




2-8-2023

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Alec Fante

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Recommended Citation

Alec Fante, *Who is Manning the Ship? The Environmental and Legal Questions Facing the Emerging Commercial Space Tourism Market*, 34 Vill. Envtl. L.J. 33 (2023).

Available at: <https://digitalcommons.law.villanova.edu/elj/vol34/iss1/2>

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WHO IS MANNING THE SHIP? THE ENVIRONMENTAL AND LEGAL QUESTIONS FACING THE EMERGING COMMERCIAL SPACE TOURISM MARKET

I. INTRODUCTION TO SPACE TOURISM: PREPARING FOR LIFTOFF

Spaceflight events during 2021 — such as tourism flights and private space missions led by Jeff Bezos, Elon Musk, Richard Branson, and more — ushered in a new era for space exploration.¹ The rapidly growing space tourism industry highlights the need for updated federal regulation and provokes polarizing viewpoints on its potential environmental ramifications.² The recent surge of space travel by billionaires is a large reason for the growing popularity within the industry.³

Since the beginning of the United States' space program in the 1950s, the environmental impacts of society's actions have become more apparent.⁴ Tremendous advances in technology and a growing awareness of the Earth's vulnerability gave rise to the environmental movement.⁵ Apollo 8 astronaut William Anders's 1968 photograph of Earth heavily contributed to the environmental conservation movement.⁶ This photo allowed the environmental movement to gain momentum and ultimately led to the creation of

1. See Michael Sheetz, *Why the First SpaceX Astronaut Launch Marks a Crucial Leap for NASA's Ambitions*, CNBC (June 3, 2020, 2:18 PM), <https://www.cnbc.com/2020/06/03/first-spacex-astronaut-launch-marks-crucial-leap-for-nasa-ambitions.html/> (discussing impact of commercial space companies on space flight and space exploration).

2. See Thomas J. Herron, *Deep Space Thinking: What Elon Musk's Idea to Nuke Mars Teaches Us About Regulating the "Visionaries and Daredevils" of Outer Space*, 41 COLUM. J. ENVTL. L. 553, 584, 588 (2016) (reviewing current federal regulatory framework and environmental considerations of federal government); see also Emma Derr, *Space Is Crucial to Understanding Climate Change*, NUCLEAR ENERGY INST. (Sept. 17, 2021), <https://www.nei.org/news/2021/space-is-crucial-to-understanding-climate-change/> (asking whether environmental impact from space travel outweighs possibility that space travel will protect Earth's environment long-term).

3. For a discussion on the space tourism industry's recent surge in popularity, see *infra* notes 57-65 and accompanying text.

4. See *The Space Race and the Rise of the Environmental Movement*, MIDDLEBURY COLL., <https://sites.middlebury.edu/landandlens/2016/10/14/the-space-race-and-the-rise-of-the-environmental-movement/> (last visited Sept. 26, 2022) [hereinafter *Space Race and Environmental Movement*] (acknowledging early efforts of United States space program to ally with environmental movement).

5. *Id.* (detailing factors that led to environmental movement).

6. See Greg Autry, *Space Research Can Save the Planet-Again*, FOREIGN POL'Y (July 20, 2019), <https://foreignpolicy.com/2019/07/20/space-research-can-save-the-planet-again-climate-change-environment/> (highlighting connection between space exploration and environmentalism).

Earth Day in 1970.⁷ The first Earth Day sparked national discussion regarding the statutory mechanisms the government must implement to help protect the environment.⁸

More recently — notwithstanding the renewed political interest in space exploration — politicians and the public have not supported increased spending on the space program.⁹ Congress's reluctance to fund space travel means the key to continued space exploration for the United States may be private citizens attempting to conquer space travel.¹⁰ Many conservationists question the motives of space explorers, stating that space programs are a splurge and that billionaires could use their resources to help fix the pressing problems on Earth.¹¹

While debates rage on about the politics, expense, and scientific merit of current space exploration, the driving force behind space travel has changed over the past fifty years.¹² Space research may be essential to solving Earth's problems, most urgently climate change.¹³ The discussion around private space exploration primarily centers on safety, legal, and financial concerns; however, the most important issue may be that humans have depleted Earth's resources and now must look to space for new alternatives.¹⁴ De-

7. *See id.* (tracking response to Apollo 8's photo); Mike Wall, *Earth Day at 50: How Apollo 8's 'Earthrise' Photo Helped Spark the First Celebration*, SPACE.COM (Apr. 22, 2020), <https://www.space.com/earthrise-image-apollo-8-earth-day-50th-anniversary.html> (noting photographs taken from space helped unite scientists and environmentalists). The photo of the Earth, portraying it as a "fragile outpost of life suspended in an endless . . . black void," provided a new perspective for many who had previously seen the planet as an impenetrable sphere. *See id.* (describing Apollo 8's photograph).

8. *See* Wall, *supra* note 7 (illustrating environmental discussions following first Earth Day).

9. *See Your Guide to NASA's Budget*, PLANETARY SOC'Y (Jan. 2022), <https://www.planetary.org/space-policy/nasa-budget> (illustrating NASA's recent budget). The Biden Administration is proposing an 8.0% increase to NASA's budget in 2022. *Id.* (highlighting Biden Administration's budget proposal).

10. *See id.* (tracking recent lack of public spending on space programs); Dylan Taylor, *The Future of Space Tourism*, SPACE (Mar. 31, 2021), <https://www.space.com/future-of-space-tourism-op-ed/> (explaining that private corporate funding of spaceflights could lead to more space exploration).

11. *See* Ron Carson, *Billionaires in Space: Privilege or Progress?*, FORBES (Aug. 17, 2021, 2:10 PM), forbes.com/sites/rcarson/2021/08/17/billionaires-in-space-privilege-or-progress/?sh=1bd1001d3e36 (describing reluctance to support billionaire space travel).

12. *See id.* (comparing purposes of space travel today with purposes of space travel in past).

13. *See* Derr, *supra* note 2 (emphasizing need to utilize space travel in fight against climate change).

14. *See* Phoebe T. Clewly, *Newspace: The Rise of the Private Space Industry is Threatening the Current Legal Framework Governing Outer Space*, 21 J. HIGH TECH. L. 354, 376-83 (2021) (reviewing problems with private space exploration); *see also*

spite the numerous concerns inherent to space exploration, space developments have significantly contributed to our understanding of the Earth's climate and will become increasingly crucial as climate change intensifies.¹⁵

Along with environmental concerns surrounding space travel comes an ambiguous legal framework that has failed to provide strict federal regulations.¹⁶ In 2021, space tourism took a giant leap forward after several billionaires led commercial flights to the edge of space.¹⁷ The Federal Aviation Administration (FAA) believes the commercial spaceflight industry will continue to grow as the interest in space travel increases.¹⁸ As commercial space exploration grows, regulatory measures must outline the level of control the government will have over private space exploration.¹⁹ It is also important to consider whether the benefits of space exploration outweigh environmental concerns in both the short and long term.²⁰ These considerations align with the National Environmental Policy Act's (NEPA) current expectation that the Office of Commercial Space Transportation integrate environmental values into its decision-making process.²¹ Despite environmental concerns, the information from studying Earth and other planets may prove invaluable in saving the environment.²²

Space Race and Environmental Program, *supra* note 4 (discussing fears of overpopulation on Earth).

15. See Derr, *supra* note 2 (illustrating urgent need for continued satellite imaging and space exploration).

16. See ALYSSA K. KING, CONG. RSCH. SERV., R46500, THE FUTURE OF SPACE TOURISM 4-6 (2020) (delineating sparse regulation of space tourism).

17. See Jackie Wattles, *2021: The Year of Space Tourism*, CNN (Jan. 3, 2022, 4:25 PM), <https://www.cnn.com/2022/01/01/tech/space-business-year-in-review-scn/index.html> (discussing fruits of billionaire space race).

18. See KING, *supra* note 16, at 1 (predicting rise in private space tourism); *Human Spaceflight*, FED. AVIATION ADMIN. (May 17, 2022), https://www.faa.gov/space/human_spaceflight/ (acknowledging commercial spaceflight has taken on greater role while government has typically directed spaceflight activity).

19. Rhiannon Wardle, *Is Space Tourism Good for the Planet?*, FUTURELEARN (Jan. 12, 2022), <https://www.futurelearn.com/info/blog/is-space-tourism-good-for-the-planet/> (addressing concerns regarding personal safety and questions over who will govern space).

20. *Id.* (asking whether space travel is worth it); see also *Benefits of Space: Environment*, U.N. OFF. FOR OUTER SPACE AFFS., <https://www.unoosa.org/oosa/en/benefits-of-space/environment.html> (last visited Jan. 25, 2022) (stating benefits of space-based technology on studying climate change).

21. See *Environmental*, FED. AVIATION ADMIN. (Oct. 28, 2021), <https://www.faa.gov/space/environmental> (requiring environmental protection practice); 42 U.S.C. § 4332 (directing federal decisionmakers to consider environmental impact of federal action).

22. See Wardle *supra* note 19 (describing pros and cons of environmental impact).

This Comment explores space tourism's global environmental impact in light of recent increases in commercial space ventures.²³ Part II examines the industry's background, the United States government's role in the emerging commercial enterprise, and the undefined role of the FAA going forward.²⁴ The long-term positive effects of environmental research and short-term concerns — including the known and unknown impact of increased space travel — are discussed in Part III.²⁵ Part IV outlines the present state of commercial space flight regulations, such as the existing regulations moratorium and outdated international space law.²⁶ Finally, Part V concludes by examining the effects of greater space travel, balancing immediate environmental concerns with potentially invaluable scientific research, and assessing the Biden Administration's position on space exploration and oversight.²⁷ The crux of this Comment considers the debate on the environmental impact of commercial space tourism relating to scientific innovation.²⁸

II. CONDUCTING ORBIT: BACKGROUND ON SPACE TRAVEL

In 1970, Congress responded to the growing public concern regarding the environmental impacts of human activity.²⁹ Following much debate, President Richard Nixon signed NEPA into law on January 1, 1970.³⁰ The federal government enacted NEPA to establish a national policy to “[e]ncourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources

23. For a discussion of the recent trend of commercial space ventures, see *infra* notes 34-73 and accompanying text.

24. For a discussion of the background and the United States government's role in current and future commercial space endeavors, see *infra* notes 29-73 and accompanying text.

25. For a discussion of the environmental impacts associated with increased space travel, see *infra* notes 74-123 and accompanying text.

26. For a discussion of current domestic and international regulations on commercial space expedition, see *infra* notes 124-66 and accompanying text.

27. For a discussion of how the United States government can approach the legal and environmental uncertainties of increased commercial space expeditions, see *infra* notes 167-96 and accompanying text.

28. For a discussion on how commercial space tourism affects the environment, see *infra* notes 74-123 and accompanying text.

29. See generally LINDA LUTHER, CONG. RSCH. SERV., RL33152, *The National Environmental Policy Act: Background and Implementation 1* (2008) [hereinafter *NEPA: Background and Implementation*] (explaining reasoning behind NEPA).

30. *Id.* at 1 (introducing first major environmental law passed regarding human activity on environment).

important to the Nation.”³¹ NEPA requires the United States government to consider environmental impacts in its decision-making.³² As billionaires lead the charge for commercial space industry growth, adjustments to the current regulatory framework are necessary.³³

A. Background on the Legal and Regulatory Framework

As commercial space travel becomes more popular, the Office of Commercial Space Transportation (the Office) — an office within the FAA — must integrate environmental values into its decision-making process.³⁴ The Office serves as the overseer of all commercial space transportation within the United States.³⁵ As part of this oversight, the Office reviews and licenses all commercial space transportation activities.³⁶ Under NEPA and as part of this review, the Office reviews the anticipated environmental impact of proposed actions and evaluates reasonable alternatives to those actions, ultimately making more environmentally conscious decisions.³⁷ This environmental review is a mandatory step in the Office’s license and permit application process.³⁸

For the Office to issue a license or permit, an application for a proposed action must meet NEPA’s requirements, its accompanying regulations, and other agency orders.³⁹ To comply with NEPA, the Office must make decisions that promote high standards of living, enhance the quality of renewable resources, and maximize attainable recycling levels of depletable resources.⁴⁰ Effectively, the

31. *See generally* 42 U.S.C. § 4321 (establishing purpose of NEPA).

32. *See* LUTHER, *supra* note 29, at 1 (illustrating federal government’s role to protect current and future generations).

33. For a discussion on the regulatory framework and growing popularity within the commercial space industry, see *infra* notes 34-73 and accompanying text.

34. *See Environmental*, *supra* note 21 (highlighting AST’s need to take environmental considerations into account when making decisions); KING, *supra* note 16, at 1 (illustrating growth of commercial space industry).

35. *See About the Office of Commercial Space Transportation*, FED. AVIATION ADMIN., https://www.faa.gov/about/office_org/headquarters_offices/ast (last visited Sept. 17, 2022) (explaining purpose of Office of Commercial Space Transportation).

36. License Application Procedures, 14 C.F.R. § 413 (2020) (mandating that commercial space transportation activities obtain license before operation).

37. *Environmental*, *supra* note 21 (stating Office’s environmental impact considerations).

38. *See id.* (mandating that environmental review occur).

39. *Id.* (listing provisions that application must comply with).

40. *See generally* 42 U.S.C. § 4332 (identifying how to comply with NEPA); *see also* 40 C.F.R. §§ 1500-08 (2022) (implementing NEPA for agency decision-making).

NEPA process ensures that commercial space transportation decision-makers understand potential environmental impacts of proposed commercial space transportation activities.⁴¹ This process guarantees that individuals adequately disclose how commercial space transportation activities they propose might impact the environment.⁴²

The Office determines the level of review for the space travel activity in question based on the potential for significant environmental effects.⁴³ The primary types of commercial space transportation environmental review are Environmental Assessments (EAs) and Environmental Impact Statements (EISs).⁴⁴ EAs are limited in scope and solely look to determine whether the Proposed Action “has the potential to significantly affect the human environment.”⁴⁵ On the other hand, an EIS is an in-depth review that the Office releases to the public with a discussion of reasonable alternatives to the Proposed Action.⁴⁶ The Office only prepares an EIS when it believes the proposed project will have significant environmental impacts.⁴⁷ In limited situations, a third type of environmental review may apply: categorical exclusions, which are activities the Office believes do not have an impact on the environment and, therefore, do not require EAs or EISs during the licensing process.⁴⁸ The Office reviews what activities pose the most severe risks to the environment to determine which category of review to apply.⁴⁹ Although the Office determines which type of review to conduct for upcoming commercial spaceflights, the free range that wealthy private actors have when approaching space exploration significantly limits its ability to do this.⁵⁰

Current NEPA regulations task the National Aeronautics and Space Administration (NASA), among other federal agencies, with preparing EAs that focus on the effects spaceflight will have on

41. See 40 C.F.R. §§ 1500.2(b)-(f) (requiring federal agency decision-makers to understand environmental impact of decisions).

42. *Environmental, supra* note 21 (explaining disclosure of information that NEPA ensures).

43. *Id.* (establishing that FAA determines level of review).

44. *Id.* (listing different standards of environmental review).

45. *Id.* (defining Environmental Assessments).

46. *Id.* (describing requirements of Environmental Impact Statement).

47. *Environmental, supra* note 21 (stating when Office will conduct EIS).

48. *Id.* (noting additional environmental review).

49. *Id.* (pointing out FAA’s responsibility in determining level of review based on potential environmental harm).

50. For a discussion on why it has become extremely difficult for the FAA to regulate space travel, see *infra* notes 65-73 and accompanying text.

Earth's environment.⁵¹ NASA's EA examines launch activities on sites looking at orbital debris when it reenters the atmosphere, but not debris in outer space.⁵² During its licensing process, the Office does not mandate analysis of the impact space launches and reentries have on the environment.⁵³ Finally, the Federal Communications Commission (FCC) — which is relevant based on its regulation of satellite communications — announced that it will apply categorical exclusion under NEPA to its review of satellite license applications.⁵⁴ The federal agency that oversees EAs and EISs — the Council on Environmental Quality — frequently allows agencies to use categorical exclusions.⁵⁵ Consequently, there is a lot of gray space because legally, NEPA has jurisdiction over outer space.⁵⁶

B. Background on the Billionaire Space Race

Public figures Richard Branson, Jeff Bezos, and Elon Musk want to take off on their quest to conquer space, the moon, and even Mars.⁵⁷ These individuals want to make space travel accessible, going as far as suggesting that this is “the dawn of a new space age.”⁵⁸ To coordinate these billionaire flights into space, compa-

51. See Michael Ellis, *Keep Environmental Red Tape out of Outer Space*, HERITAGE FOUND. (Aug. 6, 2021), <https://www.heritage.org/government-regulation/report/keep-environmental-red-tape-out-outer-space> (describing NASA's NEPA review process). While NEPA's history suggests that it does not apply to actions that affect outer space, administrative agencies comply with regulations that mandate such review. *Id.* (arguing that nothing about NEPA applies to outer space).

52. *Id.* (specifying NASA considers orbital debris only when it reenters atmosphere). For a further discussion on the impact that space debris has on the environment, see *infra* notes 78-95 and accompanying text.

53. Ellis, *supra* note 51 (focusing on environmental effects of launches and reentry sites).

54. *Id.* (establishing its own regulatory regime regarding orbital debris).

55. See 40 C.F.R. § 1507.3(f)(5) (directing agencies to use categorical exclusions when appropriate); *National Environmental Policy Act Review Process*, U.S. ENV'T PROT. AGENCY (Oct. 25, 2021), <https://www.epa.gov/nepa/national-environmental-policy-act-review-process#:~:text=Federal%20agencies%20prepare%20an%20Environmental,the%20requirements%20for%20an%20EA/> [hereinafter *NEPA Review Process*] (pointing to categorical exclusion as option when action does not significantly impact human environment); see also 42 U.S.C. § 4344 (enumerating duties of Council on Environmental Quality).

56. Ellis, *supra* note 51 (clarifying that NEPA should not include outer space).

57. Katharine Gammon, *How the Billionaire Space Race Could Be One Giant Leap for Pollution*, GUARDIAN (July 19, 2021, 2:00), <https://www.theguardian.com/science/2021/jul/19/billionaires-space-tourism-environment-emissions/> (listing notable billionaires embarking on space conquests).

58. See *id.* (emphasizing push for more frequent space travel).

nies such as Virgin Galactic, SpaceX, and Space Adventures sell tickets to space for up to \$450,000 per ticket.⁵⁹

Many experts, however, assert that a new private space industry could come with significant environmental costs.⁶⁰ That said, the United States government has given the private space industry considerable leeway to develop commercial space enterprise due to the lack of public appetite for a national space program.⁶¹ Congress has implemented a moratorium on space passenger regulation until 2023 to encourage industry progress and allow companies to devise their own medical screening and training protocols.⁶² To ensure that there is no hazard to public safety, the FAA, through the Office, still requires a license for non-governmental space flights.⁶³ Yet, the FAA can dictate neither spacecraft design nor training and does not control who is qualified for flight.⁶⁴

C. Background on the Intersection of Space Tourism and the Environment

Congress tasked the FAA with regulating the development of future aircrafts, but because the moratorium restricts its power over passenger regulation and other key aspects of space travel, its authority is vague.⁶⁵ The problem is that the FAA has conflicting roles: it must both promote commercial spaceflight activities and also develop regulations that ensure public safety and prevent environmental harm.⁶⁶ Moreover, because of the moratorium, the FAA

59. See Mike Wall, *Virgin Galactic Is Selling Tickets to Space Again, Now for \$450,000 Per Seat*, SPACE (Aug. 5, 2021), <https://www.space.com/virgin-galactic-raises-space-ticket-price/> (delineating price people are willing to pay for space travel).

60. Gammon, *supra* note 57 (highlighting harmful environmental impacts from space activity).

61. Justin Bachman, *You Only Have to Be Rich, Not Healthy, to Fly in Space*, BLOOMBERG (Dec. 6, 2017, 3:00 AM), <https://www.bloomberg.com/news/features/2017-12-06/how-to-survive-your-virgin-galactic-blue-origin-spacex-flight> (describing how private funding is essential for space flight to continue).

62. 51 U.S.C. § 50905 (c) (2) (C) (limiting FAA to impose regulations governing certain design features).

63. See 14 C.F.R. § 413.3 (2007) (delineating who needs license to operate spacecraft).

64. 51 U.S.C. § 50905 (c) (2) (C) (restricting regulatory authority of FAA); Bachman, *supra* note 61 (emphasizing FAA is limited in its reach).

65. See 49 U.S.C. § 4470I (laying out safety requirements); see generally Bachman, *supra* note 61 (listing areas of space travel activities that FAA cannot regulate).

66. Jonathan Ward, *It's Time to Rescind the Moratorium on Regulation of Commercial Spaceflight*, SPACE NEWS (Oct. 15, 2021), <https://spacenews.com/op-ed-its-time-to-rescind-the-moratorium-on-regulation-of-commercial-spaceflight/> (highlighting FAA's conflicted role due to current system implemented).

lacks authority to create safety standards in spaceflight, resulting in an industry where wealthy individuals can build spacecraft without worrying about complying with a complicated regulatory framework.⁶⁷

Regulations are still unclear and there is a growing need for transparency within the space tourism industry.⁶⁸ While questions concerning NEPA's scope and application remain, some wonder whether it would even be prudent to increase its jurisdiction.⁶⁹ Nonetheless, the lack of clarity over whether the FAA must conduct a NEPA review on current spaceflights has given rise to legal battles.⁷⁰ For example, in 2020, Viasat claimed that competitor SpaceX did not have a thorough environmental impact review before getting permission to operate in Earth's orbit.⁷¹ These legal disputes threaten to stifle further technological advances.⁷² One thing is clear: the growing space travel industry will certainly have impacts on the environment which the government must address to alleviate concerns and protect the environment for future generations.⁷³

III. INCREASED SPACE TRAVEL AND THE ENVIRONMENT

The link between outer space and the environment is central to the space travel debate and the growing trend of privately funded space exploration.⁷⁴ Launching vehicles into space creates major environmental concerns such as space debris and emis-

67. *Id.* (demonstrating that those with financial means are essentially creating their own rules).

68. For a discussion on current regulations and the problems associated with them, see *infra* notes 124-66 and accompanying text.

69. See Ellis, *supra* note 51 (noting heavy regulation could impede innovation that would help address climate concerns).

70. See Eric Boehm, *Will Environmental Regulations Stop SpaceX?*, REASON (Jan. 2022), <https://reason.com/2021/12/15/will-environmental-regulations-stop-spacex/> (acknowledging that lawsuit highlights unclear definition regarding NEPA's intended geographic scope).

71. *Id.* (providing basis of lawsuit against SpaceX).

72. See *id.* (providing context for lawsuit); Tereza Pultarova, *Do Space Tourists Really Understand the Risk They're Taking?*, SPACE.COM (Sept. 27, 2021), <https://www.space.com/space-tourism-risk-safety-regulations/> (describing where law ought to go in this industry).

73. For a discussion on how commercial space tourism affects the environment and how it should be addressed, see *infra* notes 167-96 and accompanying text.

74. See Boehm, *supra* note 70 (discussing FAA role in space travel emissions regulation); Andrew Chatzky, Anshu Siripurapu & Steven J. Markovich, *Space Exploration and US Competitiveness*, COUNCIL ON FOREIGN RELS. (Sept. 23, 2021, 11:15 AM), <https://www.cfr.org/background/space-exploration-and-us-competitiveness/> (referencing ongoing debate about merits of private space exploration).

sions.⁷⁵ Further, while rocket launches are not currently a significant source of pollution, scientists worry about long-term harm because the industry is positioned for unprecedented growth.⁷⁶ This section will review these environmental concerns and the impact they have on the Earth.⁷⁷

A. Space Debris and Rocket Emissions

Space debris is and has been a cause for concern for a long time.⁷⁸ In the 1970s, retired NASA scientist, Donald Kessler, proposed what is now known as the “Kessler Syndrome” hypothesis, which predicts that debris from collisions in Earth’s orbit will eventually create a “cascade effect.”⁷⁹ Space junk is the term space agencies use to describe artificial objects left in Earth’s orbit by spacecraft.⁸⁰ Most space junk exists in low Earth orbit (LEO), which is the same orbit as an increasing number of satellites.⁸¹ As some space debris in LEO loses altitude, it will burn up in the Earth’s atmosphere.⁸² Larger debris that does not burn up, however, can break through the atmosphere and damage the Earth and its environment.⁸³ Introducing “mass groupings of artificial satellites” into LEO will add to the growing problem of space debris.⁸⁴

In its 2018 report, the Aerospace Corporation’s Center for Space Policy and Strategy raised concerns about the potential prob-

75. For a discussion on how commercial space tourism affects the environment and how to address it, see *infra* notes 78-123 and accompanying text.

76. See Issam Ahmed, *Environmental Concerns Grow as Space Tourism Lifts Off*, PHYS.ORG (July 18, 2021), <https://phys.org/news/2021-07-environmental-space-tourism.html> (noting concerns over increased space tourism and its impacts on upper atmosphere).

77. For a discussion of the link between the environment and space travel, see *infra* notes 78-123 and accompanying text.

78. Ernie Tretkoff, *Space Debris Still a Growing Problem*, APS NEWS (June 2008), <https://www.aps.org/publications/apsnews/200806/spacedebris.cfm#:~:text=space%20debris%20has%20long%20been,%2Dintroduced%20in%20June%202007/> (explaining risks associated with space debris).

79. Richard L. Hermer-Fried, *Kessler Syndrome: A United States’ Statutory Solution for Satellite Debris Removal and the Mitigation of Orbital Collisions*, 18 J. INT’L BUS. & L. 259, 260 (2019) (recounting Kessler’s hypothesis).

80. See Charlotte Luke, *What is Space Junk and How Does it Affect the Environment?*, EARTH.ORG (Sept. 6, 2021), <https://earth.org/space-junk-what-is-it-what-can-we-do-about-it/> (defining space junk).

81. *Id.* (acknowledging increased risk of collisions and potential effect of space junk on future space exploration).

82. *Id.* (describing phenomenon that occurs when LEO space junk loses altitude).

83. *Id.* (recognizing potentially harmful effects of space junk on plants and animals).

84. *Id.* (highlighting need to remove failed satellites from space).

lem of orbital space debris.⁸⁵ NASA promulgated long-standing guidelines to ensure space station safety when it is close to space debris.⁸⁶ Additionally, the European Space Agency is looking for ways to solve or mitigate the growing space pollution problem.⁸⁷

In addition to concerns about space debris, environmental researchers predict that the launch of space vehicles will heavily impact climate change as a result of stratospheric ozone depletion.⁸⁸ Already concerned, researchers expect this to become an even bigger problem as the space tourism industry continues to grow.⁸⁹ The propellants the space industry uses to launch rockets into space emit up to three hundred tons of carbon dioxide directly into the upper atmosphere.⁹⁰ For example, Blue Origin uses liquid oxygen and hydrogen as fuel, while SpaceX and Virgin Galactic use carbon-based fuels.⁹¹ Rocket engines emit the byproducts of carbon-based fuels, aluminum oxide, and black carbon as the engines travel through the upper atmosphere.⁹² While aluminum oxide reflects visible light from the sun back into space, which creates a

85. Martin Ross & James Vedda, *The Policy and Science of Rocket Emissions*, AEROSPACE: CTR. FOR SPACE POL'Y & STRATEGY (Apr. 2018), https://csp.aerospace.org/sites/default/files/2021-08/RocketEmissions_0_0.pdf (acknowledging issue of space debris as one that presents existential threat to continuing space operations).

86. Mark Garcia, *Space Debris and Human Spacecraft*, NAT'L AERONAUTICS & SPACE ADMIN. (May 27, 2021), https://www.nasa.gov/mission_pages/station/news/orbital_debris.html (describing NASA's efforts to maintain space debris issue); *Astromaterials Research & Exploration Science*, NAT'L AERONAUTICS & SPACE ADMIN., <https://www.orbitaldebris.jsc.nasa.gov/> (last visited Sept. 20, 2022) (listing different tools NASA utilizes to mitigate risks from space debris).

87. See ESA's *e.Deorbit Debris Removal Mission Reborn as Servicing Vehicle*, THE EUR. SPACE AGENCY, https://www.esa.int/Space_Safety/ESA_s_e.Deorbit_debris_removal_mission_reborn_as_servicing_vehicle (last visited Sept. 20, 2022) (reviewing ESA's work on space debris).

88. J.A. Dallas, S. Raval, J.P. Alvarez Gaitan, S. Saydam & A.G. Dempster, *The Environmental Impact of Emissions from Space Launches: A Comprehensive Review*, 255 J. CLEANER PROD. 1, 7 (2020) (discussing combined byproducts of emissions and debris poses real risk to global atmosphere).

89. Gammon, *supra* note 57 (predicting increased ozone depletion as market expands).

90. *Id.* (pointing out that carbon dioxide emissions can remain in upper atmosphere for years).

91. Stephanie Ebbs, *Experts Say Climate Impact is a Question Mark if Space Tourism Takes Off*, ABC NEWS (Dec. 9, 2021, 6:07 AM), <https://abcnews.go.com/Technology/experts-climate-impacts-question-mark-space-tourism-takes/story?id=81609878/> (noting fuel sources used by spacecraft).

92. Volodymyr Levykin, *Going Green: Why the Launch Industry Urgently Needs Environmental Regulation*, VIA SATELLITE (Aug. 19, 2020), <https://www.satellitetoday.com/opinion/2020/08/19/going-green-why-the-rocket-launch-industry-urgently-needs-environmental-regulations/> (illustrating danger particles have on Earth's climate and atmosphere).

cooling force, it also traps heat like a greenhouse gas.⁹³ Similarly, black carbon can alter the Earth's climate by both warming and cooling the planet.⁹⁴ While each rocket launch emits a small amount of carbon into the atmosphere, because of the rise in the number of space flights in recent years, the net amount of carbon is cause for concern.⁹⁵

B. NEPA Review of Satellites

In addition to the need for environmental regulation to safeguard against space debris and emissions, regulation must ensure that satellites orbit in an environmentally responsible manner.⁹⁶ Environmental review of satellites is a prime focus of the government and other interested parties, especially in light of SpaceX's launch and deployment of its Starlink Constellation, a group of satellites SpaceX operates to provide internet coverage across the globe.⁹⁷ Viasat, a competing satellite company to SpaceX, sued the FCC claiming that it failed to complete environmental reviews in the manner NEPA requires when approving SpaceX satellite launches.⁹⁸ The FAA, however, completed NEPA reviews before granting permission to Starlink.⁹⁹

If a proposed major federal action is likely to have a significant impact on the quality of the environment, federal agencies prepare an EIS.¹⁰⁰ In justifying their request for what is essentially a duplicative environmental review of the satellite's impact, Viasat asserts that light pollution is an environmental threat.¹⁰¹ Viasat claims that

93. *Id.* (explaining how aluminum oxide affects climate).

94. *Id.* (illustrating environmental consequences of increasing number of rocket launches).

95. Ashima Talwar, *One Small Step for the EPA, One Giant Leap for the Environment: A Hybrid Proposal for Regulating Rocket Emissions Due to the Rising Commercial Space Industry*, 9 GEO. WASH. J. ENERGY & ENVTL. L. 87, 91 (2018) (reviewing how space travel creates additional carbon emissions that EPA should regulate).

96. *See* Hermer-Fried, *supra* note 79, at 262-63 (discussing satellite incidents causing space junk which threatens environment and activity in space); Levykin, *supra* note 92 (pointing to importance of satellites for measuring different aspects of climate and environment).

97. Ben Brody, *Elon Musk's Satellites Are in the Middle of a Corporate Dogpile at the FCC*, PROTOCOL (Dec. 6, 2021), <https://www.protocol.com/policy/spacex-viasat-dish-fcc/> (noting planned group of roughly forty thousand satellites in orbit that could beam internet from space to Earth).

98. *Id.* (referencing SpaceX's updated plan requesting permission for satellites to operate at significantly lower altitude).

99. Boehm, *supra* note 70 (demonstrating FCC's jurisdiction is limited to signals sent and received by satellite fleet).

100. *NEPA Review Process*, *supra* note 55 (describing purpose of EIS).

101. *See Brody*, *supra* note 97 (noting light pollution is harmful to Earth's environment).

because SpaceX wants to relocate the satellites to lower orbital altitudes, which would increase the amount of light pollution the satellite emits, the FCC must prepare an EIS on Starlink.¹⁰² Light pollution is important because it links space and Earth's environment.¹⁰³

While the lawsuit is partially a corporate move to slow down a competitor, it sheds light on a potential conflict of interest between corporate profit and environmental protection.¹⁰⁴ In claiming that the FCC failed to conduct a proper environmental review, Viasat asserts that lowering satellite altitude will discharge a significant amount of pollutants into the atmosphere, which would not only harm the ozone layer but also cause light contamination.¹⁰⁵ Other environmental claims against Starlink allege they dramatically raised the risk of space debris and collisions and that SpaceX's launch facility in Brownsville, Texas has devastated the natural environment.¹⁰⁶ While previous contentions argued about what agencies — other than the FAA — could regulate the rocket related activities, Viasat also raised a new question: whether these requirements and environmental reviews extend outside the Earth's atmosphere.¹⁰⁷ The selective use of NEPA — while likely driven in part by commercial competition — highlights the problems of utilizing expansively phrased statutes and regulations to protect the Earth's environment.¹⁰⁸

C. Regulatory Impact on Earth

In addition to competition concerns, administrative agencies worry about the environmental impacts SpaceX's Starlink satellite

102. *See id.* (requesting more detailed and rigorous review of environmental concerns than FCC initially made).

103. *See* Boehm, *supra* note 70 (specifying that space activity causes light pollution affecting Earth's atmosphere and is covered under NEPA regulations).

104. Brody, *supra* note 97 (highlighting lack of oversight and confusion on environmental review requirements). In addition, the Viasat lawsuit raises the question of whether private space flights and satellite launches must pay for the regulatory costs associated with the environmental review process. Boehm, *supra* note 70 (citing confusion surrounding NEPA's geographic scope).

105. Brody, *supra* note 97 (pointing to disruption of darkness of night sky).

106. Anna Kramer, *Brownsville, We Have a Problem*, PROTOCOL (July 28, 2021), <https://www.protocol.com/brownsville-we-have-a-problem> (noting that only FAA and not state or local government monitors space and rocket related activities in United States).

107. *See* Brody, *supra* note 97 (discussing questions raised).

108. *See* Boehm, *supra* note 70 (implying need for clarity in environmental laws and regulations).

system will cause.¹⁰⁹ The FCC recently updated its orbital-debris mitigation rules and plans to work harder to address collisions and debris risks.¹¹⁰ NASA — while enthusiastic about its relationship with SpaceX — is also concerned about traffic congestion and potential collisions hundreds of miles above Earth.¹¹¹

Again, there is no single global regulator making decisions about orbital congestion or the authority to limit the number of satellites.¹¹² As a result, regulation is inconsistent and appears to be a dangerous and sporadic game.¹¹³ Safely managing satellite fleets ultimately requires laws providing guidance on fundamental issues and agencies effectively governing space.¹¹⁴

D. Research

There are increasing calls for research to address environmental space problems, but research takes time, and the private space exploration sector is eager to continue venturing into space.¹¹⁵ Rocket launches emit harmful particles like black soot into the stratosphere, which raises concern about the particles' effect on the atmosphere and climate.¹¹⁶ In 1989, the United Nations enacted the Montreal Protocol (the Protocol) to protect the Earth's ozone layer by phasing out the use of ozone-depleting chemicals.¹¹⁷ The Protocol does not include the aerospace industry; consequently, there is no real oversight of rocket emissions as the industry

109. Micah Maidenberg, *SpaceX's Plans to Send Thousands More Satellites into Orbit Worry NASA*, WALL ST. J. (Feb. 15, 2022, 5:30 AM), <https://www.wsj.com/articles/spacexs-plans-to-send-thousands-more-satellites-into-orbit-worry-nasa-11644921000?siteid=Yhoof2&yptr=Yahoo?src=rss/> (identifying NASA's concerns regarding space traffic and collisions).

110. *Id.* (highlighting FCC's response to SpaceX's request to launch thirty thousand additional satellites).

111. *See id.* (emphasizing NASA's concern about congestion and potential disasters in space).

112. *Id.* (specifying that regulatory responsibility for satellite industry in United States is unanswered).

113. *See id.* (signaling potential problems that may arise because of lack of regulatory guidance).

114. Maidenberg, *supra* note 109 (discussing how to manage potential problems).

115. Nicole Mortillaro, *Rocket Launches Could be Affecting Our Ozone Layer, Say Experts*, CBC (Apr. 23, 2021), <https://www.cbc.ca/news/science/rocket-launches-environment-1.5995252/> (suggesting scientists did not adequately address environmental problems in past because new space age rose unexpectedly).

116. *Id.* (pointing to expert's concern over black soot).

117. *Id.* (emphasizing inclusion of airline industry and exclusion of aerospace industry regarding bans on ozone-depleting substances).

grows.¹¹⁸ Launch vehicle emissions will likely become a more pressing problem.¹¹⁹

Projects in the growing private space industry are still valuable despite environmental concerns surrounding rocket launches.¹²⁰ Space research is essential to gaining insight into environmental problems on Earth and the government should work with these private programs to gain more insight.¹²¹ In addition, studying outer space provides a perspective which helps us learn to protect our planet's habitability.¹²² This new industry urgently needs more guidance and oversight that protects — but does not inhibit — advancements.¹²³

IV. PRESENT STATE OF REGULATORY AND FUNDING ISSUES: HOUSTON WE HAVE A PROBLEM

Like any industry, the space travel industry needs regulation to provide a blueprint for growth and to set boundaries.¹²⁴ Recent congressional action makes the FAA's authority to regulate the environmental ramifications of space travel ambiguous.¹²⁵ Federal lawmakers need to address this ambiguity if the FAA hopes to regulate space travel effectively.¹²⁶

A. Current Domestic Regulation

This section will review the statutory framework governing space travel and the funding Congress allocates to the field, and it will identify areas that require amendments.¹²⁷ Congress amended and re-codified the Commercial Space Launch Act of 1984 as 51

118. *Id.* (acknowledging concern of industry experts over unknown effects of various rocket propellants).

119. *Id.* (signaling rapid increase in launch events between 2016 and 2020).

120. *See* Ellis, *supra* note 51 (pointing to benefits surrounding rocket launches).

121. *Why Space Exploration is Always Worthwhile*, THE PLANETARY SOC'Y (Aug. 30, 2021), <https://www.planetary.org/articles/space-exploration-is-always-worthwhile/> (space exploration may produce insight into mitigating impacts of climate change).

122. *Id.* (underscoring need to invest in preserving future of Earth's fragile environment).

123. *See* Ellis, *supra* note 51 (acknowledging immediate need to clarify existing ambiguous legal framework).

124. For a discussion on the present state of regulations within the space travel industry, see *infra* notes 128-66 and accompanying text.

125. 51 U.S.C. § 50905 (demonstrating FAA's ability to impose regulations).

126. For a discussion on why the FAA has trouble operating effectively, see *supra* notes 65-73 and accompanying text.

127. For a discussion on the current regulation, funding, and difficulties with space travel, see *infra* notes 128-66.

U.S.C. §§ 50901–50923 (the Act).¹²⁸ The Act permits the Department of Transportation through the FAA “to oversee, license, and regulate commercial launch and reentry activities, and the operation of launch and reentry sites.”¹²⁹ The Act guides the FAA to consider “public health and safety, safety of property, and the national security and foreign policy interests of the United States” while exercising its authority.¹³⁰ In 2004, as part of the Commercial Space Launch Amendments Act, Congress imposed a regulations moratorium on commercial human spaceflight to allow the industry to progress without regulation interference.¹³¹ Congress has extended this moratorium through 2023.¹³² Accordingly, Congress currently prohibits the FAA from “promulgating any regulations governing the design or operation of a launch vehicle intended to protect the health and safety of crew, government astronauts, and spaceflight participants”¹³³

Congress does allow the FAA to prohibit design features or operating practices only if those features or practices previously contributed to an event that posed a serious risk of or resulted in serious or fatal injuries.¹³⁴ Congress’s rationale for imposing the moratorium was to provide time for the space travel industry to establish safe commercial human spaceflight.¹³⁵ Notwithstanding the moratorium, Congress requires the FAA to ensure that launch and reentry operations are safe for both those onboard the spacecraft

128. See 51 U.S.C. § 50901 (outlining findings and purposes of FAA’s regulations for subsequent law regarding space launches).

129. See FED. AVIATION ADMIN., REPORT TO CONGRESS: FAA EVALUATION OF COMMERCIAL HUMAN SPACE FLIGHT SAFETY FRAMEWORKS AND KEY INDUSTRY INDICATORS 7 (2021), https://www.faa.gov/sites/faa.gov/files/2021-11/CSLCA_Sec111_Report_to_Congress.pdf [hereinafter *Report to Congress*] (establishing responsibilities of Department of Transportation and FAA); 51 U.S.C. § 50905(b) (delineating requirements that may be prescribed).

130. *Id.* (showing direction under which FAA exercises its authority).

131. *Id.* at 1 (explaining Congress placed moratorium on human spaceflight).

132. *Id.* (emphasizing how moratorium still prohibits FAA from regulating commercial human spaceflight).

133. *Id.* (listing activities moratorium prohibits FAA from undertaking); 51 U.S.C. § 50905 (enacting moratorium on FAA from promulgating space flight regulations); 51 U.S.C. § 50905 (c)(C) (highlighting limitation).

134. 51 U.S.C. §§ 50905(c)(2)(C)-(D) (providing two scenarios where FAA is free to regulate).

135. *Report to Congress, supra* note 129, at 1 (giving context for why Congress enacted moratorium).

and the public.¹³⁶ As such, the FAA is often helpless when trying to make decisions and changes due to the limitations.¹³⁷

As NEPA requires, the FAA takes into account the environmental effects of spaceflight activities when granting licenses or permits to applicants despite the moratorium.¹³⁸ The FAA has additional responsibilities such as licensing, regulating the development of future aircraft, ensuring public safety, and preventing environmental harm.¹³⁹ The moratorium's restriction on the promulgation of regulations regarding the design or operations of launch vehicles, however, prevents it from performing many of these tasks.¹⁴⁰

As space travel becomes increasingly popular, the FAA needs a new framework without a moratorium.¹⁴¹ The moratorium is outdated, and — even though the FAA will have more leeway once it is lifted — the statutory authority only allows it to regulate launching and landing.¹⁴² Policymakers continue to debate how much regulation is needed to keep people safe and drive discovery.¹⁴³ A solution should include more regulation, but not enough to inhibit technological improvement and innovation.¹⁴⁴

B. Funding

NASA and private space companies are no longer mutually exclusive.¹⁴⁵ Private funding is critical as the government often does not prioritize the same innovative ideas that private actors focus

136. See 51 U.S.C. § 50903(b)(1)-(2) (granting FAA authority to facilitate improvement of launch vehicle safety); see also *Report to Congress*, *supra* note 129, at 1 (describing responsibilities of FAA).

137. See *Report to Congress*, *supra* note 129, at 1 (noting things FAA can and cannot regulate).

138. For a discussion on the environmental review that goes into the application process, see *supra* notes 34-56 and accompanying text.

139. For a discussion of the FAA's responsibilities, see *supra* notes 34-73 and accompanying text.

140. 51 U.S.C. § 50905(c)(2)(c) (banning development of certain regulations).

141. For a discussion on potential changes to regulation and FAA oversight, see *infra* notes 167-96 and accompanying text.

142. 51 U.S.C. § 50903(a) (giving Department of Transportation authority to regulate spaceflight launching and landing). For a discussion on why the FAA needs a larger hand in the game, see *infra* notes 167-96 and accompanying text.

143. See Andrew Chatzky, Anshu Siripurapu & Steven Markovich, *Space Exploration and U.S. Competitiveness*, COUNCIL ON FOREIGN RELS. (Sept. 23, 2021, 11:15 AM), <https://www.cfr.org/backgrounders/space-exploration-and-us-competitiveness/> (providing context for choices policymakers must make).

144. For a discussion on future regulations and the need for innovation, see *infra* notes 167-96 and accompanying text.

145. Hanneke Weitering, *Biden's 2022 NASA Budget Proposal Gives Science and Commercial Space a Boost*, SPACE.COM (May 28, 2021), <https://www.space.com/>

on.¹⁴⁶ Despite the COVID-19 pandemic, investment in the space industry increased in 2020 and early 2021.¹⁴⁷ Private-sector funding in space-related companies topped ten billion dollars in 2021, an all-time high, and about a tenfold increase over the past decade.¹⁴⁸

As for public spending, in 2021, the Biden Administration proposed the largest ever budget request for NASA of \$24.8 billion, marking a 6.6 percent increase from previous allocations.¹⁴⁹ Further, it also proposed a five percent increase in funding for private companies to conduct deep space exploration systems.¹⁵⁰ Congress, however, failed to approve the proposed budget due to a stopgap bill that attempted to avert a government shutdown ahead of the February 2022 federal budget deadline.¹⁵¹ As such, private sector funding is crucial if both private and public actors want space travel to continue.¹⁵²

C. A Need for Change

A 1967 agreement known as the Outer Space Treaty currently governs international space law.¹⁵³ The treaty allows all nations to use and explore the moon and celestial bodies, prohibits nations

biden-nasa-2022-budget-request-science-artemis/ (discussing NASA has selected SpaceX to build lander for proposed mission).

146. See Hanh Nguyen-Le, *Billionaire Private Investment Is Good for the Space Industry, Whether We Like It or Not*, LSE: PHELAN US CTR. (July 19, 2021), <https://blogs.lse.ac.uk/usappblog/2021/07/19/billionaire-private-investment-is-good-for-the-space-industry-whether-we-like-it-or-not/> (emphasizing need for private funding in space industry).

147. Ramona Schindelheim, *Private Companies Propelling Job Growth in the Space Industry*, WORKING NATION (June 3, 2021), <https://workingnation.com/private-companies-propelling-job-growth-in-the-space-industry/> (highlighting job growth in space industry despite pandemic).

148. Ryan Brukardt, Jesse Klempner & Brooke Stokes, *Space: Investment Shifts from GEO to LEO and Now Beyond*, MCKINSEY & CO. (Jan. 27, 2022), <https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/space-investment-shifts-from-geo-to-leo-and-now-beyond> (showing increase in private funding over past decade).

149. Weitering, *supra* note 145 (noting increase in NASA funding and its ability to assist private companies in developing space stations).

150. *Id.* (discussing deep space exploration and goal of sending astronauts to moon by 2024).

151. Clare Foran, Ted Barrett & Ali Zaslav, *Senate Passes Stopgap Bill to Avert Shutdown Ahead of Friday Deadline*, CNN (Feb. 17, 2022), <https://www.cnn.com/2022/02/17/politics/senate-government-funding-vote/index.html/> (noting full year spending package delayed in Congress due mostly to funding for vaccine mandates).

152. See Chatzky, *supra* note 74 (addressing need to determine role private sector should play in space travel).

153. Outer Space Treaty of 1967, Jan. 27, 2967, 18 U.S.T. 2410, 610 U.N.T.S. 205 (defining principles governing outer space).

from claiming sovereignty over parts of space, and requires nations to oversee the activities of private space companies within their borders.¹⁵⁴ Existing space law arguably does not follow this treaty by allowing private space companies to act as they see fit.¹⁵⁵ In anticipating growth in the commercial space industry, experts recommend that Congress expand the FAA's power to regulate.¹⁵⁶

In response to this push for a new regulatory regime, the Biden Administration has issued a new policy called the United States Space Priorities Framework.¹⁵⁷ The policy keeps many of the same space priorities from the Trump Administration such as modernizing licensing regulations, researching cybersecurity concerns that come from space, and furthering the United States' space capabilities.¹⁵⁸ The Biden Administration, however, adds a new emphasis on using space to help combat climate change.¹⁵⁹

Under the new regulatory framework, the administration pledged to invest in satellites that can observe Earth from space.¹⁶⁰ This will be beneficial because the satellites will help scientists understand our changing climate.¹⁶¹ To emphasize space-based cli-

154. *Id.* at art. II-VI (noting different parts of how space law is governed internationally); see also *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, UNITED NATIONS OFF. FOR OUTER SPACE AFFS., <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html> (describing additional aspects of Outer Space Treaty); Brianna Rauenzahn, Jasmine Wang, Jamison Chung, Peter Jacobs, Aaron Kaufman & Hannah Pugh, *Regulating Commercial Space Activity*, REGUL. REV. (June 6, 2020), <https://www.theregreview.org/2020/06/06/saturday-seminar-regulating-commercial-space-activity/> (pointing out that treaty requires nations to monitor private companies).

155. Brianna Rauenzahn, Jasmine Wang, Jamison Chung, Peter Jacobs, Aaron Kaufman & Hannah Pugh, *Regulating Commercial Space Activity*, REGUL. REV. (June 6, 2020), <https://www.theregreview.org/2020/06/06/saturday-seminar-regulating-commercial-space-activity/> (emphasizing private sector growth in commercial space industry and lack of regulation).

156. *Id.* (identifying call for new regulatory regime).

157. *United States Space Priorities and Framework*, THE WHITE HOUSE (Dec. 1, 2021), <https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/01/united-states-space-priorities-framework/> [hereinafter *Space Priorities Framework*] (reporting plan to expand space exploration).

158. Loren Grush, *Biden Administration Issues New Framework for Space Policy, with a Focus on Climate Change*, VERGE (Dec. 1, 2021, 11:00 AM), <https://www.theverge.com/2021/12/1/22811737/national-space-council-kamala-harris-framework-priorities-climate-change/> [hereinafter *Biden Administration*] (noting similarities between Biden and Trump policies).

159. *Space Priorities Framework*, *supra* note 157 (discussing changes to Biden Administration's new framework).

160. *Id.* (focusing on investment in Earth observation capabilities).

161. See *Biden Administration*, *supra* note 158 (explaining how satellites can provide alternate observation point and provide helpful data about changing climate).

mate research, on December 1, 2021, President Biden signed a new Executive Order that added the position of the National Climate Advisor to the National Space Council.¹⁶²

While increased focus on the impact of climate change on the environment is a step in the right direction, Congress must allow the FAA to produce a new regulatory framework.¹⁶³ The FAA's role in combatting climate change is not clear, especially concerning private space flights.¹⁶⁴ With the current moratorium in place, the FAA regulates launch and reentry but does not cover anything in space, vehicle design, or safety.¹⁶⁵ With private spaceflight growing in popularity, updated regulations should provide more safety but should not interfere with innovation and the use of new technologies that could benefit the environment.¹⁶⁶

V. CURRENT PROBLEMS AND THEIR FUTURE IMPACT ON THE ENVIRONMENT

As the commercial space travel industry grows, lawmakers must recognize and address the environmental impact of rocket launches and satellite activity.¹⁶⁷ Although Congress is aware of these issues, its lack of action signifies that it views space travel's potential environmental harm as non-urgent, even though evidence shows otherwise.¹⁶⁸ At this time, the private space exploration sector faces pressing concerns including safety guidance, environmental regulation, and an unclear picture of how Con-

162. *Executive Order on the National Space Council*, THE WHITE HOUSE (Dec. 1, 2021), <https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/01/executive-order-on-the-national-space-council/> (creating new position among National Space Council).

163. For a discussion on the steps the FAA currently takes to ensure space travel activities do not negatively impact the environment, see *supra* notes 39-56 and accompanying text.

164. See Josef S. Koller & George C. Nield, *Human Spaceflight Safety: Regulatory Issues and Mitigating Concepts*, CTR. FOR SPACE POL'Y & STRATEGY 3 (Nov. 2020), https://aerospace.org/sites/default/files/2020-11/Koller-Nield_HumanSpaceflight_20201112.pdf (highlighting moratorium and regulatory uncertainty for FAA and government).

165. See *id.* at 3 (exploring ambiguity and problems associated with framework).

166. See *id.* (pointing out that too much regulation could restrict innovation).

167. Jocelyn Timperley, *Billionaire Space Race: What Does It Mean for Climate Change and the Environment*, SCI. FOCUS (Aug. 12, 2021), <https://www.sciencefocus.com/news/billionaire-space-race-what-does-it-mean-for-climate-change-and-the-environment/> (highlighting space travel's impacts on furthering global warming and stratospheric ozone loss).

168. See King, *supra* note 16, at 4-6 (acknowledging lack of federal oversight in space tourism industry where companies have progressed through so-called learning period extremely quickly).

gress's moratorium on regulation of the commercial space industry will look going forward.¹⁶⁹

A. Emissions Issues

There is a real, identifiable, and continuously increasing danger of engine exhaust particles from rockets that will almost inevitably affect the climate and ozone layer.¹⁷⁰ In the United States, SpaceX and Blue Origin are developing methane-powered engines.¹⁷¹ Meanwhile, Europe's largest launch company is aiming at a carbon neutral rocket running on methane produced from biomass.¹⁷² The United Kingdom-based private space company, Skyrora, upgraded its kerosene made of unrecycled waste plastic which it will use as rocket fuel.¹⁷³ While companies are developing cleaner and safer propellants and propulsion systems, they are not doing so fast enough.¹⁷⁴

B. Design Issues

In addition to the development of cleaner fuels, space equipment manufacturers must consider environmental responsibility.¹⁷⁵ While satellites are crucial in assessing climate change, these same satellites could adversely affect the environment.¹⁷⁶ CEO and founder of Skyrora, Volodymyr Levykin, spoke to the urgency of environmental regulation stating that “[w]e need more stringent and global regulation on spaceport noise, emission reduction, environmental impact, alternative fuels, collision avoidance, and space debris to prevent significant damage to Earth’s stratosphere ozone layer, orbital space, and to motivate the market to never be compla-

169. *See id.* (pointing to summary of moratorium concerns presented to Congress by analyst in transportation policy).

170. *See Levykin, supra* note 92 (highlighting need for regulation of black carbon and aluminum particles).

171. *Id.* (noting methane is more environmentally friendly due to its burning efficiency).

172. *Id.* (discussing developments of Ariane Group’s rocket scheduled for launch in 2030).

173. *Id.* (highlighting fuel called Ecosene which produces forty-five percent less greenhouse gas than traditional fuels).

174. *Id.* (indicating emission level will proportionately increase as annual number of rocket launches increases).

175. *See Levykin, supra* note 92 (pointing to need for cleaner propellants and propulsion systems).

176. *Id.* (highlighting satellites going into orbit as important factor in environmental predicament).

cent.”¹⁷⁷ Levykin suggests ways to form a global advisory panel similar to the one that exists for aviation environmental impact.¹⁷⁸ Another possible course of action is for the existing advisory panels to oversee rocket launches in addition to their tasks.¹⁷⁹

C. Safety Concerns

Although private companies generally loathe tighter regulation, the continued moratorium on regulation may jeopardize safety.¹⁸⁰ There are real safety concerns as private companies make advancements in space travel.¹⁸¹ Legally, this poses problems as the United States does not have procedures in place to certify the safety of launch vehicles for tourist passengers.¹⁸² Even with full scrutiny and review, one percent of the United States’ 379 human spaceflights since 1969 have ended in disaster.¹⁸³ The potential safety impact of overstepping regulation and oversight cannot yield to competition from private space companies and individual countries.¹⁸⁴

VI. CONCLUSION: THE FUTURE IS NOW

In 2019, the FAA reported to Congress that the private space exploration sector was not ready for stricter regulation.¹⁸⁵ At this stage in the industry’s development, companies are maturing faster

177. *Id.* (explaining that current scientific efforts proposing effective and cleaner fuel sources are not enough).

178. *Id.* (referring to International Civil Aviation Organization’s Committee on Aviation Environmental Protection (CAEP)).

179. *Id.* (pointing to fact that CAEP already has fuels task group and experts from various aviation-centered bodies).

180. *See Ward, supra* note 66 (delineating adverse effects of moratorium and lack of regulatory consistency).

181. *Id.* (noting FAA’s limitations regarding safety under current regulatory framework).

182. *See King, supra* note 16, at 4-6 (mentioning lack of commercial spaceflight safety procedures). The FAA only requires passengers on commercial spaceflights to sign a waiver acknowledging the risks. *Id.* at 4-5 (identifying passenger requirement to board commercial spaceflight). Specific examples of events that have caused safety concerns include Virgin Galactic and Blue Origin passengers not wearing pressurized suits, Virgin Galactic deviating from air traffic control clearance, and SpaceX ignoring FAA warnings resulting in its rocket exploding upon landing. *See Ward, supra* note 66 (highlighting instances of safety issues).

183. *See Ward, supra* note 66 (citing spaceflight disaster statistics since 1969).

184. *Id.* (suggesting space exploration will be safer if Congress amends or eliminates present moratorium).

185. *See King, supra* note 16, at 5 (citing Commercial Space Launch Amendments Act of 2004, Pub. L. No. 108-492, 118 Stat. 3974 (2004)) (indicating level of oversight is consistent with Commercial Space Launch Amendments Act of 2004).

than anticipated.¹⁸⁶ Environmental, legal, and safety concerns point to measures that must be taken as the moratorium reaches its pending expiration date.¹⁸⁷ Congress should impose stricter governance for space tourism activities by developing voluntary safety standards within the industry which fall under a regulatory framework.¹⁸⁸ The situation has drastically changed since 2018 when the FAA submitted an initial report to Congress on the industry's progress in developing voluntary safety standards for human spaceflight.¹⁸⁹ The benchmarks of the follow-up report presented to Congress later this year should indicate that the sector has matured and is ready to transition to a more regulated safety regime that will not undermine growth in the industry.¹⁹⁰

In short, Congress should end the moratorium.¹⁹¹ At this time, voluntary standards in the industry are not sufficient to mitigate potential environmental and safety hazards.¹⁹² One potential solution is to propose an entity within the Department of Commerce which would administer the regulation of commercial activities the FAA does not oversee.¹⁹³ At this point, the private space exploration sector has progressed sufficiently to justify a formal safety standard regime and, potentially, its own agency.¹⁹⁴ Further, rocket engine emissions and space debris are among pressing environmental concerns that require immediate global regulation.¹⁹⁵ Going forward, Congress must carefully balance potential legal issues involving

186. *Id.* at 12 (pointing to purpose of mandated learning period which was time given for companies to develop business models).

187. *Id.* at 1 (indicating rapid speed of development in private space exploration sector).

188. *See Ward, supra* note 66 (reiterating that voluntary standards without regulation can be ignored).

189. *See King, supra* note 16, at 6 (noting pending follow-up report due in 2022 on industry's progress).

190. *See id.* at 6 (discussing expected contrast to readiness indicators reported in 2019 where transition was not yet warranted).

191. *Id.* at 12 (pointing to fast moving learning period of private space exploration industry over past years and projected continuation of growth).

192. *See Ward, supra* note 66 (detailing safety concerns of private space company employees).

193. *See King, supra* note 16 (specifying activities such as asteroid mining, orbit satellite servicing, and space traffic management).

194. *Id.* (signaling chance of directing FAA to establish licensing process for launch vehicles transporting passengers).

195. *See Levykin, supra* note 92 (directing attention to lack of regulation on rocket emissions).

safety and the pressing environmental concerns of increased space travel, with constrictions on the industry.¹⁹⁶

*Alec Fante**

196. *Id.* (acknowledging paradox that space exploration poses problems but can assist with climate change solutions).

* J.D. Candidate, May 2023, Villanova University Charles Widger School of Law; B.S., Finance, 2020, University of Delaware. I would first like to thank the various people in the Villanova Law community who helped me in writing this Comment. I am particularly thankful to all the members of the Editorial Board for making this Comment the best it could be. Additionally, thank you to all the Staff Writers for taking the time to diligently source check my Comment. Finally, I am deeply grateful to my family and friends for supporting me throughout my academic journey.