
Case Study 16.4: Mauna Kea Observatory, Hawaii, USA

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Presentation and analysis of the site

Geographical position: Summit of Mauna Kea on the Island of Hawaii, Hawaiian Islands, USA. It is located about 300 km from Honolulu, which lies on the island of Oahu.

Location: Latitude 19° 49' N, longitude 155° 28' W. Elevation 4100m above mean sea level.

General description: Mauna Kea ('White Mountain') is a dormant volcano on the island of Hawaii, the largest and southernmost of the Hawaiian Islands. The highest point in the Pacific Basin, and the highest island-mountain in the world, Mauna Kea rises 9750 m from the ocean floor to an altitude of 4205 m above sea level, which places its summit above 40 percent of the Earth's atmosphere. The broad volcanic landscape of the summit area is made up of cinder cones on a lava plateau.

Mauna Kea is unique as an astronomical observing site. The atmosphere above the mountain is extremely dry—which is important in measuring infrared and sub-millimetre radiation from celestial sources—and cloud-free, so that the proportion of clear nights is among the highest in the world. The smooth shape of the isolated mountain, along with its high altitude, produces astronomical image quality that is among the best of any location on Earth. The atmospheric pressure at the summit is approximately 600 mb.

Inventory: Telescopes: Keck I and II, Subaru, Gemini North, IRTF, UKIRT, CFHT, JCMT, CSO, SMA, UH 2.2m and 0.9m, VLBA.

History of the site: The first large telescope on Mauna Kea, the 2.2m, demonstrated the remarkably stable and dry atmosphere above the observatory, and led to the development of a series of larger telescopes, many of which are owned and operated by international countries or partnerships. Mauna Kea was recently selected as the site for the Thirty Meter Telescope.

Cultural and symbolic dimension: The Mauna Kea Observatory forms part of a single set of sites in the world with exceptional conditions for observing the Universe. These sites, including their natural and cultural components, are exceptional 'windows of science and knowledge'.

Present site management

Present use: The observatory is the site of the telescopes listed above.

The Mauna Kea Visitor Center is open 365 days per year, and offers summit tours on weekends and evening stargazing. The annual visitor count exceeds 250,000. Astronomers and staff from the Mauna Kea Observatories are also engaged in extensive outreach activities across the island of Hawaii, and elsewhere in the Hawaiian Islands.

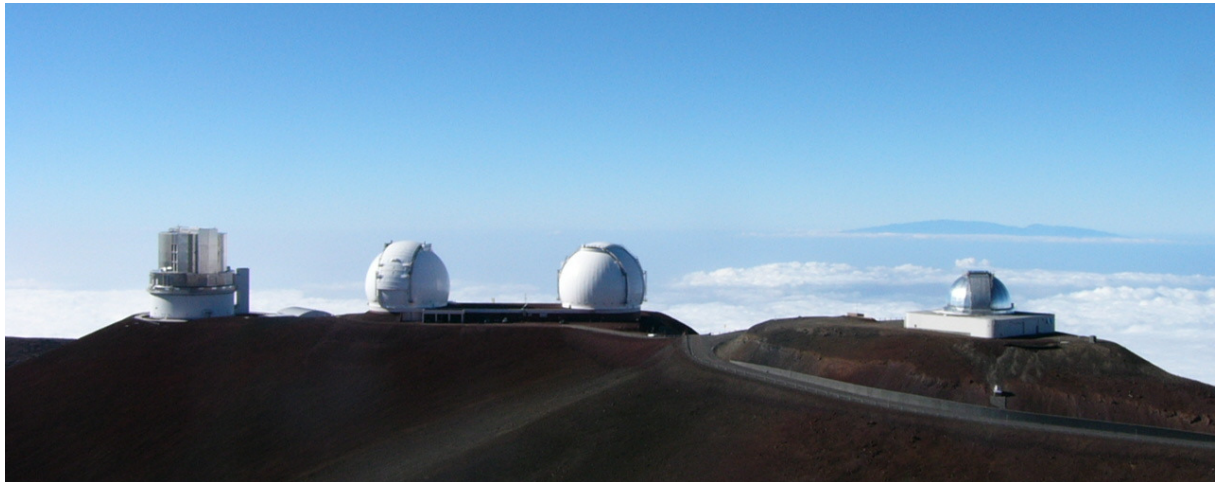


Fig. 16.4.1. View of Mauna Kea observatory showing the Subaru, Keck I and II, and IRTF telescopes. Photograph © Sasquatch at Wikimedia Commons, Creative Commons Licence.

Protection: The zone around the observatory is called the “Mauna Kea Science Reserve” and has strict controls on usage. A subset of this reserve is designated for astronomical usage. A pie-shaped sector of the zone around the observatory is preserved as the “Mauna Kea Ice Age Reserve”. A lighting ordinance for the island of Hawaii has been established to limit artificial light and its damaging effects on the observatories.

A large area around the science reserve is preservation land owned by the state of Hawaii. Few people live within 25 km of the summit.

State of conservation: The observatory has been in operation for 40 years. The buildings and telescopes are well maintained, consistent with the operation of a major research facility.

The lighting ordinance has been in place for 20 years, and has provided good protection for the night sky. However, there are many lights on the island that do not conform to the ordinance, either because they were installed prior to it, or have been installed in violation. Better enforcement is expected in the future. The present level of light pollution does not compromise research.

An ongoing eruption of nearby Kilauea volcano is producing copious amount of volcanic gases and haze. These gases are nearly always trapped at lower altitudes by a temperature inversion, and do not affect the astronomy.

Context and environment: The summit region is sacred to the native Hawaiians. The summit area is a spectacular natural landscape composed of multiple cinder cones, a high altitude lake, and glacial moraine field.

Archaeological/historical/heritage research: An ancient adze quarry is located to the south of a summit, with very hard rocks formed during the last ice age from lava being cooled by a glacier; the hard rocks were used as tools by pre-European-contact Hawaiians. Numerous archaeological monuments are located around the summit region.

Main threats or potential threats to the site: The main threat is light pollution from the nearby urban areas. Population growth is occurring mostly on the western (dry/clear) side of the island, leading to increasing artificial light.

Management: The Mauna Kea Science Reserve and Ice Age Reserve are owned by the State of Hawaii. A large area around these reserves is also owned by the State of Hawaii.

The summit area is managed by the Office of Mauna Kea Management of the University of Hawaii. Rangers patrol the summit area for conservation purposes and to assist visitors with problems. The larger conservation area surrounding the summit is managed by the Department of Land and Natural Resources of the State of Hawaii.

Each of the telescopes has a sublease from the University of Hawaii. The University of Hawaii has leased the Mauna Kea Science Reserve from the State of Hawaii. The lease expires in 2031.

Case Study 16.5: Canarian Observatories, Spain

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Presentation and analysis of the site

Geographical position: ORM: on the edge of the Caldera de Taburiente National Park, island of La Palma, Canary Islands, Spain. OT: close to the Teide National Park, island of Tenerife, Canary Islands, Spain.

Location: ORM: Latitude 28° 46′ N, longitude 17° 53′ W. Elevation 2396m above mean sea level. OT: Latitude 28° 18′ N, longitude 16° 30′ W. Elevation 2390m above mean sea level.

General description: The two observatories of the Instituto de Astrofísica de Canarias (IAC)—the Roque de los Muchachos Observatory (ORM) on the island of La Palma and the Teide Observatory (OT) on the island of Tenerife—constitute an ‘astronomy reserve’ that has been made available to the international community. The Canary Islands’ sky quality for astronomical observation has long been recognised worldwide. They are near to the equator yet out of the reach of tropical storms. The whole of the Northern Celestial Hemisphere and part of the Southern can be observed from them. The observatories are located 2400 m above sea level, above the temperature-inversion layer produced by the trade winds. This ensures that the installations are always above the so-called ‘sea of clouds’, where the atmosphere, stabilised by the ocean, is clean and turbulence-free.

Inventory: The two observatories currently house telescopes and other instruments belonging to 60 scientific institutions from 19 different countries, together with the scientific and technological resources of the IAC’s Instituto de Astrofísica at La Laguna (Tenerife) and Centro de Astrofísica en La Palma (CALP) at Breña Baja (La Palma). The main telescopes are:

ORM: 10.4m Gran Telescopio CANARIAS (GTC), 4.2m William Herschel Telescope (WHT), 3.5m Telescopio Nazionale GALILEO, 2.56m Nordic Optical Telescope (NOT), 2.5m Isaac Newton Telescope (INT), 2m Liverpool Telescope, 1.2m MERCATOR, 0.45m Dutch Open Telescope (DOT), 1m Solar Telescope (SST), MAGIC I and II (which detect very-high-energy gamma rays), SuperWASP-North (robotic observatory).

OT: 1.55m CARLOS SÁNCHEZ, 1m OGS, 0.8m IAC-80, 0.5m MONS, 0.4m OTA, 1.5 GREGOR (Solar), 0.9m THEMIS (Solar), 0.7m VTT (Solar), 0.3m Bradford Robotic Telescope, 1.2m Robotic telescopes STELLA.

History of the site: As far back as 1856, the Astronomer Royal for Scotland, Charles Piazzi Smyth, conducted astronomical experiments on the mountain summits of the island of Tenerife.