#### Weather Characteristics at Observatory Candidate Sites in West Tibet

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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 conducted to search for good sites and monitor their characteristics for several years at *Karasu* (Xinjiang Uighur), *Oma* (Tibet) and *Ali* (Tibet). As recent results of our site survey show sites in west Tibet are revealed with high possibility of good astronomical observations, we are now concentrating to monitor the site *Gar* in Ali.

Weather characteristics at *Gar* show its high clear-sky ratios especially in winter, comparable to Mauna Kea, Hawaii. But we noticed a wind problem at *Gar* in winter that higher wind speeds over 20m/sec occur frequently even though sky is clear without any cloud. To find more calm site, both with high clear-sky ratios and mild wind speed, we have searched for another site, named *ZoZo Hill*, near *Gar*.

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 results at Gar show the same tendency to wind speeds measured in Dec., 2012 to Feb., 2013. Compared with wind speeds at both sites, *ZoZo Hill* shows nearly half wind speed than at *Gar*. We should continue to monitor *Gar* site to clarify weather characteristics through a whole year and hopefully start to negotiate for site monitoring at *ZoZo Hill* this year.

# 1. West Tibet at an important longitudinal location for global astronomical observation network

Large Telescopes on the globe (larger than  $\phi 3m$ )



Fig.1 Global astronomical sites with large telescopes

As west China is indicating its importance to pay a role for the global astronomical observation network, we have conducted astronomical site monitoring since 2007 under China-Japan Astronomical Collaboration at three sites in west China; *Karasu* (Xinjiang Uighur), *Oma* (Tibet) and *Gar*/Ali (Tibet).

#### 2. Astronomical site monitoring

## 3. Another candidate site near Ali and weather numerical simulation

We are looking for other candidate site(s) around Ali, as Ali area is on the best area with clear sky condition. A certain hill on a wide basin seems nice location for astronomical observatory (Fig.7). The hill is temporarily named as *ZoZo Hill* as located near ZuoZuo town, where 90km from Ali and the radius of the basin is about 20km.



Fig.7 Location map around ZoZo Hill in west Tibet



Fig.8(a) Location around ZoZo Hill (GoogleEarth)



Fig.8(b) Location around MKO (GoogleEarth) with the same scale with Fig.8(a)

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Fig.3 Cloud monitor camera ( a front tube-shaped ) and a weather stations on a right rod at Gar. Left two cameras for sky watchers (NAOC). Behind far mountains are the Himalayans.

Fig.4 Clear sky ratios at Gar, except unknown summer season, are around 65%, which are nearly comparable to at Mauna Kea and Haleakala, Hawaii



Fig.2 Monitoring sites in west China:

Karasu, Oma, and Gar/Ali





Fig.9(a) Simulation results on wind speed at Gar in Jan, 2013 with JMA-NHM, which shows the same trend of wind speed shown in Fig 5.

Fig.9(b) Simulation results on wind speed at ZoZo Hill in Jan, 2013, which show nearly half the wind speed than at Gar in Fig 9(a).



Strong winds have been observed at the current site, *Gar*, in winter season (Fig.5), which may affects numbers of observable nights seriously (Fig.6) by applying criteria, that imaging capability of telescope optics should be reduced due to turbulence by stronger wind inside a telescope dome.

### 4. Site monitoring in near future

As weather simulation shows the vertical wind speed profile at *Gar* smoothly connects to the high wind speed layer about 12000 m above sea level, higher mountais look not suitable to achieve nice observatory conditions for astronomy in west Tibet (Fig.10). We should continue to monitor *Gar* site to clarify weather characteristics through a whole year and hopefully start to negotiate for site monitoring at *ZoZo Hill*, especially to measure atmospheric disturbance above 1000m - 2000m over the ground (Fig.11).

Fig.5 Weather data measured at Gar during Jan and June, 2013. Wind speed are shown in colors of Orange (Wind speed  $\leq 20$ m/s) and Red (> 20m/s), which is judges as NOT-observables. Marks above each figures are sky conditions with CloudMonitor Camera.

Fig.6. Clear sky ratios at Gar have been reduced due to strong wind mainly in winter.





Fig.10. Vertical wind profile by weather simulation, JMA-NHM, at Gar and ZoZo Hill in Ali.

![](_page_0_Figure_41.jpeg)

Fig.11. Schematic site monitoring measurement with possible SODAR.