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Weather Characteristics at Observatory Candidate Sites in West Tibet

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Abstract: The high plateaus in west China may provide suitable sites for astronomical observations with institute's middle-range telescopes and possibly with larger telescopes. Under China-Japan collaborations on site survey in west China, we have been conducting searches for good sites and monitor their characteristics for several years. As recent results of our site survey show, sites in west Tibet are revealed with high possibility of good astronomical observations.

Weather characteristics at Gar in Ali, Tibet, show its high clear-sky ratios especially in winter, comparable to Mauna Kea, Hawaii. But it has some wind problem in winter, where stronger wind speeds over 20m/sec occur frequently even though sky is clear without any cloud. To find more calm site, we have conducted numerical simulations in Ali area using Japan Meteorological Agency NonHydrostatic Model. We have noticed another site, named ZoZo Hill, near Gar. We should continue to monitor Gar site to clarify weather characteristics throughout a whole year and hopefully start to negotiate for site monitoring at ZoZo Hill this year.

Key words: international collaboration, site test, telescope site, west Tibet

1. West Tibet at an Important Longitudinal Location for Global Astronomical Observation Network

As west China is indicating its importance to play a role for the global astronomical observation network (Yao 2005), we have been conducting astronomical site-monitorings at three sites in west China; Karasu (Xinjiang Uighur), Oma (Tibet) and Gar/Ali (Tibet) under China-Japan Astronomical Collaboration since 2007 (Sasaki et al. 2008, Yao et al. 2011, Sasaki et al. 2011).

2. Astronomical Site Monitoring

Several astronomical site-monitoring instruments have been deployed at the sites. At Oma and Gar site, cloud monitor camera has revealed excellent sky conditions, especially in winter. Gar has shown better weather conditions than Oma.

On the other hand, strong winds that have been observed at the current monitoring site, Gar, in winter season may seriously affect numbers of observable nights (Figure 1), as imaging capability of telescope optics should be reduced due to turbulence by stronger wind inside a telescope dome by applying the criteria on wind speed [1].

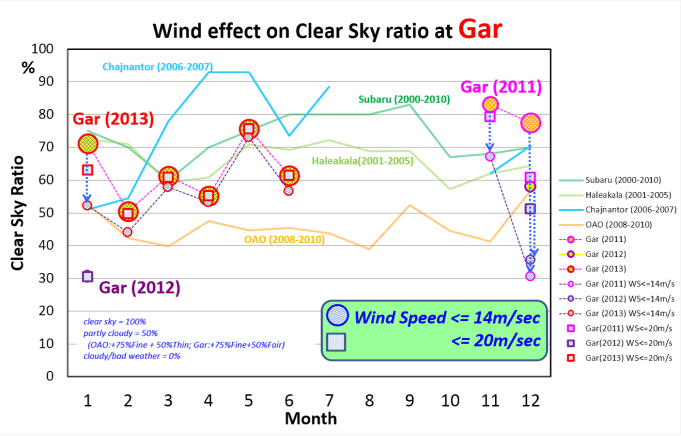

Figure 1. Clear sky ratios at Gar, except for unknown summer season, are around 70%, which are nearly comparable to ratios at Mauna Kea, Haleakala (Hawaii), and Chajnantor (Chile). OAO (Okayama Astrophysical Observatory) is located at one of the best sites in Japan. Wind restriction on astronomical observation at Gar may seriously reduce available observing nights, which result to around OAO observing conditions.
Ref.) Mauna Kea: statistics on Subaru Telescope during 2000-2010, Haleakala: Suganuma et al. 2007, PASP, 119, 567, Chajnanto: Miyata et al., 2008, SPIE 7012, 701243 , OAO: summary report during 2008-2010.

Corresponding author: T. Sasaki
[1]Operartion restriction on Subaru Telescope is of wind speed outside less than 14 m/sec to protect the telescope itself and

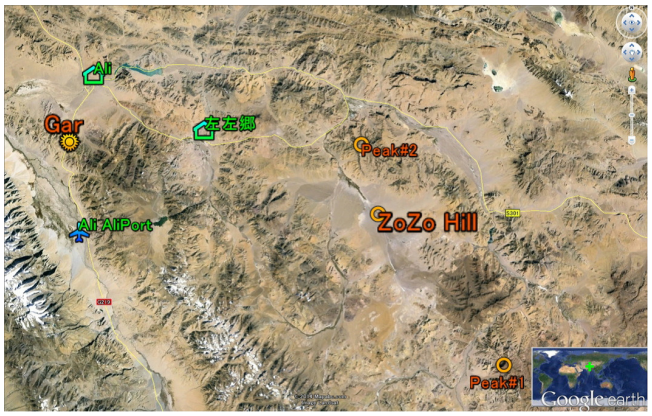

Figure 2. Location map in Ali,Tibet. Gar (5032m high above sea) of current monitoring site, ZoZo Hill (4619m) of new candidate site, and other reference peaks, Peak#1 (5849m) and peak#2 (5769m), in west Tibet.

3. Another candidate site near Ali and weather numerical simulation

We are looking for other candidate site(s) around Ali, as Ali area is of the best area with clear sky condition. A certain hill on a wide basin [2] seems like a nice location for astronomical observatory (Figure 2). The hill is temporarily named as ZoZo Hill as located near ZuoZuo town, that is 90km from Ali.

To clarify their weather characteristics, we have conducted numerical simulations at Gar and ZoZo Hill, using Weather Research and Forecast (WRF) and Japan Meteorological Agency NonHydrostatic Model (JMA-NHM). JMA-NHM simulation at Gar shows the same tendency of wind speeds measured by a weather station settled on the 10m dome at Gar in Dec., 2012 to Feb., 2013. Daily variations of wind speed at Gar and ZoZo Hill are shown in Figure 3, in which ZoZo Hill is shown less than half of the wind speed than at Gar.

As some turbulence in higher atmospher affects seeing size at the telescope site, vertical wind profile are shown in Figure 4 using JMA-NHM simulation with the referenced higher peaks on windy and calm night at 18h UT (locally around midnight). Wind speeds higher than 7000m at four sites converge on each other, though Gar is much windy near ground surface on windy night. Wind speeds at ZoZo Hill stay relatively calm throughout simulated periods as shown in Figure 3.

4. Site monitoring in near future

As weather simulation shows that the vertical wind speed profiles at Gar and ZoZo Hill continuously merge around 7000m and higher into the atmospheric layer with strong wind, higher mountains look not suitable to achieve nice observatory conditions for astronomy in west Tibet.

We should continue to monitor Gar site to clarify weather characteristics throughout a whole year and

normal operation guaranteed under wind speed of 7 m/sec as turbulence over the mirror surface should be less than 1-2 m/sec.

[2] The radius of the basin is about 20km

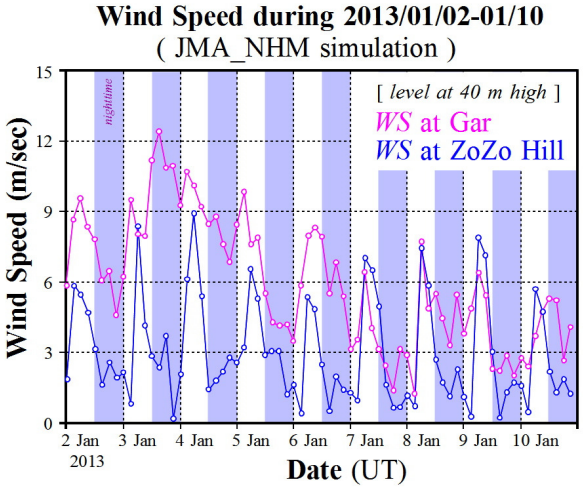

Figure 3. Wind speed simulation during 2013/01/02-2013/01/10. Wind speeds are calculated at 40m high above the ground and averaged in 1km×1km resolution.

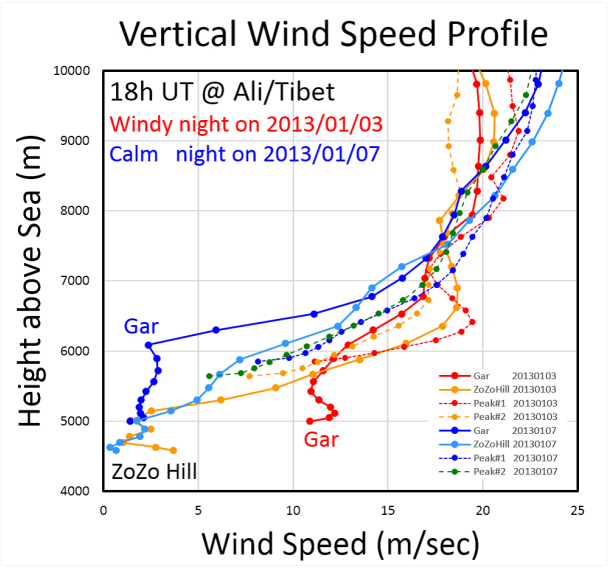

Figure 4. Vertical wind profiles at Gar and ZoZo Hill in Ali under JMA-NHM simulation.

hopefully start to negotiate for site monitoring at ZoZo Hill. We would especially like to measure atmospheric disturbance of up to 2000m above ground, possibly using site-monitoring instrument SODAR (Businger & Cherubini 2011).

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