Overview

Astronomical observatories are located worldwide, and their locations depend on many factors. I decided to examine six factors controlling the placement of major astronomical research observatories:

- Cloud cover
- Atmospheric water vapor
- Light pollution
- Latitude
- Elevation
- Annual precipitation

Data was collected from various sources, including manually cataloging 94 observatories. For practicality, I only selected observatories that fit the following criteria, based on diameter of the optical element of their largest telescope:

- Currently active in astronomical research
- Optical (visible light) observatories: telescope diameter ≥ 1.25 m
- Submillimeter and radio observatories: diameter ≥ 25 m
- Millimeter and radio observatories: diameter ≥ 10 m
- Millimeter sub-millimeter telescopes favor high and dry conditions

Other data layers such as water vapor and cloud cover were created by averaging 12 monthly images, from October 2014 to September 2015. Finally, I constructed a map showing the best (and worst) locations to place an observatory, using the above factors.

Conclusions

- Although observatories are spread worldwide, they show a strong preference for high altitude and dry locations. Places with important observatories already include the American Southwest, northern Chile, Mauna Kea, and the Canary Islands.
- The map to the left identifies some other regions that may be suitable for observatories, such as the Tibetan Plateau, southern Africa, Iran, the East African Rift mountains, Mexico, and other portions of the Atacama Desert.
- The Tibetan Plateau appears to be one of the best places on the planet, but there are very few observatories located there. Logistics in such a sparsely populated and high altitude region pose a problem, along with other unaccounted-for factors such as seismic activity, political considerations, and available infrastructure.

Light Pollution and Land Elevation

Light pollution is a major problem for optical observatories that has reached a critical point in recent years. This map’s nighttime light measurements are from the USGS/NOAA DMSP satellite program, calibrated for radiance. Transient sources such as wildfires or natural gas flares are removed, but persistent stable sources are left in.

Suitability Map Process

This map is actually one of two. It is the suitability map for optical observatories, and the other is for radio observatories. There is not much visible difference between them, so I chose to only display the optical map.

Each factor considered was rated and relaidscassed on a scale from 1 to 10, with 1 being the best and 10 being the worst. The factors were multiplied with a weighting factor, then added together to produce a final map.

Suitability Map

This map identifies the best locations for observatories. Factors taken into account were elevation, light pollution, atmospheric water vapor content, rainfall, cloud cover, and latitude. Lower numbers are better. One can immediately identify two regions that would be excellent: the Atacama Desert in Chile, and the Tibetan Plateau in Asia. The map is not high enough resolution to discern point locations such as Mauna Kea or the Canary Islands, but gives a general idea of highly desirable regions.

Data Sources

- https://www.cosmos.esa.int/web/esa-vlbi/esa-vlbi
- http://www.earth.nullschool.net
- http://www.giss.nasa.gov/data/trends/noaa.png
- http://www.remotesensing.com
- https://www.arij.net/gis/data/geo.png
- http://www.ngdc.noaa.gov/mgg/obsrvstn/observ.html
- http://www.ngdc.noaa.gov/mgg/obsrvstn/observ.html
- http://www.ngdc.noaa.gov/mgg/obsrvstn/observ.html
- https://www.esa.int/Science_Education/ESA_Science hton
- http://www.sciencedirect.com
- http://www.esrin.esa.int
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