JOURNAL OF THE KOREAN ASTRONOMICAL SOCIETY
39: 113 ~ 116, 2005

THE ASTRONOMICAL SITE SURVEY IN WEST CHINA

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(Received February 1, 2005; Accepted March 15, 2005)

ABSTRACT

The program of site survey in western China has been initiated by the National Astronomical Observatories of China(NAOC) toward large telescope facilities. The program is carried out in aspects of remote studies and local surveys. The preliminary results show that the eastern Pamirs and Ali area in Tibet may be the best candidates for further monitoring. The site survey group of NAOC will proceed to set up site testing stations on the selected sites and perform monitoring and campaign in 2005.

Key words : astronomical sites — atmospheric effects — site testing

I. INTRODUCTION

An excellent site is a necessary and crucial condition for constructing ground-based observational facilities. The site requirements for the next-generation astronomical facilities have greatly enhanced the world-wide site selection activities by whole astronomical community, involving various efforts in evaluation technology and site survey. In the East-Asian region, many astronomers also stick at good sites, and there was even a campaign under EAMA coordination(Kaifu 1995, EAROSS team 1993), but it is lack of good sites to be recognized for large observational facilities. Simply from this viewpoint, an appropriate astronomical site may be one of the critical factors in developing large facilities and establishing effective collaborations in East Asia.

The Chinese astronomical community has recently made a critical step by organizing a specific research group to startup site survey in the vast land of western China(Zhao & Zhao 2003). With high altitude over 4000m, very dry climate, high percentage of clear nights, and less human pollution, the western part of China takes basic advantage of the top-ranking observatories on this globe. The initial survey results have suggested that there are a few potential sites that could become excellent astronomical bases. Furthermore, the rapid development of economy in China and particularly of transportation in western China provides great opportunity and great expectation for us to implement the strait work.

This paper reports the site survey program in western China and the related activities.

Proceedings of *the 6th East Asian Meeting of Astronomy*, held at Seoul National University, Korea, from October 18-22, 2004.

II. THE SITE SURVEY PROGRAM

The goal of the site survey in western China is to identify the sites appropriate for constructing large telescopes (Zhao & Zhao 2003, Yao 2004). There have been already research and proposals for a 30-50m optical-infrared telescope and 25m single-dish or array facilities in the submm wavelength. The survey area will include Tibet, XinJiang, Qinhai, and Yunnan.

The site survey can be a ten year project, outlined into two five years. The main tasks in the first two years involve organization, instrumentation, data analysis and candidate site selection. It is expected to settle the candidate sites by three years via site testing on 5~10 sites. The preliminary results can be helpful to suggest for small telescopes. After five years, we would finish two year monitoring of 2~3 candidate sites, and have developed all-ready instruments and experienced team. Before the step of next five years, the academic committee and funding agencies should review and evaluate the site testing results and settle on the concept of Chinese ELT, so that clarify the final goal of site survey project. The long-term monitoring with specific instruments will be made in the later five years for thorough research toward a final selection.

¿From the technique point of view, the site survey group of NAOC has made a four phase plan. In Phase-I we set up investigation of climate, terrain, local support, and calamity by various methods of analysis and survey. Phase-II will be laborious fieldwork of turning testing on candidate sites to observe cloud amount, water vapor, wind, atmospheric turbulence, sky brightness and extinction, etc. Phase-III is an intensive monitoring when the predominant candidates fixed, emphasizing characterization and stability measurement. Phase-IV indicates a kind of self-contained monitoring for the later five years.

Our strategy of organization is to establish support stations in each provinces of western China, which are

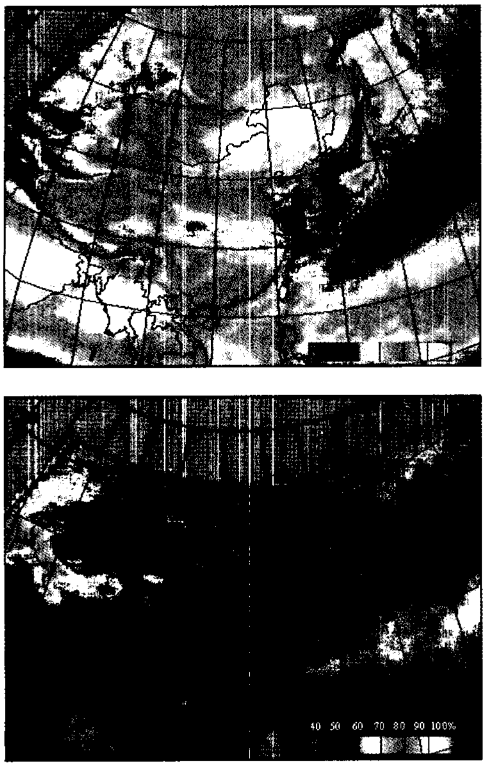

Fig. 1.— The distribution of astronomical clear nights in China, measured with GMS and NOAA satellite data over 1996-2003(Mao et al. 2004). The top image presents the mean percentage of clear nights in January and the bottom in July, with a color scale from 40% to 100%.

available now with the cooperation of Tibet University, Urumqi Observatory, Delingha Observatory and Yunnan Observatory. More efforts should be made to obtain the support from local governments. We emphasize on employing commonly used and highly automatic instruments for the observations, to guarantee stable and comparable data. Finally, international cooperation is essential for performing the program. The collaborations will include both instrumentation and site testing, and the setup of international expertise and advisory committees. International cooperation in site survey can be a precursor for ELT projects in the future.

III. THE ACTIVITIES

(a) THE REMOTE STUDIES

By remote studies, we compile and investigate existing databases, such as topographic maps and the archival data by satellite and weather stations.

An analysis of GMS and NOAA satellite data (11-12μm channels) was made by Mao et al. (2004) of Beijing University, to investigate the distribution of astronomical clear nights in China. The study employs 43766 images and covers seven years over 1996-2003. The analysis provides long enough baseline to cover

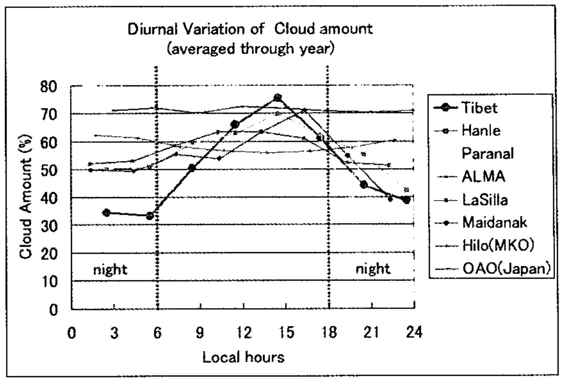

Fig. 2.— The diurnal variation of cloud amount in Tibet comparing with other good observatories(Sasaki & Takato 2004).

the most recent phenomena and recommends effectively good areas or sites with a resolution of 12-20km. Specific sites can be further identified via the topographical study. Fig. 1 shows the average clear nights in January and July(the best and worst seasons over China). It is notable that the western and northern parts of China bear high percentage of clear nights, and especially, the western Tibet, the Pamirs, and the Arjin Mountain area can keep 80%-90% clear nights over a year.

TABLE 1.
THE BASIC CLIMATE IN WESTERN CHINA

SITE	T_{max}	T_{min}	RH(%)	ΔT_{daily}	ΔT_{annual}	P(HPA)
GAR-SQH	8.1	-7.5	34	15.5	26.2	604.4
PULAN	10.8	-3.1	48	13.9	22.5	637.0
GAIZE	8.2	-8.8	34	17.0	24.6	593.9
LENGHU	11.7	-5.7	29	17.4	29.6	726.3
KASHI	18.3	-5.5	52	12.8	30.9	872.0
TAXKORGAN	10.9	-3.5	40	14.4	28.3	699.9

Note: all the parameters are presented with mean values over the years 1971-2000.

A global study with NOAA/GOES satellite data has been conducted by the Japanese team(Sasaki & Takato 2004). The analysis also show a certain area in the western Tibet (Oma area, 83E-32N) as one of the best sites in the world. Fig. 2 presents the cloudiness in Tibet comparing with other good observatories; the cloud amount in Tibet dwells in the lowest through night but varies to the worst in daytime.

The statistics of meteorological data of local weather stations in western China was carried out by Wang (2004) of National Meteorological Center, China Meteorological Administration. The study selects a typical climate period of 30 years over 1971-2000 and employs both surface data and upper-air data. The surface data allow multimode approach to cloudiness, sunshine duration(low cloud and aerosol), vapor pressure, precipitation and surface wind, and the the upper-air data provide properties of layer temperature, humidity and

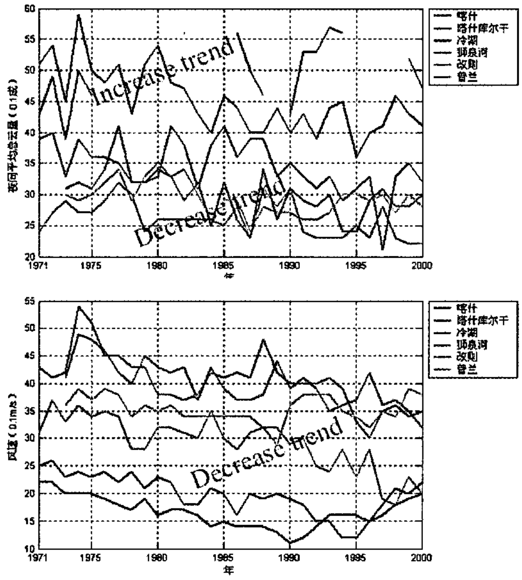

Fig. 3.— The long-term variation of cloudiness(top plot) and wind speed(bottom plot) in western China. The top-right panels list the locations of weather stations: from top to bottom, Kashi, Taxkorgan, Lenghu, Gar-SQH, Gaize, and Pulan.

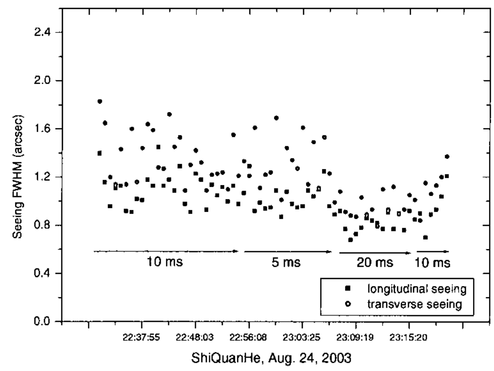

Fig. 4.— The seeing measurements at Gar, Ali area, on 24 August 2003. A tendency of improved seeing can be observed from sunset to midnight.

wind up to altitude of 30km. Table 1 and 2 present basic climate and localized weather conditions in western China. While the systematical study is reliably helpful to site selection, the measurements with weather stations in habitable towns are not equal to real conditions of candidate sites due to quite different topographies. The long-term climatologic changes has also been observed. Fig. 3 illustrates the continuous decrease over the 30 years of cloud amount and wind speed in most part of western China.

TABLE 2.
THE WEATHER CONDITIONS OF SELECTED SITES

SITE	N_{clear} (/YEAR)	N_{cloud} (%)	P_{vapor} (HPA)	PW (MM)	V (0.1M/S)
GAR-SQH	241	26.1	2.5	71.2	29.62
PULAN	228	29.5	4.3	157.2	35.43
GAIZE	220	30	2.6	163.8	40.11
LENGHU	213	36	2.4	15.8	39.48
KASHI	165	48	7.2	62.9	19.14
TAXKORGAN	159	46	3.3	69.3	19.80

Note: the parameter symbols denote the mean values of clear nights per year, percentage of cloudiness, vapor pressure, precipitation, and wind speed.

(b) The Local Surveys

Based on the knowledge by remote studies, local surveys have been performed in 2003-2004, covering the wide area of Tibet, XinJiang, and Qinghai. The main sites explored include Ali area in far western part of Tibet, the central Tianshan Muntain and eastern Pamirs in Xinjiang, and Arjin Mountain and Lenghu area between Qinghai and Xinjiang. All the sites can be accessible by car.

The local surveys allow us to acquire support from local governments and bring forward evaluation of infrastructure of the sites. It may be interesting to mention the routes to visit Gar, the western area of Ali; one can traverse Tibet plateau from Lhasa, or pass over the Kunlun mountain from Kashi. There are train stations and airports in both Lhasa and Kashi. It is also reported that the construction of Ali airport can be completed within three years.

The survey teams usually made measurements through the explorations, besides topographical examination, with instruments of DIMM telescope, water vapor monitor, sky brightness photometer, GPS, and portable devices for wind, temperature and humility. In the survey in July 2004, the Japanese team has even performed T-profiler measurements with a small airplane.

Fig. 4 and 5 present examples of measurements during the explorations. Fig. 4 is the seeing measurements by DIMM at Gar, where the telescope was simply put on the ground of foothill. The measurements indicate a mean value of seeing of ~1 arcsec, although the observation was made just after sunset in summer season. Fig. 5 displays water vapor measurements on the way from Lhasa to Gar in August 2004. The data show great variation from place to place, with most measurements of precipitable water vapor of 1-4mm. The lowest PWV can be found around Gar area to reach values of 0.5mm. There are evidences that Pamirs, Arjin Mountain and Lenghu area possess lower PWV of 1.0mm or less in autumn season.

The survey teams have examined a dozen of interesting candidate sites in western China, and picked out the best candidates in Ali area and Pamirs in view of weather condition, topography and infrastructure.

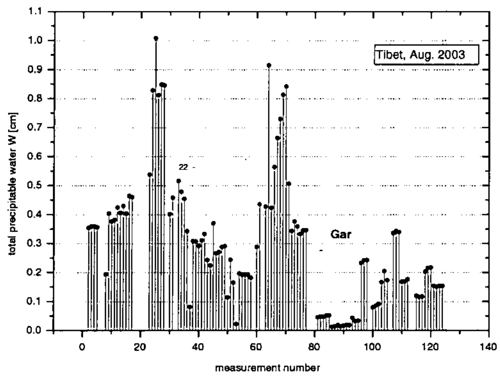

Fig. 5.— The water vapor measurements on the way from Lhasa to Gar in August 2003. The lowest PWV values can be found around Gar, Ali area.

Fig. 6 displays three candidate sites located in Gar, Oma, and Taxkorgan areas with altitudes over 4500m. All the sites have enough relative height on the plateau, and are wide, flat, and easily accessible by car. There is a plan to set up stations on the sites to initiate site testing works.

IV. SUMMARY

The program of site survey in western China has been initiated at NAOC in 2003, and carried out with efforts in both remote studies and local surveys. The best candidate sites seem to be located in the eastern Pamirs and Ali area in Tibet. The local research has made measurements of seeing and water vapor over the open areas, by the experience we observe that seeing and stability may be the crucial parameters to evaluate the sites. The site survey activities have got support from the local governments, and the program makes progress in technique, instrumentation and international collaborations.

The site survey program will phase out into fieldwork of testing in 2005. The site testing stations can be set up soon on the candidate sites, and we will proceed to perform monitoring and campaign. The site survey group of NAOC would enhance collaborations on instrumentation and campaign, and promote small telescope programs for the candidate sites.

ACKNOWLEDGEMENTS

We wish to thank the SOC and LOC for organizing the nice EAMA6 meeting. We also acknowledge J. Mao, G. Wang and T. Sasaki for their collaboration and admission to present the related studies.

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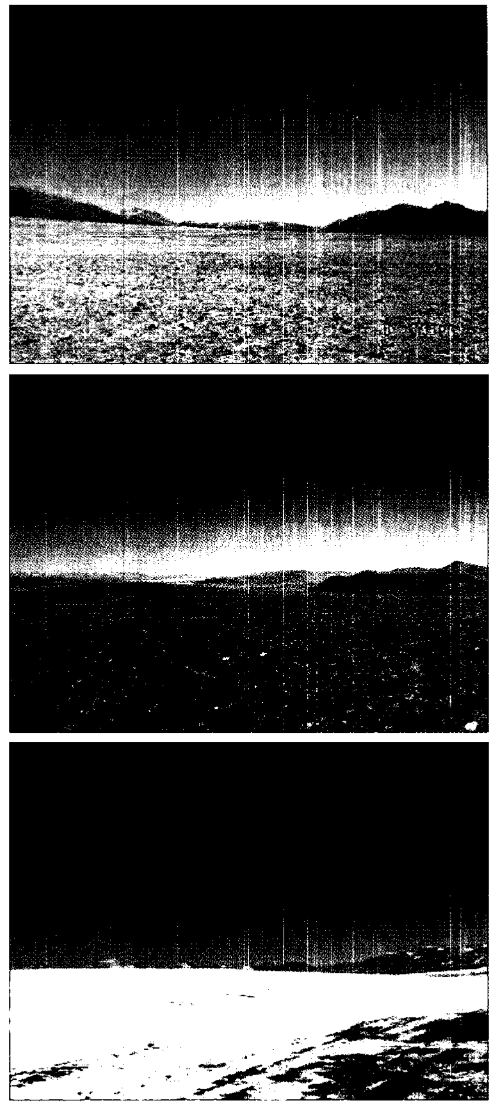

Fig. 6.— The selected good sites in Gar, Oma and Taxkorgan. From top to bottom, the sites are named Zadudin, Omadaban, and Kurmai, with altitudes of 5500m, 5020m, and 4500m, respectively.