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THE LEGAL GREY AREA OF INDIA'S STRATOSPHERE

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Abstract

The distinction between airspace and outer space has remained one of the most unresolved questions in international law despite decades of legal and technological developments. Rapid advancements in aerospace technology have increasingly blurred this distinction, particularly within the stratosphere. The stratosphere has evolved into a strategically significant region supporting scientific research, high-altitude surveillance, defence operations, telecommunications, reusable launch vehicles, pseudo-satellites, and other near-space activities. However, neither international air law nor space law provides a definitive legal status for this region. This paper examines the legal uncertainty surrounding the status of the stratosphere from an Indian perspective by analysing the interaction between the Chicago Convention, 1944, the Outer Space Treaty, 1967, and India's domestic legal framework, including the Aircraft Act, 1934 and the National Space Policy, 2023. Although the Chicago Convention recognises the complete and exclusive sovereignty of every State over the airspace above its territory, it does not prescribe the vertical extent of such sovereignty. Likewise, the Outer Space Treaty establishes the principles of freedom of exploration, peaceful use, and non-appropriation of outer space without defining where outer space legally begins. This absence of a universally accepted boundary has created a regulatory vacuum with significant implications for India's sovereign rights, jurisdiction, national security, commercial space activities, and international obligations. Contemporary developments, including high-altitude surveillance platforms, hypersonic technologies, reusable launch systems, and near-space operations, have demonstrated that the existing legal framework is insufficient for modern aerospace activities. Through a doctrinal analysis of international treaties, domestic legislation, policy documents, and technological developments, this paper identifies legal gaps hindering effective governance of this transitional atmospheric region. It contends that the stratosphere should be recognised as an emerging legal and strategic domain requiring greater regulatory attention. The paper concludes that India should adopt a comprehensive legal framework clarifying its jurisdiction over stratosphere while remaining consistent with international law.

Keywords: Stratosphere, Air and Space Law, India, Sovereignty, Outer Space Treaty

Introduction: The Stratospheric Dilemma

The stratosphere, spanning approximately 12 to 50 kilometres above the Earth's surface, occupies a uniquely ambiguous position in international law, situated between national airspace, where States exercise complete sovereignty, and outer space, designated as the province of all mankind. For India, a nation rapidly advancing its aerospace technology, defence capabilities, space exploration ambitions, and commercial space ventures, this region—often termed the "stratosphere grey zone" or "near-space zone"—presents profound legal, strategic, diplomatic, environmental, economic, and technological challenges. The absence of a clearly recognised legal boundary between sovereign airspace and outer space has created a regulatory vacuum that complicates India's ability to regulate activities, assert sovereignty, address foreign incursions, manage environmental impacts, foster a burgeoning space economy, and leverage technological advancements within this critical zone. Despite significant developments in international air and space law, the legal status of the stratosphere remains uncertain, giving rise to questions regarding jurisdiction, applicable legal regimes, and the extent of State authority over activities occurring in this transitional region.

Against this backdrop, the present paper examines the legal grey area surrounding India's stratosphere through an analysis of the Convention on International Civil Aviation, 1944 (Chicago Convention) and the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 1967 (Outer Space Treaty). The study adopts a doctrinal research methodology by examining the relevant treaty provisions, India's domestic legal framework, and contemporary developments relating to air and space activities. In particular, it analyses Articles 1, 2, and 3(a) of the Chicago Convention together with Articles I, II, and III of the Outer Space Treaty to evaluate how the existing legal framework contributes to the uncertainty surrounding the status of India's stratosphere. It further examines the implications of this uncertainty for India's national security, aerospace activities, commercial space ventures, environmental sustainability, international obligations, economic opportunities, and technological advancement. Accordingly, this paper seeks to examine whether the absence of a legally recognised boundary between sovereign airspace and outer space creates regulatory uncertainty over the legal status of India's stratosphere.

Article 1 of the Chicago Convention: Sovereignty over Airspace

Article 1 of the Chicago Convention establishes that “every State has complete and exclusive sovereignty over the airspace above its territory.”¹ For India, this provision constitutes the legal foundation for exercising sovereignty over its landmass and territorial waters, which extend up to 12 nautical miles from the baseline, as recognized under customary international law and the *United Nations Convention on the Law of the Sea 1982*.² However, the Chicago Convention fails to define the upper limit of this “airspace”, thereby creating the central legal issue examined in this paper: where does India's sovereign airspace end and outer space begin? The Kármán Line, approximately 100 kilometres above Earth, is often cited as the boundary between airspace and outer space, but this threshold lacks legal endorsement in any international treaty.³ The stratosphere, ranging from 12 to 50 kilometres, falls within this undefined zone, where conventional aircraft operations diminish and outer space activities remain undefined. This omission creates regulatory uncertainty regarding India's claim to sovereignty over the stratosphere, as the Convention provides no vertical limit to the term “airspace”. The legal uncertainty has significant practical implications, particularly as India increasingly relies on high-altitude platforms, such as weather balloons, surveillance drones, high-altitude pseudo-satellites (HAPS), and scientific experiments, which operate in the stratosphere. For instance, the India Meteorological Department deploys stratospheric balloons to monitor weather patterns and atmospheric conditions, supporting disaster preparedness against monsoons, cyclones, and floods. Although these activities are generally treated as occurring within India’s sovereign airspace, the absence of a clearly recognised legal boundary raises uncertainty regarding the legal regime applicable to such operations, particularly where they approach the transitional zone between sovereign airspace and outer space. Consequently, this uncertainty may affect India's jurisdiction over such operations and create diplomatic and regulatory challenges. Moreover, India’s ambitious space programmes, including the *Chandrayaan* lunar missions and the *Gaganyaan* human spaceflight initiative, involve stratospheric transits, highlighting the need for legal certainty regarding the stratosphere.

¹ Convention on International Civil Aviation (adopted 7 December 1944, entered into force 4 April 1947) 15 UNTS 295 (Chicago Convention), art 1.

² United Nations Convention on the Law of the Sea (adopted 10 December 1982, entered into force 16 November 1994) 1833 UNTS 3, art 3.

³ Thomas Gangale, *The Development of Outer Space: Sovereignty and Property Rights in International Law* (Praeger 2009) 45.

Article 2 of the Chicago Convention: The Undefined Vertical Extent of Sovereignty

Article 2 of the Chicago Convention defines a state's territory as "the land areas and territorial waters adjacent thereto under the sovereignty, suzerainty, protection or mandate of such State."⁴ This provision delineates the horizontal extent of India's sovereignty, encompassing its landmass and territorial waters up to 12 nautical miles. However, it remains silent on the vertical dimension, failing to specify the altitude at which India's sovereign airspace ends and outer space begins. Accordingly, Article 2 assumes particular significance in examining the central question of this paper, namely whether the absence of a legally recognised boundary between sovereign airspace and outer space creates regulatory uncertainty over the legal status of India's stratosphere. For example, India may seek to regulate high-altitude activities, such as stratospheric balloons used for scientific research, HAPS for telecommunications and internet connectivity, or hypersonic vehicles developed for defence purposes, as extensions of its sovereign airspace. In the absence of a legally defined altitude limit, such claims may be contested by other States on the ground that these activities occur within outer space, where national sovereignty is prohibited under international law. The resulting uncertainty complicates India's ability to exercise jurisdiction, enforce domestic laws, and fulfil its international obligations in relation to activities occurring within the stratosphere, particularly as emerging aerospace technologies increasingly blur the distinction between aircraft and spacecraft. The rise of private space companies in India, such as Skyroot Aerospace, Agnikul Cosmos, and Pixxel, which are developing suborbital launch vehicles, HAPS, and hyperspectral imaging satellites that traverse the stratosphere, underscores the need for legal clarity to regulate these activities effectively. The absence of legal certainty not only affects governmental regulation but also influences commercial decision-making, compliance requirements, and long-term investment within India's emerging aerospace sector. These companies are driving India's ambition to become a global leader in space technology, with projections estimating India's space economy to reach \$13 billion by 2027. However, the lack of a defined legal framework for stratospheric operations creates uncertainty for both regulators and industry players, potentially deterring investment, stifling innovation, and limiting India's competitiveness in the global space market.

⁴ Chicago Convention (n 1), art 2.

Article 3(a) of the Chicago Convention: The Regulatory Gap for State Aircraft

Article 3(a) of the Chicago Convention limits its applicability to civil aircraft, explicitly excluding state aircraft used for military, customs, or police purposes.⁵ This exclusion means that India's military aircraft, high-altitude surveillance drones, HAPS, or experimental vehicles operating in the stratosphere are not governed by the Chicago Convention. While this grants India significant discretion over its state aircraft operating within its sovereign airspace, it simultaneously creates a regulatory gap for stratospheric operations, as no comprehensive international legal framework specifically governs state aircraft operating within this transitional zone. This regulatory gap assumes particular importance in the context of the present study, as it further illustrates how the absence of a legally recognised boundary between sovereign airspace and outer space contributes to uncertainty regarding India's jurisdiction over stratospheric activities. The exclusion of state aircraft from the Convention also raises important legal questions concerning the regulation of foreign military operations within India's stratosphere, particularly where jurisdiction itself remains uncertain. For instance, if a foreign state operates a high-altitude surveillance drone at 30 kilometres above Indian territory, India may view this as a violation of its sovereignty. However, the lack of a clear boundary between airspace and outer space, combined with the exclusion of state aircraft from the Chicago Convention, leaves India with limited legal recourse to challenge such activities. Consequently, the legal uncertainty extends beyond questions of sovereignty and has direct implications for national security, defence planning, intelligence gathering, and regional strategic stability. India's development of hypersonic weapons, such as the BrahMos-II missile, which operates at stratospheric altitudes, highlights the need for a clear legal framework to govern such activities. Without such legal clarity, India risks jurisdictional disputes concerning the legality of its stratospheric military operations, particularly as major powers continue expanding their high-altitude defence capabilities. The absence of regulation also raises concerns about potential escalations, as misidentification of stratospheric objects could lead to diplomatic or military tensions, especially in a geopolitically sensitive region like South Asia, where India shares borders with China and Pakistan. For example, incidents involving unidentified high-altitude objects could exacerbate tensions in disputed border regions like Ladakh, where India and China have faced military standoffs. Thus, Article 3(a) further highlights the regulatory uncertainty governing state aircraft operations in India's stratosphere.

⁵ Chicago Convention (n 1), art 3(a).

Article I of the Outer Space Treaty: Freedom of Exploration and the Jurisdictional Dilemma

The Outer Space Treaty introduces further complexities to the legal status of India's stratosphere. Article I declares that "the exploration and use of outer space... shall be carried out for the benefit and in the interests of all countries... and shall be the province of all mankind."⁶ It guarantees free access to outer space for all states without discrimination and encourages international cooperation in scientific investigation. However, the treaty does not define where outer space begins, leaving the stratosphere's status ambiguous. This legal uncertainty creates a tension between India's sovereign rights under the Chicago Convention and the principle of free exploration and use of outer space recognised under Article I of the Outer Space Treaty. If the stratosphere were considered part of outer space, the scope of India's authority to restrict foreign activities would require assessment under the Outer Space Treaty and other applicable rules of international law. For example, the 2023 incident involving a Chinese high-altitude balloon over North America sparked debates about whether such objects fall under airspace or outer space jurisdiction, highlighting the global relevance of this issue. India faces a similar jurisdictional dilemma, as foreign entities may characterise their stratospheric operations as scientific activities protected under Article I, thereby limiting India's ability to exercise effective regulatory control. Furthermore, Article I's characterisation of outer space as the "province of all mankind" presents a practical challenge to India's assertion of sovereign authority over activities occurring within the stratosphere. The Indian Space Research Organisation (ISRO) frequently conducts launches that traverse the stratosphere, such as the Polar Satellite Launch Vehicle (PSLV), Geosynchronous Satellite Launch Vehicle (GSLV), and Small Satellite Launch Vehicle (SSLV) missions, which are critical for India's satellite deployment, navigation, communication, and scientific research. While these activities are regulated under domestic law as airspace operations, their classification could shift to outer space activities if the stratosphere is deemed beyond India's sovereign control, subjecting them to international scrutiny under the Outer Space Treaty. Accordingly, the continued absence of a clearly recognised international boundary between airspace and outer space may complicate India's expanding space ambitions and reinforces the need for greater international legal clarity through multilateral efforts to address this jurisdictional uncertainty.

⁶ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (adopted 27 January 1967, entered into force 10 October 1967) 610 UNTS 205 (Outer Space Treaty), art I.

Article II of the Outer Space Treaty: Non-Appropriation and India's Regulatory Authority over the Stratosphere

Article II of the Outer Space Treaty states that “outer space... is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.”⁷ This provision explicitly prohibits states, including India, from claiming sovereignty over outer space. If the stratosphere is considered part of outer space, India's assertions of jurisdiction over stratospheric activities—including regulating rocket launches, intercepting foreign objects, or conducting military tests—could conflict with the principle of non-appropriation embodied in Article II. Consequently, the absence of a legally recognised boundary between sovereign airspace and outer space assumes direct relevance to the central question of this paper, as it creates uncertainty regarding the extent of India's lawful regulatory authority. India currently enforces sovereignty over its stratospheric operations, such as licensing commercial launches or conducting defence-related activities. For instance, India's 2019 *Mission Shakti* anti-satellite (ASAT) test, which demonstrated its ability to destroy satellites in low Earth orbit, likely involved operations that traversed the stratosphere. If such activities are interpreted as occurring in outer space, India could face international criticism for militarizing a zone where sovereignty is prohibited. Accordingly, Article II presents a jurisdictional dilemma rather than a straightforward prohibition, as the legality of India's actions depends upon whether the relevant activities are characterised as occurring within sovereign airspace or outer space. The resulting legal uncertainty also affects India's ability to regulate emerging aerospace technologies, including reusable launch vehicles, HAPS, space tourism platforms, and stratospheric airships, whose operations increasingly blur the distinction between aviation and space activities. India's own space tourism initiatives, such as those proposed by private companies like Skyroot Aerospace and supported by ISRO's *Gaganyaan* programme, further highlight the need for a clear legal framework to govern stratospheric operations. As commercial and private participation in the aerospace sector continues to expand, the absence of legal certainty may create regulatory inconsistencies affecting licensing, liability, investment, and international cooperation. If these activities fall under outer space law, India's regulatory authority may be limited, complicating its efforts to ensure compliance with national security, safety, environmental, and economic standards.

⁷ Outer Space Treaty (n 13), art II.

Article III of the Outer Space Treaty: International Law and Peaceful Use

Article III of the Outer Space Treaty mandates that outer space activities be conducted “in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security.”⁸ This provision underscores the peaceful use of outer space and holds states accountable for their activities. However, its applicability to the stratosphere depends on whether this zone is legally classified as outer space, an unresolved issue that lies at the centre of the present study. India’s stratospheric activities, such as military surveillance, missile defence tests, ASAT operations, or HAPS deployments, are often justified as sovereign rights under the Chicago Convention. If the stratosphere is legally regarded as outer space, these activities would be subject to the peaceful use principle under Article III, potentially limiting India's ability to undertake certain defence-oriented operations. For example, If such activities were considered to take place in outer space, their legality would have to be assessed in accordance with the Outer Space Treaty, the UN Charter and other applicable rules of international law. Conversely, Article III provides India with a mechanism to protest foreign activities in its stratosphere, such as surveillance balloons, drones, or airships, if they threaten international peace. The 2023 Chinese balloon incident serves as a pertinent example, as it raised questions about the legality of stratospheric operations under international law. However, the undefined boundary between airspace and outer space weakens India’s legal standing, as it cannot definitively claim jurisdiction over the stratosphere. This creates a legal grey zone in which the scope of India's sovereign rights and its corresponding international obligations remain uncertain, complicating both the regulation of domestic activities and the legal response to foreign incursions within the stratosphere.

Implications for India's National Security

The legal grey area of the stratosphere has profound implications for India's national security. The stratosphere is increasingly critical for strategic operations, including surveillance, missile defence, communication systems, early warning systems, and counter-space capabilities. India's advancements in aerospace technology, such as the BrahMos-II hypersonic missile, DRDO's high-altitude platforms, and ISRO's reusable launch vehicles, rely on access to this zone. However, the absence of a clearly recognised legal boundary between sovereign airspace and outer space undermines India's ability to regulate and defend activities within the stratosphere. Foreign incursions, including high-altitude drones, balloons, or stratospheric

⁸ Outer Space Treaty (n 13), art III.

airships, could exploit this legal uncertainty to conduct reconnaissance over Indian territory. India's strategic location in South Asia, bordering China and Pakistan, further heightens the importance of securing its stratospheric zone. For example, China's advancements in stratospheric airships and surveillance drones pose potential security concerns for India, particularly in disputed regions such as Ladakh, where high-altitude surveillance is vital for monitoring military activities. Without a clearly defined legal boundary, India may face difficulties in establishing violations of its sovereign rights, particularly where foreign States contend that their activities occur within outer space. The exclusion of state aircraft from the Chicago Convention further complicates this issue, as military operations in the stratosphere remain largely unregulated, reinforcing the regulatory uncertainty surrounding India's response to foreign surveillance and reconnaissance activities.

Challenges to India's Commercial Space Sector

India's burgeoning space sector, driven by ISRO and private companies such as Skyroot Aerospace, Agnikul Cosmos, Pixxel, and Dhruva Space, is increasingly expanding into stratospheric operations, including suborbital launches, high-altitude testing, hyperspectral imaging, and communication platforms. The legal uncertainty surrounding the status of the stratosphere complicates the regulation of these activities. The absence of a clearly recognised boundary between sovereign airspace and outer space creates uncertainty regarding the legal regime applicable to such operations. If the stratosphere is treated as outer space, India must ensure compliance with the Outer Space Treaty, potentially limiting its ability to impose domestic licensing and regulatory requirements. For example, private space companies may face international scrutiny if their stratospheric operations are considered inconsistent with the Treaty's principles of free access or peaceful use. Conversely, if the stratosphere is treated as sovereign airspace, India retains broader regulatory authority but may face disputes concerning the extent of its jurisdiction. The emergence of space tourism and reusable launch vehicles further complicates this legal landscape, as these technologies frequently traverse the stratosphere and blur the distinction between aircraft and spacecraft. Skyroot Aerospace's successful launch of India's first private suborbital rocket in 2022 and Pixxel's hyperspectral imaging satellites demonstrate the growing commercial significance of this zone. Similarly, Dhruva Space's satellite platforms underscore the economic potential of India's expanding space sector. Consequently, the absence of a clear legal framework governing stratospheric activities creates regulatory uncertainty relating to licensing, taxation, operational safety, and

commercial investment as private participation continues to shape India's space economy.

Environmental Concerns in Stratospheric Operations

The environmental implications of stratospheric activities add a critical dimension to the legal grey area. The stratosphere plays a vital role in regulating Earth's climate through the ozone layer, which protects against harmful ultraviolet radiation. High-altitude operations, including rocket launches, hypersonic flights, HAPS, and stratospheric balloons, can release pollutants such as black carbon, nitrogen oxides, and water vapour, contributing to ozone depletion and atmospheric warming. India's increasing stratospheric activities necessitate a legal framework addressing environmental concerns alongside security and regulatory issues. The Outer Space Treaty's emphasis on international cooperation could provide a basis for India to advocate global standards for stratospheric environmental protection, although the absence of a clearly recognised boundary complicates their implementation. India's commitment to sustainable development underscores the need to integrate environmental considerations into its stratospheric policies. ISRO's rocket launches traversing the stratosphere must balance scientific, strategic, and economic objectives with environmental impacts, including minimising ozone depletion and greenhouse gas emissions. Failure to address these concerns could invite international criticism and weaken India's position as a responsible space-faring nation.

Economic Implications of the Stratospheric Legal Vacuum

The economic implications of the stratospheric grey zone are equally significant. India's space economy, projected to grow to \$13 billion by 2027, relies heavily on stratospheric operations for satellite launches, space tourism, high-altitude communication platforms, and remote sensing. The legal uncertainty surrounding the stratosphere could deter foreign investment and hinder the growth of India's private space sector. For instance, companies such as Skyroot Aerospace, Agnikul Cosmos, and Pixxel require a clear regulatory framework to attract global partners and secure funding for their space programmes. Such legal certainty would foster innovation, generate employment, and strengthen India's position as a global hub for space technology. Additionally, the stratosphere's potential for high-altitude internet connectivity through HAPS could help bridge India's digital divide, particularly in rural and remote areas. Regulatory ambiguity could delay these initiatives and reduce their socio-economic benefits. Public-private partnerships between ISRO and private companies could further promote

technological advancement while ensuring regulatory compliance, thereby strengthening India's expanding space economy.

Technological Developments and Regulatory Challenges

The technological implications of the stratospheric grey zone are significant, as India seeks to leverage advancements in aerospace and space technology to strengthen its capabilities in this zone. Developing surveillance systems, including high-altitude drones, stratospheric airships, and satellite-based monitoring, can enhance India's ability to detect and respond to unauthorised stratospheric activities. The Defence Research and Development Organisation (DRDO) is developing high-altitude platforms for surveillance, communication, and missile defence that could monitor activities within the stratosphere. Similarly, ISRO's reusable launch vehicle programme and private companies' suborbital technologies depend on stratospheric operations, reinforcing the need for a clear legal framework to support technological innovation and regulatory certainty. Collaborative research with international partners, including the European Space Agency, Japan Aerospace Exploration Agency, and NASA, could further strengthen India's technological capabilities while promoting cooperative approaches to stratospheric governance. Joint initiatives on stratospheric environmental monitoring could also address the ecological impacts of high-altitude operations while encouraging international cooperation and technological exchange.

India's Diplomatic Position in International Space Governance

The legal grey area surrounding the stratosphere also places India in a delicate diplomatic position. As a signatory to both the Chicago Convention and the Outer Space Treaty, India must balance its sovereign rights with its international obligations. Asserting sovereignty over the stratosphere risks accusations of violating the Outer Space Treaty's principle of non-appropriation, while failing to regulate stratospheric activities could weaken India's strategic and regulatory position. This unresolved legal uncertainty also limits India's ability to adopt a consistent diplomatic stance on the status of the stratosphere in international negotiations. India's active participation in international forums, such as the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), provides an opportunity to advocate for a clearly recognised legal demarcation between sovereign airspace and outer space. Such a position would not only enhance legal certainty but also reduce jurisdictional disputes relating to emerging aerospace technologies and high-altitude operations. However, achieving global

consensus remains challenging because States continue to pursue divergent legal and strategic interests. Developed nations with advanced space capabilities, such as the United States, China, and Russia, may favour a lower boundary to maximise freedom of access to outer space, whereas developing nations, including India, Brazil, and South Africa, may support a higher boundary to preserve greater sovereign control over the stratosphere. The lack of international agreement on this issue has persisted for decades, with proposals such as the Kármán Line failing to secure universal acceptance due to competing national interests. India's growing influence in global space governance, demonstrated through its leadership in initiatives such as the Global Space Summit 2024 and its participation in the Artemis Accords, places it in a favourable position to contribute meaningfully to future discussions on establishing greater legal certainty regarding the boundary between sovereign airspace and outer space.

Towards an International Legal Framework

Addressing the legal grey area of India's stratosphere requires a multifaceted approach that combines international advocacy, domestic policy reforms, technological innovation, regional cooperation, environmental stewardship, economic incentives, and public engagement. Given that the central challenge arises from the absence of a legally recognised boundary between sovereign airspace and outer space, any long-term solution must seek to reduce regulatory uncertainty while balancing State sovereignty with the principle of freedom of outer space. India should leverage its position within the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) to promote discussions on a universally accepted legal demarcation between airspace and outer space. The Kármán Line at approximately 100 kilometres remains the most widely referenced threshold, but its lack of formal legal recognition limits its practical value in resolving jurisdictional disputes. India could therefore support the development of a treaty-based definition of the boundary between airspace and outer space. Such a framework would enhance legal certainty by clarifying the regulatory regime applicable to military surveillance, commercial launches, scientific research, high-altitude pseudo-satellites (HAPS), and other emerging aerospace activities. However, achieving global consensus will require sustained diplomatic engagement, as technologically advanced States such as the United States and China may be reluctant to accept a fixed boundary that could restrict operational flexibility in near-space activities. India could strengthen its negotiating position by building coalitions with other developing nations, including Brazil, South Africa, Nigeria, and Indonesia, which share similar concerns regarding sovereignty, regulatory certainty, and equitable participation

in the future governance of the stratosphere.

Strengthening India's Domestic Regulatory Framework

India can strengthen its domestic legal framework to regulate stratospheric activities regardless of their legal classification. The Draft Space Activities Bill 2017, which seeks to regulate India's space sector, could be expanded to expressly address stratospheric operations. The legislation could establish regulatory requirements for stratospheric activities without prejudging the unresolved international boundary between airspace and outer space. It could also establish licensing requirements for private entities operating in the stratosphere, ensuring compliance with domestic and international obligations and promoting greater regulatory certainty. Such a framework would provide greater legal certainty for companies such as Skyroot Aerospace, Agnikul Cosmos, Pixxel, and Dhruva Space while reinforcing India's regulatory authority and encouraging responsible private participation in emerging aerospace activities. India should also develop regulations for emerging technologies, including space tourism, hypersonic vehicles, HAPS, and stratospheric airships, to ensure safety, security, environmental sustainability, economic viability, and effective risk management. The National Space Policy 2023 could provide the foundation for a comprehensive regulatory framework balancing economic growth with environmental protection, national security priorities, and long-term technological advancement.

Technological Measures for Effective Governance

Technological advancements can help India exercise practical control over its stratosphere despite the absence of legal clarity. Developing surveillance systems, including high-altitude drones, stratospheric airships, and satellite-based monitoring, can improve the detection of unauthorised stratospheric activities. DRDO's high-altitude platforms for surveillance, communication, and missile defence could monitor the stratosphere and strengthen national security. Investment in hypersonic and suborbital technologies would also enhance India's strategic capabilities. ISRO's reusable launch vehicle programme and private companies' suborbital technologies rely on stratospheric operations and would benefit from greater legal certainty. International collaboration with the European Space Agency, Japan Aerospace Exploration Agency, NASA, and the Indian Ocean Rim Association could strengthen India's technological capabilities while promoting cooperative approaches to stratospheric governance. Joint projects on stratospheric environmental monitoring could address the

ecological impacts of high-altitude operations while promoting international cooperation and technological exchange.

The Role of Regional Cooperation

Regional cooperation can serve as an interim mechanism for addressing the regulatory uncertainty arising from the absence of a legally recognised boundary between sovereign airspace and outer space. Although it cannot resolve the issue of international delimitation, it can facilitate common operational standards for stratospheric activities pending a universally accepted legal framework. India could pursue regional agreements through organisations such as the South Asian Association for Regional Cooperation (SAARC), the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), and the Quadrilateral Security Dialogue (Quad) to establish cooperative norms governing surveillance, high-altitude operations, information sharing, and responses to unauthorised stratospheric activities. Such agreements could include notification mechanisms, confidence-building measures, and protocols for addressing potential incursions, reducing the risk of diplomatic misunderstandings and escalation. India and Pakistan could develop bilateral arrangements on high-altitude surveillance activities to minimise tensions arising from the misidentification of stratospheric objects. India's leadership in regional forums and strategic partnerships with Japan, Australia, and the United States through the Quad place it in a favourable position to promote coordinated approaches to stratospheric governance. While regional cooperation cannot replace an internationally recognised legal boundary, it offers a practical interim solution for reducing regulatory uncertainty until global consensus is achieved.

Promoting Economic Growth through Regulatory Certainty

Economic incentives can further support India's efforts to address the regulatory uncertainty surrounding the stratosphere. By establishing a clear regulatory framework, India can attract foreign investment and foster innovation in its space sector. For example, tax incentives for companies developing stratospheric technologies, such as HAPS, suborbital vehicles, or hyperspectral imaging, could accelerate India's space economy growth. Public-private partnerships, such as those between ISRO and private companies, could drive technological advancements while ensuring regulatory compliance. India's *Make in India* initiative could be leveraged to promote domestic manufacturing of stratospheric platforms, creating jobs and boosting economic development. Additionally, public engagement through education and

outreach programmes could raise awareness of the stratosphere's importance, fostering domestic support for India's space policies and encouraging STEM education to build a skilled workforce for the space sector.

Research Suggestion

India should establish a mandatory registration and tracking system for stratospheric objects and high-altitude platforms operating over its territory as an interim measure to address the regulatory uncertainty caused by the absence of a legally recognised boundary between airspace and outer space. Operators of scientific balloons, HAPS, high-altitude drones and similar platforms could be required to register their activities, disclose their purpose and payload, provide identification information, and maintain continuous or periodic tracking during operations. India could also establish a central database accessible to relevant aviation, defence and space authorities for monitoring such activities. A similar regulatory approach is followed in the United States, where unmanned free balloons are subject to notification, tracking and reporting requirements⁹. Such a system would improve situational awareness, enhance national security and safety, and enable India to exercise more effective regulatory oversight over stratospheric activities while the international legal status and boundary between sovereign airspace and outer space remain unresolved.

Conclusion

In conclusion, the legal grey area concerning India's stratosphere highlights the difficulty of regulating a region between sovereign airspace and outer space. Articles 1, 2 and 3(a) of the Chicago Convention recognise India's sovereignty over its airspace but do not define its vertical limit, while Articles I, II and III of the Outer Space Treaty apply to outer space without clearly establishing where it begins. This uncertainty creates challenges for national security, aviation safety, scientific activities and commercial operations.

Until an internationally recognised boundary is established, India should adopt an interim mandatory registration and tracking system for stratospheric objects and high-altitude platforms operating over its territory. Scientific balloons, HAPS, high-altitude drones and similar platforms could be required to disclose their purpose, payload and identification details and maintain appropriate tracking. A central database accessible to aviation, defence and space authorities would improve situational awareness and regulatory oversight. Such measures

⁹ 14 CFR §§ 101.33–101.37 (United States), *Unmanned Free Balloons*, Federal Aviation Regulations.

would allow India to address immediate security and safety concerns without prejudging the unresolved international question of the boundary between airspace and outer space.

References

The present research is based on an analysis of the following treaties, statutes, policy documents, official reports, and academic literature. These sources have provided the legal and conceptual foundation for the arguments advanced in this paper.

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