Collaborative Site Testing in West China

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on behalf of Site Survey Team
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L. Liu (NAOC) and other Chinese collaborators

Contents

- Possible candidate sites in China and Topographical tours around west China
- Site testing, showing good conditions in winter at Oma/Tibet
- Telescope Plan near Gar and possible 4m telescope in future for Asian astronomers

Collaborative Site Testing in West China

Summary

1) **Site Survey and testing** has been conducted since 2003, led by Prof. Y. Yao, and two weather-monitoring stations have been settled at **Karasu** (Xinjiang) and **Oma** (Tibet).
2) Japanese team has joined the site survey project after the workshop at Lhasa, 2004. We introduced **MIR cloud monitor** cameras (CMC), **CT2** atmospheric micro-turbulent sensors, and weather stations at both sites.
3) At **Oma** site, CMC revealed excellent sky conditions in winter, but not good in summer.
4) Strong winds have been observed at Oma in winter season, which may affects seeing seriously.
5) Nominal seeing measured with CT2 was less than 0.1 arcsec up to 36m height in Nov. 2008. We must conduct seeing measurement through total atmosphere w/ DIMM/MASS/SODAR to evaluate seeing condition at the site soon.
6) We are settling site survey instruments at possibly best site near **Gar** in west China.
7) We are discussing to deploy a small telescope w/some observation instruments and negotiating to introduce a possible 4m telescope near Gar.

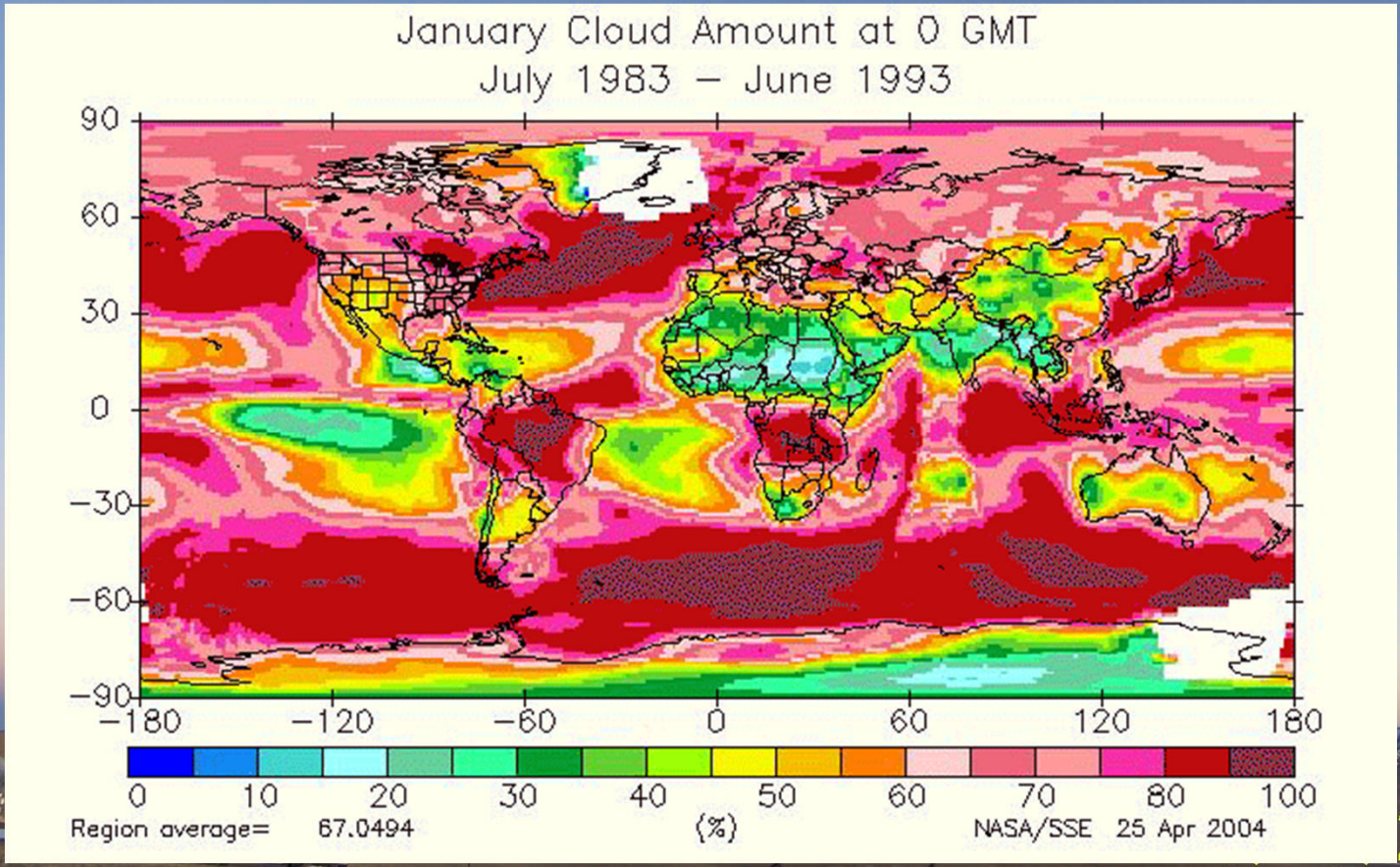
10/26/2009

1.Possible candidate sites in China

Dr. Sarazin (ESO) showed a global weather map at SPIE at Kona, 2002 .

Refer to **http://eosweb.larc.nasa.gov/sse/**
Meteorology and Solar Energy
Global/Regional Plots

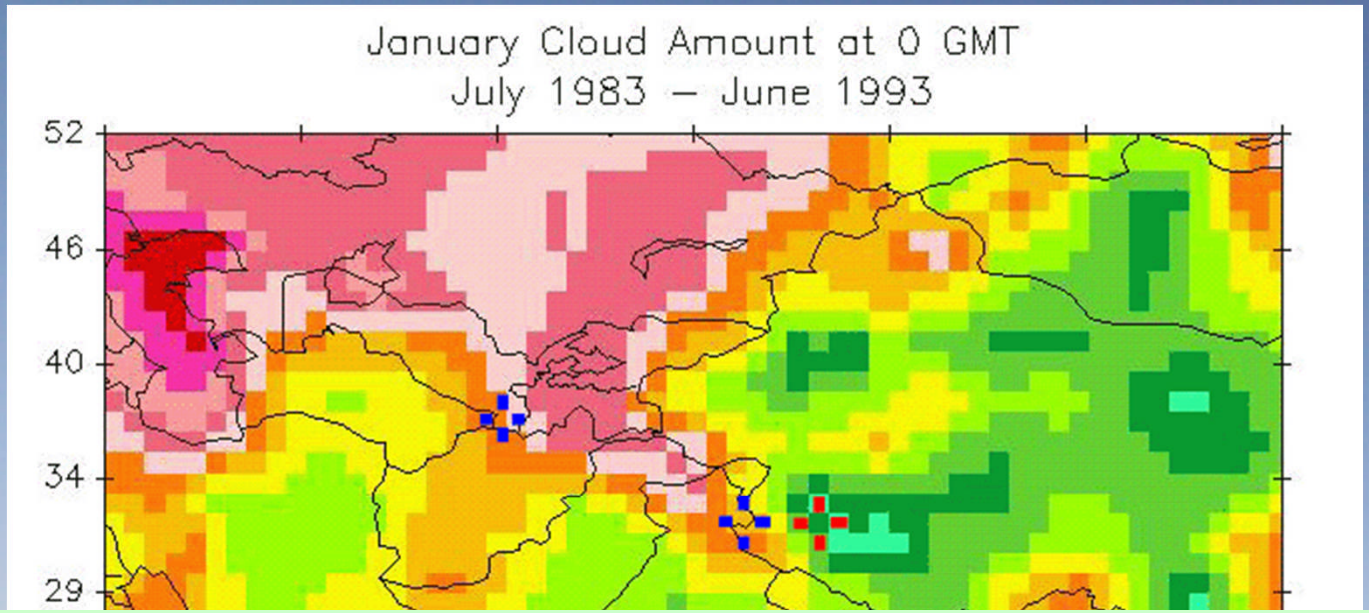
Global Cloud Distribution



2009

Cloud map around west China

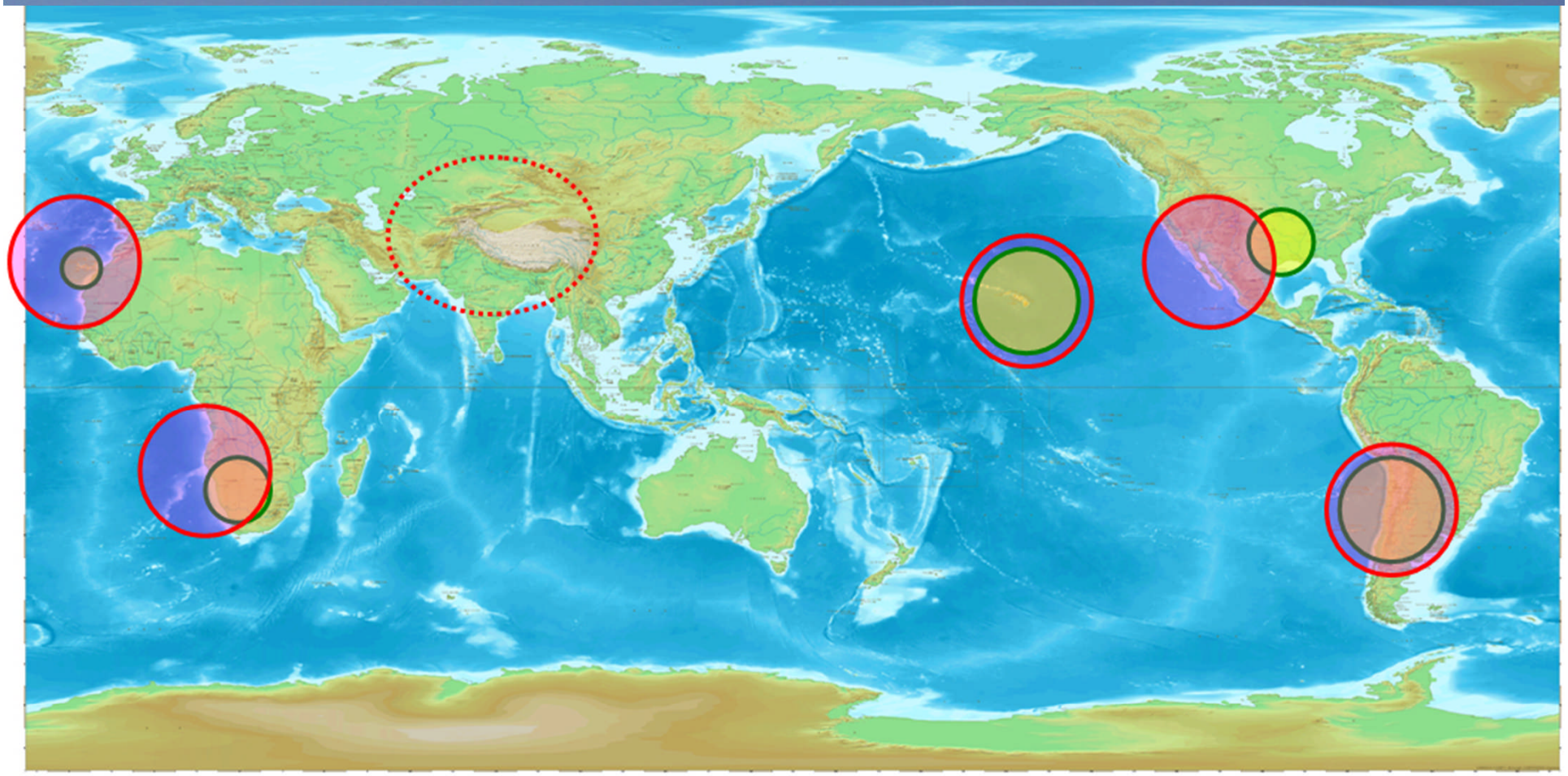
Arranged only for night data.
Two blue crosses show *Hanle* (India) and *Maidanak* (Uzbekistan). Red cross shows candidate site in Tibet.



1. We were considering our plan for Japanese next Telescope after Subaru with good site over the globe.
2. Good site(s) where covers global telescope network .
3. Good site(s) for future Asian Astronomical collaborations.

⇨ west China/Tibet is so interesting site in searching a good site for OPT/IR telescope.

Current and planned sites of big telescopes on the globe



Cloud map around west China

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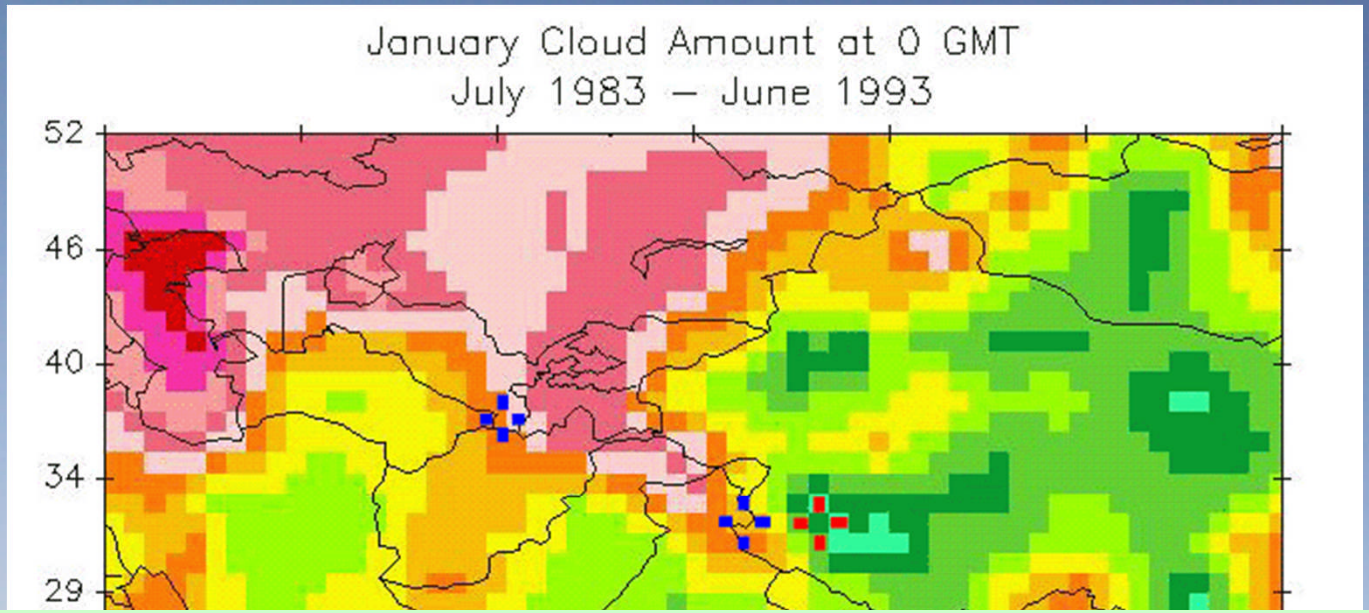

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2. Topographical tours around west China

For several years **Chinese astronomers** have been looking for good site in China, and held workshop on site survey at Lhasa in 2004.

Seven Japanese astronomers/engineers joined the WS.
After then, we (Japanese side) have joined the site survey project in west China (MOU between NAOC and NAOJ was signed in Mar,2006 and updated in 2009).

Site Tours was conducted around west China to look for sites several times. In May-June 2007 tour in northern Xinjiang, we started Lhasa via Kashi to Urumqi, for more than 3 weeks about 5000km.

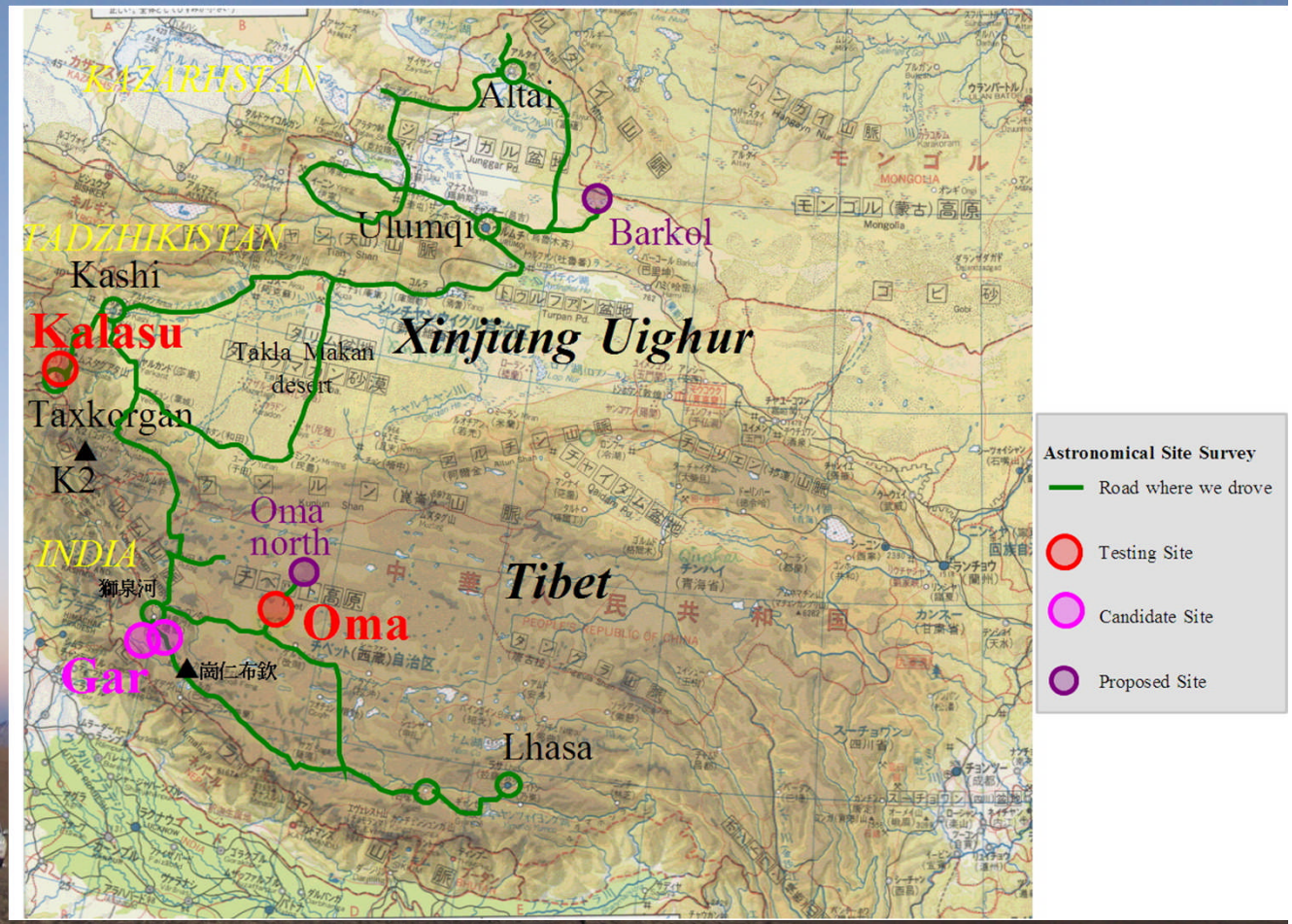
Testing Sites

Karasu
38:10:29.3 N
74:48:08.7 E
4495 m high

Oma
32:32:39.8 N
83:03:22.0 E
5032m high

New Site

Gar
32:17:16.8 N
80:06:59.0 E
5100m



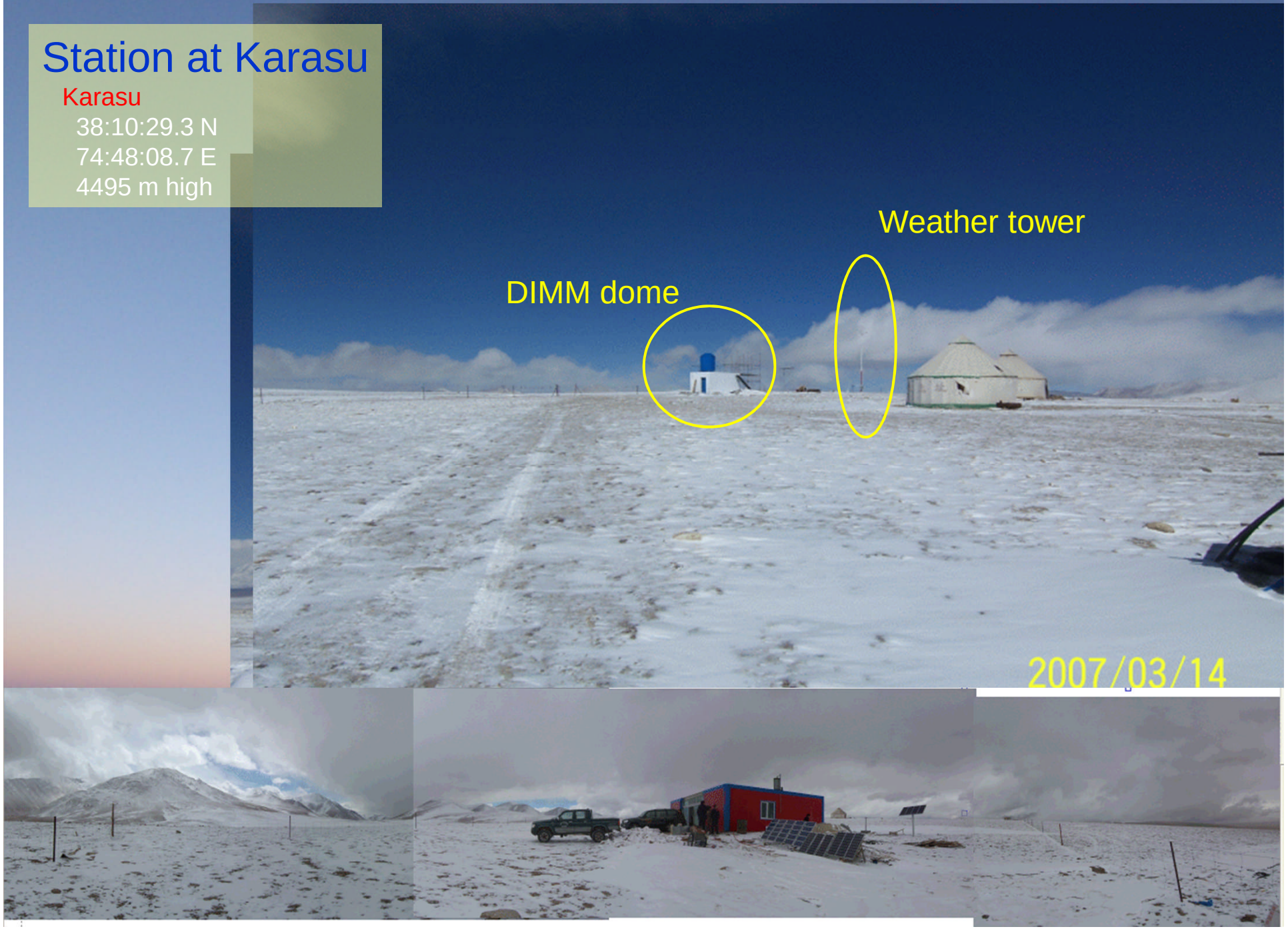
Site Tours was conducted around west China to look for sites several times. In May-June 2007 tour in northern Xinjiang, we started Lhasa via Kashi to Urumqi, for more than

Sometime we met accident(s)…

… overcome to continue the site survey.

Station at Karasu

Karasu
38:10:29.3 N
74:48:08.7 E
4495 m high



Station at Oma

Oma

32:32:39.8 N
83:03:22.0 E
5032m high

View from DIMM dome at Oma

Station at Oma

Oma

32:32:39.8 N
83:03:22.0 E
5032m high

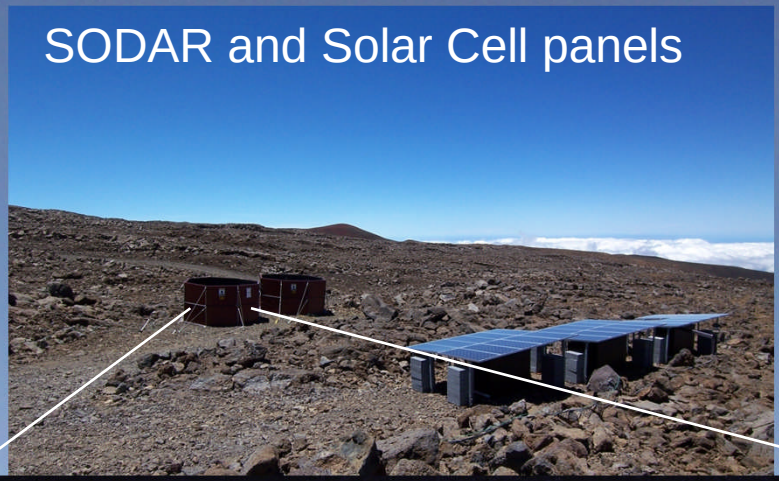
Satellite communication antenna has been installed at Oma site in 2008, thanks to Collaboration with Taiwanese Astronomer

3. Site testing instruments available at the sites

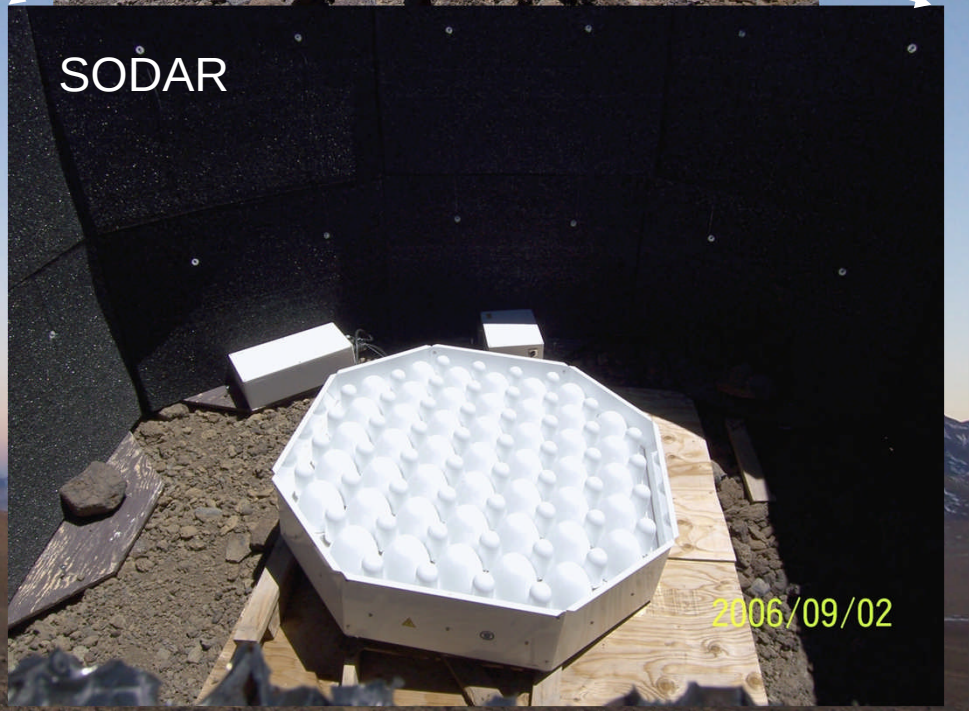
Site testing at Mauna Kea for **TMT**

DIMM/MASS tower,
Subaru, Keck, IRTF, & Gemini on background

SODAR and Solar Cell panels



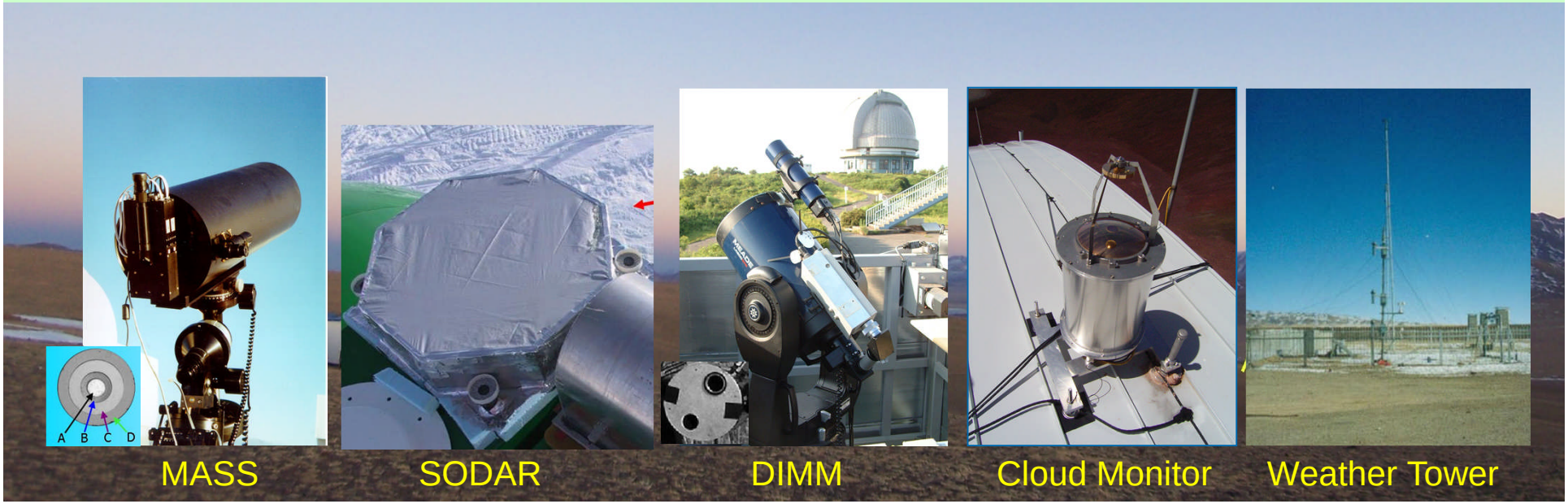
SODAR



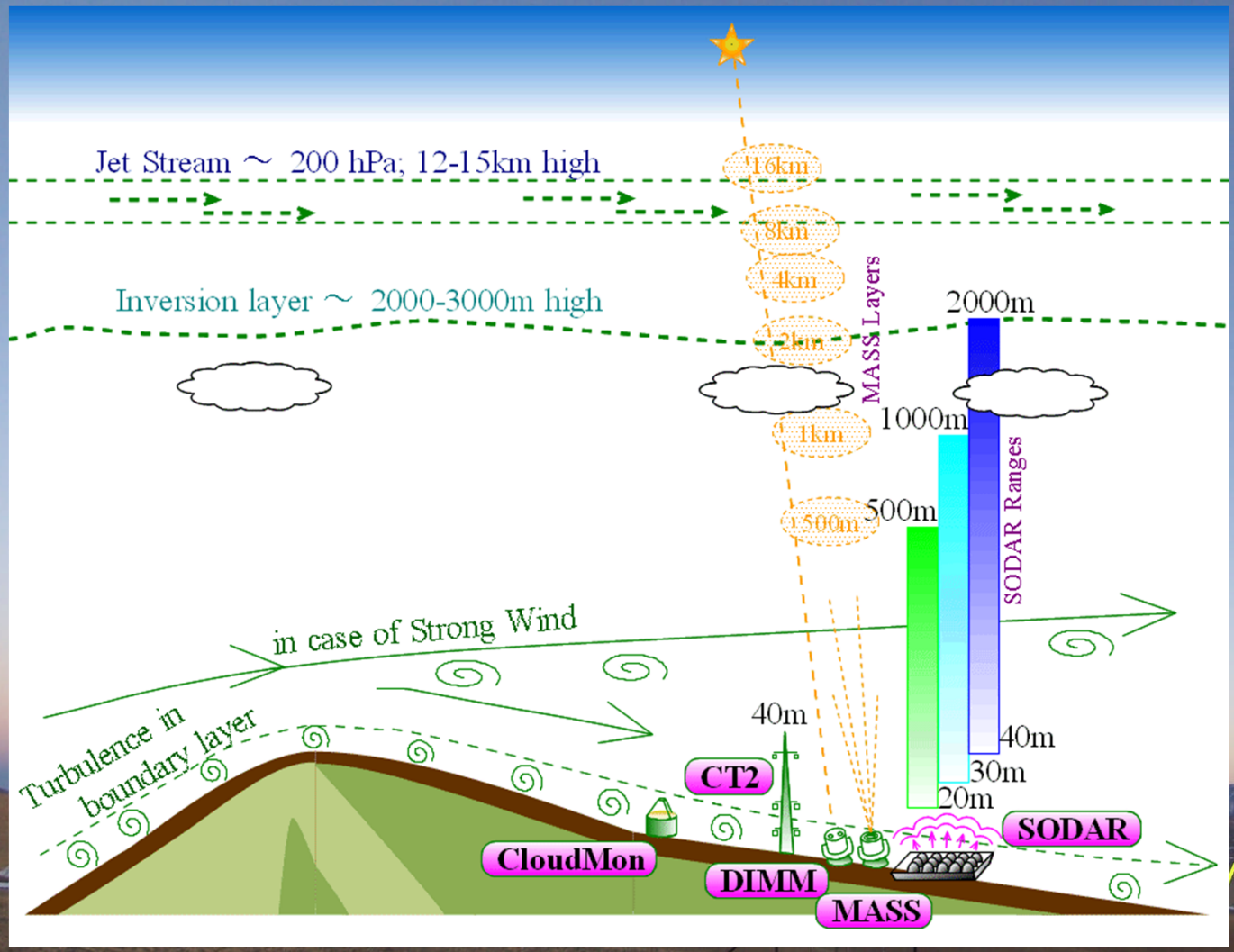
Site testing instruments available at the sites

Instrument	Charge	Method	Contents	Height range
Visible whole-sky camera*	China	visible CCD camera	Night sky	through above sky
IR Cloud monitor*	Japan	10μm-band MIR camera	Cloudiness	through above sky
Weather station*	Both	Temperature, Humidity, Pressure, Wind, Rain	Meteorological data	0 m to several 10 m on the tower
C_T^2 sensors	Japan	variation of micro-thermal turbulence	Seeing	up to tower height
DIMM *	China	Differential Image Motion Monitor	Seeing	through above sky
MASS	China	Multi-Aperture Scintillation Sensor	Scintillation	1km to several 10km
SODAR	Japan??	Sound detection and ranging	Scintillation	15m to 1km

*Currently available instruments

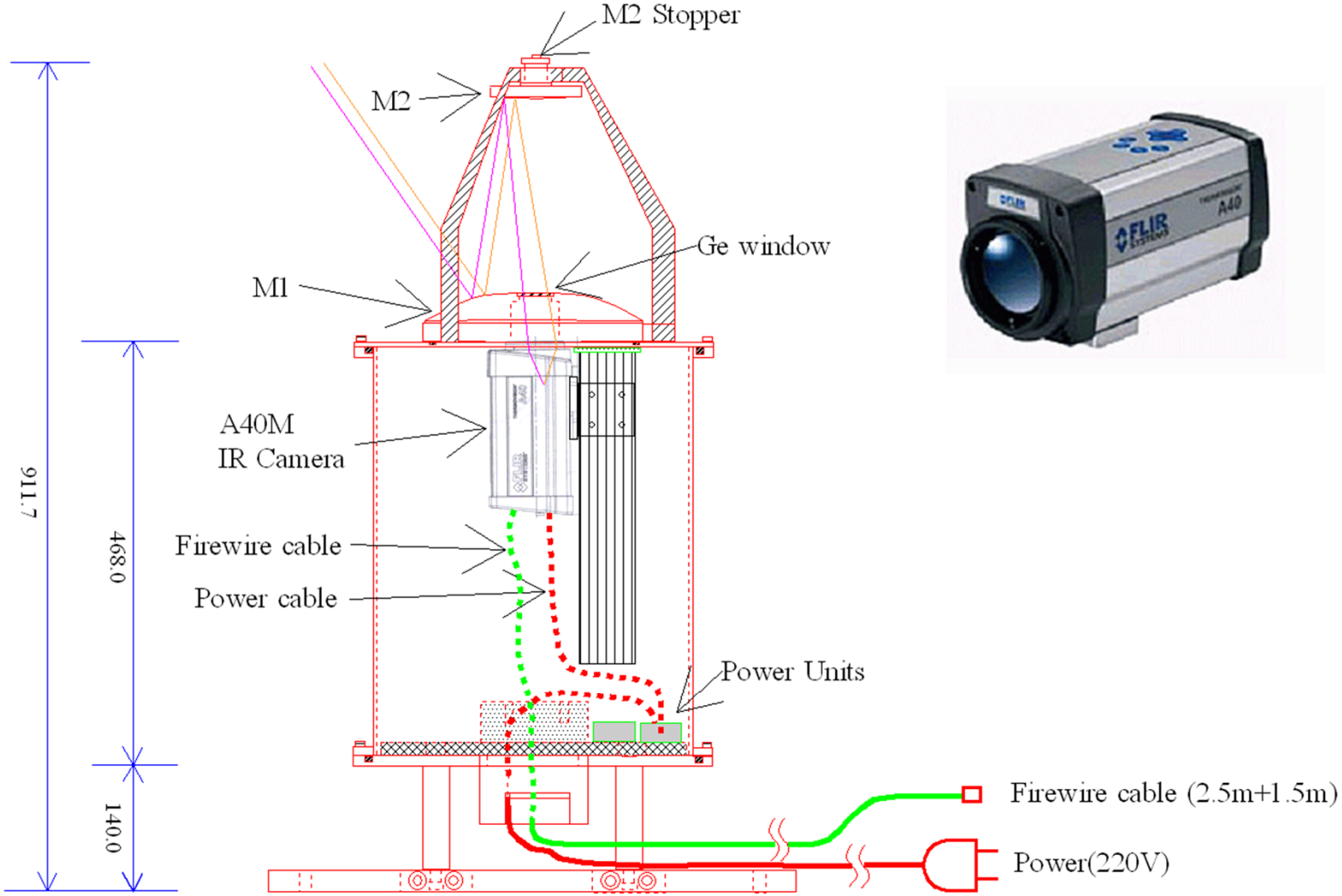


Site testing instruments available at the sites



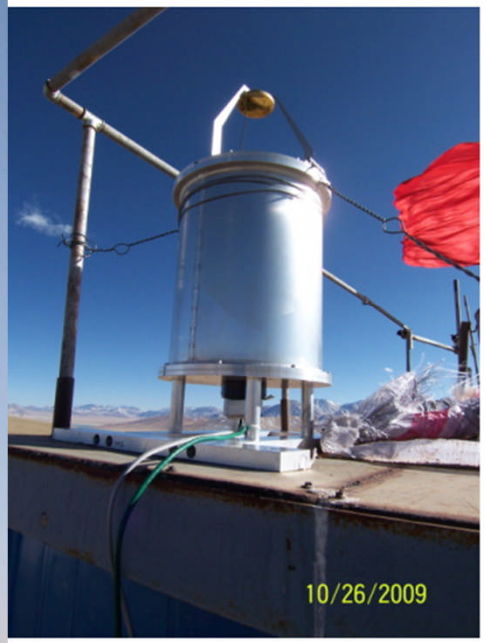
/26/2009

CloudMonitor at Karasu and its results

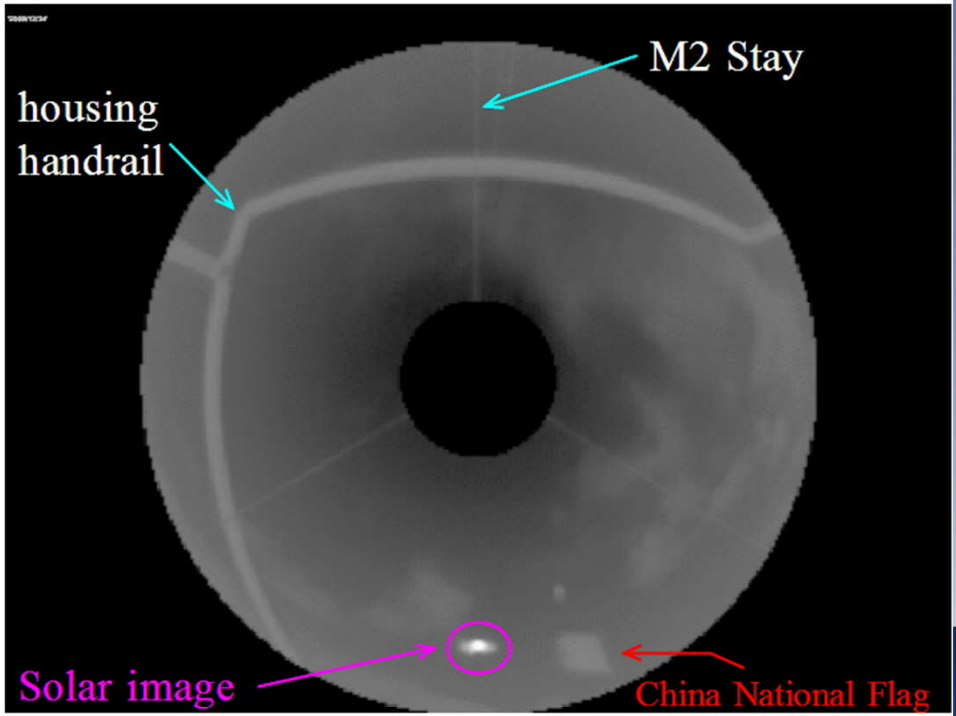


Cloudiness observed w/ CloudMon at Oma in 2008 and 2009

FOV of Cloud Monitor



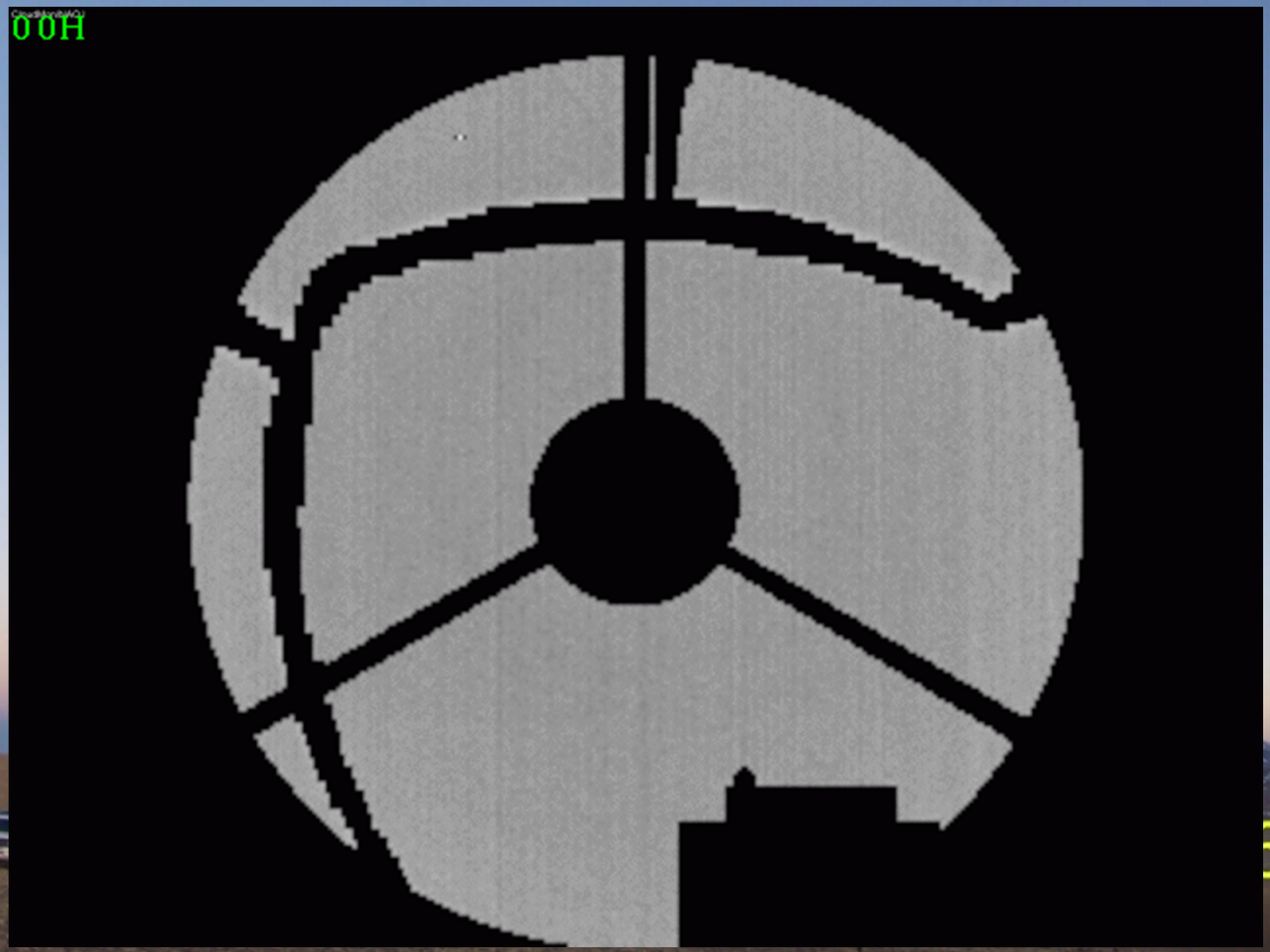
A Cloud Monitor
on housing roof
at Oma, Tibet



Cloudiness observed w/ CloudMon at Oma in 2008 and 2009

All-sky images, every 1 hous, taken w/Cloud Monitor at Oma on 2008-12-24

Ground-based MIR images (Thermal-Eye 2000B Camera, 7-14 μm (320x240 pixel array), 1 frame/ 1 min)



Cloudiness observed w/ CloudMon at Oma in 2008 and 2009

Oma	天候概況判断	○	快晴
		△	雲あり
		×	降雨

昼間 夜間

UT	0h	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h
2008/12/1	△	△	△	△	△	△	△	△	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2008/12/2	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2008/12/3	○	○	△	△	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2008/12/4	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2008/12/5	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2008/12/6	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△	○	○	○	○	○	○	○	○	○
2008/12/7	○	○	○	△	○	○	○	○	○	△	△	△	○	○	○	○	○	○	○	○	△	△	△	△
2008/12/8	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	○	○
2008/12/9	○	○	○	○	○	△	△	△	△	△	△	△	△	△	○	○	○	○	○	○	○	○	○	△
2008/12/10	○	○	○	○	○	○	○	△	△	△	△	△	○	○	○	○	○	○	○	○	○	○	○	○
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2008/12/12	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
2008/12/13	○	○	△	○	○	○	○	○	○	○	○	○	△	△	△	○	○	○	○	○	△	○	○	○
2008/12/14	△	○	△	○	○	○	○	○	○	○	○	○	○	○	△	○	○	○	○	○	○	○	○	○
2008/12/15	○	○	△	○	○	○	△	△	△	△	△	△	△	○	○	○	○	○	○	○	○	○	○	○
2008/12/16	○	○	○	○	○	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
2008/12/17	△	△	△	△	△	△	△	△	△	△	△	△	○	○	○	○	○	△	○	○	○	○	○	○
2008/12/18	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△	△	△	△	○	○	○	○
2008/12/19	△	○	○	○	○	○	△	△	△	△	△	△	△	△	△	△	△	△	○	△	△	△	△	△
2008/12/20	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	○	○	○	△	△	○
2008/12/21	○	○	○	○	○	△	△	△	△	△	△	△	△	○	○	○	○	○	○	○	○	○	○	○
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2008/12/23	△	△	△	○	△	△	△	△	△	△	△	△	△	△	△	△	△	○	○	○	○	○	○	○
2008/12/24	○	○	○	○	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	○	○	○	○	○
2008/12/25	○	○	○	○	○	△	○	△	○	○	○	○	○	○	○	○	○	○	△	△	△	△	○	○
2008/12/26	○	○	○	○	○	△	△	△	○	△	△	△	○	○	○	○	○	○	○	○	○	○	○	○
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2008/12/29	○	○	○	○	○	○	△	△	△	△	△	△	△	△	△	△	△	○	○	○	○	○	○	○
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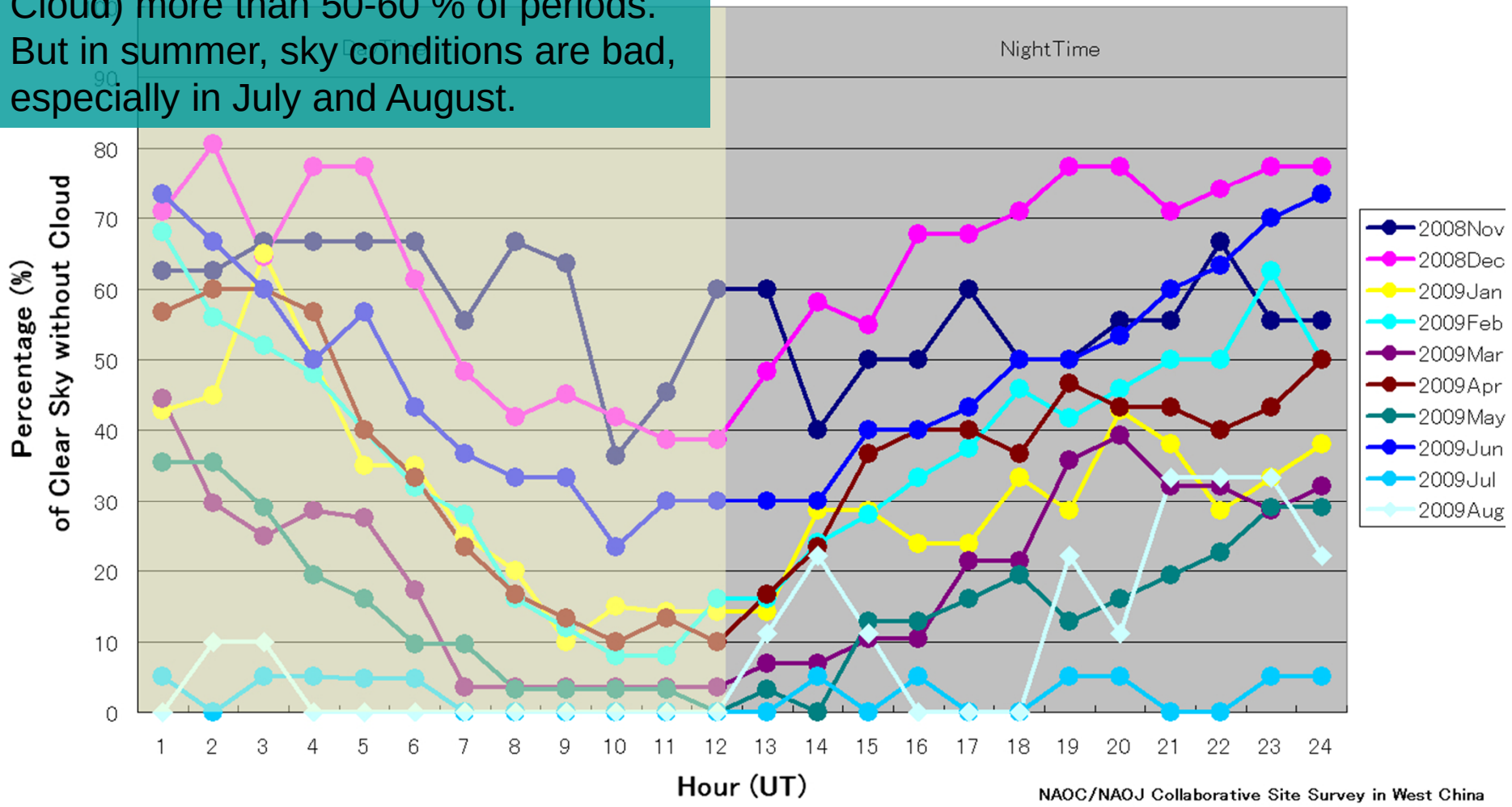
2008/12/31	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
UT	0h	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h

Percentile of Clear sky at Oma in 2008 and 2009

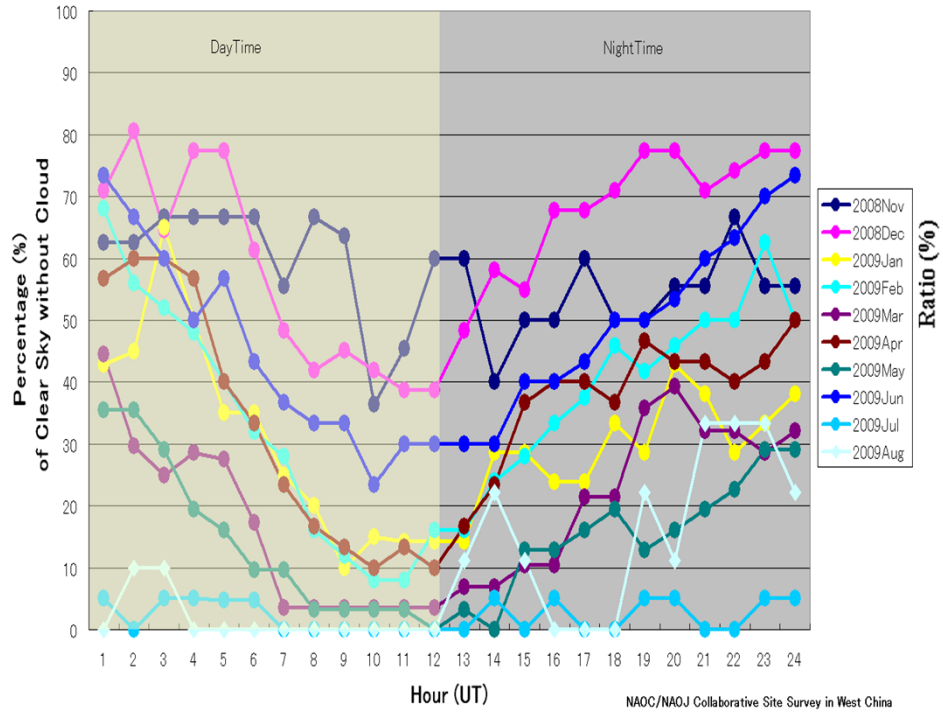
Clear sky means exactly "NO" cloud in the sky in this viewgraph.

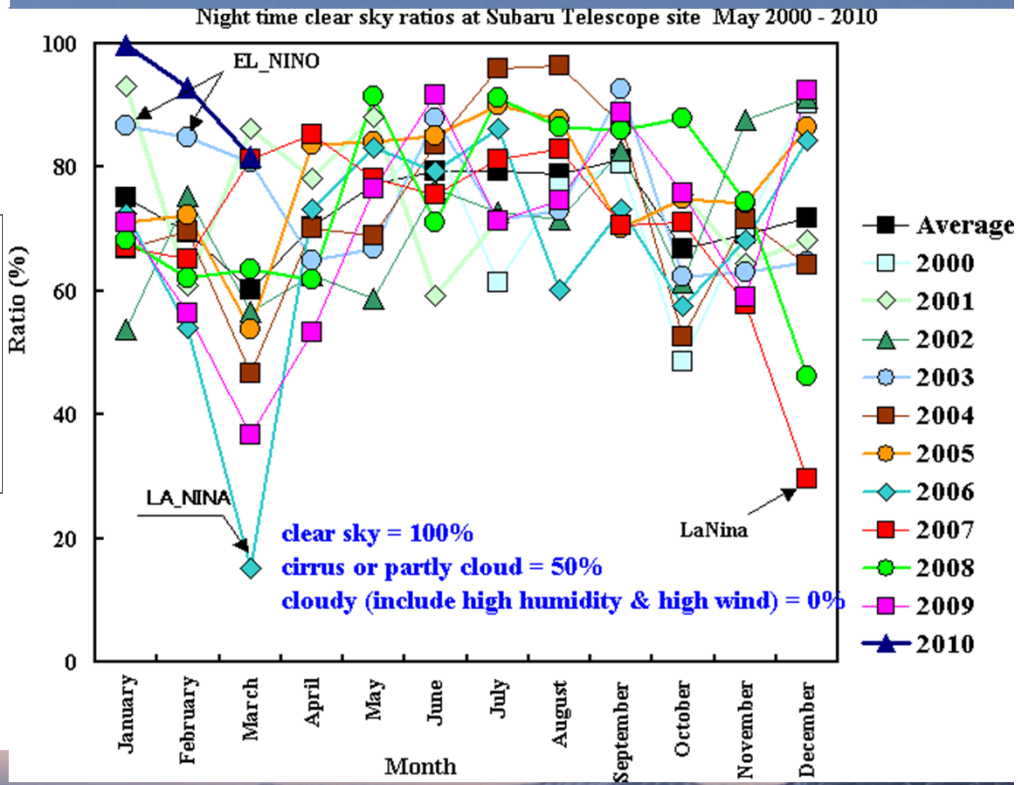
Oma have a nice conditions in winter season with clear sky (completely "NO" Cloud) more than 50-60 % of periods.
But in summer, sky conditions are bad, especially in July and August.



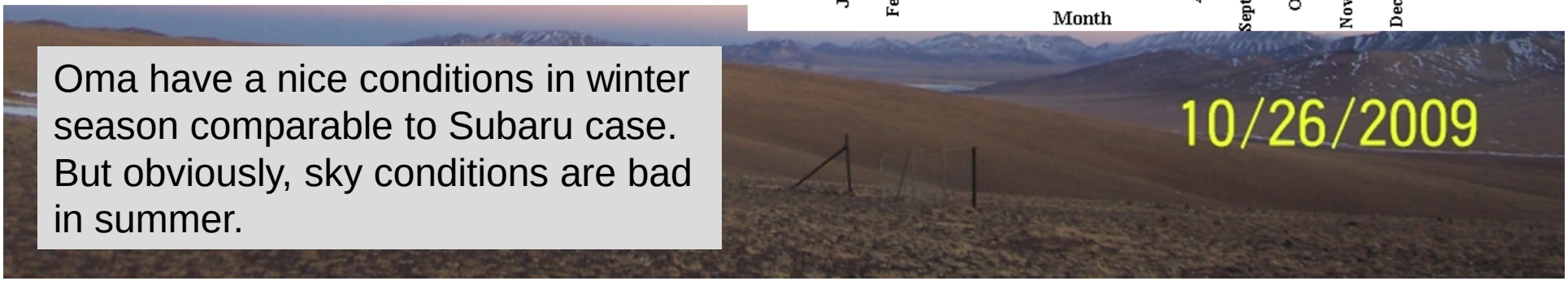
Compare to Subaru measurement on Clear sky percentage

Clear sky means exactly “NO” cloud in the sky at Oma.
For Subaru case, sky with some cloud is counted as percentage of 50%.





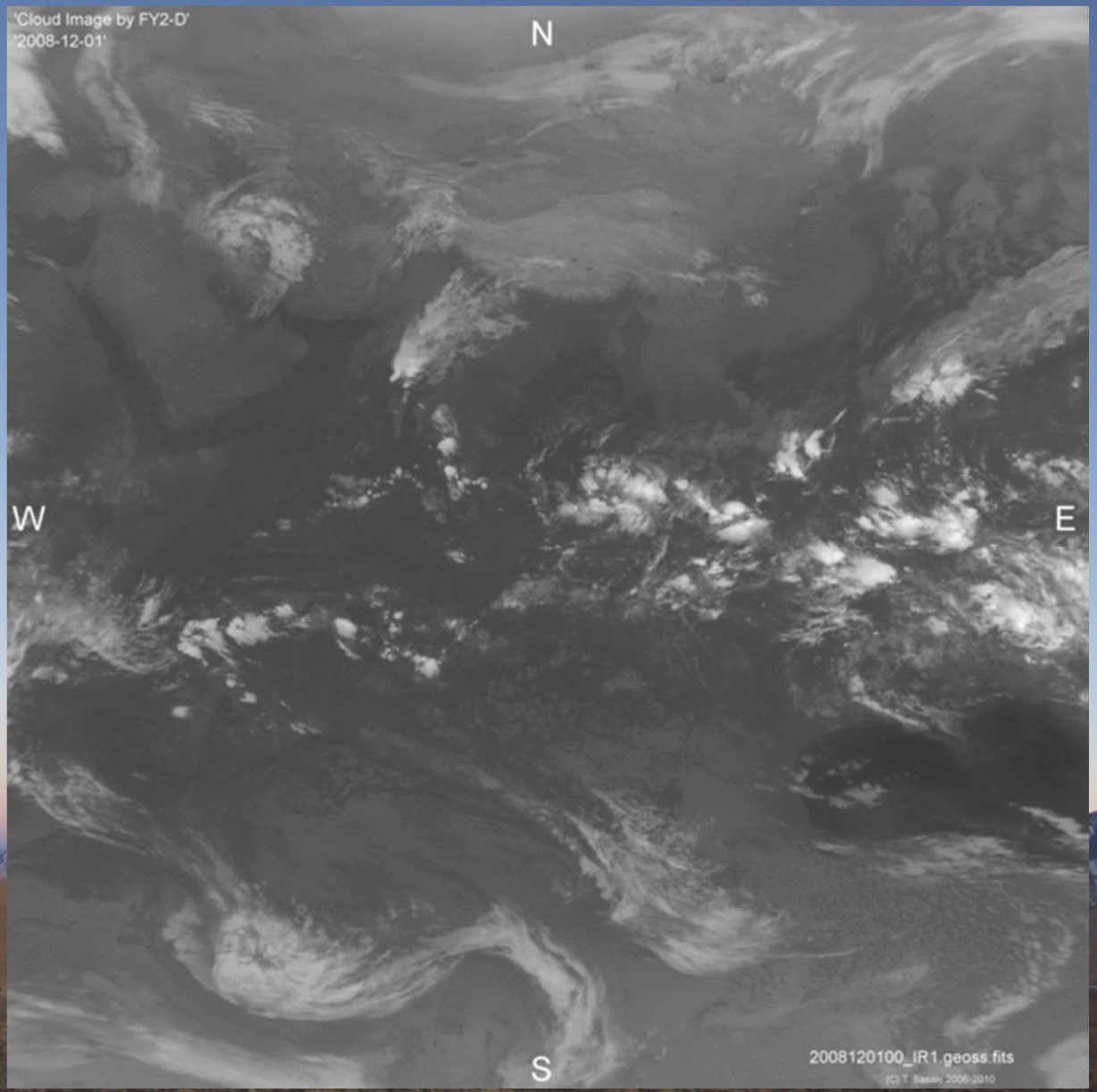
Oma have a nice conditions in winter season comparable to Subaru case.
But obviously, sky conditions are bad in summer.



Cloudiness observed w/ CloudMon at Oma in 2008 and 2009

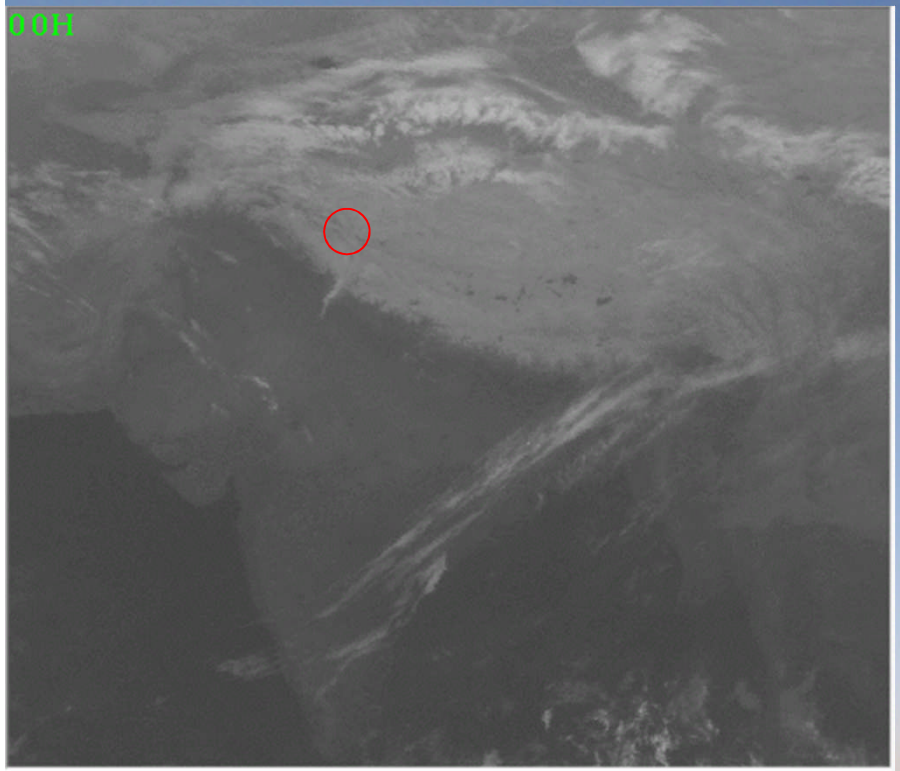
Chinese Weather Satellite, FY2-D, is currently working and their data are available at Chiba-U, Japan on Web site,
ftp://fy.cr.chiba-u.ac.jp/

(Resolution = 0.04° ～ 4km)



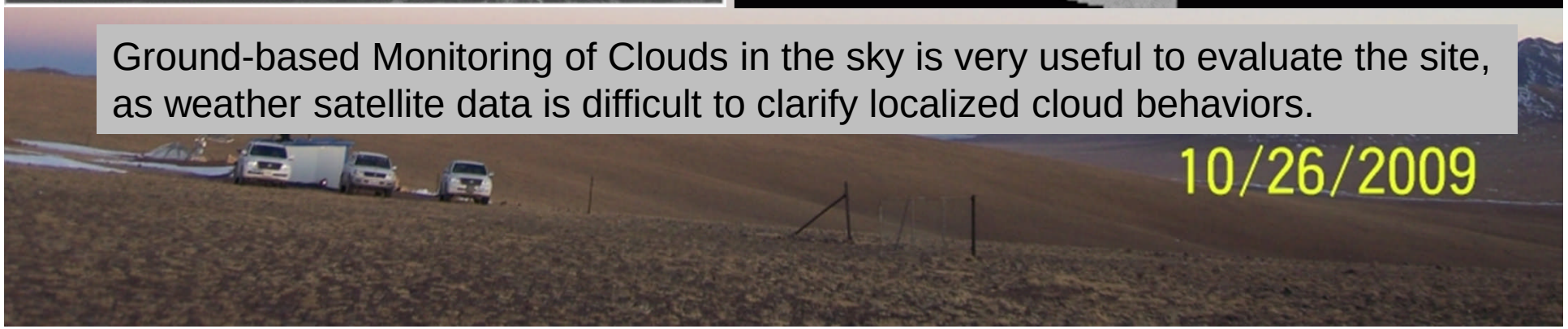
Clouds observed w/Weather Satellite and ground-based CloudMon

Weather Satellite, FY2-D in IR(10μm)

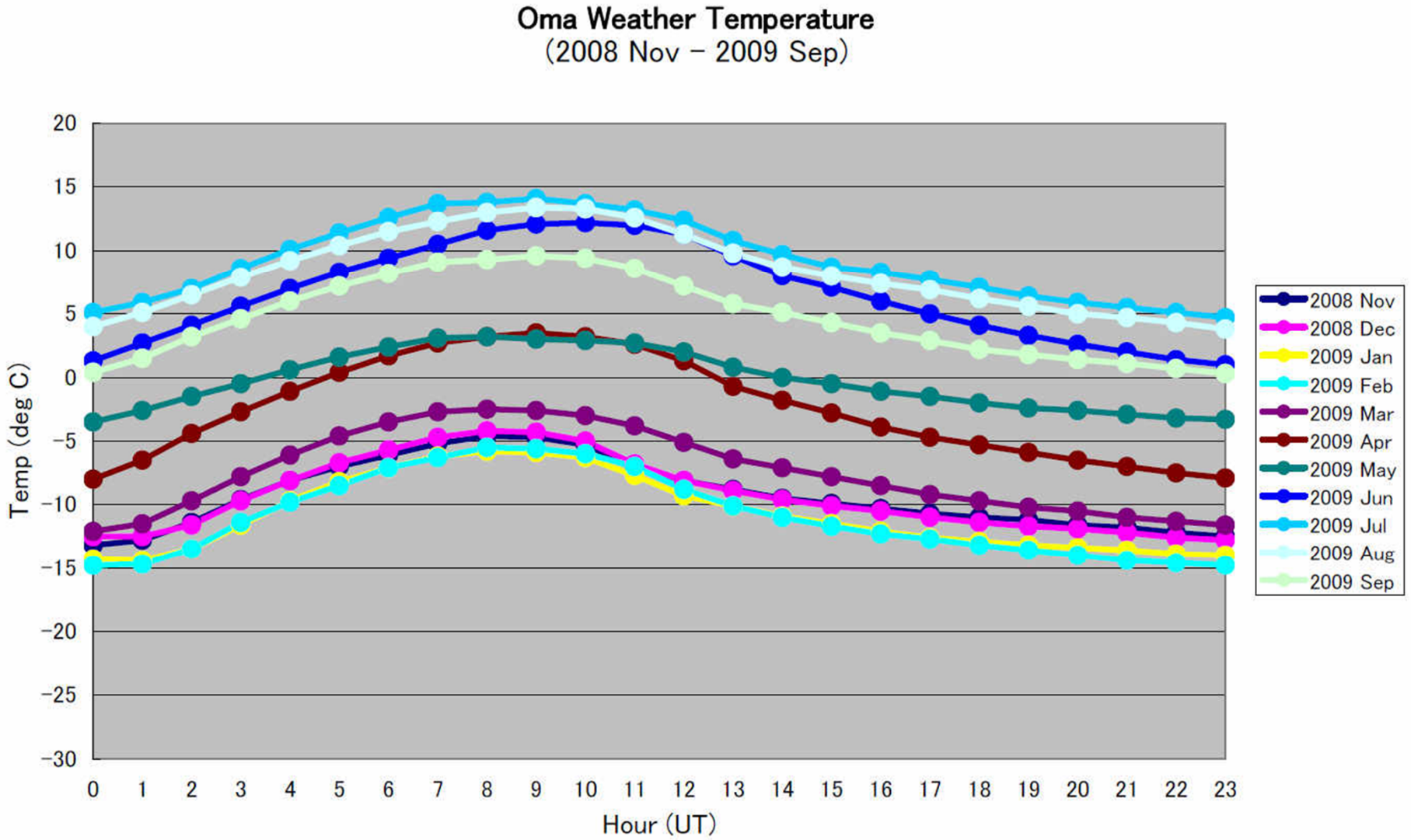


MIR Cloud Monitor Camera (7-14μm)

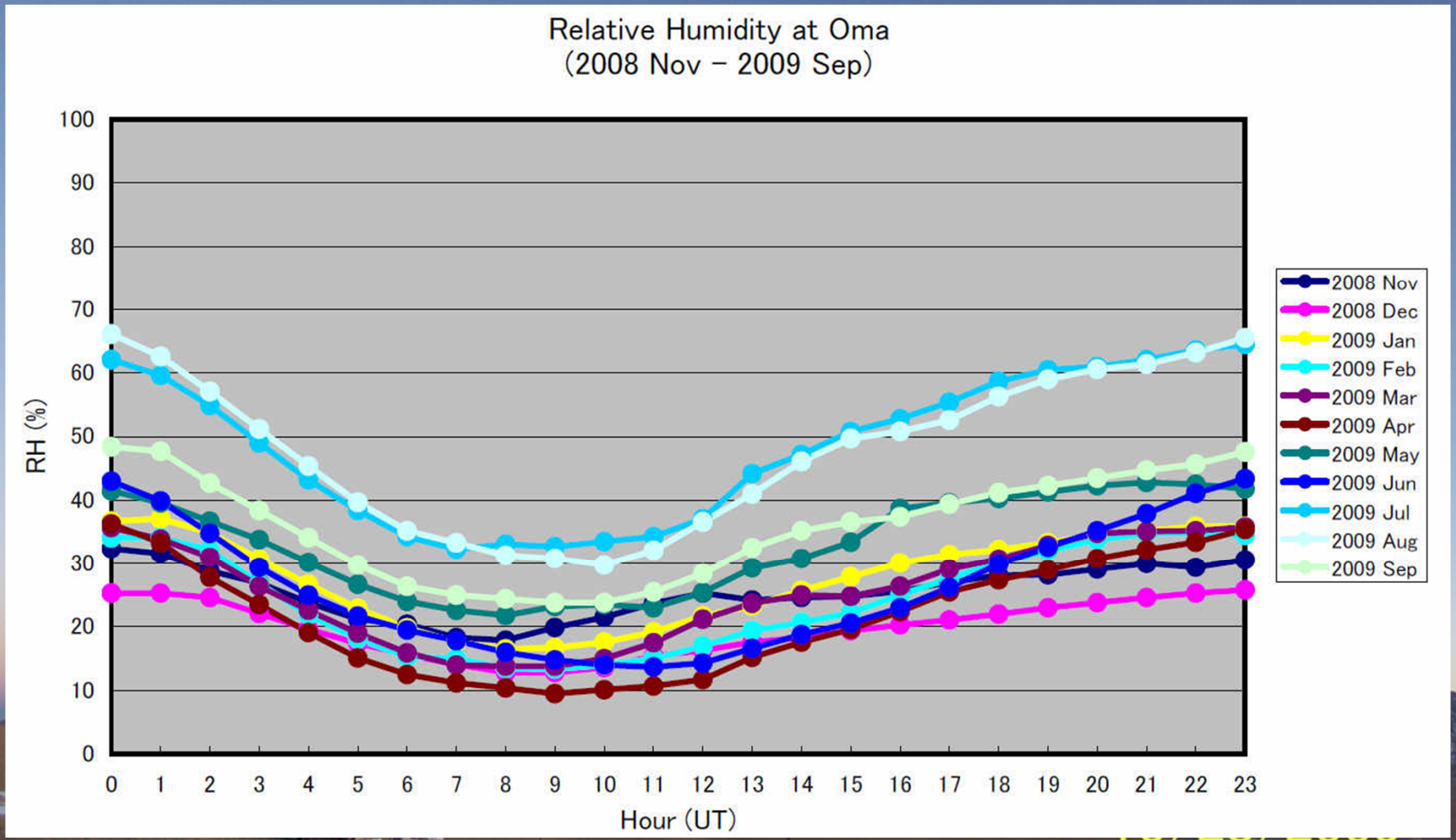
Ground-based Monitoring of Clouds in the sky is very useful to evaluate the site, as weather satellite data is difficult to clarify localized cloud behaviors.



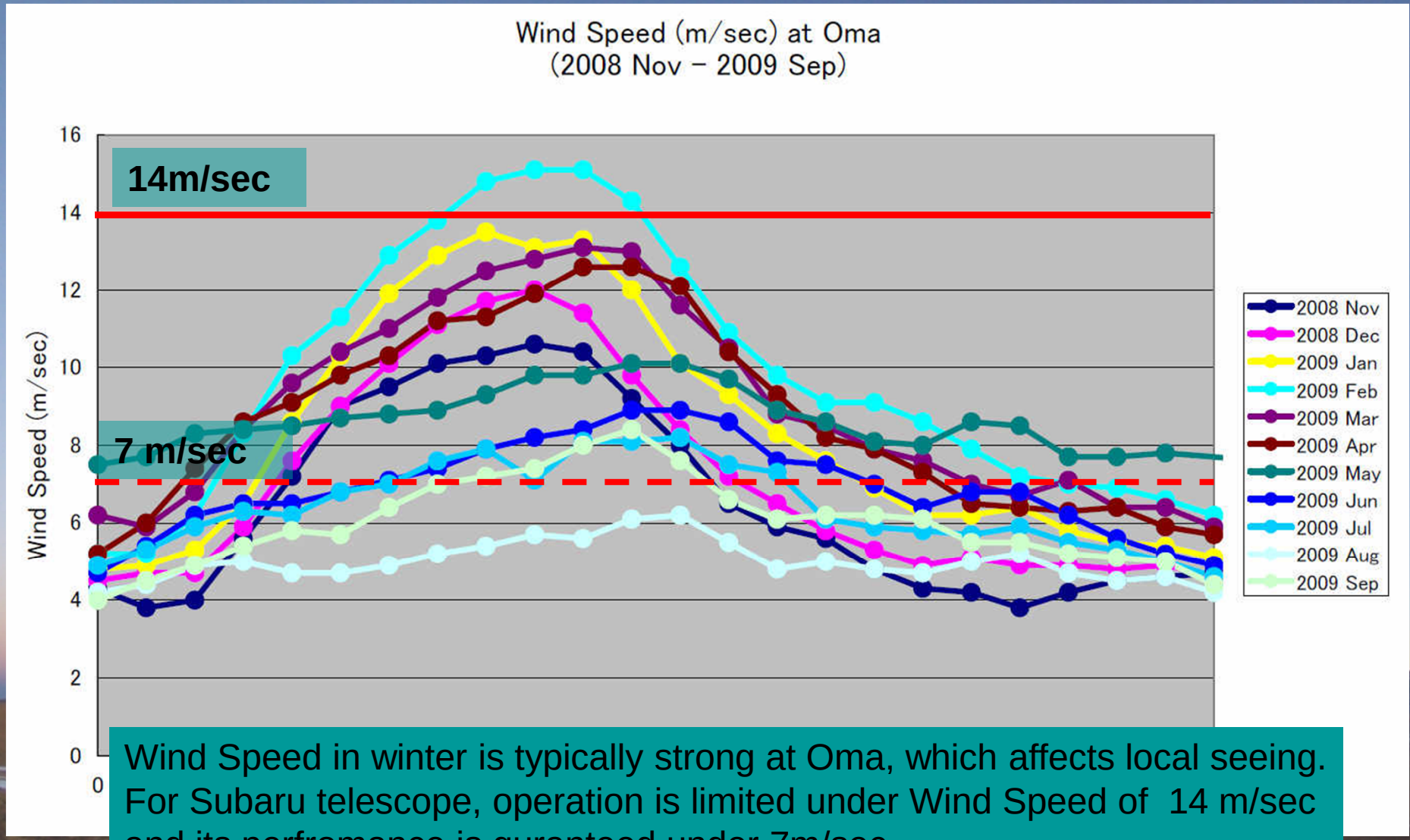
Weather station data at Oma in 2008 and 2009



Weather station data at Oma in 2008 and 2009

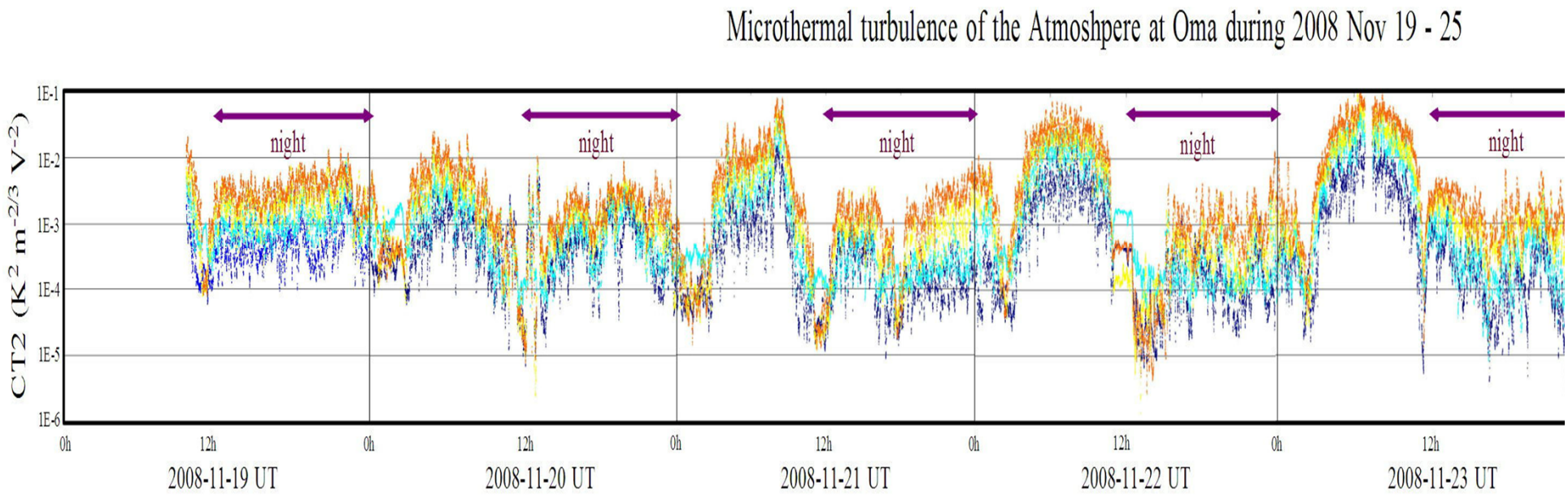


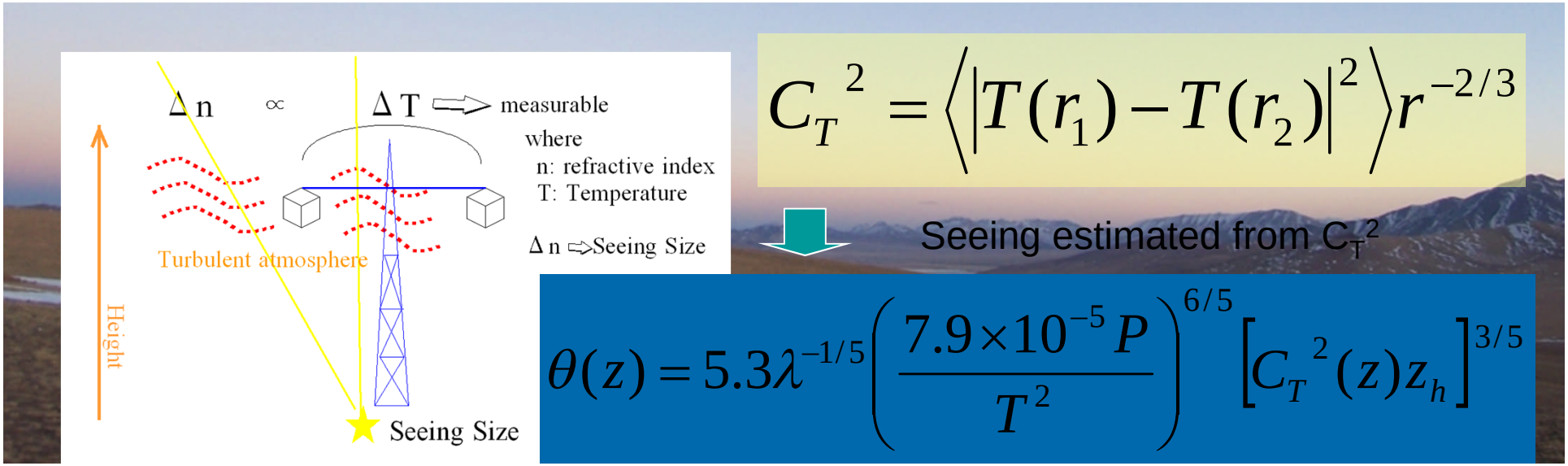
Weather station data at Oma in 2008 and 2009



Wind Speed in winter is typically strong at Oma, which affects local seeing. For Subaru telescope, operation is limited under Wind Speed of 14 m/sec and its perfromance is guranteed under 7m/sec.

Local Seeing at Oma estimated from Micro-Thermal Turbulence



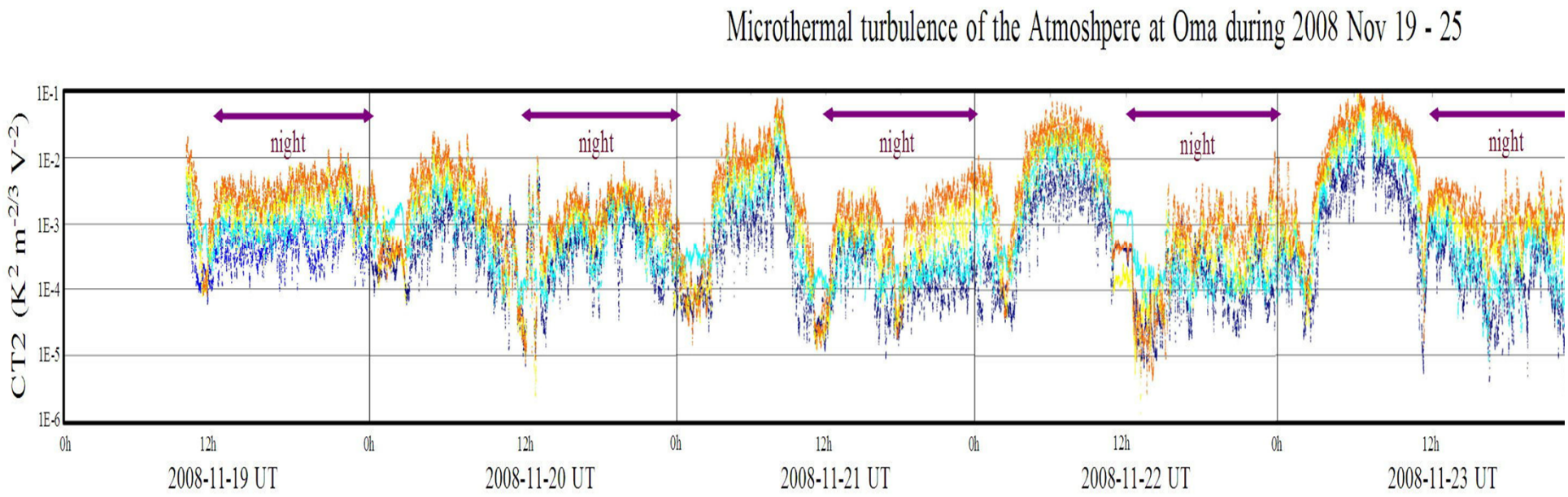


$$C_T^{\,2} = \left\langle \left| T(r_1) - T(r_2) \right|^2 \right\rangle r^{-2/3}$$

Seeing estimated from $C_T^{\,2}$

$$\theta(z) = 5.3\lambda^{-1/5} \left(\frac{7.9\times10^{-5} P}{T^2} \right)^{6/5} \left[C_T^{\,2}(z) z_h \right]^{3/5}$$

Local Seeing at Oma estimated from Micro-Thermal Turbulence



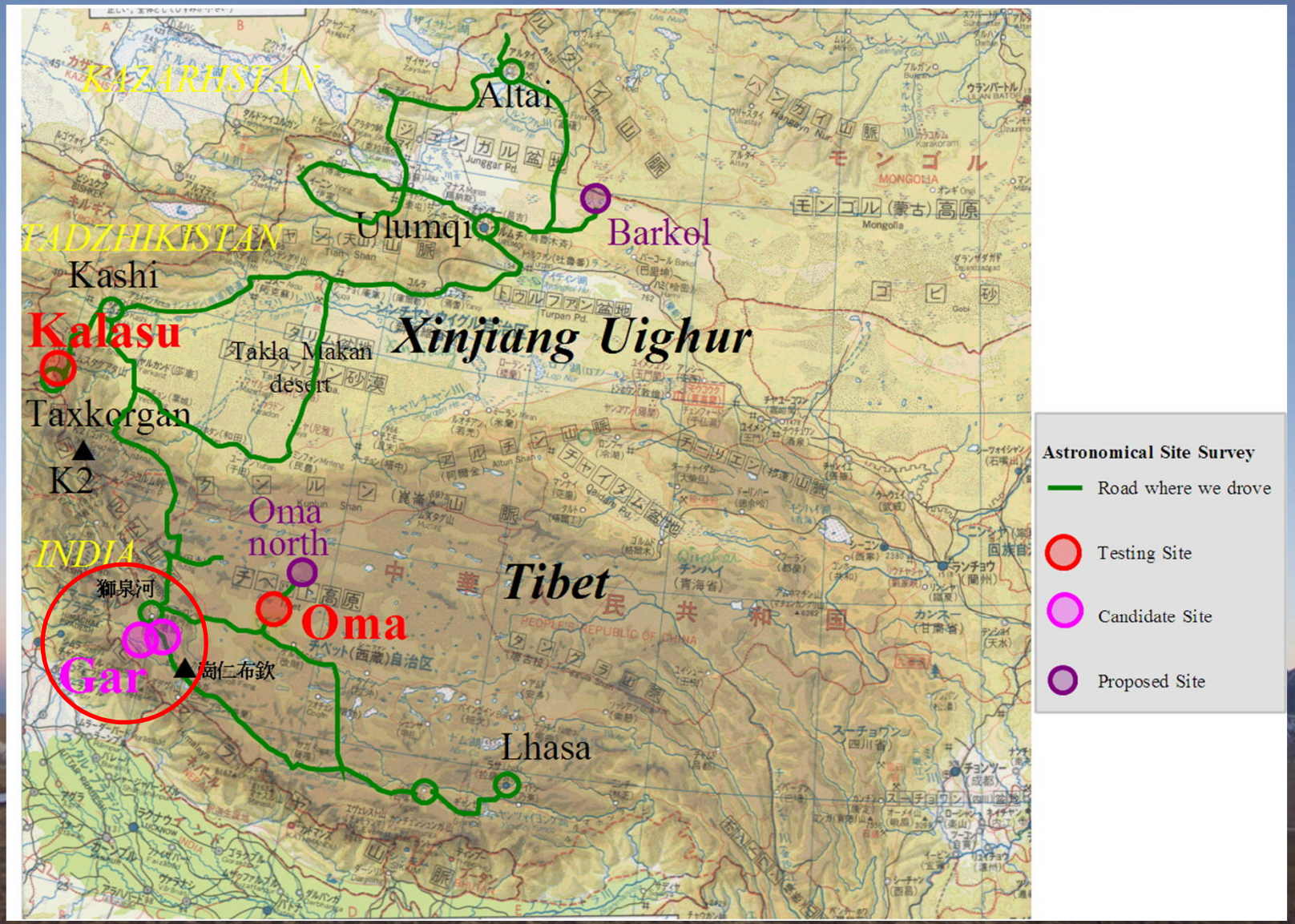
$$\theta(z) = 5.3\lambda^{-1/5}\left(\frac{7.9\times10^{-5}P}{T^2}\right)^{6/5}\left[C_T{}^2(z)z_h\right]^{3/5}$$

Oma Seeing during 2008-11-19 ～11-25

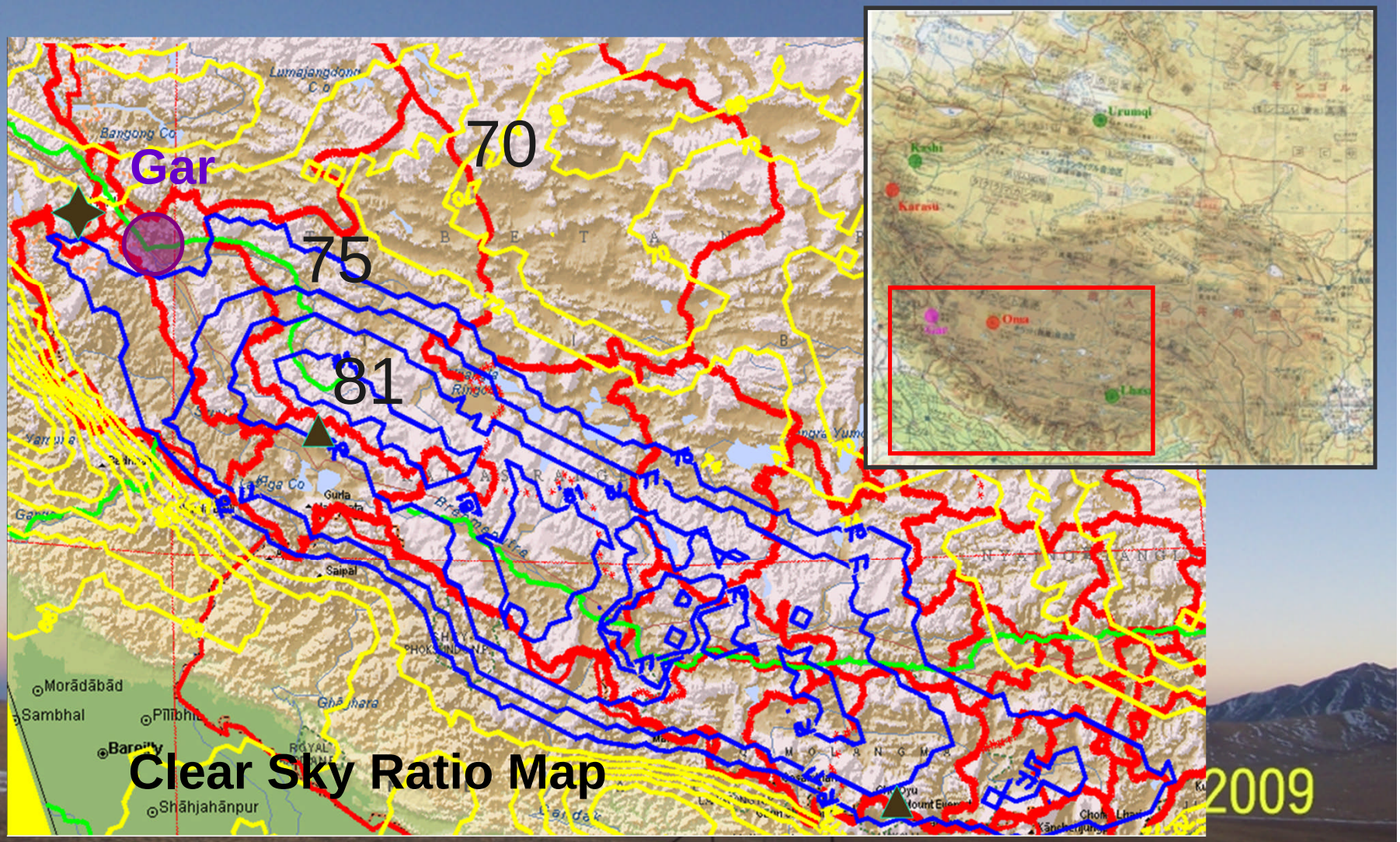
Layer#1 at height 36.65m : 0.02"
Layer#2 at height 27.65m : NG
ht 19.15m : 0.03"
ht 14.15m : 0.05"
ht 9.65m : 0.07"

Seeing estimated CT2 shows only seeing around surface layer, we need seeing evaluation through full atmosphere using DIMM/MASS/SODAR.

4. Possibly best site near Gar in west China



Possibly best site near Gar in west China



2009

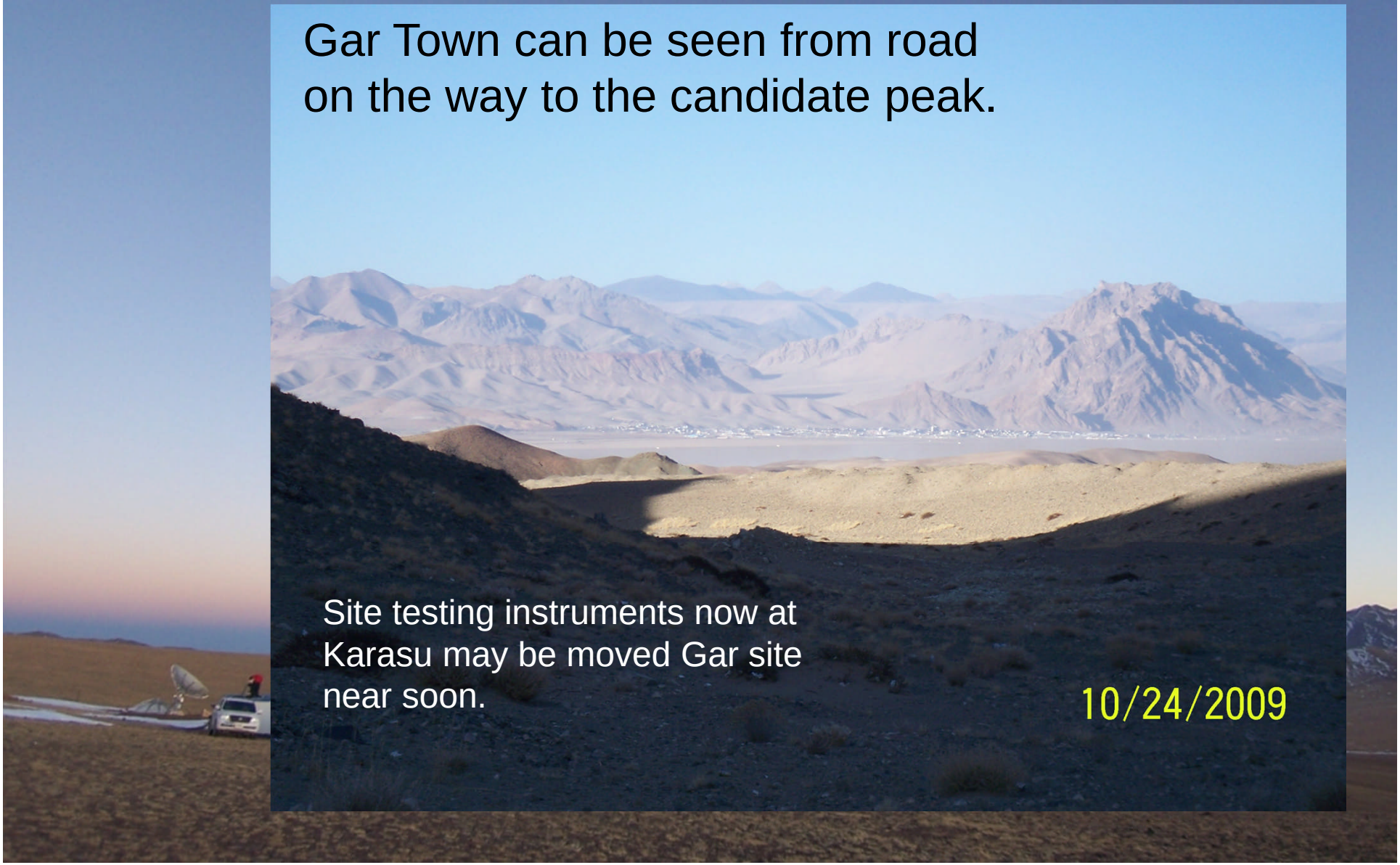
Possibly best site near Gar in west China

Gar#1 5000m
32° 17'16.80"N
80° 06'59.00"E

Another peak can be nominated, far west over the mountain range.

Gar#2 5100m
31° 47’53.96"N
79° 43’04.28"E

Possibly best site near Gar in west China



5. Possible Telescope plan at Gar site

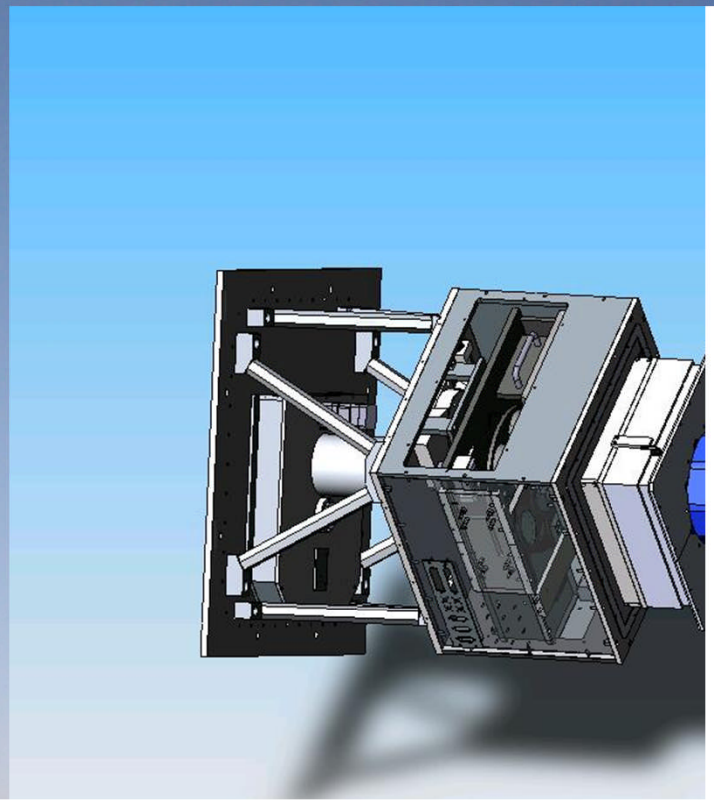
After we evaluate and confirm the good condition around Gar,
We'd like to promote to deploy a **small telescope** w/observation **instruments**.

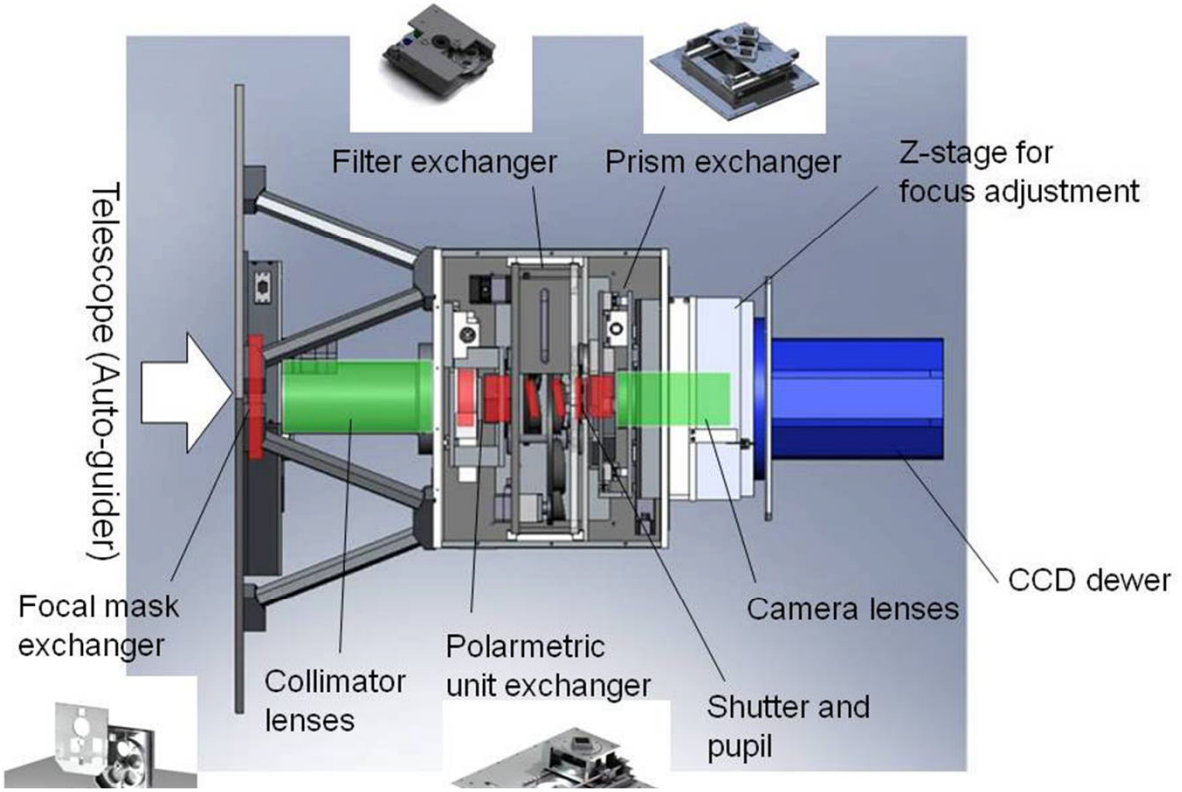
- 1m ～2m Telescope, like TAO 1m telescope made by NISHIMURA's.
- Optical Imaging/Spectroscopic/Polarimetric Instrument,
  like Hiroshima-U's **HOWPol**

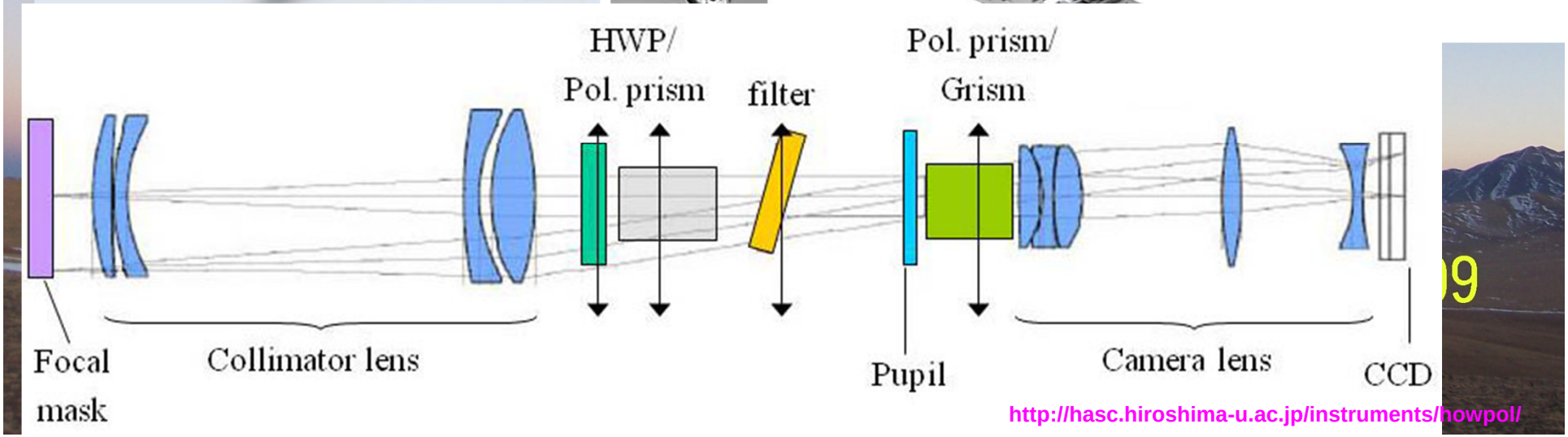
(HOWPol use two Optical CCDs, which are exported into China easily even now.)

And also we like to introduce a possible **4m telescope** near Gar.

- A Copy of Kyoto-U 3.8m telescope, now developing to install at OAO, Japan.
- Now negotiating to make another copy with Kyoto-U leading people.







http:///hasc.hiroshima-u.ac.jp/instruments/howpol/

Possible Telescope plan at Gar site

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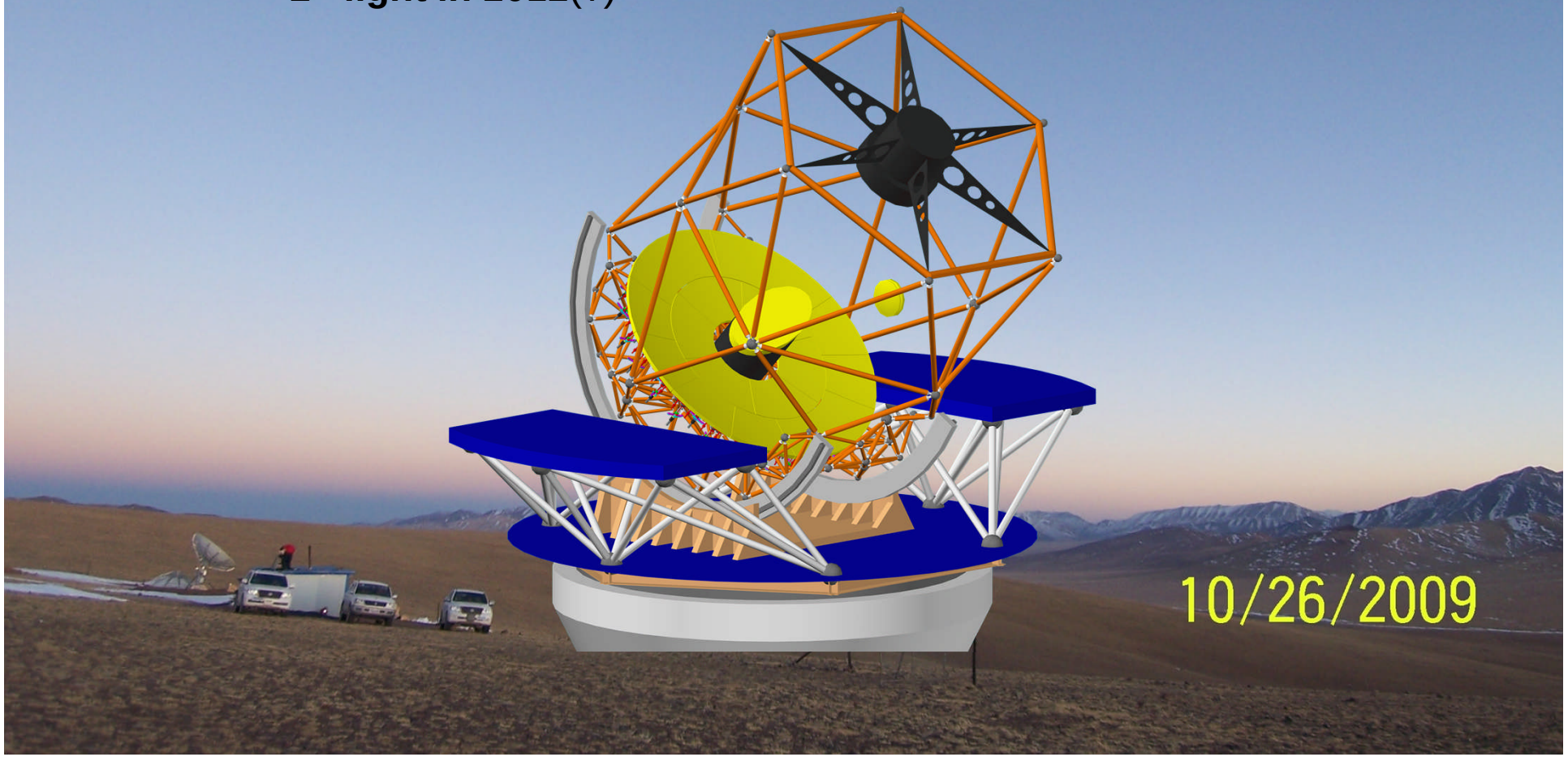
Kyoto 3.8m telescope, possibly installed in west China

http://www.kusastro.kyoto-u.ac.jp/~nagata/Kyoto3m/

- **Fan-shaped segmented 18 mirros**
- **light-weighted truss structure**
- **1st light in** 2012(?)



Possible Telescope plan at Gar site

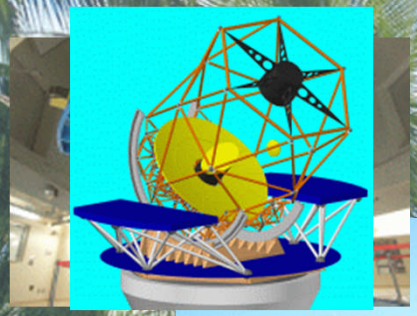
Telescope located covering global telescope network

- **Follow-up observation of GRB to find primordial objects in the early universe and reveal its characteristics**
- **continuous observations of Blazar, Supernova, nova, X-ray binaries, cataclysmic variables, variable stars, so on.**
- **Proper astronomical observations for Asian astronomers**

GRB 090423, z=8.2
13.0 billion l.y.

10/26/2009

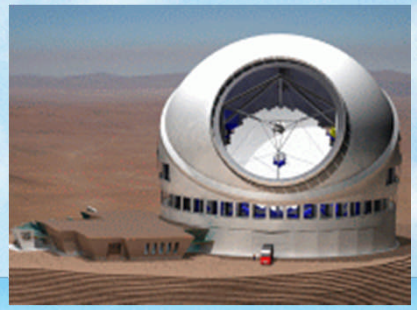
(Most distant galaxies ever detected : z=6.96, 12.9 b.l.y.)



~1m Tel

⇒~4m Tel

for Asian Astronomers in coming era



Gar/Oma

> 5000 m

Mauna Kea

4200 m

Aloha and Mahalo

2008/04/05

***Mauna Kea**, viewed from Wailoa Park, Hilo*

Mauna Kea, viewed from Wailoa Park, Hilo


1.5m
1.5m
2.16m
Xinglong
Bohyun
2m
30m
TMT 30m
Turkey
Maidanak
Tibet?
NishiHarima
Gunma ...
Okayama
Okayama 3.8m
Sinai?
Hanle
Yunnan
China
Lulin
Subaru
Kottamia
2.4m
1.88m
1.88m
1m
3.8m
2m
8.2m
Indonesia
Malaysia
Australia
Indian Ocean
Bering Sea
Gulf of Alaska
Pacific Ocean
Telescope available
Telescope in plan
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