COMMISSION 50 : PROTECTION OF EXISTING AND POTENTIAL OBSERVATORY SITES (PROTECTION DES SITES D'OBSERVATOIRES EXISTANTS ET POTENTIELS)

Report of Meetings, 20 and 21 November 1985

PRESIDENT: A. Hoag

20 November 1985

SCIENTIFIC SESSION I

This meeting, organized and chaired by Vernon Pankonin, National Science Foundation, U.S.A., was begun at 11:00 a.m., and approximately 40 persons attended. Presentations were made as follows:

V. Pankonin, National Science Foundation, U.S.A., started the session with an **Introduction and Overview of Radio Spectrum Management.** There is a wide base of interest in radio frequency interference (RFI) at both the local and the international levels. The noise environment in the higher telecommunication frequencies has been augmented by satellites and at lower frequencies by increased traffic. In spite of care in frequency allocation, technical imperfections such as side band spillover contribute to RFI. International organizations concerned with radio frequency allocations and control include ITU, the International Telecommunications Union; WARC, the World Administrative Radio Conference; CCIR, the International Radio Consultative Committee; and the IFRB, the International Frequency Registration Board. International policies, regulations, and allocations are made in the following way: Scientific requirements are formulated and communicated through the IAU, URSI (Union Radio Scientifique Internationale), or COSPAR (Committee on Space Research) to the Inter-Union Commission on Frequency Allocation for Radio Astronomy and Space Science, IUCAF, whose recommendations then go to the WARC and CCIR and thence to the ITU for regulatory administration. Major international RFI problems remain. Among them are geostationary and navigational satellite transmissions.

G. Swarup, Tata Institute of Fundamental Research, Bangalore, spoke about **Radio Noise Surveys for India's Giant Meter-Wavelength Radio Telescope.** He described plans for a 14-km sized Y-array radio telescope designed to work in the 21-cm to meter wavelength region. Swarup, who represents the IAU in the work of the Inter-Union Commission on Frequency Allocations for Radio Astronomy and Space Science, has discussed these plans at World Administrative Radio Conferences. Sites in India have the advantage of being near the Earth's magnetic equator, but a place must be found having sufficiently low levels of interference from radio, power-line, and vehicle ignition emissions. RFI measures made over extensive ranges of time for a few sites were presented as power versus frequency plots. Additional site factors and future prospects were discussed.

V. Pankonin, NSF, U.S.A., gave a brief description of the administration of **Protection of Radio Astronomy in the U.S.A.** All U.S. governmental radio transmission is coordinated by the National Telecommunications and Information Administration (NTIA). Non-governmental radio transmission is regulated by the Federal Communication Commission (FCC), and overall coordination is achieved by means of an Interdepartmental Radio Advisory Committee. Specific site protection has been provided at Greenbank by the estabishment of a National Radio Quiet Zone and at the VLA by designation of a Coordination Zone where emission in certain

https://doi.org/10.1017/S0251107X00026432 Published online by Cambridge University Press

frequency bands is limited in a specific geographical area. Protection for components of the Very Long Baseline Array, now being developed in the United States, will be provided by individual Coordination Zones.

A paper by J. Carneiro and A. Magalhães, Universidade do Porto, Portugal, **Radio Frequency Interference to an Optical Telescope**, was read by J. Osório. The 76-cm telescope of the Astronomical Observatory of the University of Porto has been subject to radio interference problems caused by three transmitters 100 meters distant, each having 10 kw input power. Two RFI problems have been encountered. Until four years ago, when use of an AM transmitter terminated, serious problems were encountered with the servo tracking and pointing system that included frequent destruction of integrated circuit components. Sometimes the broadcast could actually be heard from the servo tracking motor. No fully effective shielding and grounding methods could be found. The two remaining FM transmitters have caused severe interference problems when photon-counting photometric equipment has been used. In this case, empirical changes in shielding, filtering, and grounding have made photometric measures possible.

Weather RADAR - A Possible Threat was the subject of a report by A. Hoag, Lowell Observatory, U.S.A. The U.S. National Weather Service is planning a countrywide system of doppler RADARs for detecting and mapping storms and for weather surveillance at airports. Each of approximately 150 units in the system is to consist of an 8.5-meter parabolic antenna that will transmit a one-degree beam that scans in azimuth at elevations from -1° to 20°. The properties of emission are to be as follows: Frequency = 2700-3000 MHz; Peak Power = 750 kw, Duty Cycle = 0.002; Average Power = 1.5 kw; Bandwidth = 8 MH ; Pulse Width = 1.5-4 μs; Pulse Repetition = 25-1250 sec^{-1}; Rise-Fall times = 0.4/0.4 μs. An experiment has been carried out by the Weather Service and a consortium of Arizona observatories to determine the susceptibility of astronomical equipment to this radiation. Preliminary results indicate that optical through near-infrared detectors, when shielded and grounded according to current practices, show little susceptibility to RADAR output at anticipated power levels but that some submillimeter to radio detection systems may be subject to hazard.

21 November 1985

SCIENTIFIC SESSION II

This was the first of two meetings on the subject of identification and protection of observatory sites chaired by Sidney van den Bergh, Dominion Astrophysical Observatory, Canada. The meeting took place between 9:00 and 10:30, and 26 persons attended.

Results of an **Optical Site Evaluation in Saudi Arabia** were discussed by E. Brosterhus, Dominion Astrophysical Observatory, Canada. He described a May 1982 to October 1985 survey in the Kingdom of Saudi Arabia that was a cooperative venture between the Saudi Arabian National Center for Science and Technology and the National Research Council of Canada. Of the four sites surveyed, three were used to explore the Asir range that borders the Red Sea. Two of these were used to evaluate the highest available sites, which are near the coast, while site number 3 was 35 km inland. The fourth site was on a relatively low escarpment in the central part of the country. Computer-based telescopes were used to collect image-quality and photometric-quality data of unprecedented precision and completeness. These data and meteorological observations indicate that all four sites are of high quality but that the inland site in the Asir range offers more clear hours than the sites near the coast as well as excellent seeing. It appears that there may be many sites having the characteristics of site 3. A supplemental aereal survey has been made to identify additional possibilities that could be considered for final selection and testing.

J. Davis, University of Sydney, Australia, described **An Interferometric Seeing Monitor - Measuring r_0 Directly.** The Chatterton Astronomy Department of the University of Sydney is developing a new high angular resolution stellar interferometer. As part of this program, J. O'Byrne has built an instrument to measure the atmospheric coherence diameter, r_0. A folded-shearing interferometer is used to image a 35-cm telescope aperture, via a three-stage image intensifier, onto a cooled 50×50 Reticon array detector. The aperture image contains interference fringes whose time-averaged profiles correspond to the atmospheres' long exposure MTF. At the end of each several-second exposure, the Reticon output is digitized and analyzed to yield a value of r_0. The instrument has a limiting sensitivity of B = 2, and it measures r_0 to ±5%. An observational program is under way to correlate r_0 values with meteorological parameters and with observational data from the 11.4-meter baseline prototype stellar interferometer. The instrument will also be used to compare astronomical sites and, in particular, to evaluate the proposed site for a new 640-meter baseline stellar interferometer.

BUSINESS SESSION I

H. Ables announced that an international conference on **Identification, Optimization, and Protection of Optical Telescope Sites** will be held in Flagstaff, Arizona, during 22-23 May 1986, under the joint sponsorship of the Lowell and U.S. Naval Observatories. R. L. Millis, Lowell Observatory, is the chairman of the organizing committee.

A. Hoag distributed a summary of past IAU Resolutions having to do with protection of observatory sites and of experimental techniques as a basis for consideration of further resolutions concerning contamination of space and of the electromagnetic spectrum.

SCIENTIFIC SESSION III

The second meeting on the subject of identification and protection of observatory sites chaired by S. van den Bergh; 11:00-12:30, with 36 in attendance.

La Palma as an Observing Site and the Protection of Its Future, a report by P. Murdin, Royal Greenwich Observatory, United Kingdom, and F. Sanchez, Instituto de Astrofisica de Canarias (IAC), Tenerife, was presented by Murdin. An extensive review of the quality of the Tenerife and La Palma sites and the astronomical facilities there is the subject of a special issue of **Vistas in Astronomy** (Vol. 28, Pt. 3, 1985). Murdin emphasized the role of the Carlsberg Automatic Meridian Circle at La Palma in providing systematic records of image quality and atmospheric extinction at this major observing site. The La Palma site (2400 meter altitude) has proven to be of such good quality that a major effort has been made to protect its future. As part of the Royal Inauguration of the IAC Observatories in 1985, the Autonomous Government of the Canaries passed a law designed to protect the observatories on La Palma. Outdoor lights emitting 20,000 lumens or more are required to be monochromatic (low-pressure) sodium and beamed downward. Radio transmitters emitting more than 250 watts will be approved by the IAC only if the power at the observatories is less than the Commission 50-recommended upper limit. Any industrial activity above 1500 meters in elevation (the height of the inversion layer) is subject to approval by the IAC. These regulations are retroactive and are expected to be ratified and financed by the national government of Spain in 1986.

In a report of **Site Testing for an Infrared Telescope Near Leh, Ladhak,** A. Bhatnagar of the Udaipur Solar Observatory, India, described an interinstitutional search for a site for infrared and solar coronographic observations in the Ladhak region of the Himalayas. The Ladhak plateau is a high and dry desert region with an annual rainfall of only 120 mm and is relatively free of clouds during the

https://doi.org/10.1017/S0251107X00026432 Published online by Cambridge University Press

monsoon months when the rest of India is cloudy. Preliminary data from the base (3700 meters) and summit (4100 meters) of Mount Nimmu, near Leh, show promising results as far as precipitable water vapor, sky brightness, wind, microthermals, and cloud cover are concerned. Regular observations of nighttime "seeing," microthermal fluctuations, extinction, and sky brightness are being supplemented by hourly data from an automatic meteorological station. Leh, a town of 5000 persons, and having minimal outdoor lighting, is accessible all year by air and by highway.

A. Ardeberg, Lund Observatory, Sweden, and the European Southern Observatory, summarized an **ESO Site Survey in Northern Chile.** In connection with plans for a Very Large Telescope, sites in the high (2300-6100 meters), dry area of Chile north of -25° latitude are being compared to La Silla, which is well known for good observing conditions. A reference site at Paranal, a 2700-meter coastal mountain, has been occupied since September 1983. Cloud cover, precipitable water vapor, wind, and thermal properties have been monitored continuously. Approximately 80% of the nights at Paranal are photometric, compared to about 60% for La Silla; and it is drier, precipitable water being frequently less than 1 mm. A dozen sites have been selected for further investigation, and several of them are being studied regularly. For the higher inland sites there is some increase in cloud cover and wind, but conditions can be even drier than at Paranal. Systematic image-quality measures will now be made at a number of sites. Test data so far obtained clearly indicate that northern Chile is an excellent place for optical, infrared, and submillimeter astronomy.

G. Teleki, Beograd, Yugoslavia, spoke about **Astrometric Site Selection,** stressing special needs for ground stability, a homogeneous temperature regime, and an even distribution of clear weather day and night for continuity in observations. Global evaluation shows that there are only a very few locations where these conditions may be met. Harlan Smith pointed out in discussion that modern space techniques are providing new information about ground stability.

SCIENTIFIC SESSION IV

The first of two meetings on the subject of atmospheric extinction and volcanism; 14:00-15:30, and 24 in attendance.

G. W. Lockwood, Lowell Observatory, U.S.A., started the first of two sessions on atmospheric extinction that he subsequently chaired by reporting **The Effects of Volcanic Eruption on Atmospheric Transparency.** He illustrated a variety of methods now used to estimate mass loading of the atmosphere by volcanic aerosols. Photometry of sunrise and sunset observed from orbiting SAM and SAGE satellites provides a sensitive means of detecting suspended material and stratospheric clouds. Alternative methods include LIDAR backscatter measures that have been routinely made from Hampton, Virginia, and from Mauna Loa, Hawaii, since 1976. In addition, sun photometers operating at Mauna Loa and at the Atmospheric Physics Department of the University of Arizona in Tucson provide systematic atmospheric transmission data. Nighttime measurements of atmospheric transparency derived from stellar photoelectric photometry have been made frequently with one telescope at Flagstaff (elevation 2200 meters) since 1955. Removal of the normal seasonal variation, which has a range of 0.05 in optical depth, reveals a record of changes strongly associated with volcanic activity. Dips in transparency are seen following eruptions of Agung, Hekla, de Fuego, St. Helens, and El Chichón. The increase in optical depth has been typically on the order of 0.05, except for El Chichón, which was much larger. The spectrophotometric properties of the El Chichón cloud transmission were investigated with a spectrum scanner during and following May 1982 during the course of a detailed Sun-Vega comparison. The Flagstaff data are highly correlated with published transmission values obtained from Mauna Loa (latitude 20°), much less so with values obtained from Davos, Switzerland (latitude 46°).

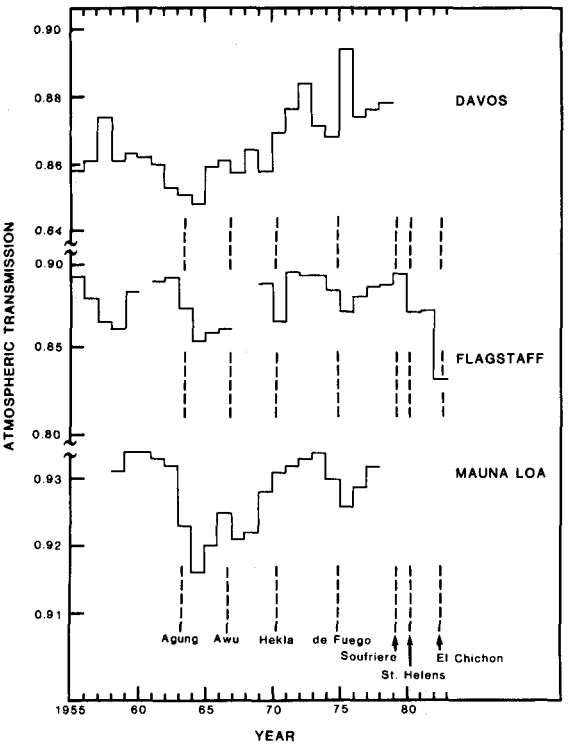

Figure: Annual mean transparency trends at Davos, Switzerland (latitude 46°, elevation 1600 meters) [Hoyt and Fröhlich, 1982 preprint], Flagstaff (latitude 35°, elevation 2200 meters) [Lockwood, unpublished], and Mauna Loa (latitude 20°, elevation 3500 meters) [Mendonca, Hanson, and DeLuisi, 1978 **Science** 202, 513].

While some authors dealt with volcanism as a photometric hazard, a paper by C. Blanco, Osservatorio Astrofisico di Catania, Italy, **Volcanic Activity and Astronomical Observations,** which was read by M. Fracastoro, was used to describe successful observatory operation on the slope of an active volcano. If one avoids those volcanoes on active continental margins, good sites can be found on active volcanoes having suitable orographic properties. Mount Etna is an example. The Serra la Nave station of the Catania Astrophysical Observatore is located on a reverse slope on Mount Etna at an elevation of 1725 meters and 90° from the direction of the prevailing wind. The reverse slope provides protection from lava and from thermal mixing in the boundary layer between subsiding air and the free air of the prevailing wind. Records show that only 20 nights have been rendered nonphotometric by volcanic activity since 1965. Further, systematically collected extinction coefficients show no correlation with volcanic activity or with season, and values are typical of those from other good sites at similar elevations.

B. Hidayat and H. L. Malasan, Bosscha Observatory, Java, described dust phenomena and **Coefficients of Extinction at Lembang** in connection with 1982 eruptions of Mount Galunggung. This volcano, some 60 km southeast of the Bosscha Observatory, persistently emitted dust during March to October 1982 and covered some 10^5 km^2 of West Java with dust and ash. During the peak of the eruption in July 1982, the daytime sky became as dark as at normal civil twilight, and dust fallout was detected 700 km away in Sumatra. However, a change in wind direction

https://doi.org/10.1017/S0251107X00026432 Published online by Cambridge University Press

and a clearing rain permitted standard extinction measures to be made on 18 July, when values of k_v near 1 mag. were obtained. Measures resumed in April 1983 and continued through 1984 showed a steady decline toward normal values of $k_v < 0.2$.

BUSINESS SESSION II

Ratification of membership, organizing committee, and officer lists prior to submission to the IAU-UAI Secretariat.

SCIENTIFIC SESSION V

The second meeting on the subject of atmospheric extinction chaired by G. W. Lockwood; 16:00-17:30 and 24 in attendance.

Atmospheric Extinction at Kavalur Observatory During 1980-85, B. S. Shylaja and J. C. Bhattacharyya, Indian Institute of Astrophysics, Bangalore, was discussed by Shylaja. Observations made with an automated spectrum scanner (M. K. V. Bappu, 1977, **Kodaikanal Obs. Bull.** Series A2, 64) on 40 nights have been used to monitor extinction at the Kavalur Observatory in the range λλ4000-7700 Å. Components due to Rayleigh scattering, aerosol scattering, and ozone and water vapor absorption have been separately analyzed and correlated with meteorological information. A small systematic increase in aerosol scattering has been observed during the interval 1980-1985. Ozone absorption was significantly larger in 1980-1981 than during the rest of the interval, a change confirmed by the meteorological measures. The spectrophotometric water vapor measures are correlated with meteorological determinations made at Bangalore.

A study of **Extinction Coefficients at the Xinglong Station of the Beijing Observatory** by Huang Lin, Guo Zi-he, Jiang Shi-yang, Zhang Rong-xian, and Zhang Ji-tong was reported by Huang Lin. Visual extinction values collected from site-testing measures made in 1964 and from five photometric programs carried out from then until June 1985 show appreciable scatter and a slight systematic increase with time. Color extinction terms, however, show little change, indicating that variations in k_v may be caused by dust particles which produce neutral extinction. Seasonal analysis shows that a minimum number of large values of k_v occur during June to November, which is the calm rainy season when dust is minimized. From seven to twelve months after the El Chichón eruption there is a group of k_v values having small scatter but larger values than the mean of the 1980s, which may represent a detection of volcanic dust.

F. Rufener, Observatoire de Genève, Switzerland, described **The Evolution of Atmospheric Extinction at La Silla.** He based his discussion on precise values of extinction coefficients determined by the M and D method (Rufener 1964, **Publ. Obs. Genève,** A, 66, 413) on 452 nights uniformly distributed over the period November 1975 to March 1985. The method makes use of repetitive observations of mounting and descending (M and D) stars at about the same air mass and allows for gradual isotropic changes in extinction that may occur during the night. Extinction coefficients in [U], [B], and [V] show monotonic decreases in values during the interval 1975 to April 1982 with color behavior suggesting scattering from small particles distributed around 0.1 nm. This systematic decrease in extinction is attributed to the gradual fallout of particles injected into the atmosphere by the eruptions of Agung (Bali, 1963) and El Fuego (Guatemala, 1974). The gradual decrease in extinction is uniform because volcanic activity in the southern hemisphere remained low during 1975 to April 1982. The extinction coefficients show a small annual variation with minima in July. There is a marked discontinuity in extinction values following the El Chichón eruption with a maximum effect observed seven months after the event, the delay being a result of the latitude difference between El Chichón (17°) and La Silla (-29°).