

# Amateur Scientists, the International Geophysical Year, and the Ambitions of Fred Whipple

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## ABSTRACT

The contribution of amateur scientists to the International Geophysical Year (IGY) was substantial, especially in the arena of spotting artificial satellites. This article examines how Fred L. Whipple and his colleagues recruited satellite spotters for Moonwatch, a program for amateur scientists initiated by the Smithsonian Astrophysical Observatory (SAO) in 1956. At the same time, however, the administrators with responsibility for the IGY program closely monitored and managed—sometimes even contested—amateur participation. IGY programs like Moonwatch provided valuable scientific information and gave amateurs opportunities to contribute actively to the research of professional scientists. Moonwatch, which operated until 1975, eventually became the public face of a vast satellite-tracking network that expanded the SAO's global reach and helped further Whipple's professional goals. Understanding amateurs' interactions with the professional science community enables us better to understand the IGY as a phenomenon that enlisted broad participation and transcended traditional boundaries between professional and amateur scientists.

**I**N 2007 SCIENTISTS WILL MARK the fiftieth anniversary of the International Geophysical Year (IGY), arguably the most ambitious international science project of the twentieth century. Between July 1957 and December 1958, tens of thousands of professional scientists from sixty-seven nations manned hundreds of stations around the globe and researched topics in geodesy and geophysics, atmospheric sciences, oceanography,

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and other fields. Major achievements of the IGY include the detection of the Van Allen radiation belts around the earth, further exploration of Antarctica, and confirmation of a worldwide system of underwater mountains and ridges that helped further scientists' understanding of plate tectonics. Most stunning of all was the appearance of the first artificial satellites, beginning with the 4 October 1957 launch of *Sputnik* by the Soviet Union.<sup>1</sup>

Historians of science, international relations, and space policy have examined the establishment of the IGY, its political context, its role in fostering Big Science, and its legacy in terms of scientific results and international cooperation.<sup>2</sup> The focus of these studies has consistently been on the scientists and administrators who organized, managed, and did research during the IGY. Historians have not fully examined or appreciated the role of amateur scientists—a broad category that I will discuss in the next section—in IGY activities. Amateurs contributed substantially to the IGY, much to the surprise of detractors, especially in the area of satellite tracking. Indeed, the amateur satellite-spotting program of the Smithsonian Astrophysical Observatory (SAO) known as Moonwatch engaged the enthusiastic attention of thousands of amateurs for nearly two decades, continuing long after the IGY ended.

In 1975 the astronomer Fred L. Whipple, recently retired director of the Smithsonian Astrophysical Observatory (SAO), wrote to a worldwide corps of amateur astronomers, “THEY said it couldn’t be done! THEY said it couldn’t work!” But, as Whipple exulted, “THEY were dead wrong!” And who was the target of Whipple’s glee? “They” were the “professional scientists, engineers, and administrators” who, according to Whipple, had claimed that amateurs were incapable of making useful and systematic contributions to the International Geophysical Year.<sup>3</sup>

By focusing most closely on Moonwatch, this essay explores the interaction between amateurs and professional scientists during the IGY and considers how scientific leaders negotiated this relationship. Against this backdrop, we can better understand the contri-

<sup>1</sup> Except where otherwise noted, I have followed the popular convention of referring to the first Soviet satellite simply as *Sputnik*. As many historians of science know, the first *Sputnik* involved at least two orbiting bodies—the 22.8-inch satellite itself and the much larger and more visible rocket body that accompanied it into orbit.

<sup>2</sup> The IGY has been treated in varying degrees and ways by historians, political scientists, journalists, and participants. General works on the history and accomplishments of the IGY include Walter Sullivan, *Assault on the Unknown: The International Geophysical Year* (New York: McGraw Hill, 1961); Sydney Chapman, *IGY: Year of Discovery* (Ann Arbor: Univ. Michigan Press, 1959); and J. Tuzo Wilson, *IGY: The Year of the New Moons* (New York: Knopf, 1961). Consideration of the political aspects of the IGY can be found in Harold Bullis, *The Political Legacy of the International Geophysical Year* (Washington, D.C.: U.S. Government Printing Office, 1973), while Allan A. Needell, *Science, Cold War, and the American State: Lloyd V. Berkner and the Balance of Professional Ideals* (Amsterdam: Harwood, 2000), Chs. 11, 12, treats the organization and management of the IGY and the launch of the first satellites. The support of the National Science Foundation for the IGY is discussed in J. Merton England, *A Patron for Pure Science: The National Science Foundation's Formative Years, 1945–57* (Washington, D.C.: National Science Foundation, 1983). The literature on *Sputnik* and the first satellites alone is voluminous. Book-length studies include Robert A. Divine, *The Sputnik Challenge: Eisenhower's Response to the Soviet Satellite* (New York: Oxford Univ. Press, 1993); Walter A. McDougall, *The Heavens and the Earth: A Political History of the Space Age* (Baltimore: Johns Hopkins Univ. Press, 1997); and Roger D. Launius, John M. Logsdon, and Robert W. Smith, eds., *Reconsidering Sputnik: Forty Years since the Soviet Satellite* (New York: Routledge, 2000). In the last book, Rip Bulkeley's contribution—“The Sputniks and the IGY” (pp. 125–159)—is especially useful, as is Michael J. Neufeld's “Orbiter, Overflight, and the First Satellite: New Light on the Vanguard Decision” (pp. 231–257). Jacob Darwin Hamblin's *Oceanographers and the Cold War: Disciples of Marine Science* (Seattle: Univ. Washington Press, 2005) considers the issue of international cooperation with reference to the IGY. Its influence on Big Science is examined in Robert W. Smith, “Large-Scale Scientific Enterprise,” *Encyclopedia of the United States in the Twentieth Century*, ed. Stanley Kutler, Vol. 2 (New York: Scribner's, 1996), pp. 739–765.

<sup>3</sup> Fred Whipple to Moonwatch members, 15 June 1975, Folder “Test Alert #1,” Box 45, Moonwatch Papers, RU 255, Smithsonian Institution Archives, Washington, D.C. (hereafter cited as **Moonwatch Papers**).

butions, meaningful as well as frivolous, of amateurs to the IGY. The essay furthers our understanding of the IGY by demonstrating how amateur scientists contributed to formal research programs and how professional scientists and administrators tried to set limits on amateur participation.

How Whipple mediated and organized the participation of amateurs to further his own goals is also explained. Moonwatch became the public face of a satellite-tracking network that expanded the SAO's global reach. Whipple used the satellite-tracking program as the primary means to secure funding for the observatory and to enlarge the SAO's staff in the late 1950s and early 1960s. These resources and the institutional connections they helped create provided a gateway for the observatory to participate in new research opportunities that arose in the early years of space exploration.

Finally, this essay demonstrates that the thousands of amateur scientists who contributed to the IGY were not merely passive collectors of data. Throughout the IGY, amateurs built and refined their equipment, developed new techniques, provided information to the public, and formed local and regional networks to communicate their work. While amateurs carried out research in a number of fields, ranging from aurora and variable star watching to seismology and oceanography, Moonwatch was the IGY's most successful amateur activity, and its impact persisted long after 1958. In fact, the SAO continued Moonwatch until 1975. Understanding the interactions of Moonwatchers with the professional science community enables us better to understand the IGY as a phenomenon that enlisted broad participation and transcended traditional boundaries between professional and amateur scientists.

#### WHO WAS AN AMATEUR SCIENTIST?

People who participate in amateur science activities like astronomy, birding, and archaeology fall into diverse categories: dabbler, hobbyist, recreation seeker, devotee, and serious amateur.<sup>4</sup> The same imprecise and flexible labels challenge our attempts strictly to separate amateur scientists from their professional counterparts. Historians have devoted considerable attention to the study of amateur scientists, their interaction with professional science communities, and the extent of amateur contributions to research. Amateur astronomers have received an especial amount of attention.<sup>5</sup> Most of this historiography focuses on the

<sup>4</sup> These categories appear in several publications by Robert A. Stebbins, including "Avocational Science: The Amateur Routine in Archaeology and Astronomy," *International Journal of Comparative Sociology*, 1980, 21(1–2):34–48; "Amateur and Professional Astronomers: A Study of Their Interrelationships," *Urban Life*, 1982, 10:433–454; and *Amateurs, Professionals, and Serious Leisure* (Montreal: McGill-Queen's Univ. Press, 1992). Thomas R. Williams uses a different set of criteria to separate amateur astronomers from what he terms "recreational observers," including "a serious intent to contribute to the advancement of astronomy" that is demonstrated over an extended period of time and involves communicating the results of one's work to others; see Williams, "Criteria for Identifying an Astronomer as an Amateur," in *Stargazers: The Contribution of Amateurs to Astronomy*, ed. S. Dunlop and M. Gerbaldi (Berlin: Springer, 1987), pp. 24–25.

<sup>5</sup> For a representative sample of this extensive literature see Sally Gregory Kohlstedt, "The Nineteenth-Century Amateur Tradition: The Case of the Boston Society of Natural History," in *Science and Its Public: The Changing Relationship*, ed. Gerald Holton and William Blanpied (Boston: Reidel, 1976), pp. 173–190; Susan Leigh Star and James Griesemer, "Institutional Ecology, Translations, and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology," *Social Studies of Science*, 1989, 19:387–420; Elizabeth Barnaby Keeney, *The Botanizers: Amateur Scientists in Nineteenth-Century America* (Chapel Hill: Univ. North Carolina Press, 1992); and Mark V. Barrow, *A Passion for Birds: American Ornithology after Audubon* (Princeton, N.J.: Princeton Univ. Press, 1998). Studies that look especially at amateur astronomy include John Lankford, "Amateurs versus Professionals: The Controversy over Telescope Size in Late Victorian Science," *Isis*, 1981, 72:11–27; Marc Rothenberg, "Organization and Control: Professionals and Amateurs in American Astronomy, 1899–

nineteenth and early twentieth centuries. At that time, scientists were establishing their professional identities and delineating major research disciplines. By the time of the IGY, the traditional tensions historians have noted between professional scientists and amateurs were generally not an issue.

In the mid-twentieth century astronomy enthusiasts—the group most pertinent to this essay—formed a socially complex community. Prior to the start of the IGY, amateur astronomers made multiple attempts to organize themselves into local, regional, and national associations and met with varying success. At the same time, these amateurs engaged in activities that spanned a broad range of interests. Some oriented themselves primarily toward building their own telescopes, and, indeed, there was a renaissance in amateur telescope making in the United States beginning in the 1920s. Other amateur astronomy clubs had roots as civic organizations and encouraged recreational sky watching with an emphasis on entertainment and education. Finally, there were quasi-amateur groups like the American Association of Variable Star Observers and the Association of Lunar and Planetary Observers, which saw themselves as contributing to the research of professional scientists.<sup>6</sup>

Rather than trying strictly to distinguish the categories of “scientist” and “amateur” and to parse the latter group into more specific yet potentially confusing subgroups, in this essay I use the terms “professional scientist” and “amateur scientist” with the recognition that the boundaries between and the identities of these groups were indistinct and that they sometimes overlapped.

Consider, for instance, the case of Arthur S. Leonard, who organized and led a Moonwatch team near Sacramento, California, for years.<sup>7</sup> A professor of agricultural engineering at the University of California, Leonard had considerable professional training that, combined with an amateur’s passion for astronomy, made him one of the most active and reliable Moonwatch volunteers. While nominally an “amateur” satellite spotter, Leonard’s mathematical prowess and observational precision enabled him to make calculations of satellite orbits during the IGY that rivaled those of his “professional” counterparts for accuracy.

Many people with backgrounds similar to Leonard’s took part in Moonwatch or other amateur IGY activities. Their involvement makes it clear that the identity of “amateur scientists” is more nuanced than one might first suspect. Credentials, institutional affiliation, and access to key equipment and other resources all serve as possible ways to separate amateur scientists from professional scientists engaged in the IGY. We may also inquire as to individuals’ motives for taking part in the IGY and the degree of commitment they displayed. Moonwatch, especially after *Sputnik* appeared, naturally attracted people intrigued by its Space Age novelty. Their contributions were indeed often “amateurish”—and so perhaps not of much use to scientific research. Yet their participation in Moonwatch or other amateur science programs may have served civic or educational purposes that were valuable in other ways. What stimulated the interest and participation of amateur

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1918,” *Soc. Stud. Sci.*, 1981, 11:305–325; Lankford, “Amateurs and Astrophysics: A Neglected Aspect in the Development of a Scientific Specialty,” *ibid.*, pp. 275–303; and Ken Willcox, “The Golden Age of Amateur Astronomy,” *Mercury*, 1996, 24(1):32–34.

<sup>6</sup> See Thomas R. Williams, “Getting Organized: A History of Amateur Astronomy in the United States” (Ph.D. diss., Rice Univ., 2000); Williams, “Albert Ingalls and the ATM Movement,” *Sky and Telescope*, Feb. 1991, pp. 140–143 (on amateur telescope making); and Leif J. Robinson, “Enterprise at Harvard College Observatory,” *Journal for the History of Astronomy*, 1990, 21:89–103 (on the quasi-amateur groups).

<sup>7</sup> Leonard’s Moonwatch activities are recorded in Box 18, Moonwatch Papers.

scientists in the IGY? Did they hope to contribute to and further scientific knowledge, or were they simply caught up in the excitement the IGY stimulated? Did they set and follow established standards and practices? Were they members of a larger community that circulated news and technical tips? Did they meet with other groups of amateur scientists or interact with professional scientists in some fashion? These are key points to consider, and I will return to them in the final section of this essay.

#### EARLY PROPOSALS FOR AMATEUR PARTICIPATION

The degree to which amateurs contributed to the IGY was made possible, in part, by professional scientists like Whipple who cultivated their participation. Their contributions were, in turn, closely monitored and managed—sometimes even contested—by the administrators and scientists who had responsibility for the IGY program. In the United States, the IGY activities of professionals and amateurs alike were organized under the auspices of the National Academy of Sciences (NAS). Hugh Odishaw, formerly a scientist and administrator from the National Bureau of Standards, directed the IGY in the United States. He was assisted by dozens of scientists and administrators the academy asked to serve on the United States National Committee (USNC) or one of its working groups or technical panels.

In October 1955, only a few months after President Eisenhower announced that the United States would launch a series of satellites during the IGY, Clair L. Strong contacted Odishaw about whether the IGY had a “plan for any amateur participation.” Strong, an electrical engineer for Westinghouse and expert tinkerer, wrote a popular column for *Scientific American* called “The Amateur Scientist.” He argued that the enthusiasm of amateur scientists (people he defined as making an “avocation of one or another aspect of science”) and their “fine grained network” would more than compensate for any shortcomings in their training and equipment.<sup>8</sup> These amateurs—he claimed there were at least a hundred thousand in the United States alone—included cooperative weather observers, aurora and variable star watchers, radio enthusiasts, and even amateur seismologists and particle physicists.

While Odishaw and the other leaders of the U.S. IGY program postponed making any decisions regarding the role of amateurs, Fred L. Whipple was already seriously considering the possibility of enlisting their services. By the conclusion of the IGY, Whipple and his colleagues at the SAO had done more than anyone else to engage the cooperation of amateur scientists and other enthusiasts worldwide.

<sup>8</sup> Clair L. Strong to Hugh Odishaw, 3 Oct. 1955, Folder “Volunteer Programs: Amateur Participation and Offers of Cooperation,” Series 12.26, Papers of the International Geophysical Year, Archives of the National Academy of Sciences, Washington, D.C. (hereafter cited as **IGY Papers**, with appropriate series). Odishaw, immersed in the details of organizing funding and political support for the IGY program, responded perfunctorily, saying that he and his colleagues were aware of potential contributions from amateurs but had not yet decided how best to proceed: Odishaw to Strong, 10 Oct. 1955, Folder “Volunteer Programs: Amateur Participation and Offers of Cooperation,” Series 12.26, IGY Papers. The recommendation that satellites be launched during the IGY was actually made as early as 4 Oct. 1954 by the Special Committee for the IGY (the Comité de l’Année Géophysique Internationale, or CSAGI). The National Security Council’s “Draft Statement of Policy on U.S. Scientific Satellite Program,” dated 20 May 1955, recommended the creation of a scientific satellite program as part of the IGY as well as the development of satellites for reconnaissance purposes; see John M. Logsdon *et al.*, eds., *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program*, Vol. 1: *Organizing for Exploration* (Washington, D.C.: NASA, 1995), doc. II-10. On the basis of this report, the NSC approved the U.S. satellite program for the IGY on 26 May 1955. However, it was not until 29 July that the Eisenhower administration made a public announcement.

Whipple was born in Red Oak, Iowa, in 1906. While not especially interested in astronomy as a child, he displayed great enthusiasm for investigating how things worked. Childhood hobbies taught Whipple the joy of building things, while chemistry experiments nurtured his interest in science—just as they would for later generations of children. As a graduate student at the University of California, Berkeley, Whipple studied under Armin O. Leuschner, one of the most adept campus political networkers in astronomy of his day.<sup>9</sup> Whipple brought his scientific and organizational expertise to the Harvard College Observatory in 1931, becoming the chair of Harvard's astronomy department eighteen years later. During World War II he was a member of several advisory panels that coordinated activities between the military and the scientific community. Whipple continued to advise the Office of Naval Research, the Air Force, and other agencies after the war, and he learned how to negotiate Washington's bureaucratic channels and to secure institutional funding and personal recognition.

In 1955 Whipple became the director of the Smithsonian Astrophysical Observatory when it moved from Washington, D.C., to Cambridge. Prior to Whipple's appointment, the SAO was a moribund institution with a small staff and a relatively obscure research program devoted almost solely to measuring solar radiation.<sup>10</sup> When Leonard Carmichael, the Smithsonian Institution's Secretary, chose Whipple to lead the SAO into the Space Age, he selected an ambitious and respected scientist who would transform the observatory into the world's largest astronomical institution in less than a decade. Whipple's decision to accept Carmichael's offer was motivated by his belief that Harvard's astronomy program had become "decadent" in the last years of Harlow Shapley's tenure. Whipple also clearly disagreed with Shapley's view that faculty should not receive military funds for research; moreover, Harvard itself forbade classified research on its campus. As he later recounted, "I took the job of directorship so that I could operate this photographic satellite observing program under the aegis of the Smithsonian, rather than Harvard."<sup>11</sup>

Whipple's tenure in Cambridge had served to acquaint him with the capabilities of amateur scientists, especially in the field of astronomy. For years, the Harvard College Observatory had hosted two of the principal organizations for amateur astronomy. The American Association of Variable Star Observers (AAVSO) was founded there in 1911. It became a model of amateur–professional interaction as its growing membership accumulated thousands of estimates of changing stellar magnitude. In addition, *Sky and Telescope*, the premier magazine for amateur sky watchers, was based at the Harvard College Observatory in the 1940s.<sup>12</sup>

Whipple also knew the problems that could result when amateur scientists and other enthusiasts interacted with professionals. For years he witnessed feuds between scientists

<sup>9</sup> My thanks to David H. DeVorkin for clarifying Leuschner's activities for me.

<sup>10</sup> On the SAO's move to Cambridge see Ronald E. Doel, "Redefining a Mission: The Smithsonian Astrophysical Observatory on the Move," *Journal for the History of Astronomy*, 1990, 21:137–153. On its earlier research program see *ibid.*; and David H. DeVorkin, "Defending a Dream: Charles Greely Abbot's Years at the Smithsonian," *J. Hist. Astron.*, 1990, 21:121–136.

<sup>11</sup> Fred L. Whipple, 29 Apr. 1977, oral history interview with David DeVorkin, Niels Bohr Library, American Institute of Physics, College Park, Maryland (hereafter cited as **Whipple oral history interview**). See also minutes of meetings of the Harvard College Observatory Council, Box 2, Fred L. Whipple Papers, RU 7431, Smithsonian Institution Archives, Washington, D.C. (hereafter cited as **Whipple Papers, SI**). By June 1960 the SAO employed some 265 people and its budget had risen from about \$70,000 annually to well over \$4 million. See "Reports on the Astrophysical Observatory," published each year in *Smithsonian Institution Annual Reports*.

<sup>12</sup> For Whipple's views on the capabilities of amateurs see, e.g., Whipple oral history interview, pp. 88–91. Both the AAVSO and *Sky and Telescope* later left the Harvard College Observatory, though they remained in Cambridge.

and other enthusiasts who collected and studied meteorites, and he complained that many of the amateurs were “quarrelsome” and prone to “bickering.”<sup>13</sup> He was also on hand for the messy split between the AAVSO and the Harvard College Observatory in 1953, when Donald H. Menzel asked the amateur organization to leave as part of an overall reorganization of the observatory.<sup>14</sup> When it came to the IGY, however, Whipple believed that amateurs—properly managed—could make significant contributions to science.

Whipple’s personal interest in satellite tracking stemmed from his enthusiasm for space exploration. His long-standing program in studying meteors as they entered the earth’s atmosphere linked his research with that of geophysicists as well as with military interest in the upper atmosphere. For years, Whipple served on the Upper Atmosphere Rocket Research Panel, which guided research using rocket-borne instruments after World War II.<sup>15</sup> In 1954, when the military was considering plans—never realized—for what was known as Project Orbiter, he offered technical advice about how a small satellite could be tracked optically.<sup>16</sup> A year later, after the United States had formally committed itself to launching a satellite, the USNC convened the Technical Panel on the Earth Satellite Program (TPESP) to oversee the scientific and engineering aspects of the project, offer input on institutional relations, and inform the public.

Whipple envisioned a global network of specially designed instruments that could track and photograph satellites. This network, aided by a corps of volunteer satellite spotters and a computation bureau in Cambridge, would establish ephemerides—predictions of where a satellite would be at particular times.<sup>17</sup> The instruments at these stations were eventually designed by James G. Baker and Joseph Nunn and hence known as Baker-Nunn cameras (see Figure 1). Based on a series of super-Schmidt wide-angle telescopes and strategically placed at twelve locations around the globe, the innovative cameras could track rapidly moving targets while simultaneously viewing large swaths of the sky.

From the start, Whipple planned that the professionally manned Baker-Nunn stations would be complemented by teams of dedicated amateurs. Amateur satellite spotters would collect information that would be used to tell the Baker-Nunn stations where to look—an important task, given that scientists working on the U.S. satellite program likened finding a satellite in the sky to finding a golf ball tossed out of a jet plane.<sup>18</sup> Amateur teams would relay the information back to Cambridge, where professional scientists would use it to

<sup>13</sup> See, e.g., Whipple to Harrison Brown, 2 May 1949, and Brown to Whipple, 10 May 1949, Folder “B, 1940–1950,” Box 3, Fred Whipple Papers, Harvard University Archives, Cambridge, Massachusetts (hereafter cited as **Whipple Papers, HUA**). Brown complained to Whipple of the “amazing hold that unadulterated scientific amateurism” had on the field, something with which Whipple agreed. See also Howard Plotkin, “The Henderson Network versus the Prairie Network: The Dispute between the Smithsonian’s National Museum and the Smithsonian Astrophysical Observatory over the Acquisition and Control of Meteorites, 1960–1970,” *Journal of the Royal Astronomical Society of Canada*, 1997, 91(2):32–38.

<sup>14</sup> This episode is described in Robinson, “Enterprise at Harvard College Observatory” (cit. n. 6).

<sup>15</sup> Ronald E. Doel, *Solar System Astronomy in America: Communities, Patronage, and Interdisciplinary Science, 1920–1960* (Cambridge: Cambridge Univ. Press, 1996); and David DeVorkin, *Science with a Vengeance: How the Military Created the U.S. Space Sciences after World War II* (New York: Springer, 1992).

<sup>16</sup> “A Minimum Satellite Vehicle: Based on Components Available from Missile Developments,” 15 Sept. 1954 [report by Wernher von Braun]; Logsden *et al.*, eds., *Exploring the Unknown* (cit. n. 8), Vol. 1, doc. II-7. See also Neufeld, “Orbiter, Overflight, and the First Satellite” (cit. n. 2), pp. 235–236.

<sup>17</sup> Similar instruments were employed by the Harvard Meteor Project, based in New Mexico, which Whipple directed. During the IGY, twelve Baker-Nunn cameras were eventually deployed in New Mexico, Florida, Hawaii, South Africa, Australia, Spain, Japan, India, Peru, Iran, Argentina, and Curaçao. The SAO’s tracking program is described in E. Nelson Hayes, *Trackers of the Skies* (Cambridge, Mass.: Doyle, 1968); and Eloise Engle and Kenneth H. Drummond, *Sky Rangers: Satellite Tracking around the World* (New York: Day, 1965). Both volumes contain useful information yet lack contextual grounding and a critical perspective.

<sup>18</sup> Alton L. Blakeslee, “Volunteers Organized to Watch for Satellite,” *Los Angeles Times*, 9 June 1957, p. A15.



**Figure 1.** One of the twelve Baker-Nunn satellite-tracking cameras operated by the Smithsonian Astrophysical Observatory. This one, shown at its dedication on 2 August 1958, was located on the mountain of Haleakala on the Hawaiian island of Maui. Photo courtesy of Dr. Walter Steiger, University of Hawaii.

generate accurate satellite orbits. At this point, professionals at the Baker-Nunn stations would take over the task of photographing them.

In November 1955 Whipple presented his plan for enlisting amateurs to help track satellites to colleagues on the TPESP. Who did Whipple imagine would be the most likely respondents to his call? Amateur astronomy groups were obvious candidates, and these would in fact become the foundation of Moonwatch. Whipple explicitly identified groups like the American Association of Variable Star Observers and the Astronomical League, “many of whom have attained a high degree of proficiency in the observation of the skies.”<sup>19</sup> As Whipple saw it, these amateur organizations had clearly demonstrated their value to professional scientists and were generally well regarded by them.

Participation was not limited to amateur astronomers, however. Whipple called attention to the “extensive network of the Ground Observer Corps,” teams of volunteer aircraft spotters that monitored U.S. skies in the 1950s. Whipple’s initial plans for Moonwatch bear considerable similarity to Operation Skywatch, a civil defense plan the Truman administration created in 1952 to scan the skies for hostile Soviet aircraft. While these Cold War-era aircraft spotters did not have “the extended sky watching experience of the bona fide amateur astronomer, the potential usefulness of [them] should not be overlooked.”<sup>20</sup>

<sup>19</sup> “Proposal for the Initiation of an Optical Tracking and Scientific Analysis Program for the U.S. Earth Satellite Program,” undated report (likely Nov. 1955), Folder “Project 30.3 Initial Development of Optical Tracking,” Series 6.1, IGY Papers.

<sup>20</sup> *Ibid.*



Even the name Whipple chose for the amateur satellite-tracking program in the fall of 1955—the Visual Observer Corps—suggests the affinity between aircraft and satellite spotters in his mind at that point.

Moonwatch ultimately brought together a wide assortment of people, going well beyond vigilant aircraft spotters and amateur scientists conversant with astronomy and telescopes. All of these enthusiasts were organized under the aegis of the Smithsonian Institution, an entity “widely known for its activities in the dissemination of scientific information” and interest in encouraging amateur participation in science. Though he never directly acknowledged it, Whipple’s proposal for a global network of satellite spotters harked back to the Smithsonian’s first major project. In 1847, Secretary Joseph Henry had called for the collection of weather reports from a network of volunteer observers, a task the Weather Bureau took over when Congress established it in 1870.<sup>21</sup>

Amateur satellite spotters were not just to provide cheap labor for their professional counterparts. Their activities, Whipple’s proposal argued, would “attract young people of scientific promise” and foster a “spirit of scientific cooperation.” Even at this early stage, Whipple had considered the question of maintaining morale, something that had bedeviled leaders of the Ground Observer Corps. While bonuses like a rewards and recognition program could boost morale, Whipple believed that the “satisfaction of participation in a significant scientific program” would provide sufficient motivation for most amateurs.<sup>22</sup>

In late 1955 the NAS awarded the SAO \$50,000 to initiate a program of optical satellite tracking. In the spring of 1956 the SAO received some \$3.4 million more to carry out all of the optical tracking of satellites during the IGY.<sup>23</sup> These funds provided Whipple with resources to expand the scope and visibility of the SAO’s activities and represented one of the largest grants made to a civilian institution during the IGY.

Spurred in part by growing media attention, amateur scientists sent scores of letters to the National Academy of Sciences.<sup>24</sup> Some correspondence came from high school teachers wanting to encourage student participation in the IGY, while other letters were from individuals offering their companies’ services. By January 1956 the NAS had compiled a lengthy list of individuals, professional organizations, and industries that wanted to contribute to the IGY in some fashion. Most of the correspondence came from people interested in some aspect of astronomy or the satellite program.<sup>25</sup>

Odishaw and those managing the IGY were soon challenged with reconciling often conflicting tasks. They needed to respond to the public’s mushrooming interest in the IGY while controlling both the participation of amateurs and the enthusiasm of people like Whipple who were eager to enlist and employ them. At the same time, they needed to

<sup>21</sup> *Ibid.* See also Daniel Goldstein, “‘Yours for Science’: The Smithsonian Institution’s Correspondents and the Shape of Scientific Community in Nineteenth-Century America,” *Isis*, 1994, 84:573–599. The Smithsonian officially transferred its volunteer corps to the Weather Bureau in early 1874.

<sup>22</sup> “Proposal for the Initiation of an Optical Tracking and Scientific Analysis Program for the U.S. Earth Satellite Program” (cit. n. 19).

<sup>23</sup> Only \$89,500 was initially allocated for the amateur observing program: “Summary of Fiscal Information,” 23 Jan. 1957, Folder “Project 30.9 Administration of Visual Observing Programs,” Series 6.1, IGY Papers.

<sup>24</sup> In 1954 and 1955 alone, the *New York Times* mentioned the IGY in over a hundred articles. Popular magazines like *Scientific American* and *National Geographic* regularly featured articles on the IGY. See, e.g., Hugh L. Dryden, “The International Geophysical Year: Man’s Most Ambitious Study of His Environment,” *National Geographic*, Mar. 1956, pp. 285–298; Heinz Haber, “Space Satellites: Tools of Earth Research,” *ibid.*, Apr. 1956, pp. 487–509; and James A. Van Allen, “The Artificial Satellite as a Research Instrument,” *Scientific American*, Nov. 1956, pp. 41–46.

<sup>25</sup> See “Memorandum for the Files,” 19 Jan. 1956; and memo, 14 Mar. 1956: Folder “Volunteer Programs: Amateur Participation and Offers of Cooperation,” Series 12.22, IGY Papers.

ensure that professional scientists benefited from amateurs' involvement. Nowhere were these tensions more evident than in debates and discussion about Moonwatch.

#### WHIPPLE PROMOTES PLORB

As soon as the task of tracking satellites optically had been assigned to the SAO, Whipple began to promote amateur participation. Believing that "the importance of amateur astronomers in the project can hardly be overestimated," he gave a talk to the Institute of Aeronautical Sciences in New York City in January 1956. He explained that the IGY satellite program offered "sky watchers an unparalleled opportunity to be of significant service to science." Amateur scientists were especially needed to spot satellites after their launch and transmit their location, via the SAO, to the Baker-Nunn stations around the world. Amateur participation was also vital for monitoring the death throes of satellites in the moments before they reentered the atmosphere. Finally, in the event that a satellite's radio transmitter failed—not unlikely, in the brand new era of microelectronics—amateur sky watchers might be "the only means of locating it."<sup>26</sup>

Whipple assumed that groups of amateur astronomers would form the initial nuclei around which Moonwatch would coalesce. After publicizing Moonwatch to the amateur astronomy community, he reached out to broader audiences in an effort to alert ordinary citizens that they too could play a part in the IGY. In September 1956 the *Saturday Review* published his article with the catchy title "Moontracking: The New Global Science-Sport." During the IGY, Whipple told readers nationwide, "thousands of men and women of all hues, creeds, and ideas" will work together on a project "so new it does not even have a name." To remedy this deficiency, Whipple suggested "PLORB: the *pl*acing of artificial moons in *or*bits in space." He went on to describe how amateurs everywhere could contribute to what might be "the biggest scientific venture ever shared by the common man."<sup>27</sup> Whipple's promotional campaign paid off, and the SAO received hundreds of letters from people around the world eager to be satellite spotters.

In January 1956 Whipple recruited J. Allen Hynek, a professor of astronomy at Ohio State University, to direct the SAO's entire optical tracking program, including Moonwatch.<sup>28</sup> Born in 1910, Hynek received his bachelor's degree from the University of Chicago before earning his doctorate while working at Yerkes Observatory. During World War II he took leave from his university position to help develop proximity fuse technologies at the Applied Physics Laboratory run by the Johns Hopkins University. After the war Hynek returned to Ohio State, but he remained involved with the lab's research projects using instruments carried by V-2 rockets, work that introduced him to Whipple.

The SAO also asked Armand N. Spitz to generate grassroots enthusiasm among amateur scientists. Spitz was an enthusiastic amateur astronomer and active science popularizer whose Philadelphia company manufactured planetaria for schools and science museums.

<sup>26</sup> "Amateurs to Observe Satellites," *Sky Telesc.*, Mar. 1956, p. 203. Whipple's speech was accompanied by an SAO press release on the same date: Folder "Earth Satellite Program, 1956," Box 13, Papers of the Office of the Secretary, RU 50, Smithsonian Institution Archives, Washington, D.C. (hereafter cited as **Office of the Secretary Papers, SI**).

<sup>27</sup> Fred L. Whipple, "Moontracking: The New Global Science-Sport," *Saturday Review*, 1 Sept. 1956, pp. 37–39, on pp. 37, 38. A similar article is Whipple, "Wanted: Spotters for Satellites," *Science Digest*, Dec. 1956, pp. 33–37. His appellation never took hold with the public. One reader complained in verse: "To have this brand new fun celestial/ruined by a word so bestial/PLORB! . . . We need a brand new Keats/To name with grace such stellar feats." Persis Smith, "Watcher of the Skies," *Saturday Rev.*, 5 Jan. 1957, p. 41.

<sup>28</sup> Folder "Hynek, J. Allen," Box 2, Whipple Papers, SI.

He would embark on a series of trips around the United States to help enlist the support of “amateur astronomers and other observers.”<sup>29</sup> Whipple, Hynek, and Spitz still needed a name for their program. One idea they considered briefly was SEESAW, as in “I see it . . . I saw it.” By the time Spitz began his recruitment travels, however, the three men agreed that “Moonwatch” was the best moniker for a program in which people would be looking for what were, in fact, new moons. By May 1957 Spitz’s efforts had paid off: more than sixty teams were registered in the United States, while others were forming in Chile, Japan, South Africa, and over a dozen other countries.

#### MARKING TERRITORY

While Hynek and Spitz organized teams of amateur satellite spotters around the world, Whipple fended off criticism of the SAO’s plans to enlist the participation of amateurs. One skeptic was Homer E. Newell, the coordinator of science programs for the Naval Research Laboratory (NRL), which managed Project Vanguard, the U.S. IGY satellite program effort. The NRL had responsibility for tracking satellites electronically using Minitrack, a global network of specially designed radio facilities. Newell recognized the importance of an optical tracking program but argued that “amateur astronomers cannot be expected to serve this purpose satisfactorily.”<sup>30</sup> In an attempt to undercut Whipple’s initiative, Newell proposed that the NRL establish its own network of stations employing salaried observers.<sup>31</sup>

The turf war between Whipple and naysayers at the Naval Research Laboratory continued throughout 1956. In sticking to his guns, Whipple ran a certain risk. While the Air Force had taken over support of his meteor research in 1954, the Navy had generously funded his work on meteors and astrobballistics for years. In 1956, Whipple expected to receive some \$200,000 in contracts and grants from the Department of Defense, and he was obviously concerned about jeopardizing future funding.<sup>32</sup>

In December 1956 the TPESP finally ended the debate when it declined the NRL’s proposal to establish its own visual tracking network manned by paid professionals. William H. Pickering, director of the Jet Propulsion Laboratory and a key member of the TPESP, supported this decision, noting that “the use of paid observers might adversely affect the morale of the unpaid volunteer observers of Moonwatch.” Whipple concurred—

<sup>29</sup> J. Allen Hynek to Armand N. Spitz, 1 May 1956, Folder “Spitz, Armand,” Box 5, Whipple Papers, SI. For information on Spitz see Brent Abbatantuono, “Armand Spitz: Seller of Stars,” *Planetarian*, 1995, 24(1):14–22; and Jordan D. Marché, *Theatres of Time and Space: American Planetaria, 1930–1970* (New Brunswick, N.J.: Rutgers Univ. Press, 2005), Ch. 5.

<sup>30</sup> Homer E. Newell to TPESP, 25 Jan. 1956, Folder “3rd Meeting of TPESP,” Series 4.10, IGY Papers. Constance McLaughlin Green and Milton Lomask, *Vanguard: A History* (Washington, D.C.: NASA History Office, 1969), Ch. 8, discusses the various tracking programs that were part of Project Vanguard.

<sup>31</sup> TPESP members predicted that the NRL’s radio tracking program had a roughly fifty-fifty chance of working properly the first time: “January 28, 1956 minutes of the 3rd meeting of the TPESP,” Folder “3rd Meeting of TPESP,” Series 4.10, IGY Papers. The minutes are unclear as to who pointed out the potential unreliability of NRL’s Minitrack system, but Whipple is an obvious candidate. The NRL objected to Moonwatch on several likely grounds—its belief that amateurs were not up to the task, its desire to compete for a share of the substantial funding allocated to the SAO for IGY satellite spotting, and perhaps a wish to centralize acquisition and tracking activities in one agency. The fact that Moonwatch was generating favorable publicity for the SAO also should not be overlooked. Green and Lomask, *Vanguard*, notes that Moonwatch received as much if not more publicity than Vanguard. The wide coverage given to Moonwatch in major newspapers throughout 1956 and 1957 supports this assertion.

<sup>32</sup> Whipple to Leonard Carmichael, 7 Oct. 1955, Folder “Whipple, Fred, 1954–55,” Box 24, Office of the Secretary Papers, SI.

fostering the interest of amateurs was a “delicate matter of personal sensitivities [for] people who are doing research for nothing. It’s rather important to make them feel that it’s all worthwhile and their efforts are appreciated.” Whipple assured his colleagues that “amateurs will help dependably at least in the early stages [of the IGY] when the glamour is new” and invited staff at the NRL to cooperate with Moonwatch.<sup>33</sup>

By the end of 1956, Whipple had achieved his initial goals of establishing the SAO’s claim on the optical tracking of IGY satellites. This was a major coup for the observatory, which was still establishing itself after its move from Washington. The SAO’s expansion into satellite tracking also provided a significant window of opportunity for amateur scientists who wished to participate in the IGY.

#### LIMITS ON AMATEUR PARTICIPATION

Throughout the summer and fall of 1956, the USNC and the SAO attempted to manage amateurs’ participation. They preferred that professional scientists participate directly with amateurs, that the amateurs have technical experience, and that their activities be coordinated through official IGY channels, especially overseas. At the same time, the USNC became equally concerned with controlling how the SAO was organizing and promoting amateur participation.

The organizers of the IGY were obliged to consider professional scientists’ reactions to amateur participation. Odishaw and other USNC members wanted professional scientists to become involved in amateur programs, believing that this might reinforce the public’s image of the IGY as a professional scientific undertaking. Odishaw reminded Hynek, for example, that professional scientists were a valuable resource to be tapped and that “to restrict the [satellite tracking] program to the high precision approach [i.e., the Baker-Nunn network] and ‘amateurs’ may well kill professional interest abroad.” He encouraged Hynek to “stimulate scientists” to help improve the performance of amateur groups that lacked formal scientific training or experience. Odishaw also asked that the SAO’s publicity campaign for Moonwatch convey the amateurs’ appropriate place. As he told Whipple, “The visual observer has an important, a significant role, but I don’t think he should feel his role is bigger than it is.” Whipple promised Odishaw that the SAO would carefully articulate how amateur satellite spotters could participate in the IGY.<sup>34</sup>

Whipple had managerial reasons to limit the participation of amateurs in Moonwatch. He recognized that solitary professional astronomers probably had the background and equipment to track satellites with “quite surprisingly good results.” However, he was less sanguine about encouraging such activity among “isolated observers who are non-professional. . . . How would we know who was good and who was not?” The program, he insisted, would function best using teams of amateurs; it was not for the “lone wolf” observer.<sup>35</sup>

As amateurs’ interest in the IGY grew, the USNC staff worried that they would be

<sup>33</sup> “December 3–4, 1956 minutes of the 9th meeting of the TPESP,” Folder “9th Meeting of TPESP,” Series 4.10, IGY Papers; and “December 3, 1956 minutes of the Tracking and Computation Working Group,” Folder “4th Meeting of Tracking and Computation,” Series 4.11, IGY Papers.

<sup>34</sup> Odishaw to Hynek, 26 July 1956; Odishaw to Whipple, 19 May 1956; and Whipple to Odishaw, 24 May 1956; Folder “IGY Office of Information, Volunteer Programs, Moonwatch,” Series 12.26, IGY Papers.

<sup>35</sup> Whipple to Hynek, 6 Apr. 1956, Folder “Hynek, Allen,” Box 2, Whipple Papers, SI; and *Bulletin for the Visual Observers of Satellites*, no. 1, July 1956, p. 2. The full run of the *Bulletin*—which appeared periodically in *Sky and Telescope*—may be found in Folder 1, Box 61, of the Moonwatch Papers. See also Whipple, “Moon-tracking” (cit. n. 27), p. 38.

besieged by citizens not only seeking news and information but wanting actually to participate. Odishaw and others at the NAS tried to restrict participation to those with advanced skills. When a writer from *Popular Mechanics* contacted Odishaw for a story on Moonwatch, his staff's reply emphasized that while contributions from "amateur-professionals" were encouraged, the scientific programs did not want to be "overwhelmed with masses of uncalibrated data of various levels of professional worth." Odishaw's office preferred to steer the reporter away from Hynek to "someone with restraint. . . . In that way, we might better slant the story . . . instead of inviting all amateurs to come batter down our doors and overwhelm us with unnecessary data."<sup>36</sup>

Odishaw and his assistant, S. Paul Kramer, were also concerned about the international ambitions Whipple had for Moonwatch. Whipple had long promoted the possibility of amateur participation in satellite tracking beyond the borders of the United States. Like Odishaw, Kramer, who had a background in military intelligence, was keenly sensitive to public relations. Before and during the IGY, for example, he worked with the U.S. Information Agency to spread the message that it was a civilian, scientific enterprise rather than a militaristic, engineering endeavor. Kramer feared that the SAO was promoting Moonwatch too quickly. He was especially concerned that the observatory's plans would be too developed before the Comité de l'Année Géophysique Internationale, the international group that directed the IGY worldwide, made an official announcement. Premature attempts by the SAO to mobilize amateurs, especially in the United States, might "give the [U.S.] satellite a nationalistic tone."<sup>37</sup> Kramer insisted that the SAO postpone further public announcements about the international character of Moonwatch until IGY officials made a formal statement at their plenary meeting in Barcelona in September 1956.<sup>38</sup> The delay, however, placed a greater administrative burden on the SAO, leaving it less time to recruit and coordinate Moonwatchers overseas.

Odishaw and his colleagues also suspected that the SAO was unprepared to manage Moonwatch. Media gaffes by Spitz did not bolster their confidence. For example, in late April 1956, while visiting Montreal, Spitz compared the relative scientific merit of the U.S. satellite program with what the Soviets were doing and predicted that the Soviets would beat the Americans into space. His statements were picked up by the Associated Press wire service just as he was about to travel around the United States to promote local interest in Moonwatch. Joseph Kaplan, the USNC chair, called Spitz's statements "disturbing," while an internal memo labeled Spitz as "one of the two-bit publicity hitchhikers" who had to be carefully rebuked lest he go to the press and strike a "martyr pose."<sup>39</sup>

<sup>36</sup> Memo on phone conversation originating in Odishaw's office, 22 May 1956, Folder "IGY Office of Information, Volunteer Programs, Moonwatch," Series 12.26, IGY Papers.

<sup>37</sup> S. Paul Kramer to Odishaw, memo, 5 June 1956, Folder "IGY Office of Information, Volunteer Programs, Moonwatch," Series 12.26, IGY Papers. For expressions of concern over perceptions of military influence on the U.S. IGY program see Kramer to Odishaw, 18 June 1956, Folder "IGY Office of Information Chron. File Apr–Jul 1956," Series 12.1, IGY Papers; and Needell, *Science, Cold War, and the American State* (cit. n. 2), pp. 333–336. On Kramer's background and intent see Fae L. Korsmo, "Shaping Up Planet Earth: The International Geophysical Year (1957–1958) and Communicating Science through Print and Film Media," *Science Communication*, 2004, 26(2):162–187, esp. p. 170.

<sup>38</sup> Correspondence in the IGY Papers indicates that Whipple and others at the SAO backed off on their organizing plans somewhat, at least with regard to amateurs outside the United States. As Whipple told Kramer, "We have not made steps to set up international relations because we have received a firm 'No' until very recently from your central committee": Whipple to Kramer, 18 July 1956, Folder "IGY Office of Information, Volunteer Programs, Moonwatch," Series 12.26, IGY Papers.

<sup>39</sup> Joseph Kaplan to Spitz, 9 May 1956 (with attached memo, carbon copies to Whipple and Carmichael), Folder "IGY Office of Information, Volunteer Programs, Moonwatch," Series 12.26, IGY Papers.

The *Bulletin for Visual Observers of Satellites*, first available in July 1956 and included regularly in issues of *Sky and Telescope*, reflected efforts to control amateur participation in Moonwatch. The first *Bulletin* introduced Moonwatch with no explicit mention of international participation. Instead, it focused on the basic facts of satellite orbits and the U.S. satellite program. Interested parties were directed to contact members of a National Advisory Committee the SAO had formed, not the USNC. As published, the *Bulletin* took a professional tone and employed considerable technical jargon. It attempted to draw a boundary between amateurs with science backgrounds and curiosity seekers stimulated by IGY-related media attention. It emphasized that participants in Moonwatch needed to meet established qualifications, take part in practice sessions, be “interested in science,” and serve as part of an organized team of “completely dependable” amateurs.<sup>40</sup> It emphasized, in short, that while Moonwatchers might be amateurs, they were also fortunate participants in an important scientific enterprise.

#### AMATEURS MOBILIZE FOR ACTION

In September 1956 the *New York Times* ran a series of articles describing how professional and amateur scientists would spot and track IGY satellites. Besides highlighting the valuable role that amateur observers could play in the IGY program, articles such as these provided the public with information about how a typical Moonwatch team would function. Each member would observe with a specially designed “satellite spotter,” a short aluminum tube with optics that combined a wide-angle view with modest magnification. As the magazine *Natural History* noted, “Any amateur who has ever made a telescope should be able to assemble the device.”<sup>41</sup> Those lacking such experience could order a “Satellite Scope” from the Edmund Scientific Company for \$49.50. Because using the telescope for extended periods could give satellite spotters neck pains, amateurs’ telescopes were often designed so that users actually looked down and aimed their telescope at a fixed mirror (see Figure 2).

So equipped, groups of observers were to organize themselves into an “optical fence” by positioning themselves along a north–south meridian, in the center of which was a tall pole with a crossbar at the top. Team members would mount their telescopes along this meridian and align them on the pole. Each observer’s view, therefore, would take in a different part of the sky, while slightly overlapping those of his neighbors on either side. The cover illustration shows one such group, a Moonwatch team based at a private school for boys in New York, posing in front of the observatory they built themselves.

Critical times for observing satellites were dusk and dawn, when the objects would reflect sunlight and be most visible in the semidark sky. Observers would record the exact moments when the satellite entered their field of view, when it passed the crossbar, and, finally, when it left their field of view. In popular articles on satellite tracking, the SAO recommended that Moonwatch teams use a tape recorder that registered short-wave time signals broadcast by the National Bureau of Standards in Maryland. The machine would also record the voices of spotters calling out prearranged signals. After a satellite was spotted, the team leader would transmit the information to the SAO by telegram or collect

<sup>40</sup> *Bulletin for Visual Observers of Satellites*, no. 1, July 1956, insert in *Sky Telesc.*, July 1956.

<sup>41</sup> John T. Kane, “Operation Moonwatch,” *Natural History*, Mar. 1957, pp. 126–129. The *New York Times* articles—all authored by staff writer Walter Sullivan—appeared 1–3 Sept. 1956. The 2 Sept. piece was devoted solely to Moonwatch.



**Figure 2.** Donald Charles, a member of a Moonwatch team based in Walnut Creek, California, with a homemade Moonwatch telescope. Note the school protractor integrated into the mount, as well as the flat mirror in front of the telescope positioned to enable an observer to look down rather than up. The astronomer's hand holds a pushbutton device to mark passage of a satellite through his field of view. Photograph courtesy of Jack Borde.

phone call. Using electronic computers and Moonwatch data, SAO staff would calculate a predicted orbit for the satellite and send it to the Baker-Nunn sites, which would then take over tracking and photographing duties.

Descriptions of Moonwatch in the popular press followed the SAO's lead. They emphasized the need for team-based observing and described Moonwatch teams as well-organized groups primed for action. These articles also stressed that Moonwatch members, who had taken the time to practice and refine their skills, formed a global data-gathering fraternity whose contributions would be a valuable part of the IGY program. As Hynek told one writer, "The amateur astronomy teams of Moonwatch may well be the backbone of the visual tracking assignment."<sup>42</sup>

The SAO was besieged with inquiries from interested people around the world who wanted to take part. In October 1956, to help manage the Moonwatch program more

<sup>42</sup> Kane, "Operation Moonwatch," p. 129. Similar articles appeared throughout 1956 and 1957 in *Popular Science*, *Popular Mechanics*, and other such magazines. The article in *Popular Mechanics* even described how readers could build their own spotting scopes: Richard F. Dempewolf, "How You Can Spot the Satellites," *Popular Mechanics*, Aug. 1957, pp. 72–76, 234, with directions on p. 170.

effectively, the SAO hired Leon Campbell, Jr. Like Whipple, Campbell was well acquainted with the American amateur astronomy community and its potential to contribute to scientific research. His father, Leon Campbell, Sr., had been a staff member of the Harvard College Observatory and an active participant in the AAVSO from 1915 until his death in 1951. The younger Campbell, in addition to being exposed to amateur and professional astronomy communities throughout his life, had professional experience in public relations and journalism.<sup>43</sup> As the SAO's coordinator for Moonwatch stations around the world, Campbell fielded the dozens of requests for IGY and satellite information the SAO received each week and served as a liaison between the professionals at SAO and the amateur teams.

With Campbell's oversight, the SAO began promoting Moonwatch abroad. To assist these efforts, Whipple enlisted the help of Teofilo Tabanera, a scientist in Argentina, to organize teams in South America. Tabanera also translated the *Bulletin for Visual Observers of Satellites* into Spanish and helped distribute it to local teams.<sup>44</sup> By the time *Sputnik* was launched, Moonwatch teams were in place throughout Argentina, Chile, Peru, South Africa, and Australia.

Outside the United States, Japan showed the most enthusiasm for Moonwatch. Newspapers and other companies stimulated amateurs' interest through team sponsorships. By October 1957 Japan fielded over seventy Moonwatch teams, initially coordinated by Masasi Miyadi, a professor at Tokyo Astronomical Observatory. In fact, Miyadi faced such a surge of interest that he lamented that there were "so many amateurs proposing to participate in the work that it is rather difficult to us to qualify them [all]."<sup>45</sup>

Back in Cambridge, the SAO was experiencing Miyadi's organizational dilemmas on a grander scale. The scores of Moonwatch groups that sprang up around the world presented the SAO with a management challenge that brought it into conflict with the Smithsonian Institution's Washington-based administration. Leonard Carmichael, the Smithsonian Secretary, and his staff were especially alarmed that the SAO's "crash program" in satellite tracking had a budget that rivaled the outlays of the entire Smithsonian operation. Moreover, Smithsonian staff in Washington questioned the SAO's management of the globally dispersed Moonwatch program and Baker-Nunn stations.<sup>46</sup> By early 1957, however, the SAO's satellite tracking program had acquired enough funding, institutional momentum, and international publicity that Smithsonian officials could not easily cancel or curtail these efforts.

As more teams joined Moonwatch, the SAO struggled to cultivate adequate public relations while maintaining morale among its amateur groups. Hynek warned Whipple that it was "preposterous" to expect Campbell to "handle such a far-flung operation" without

<sup>43</sup> "Resume of Leon Campbell, Jr.," Folder "Campbell, Leon," Box 1, Whipple Papers, SI.

<sup>44</sup> Folder "Argentina Teofilo Tabanera Correspondence," Box 25, Moonwatch Papers. Tabanera was vice president of the International Astronautical Federation. The Moonwatch papers at the Smithsonian are full of requests from and correspondence with participants and team leaders throughout the world, including Cuba, Egypt, the Philippines, and Iran.

<sup>45</sup> Masasi Miyadi to Whipple, 7 Feb. 1957, Folder "Japan, Correspondence with the Coordinator, 1956-70," Box 34, Moonwatch Papers.

<sup>46</sup> John L. Keddy, Assistant Secretary of the Smithsonian Institution, note for file, 14 Mar. 1956, Folder "Earth Satellite Program, 1956," Box 13, Office of the Secretary Papers, SI. Keddy claimed that he would not be happy until the SAO had established some "centralized administrative control" and charged Whipple and Hynek with "abdicated their jobs." See Carmichael's notes, Folder "August 23, 1957 Meeting," Box 19, Office of the Secretary Papers, SI. Whipple, on the other hand, resented what he perceived as micromanagement from Washington and, after he retired, reflected that at least one of the administrators he had to deal with in this period was "an S.O.B. of the first order": Whipple oral history interview.



additional staff or funding, given the extraordinary amount of public and administrative attention the program was receiving.<sup>47</sup> Nevertheless, the Smithsonian administration continued to exert pressure on the SAO as Whipple's estimates for when the professionally manned Baker-Nunn cameras would be operational proved overly optimistic. This scrutiny only increased after the launch of *Sputnik* and the media blitz that followed.

At the local level, amateur scientists struggled to organize and train their teams before the IGY began. Raising funds to start and equip a team was a fundamental challenge. Sponsorship varied from town to town, as leaders tried with varying degrees of success to solicit donations from businesses to support community teams. In a few cases, national companies got involved. The soft drink company Seven-Up sponsored several teams around the United States, while Beech Aircraft contributed handsomely to erect a permanent station for a team in Wichita, Kansas.

Meanwhile, Moonwatch's five thousand members were a relatively diverse lot, at least in terms of their occupations. As the caption of a cartoon in the *Great Plains Observer*, a newsletter for Midwestern amateur astronomers, noted, "The thing about Moonwatch that intrigues us is the considerable range of society it draws from. Old men shiver, junior high kids romp, local bankers rub elbows with the guy who sweeps out the bank." While a demographic study of Moonwatch would be extremely difficult to do and certainly incomplete, photographic and documentary evidence suggests that Moonwatch primarily engaged the interest of white, middle- to upper-class Americans. This was perhaps not surprising, given that expected costs for a Moonwatch station were about \$2,000, equal to several months' salary for most Americans.<sup>48</sup>

Moonwatch appears primarily to have attracted men. Nevertheless, some women were active participants. Two women served on the national advisory committee, women led Moonwatch teams, and many girls participated with high school groups. One Texas team tried actively to recruit Girl Scouts, encouraging their participation with the jingle "Boop de-boop-boop, boop de-boop-boop. We're the girls from the Moonwatch group. We don't squint and we don't blink and we don't close our eyes to think—Our team saw the satellite!"<sup>49</sup>

Some communities used Moonwatch to expand existing amateur science and education programs and connect to programs in other cities. For example, in 1933 Dr. Eldred R. Harrington, a science teacher at Albuquerque High School, started a "Dawn Patrol" program for promising students and science buffs. Vioalle Hefferan, director of the school's

<sup>47</sup> Hynek to Whipple, memo, 8 Feb. 1957, Folder "Earth Satellite Program, 1957," Box 13, Office of the Secretary Papers, SI. *Time*, *Life*, Disney, and local and national radio and television stations had all contacted the SAO. See Hynek to Whipple, 23 Sept. 1957, Folder "Moonwatch," Box 33, Papers of the Smithsonian Astrophysical Observatory, 1954–1966, RU 188, Smithsonian Institution Archives, Washington, D.C. (hereafter cited as **SAO Papers**). As Hynek pointed out, Campbell was close to the breaking point in his "attempt to turn back the tide of work."

<sup>48</sup> The cartoon was reprinted in the *Bulletin for the Visual Observers of Satellites*, no. 8, Mar. 1958, p. 8. The information on cost comes from "The Moonwatch Program," undated (likely late 1957), Folder "Moonwatch," Box 33, SAO Papers. Information on members' occupations is available for some groups via the membership rolls they provided to the SAO. The Moonwatch team in Alamogordo, New Mexico, e.g., reported some 150 observers, listing 23 senior Boy Scouts, 20 senior Girl Scouts, 30 airmen and officers, 40 "adult engineers, technicians, and scientists," 10 high school science students, 10 "Church, Lions Club, similar adults," and 25 "townsman and housewives." See E. P. Martz to Leon Campbell, 21 Sept. 1957, Folder "Alamogordo, NM," Box 4, Moonwatch Papers.

<sup>49</sup> Martz to Campbell, 27 Apr. 1958, Folder "Alamogordo, NM," Box 4, Moonwatch Papers. Some of the tropes identified in Kristen Haring, "The 'Freer Men' of Ham Radio: How a Technical Hobby Provided Social and Spatial Distance," *Technology and Culture*, 2003, 44:734–761, can also be seen in the correspondence pertaining to Moonwatch, although the latter appears to have been more inclusive in terms of gender.

Astronomy Club, expanded the Dawn Patrol's offerings by forming a Moonwatch team in late 1956 with sponsorship from a local bank. During the IGY, Hefferan was one of the most active Moonwatch leaders, and her team of high school students established an impressive record for accurate satellite spotting.<sup>50</sup>

Moonwatch was not the only opportunity for amateur scientists to contribute to the IGY. Despite its expressed pessimism about the abilities of amateurs, the Naval Research Laboratory organized a parallel effort called Project Moonbeam that enlisted ham radio operators to record the passing of satellites.<sup>51</sup> In the Soviet Union, scientists and government officials established similar amateur tracking efforts using both radio and optical means. The Soviets encountered many of the same challenges the SAO faced, such as organizing volunteers, obtaining proper equipment, and training teams.<sup>52</sup> While satellite spotting was the primary way in which amateurs chose to take part in the IGY, the USNC eventually identified other activities in which volunteers could participate. Throughout the IGY, Clair Strong's monthly column in *Scientific American* described a whole range of projects amateurs were carrying out.<sup>53</sup>

Articles in popular American magazines, combined with the SAO's proselytizing, helped generate the belief among amateurs that they could usefully participate in the IGY. As the start of the IGY neared, ordinary citizens and curiosity seekers joined hundreds of amateurs with experience in astronomy and other fields who wished to make a genuine contribution to IGY research and perhaps gain recognition for their activities in the process. The abilities of Moonwatch teams and the SAO's management acumen would be tested in the hurly-burly weeks following the launch of *Sputnik*.

#### THE MONTH OF NEW MOONS

The first test arrived early for Vioalle Hefferan and her Albuquerque team. Hefferan returned to her apartment in the afternoon of 4 October 1957 to find the phone ringing. It

<sup>50</sup> Albert Q. Maisel, "'Doc' Harrington's Dawn Patrol of Young Scientists," *Reader's Digest*, Nov. 1956, pp. 142–146. Correspondence and other materials pertaining to Hefferan's team are located in Box 4, Moonwatch Papers.

<sup>51</sup> "Ham Participation in IGY," *Radio and TV News*, Jan. 1958, pp. 8, 142. Project Moonbeam was nowhere near as well organized or successful as Moonwatch, in part owing to the much greater cost of establishing an adequate radio receiving setup. Smaller amateur tracking efforts appeared during the IGY—e.g., Phototrack, a program organized by the Society of Photographic Scientists and Engineers and based in Washington, D.C. Phototrack was a modestly funded operation whose goal was to track as well as photograph passing satellites; it never competed with Moonwatch. My thanks to Dr. Victor Slabinski of the United States Naval Observatory for sharing documents in his possession regarding Phototrack; see also "Operation Phototrack," *Sky Telesc.*, June 1958, p. 387.

<sup>52</sup> See, e.g., A. G. Masevitch, "Optical and Radio Tracking of Satellites (and Interplanetary Probes)," in *Space Age Astronomy: Proceedings of an International Symposium Held August 7–9, 1961, at the California Institute of Technology in Conjunction with the 11th General Assembly of the International Astronomical Union*, ed. Armin J. Deutsch and Wolfgang Klemperer (New York: Academic, 1962), p. 127. The USSR also organized its large network of amateur radio operators through its Ministry of Communication, an effort described in Rip Bulkeley, "Harbingers of *Sputnik*: The Amateur Radio Preparations in the Soviet Union," *History and Technology*, 1999, 16:67–102. Comparatively little is known about the involvement of Soviet amateurs in satellite tracking, although Whipple once quipped that he suspected "there was more compulsion on the [Soviet] observers to get out early in the morning and late at night and make observations [than in the U.S.]:" "Introductory Remarks," 18 June 1960, Folder "STP-Moonwatch," Box 117, SAO Papers.

<sup>53</sup> Similar pieces appeared in other magazines like *Sky and Telescope*. While most of these articles were written for adults, the USNC also provided information for teenagers in the 25 Oct. 1957 issue of *Senior Scholastic*, the entire issue of which was devoted to the IGY. Moonwatch, Project Moonbeam, and aurora watching were activities where "the teenager may make his greatest contribution" (p. 21). See also Kramer to Strong, 8 Feb. 1957, Folder "IGY Office of Information, Volunteer Programs, Moonwatch," Series 12.26, IGY Papers.

was less than an hour after the SAO had received word that *Sputnik* was in orbit, and the voice from Cambridge asked if she could have her Moonwatch team ready to observe at twilight. Hefferan quickly called her students—many of whom had to cancel dates for the homecoming game—and convened them for an evening of sky scanning. Their prompt response resulted, in part, from the extensive training they had done with Hefferan. This included spotting pebbles tossed over the crossbar of their mast, registering the flight of moths, and participating in national Moonwatch alerts carried out with the cooperation of the Civil Air Patrol. Despite their preparations, that night they spotted neither the satellite nor the more visible rocket body that had boosted it into orbit. Unbeknownst to them at the time, these objects were not yet visible from their location in New Mexico, and Hefferan's group did not spot one of the orbiting bodies until 19 October. The sight elated her team of high school students, who “swaggered a bit” in the school hallways afterward.<sup>54</sup>

Whipple and Campbell were both in Washington, D.C., on 4 October, the former attending a meeting of the USNC. Members of the committee grilled Whipple about the lagging schedule for the construction of the Baker-Nunn cameras needed to equip the SAO's network of satellite-tracking stations. By *Sputnik*'s launch, none had yet been deployed, and the first camera system was still being tested at the Boller & Chivens factory in Pasadena.<sup>55</sup>

Because of production delays, when *Sputnik* went into orbit the Moonwatch teams were the only means available to track satellites optically. Rather than supplementing the professionally manned stations, as planned, amateur teams quickly became an essential stop-gap, fulfilling a task the SAO never intended for them. By all accounts, the amateur scientists in the Moonwatch program acquitted themselves admirably. Teams in Australia made the first confirmed *Sputnik* observations on 8 October, eleven days before the first Baker-Nunn camera—hastily assembled and mounted in Pasadena—took photographs of the orbiting rocket body. A Moonwatch team in New Haven, Connecticut, made the first confirmed sighting in the United States on 10 October.

The launch of *Sputnik* put extraordinary demands on Moonwatchers, who found themselves not only watching for satellites but also responding to a flood of inquiries from citizens in their communities. Not surprisingly, even more people wrote the SAO with requests to join Moonwatch. The observatory's staff was further taxed as reporters from around the world descended on Cambridge, eager for information. Whipple and Hynek found themselves on the front lines of a media blitz, obliged to answer questions—serious and silly—about *Sputnik*'s significance. When a major national newspaper printed off-the-cuff remarks from SAO staff members predicting that the Soviets would soon land a rocket on the moon, Leonard Carmichael insisted that the SAO route all communications regarding satellites through the main Smithsonian office in Washington. Throughout the IGY, Smithsonian administrators monitored SAO staff for any comments that might provoke similar “grave misunderstandings” in the politically charged atmosphere.<sup>56</sup>

The success of Moonwatch, ironically, somewhat embarrassed the professional science community. It drew attention to the fact that the IGY satellite program depended on the contributions of amateurs because of the failure to have professionally manned optical and

<sup>54</sup> “Story of the Albuquerque High School Moonwatch Team,” Aug. 1958, Folder “Team Histories, A–F,” Box 43, Moonwatch Papers. On 26 Nov. Hefferan's team spotted the *Sputnik* satellite itself.

<sup>55</sup> “Minutes of the Twelfth Meeting of the TPESP,” 3 Oct. 1957, Series 4.10, IGY Papers.

<sup>56</sup> Carmichael to Whipple, telegram, 11 Nov. 1957, Folder “Earth Satellite Program 1957,” Box 13, Office of the Secretary Papers, SI. Whipple and Hynek were featured in the 21 Oct. 1957 issue of *Life*.

radio tracking stations operating at full effectiveness when *Sputnik* went into orbit.<sup>57</sup> As pressure for news and data mounted, the USNC and the Smithsonian scrutinized the SAO's management of the entire satellite-tracking program, calling it a "very un-professional looking operation" and a "confused circus."<sup>58</sup>

At hastily convened meetings in October and November, TPESP scientists like William Pickering challenged Whipple's request for an additional \$200,000 to support Moonwatch, a plea necessitated by the sudden spike in the program's expenses. Hynek reported that two dozen new teams were waiting to be registered in the United States, while "99 percent of the inquiries we get at SAO have to do with Moonwatch." It would be "a most inauspicious move" to ignore these people or cancel Moonwatch, especially "as this is the public's chance to get in on the act." Athelstan Spilhaus, a geophysicist from the University of Minnesota and USNC member, came to Moonwatch's defense: "This is the one program," he said, "where for comparatively little money you can get the ordinary person to play a part in IGY. . . . The stimulus that this thing gives at a fairly small cost is very considerable."<sup>59</sup> The USNC approved Whipple's request for additional funds, with the caveat that it would send a representative to Cambridge to offer suggestions on improving operations there.

Despite criticism about the SAO's management of its satellite-tracking program, Whipple and his colleagues not only kept the amateur program going but expanded it throughout the IGY. Moreover, in the emotionally and politically charged opening weeks of the Space Age, amateurs had a clear advantage over the community of professional scientists. The network of amateur scientists, after all, was the only global system capable of providing crucial visual tracking information regarding the world's first satellites. Moonwatchers around the world, despite the low expectations many professional scientists initially had, found themselves an essential component of the IGY's professional research program.

#### WAS HISTORY "MADE AT A SMALL TELESCOPE"?

In the summer of 1957, Fred Whipple helped draft an article for *National Geographic* about Moonwatch and the opportunities for amateur participation. While the article was eclipsed by rapidly unfolding events in the autumn of 1957 and never appeared, it predicted that amateurs would take part in "history being made at a small telescope."<sup>60</sup> Was Whipple's boast accurate? What did amateur scientists contribute to the work of their professional colleagues?

The number of Moonwatch teams peaked during 1958, when some 230 teams around the world were formally registered with the SAO. Of the 128 teams registered in the United

<sup>57</sup> In fairness to the SAO, it should be noted that the radio tracking program run by the Naval Research Laboratory was also incomplete, while its amateur-based Project Moonbeam was slow to yield useful information.

<sup>58</sup> "Minutes of the Fourteenth Meeting of the TPESP," 6 Nov. 1957, pp. 149, 151, Series 4.10, IGY Papers. This concern is reflected in the fact that, by April 1958, the Smithsonian Institution, acting on a recommendation from the National Academy of Sciences, commissioned an "Administrative Analysis of the Optical Satellite Tracking Program." While primarily directed toward the implementation of the Baker-Nunn system, the analysis by a Boston management firm referred to the SAO's "unstable administrative situation," which was "in danger of developing a 'crash psychosis':" Folder "Earth Satellite Program 1958," Box 14, Office of the Secretary Papers, SI.

<sup>59</sup> "Minutes of the Thirteenth Meeting of the TPESP," 22 Oct. 1957 (Spilhaus's defense of Moonwatch is on p. 92); and "Minutes of the Fourteenth Meeting of the TPESP," 6 Nov. 1957, pp. 137 ("99 percent of inquiries"), 138 ("most inauspicious move"); Series 4.10, IGY Papers.

<sup>60</sup> Draft article, n.d. (likely Aug. 1957), unpublished, Folder "Whipple, Fred 1957," Box 24, Office of the Secretary Papers, SI.

States, over 80 percent held productive observing sessions (1,659 in all) that yielded some 3,500 “scientifically useful observations.”<sup>61</sup> The contributions made by amateurs during the IGY cannot be measured solely in terms of numbers. The SAO’s Baker-Nunn network did not become fully operational until July 1958; Moonwatch’s amateurs provided a valuable and cost-effective optical tracking system in the interim. Amateur observations helped professional scientists predict the passage of satellites launched during the IGY, an especially useful function when the batteries on *Sputnik I* and *Sputnik II* failed and radio transmissions ceased. Moonwatchers made the first sightings of *Explorer I*, the first U.S. satellite, and participated in the “death watch” of *Sputnik II* as it reentered the atmosphere in April 1958. The plethora of Moonwatch observations helped the SAO refine models of the upper atmosphere and the shape of the earth. Even more important, Moonwatch teams in the United States and Australia located “lost satellites” when professional predictions were flawed and other tracking systems could not find them.

Many professional scientists were initially skeptical about enlisting the help of amateurs for the IGY. Their reluctance at first stemmed from the perceived need to maintain boundaries between the research efforts of amateurs and professionals. Once amateur participation had proved useful, attention focused on how such a “polyglot assortment of some thousands of men and women” could best be managed and coordinated. While President Eisenhower thanked “the hard-working Moonwatch teams” for their contributions, some amateurs were perhaps even more pleased when the National Academy of Sciences formally acknowledged the “importance of volunteer programs” and began to report their activities in the *IGY Bulletin*.<sup>62</sup>

Just as substantial as amateurs’ contributions to IGY research is the influence Moonwatch had on communities of amateur scientists. During the IGY, amateur scientists did not perform solely as passive observers, watching the night skies and reporting their findings to the SAO and other institutions. Instead, they actively and enthusiastically pursued a range of scientific programs. Besides tracking satellites, dedicated amateurs developed innovative ways of making seismic observations, counted meteors using radio-wave reflection, and detected solar flares.<sup>63</sup> The IGY presented amateurs with opportunities to strengthen their social networks, enlist new members, and embark on new areas of study. In the broadest sense, Moonwatch helped unite thousands of amateur scientists from all around the globe for a mission that had important scientific, cultural, and political dimensions.

Moonwatchers were especially creative in taking the initiative to modify and improve their equipment and observing techniques.<sup>64</sup> Amateur satellite spotters communicated the results of their work to other groups as well as to professional scientists. Many Moonwatch

<sup>61</sup> *Bulletin for the Visual Observers of Satellites*, no. 9, July 1958, p. 8.

<sup>62</sup> Daniel Lang, “Earth Satellite No. 1,” *New Yorker*, 11 May 1957, p. 116; Dwight D. Eisenhower to Carmichael, 1 Feb. 1958, telegram (with copies to the SAO), Folder “Earth Satellite Program, 1958,” Box 14, Office of the Secretary Papers, SI; and *IGY Bulletin*, no. 6, Dec. 1957. The full run of the *Bulletin* is in the IGY Papers.

<sup>63</sup> These ideas appeared in C. L. Strong’s “The Amateur Scientist” column in *Scientific American* during and after the IGY; see, e.g., articles in July 1957, January 1958, July 1958, October 1958, September 1960, and January 1961.

<sup>64</sup> Some Moonwatchers, e.g., decided to abandon the use of the vertical mast with crossbar and opted instead for the more challenging task of locating the satellite’s position in the sky using star maps. Those Moonwatch groups with access to local sponsors built elaborate observing stations so their members could make observations in greater comfort. Many teams also used local planetaria to get observers acquainted with the night sky or took advantage of “satellite simulators” that the SAO sent around the country to help train sky watchers. These examples are drawn from various issues of the *Bulletin for Visual Observers of Satellites*.

teams in the United States organized regional meetings to share tips for observing satellites more effectively and published newsletters describing their activities.<sup>65</sup> With help from the SAO, they established accepted community standards of work, recognized those groups that performed especially well, and encouraged others to try harder. Some Moonwatchers also established connections with other amateur groups more interested in activities like ham radio tracking and satellite photography.

When the IGY ended, interest in satellite spotting among the general public lapsed. For the overworked SAO staff, this was something of a relief.<sup>66</sup> As less dedicated amateurs—“joy riders,” as one team leader referred to them—dropped out, the program’s character changed. The SAO refashioned Moonwatch to make use of fewer teams composed of better trained and more committed amateurs who contributed increasingly precise data for satellite tracking. The SAO adapted to the needs and wishes of the “hard cores” who remained and gave Moonwatch teams more challenging assignments, such as locating extremely faint satellites and improving the precision of their observations.<sup>67</sup>

Did programs like Moonwatch have any lasting effect on communities of amateur scientists after the IGY, or were they simply curiosities, a fad of the early Space Age? After *Sputnik*, amateur science clubs experienced a surge in membership and there was a renewed interest in “do-it-yourself” science activities such as telescope making. Meanwhile, companies that made telescopes and science kits reported growth in sales.<sup>68</sup> The serious observers who remained in Moonwatch after 1958 continued to develop ever more sophisticated techniques; eventually their work rivaled that of the professionally manned Baker-Nunn stations. Throughout the 1960s, these two branches of the SAO’s tracking network shared data and, in a few cases, personnel. These collaborations further blurred the divide between amateurs and professionals.<sup>69</sup>

Some teenagers parlayed the experience they gained as amateur participants in the IGY and Moonwatch into long-term careers in science, especially astronomy.<sup>70</sup> One young man from the Albuquerque Moonwatch team credited Moonwatch for his prizewinning entry in a national science fair, admittance into MIT, and eventual career as a professional astronomer and university professor.<sup>71</sup> When the SAO discontinued Moonwatch in 1975, another participant eulogized that “[it was] my greatest single contribution to life in my 42 years.”<sup>72</sup>

<sup>65</sup> Series 10 of Record Unit 255 at the Smithsonian Institution Archives has a large collection of these materials.

<sup>66</sup> As early as the spring of 1958, the SAO had stopped trying to recruit new members. Campbell noted that his office was already “simply swamped by the detail work and cannot cope”: Campbell to Whipple, memo, 1 Apr. 1958, Folder “Moonwatch Program General,” Box 35, SAO Papers.

<sup>67</sup> “Summary of Consultation with Arthur S. Leonard and Dr. Armand N. Spitz, January 19–21, 1959,” Folder “Moonwatch Correspondence 1959,” Box 125, SAO Papers.

<sup>68</sup> Donald G. Cooley, “Astronomical Number of Sky Watchers,” *New York Times Magazine*, 26 Jan. 1958, p. 21; and Williams, “Getting Organized” (cit. n. 6), Ch. 12.

<sup>69</sup> One satellite observer, Russell Eberst of Scotland, produced extremely accurate and efficient observations—the 31 July 1972 *Moonwatch Newsletter* (the full run of newsletters can be found in Boxes 61–63 of the Moonwatch Papers) reported that Eberst once made 127 observations of some 72 transits of 40 different satellites in a single night. He also recorded over 40,000 observations during his time as a Moonwatch member.

<sup>70</sup> Several of these people were identified during the course of this research, in part through a query David DeVorkin and I circulated in the *Bulletin of the American Astronomical Society* in 2004. Among those who were active in Moonwatch as youngsters is Stephen P. Maran, an astronomer and longtime press officer for the AAS, who was a member of the Junior Astronomy Club of New York during the IGY. The late James P. Westphal, a noted astronomer and instrument designer at Caltech, is another example.

<sup>71</sup> Personal communication between Joel Weisberg and W. Patrick McCray, 3 Nov. 2005. Numerous other stories and examples exist; they will be presented in more detail in the book-length study of Moonwatch I am preparing.

<sup>72</sup> William Griffin to Albert Werner, 15 June 1975, Folder “G,” Box 2, Moonwatch Papers.

The recognition of what amateurs could contribute to professional scientists extended to other fields of IGY-related research. As noted, Clair Strong's articles for *Scientific American* described a whole range of amateur efforts in seismology, meteorology, and amateur rocketry. Relatively little attention has been paid to amateur contributions in these areas, and an exploration of how and to what extent these groups of amateurs interacted with professional scientists would be worthwhile.

Amateur scientists' participation in the IGY also suggests that there are still issues to consider with regard to the historiography of amateur–professional relations. As noted earlier, much of the work by historians has focused on the nineteenth and early twentieth centuries, when the various disciplines of science were still professionalizing. In astronomy, at least, the roles of amateurs and professionals were not firmly fixed. Indeed, some tensions remained between the two groups as they negotiated their relations and determined how they could derive benefit from each other. Moreover, the story of Moonwatch told here focuses largely on the United States. Amateurs also formed scores of teams overseas. Japan alone had more than seventy at the peak of activity, many of which were more closely connected to professional organizations than those in the United States, while the Soviet Union operated a program similar to Moonwatch. A broader global perspective could yield additional insights into amateur–professional relations in other countries as well as, perhaps, international relations between scientists. Professional scientists and journalists hailed the IGY as a model of international cooperation in science.<sup>73</sup> Did this ideal also extend to amateur scientists? If so, how was such cooperation achieved?

Moonwatch stands out among IGY activities because of its scope, scale of organization, and relative standardization. All around the world, amateurs built or bought similar equipment, developed standard observing techniques, and mobilized for the common purpose of spotting satellites. This standardization of purpose and practice was, of course, enabled by the very nature of artificial satellites. Unlike a seismic event or a meteor shower, which only professionals and amateurs in a particular locale could witness, satellites that circled the entire earth were objects that everyone could watch for and study.

Are there any historical analogues to Moonwatch in fields other than amateur astronomy? Since May 1999, millions of people have participated in SETI@home. This international effort harnesses their inactive personal computers to analyze radio telescope data for signs of extraterrestrial communications. While the venture is an intriguing social experiment and quite possibly (according to the *Guinness Book of World Records*) the largest single computation to date, it is hard to interpret SETI@home, which runs as a background program on participants' computers and requires little specialized skill or knowledge, as an example of active participation in amateur science.<sup>74</sup>

Another historical analogue might be the annual Christmas Bird Count (CBC), an event initiated in 1900 and carried out today under the supervision of the National Audubon Society. This annual survey provides useful information about avian species status and distribution for ornithologists and wildlife managers. Over fifty thousand people participate in this "citizen science" event each year, providing systematic information about bird

<sup>73</sup> Lloyd Viel Berkner, "The International Geophysical Year, 1957–1958: A Pattern for International Cooperation in Research," *Proceedings of the American Philosophical Society*, 1957, 101(2):159–163; and Walter Sullivan, "The IGY—Scientific Alliance in a Divided World," *Bulletin of the Atomic Scientists*, 1958, 2:68–72.

<sup>74</sup> SETI@home's mission is described on the organization's web site: <http://setiathome.ssl.berkeley.edu/> (accessed 30 Mar. 2006). Within astronomy itself, the best analogue obviously is the nearly century-old American Association of Variable Star Observers.

populations across wide swaths of North and South America.<sup>75</sup> The CBC, however, lasts only a few weeks each year, while people in each locale record data for only one day; Moonwatchers stayed active for months and years at a time.

Perhaps the most salient comparison is the extensive record-keeping activities of amateur meteorologists. In 1970, for example, amateurs formed the Climatological Observers Link, the “enthusiasts’ weather observer network for the United Kingdom,” which shares data with professional scientists.<sup>76</sup> But, again, the scale and international membership of groups like these do not compare with the scope of Moonwatch.

One conclusion is that the IGY presented a unique opportunity for amateurs to interact with the professional science community. Emerging as it did in the context and with the support of a massive global scientific enterprise, the IGY provided amateur scientists with a mission—one that, to the satisfaction of Fred Whipple, outlasted the IGY itself. Years after Moonwatch ended, a representative of the SAO cited the program as a model of amateur–professional collaboration, indicating that it helped change the perception of what amateurs could contribute to professional science.<sup>77</sup>

During the IGY, amateur scientists were not the only individuals who benefited. Fred Whipple, for example, used IGY funding of the SAO’s satellite-tracking program to initiate other large-scale projects. Satellite tracking also enabled the SAO to de-emphasize its long-running but moribund program of solar constant research while simultaneously connecting the observatory to new federal and military patrons. All of this was done while fulfilling the Smithsonian Institution’s traditional mission of “aiding the increase and diffusion of knowledge among men.”<sup>78</sup>

Once the IGY ended, Whipple capitalized on Moonwatch’s popularity and the eventual success of the SAO’s Baker-Nunn stations to secure years of support for satellite tracking from the newly formed National Aeronautics and Space Administration (NASA). NASA and military contracts for satellite tracking, worth millions of dollars annually, were the SAO’s largest source of revenue in the early 1960s. They enabled Whipple to oversee a rapid expansion of the SAO into promising new areas of research such as space studies, planetary science, and astrophysics while strengthening its expertise in meteoritic and cometary studies.<sup>79</sup> These endeavors were linked to Whipple’s own interests in the upper atmosphere and meteorites and greatly expanded his observatory’s research networks.<sup>80</sup> In the 1960s, the SAO adopted the Moonwatch model for other programs, such as the Center for Short-Lived Phenomena, which monitored the earth for new natural events.<sup>81</sup>

<sup>75</sup> Barrow, *Passion for Birds* (cit. n. 5), pp. 167–169, discusses the role of the ornithologist Frank Chapman in establishing the Christmas Bird Count. Statistical and historical information about the CBC is available on the National Audubon Society’s web site: <http://www.audubon.org/bird/cbc/index.html> (accessed 28 Mar. 2006).

<sup>76</sup> Information comes from the COL’s web site: <http://www.met.rdg.ac.uk/~brugge/col.html> (accessed 30 Mar. 2006).

<sup>77</sup> James Cornell, “The Moonwatch Program: A Model for Amateur Contributions to the ISY,” in *Stargazers*, ed. Dunlop and Gerbaldi (cit. n. 4), pp. 181–182. Articles and conferences about the resurgence of amateur–professional collaboration in astronomy support this observation. See, e.g., Jeffrey Kluger and David Bjerklie, “Calling All Amateurs,” *Time*, 11 Aug. 1997, p. 68.

<sup>78</sup> See the Smithsonian Institution’s history page: <http://www.si.edu/about/history.htm>.

<sup>79</sup> E.g., in terms of personnel, the SAO hired over 120 new staff between 1959 and 1961, according to “Reports on the Astrophysical Observatory” in *Smithsonian Institution Annual Reports*.

<sup>80</sup> On Project Telescope, another program Whipple and the SAO initiated to expand the observatory’s research and funding profile, see David H. DeVorkin, “SAO during the Whipple Years: The Origins of Project Telescope,” in *The New Astronomy: Opening the Electromagnetic Window and Expanding Our View of Planet Earth*, ed. Wayne Orchiston (New York: Springer, 2005), pp. 1–20. My thanks to DeVorkin for providing me with an advance draft.

<sup>81</sup> The Center for Short-Lived Phenomena was established and based at the SAO in 1968 and run by former



During the IGY, amateurs demonstrated that they could make a meaningful contribution to one of the largest science enterprises in history. For several months, their participation proved essential to the success of the IGY's satellite program. Leon Campbell, Jr.'s, assessment of Moonwatch—that “probably no organization of laymen in all history has contributed so valuably to a scientific program”—may be an overstatement that reflected his fondness for amateur science programs.<sup>82</sup> Nevertheless, amateur participation created favorable publicity for the Smithsonian and the IGY, while Moonwatch was the public manifestation of Whipple's emerging empire of research and data collection stations. Just as important, the IGY and programs like Moonwatch provided opportunities for amateurs to earn respect from their professional counterparts and contribute both to a prominent Big Science endeavor and to the opening of the Space Age.

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Baker-Nunn station manager Robert Citron. Another example is the Prairie Network, an SAO sky-monitoring program that amateurs were encouraged to contribute to.

<sup>82</sup> “Summary of Moonwatch Operations for 1960,” 1 Mar. 1961, Folder “Moonwatch,” Box 33, SAO Papers.