A China-Japan Collaborative Site Survey in west Tibet
Sky clearness at Oma, 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 Tibet, we have been conducted to search for good sites and monitored their characteristics for several years at Karasu（Xinjiang Uighur）and Oma（Tibet）. Recent results of our site survey show sites in west Tibet are revealed with high possibility of good astronomical observations. We present the characteristics at Oma, west Tibet, with its high clear-sky ratios especially in winter, which is comparable to Mauna Kea, Hawaii.

1. Monitoring sites in west China

As west China is indicating its importance to pay a role for the global astronomical observation network, astronomical monitoring have been conducted since 2007 under ***China-Japan Astronomical Collbaration*** at two sites in west China; **Karasu** in Xinjiang Uighur and **Oma** in Tibet.

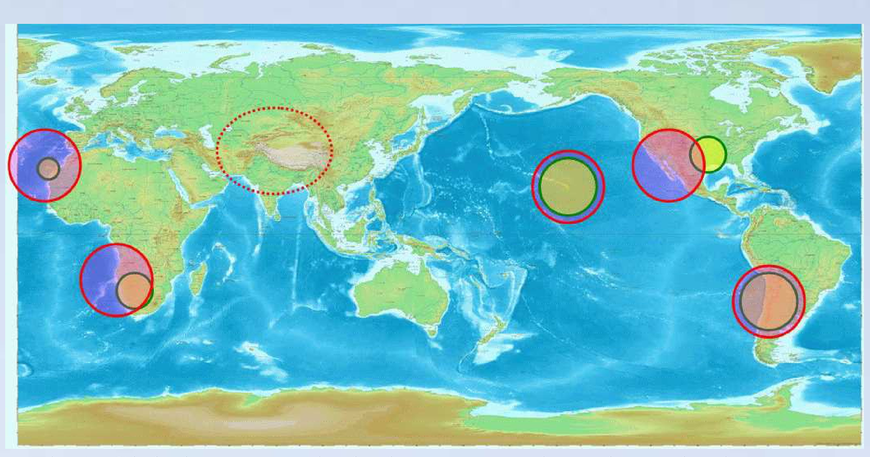

Fig.1 Global astronomical observatory sites show the importance of west Tibet area for global astronomical observation network.

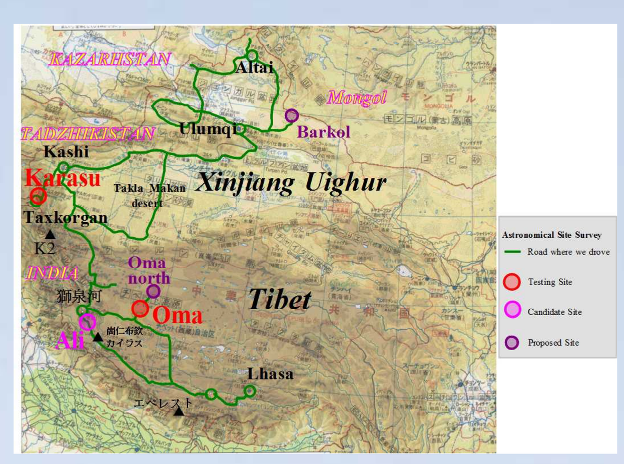

Fig. 2 Monitoring Sites in west China

3. Sky clearness at Oma and Karasu

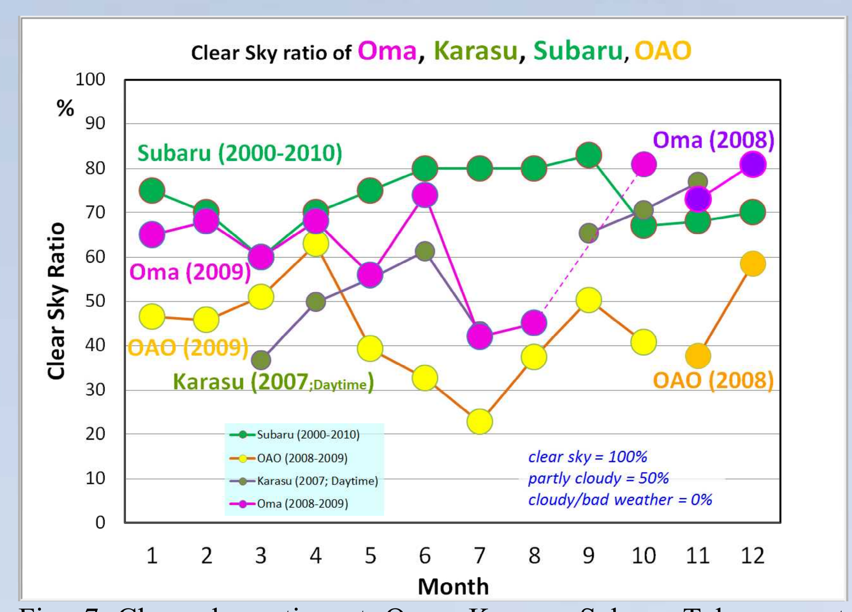

Fig. 7 Clear sky ratios at Oma, Karasu, Subaru Telescope at Mauna Kea, and Okayama

Whole sky had been observed every 1 min to detect clouds in the sky with MIR Cloud monitor Camera at Oma during 2008 and 2009 and at Karasu during 2007 and 2008. Clear sky ratios are estimated after image frames were flat-fielded and subtracted of their back-ground intensity. Clear sky ratios at Oma, except summer monsoon season, are around 70%, which are comparable to at Mauna Kea, Hawaii, and much bettre than at Okayama, Japan. At Karsu shows lower ratios than at Oma.

2. Site monitoring instruments

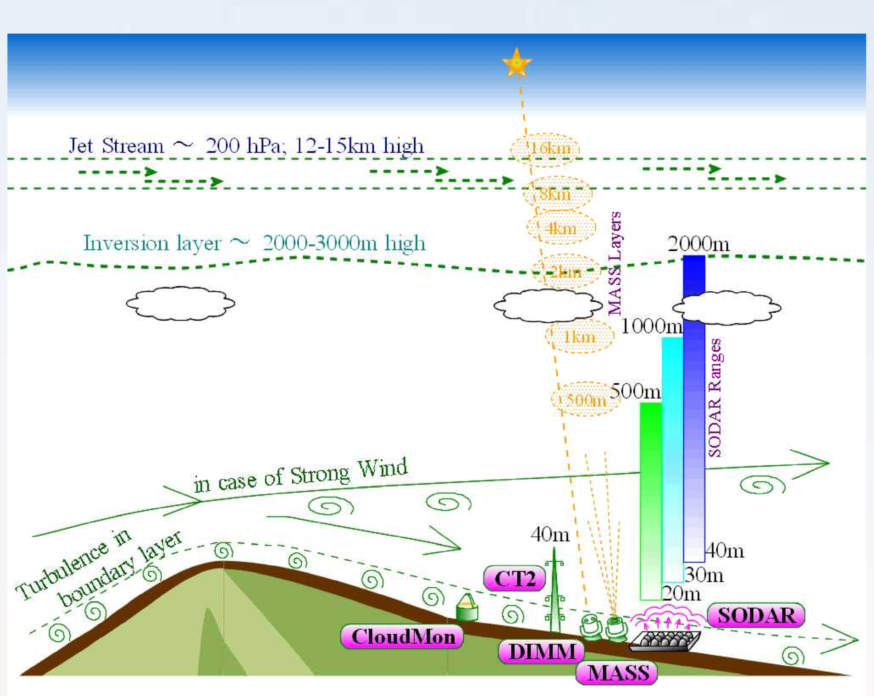

Fig.3 Turbulent elements in the atmosphere and monitoring instruments

Instrument	Method	Responsible
MASS	Multi-Aperture Scintillation Sensor	China(planned)
SODAR/Snodar	Sound detection and ranging	Japan(planned)
DIMM *	Differential Image Motion Monitor	China
SSS	single star SCIDAR	China(planned)
CT2 *	Atmospheric Microthermal Turbulence	Japan
IR Cloud monitor*	10μm-band MIR camera	Japan
Visible whole-sky camera*	visible CCD camera	China
Weather tower*	Temperature, Humidity, Wind, Pressure Rain, Sunshine, IR radiation, Dust	China/Japan

* Currently available instruments

Ref.)
IR Cloud monitor camera: Suganauma, M., et al., 2007, PASP, 119, 567.
Snodar: C.S. Bonner, et al., "Snodar: a new instrument to measure the height of the atmospheric boundary layer on the Antarctic plateau", Proc. SPIE, 7014,（2008）70146I-7.
Book "Seeing Clearly: The Impact of Atmospheric Turbulence on the Propagation of Extraterrestrial Radiation", edited by S. Businger and T. Cherubini, 2011.

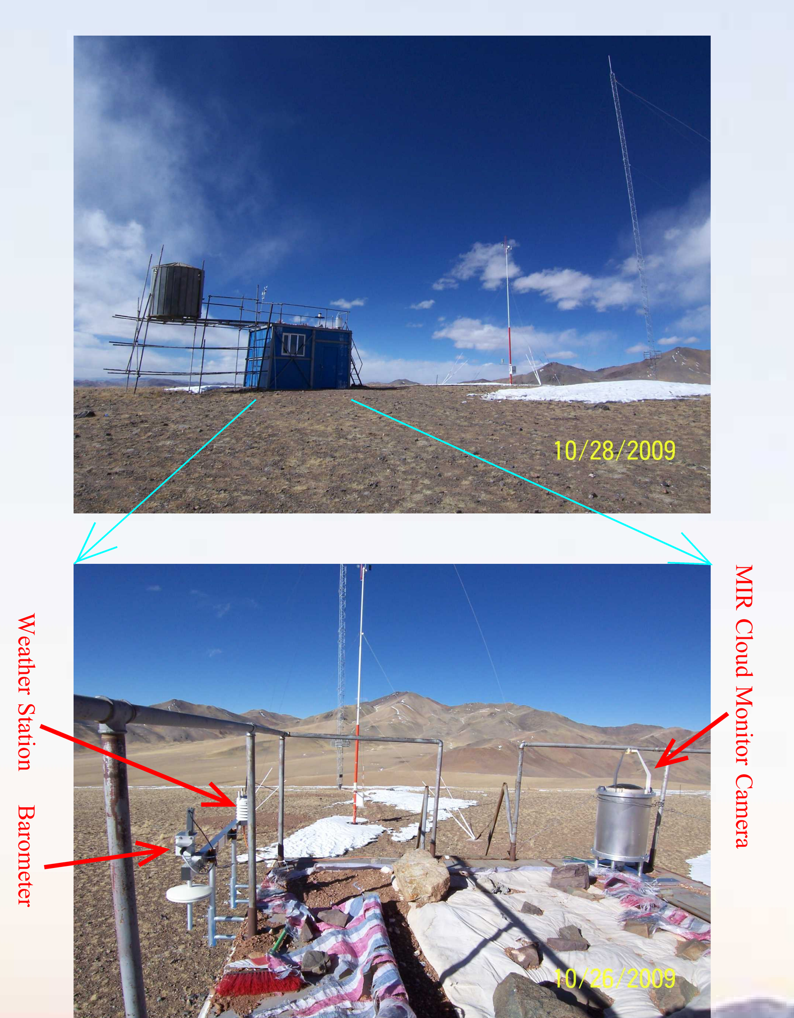

Fig.4. Site monitoring instruments on the roof of cottage and CT2 sensors on the 40m tower at Oma

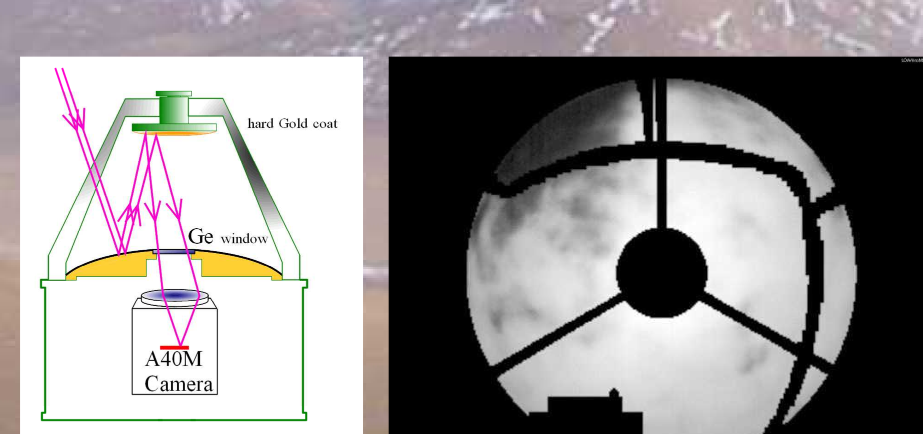

Fig.5 A structure of Cloud Monitor Camera and a whole-sky image taken with Cloud Monitor Camera

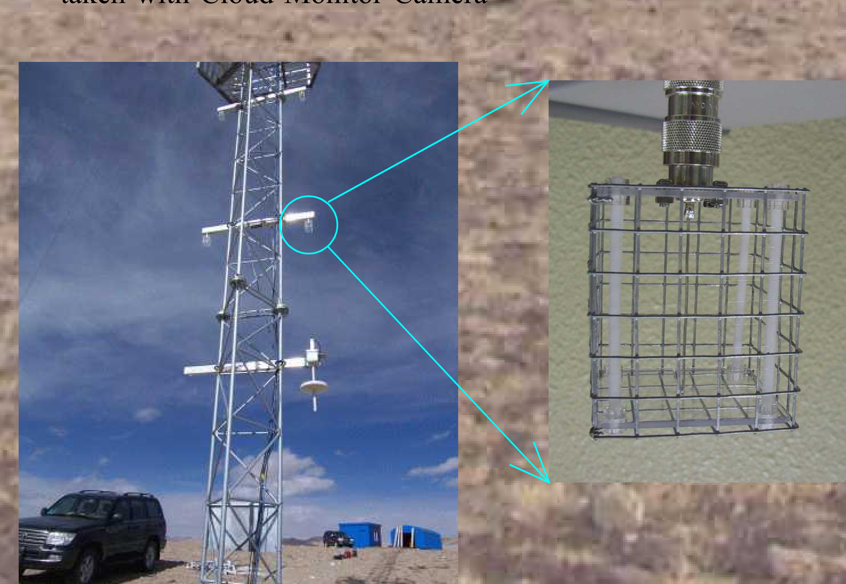

Fig.6 C_{T2} sensors on the 40m tower

To evaluate astronomical observation characteristics at candidate sites, we are conducting

1）to monitor weather conditions,
2）to observe cloudiness using a mid-irafred (MIR) camera to estimate clear sky ratios,
3）to measure atmospheric turbulence in the ground-boudary layer to estimate seeing conditions using CT2 sensors on the 40m tower and DIMM/MASS with a small telescope.

4. Image degradation in a boudary layer estimated with C_T^2 monitoring

Micro-thermal sensors on the 40m tower were measuring atmospheric turbulence in the ground layer. Atmospheric turbulence is high relatively about C_T^2～1.0e-2 in daytime and low about C_T^2～1.0e-3 - 1.0e-4 in nighttime. Seeing degradations are estimated using C_T^2 values to be around 0.4 arcsec and 0.1 arcsec, respectively, at Oma（Fig. 8）. Seeing degradation seems to be correlated to wind speeds at the site. Under blown-in winds, seeings were degraded much up to higher layers, as shown aroud 1h and 19h in the case of 2011/10/31 at Oma.

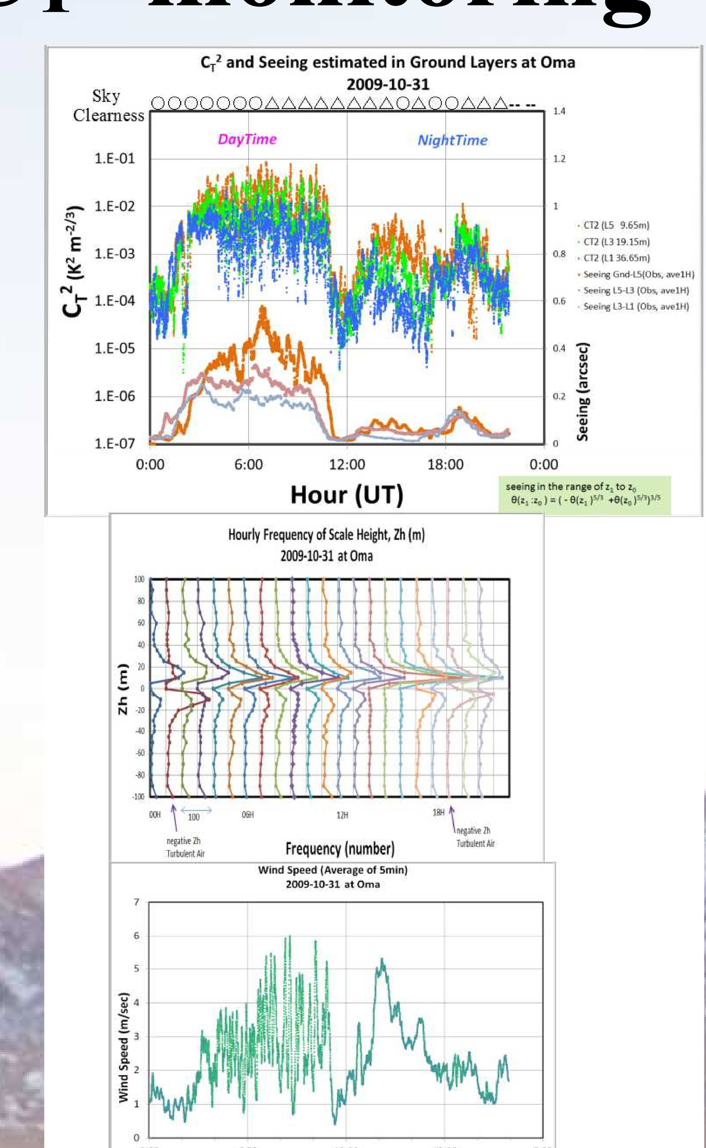

Fig. 8 Temperature structure coefficient, C_{T2}, measured with CT2 sensors at Oma and estimated seeing in the boudary layer, Hourly drequency distribution of Scale Height, Zh(m), and Wind Speed.

5. Future monitoring at the new site Ali

A new site, **Ali**, is proposed and a monitoring station has been constructed（see Prof. Yao's poster in this conference: **S7P08**）.

The Cloud Monitor Camera, CT2 sensors, and weather station shall be moved to Ali from Oma this year to start monitoring of astronomical observation conditions at **Ali.**

A new instruments, Snodar, is hoped to be installed at **Ali** when the budget is available.

Comparison of cloudiness observed from the groud using Cloud Monitor Camera and satellite weather data shall be conducted to forecast a weather trend at the monitoring site.

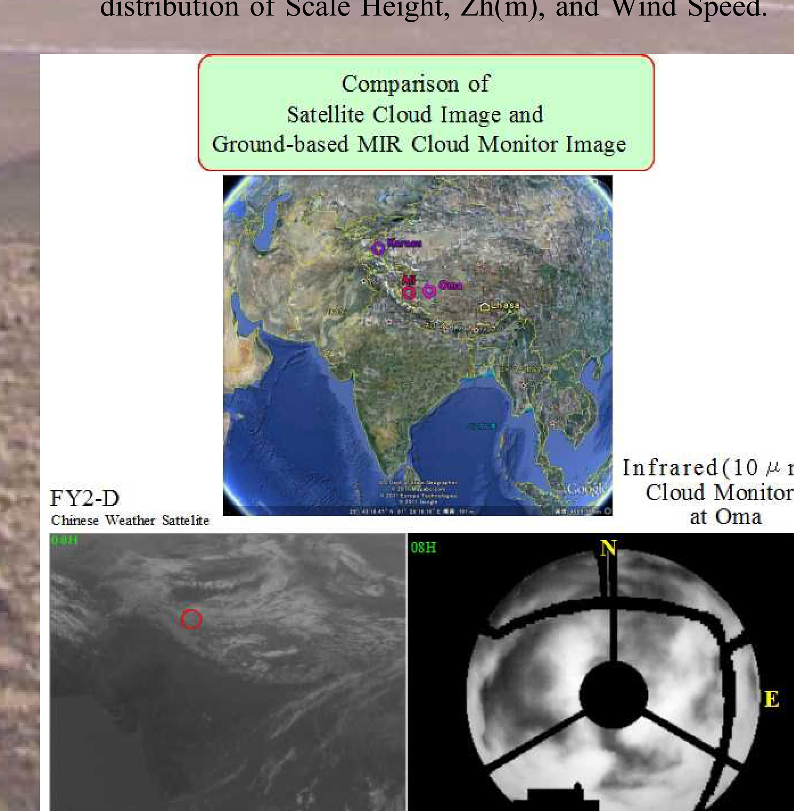

Fig. 9 (left) Image of Weather Satellite, FY2, and (right) of Cloud Monitor Camera

Background Photo: Oma brightened with a half moon