Alliance for Space Development 2022

Citizens' Space Agenda

WHO WE ARE:

- Private U.S. citizens who advocate at our own expense for a bold and well-reasoned space agenda worthy of the U.S.

NON-PROFIT SUPPORTING ORGANIZATIONS:

- National Space Society
- Space Frontier Foundation
- Foundation for the Future
- The Lifeboat Foundation
- The Mars Foundation
- The Mars Society
- The Moon Society
- Space Development Foundation
- Space Development Network
- Space Development Steering Committee
- Space for Humanity
- Space Renaissance USA
- Space Tourism Society
- Students for the Exploration and Development of Space
- Waypaver Foundation

Alliance for Space Development Goals

1. Reduce the cost of access to space
2. Stimulate and accelerate the growth of space industries and commerce
3. Make the development and settlement of space a clearly defined part of why we are sending humans into space

Alliance for Space Development 2022 Objectives

Citizens' Space Agenda

1. Protect Earth from hazardous asteroids by funding the **NEO Surveyor** space telescope optimized for detecting asteroids ($170M; $130M above PBR)
2. Support continued US access to, and presence in, low Earth orbit (LEO) by fully funding **Commercial LEO Destinations** program ($270M)
3. Jumpstart US leadership in Space Solar Power by funding Office of Space Commerce (DoC) to study public-private partnerships on SSP. ($2M)
4. Accelerate US leadership in the space economy by funding the Office of Space Commerce to study a Strategic Space Commodities Reserve. ($2M)

The Asteroid Threat

About 25,000 asteroids >140 meters across and half a million asteroids 44-140 meters across could come close to Earth.[1]

Potential asteroid impact effects range from city-wide destruction to regional devastation to a major extinction event.

65,000,000 years ago: Chicxulub Extinction Event. A 6-9 mile wide asteroid struck near what is today the Yucatán Peninsula, Mexico. Impact created a 90-mile wide crater and led to the extinction of 75% of then living animals.[2]

50,000 years ago: Meteor Crater, Arizona. A 160 ft meteor created a crater ¾ mile across, 560 ft deep. Resulting fireball 12 miles across; large animals killed or wounded within 15 miles; major winds and pressure up to 25 miles away.[3]

June 1908: Tunguska, Siberia. An airburst devastated 5 mile diameter area, leveled forrest in a 35 x 43 mile area (830 sq mi). Knocked people off their feet and broke windows hundreds of miles away. Estimated 150-250 ft object and a 10-20 megaton yield.[4]

Feb 2013: Chelyabinsk, Russia. A ~65 ft asteroid exploded at 95,000 ft, damaging buildings, collapsing roofs, shattering windows in 50 x 100 mi area; up to 1600 injured. Estimated yield ~400-500 kilotons.[5]

Near-misses happen regularly. Large, previously unknown asteroids came within 50% the distance to Moon, with days, weeks, or no notice, in 2008, 2013, 2018, 2019, and 2022.[6]

Chelyabinsk Meteor, Feb 2013
Credit: Alex Alishevskikh

Meteor Crater, Arizona (Source: USGS)

Planetary Defense Programs

Congress directed NASA to locate 90% of >140 meter near Earth asteroids (George E. Brown, Jr, NEO Survey Act, 2005) by 2020. Far from complete.[7]

NASA estimates with current survey methods it will take 30+ years to meet this goal, as of Jan 2022.

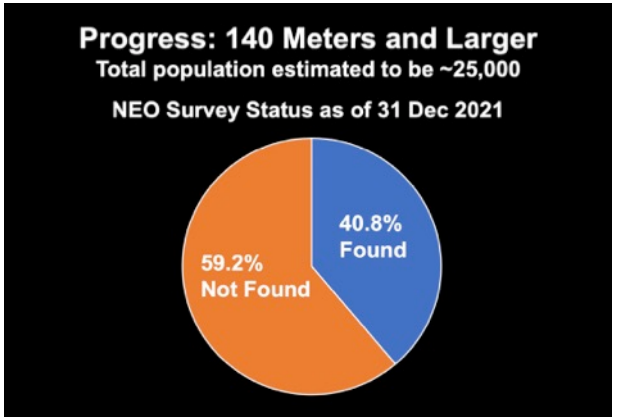
NASA Planetary Defense program (~$40M/year) supports numerous ground telescope surveys. Along with international observations and analysis, these provide most of our detection capability.

2010 National Academies report: IR space telescope plus ground-based surveys is most effective way to meet the "90% of >140m" survey goal.[8]

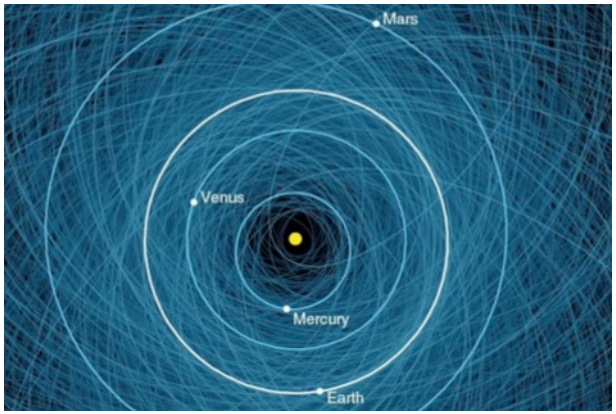
NEOWISE: A retired space telescope reactivated in 2013 to search for NEOs. Narrow field of view, sensor wavelength, and orbital position are not optimal for the task. Mission ends summer 2023.

2019 National Academies report: To achieve the 90% of >140m goal in the next 10 years, "NASA should fund a dedicated space-based infrared survey telescope." Also said asteroids *smaller than 140m* are a significant hazard.[9]

2022 Planetary Science Decadal Survey: NASA should launch NEO Surveyor as soon as possible. Rising cost of flagship missions should not delay NEO Surveyor.[10]



George E. Brown, Jr. NEO Surveillance Act Progress
Source: NASA PDCO



Orbits of known potentially hazardous asteroids
Source: NASA-JPL

NEO Surveyor Mission

NEO Surveyor will provide improved capabilities to find and characterize NEOSM more effectively than ground-based telescopes or NEOWISE.

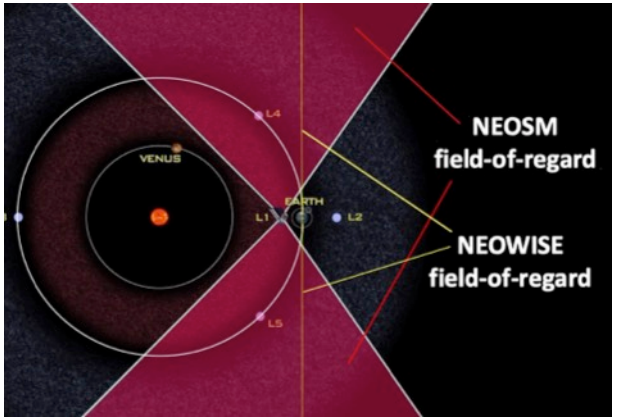
- Optimized for infrared spectrum to spot dark asteroids, and accurately assess their size.
- Orbit at the Earth-Sun L1 point, allowing it to detect objects closer to the sun and inside Earth's orbit.
- Total cost less than $1B if fully funded.

Significant improvement in detection and progress toward the *GEB NEO Survey Act* goal. Expected to locate:

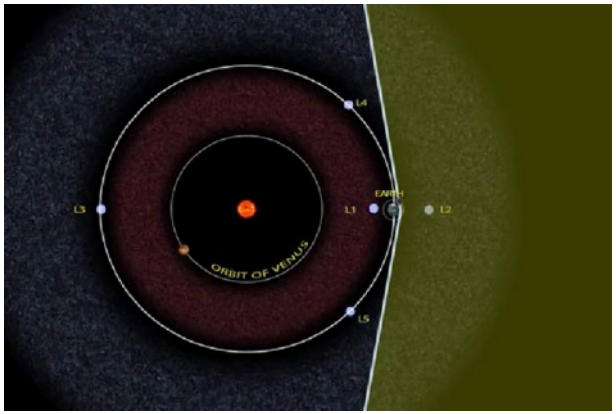
- 2/3 of >140 meters NEOs within five years.
- More than 90% of >140 meter NEOs within 10 years.

Program schedule as of Jan 2022:

- June 2021, NASA approved NEO Surveyor for Preliminary Design phase.
- Jan 2023, Expected Final Design and Fabrication.
- Planned launch in 2026.



NEO Surveyor field of regard compared with NEOWISE (Adapted from NASA image)



Field of regard for ground-based telescopes. (NASA Image)

NEOSM Needs Your Support

FY22 Appropriation $142M (first year as budget line item); NASA withheld most of this funding from NEOSM.

FY23 program expected $170M to support scheduled launch in 2026.

PBR included only $39.9M (a 76% reduction) and announced "at least 2 year delay."

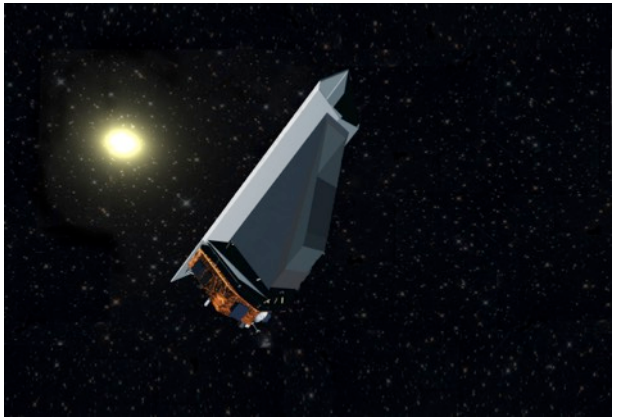
- Justification: to *pay for cost overruns* of flagship programs.

House CJS Appropriation Bill provided $98.8M; directed launch in 2027.

NASA Authorization Act 2022 instructs NASA to annually report:

- All Planetary Defense fund expenditures,
- Progress toward *GEB NEO Survey Act* goal,
- Progress toward launching NEOSM by March 2026 or as soon as practical.

Can you support restoring up to $170M for NEOSM?



NEO Surveyor (rendering) *Created for NSS from NASA JPL image*

Illustration: Sebastian Kaulitzki. Wikimedia

Footnotes

1. Asteroid Institute. https://asteroidday.org/resources/asteroid-learning/how-many-near-earth-asteroids-are-there-to-find

2. The exact mechanisms linking the Chicxulub impact event to the mass extinctions between the Cretaceous and Tertiary Periods are still debated, however a consensus believe the impact caused, directly or indirectly, the extinction of about 75% of then-living animals. See Gulick, Sean P. S. et al. (2019) The first day of the Cenozoic. Proceedings of the National Academy of Sciences, Vol. 116, Number 39, 19342-19351. https://doi:10.1073/pnas.1909479116, https://www.smithsonianmag.com/science-nature/dinosaur-killing-asteroid-impact-chicxulub-crater-timeline-destruction-180973075/, and https://www.lpi.usra.edu/science/kring/Chicxulub/

3. "Barringer". Earth Impact Database. Planetary and Space Science Centre University of New Brunswick Fredericton. http://www.passc.net/EarthImpactDatabase/New%20website_05-2018/Barringer.html

4. Tunguska Event: Boyarkina, A. P., Demin, D. V., Zotkin, I. T., Fast, W. G. "Estimation of the blast wave of the Tunguska meteorite from the forest destruction". Meteoritika, Vol. 24, 1964, pp. 112–128. Peter Jenniskens, Olga P. Popova, Dmitry O. Glazachev, Elena D. Podobnaya, Anna P. Kartashova, "Tunguska eyewitness accounts, injuries, and casualties," Icarus, Volume 327, 2019, Pages 4-18. https://doi.org/10.1016/j.icarus.2019.01.001

5. "2013 February 15 Chelyabinsk fireball," SETI Institute Blog, 29 Nov 2013.http://cams.seti.org/index-chelyabinsk.html and David, Leonard. "Russian Fireball Explosion Shows Meteor Risk Greater Than Thought." Space.com, 7 Oct 2013, https://www.space.com/23423-russian-fireball-meteor-airburst-risk.html

6. Notable close approaches of previously unknown, >50m asteroids: 2008 (https://www.spacereference.org/asteroid/418135-2008-ag33), 2013 (https://en.wikipedia.org/wiki/List_of_asteroid_close_approaches_to_Earth_in_2013), 2018 (https://en.wikipedia.org/wiki/2018_GE3), 2019 (https://www.universetoday.com/143527/this-summers-asteroid-near-miss-helped-greenlight-nasas-neocam-mission-to-search-the-skies-for-killer-spacerocks/), 2022 (https://www.virtualtelescope.eu/2022/07/07/near-earth-asteroid-2022-nf-extremely-close-encounter-a-image-6-july-2022/).

7. George E. Brown Act NEO Survey Act, 2005 https://www.congress.gov/bill/109th-congress/senate-bill/1281/text.

8. National Research Council. 2010. Defending Planet Earth: Near-Earth-Object Surveys and Hazard Mitigation Strategies. Washington, DC: The National Academies Press. https://doi.org/10.17226/12842.

9. National Academies of Sciences, Engineering, and Medicine. 2019. Finding Hazardous Asteroids Using Infrared and Visible Wavelength Telescopes. Washington, DC: The National Academies Press. https://doi.org/10.17226/25476.

10. National Academies of Sciences, Engineering, and Medicine. 2022. Origins, Worlds Life: A Decadal Strategy for Planetary Science and Astrobiology 2023-2032. Washington, DC: The National Academies Press. https://doi.org/10.17226/26522.

Commercial LEO Development - CLD

Orbital Reef (Source: Blue Origin)

Starlab (Source: Nanoracks)

Axiom Station (Source: Axiom)

HALO (Source: Northrop)

Commercial LEO Development Program

- We have had a sustained human presence in Low Earth Orbit (LEO) with the International Space Station (ISS) since 2000. The ISS has a limited lifetime and is scheduled to be decommissioned in 2030. To support NASA needs, maintain the ISS national laboratory, and to continue to grow the LEO economy we need a gapless transition away from the ISS.
- Commercial companies are developing their own platforms that NASA will use post-ISS. Current funding from NASA compensates the companies for adhering to NASA's process and reporting requirements. No NASA funds are currently intended for actual station construction.
- These stations will be partially supported by government purchase of space-produced goods and services. Guaranteed markets with fixed prices helps companies raise capital for product development. All expect to become independent stations with a diverse customer base.
- A robust commercial ecosystem in LEO can satisfy the government's need for a LEO facility at a far lower cost than ownership.
- Commercial LEO stations can provide a greater range of services to international partners than the ISS can currently support.

Commercial LEO Development Program

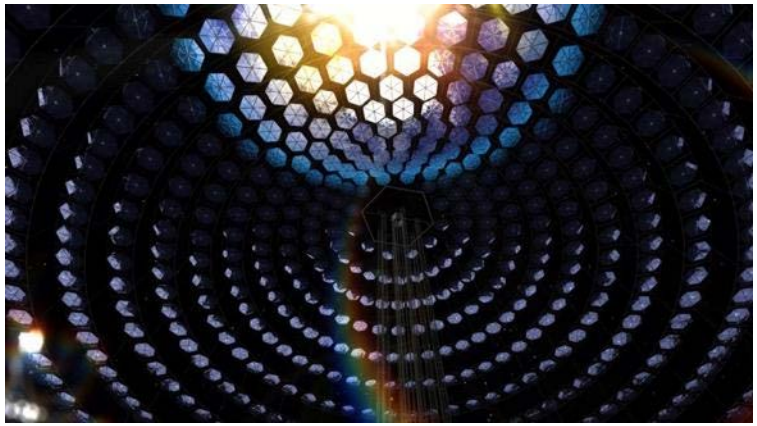
- The Commercial LEO Development Program supports:
  - Commercial development/transition of LEO facilities and transportation from NASA to commercial partners. This has already begun.
  - Development of Commercial LEO Destinations (CLD) and capabilities for use by NASA and the private sector to enable a seamless ISS transition.
  - Stimulation of the growth of commercial activities in LEO such as biotech manufacturing (artificial retinas, artificial hearts, cartilage, etc) and advanced materials (high quality fiber optics and single-crystal semiconductor wafers).
- Request:
  - Support the FY2023 CLD request by the administration of $224.3M
  - Support $691.9M as requested over FY2023-2025 for CLD stations
  - An additional $500-600M or more over FY2024-2030 to purchase CLD products

ISS at Risk Due to Situation in the Ukraine

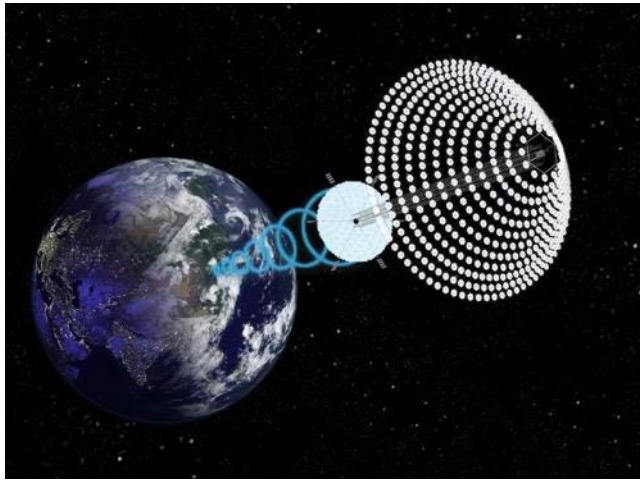
The Russian invasion of Ukraine has created a significant risk that Russia has said they will withdraw from the ISS by 2024, prematurely ending a program of immense value, and risking uncontrolled re-entry of the entire station.

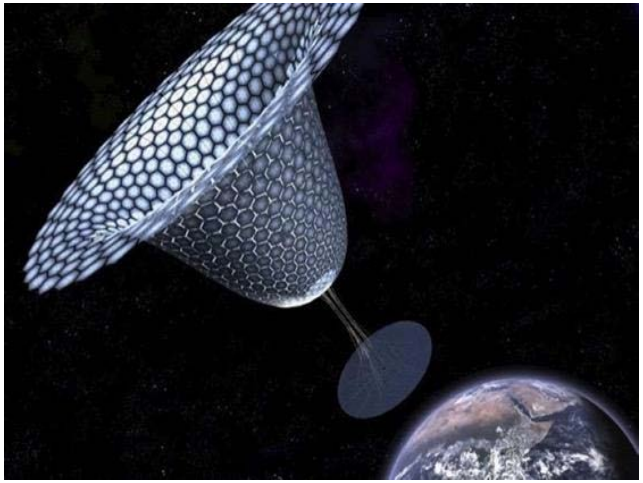
- **Congress should direct NASA to develop a contingency plan within 90 days to continue ISS operations in case Russia withdraws any time between now and 2024.**
    - **Congress should provide emergency funding to replace all essential Russian functions by 2024.**
- **Congress should provide additional emergency funds to accelerate the Commercial LEO Destination (CLD) program so that multiple commercial space stations become operational as soon as possible.**

Space Solar Power (SSP)



SSP uses mirrors that reflect onto panels that take in sunlight on one side and put out microwaves on the other (Source: John Mankins)





Space Solar Power (SSP)

- SSP refers to gathering the Sun's energy in space and beaming it to Earth.
  - Can supply huge quantities of reliable, predictable, carbon free base load energy.
  - Integrates well with ground solar and wind.
  - Can export energy to global markets.
- In the past SSP could not compete with ground production. However:
  - Launch cost is a large fraction of SSP expense. It has dropped substantially (from $20,000/kg to $1,400/kg) in the last 10 years, and new vehicles in flight test today may reduce these costs a great deal more.
  - Manufacturing space hardware is an even larger expense. Hyper modular designs consisting of large numbers of identical modules amenable to mass production have been demonstrated by fleets of identical communication satellites to reduce hardware cost by as much as 99%.
- Much of the needed technology has been developed, but significant technical and financial risks remain. Much of this risk could be retired by sub-scale SSP demonstration plants built as public/private partnerships.
- See materials at space.nss.org/space-solar-power-resource-page

Space Solar Power (SSP)

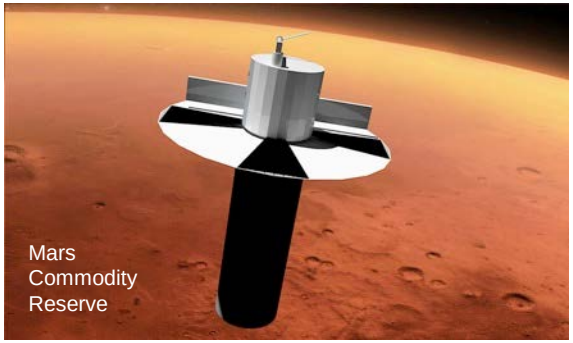
- A partial sample of SSP momentum:
  - Japan's Basic Space Law Development added a demonstration of SSP microwave wireless power transmission from low Earth orbit (LEO) to Earth by 2025.
  - UK delivered a September 2021 report finding that SSP can be price competitive while making a significant contribution to achieving carbon Net Zero by 2050.
  - Beyond Earth Institute published a very positive August 2021 report and a draft Space Policy Directive placing SSP at the heart of a government-wide initiative
  - Progressive Policy Institute published a very favorable report in August 2021.
- The energy market is so large that those developing successful SSP will dominate cislunar space. China has a vigorous SSP program.

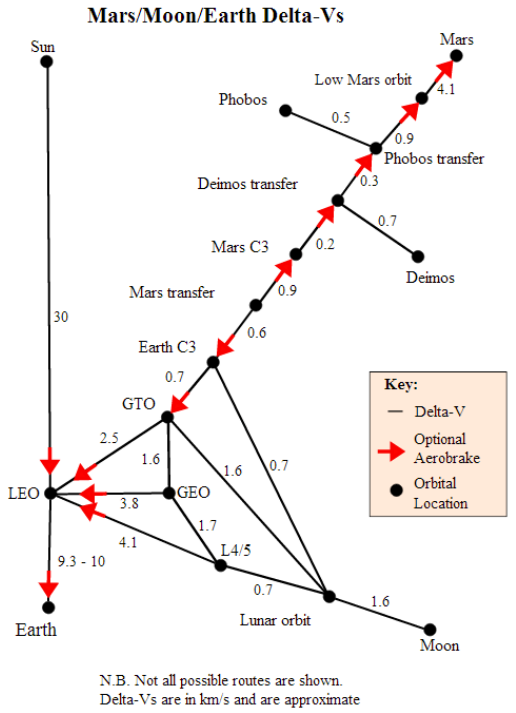
Request: Will you support (FY2023)

- **$2M to the DoC office of Space Commerce to propose a program along the lines of NSS' *A Public/Private COTS-Type Program to Develop Space Solar Power*?**
- **DoD's Space Rapid Capabilities Office at $80M (PE 1206857SF) with at least $60M for SSPIDR for global energy distribution from space?**
- **DoD's Operational Energy Capability Improvement Fund at $74M (PE 0604055D8Z) with at least $24M for power beaming and advanced photovoltaics tech. development?**
- **DoD's OECIF – Non S&T (PE 0604555D8Z) at $28M with at least $8M for power beaming and advanced photovoltaics prototyping and transition?**

Strategic Space Commodities Reserve

In order to incentivize the commercial development of the Earth/Moon system, the U.S. Government should create a commodities purchase program for delivery to key locations in the Earth/Moon/Mars system.





Strategic Space Commodities Reserve

- Commodities are chemical precursors containing Carbon, Hydrogen, Oxygen, Nitrogen, Phosphorus, Sulfur, and/or Sodium (CHONPSS) which can be used to create air, water, fuel, fertilizer, and most organic compounds.
- The price paid is a combination of the base mass and a transportation component. Example: if a kilogram of water to the ISS costs $2,000/kg and the base calculated cost of 1kg transported from the Moon to Earth orbit is $3,000/kg, then the price paid at ISS for 1kg of lunar water is $5,000.
- **No money is paid unless and until the commodity is delivered.** Initial amounts will be small enough to fit into existing program's reprogramming authority. See FAA launch indemnification laws for triggering legislative events.
- Commodity depots at each node are provided commercially and are financed through Government loan guarantees with revenue coming from storage fees for non-Government purchased commodities and other services.

Strategic Space Commodities Reserve

Benefits

- Government acts as an aggressively neutral market maker.
- Immediate appropriations are not required.
- Payment only on delivery makes it difficult to game through political means.
- Government is buying an asset that can increase in value.
- Is purely agnostic as to how the commodity is derived or where it came from. Space logistics companies can rely on a market and futures contracts can monetize and match producers and consumers.

Will you support:

- **$2M in funding the Office of Space Commerce in the Department of Commerce to develop an enabling plan for the creation and operation of the Reserve?**