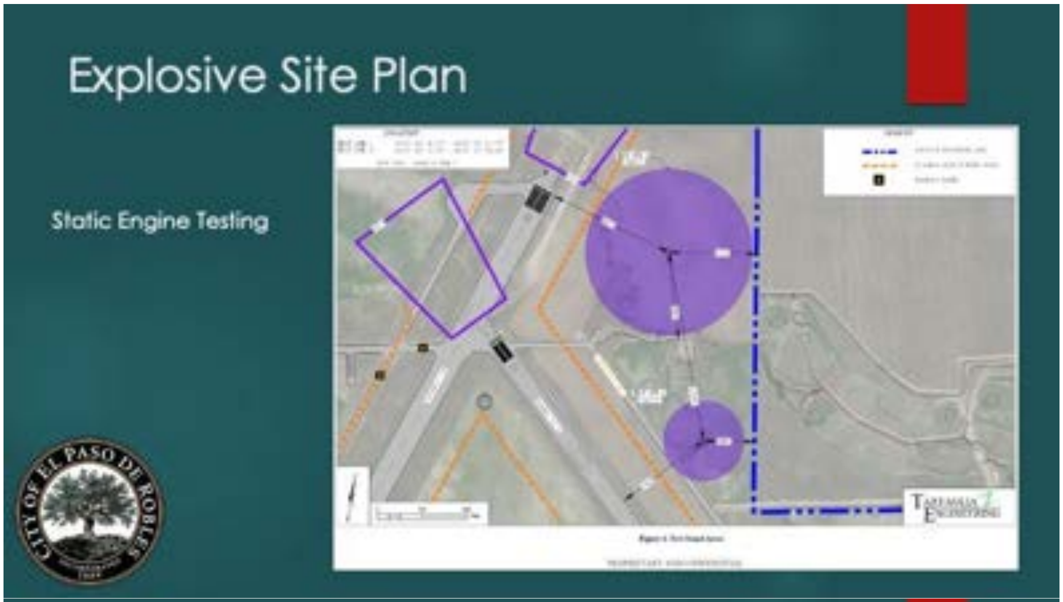

Council Action: August 16, 2022
Authorization to Work with Cal Poly to begin Part 420 License Application
CAL POLY
CITY OF EL PASO DE ROBLES

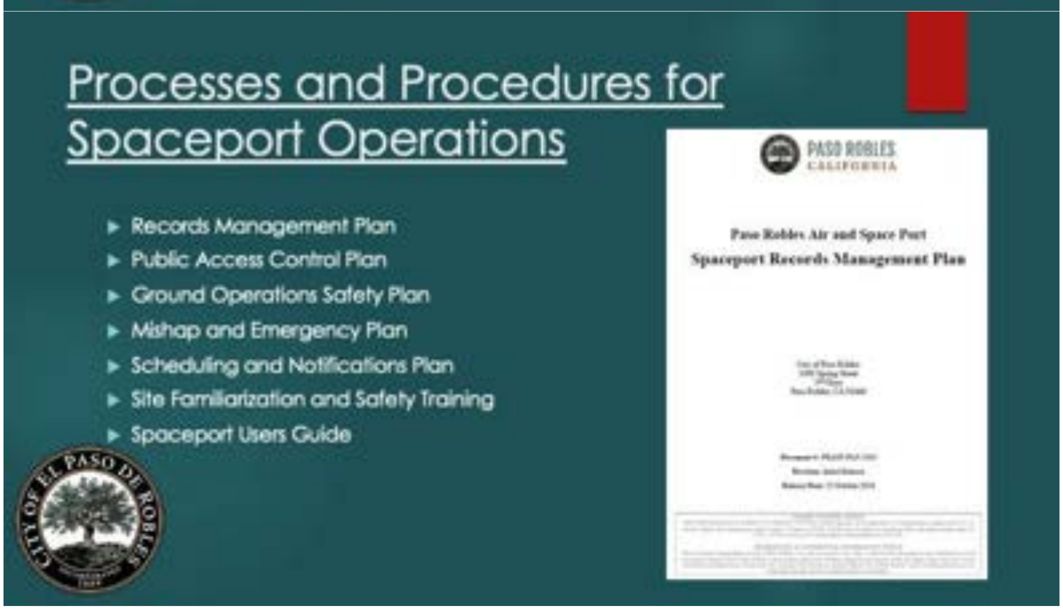

Major Components - Spaceport License
San Francisco Airports District Office:
Master Plan/ALP
Agreements with Local Agencies
Washington DC Office of Commercial Space (AST):
Explosive Site Plan
Processes and Procedures for Spaceport Operations
Launch Site Location Review and Hazard Analysis
Environmental Analysis
CITY OF EL PASO DE ROBLES

Explosive Site Plan

Explosive Site Plan

Spacecraft Fueling and Launch Site


Explosive Site Plan
Static Engine Testing
CITY OF EL PASO DE ROBLES

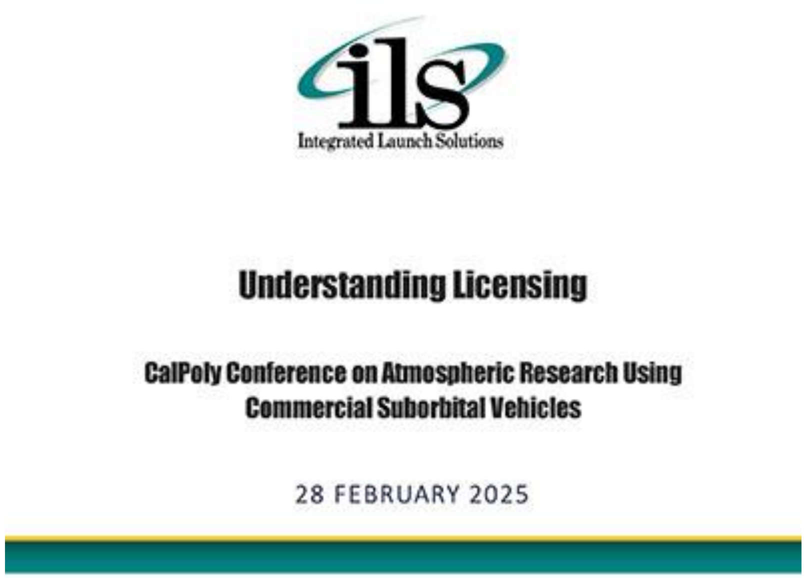

Processes and Procedures for Spaceport Operations
Records Management Plan
Public Access Control Plan
Ground Operations Safety Plan
Mishap and Emergency Plan
Scheduling and Notifications Plan
Site Familiarization and Safety Training
Spaceport Users Guide
PASO ROBLES CALIFORNIA
Paso Robles Air and Space Port
Spaceport Records Management Plan
CITY OF EL PASO DE ROBLES

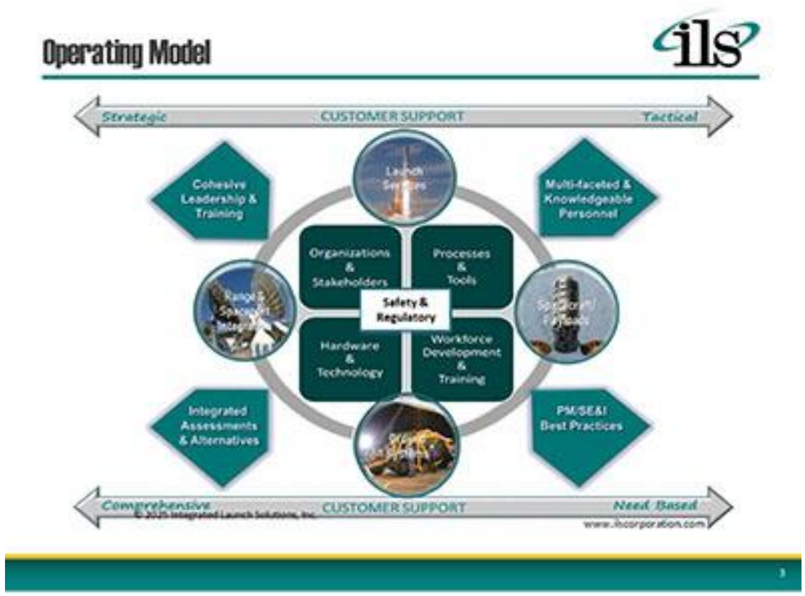

Council Action: April 2, 2024
Authorization Accept FAA Grant to Update Master Plan to Include Spaceport concept (90% FAA Grant)
Coffman Associates
Airport Consultants
CITY OF EL PASO DE ROBLES


To Do
Launch Site Location Review and Hazard Analysis
Environmental Assessment
Agreements with Local Agencies
Coast Guard
FAA Air Traffic
Camp Roberts
Fort Hunter Liggett
Others
CITY OF EL PASO DE ROBLES


Thank You
CITY OF EL PASO DE ROBLES

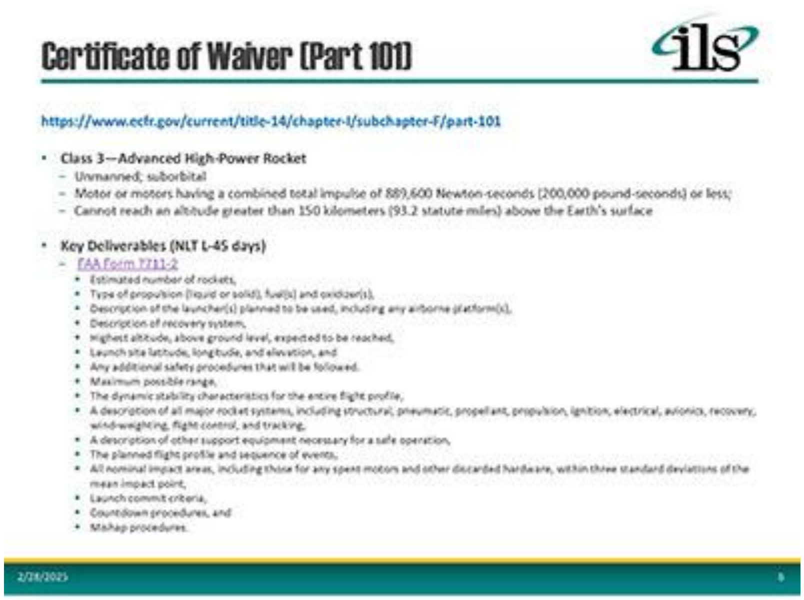
C13 - Understanding Spaceport, Vehicle, and Payload Licensing – Kiernan



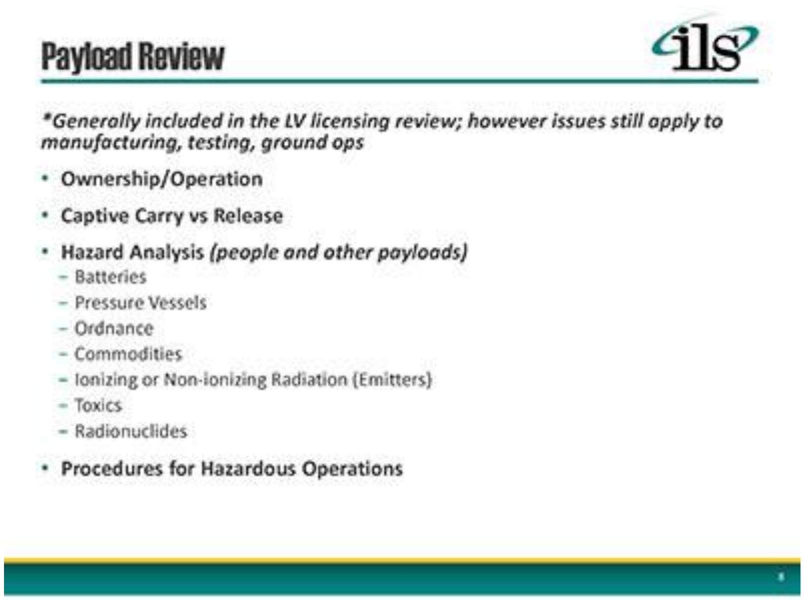

Operating Model
Strategic
CUSTOMER SUPPORT
Tactical
Cohesive Leadership & Training
Launch Services
Multi-faceted & Knowledgeable Personnel
Organizations & Stakeholders
Processes & Tools
Safety & Regulatory
Hardware & Technology
Workforce Development & Training
Integrated Assessments & Alternatives
PM/SE&I Best Practices
Comprehensive
CUSTOMER SUPPORT
Need Based
© 2025 Integrated Launch Solutions, Inc.
www.ilscorporation.com
3


Regulatory Compliance / Licensing
Federal Aviation Administration (FAA)
Part 101 Certificate of Approval or Waiver
Kites
Balloons (Moored, Free)
Amateur Rockets (3 Classes)
Part 414 Safety Element Approval
HW/SW solutions (e.g., Flight Safety System)
Services (e.g., Comm and Telemetry, Recovery)
Part 420 Spaceport Operator License
Vertical
Horizontal
Part 450 Launch/Reentry Vehicle License
Suborbital/Orbital Expendable Launch Vehicles
Suborbital/Orbital Reusable Launch Vehicles
Reentry Vehicles
Federal Communications Commission (FCC) [spectrum]
National Oceanic and Atmospheric Administration (NOAA) [imaging]
Environmental Protection Agency (EPA)
State/County specific
4


Spaceports (Part 420)
ils
• FAA responsible for International Policy, Public Safety, Environmental Stewardship
• Site Ownership, Integration & Safety
– Spaceport User Guidelines & Requirements
– Explosive Site
– Lightning Protection
– Hazard Analysis
– Ground Safety
– Flight Safety
– Public Access Control
– Scheduling and Notification
– Records Management
– Mishap and Emergency Response Plan
– Site Familiarization and Safety
• Environmental Review
• Agreements
5


Certificate of Waiver (Part 101)
ils
https://www.ecfr.gov/current/title-14/chapter-I/subchapter-F/part-101
• Class 3—Advanced High-Power Rocket
– Unmanned; suborbital
– Motor or motors having a combined total impulse of 889,600 Newton-seconds (200,000 pound-seconds) or less;
– Cannot reach an altitude greater than 150 kilometers (93.2 statute miles) above the Earth's surface
• Key Deliverables (NLT L-45 days)
– FAA Form 7711-2
• Estimated number of rockets,
• Type of propulsion (liquid or solid), fuel(s) and oxidizer(s),
• Description of the launcher(s) planned to be used, including any airborne platform(s),
• Description of recovery system,
• Highest altitude, above ground level, expected to be reached,
• Launch site latitude, longitude, and elevation, and
• Any additional safety procedures that will be followed.
• Maximum possible range,
• The dynamic stability characteristics for the entire flight profile,
• A description of all major rocket systems, including structural, pneumatic, propellant, propulsion, ignition, electrical, avionics, recovery, wind-weighting, flight control, and tracking,
• A description of other support equipment necessary for a safe operation,
• The planned flight profile and sequence of events,
• All nominal impact areas, including those for any spent motors and other discarded hardware, within three standard deviations of the mean impact point,
• Launch commit criteria,
• Countdown procedures, and
• Mishap procedures.
2/28/2025
6


Launch/Reentry Vehicle Operator License (Part 450)
ils
https://www.ecfr.gov/current/title-14/chapter-III/subchapter-C/part-450
Means of Compliance
• Toxics Assessment for Flight
• Toxics Assessment for Ground
• Flight Safety Analysis Methodologies
• Highly Reliable Flight Safety System
• Lightning Protection
Policy Review
• Company Overview/Ownership
• Program Overview
• Site Overview
• Flight Profile Overview
Environmental Review
• Written Re-evaluation [of site with existing EA]
• Environmental Assessment (EA) [change in nature of operations]
• Environmental Impact Statement (EIS) [greenfield]
Payload Review
• Envelope payload types/hazards
• Processes for reviews
• Payload specific review
Safety Review
• System Safety Program
• Functional Hazard Analysis
• Hazard Control Strategy
• Flight Abort
• Flight Hazard Analysis
• Wind Weighting
• Physical Containment
• Flight Safety Analysis
• Normal Flight Trajectory Analysis
• Malfunction Flight Trajectory Analysis
• Population Exposure Analysis
• Probability of Failure Analysis
• Flight Hazard Area Analysis
• Debris Risk Analysis
• Far field overpressure analysis
• Toxics for flight analysis
• Computing Systems
• Safety Critical Systems OR
• Highly Reliable FSS
• Operations (Agreements, Procedures, Readiness, Comm, Tracking, etc.)
• Collision Avoidance
• Mishap and Emergency Planning
• Ground Safety
> 12 months
Pre-Application Consultation
Means of Compliance
3-6 weeks
"Complete Enough" Determination
180 days
Application Review/Approval
Phase 1
Phase 2
Phase 3
Launch
90 days
App Updates
2/28/2025
7


Payload Review
ils
*Generally included in the LV licensing review; however issues still apply to manufacturing, testing, ground ops
• Ownership/Operation
• Captive Carry vs Release
• Hazard Analysis (people and other payloads)
– Batteries
– Pressure Vessels
– Ordnance
– Commodities
– Ionizing or Non-ionizing Radiation (Emitters)
– Toxics
– Radionuclides
• Procedures for Hazardous Operations
8


License Approval Schedule/Cost Drivers
ils
Maturity, availability, and level of fidelity of the launch vehicle design and test data.
Certification of the Autonomous Flight Safety and Navigation Systems to RCC 319/324.
Flight Safety Analysis Methodologies require deep dive into model source data and algorithms, 6-DoF trajectory model, materials/debris, risk analysis software (third party), and benchmarking data/information. [critical path]
Approval of Flight Safety Analysis Methods and satisfaction of risk criteria (e.g., population overflight, debris risk, hazard area control, expected casualty) [critical path]
FAA-AST resources and review timelines (extremely backed up – "the queue").
FAA-AST evolving expectations and checklists (each vehicle/mission/flight profile has a learning curve).


Paso Robles Air and Space Port
ils
Licensing
– Plans/Procedures
– Flight corridor and launch area analysis
– Environmental Review
Spaceport/Customer Integration
– ConOps/Requirements Review
– Safety Review
Hazard Analyses
Process/Procedure Reviews
– Licensing / Approval Guidance & Support
Infrastructure
– Capabilities and services
– Facility layout
– Operability
Community Outreach / Communication
PASO ROBLES
10


Contact Information
Integrated Launch Solutions, Inc.
350 Tangerine Ave. STE 5
Merritt Island, FL 32953
www.ilscorporation.com
Cheree Kiernan
cheree.kiernan@ilscorporation.com
(o) 321-877-2206
(m) 321-830-2481
11

C14 - Bridging the Gap: Collaboration Between Industry, Academia, & Government for Spaceport Operations – Kiernan, Meyer, Sanchez, Crocket, Mierau


Industry Challenges/Gaps
Purpose/Utilization – If you Build it, Will They Come?
It's easier to get a spaceport operator license than a launch license
Paso's approach → Education is a purpose with a spaceport
Funding – What Comes First, the Chicken or the Egg?
Can't get contracts without the vehicles and infrastructure
Can't get vehicles and infrastructure without the contracts
Low-cost programs require low-cost platforms which require high launch cadence
Paso's approach → Leverage education grants, private industry, and consortiums to potentially sponsor payloads and flights
Spaceport Ecosystem – It Takes a Village!
Think beyond launch operations (e.g., R&D, engineering, manufacturing, test, etc.)
Engage support services (e.g., Logistics, Processing, Comm and Telemetry, etc.)
Engage the community using recurring and open communication
Paso's approach → Here we are today
Workforce/Education – Can We Create and Keep Skilled Resources Here!
Availability of engineers, technicians, quality, safety, security, contract management,…
Paso's approach → Leverage local and state resources to educate, prioritize, and train the workforce to attract and sustain new business/industry.


Employment Training Panel
Building the Paso Robles Space Economy
February 28, 2025
Robert Meyer
Director of Economic Development
916- 737-4181
Robert.Meyer@etp.ca.gov
CA ETP
EMPLOYMENT TRAINING PANEL


Essential ETP
ETP is a business and labor supported State agency that uses a pay-for-performance contract to reimburse the costs for employer-customized job skills training.
The Panel works because employers define the occupations to be trained, training topics, delivery methods and training providers.
ETP will award $95M in contracting capacity for FY24/25.
ETP
WWW.ETP.CA.GOV


ETP Contract Models
Single Employer ($600,000 cap for FY2024/25)
ETP eligible employer trains employees in employer-customized job skills training.
Multiple Employer Contractor (MEC) ($850,000)
ETP contractor aggregates training needs to train and place job seekers and/or upskill workers.
• Group of Employers (Trade Association, Chamber of Commerce, Economic Development Corporation)
• Training Agency (University Foundations, K-16)
• Workforce Development Board, WIOA Grant Administrators
ETP
WWW.ETP.CA.GOV


Job Creation, Equity and Impact
Priority Industries and Small Business
-Grow businesses, create new jobs, and retain jobs
-Align training programs to fit job needs
Climate and Environmental Strategy
-RESPOND to natural disasters, Forestry Workforce,
-Agriculture Technology and Workforce
-Support zero-emission vehicle technology
Aligned State / Federal Grants
-CASCADE (OLUCI), CHIPS Act, DOD Supply Chain
Equity
-Focus on underrepresented workers and job seekers
-Support economically disadvantaged communities
ETP
WWW.ETP.CA.GOV


Wider Investment Lens
California Jobs First
-Leveraging the Uplift Central Coast regional plan
California Workforce Development Board
-High Road Training Partnerships
-Workforce Accelerator Fund
Department of Industrial Relations /
Division of Apprenticeship Standards
-Apprenticeship Innovation Funding
Federal Investment for Defense and Energy Sectors
-Leveraging investments for adding resilience and capacity to DOD and DOE supply chains particularly for manufacturing and technology
ETP
WWW.ETP.CA.GOV


Employment Training Panel
Connect with our team!
ETP
connect@etp.ca.gov
916-737-4181
Thank you for your time!
connect@etp.ca.gov
916-737-4181