Polar Motion Studies and NOAA's Legacy of International Scientific Cooperation: Ukiah and Gaithersburg Latitude Observatories

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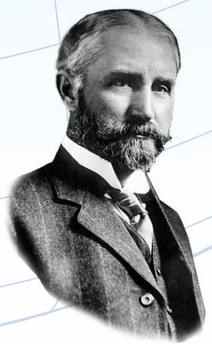
Transforming the Legacy of the U.S. Latitude Observatories for Future Generations
Ukiah & Gaithersburg



Great Reorganization of the Coast & Geodetic Survey: Military to Civilian

In 1897, astronomer and mathematician Henry Smith Pritchett succeeded retired Civil War General William Duffield as the ninth superintendent of the US Coast and Geodetic Survey. Pritchett is credited with the "Great Reorganization of the Coast & Geodetic Survey" out from under a heavily militarized mobilization during the Civil War toward a more civilian scientific organization, resulting in the "modern" 20th century Survey that eventually became a major component of NOAA. During Pritchett's administration, permanent astronomical observatories were established at Ukiah, California, and Gaithersburg, Maryland.

International Scientific Cooperation

In 1895, the International Geodetic Association invited the United States Coast and Geodetic Survey (USC&GS) to join in an unprecedented international effort to observe and measure Earth's polar motion. This effort was in response to the American astronomer Seth C. Chandler Jr. announcing his 1891 discovery that Earth's axis of rotation—and hence the direction of true north—wobbles with a period of about 14 months, varying latitude everywhere on the globe. In 1899, two astro-geodetic observatories were built in Gaithersburg, Maryland, and Ukiah, California, with three others in Carloforte, Italy; Kitab, Russia (now Uzbekistan); and Mizusawa, Japan. (A sixth station was located and operated until 1916 at an astronomical observatory in Cincinnati, Ohio, using instruments loaned by USC&GS.) All observatories were located along the same parallel – approximately 39 degrees – 8 minutes.

Measuring the Wobble

Latitude Observatories around the world used the same observational technique– the Horrebow-Talcott method: measuring and observing the differences in the angles at which pairs of stars crossed the line of longitude (meridian) at nearly equal distances north and south of a point directly overhead (the zenith). The same star pairs were observed at all of the latitude observatories; any degree of variation between observatories reflected a shift of Earth's axis of rotation. Weather permitting, readings from eighteen pairs of stars were recorded every night at every station.

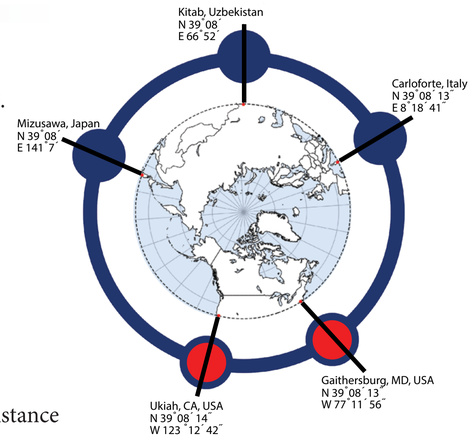
By this method the latitude is determined by observing with a micrometer eyepiece the difference between the nearly equal zenith distances of two stars which pass the meridian within a few minutes of each other, one north and the other south of the zenith. The zenith telescope is set to the proper zenith distance for the first star with the bubbles of the delicate level, which is attached to the telescope, adjusted and read. After the star has been observed, the telescope is reversed on its vertical axis without altering the position of the level. The telescope can now be adjusted to point to the same zenith distance as used for the first star. Since the stations have nearly the same latitude, the same stars can be used at each, thus assuring homogeneous results.

Horrebow-Talcott Equation

From Popular Science Monthly, Vol LXXV, No. 5, Nov 1909.

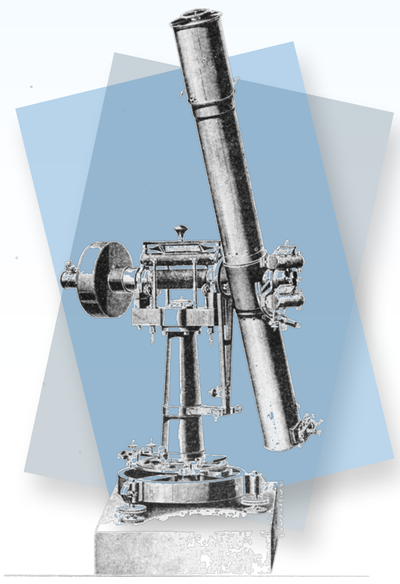
$$\Phi = \tfrac{1}{2}(\delta n + \delta s) + \tfrac{1}{2}(mn - ms)*R + \tfrac{1}{2}(ln + ls) + \tfrac{1}{2}(rn - rs)$$

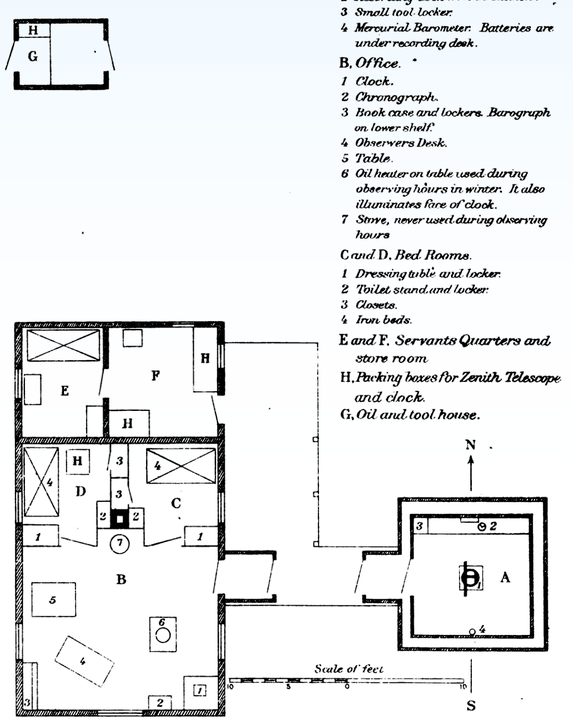
where:
subscript s means to the south, and n to the north
Φ = latitude
δ = measured star declination from vertical circle
m = micrometer measurement
R = micrometer to angle conversion factor
l = reading of vertical circle levels
r = refraction correction as a function of telescope zenith distance

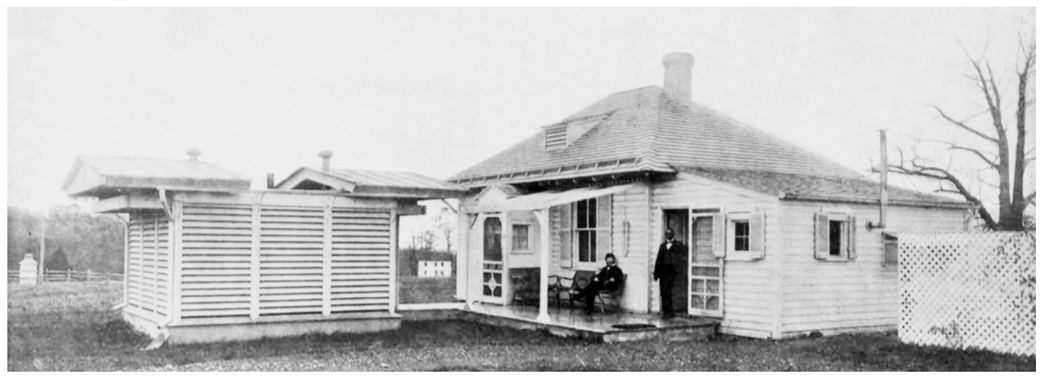


If the two stars are at exactly the same declination δ and the instrument is reversed without disturbing the pointing, then the m, l and r terms become zero and the latitude becomes δ star zenith angle.

The declination of a star is measured the same way as latitude. So an observer on the equator looking at a star with zero degrees declination would look straight up, zenith angle of zero. For an observer at 39 degrees North, a star with a declination of 39 N would be straight up.







The zenith telescopes made by Julius Wanschaff in Berlin (circa 1895) exclusively for the International Latitude Observatories. (top left) The floor plans and photo of the Gaithersburg observatory and residence circa 1900. (top right and bottom photo)

NOAA's Polar Motion Legacy: Science to Parks

The observatories were decommissioned in 1982, and NOAA subsequently deeded the two remaining U.S. observatories to the cities of Gaithersburg and Ukiah. The observatories and adjacent property were to be used as parkland. Both cities have restored the observatories and opened public parks. In 1989, the Gaithersburg Latitude Observatory was designated as a National Historic Landmark. In 2014–15, the National Geodetic Survey (NGS, the present-day NOAA successor to the USC&GS) loaned the original zenith telescopes to the communities, returning the observatories to their original configuration. The contribution of NOAA observers and the data collected is still important to astronomers and geophysicists and has practical applications in spacecraft navigation and geospatial positioning.

Restored and Celebrated

Through programs and historic exhibits, the observatory parks increase exposure and awareness of NOAA's rich and formative heritage, as well as its enduring modern scientific research and services. Thus, NOAA's legacy and assets of the International Latitude Observatories will be protected and preserved for generations to come through activities for education, outreach, and tourism.

References

Brooke Clarke website: http://prc68.com/I/UkiahObs.shtml

Schlesinger, Frank, 1900. "The International Latitude Service at Gaithersburg, MD, and Ukiah, Cal., under the auspices of the International Geodetic Association". Appendix No. 5, Report of the Superintendent of the US Coast and Geodetic Survey for the year 1901

Science on the Edge, Chapter One: Henry S. Pritchett and the Great Reorganization of the Coast & Geodetic Survey. John Cloud, NOAA Central Library
ftp://ftp.library.noaa.gov/docs.lib/htdocs/rescue/coastandgeodeticsurvey/Pritchettchapter.pdf

Popular Science Monthly, Vol LXXV, No. 5, Nov 1909
https://en.wikisource.org/wiki/Popular_Science_Monthly/Volume_75/November_1909/The_Shifting_of_the_Earth%27s_Axis

A park interpreter uses the shadow cast by Peace Pole monument at Observatory Park in Ukiah to demonstrate the rotation of the earth for a group of students.

Students from Mendocino College the Ukiah Observatory review captured images from Cameras for Allsky Meteor Surveillance (CAMS). A NASA/SETI Institute project for mapping meteor trajectories.

Friends of the Observatory historian, Judy Pruden, leads a group tour of the observatory and grounds.

Find Out More

City of Ukiah
http://www.cityofukiah.com/
http://www.cityofukiah.com/observatory-park/

City of Gaithersburg
http://www.gaithersburgmd.gov/
http://www.gaithersburgmd.gov/about-gaithersburg/city-facilities/international-latitude-observatory

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