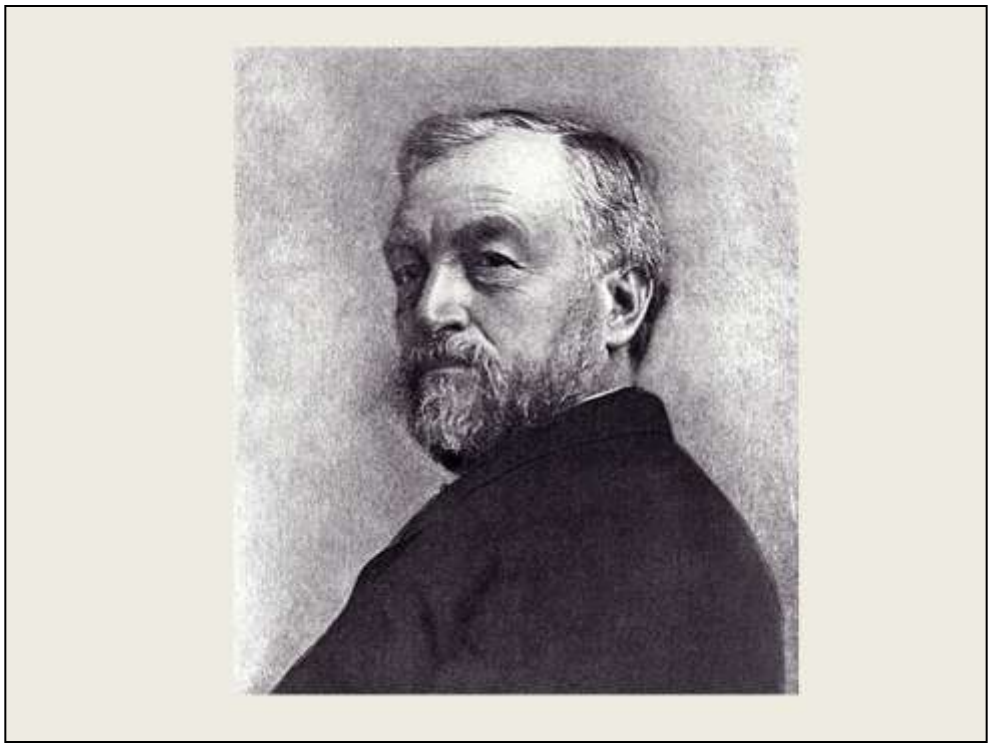


S - Samuel Pierpont Langley was an astronomer, architect, civil engineer, inventor, observatory director, father of the railroad automatic time-signal system, popular writer and communicator, pioneer in aerodynamics, founder of the Smithsonian's Astrophysical Observatory and third Secretary of the Smithsonian Institution.[cite B.J p. 105] There are few if any names in science today that can be described in so many different ways. But Langley's world was very different than today. The world of science was also a very different place then. To appreciate the story I will be telling, you need to keep this in mind.

Today, we will think of Langley in terms of the mission he created for the SAO - to study the sun's radiation, not only its visible character, but its infrared heat signature, and to relate this study to the needs of society. But first, we must ask two questions:

-- Was this accepted practice in Langley's day?

-- and what does this have to do with Jack Eddy?

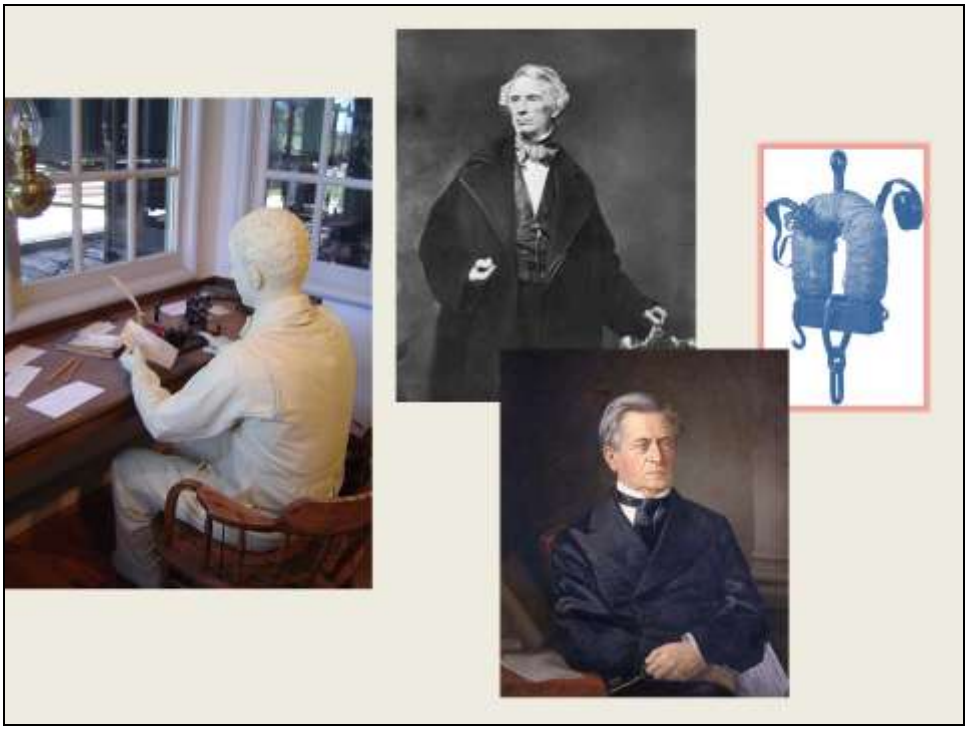
So first, what was Langley's mission?

The Smithsonian's Astrophysical Observatory:

Mission:

If the observation of the amount of heat the sun sends the earth is among the most important and difficult in astronomical physics, it may also be termed the fundamental problem of meteorology, nearly all whose phenomena would become predictable, if we knew both the original quantity and kind of this heat.

[S. P. Langley, "Report of the Mount Whitney Expedition" (1884), quoted frequently by Charles Greeley Abbot, most recently in Adventures in the World of Science (Washington, D. C., 1958), 17.]



In the 19th century, one might say that the boundaries between what was science and what was not science were in great flux. Langley came to the Smithsonian, an institution that combined a lot of both in its history, and this combination was in ways directly germane to Langley's goals. Lets look at one example: the telegraph

S – the telegraph is an excellent example for us today, because it made the ancient dream of predicting the weather actually possible. So did this technology make a new science possible and feasible? If so, who invented the technology and why, and who applied it to social uses?

S -- We all give credit to Samuel F. B. Morse, of course, a portrait painter by training and profession, who created the first working telegraphic system. Once he had conceptualized the idea, he secured help from men who possessed the technical skills he lacked.

S -- Joseph Henry was one of those men. Henry's own studies in the science of electromagnetism led to his design

S -- for a powerful electromagnet that Morse adopted under Henry's guidance. Henry even endorsed Morse's designs in the 1840s and never lay claims to the invention himself. But when Morse applied for patents in the 1840s, he failed to credit Henry. This angered Henry and all sorts of tussles ensured, which are beyond our story. The point to make here, though, is that Henry knew that his contribution was to science, and what Morse did was make it useful to society. To Henry, these were very separate but definitely complementary acts: as one Henry biographer put it

"Henry was perhaps conscious of the wide gulf separating a lecture-hall demonstration from a commercial

communications system, between ringing a bell through a mile of wire and actually sending messages reliably between two

S - “Henry the scientist heralded basic research as the mainspring of social improvement, and thought of technological advances as the mere application of scientific discoveries. He conceived of his findings as contributions to the fund of human knowledge, freely available to anyone who found them useful.” As the founding Secretary of the Smithsonian Institution, he championed “the Baconian ideal of utilizing natural philosophy to improve the mechanic arts” (Ronald Kline 198) As the historian Ron Kline has observed, “prominent scientists from Joseph Henry in the 1820s

S -- to Simon Newcomb in the 1870s transformed this historically sensitive prescription into a timeless, universal statement that all useful arts-past and present-were based on the application of science. By 1880 this interpretation had become part of the rhetorical arsenal of presidents and vice presidents of the American Association for the Advancement of Science (AAAS), who often expressed it by the shorthand phrase pure and applied science in order to define and promote their profession."

Through the work of Kline, Reingold, Rothenberg, Moyer and many other historians, we know today that Henry designed the Smithsonian as the first center in the United States for “**abstract research sheltered from the pressures of immediate industrial or social demands.” [Reingold Wilson Quarterly] …but he felt that application would emerge..based upon numerous experiences like he had with Morse….**

So in this framework we find ample room for Langley’s obvious passion for meteorological forecasting. In America, unlike in Europe, applied and basic research were only theoretically or rhetorically distinct, and definitely not separate.

"[science] on the part of the Government should be limited nearly to utilitarian purposes evidently for the general welfare."

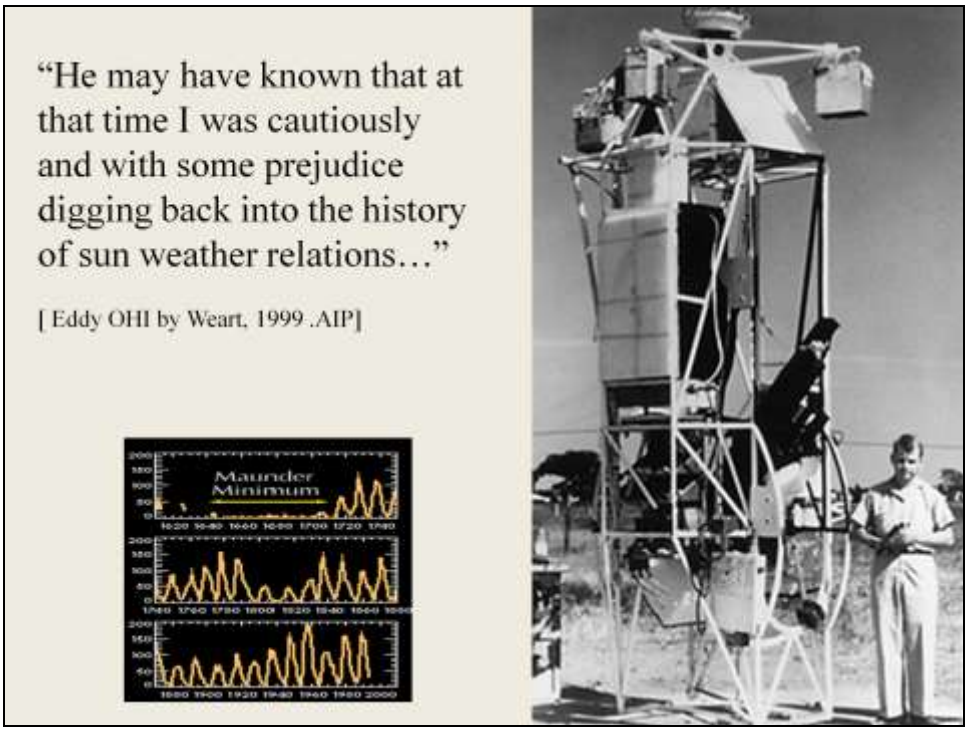
[C. D. Walcott (USGS Director and soon to become SI Sec'y), et al to T. Roosevelt July 20, 1903, quoted in Dupree, Science in the Federal Government, (Hopkins 1986), p. 296.]

Langley's successor as the 4th Secretary, Charles Walcott, from the USGS, made the ultimate statement when it applied to government supported science -- The legacy of the government research establishment was problem-oriented science, according to Walcott, Pinchot, et al

Walcott certainly went farther than Henry would have liked, but between the two you can clearly sense an arc .. At least there was little or no bifurcation in the early 20th century… an era of strong pragmatic progressivism.

Both Langley and Abbot were engineers at heart, and definitely of that mold….this was mainstream science….

Now, what about Jack Eddy? How does following the course of Langley's work, and of Charles Greeley Abbot's after him, for another half century, bring us back to Jack?



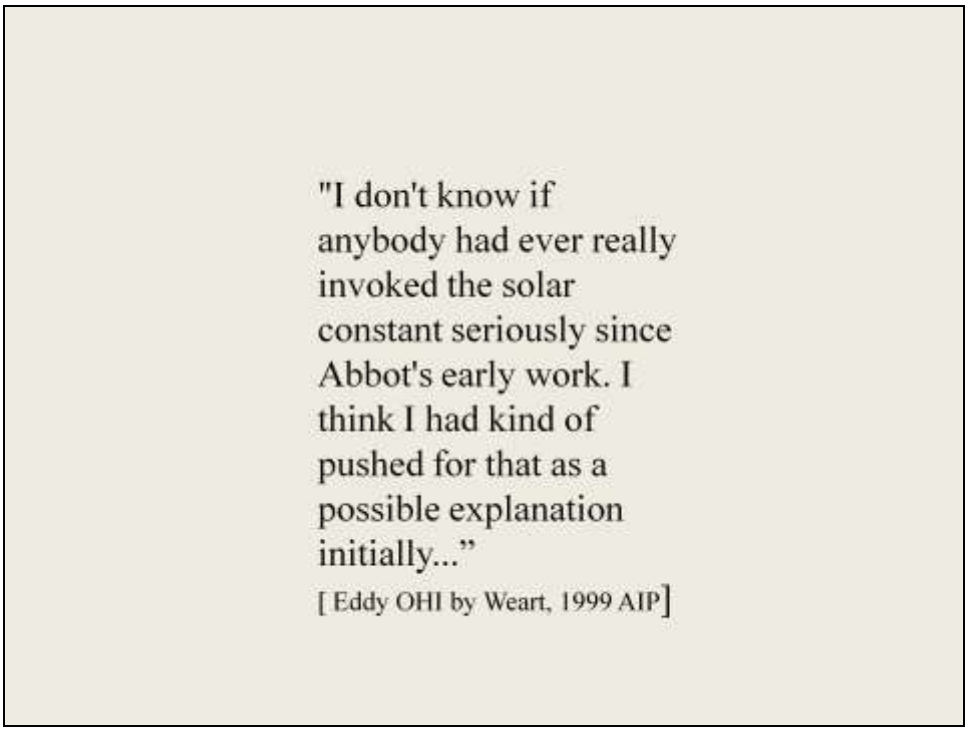
S - Jack Eddy was a graduate student working with Gordon Newkirk, doing a thesis on measuring sky brightness in a series of balloon launched coronagraphic flights in the late 1960s. During his years at the High Altitude Observatory, he encountered Eugene Parker from the University of Chicago, and recalls in a 1999 interview with Spencer Weart that Parker directed his attention to E. W. Maunder's papers from the late 19th century on a strange period in history in the 1600s when sunspots were absent. Eddy believes Parker made this gesture, because

S - "He may have known that at that time I was cautiously and with some prejudice digging back into the history of sun weather relations…"

Jack went on to explain to Spencer:

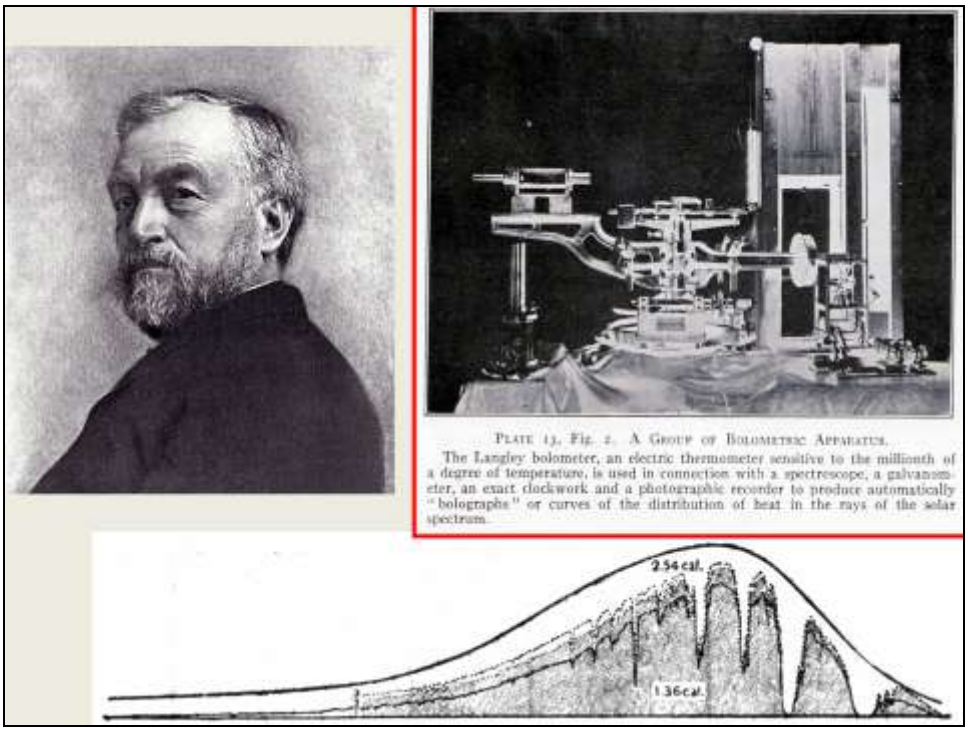
"I had been taught that while the Sun indeed affects the upper and outer atmosphere of the Earth, purported connections with the troposphere and weather and climate were uniformly wacky and to be distrusted. I still believe that to some extent, for there is a hypnotism about cycles that seems to attract people. It draws all kinds of creatures out of the woodwork."
[Eddy OHI by Weart, 1999AIP]

As a result of his interest, he learned about the old work of the Smithsonian Astrophysical Observatory when it was based in Washington, and the claims mainly of Charles Greeley Abbot, Langley's successor, and began to look into the matter more carefully…



And so the connection is made.

So lets now move on to the Smithsonian, and Abbot's quest to link solar activity to the weather.



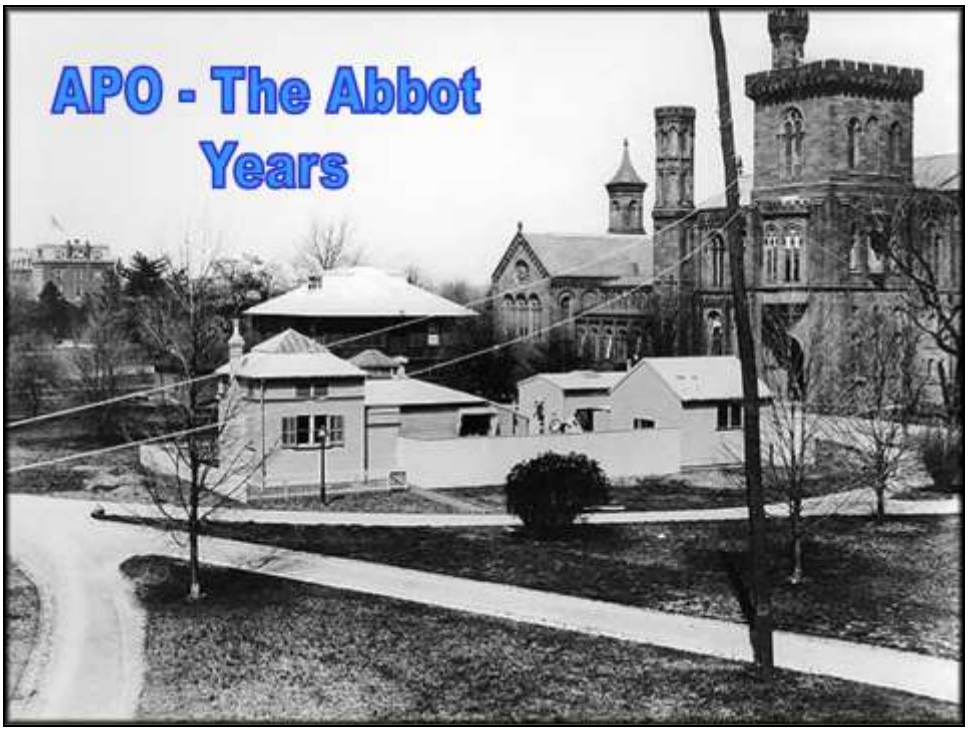
Langley wanted to pursue what he saw was a central problem in the New Astronomy – that of the Sun, not only its visible character, but its infrared heat signature….its energy, in other words….Langley was largely self-trained as a civil engineer in Chicago and St. Louis before becoming an assistant at the Harvard Observatory. During the civil war he taught mathematics at the U.S. Naval Academy in Annapolis, Md. And then directed the Allegheny Observatory at the Western University of Pennsylvania (now known as the University of Pittsburgh).

S - In 1878 Langley had improved upon a device we call a thermometer, giving it a new name, a bolometer – This instrument was based on the well-known property of metals – that its ability to conduct electricity, or to resist its conductivity, is very delicately influenced by the temperature of the metal. He used thin strips of blackened platinum in an electrical circuit and created devices that, it has been said, could detect the heat from a cow a quarter of a mile away.

S - Instead of cows, though, Langley explored the sun, putting his bolometers at the eye end of telescopes equipped with rock salt prisms. Langley explored the infrared spectrum of the sun, notably where water vapor, carbon dioxide and oxygen in our atmosphere swallow solar energy in deep gulps – his goal was to reconstruct the overall curve, and hence the total amount, of solar energy before our atmosphere swallowed and stored chunks of it.

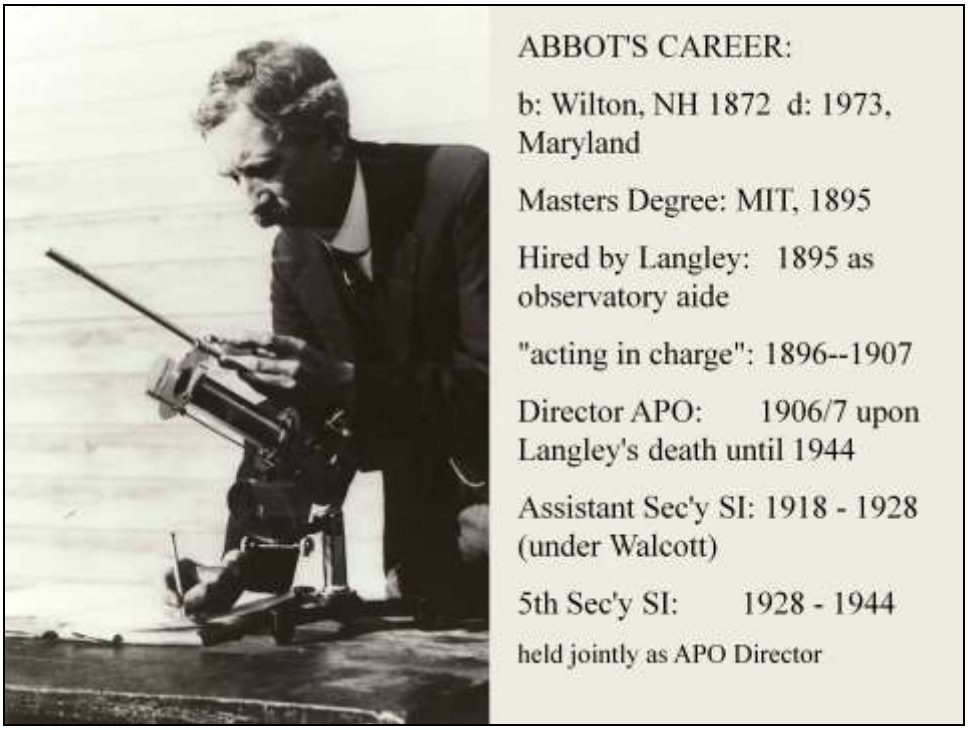
In the 1880s, Langley had established himself as one of the most innovative proponents of the New Astronomy as he called it: the study of

S - Although Langley built the APO, and set its agenda, he did not tend to it daily as he was soon made secretary of the institution and later became preoccupied with aviation. Others, like his chief assistant, carried forth the mission – today, we associate Charles Greely Abbot most closely with that mission…

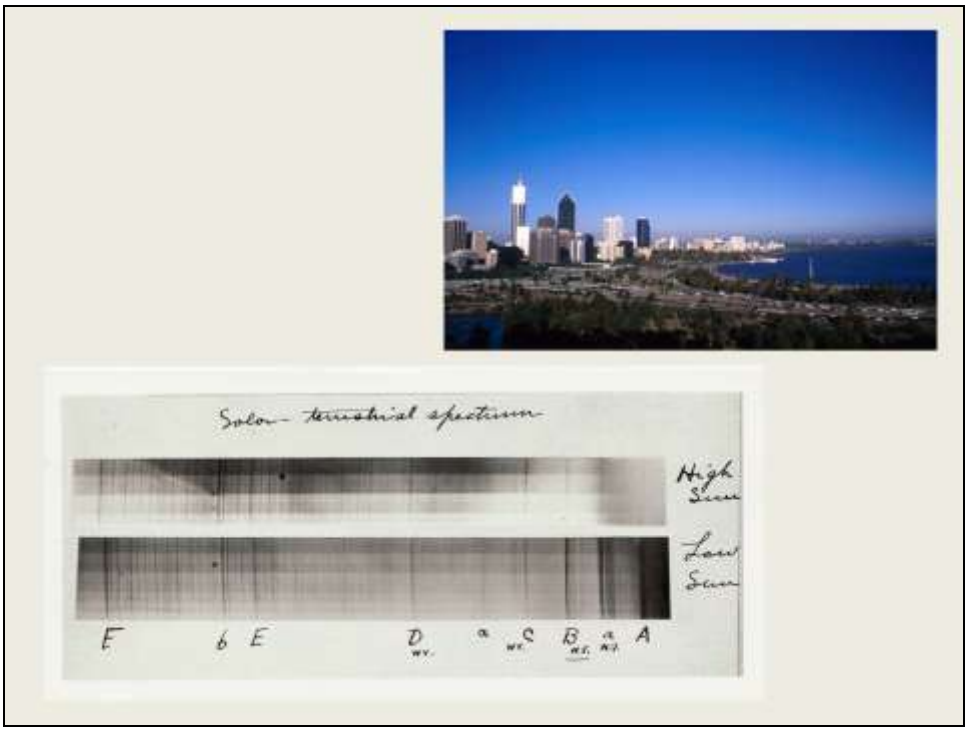


Purpose of talk today: Not to point out or ascertain why and where Abbot and his staff went wrong in their observational

procedures, methodologies or assumptions…like other famous cases, the canals of Mars and the direct astrometric observation of rotational motion in spiral nebulae, the source of the errors lie deep in human nature and in the nature of consensus formation in science and society. I also will not explore how the limitations of available technologies shaped the story. That is mleft for another day and clearly deals with direct and continued access to space. Today, my task is to show how and why Abbot was able to persevere in his mission. We explore the challenge of searching for a phenomenon at or beyond the limits of detection, and examine how his institutional base fostered research of this type, but ultimately called it into question when the institution itself felt threatened by changing times.

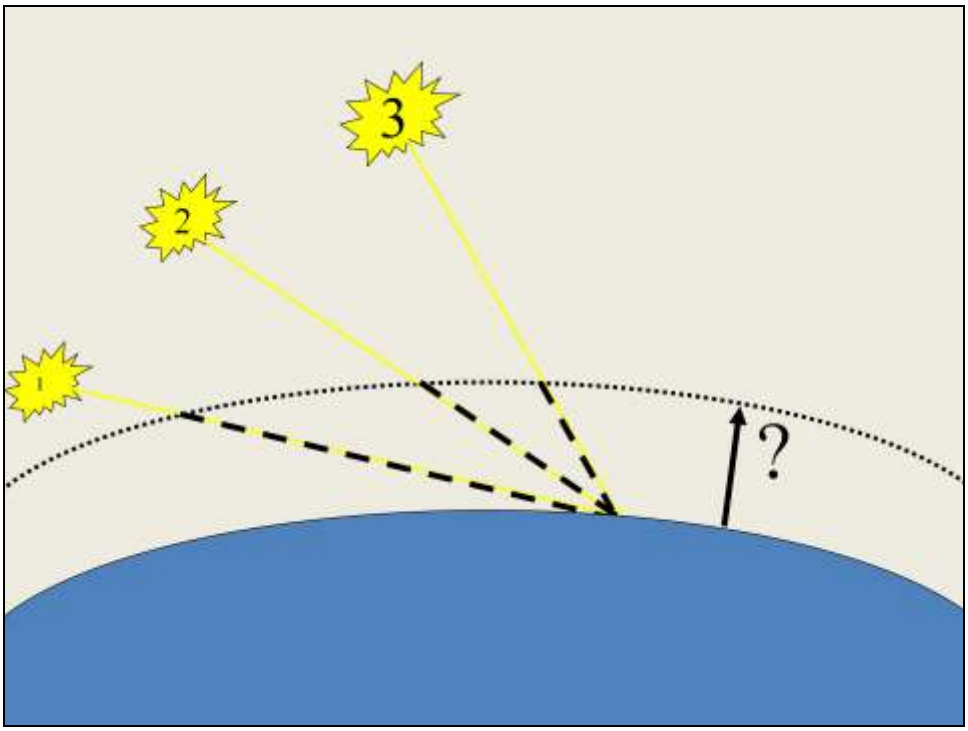


A promising chemical physics student – Abbot arrived in Washington in 1895 and rapidly took over all APO duties as Langley was distracted by other things... Unlike Langley, who was an avid experimentalist, Abbot was both an experimentalist and a dutiful data collector.



Langley and Abbot keenly knew, however, that their solar studies were heavily influenced by the atmosphere. Langley's spectro-bolometry, of course, was one way to determine how much selective absorption was at play, but there was also general absorption he knew was taking place….

Among astrophysicists, the amount and character of the sun's radiation are still most basic quantities. Determining these quantities in practice, however, was far from a simple matter. HIGH SUN/LOW SUN



S - Langley's method of determining the solar constant was to take observations of the sun as it rose in the sky, noting its increase in radiating power and then extrapolating his maximum finding to the top of the atmosphere.

S - Given the vagueries of the atmosphere and the limitations of technology, the value of the solar constant could vary as much as 50 percent. Langley established the value 3.00 cal/cm**2/min outside the atmosphere as the Smithsonian standard, and held to it tenaciously to the end of his life. But as Peggy Kidwell at NMAH has shown, others who made different assumptions about atmospheric absorption coefficients or other variables in the latter part of the 19th century came up with values between 1.5 and 4.0.

Abbot was bound and determined to narrow the uncertainty....and in his first decade as APO director in Langley's wake, carried his instruments to the tops of mountains like Mount Whitney… and ultimately into the stratosphere….

S - He was a very quick learner – first from Langley and soon from some of the most innovative astronomers active in that day, most critically George Ellery Hale, who had just opened his new Mount Wilson Solar Observatory and was hell bent on changing the way astronomy was done

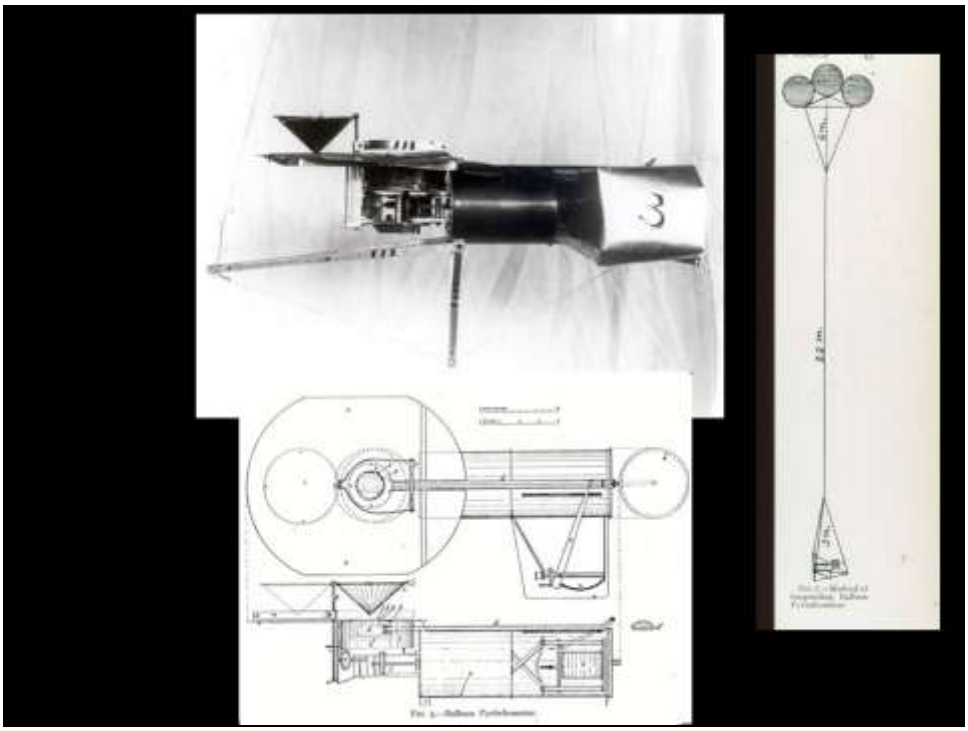
S… Influenced, aided and abetted by Hale, over the next half-century, Abbot's mission in life was to extend Langley's solar constant studies from its determination to its world-wide synoptic monitoring and to a deeply passionate search for its variations.

-- First of all, Hale offered Abbot a mile-high observing site where he could build an outpost to monitor the Sun, extending his reach by a good three hours of time from day to day…

. But Abbot wanted to go higher….

Helped to promote and support an expedition to Mount Whitney, not for a temporary study, but for a prolonged stay – Mars, Campbell, while Abbot quietly examined the solar constant…

But Abbot still wanted to go higher, partly to answer critics of Langley's Smithsonian value….



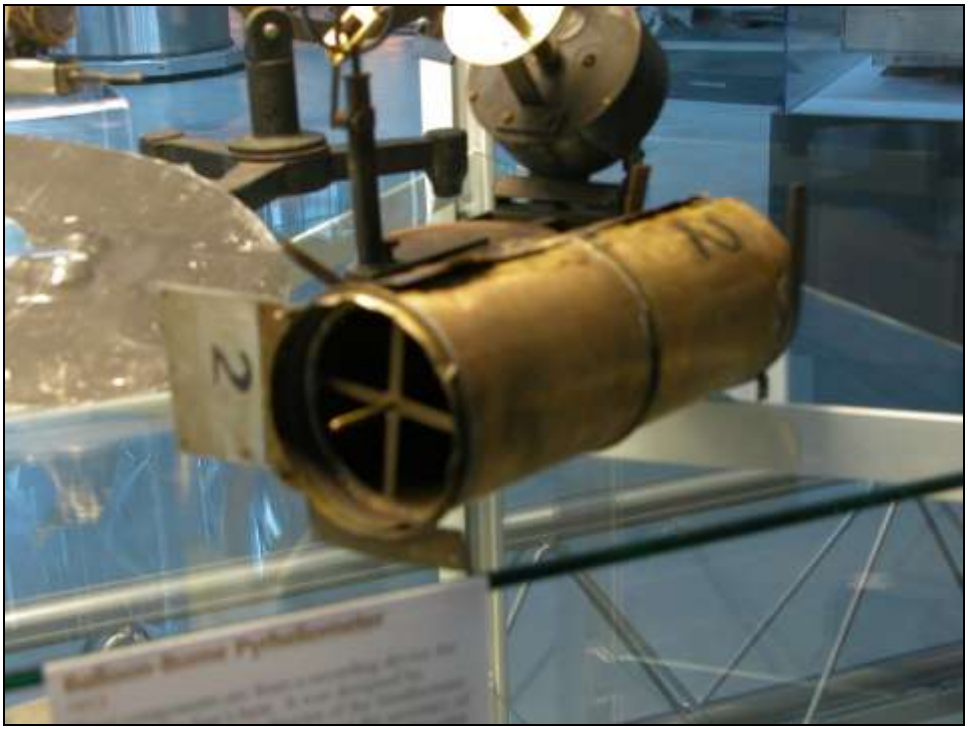
One of Abbot's most creative episodes came in 1912 when he planned a series of balloon flights of automated instruments – a significant feat in that day -- When critics attacked Langley's methods of accounting for atmospheric extinction, Abbot decided to send pyrheliometers aloft under balloons to remove as much of the atmosphere as possible. Flying to over 25 kilometers in 1914 from Catalina Island off the SoCal coast, one of these instruments brought back data that confirmed Abbot's terrestrial extrapolations and quieted most criticism.

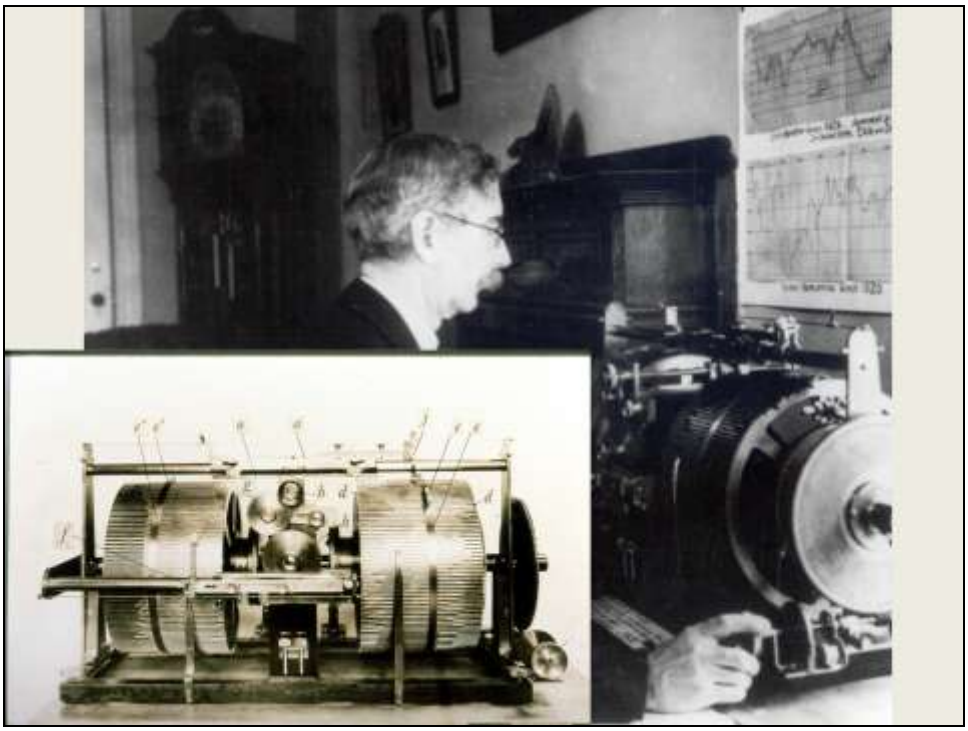
[pyrheliometer] - diagram - point out barograph needle and entrance

This technical feat, requiring the cooperation of the Weather Bureau and the Signal Corps, quieted criticism of the Smithsonian value for the solar constant. It also helped to confirm Abbot's reputation. On more than one occasion, lasting at least until 1930, Hale tried to convince Abbot to abandon Washington and the solar constant, and apply his talents to mainstream problems in astrophysics at Mount Wilson… But Hale was probably just as happy when Abbot constantly refused. Not only did Hale's favor strengthen Abbot's position in Washington scientific circles, but Abbot many times acted as Hale's eyes and ears on the Mall, working loyally to provide the public and congressional exposure to science that Hale always coveted in his constant push to establish an American culture informed by science.

1.93 cal/cm**2 min - received Rumford Medal of the American Acad of Arts and Sciences…in 1915…

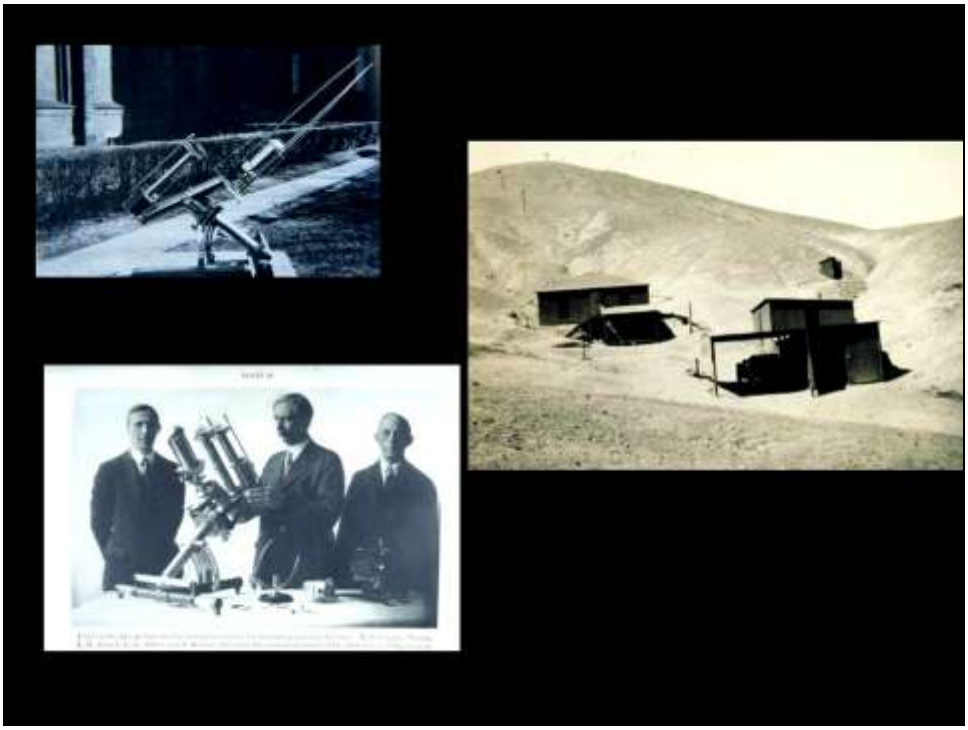

FERNO





With his solar constant critics vanquished, Abbot focused more on Langley's ultimate goal: to search for evidence of variations in the solar constant, and to show that these cycles influenced cycles in weather and climate.

He applied ingenious mechanical devices to search out these cycles of behavior, like this Harmonic Analyzer, which through a series of cogs and gears could measure the relative amplitudes of sinusoidal components of a periodically recurrent function – note the charts on the wall indicating variations in solar energy…

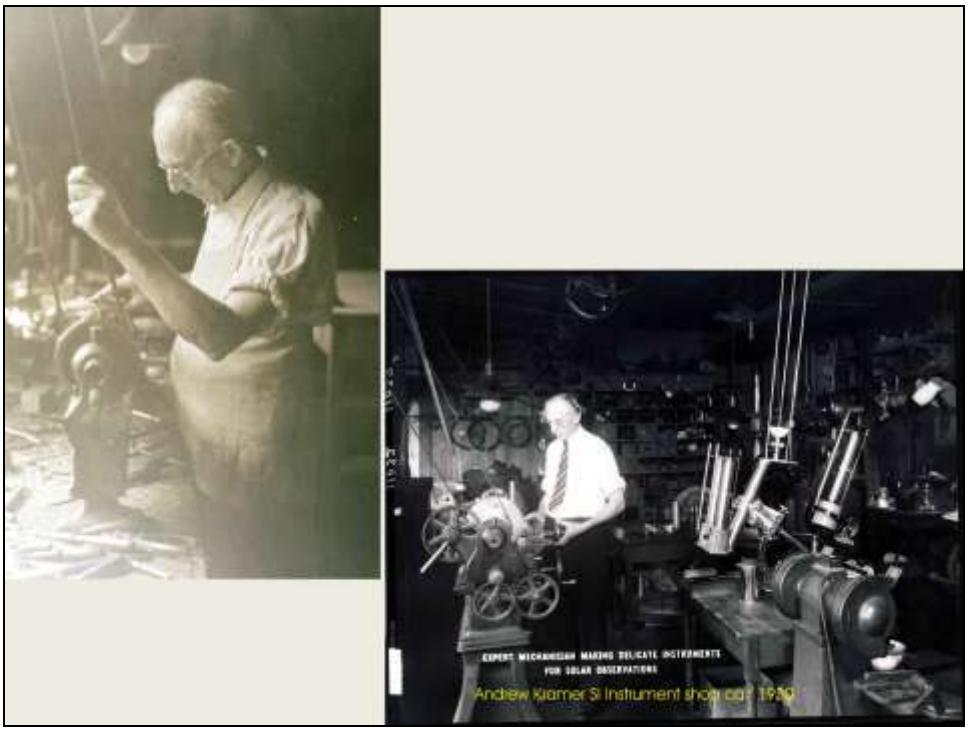


Abbot became obsessed with practices just then only emerging in the new hybrid study called “astro-physics”: the standardization of instruments, observing procedures, recording and data reduction methods.... All had to be routinized and rendered insensitive to the personal equation of the observer, of which he hired many, both in Washington and at the outlying stations he created over the decades.

His first outstation was at Mount Wilson in California, at the invitation of Hale, who at the time he was creating the International Union, viewed Langley’s and Abbot’s mission as one of the most obvious and worthwhile means of establishing international networks of peer colleagues in astrophysics.

Instrumentation:

-- Overall – develops pyrheliometers and increasingly more sophisticated and sensitive spectrobolometers and has them constructed to careful and consistent specifications.
-- Joins close interlocking network of elite friends and colleagues within scientific Washington and in the astronomical, geological, and meteorological communities.
-- Maintains mission-oriented research engine of programmatic studies centered on solar radiation.
-- maintained when most institutions and patterns of patronage migrate into project oriented research driven by particular interests of staff members.



Following once again Langley's direction, a large portion of the Observatory's effort was given over to instrument design and construction. Abbot was an excellent designer, and he had a series of fine craftsmen, most notably Andrew Kramer. By the 1930s, the APO's instrument maker Andrew Kramer had produced about 100 standard pyrheliometers, and dozens of larger and more sophisticated sets of multiple instruments, including spectrobolometers. APO distributed them to observatories world-wide. On many occasions, in a constantly defensive state regarding the reality of his provocative conclusions --- that the sun varied by as much as 3 percent in a nested series of 23 cycles, Abbot employed observations from other observatories, mainly European, as confirming his own results on solar variation.

Mount Wilson

His first outlying station was at Hale's Mount Wilson solar observatory, where with Hale's staff Abbot established experimental recording techniques and built upon Hale's extensive infrastructure at Mount Wilson -- Abbot also hired an assistant to work at Mount Wilson – Loyal B. Aldricbh - but soon knew he had to keep a continuous monitoring record from many sites separated widely in longitude. Again inspired and facilitated by Hale, Abbot sought the means to reproduce his equipment and distribute samples around the world, but he also felt it neccesary to create his own stations…

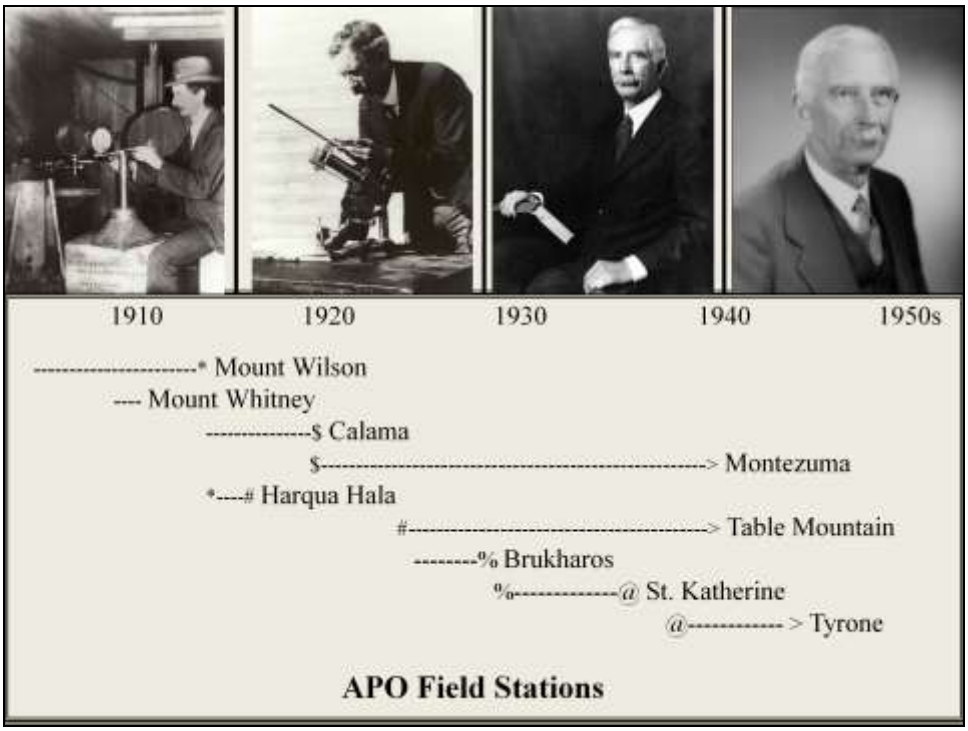
Record Unit 7005, Box 187, Folder 2, Negative Number: 94-12574.

Montezuma

More and more sophisticated – temperature stability by sending light into a deep mine.....

These sites were established in some of the remotest and driest parts of the friendly and more accessible world, from the wesspread out Jones made much of the isolation and frustrations experienced by workers at each site, but there was no mention of any substantial contact with the locals, other than reference to maintenance and supply issues.

Appendix 1 to her history identifies the staffs of each of the stations over the entire history of the project, including Field Station Directors, assistant directors, and assistants. None of the names mentioned beyond the principals based in Washington are known to have become professional astronomers in their own right, all have clearly western-European surnames.



Established Field Stations - very much influenced by Hale's appeals in 1900, 1902 and 1904 . . . . and started at Hale's Mount Wilson

By 1930, Abbot had succeeded Walcott as Secretary of the Smithsonian, but his focus remained on the Astrophysical Observatory and its programs. With support from the Research Corporation of New York, he established a new division of Radiation and Organisms in 1929, and with Roebling and NGS support he built the St. Katherine site while maintaining Table Mountain and Montezuma.

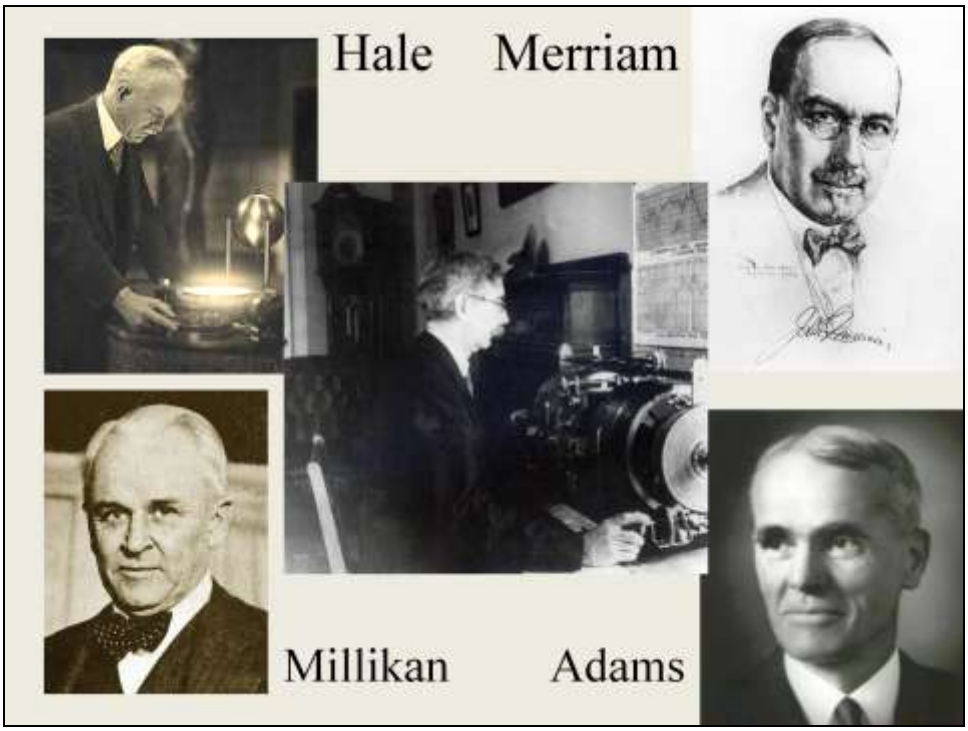
By the mid-1930s, while continuing to make claims before patrons and public that means for weather prediction were at hand, Abbot realized that he needed more help to nail it all down. His staff had made a detailed comparative analysis of the Montezuma, Table Mountain and St. Katherine observations, and felt that three stations were not enough. With the endorsement of Willis Gregg, the new chief of the Weather Bureau, and a new blue ribbon panel Gregg had assembled out of Abbot's old friends, they concluded that Abbot's findings were real and warranted not only continued support, but a substantial increase.

Calama – Chile

Montezuma – Chile

Mt W – Harqua Hala – Table Mountain -- Sierra Nevada

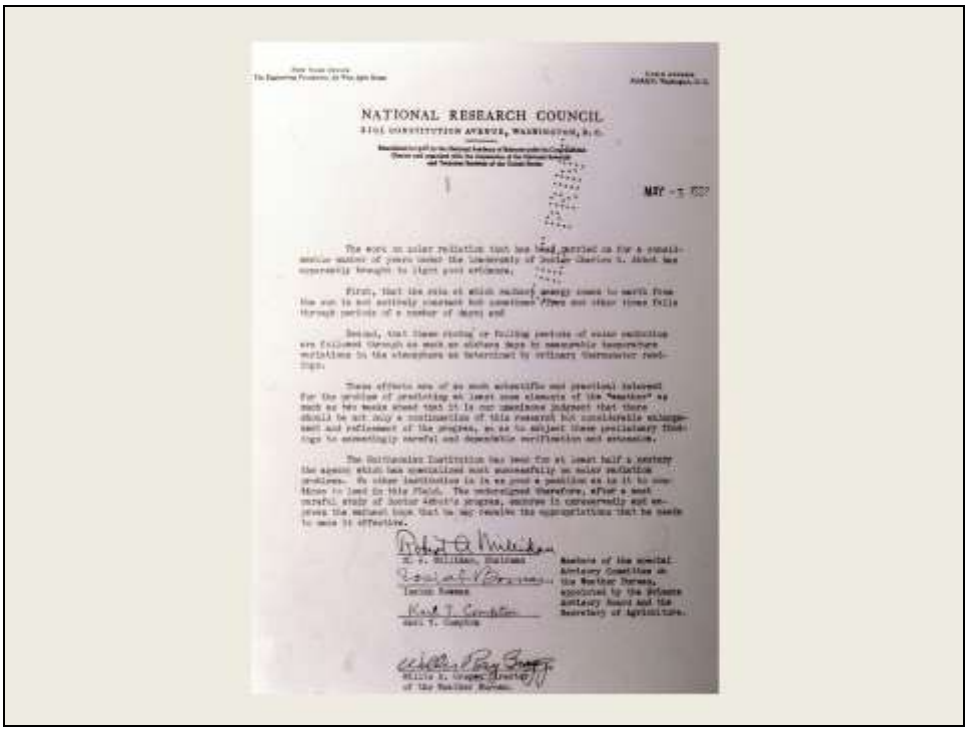
Brukharos – SW Africa – funded by the Geographic Society – soon closed to open St. Katherine in the Sinai – more accessible



Largely because of his highly agreeable social nature, Abbot became part of a close interlocking network of elite friends and colleagues within scientific Washington and in the astronomical, geological, and meteorological communities. Within this circle, especially starting in the 1920s, what Abbot believed he was finding was a phenomenon very much in vogue at the time – cyclic behavior – that the Sun's energy varied in measurable and ultimately predictable cycles. In the 1920s, cycles were a fascination to students of nature. The Carnegie Institution hosted "cycles conferences" looking for correlations in all natural phenomena; there were many voices in support, therefore, not so much of Abbot's conclusions but in support of his continued work, holding out the hope that his conclusions would be vindicated. Thus in circles of support like this one, Abbot was able to maintain the APO, even when most other institutions and patterns of patronage migrated into project oriented research driven by the particular interests of staff members.

--- The continuance of the solar-radiation work under the auspices of the Smithsonian Institution in at least two stations is highly desirable, both from an astronomical and meteorological point of view. [IAU Transactions, volume 1, 1922].

1925: NAS special committee (Gilbert Lewis, R. A. Millikan and W. W. Campbell): argues that support continue for SAO observing stations "without



NATIONAL RESEARCH COUNCIL

2101 CONSTITUTION AVENUE, WASHINGTON, D. C.

MAY - 5 1937

The work on solar radiation that has been carried on for a considerable number of years under the leadership of Doctor Charles G. Abbot has repeatedly brought to light good evidence.

First, that the rate at which radiant energy comes to earth from the sun is not entirely constant but sometimes rises and other times falls through periods of a number of days; and

Second, that these rising or falling periods of solar radiation are followed through as much as sixteen days by measurable temperature variations in the atmosphere as determined by ordinary thermometer readings.

These effects are of so much scientific and practical interest for the problem of predicting at least some elements of the "weather" as much as two weeks ahead that it is our unanimous judgment that there should be not only a continuation of this research but considerable enlargement and refinement of the program, so as to subject these preliminary findings to exceedingly careful and dependable verification and extension.

The Smithsonian Institution has been for at least half a century the agency which has specialized most successfully on solar radiation problems. No other institution is in as good a position as is it to continue to lead in this field. The undersigned therefore, after a most careful study of Doctor Abbot's program, endorse it unreservedly and approve the modest sum that he may receive the appropriations that he needs to make it effective.

R. A. Millikan, Chairman

Members of the special Advisory Committee on the Weather Bureau, appointed by the Science Advisory Board and the Secretary of Agriculture.

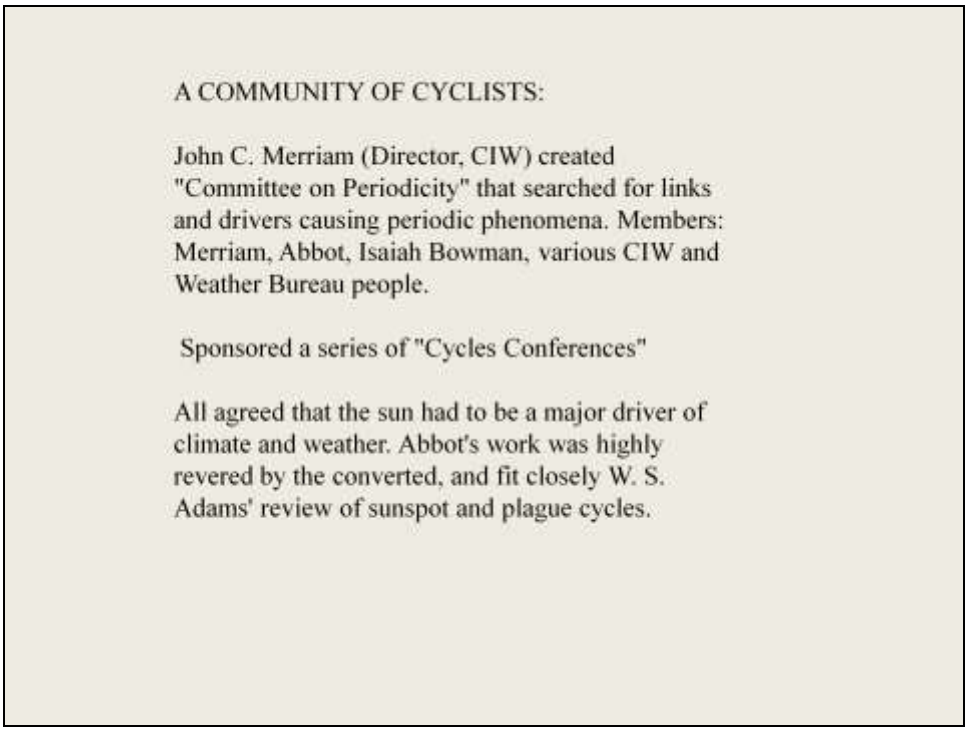
Isaiah Bowman

Karl T. Compton

Willis R. Gregg, Director of the Weather Bureau.

The Smithsonian had been in the business so long, ROBERT MILLIKAN, K. T. COMPTON AND ISAIAH BOWMAN argued, it would be a pity to stop. It was, after all, "the agency which has specialized most successfully on solar radiation problems. No other institution is in as good a position as is it to continue to lead in this field."

In response, Abbot called for a vastly expanded program, from three stations to ten, and a series of balloonsonde probes that would measure the ultraviolet flux of the sun. The barely perceptible variations seen in the visible range, Abbot thought, would be greatly magnified in the ultraviolet, visible only at great height.®FN1. Lighthouse, pp. 231 - 232.¯



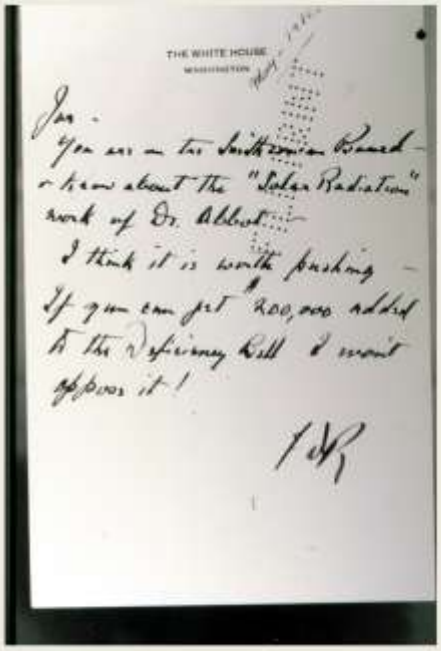
John C. Merriam (Director, CIW) created "Committee on Periodicity" that searched for links and drivers causing periodic phenomena. Members: Merriam, Abbot, Isaiah Bowman, various CIW and Weather Bureau people.

Cycles Conferences -

o Disciplines: climatology; paleontology; botany; geology; physiology, economics, archaeology, astronomy.

o 1922 cycles conference: A. E. Douglass, Merriam, Humphreys, Matthew, Abbot, Marvin, Clements, Clayton, and many others.

o 1933 conference: Merriam, Douglass, Abbot, Adams, Bowman:


THE WHITE HOUSE
WASHINGTON

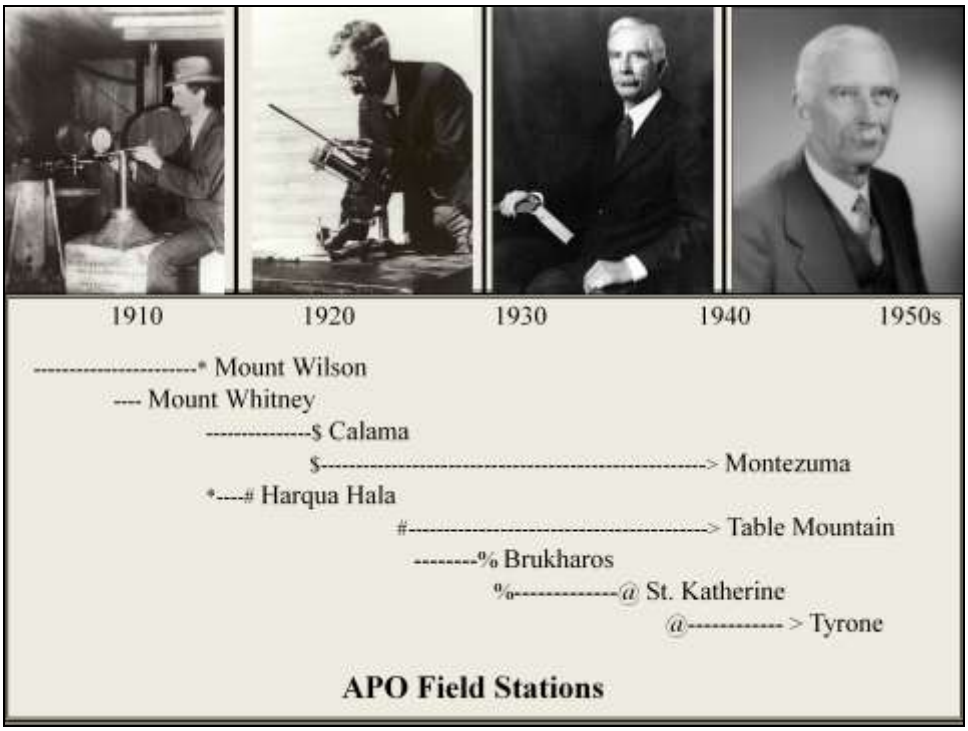
Jim -

You are on the Smithsonian Board - how about the "Solar Radiation" work of Dr. Abbot?

I think it is worth pushing. If you can get $200,000 added to the Deficiency Bill I want to know it!

F.D.R.

This $300,000 per year project was actually endorsed by FDR and approved by the Senate, but lost in conference in 1936. Abbot therefore had to retrench for the first time. He dropped the idea of expanding the stations, closed down the expensive St. Katherine station and moved it to New Mexico, but managed to support some ballooning experiments by the Rochester physicist Brian J. O'Brien in a reduced project to develop photoelectric ultraviolet systems for balloon flights.®FN1. D. H. DeVorkin, ®MDUL¯Spectacle in the Stratosphere: Manned Scientific Ballooning in America®MDNM¯ manuscript draft.¯



Established Field Stations - very much influenced by Hale's appeals in 1900, 1902 and 1904 . . . . and started at Hale's Mount Wilson

By 1936, however, the St Katherine station had serious logistical and supply problems. Abbot was still able to secure gifts, but funds were harder to come by, and staff were unhappy in such a remote part of the world. Abbot decided to close St. Katherine in December 1937 in favor of a continental spot that would cover the months December through February, when his other two stations were usually clouded out. He eventually selected Burro Mountain in New Mexico, and sent the St. Katherine instrument and staff to what was the Tyrone station where another Smithsonian Tunnel was excavated into the mountain.

Calama – Chile

Montezuma – Chile

Mt W – Harqua Hala – Table Mountain -- Sierra Nevada

Brukharos – SW Africa – funded by the Geographic Society – soon closed to open St. Katherine in the Sinai – more accessible

Brukharos – SW Africa

St. Katherin – Egypt – Sinai

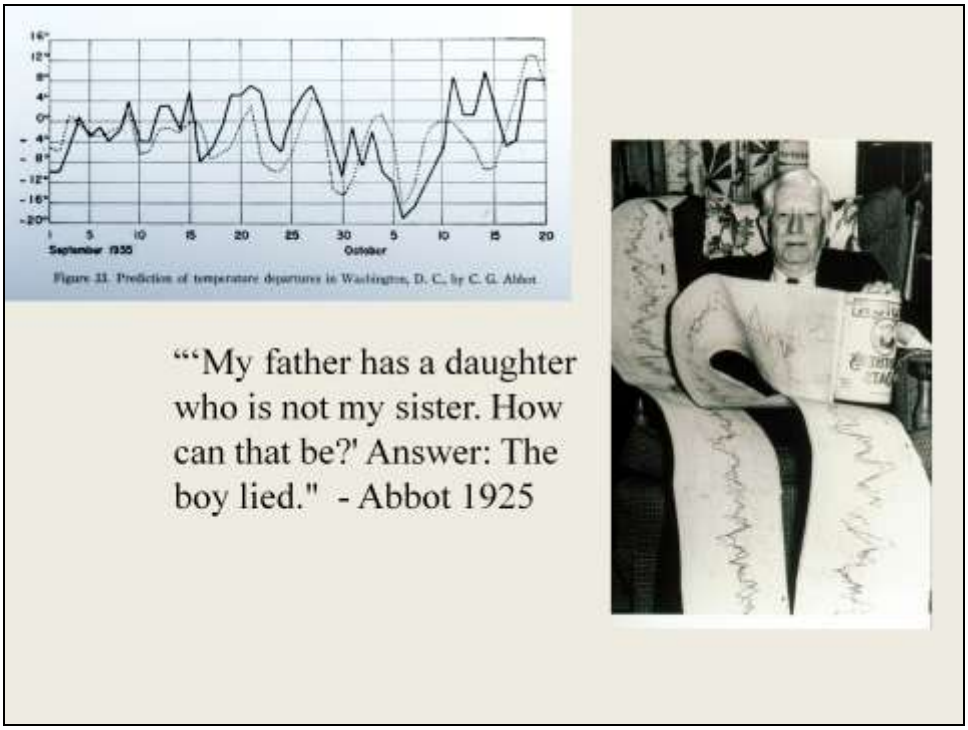
CRITICS

Abbot's critics:

- o 1910 - 1915: F. W. Very and others question value of solar constant based upon the Langley technique of extrapolation.
- o 1920s - 1930s: C.F. Marvin and colleagues at Weather Bureau criticize reality of cycles and weather correlations.
- o 1939 – 1940 – Sterne, Guthe, Roberts – harmonic analysis yields periodicities – no correlation with Abbot's
- o 1940s: Kurt Wegener criticizes observational technique.
- o 1940s - 1950s: Theodore Sterne and others criticize statistical procedures.

Style and manner of answering critics: **Bluster**

Abbot indulged in polemic and self-righteousness, especially in later years as Abbot grew more frustrated with those he felt should see the value of what he was doing. But Abbot also sought out alternative ways of getting around the atmosphere: ballooning and Goddard's rocketry.



In 1925, for instance, Abbot met criticisms even from friendly meteorologists like C H Marvin with thinly veiled threats. Abbot appealed to cooperation and loyalty between kindred government bureaus and called for a conference before Marvin delivered his paper. Abbot told Marvin that he would "put the matter in such a form as would convince you that your objections should be withdrawn." He assured Marvin that he and his colleague H. H. Clayton had new evidence "which is far more powerful than you are at all aware of.“ [Abbot to Marvin, April 27, 1925.] Abbot would use this trope many times. What Abbot could not do was face Marvin's statistics square on. When Marvin delivered his paper before a meeting of meteorologists in Washington, Abbot defended his position by stating that if the audience sided with Marvin, it would be tantamount to calling Clayton a liar. He made his point with a joke: "There is an old conundrum proposed by a school boy," Abbot quipped.

S - "`My father has a daughter who is not my sister. How can that be?' Answer: The boy lied."

Abbot continued: "I believe no one in this room will dare to make that answer to Mr. Clayton's figures. There is no man here who is more conscientious and careful then he.“ Abbot papers SIA.

S- Abbot always pushed his correlations of weather with solar constant variations, making strong visual statements but rarely discussing how he arrived at them….

The periodicities suggested by Abbot were not found by him through any systematic periodogram analysis, but only from a partly subjective examination of a rather loose sort. With the collaboration of Messrs. W. O. Roberts and K. F. Guthe, I have recently completed (by Hollerith) a thorough periodogram analysis of 540 ten-day mean values of the solar constant from 1920 through 1934. The analysis (of a modified Schuster type) has

Ted Sterne and Walt Roberts teamed up with Karl Guthe -- making a strong statement in 1939-1940….

Factors promoting the Langley/Abbot research agenda:

1) The heritage of the government research establishment: problem-oriented research: In 1903, Walcott had argued: **science "on the part of the Government should be limited nearly to utilitarian purposes evidently for the general welfare."**

[C. D. Walcott, et al to T. Roosevelt July 20, 1903, quoted in Dupree, Science in the Federal Government, (Hopkins 1986), p. 296.]

2) Lack of sufficient patronage to diversify: enough, however, to concentrate on strengths in monitoring the energy output of the sun, developing bolometric techniques for coronal studies during solar eclipses and spectrobolometry of bright stars.

3) Continual endorsement from the scientific elite.

PATRONAGE

In roughly decreasing order of support:

Smithsonian: Roebling Fund
(personal interest of
John Roebling)
National Geographic Society
Smithsonian: Hodgkins fund
Research Corporation of New York
Carnegie Institution of Washington
Congress

Abbot's Legacy

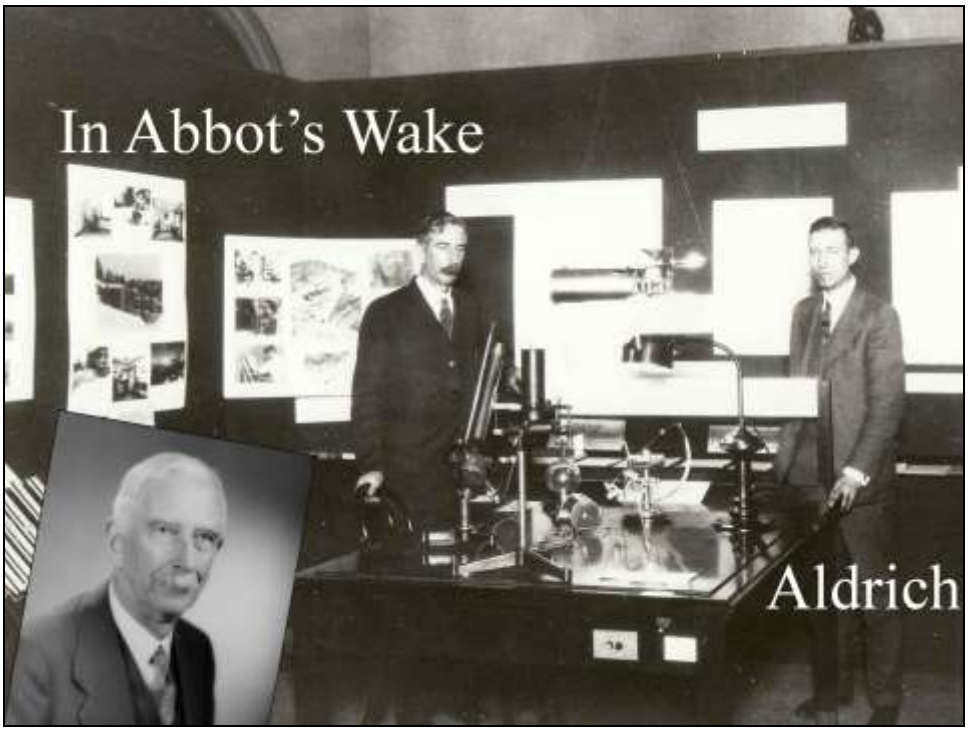
-- Maintained Smithsonian's Astrophysical Observatory and its programs established by S. P. Langley.

-- Refined methods for measuring solar constant and established the range of the modern value.

- o improved measurement devices. [precision of T readout and thermal isolation.]
- o created and extended field stations.
- o experimented with upper air measurements.

-- Argued for the variability of the solar constant and its influence upon weather.

-- Pioneered solar energy utilization studies and studies of solar radiation and its effect on biological organisms.



Aldrich filled Abbot's shoes in every practical way. But politically, there were two strikes against him:

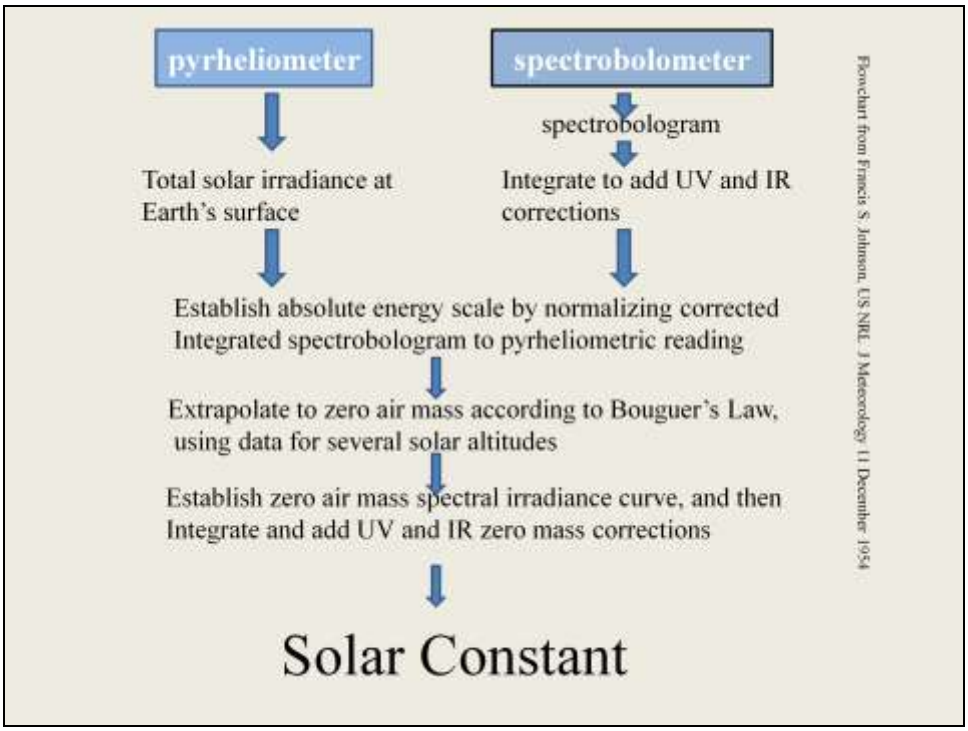
-- He lacked Abbot's engaging charisma and skill moving through scientific Washington

-- Aldrich had a new Secretary and a new administration to report to – Abbot had only himself, effectively.

Aldrich was also near retirement himself – he would be 65 in 1950.....

Throughout the latter part of the 1940s and into the 1950s, Aldrich repeated most of the same claims that had been crafted by Abbot for the continued support of the APO programs – but that's literally all he did – repeat the same arguments, time after time, with no new twists and turns that Abbot was always able to marshal...And Aldrich was true to his word – there were no promises about solar variations, and none about weather influence…

His mantra to Keddy and Graf was simple…..



Flowchart from Francis S. Johnson, US NRL J Meteorology 11 December 1954

-- In the early 1950s, Johnson, a member of one of the NRL's sounding rocket teams, carefully reviewed the Smithsonian data to determine if their irradience and spectroscopic studies of the sun from rockets might aid in refining the calibration and extrapolation of the Smithsonian data to the top of the atmosphere --- led to a small revision in the Smithsonian value, upward from 1.946 to 2.00 cal cm(-2) min(-1)

During his analysis, Johnson found that "the steps involved" [by the Smithsonian] in obtaining the data and applying the corrections are rather difficult to follow. He therefore unpacked and summarized the Smithsonian's methods, and explained why the pyrheliometer observations were needed to measure total radiation because, as Abbot always knew, the extreme temperature sensitivity of their spectrobolometers made them "subject to some drift between the recording of one spectrobologram and the next." (p. 431) … Johnson felt that inspits of this, and the fact that the Smithsonian was more interested in variations than the absoluyte value of the solar constant, still it was the largest and most consistent source of information on the absolute value.. And the one most frequently used and quoted…" He added that one of the problems in using the value has been confusion, over past years, "over the scale in which their data are presented, and frequently the data have been used incorrectly."

Aldrich's Mission

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Abbot was retired in July 1944 as SI Secretary and APO Director and given an "honorary appointment" – he was succeeded by Alexander Wetmore as Secretary, and by his long-time faithful assistant, Loyal B. Aldrich as APO director.

Aldrich's succession seemed to raise no issues. The world was at war, the APO had been contributing quietly to wartime studies of the effect of solar radiation on war materiel, like the flexibility of canvas. Aldrich had effectively been Abbot's apprentice – trained in Physics at Wisconsin to the MS level in 1909, he had worked for APO since 1908, first at Mount Wilson .... And was 60 years of age when he became director

Aldrich, however, had his own opinion of the APO mission…

"I have always felt that we should confine our efforts to improvement of the solar constant records, and leave to others the uncovering of possible correlations with weather. Mr. Abbot's papers on this subject in my judgment tend to emphasize the favorable factors and to neglect the unfavorable, rather than to weigh impartially all factors. As a result, one is left with a feeling of doubt."

"Mr. Abbot has come close to something big, but our solar constants are not quite accurate enough to reveal it clearly. I have the greatest hope that we **can** sufficiently improve our measurements so that in capable hands they will be of real value to weather studies."

Loyal B. Aldrich to W. S. Adams, circa January 30, 1946, Abbot Papers, SI

Aldrich had befriended many of Hale's staff during his years of service at Mount Wilson, and like Abbot, remained on intimate terms with them for decades. After he succeeded Abbot, he began to express some of his deeper concerns to W S Adams, who had been Hale's successor at Mont Wilson and was always a supportive patron of the APO mission....

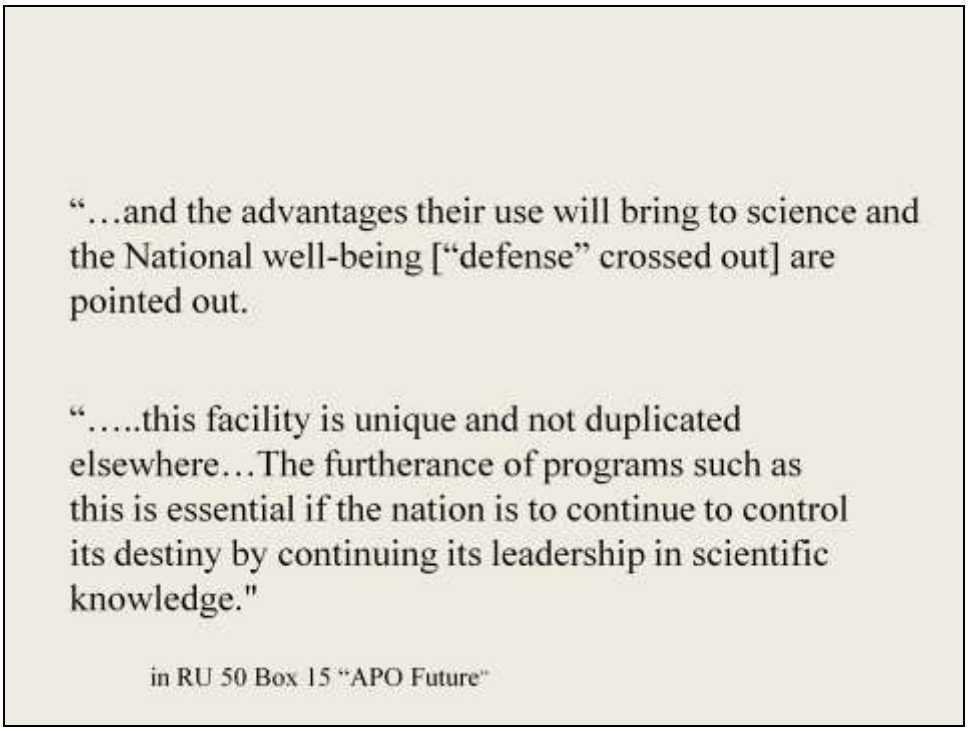
First quote – then

CLICK

Then cap…

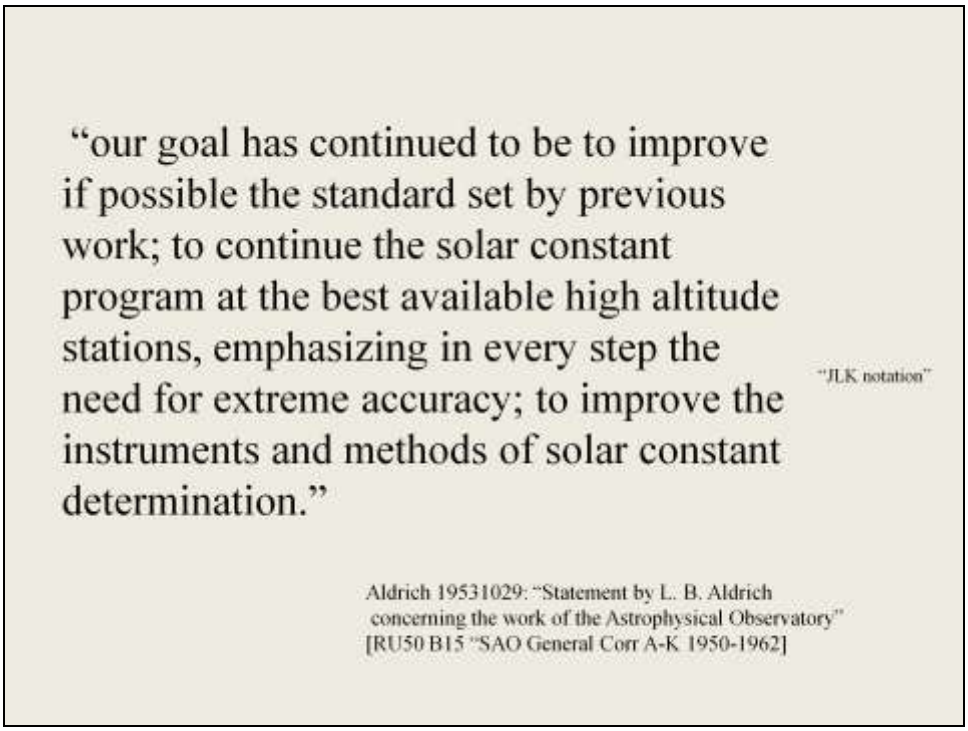
Aldrich's prudence appealed to Adams...and Adams was an advisor to Wetmore…he was a member of the Smithsonian's "future policies committee" and Aldrich's remarks may well have been transmitted – in fact he knew they would --- but neither Adams nor Aldrich could guess how this new prudent perspective might eventually be received by Wetmore or his staff.

-- In a postwar world that promised reformations of governmental science, storm clouds were building about accountability and productivity…



"The importance to the national scientific effort of continuing the Smithsonian solar radiation studies and the continuation in this respect made by the Astrophysical Observatory of the Smithsonian Institution, are here shown." -- the observatory needs "modern electronic measuring instruments" "and the advantages their use will bring to science and the National well-being [defense crossed out] are pointed out.

Finally: "this facility is unique and not duplicated elsewhere…The furtherance of programs such as this is essential if the nation is to continue to control its destiny by continuing its leadership in scientific knowledge."



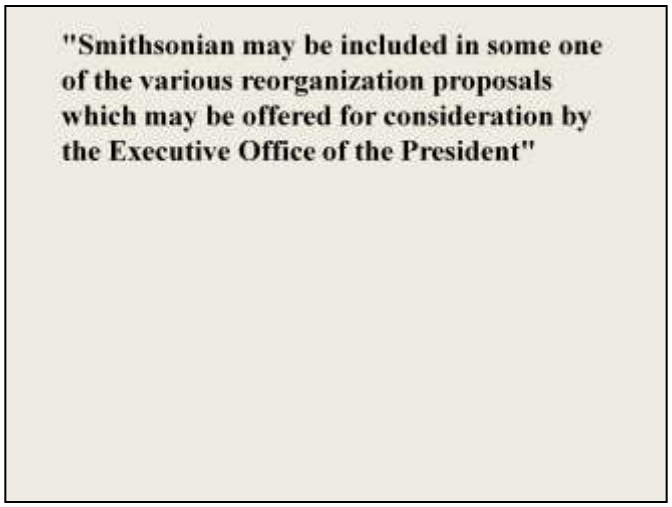
, "our goal has continued to be to improve if possible the standard set by previous work…" Aldrich told the Castle in 1953

APO would "continue the solar constant program at the best available high altitude stations, emphasizing in every step the need for extreme accuracy; to improve the instruments and methods of solar constant determination."

This argument, made in October 1953 as Aldrich neared retirement, was the same as those he issued at every juncture in the 9 years of his directorship....

This led the Smithsonian administration to lose all patience with Aldrich and confidence in the SAO as something that the Smithsonian could point to as a national asset . . . The Smithsonian then was facing a whole new world – the postwar reorganization of science in terms of cold war priorities, the acceleration of science and technology support from both military and civilian agencies, and the expectation that this science be responsive…

The question of the future autonomy of the Smithsonian as an independent bagency…..



Sometime in 1948, members of Wetmore's staff, mainly John Keddy, an assistant secretary, became alarmed that various Congressional and Executive Branch deliberators were considering some form of general government reorganization [CLICK]

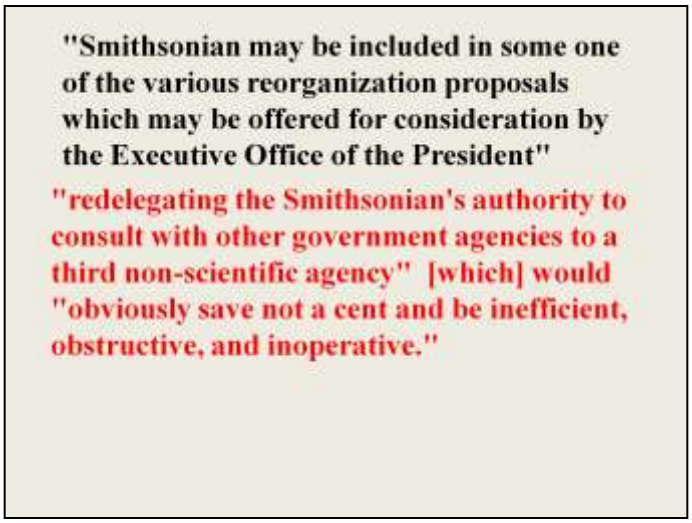
Through early 1949 Keddy had been reassured that the Smithsonian would not be part of this re-organization, but he remained keenly vigilant, and became especially nervous in May when a Senate Committee on "Expenditures in the Executive Department" convened and started asking queistions…

He drafted appeals for Wetmore on the dangers of these proposed legislative changes… [CLICK]

"redelegating the Smithsonian's authority to consult with other government agencies to a third non-scientific agency" [which] would "obviously save not a cent and be inefficient, obstructive, and inoperative." ***

Keddy made further inquiries toward the end of the year, as the newly created GSA began to shake things up in Washington, and was again reassured that SI was safe, even immune... Still, he strongly advised Wetmore to the need to prepare Senate and House Regents of the grave danger afoot+ [click]

"proposed subordination of the Smithsonian to the General Services Administration..."



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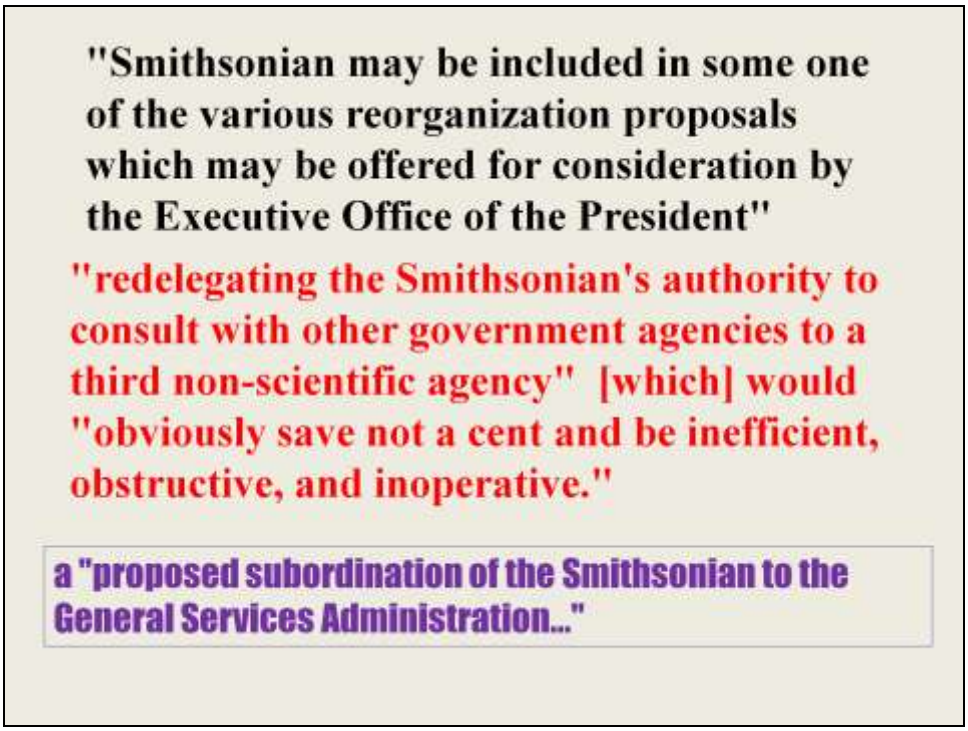

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"proposed subordination of the Smithsonian to the General Services Administration..."

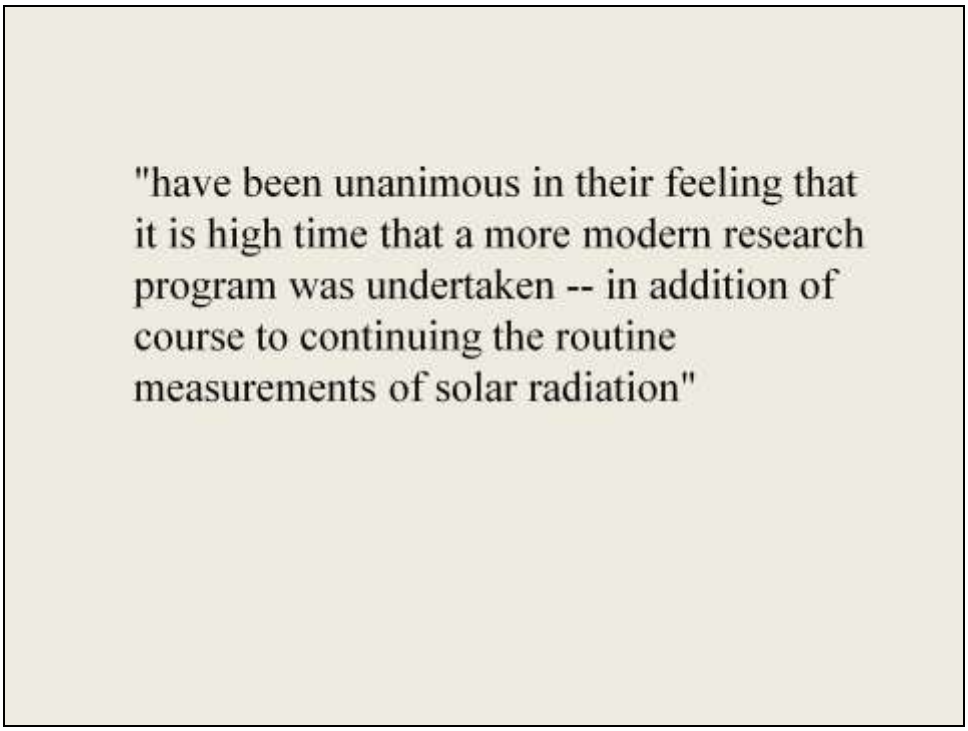
Leonard Carmichael, Secretary (1953-1964)

The seventh Secretary Leonard Carmichael (1898-1973) served from 1953 to 1964 – he was the first Secretary selected from outside the Institution, coming to SI from being president of Tufts College for some 14 years. He was trained as a physiological psychologist.

Carmichael was, unlike his predecessor Secretaries, closely associated with academia and shared many important associations, most significantly

+Click

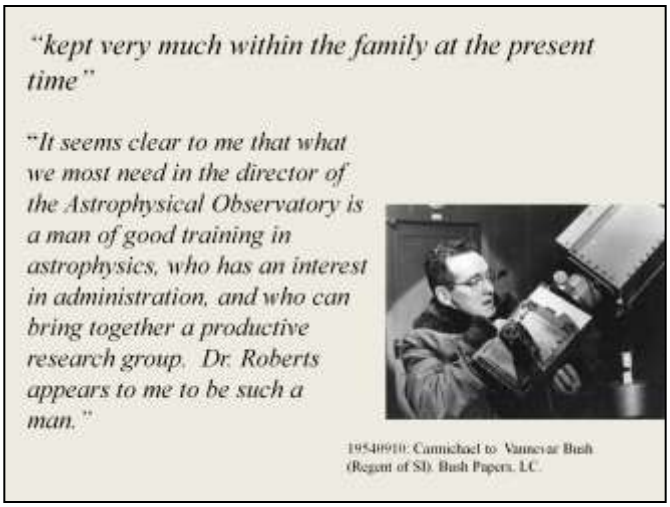
With Vannevar Bush who was then a Regent.



Well before the committee issued its report, Carmichael took the first steps to finding a successor to Aldrich. In October 1953, Carmichael contacted an old Tufts colleague, Stanley Ballard, chair of the department of Physics and a RAND consultant, asking for his advice about the APO. Ballard responded firmly that the 4 or 5 physicists and astronomers he consulted "have been unanimous….

+click

At this point, Carmichael began his search, trying to lure a solid solar astrophysicist to Washington. The historian Ron Doel has done an admirable job tracing the steps through which Carmichael eventually was frustrated in his mission and decided to accept a proposal from Harvard to close the APO on the Mall and move it to Cambridge – Doel has shown that the route was by no means linear, and was fraught with conflict and intrigue. For well over a year, Carmichael's choice was not Harvard, but Colorado, where a former solar observing station created by Donald Menzel from Harvard was rapidly growing into a strong solar observatory linked to the University in Boulder. The leading candidate was Menzel's protégé, Walter Orr Roberts….



As of September 1954, Roberts was Carmichael's choice, as he reported to Vannevar Bush:

+Click 1

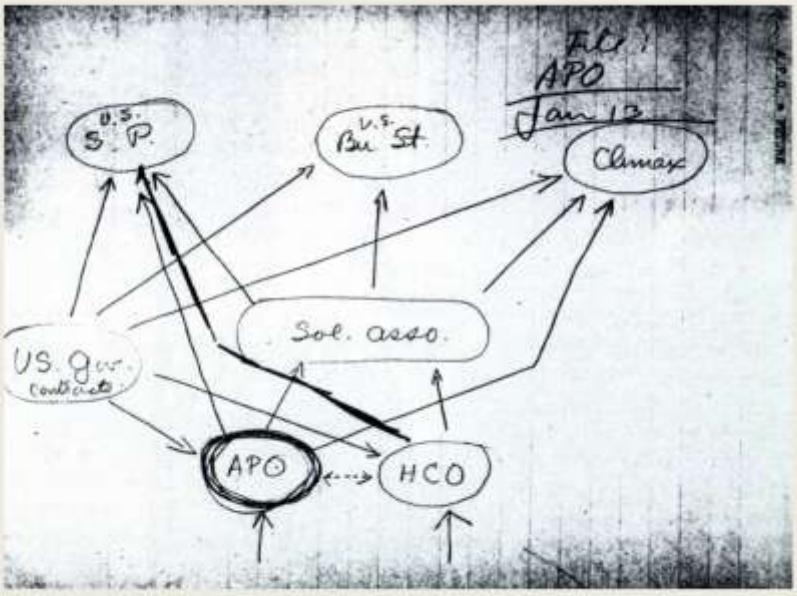
He felt that the solar work should be *"kept very much within the family at the present time".* - hoping to find a man who will come to Washington…..

And he concludes

+_CLICK 2

"*It seems clear to me that what we most need in the director of the Astrophysical Observatory is a man of good training in astrophysics, who has an interest in administration, and who can bring together a productive research group. Dr. Roberts appears to me to be such a man."*

[RU 50 Office of the Secretary 1949-1964. Box 15 Folder "A.P.O. Future" 19540910: -91054 Letter to Dr. Vannevar Bush (Regent of SI) from LC.]



From Doel "SAO on the Move"

In December 1954, Thomas had developed a new consortium concept that he called the "Solar Associates" that would include Harvard, the APO, the Bureau of Standards, HAO, all fuelled by the "U S Government" By early January 1955, Thomas had briefed Fred Whipple on the scheme, and in deliberations between Carmichael, Menzel and Whipple that month in Washington, the organization of a new hybrid entity centering on solar research remained uppermost on paper. It was not uppermost in Whipple's mind, however, as we shall soon see.

There is much still to learn about this critical transition period – about the rejection of Roberts, and then of his growing Colorado empire, which Carmichael was initially highly attracted to, but we must move on now, situate the new SAO at Harvard, and ask – how did it get so big, so quickly?

The answer is Fred Whipple…..

"what I had in mind, or why I took the job of the directorship was that so that I could then operate this photographic satellite observing program under the aegis of the Smithsonian, rather than Harvard."

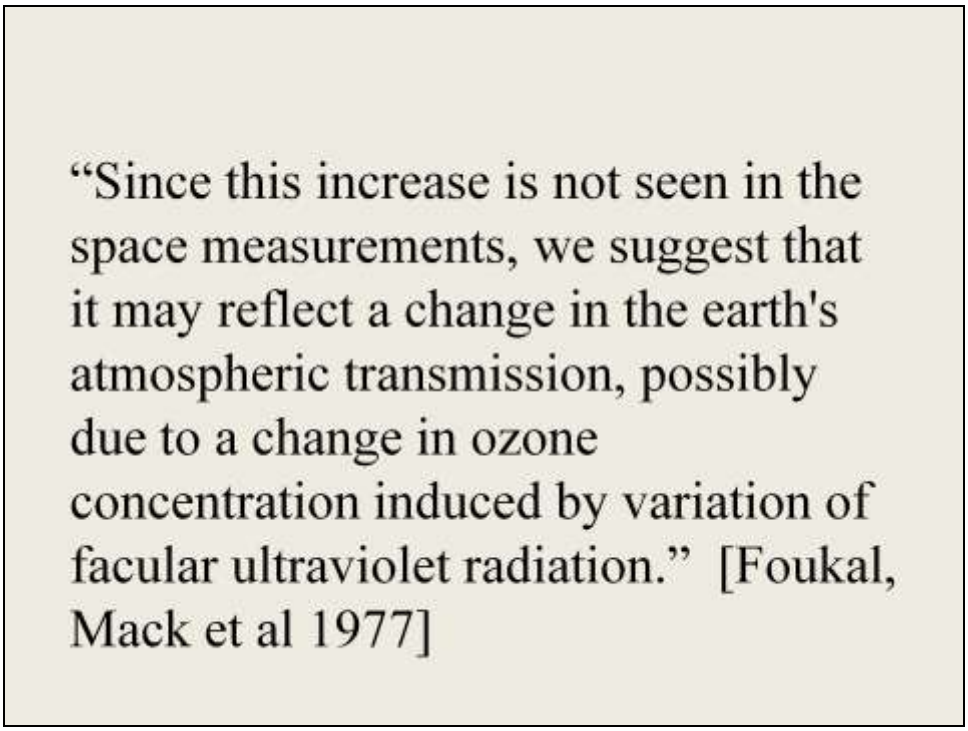
Whipple OHI 4/29/77 p. 82 AIP

As Whipple recollected in an oral history in April 1977, "**what I had in mind, or why I took the job of the directorship was that so that I could then operate this photographic satellite observing program under the aegis of the Smithsonian, rather than Harvard."**

But he had other plans too – however, he also knew that Smithsonian expected that he pick up the solar constant work …

"It is concluded that the simultaneous Smithsonian measurements of the solar constant … indicate that if the solar constant really changed at all between 1926 and 1955, it changed by amounts having a smaller root-mean-square value than 0.17 per cent of the solar constant itself."

- Sterne and Dieter, AJ 62 (July 1957), 147



The data from radiometers on Mariners 6 and 7 rule out any relative change of the solar constant in space due directly to faculae or spots exceeding 0.03%. This limit is two orders of magnitude smaller than previous values obtained from ground measurements. The measurements made at mountain stations of the Smithsonian Astrophysical Observatory between 1923 and 1952 show a marginally significant increase of solar constant at the level of 0.1%, related specifically to high projected facular area. Since this increase is not seen in the space measurements, we suggest that it may reflect a change in the earth's atmospheric transmission, possibly due to a change in ozone concentration induced by variation of facular ultraviolet radiation. [Foukal, Mack et al 1977]

That's All Folks!