Collaborative Site Testing in West China,

comparing with Subaru and Okayama

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Contents

- Overview on Observational conditions at Subaru Telescope and OAO
- Site testing, showing good conditions in winter at Oma/Tibet
- Telescope Plan near Ali and possible 4m telescope in future for Asian astronomers

Collaborative Site Testing in West China

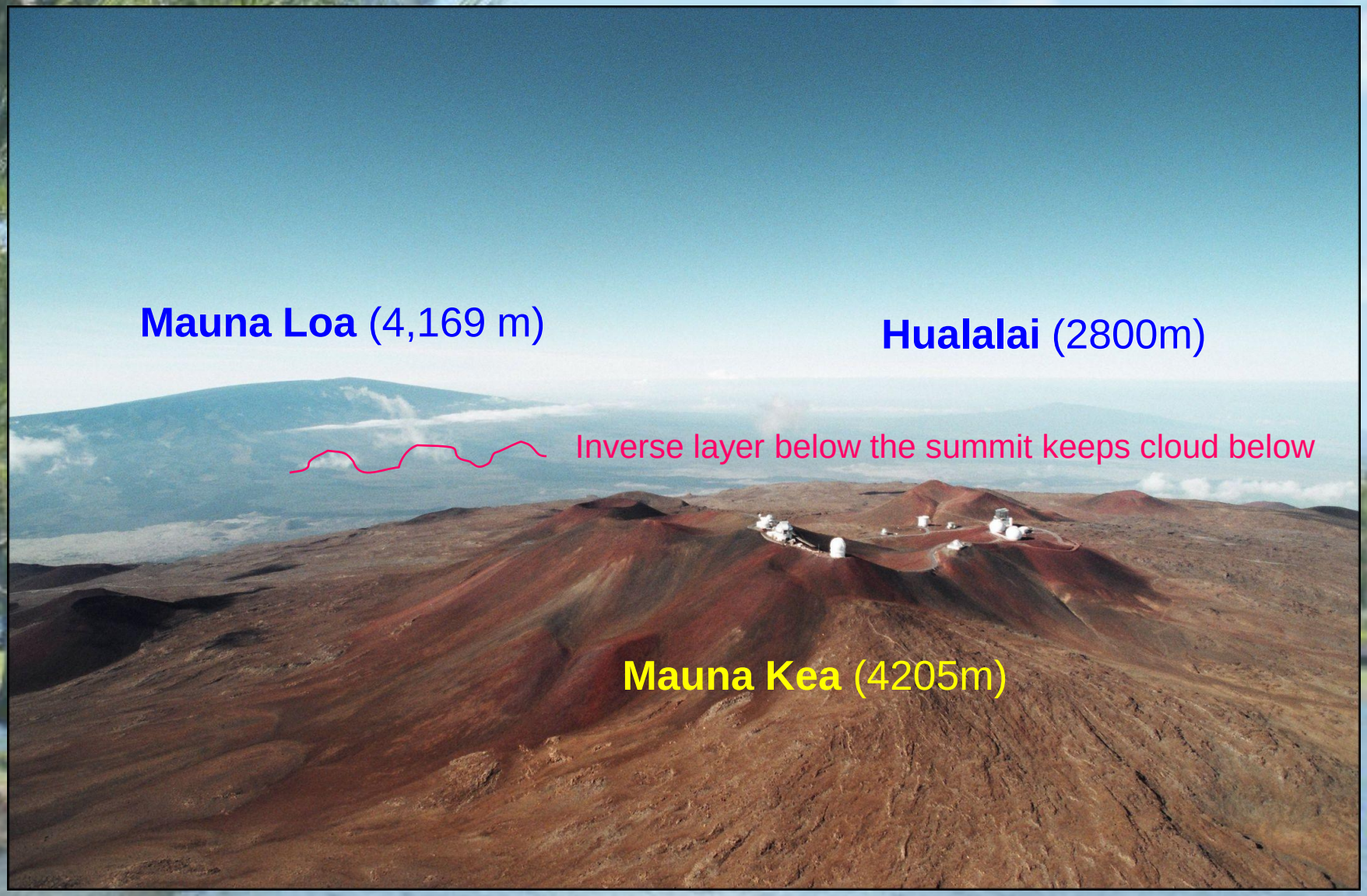
Summary

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 **Ali** 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.

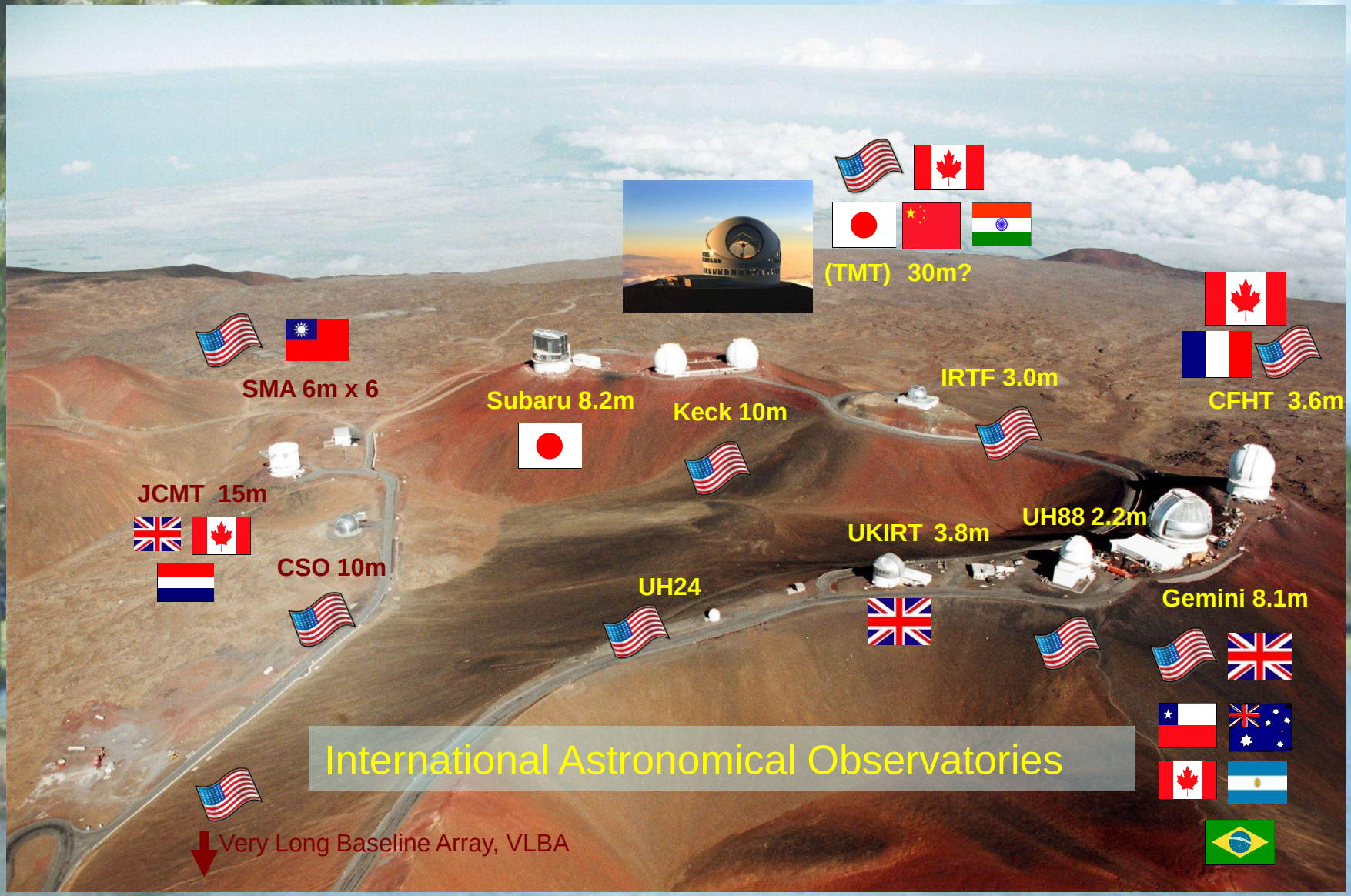
Observational Conditions at Subaru Telescope

This picture shows Mauna Kea covered with light snow, viewed from sea-side town, Hilo.

Observational Conditions at Subaru Telescope

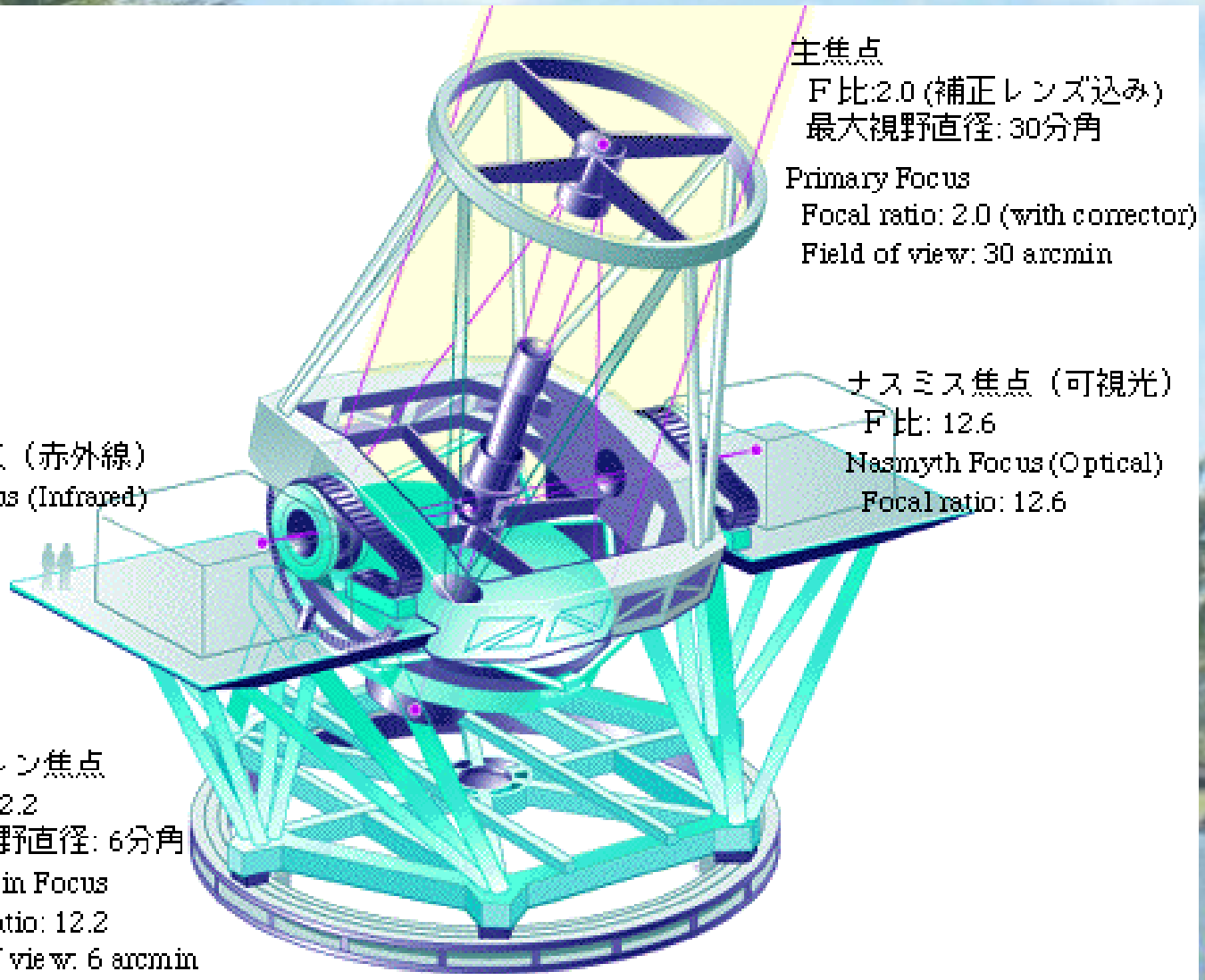


Observational Conditions at Subaru Telescope

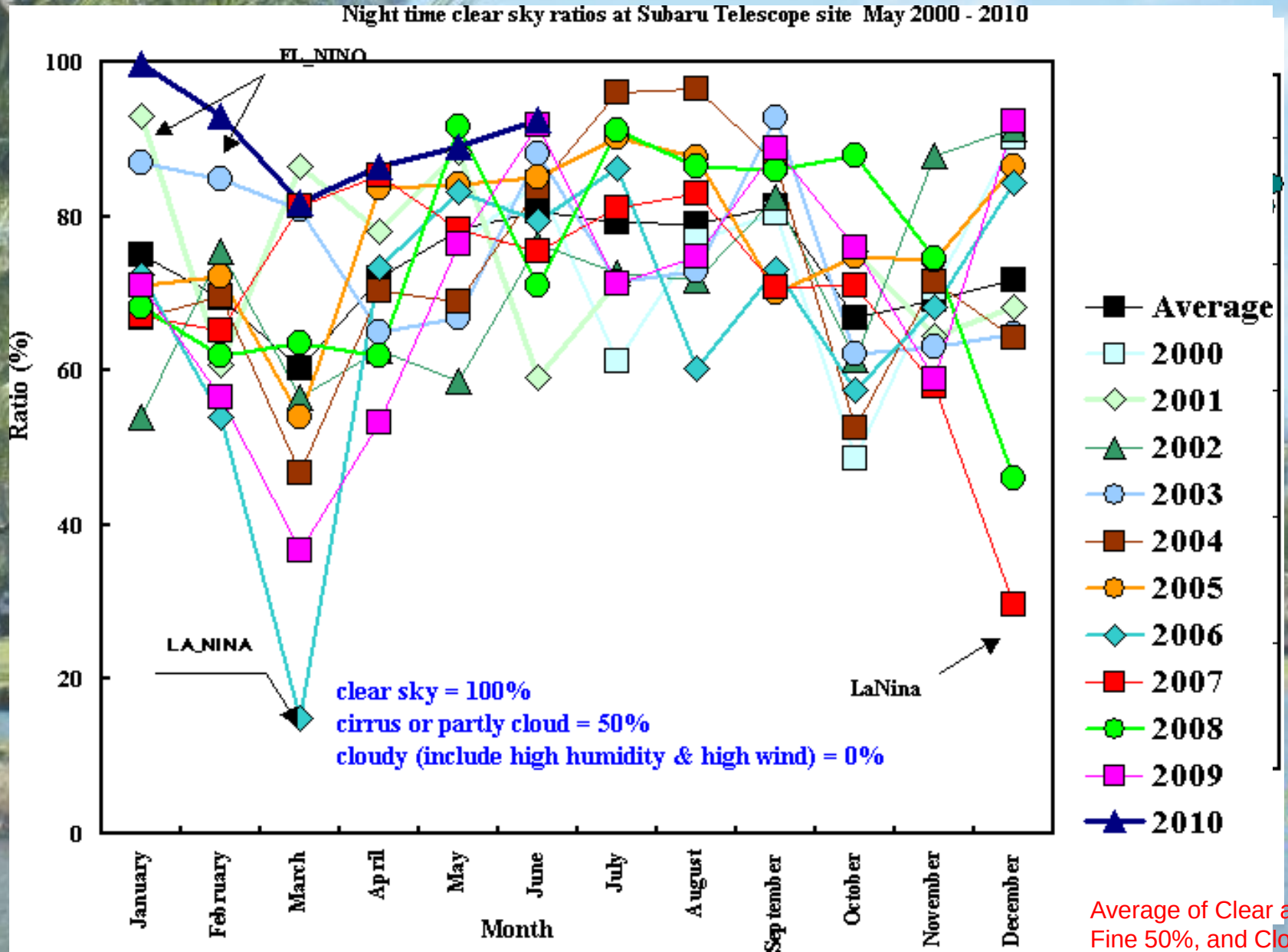


Observational Conditions at Subaru Telescope

Observational Conditions at Subaru Telescope

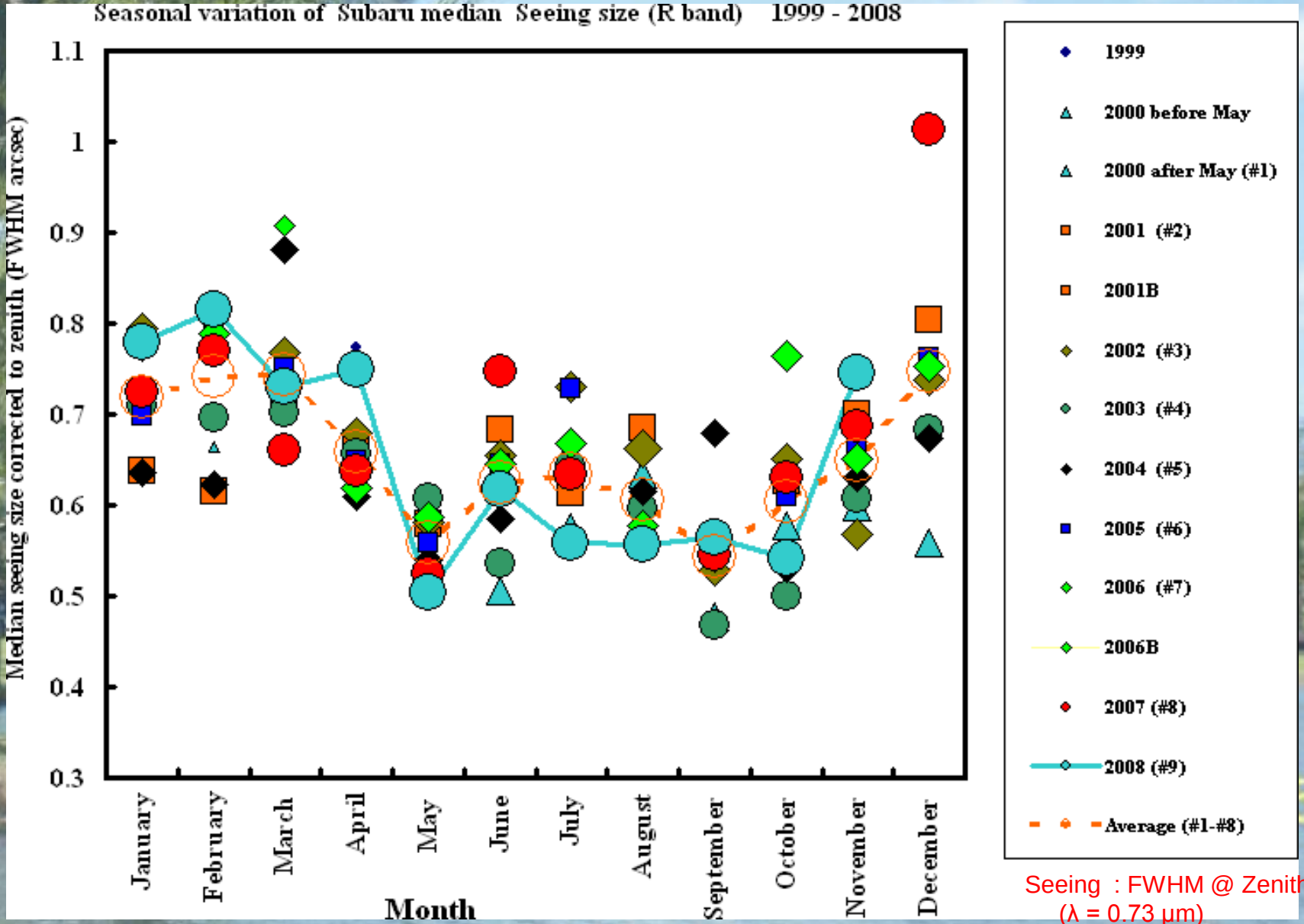


Observational Conditions at Subaru Telescope



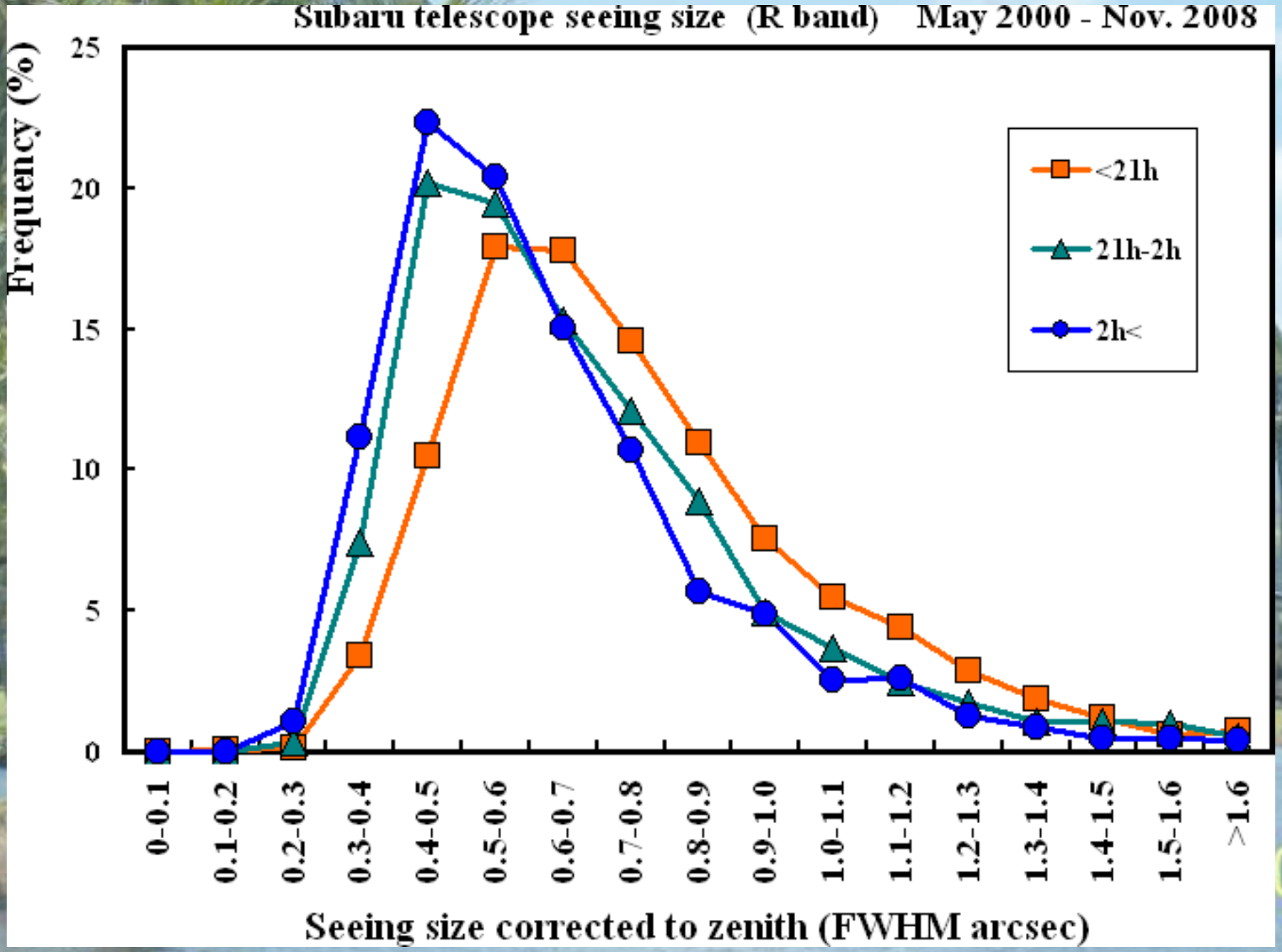
Average of Clear as 100%, Fine 50%, and Cloudy 0%

Observational Conditions at Subaru Telescope

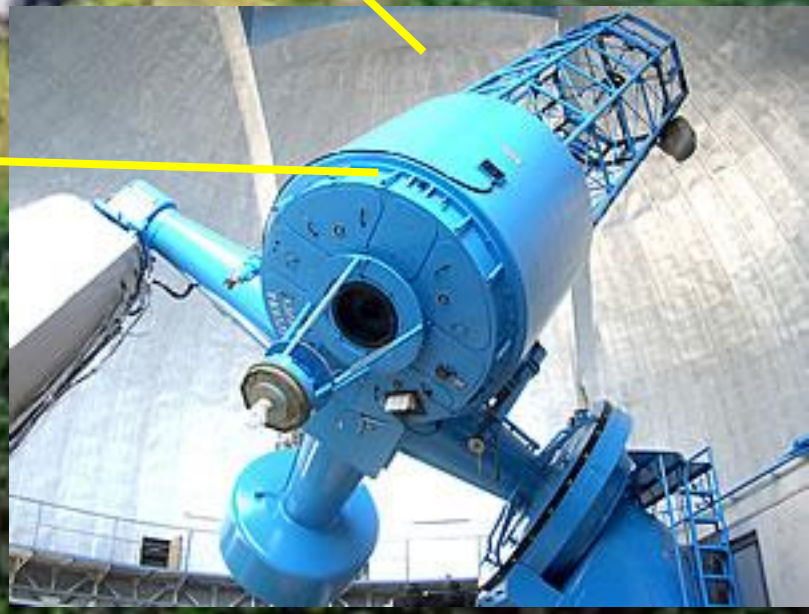


Seeing : FWHM @ Zenith
(λ = 0.73 μm)

Observational Conditions at Subaru Telescope

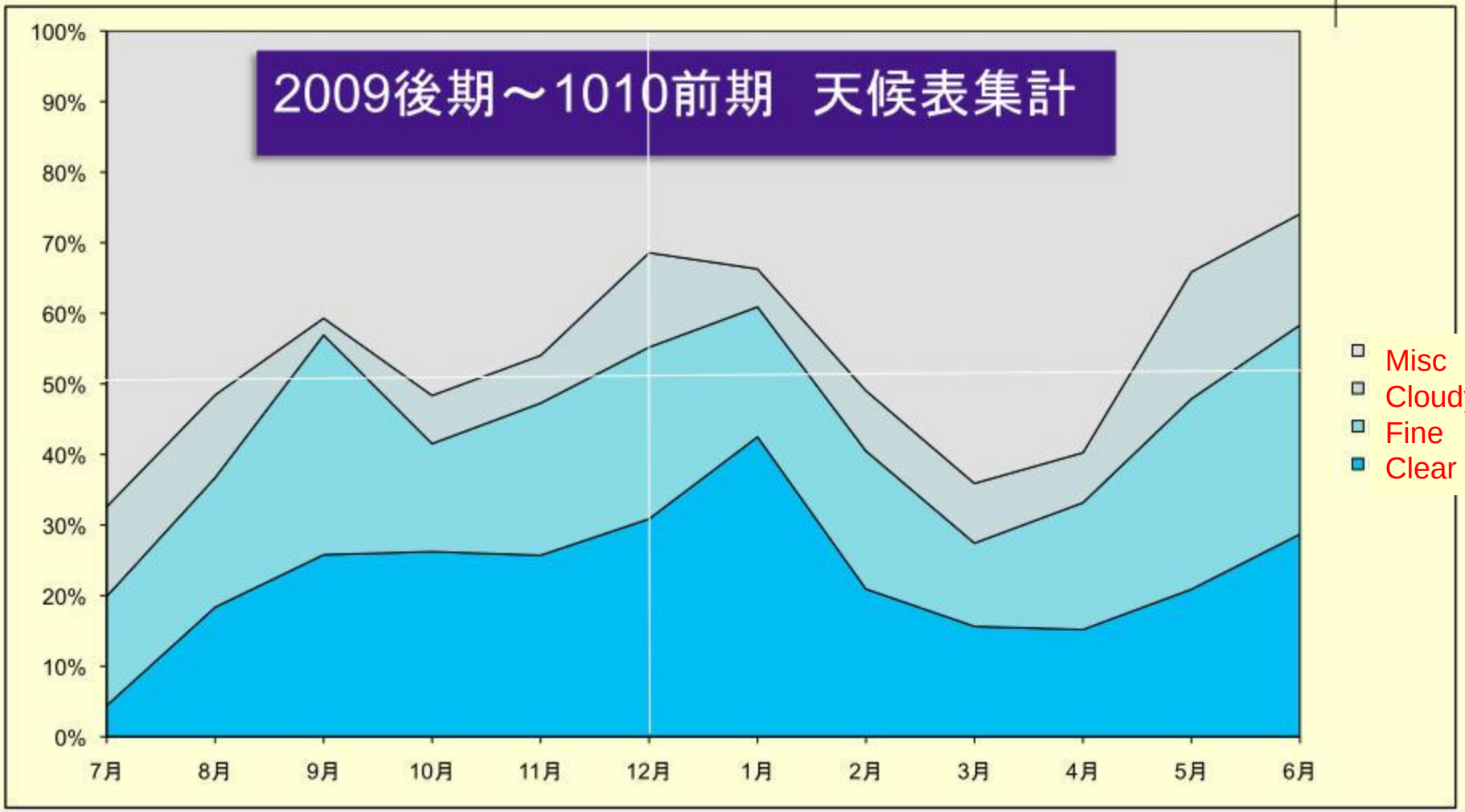


Observational Conditions at OAO, Japan

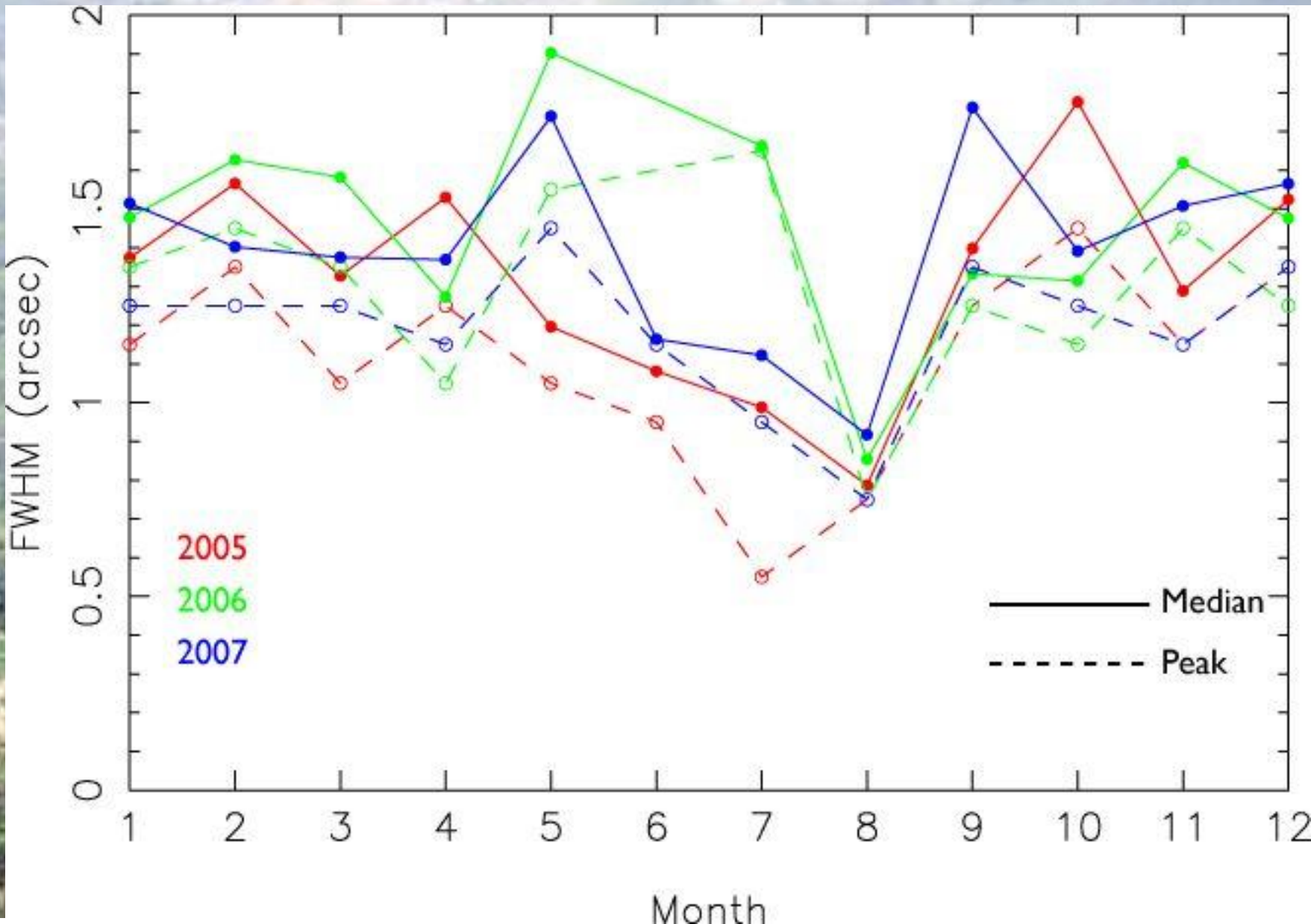


Observational Conditions at OAO, Japan

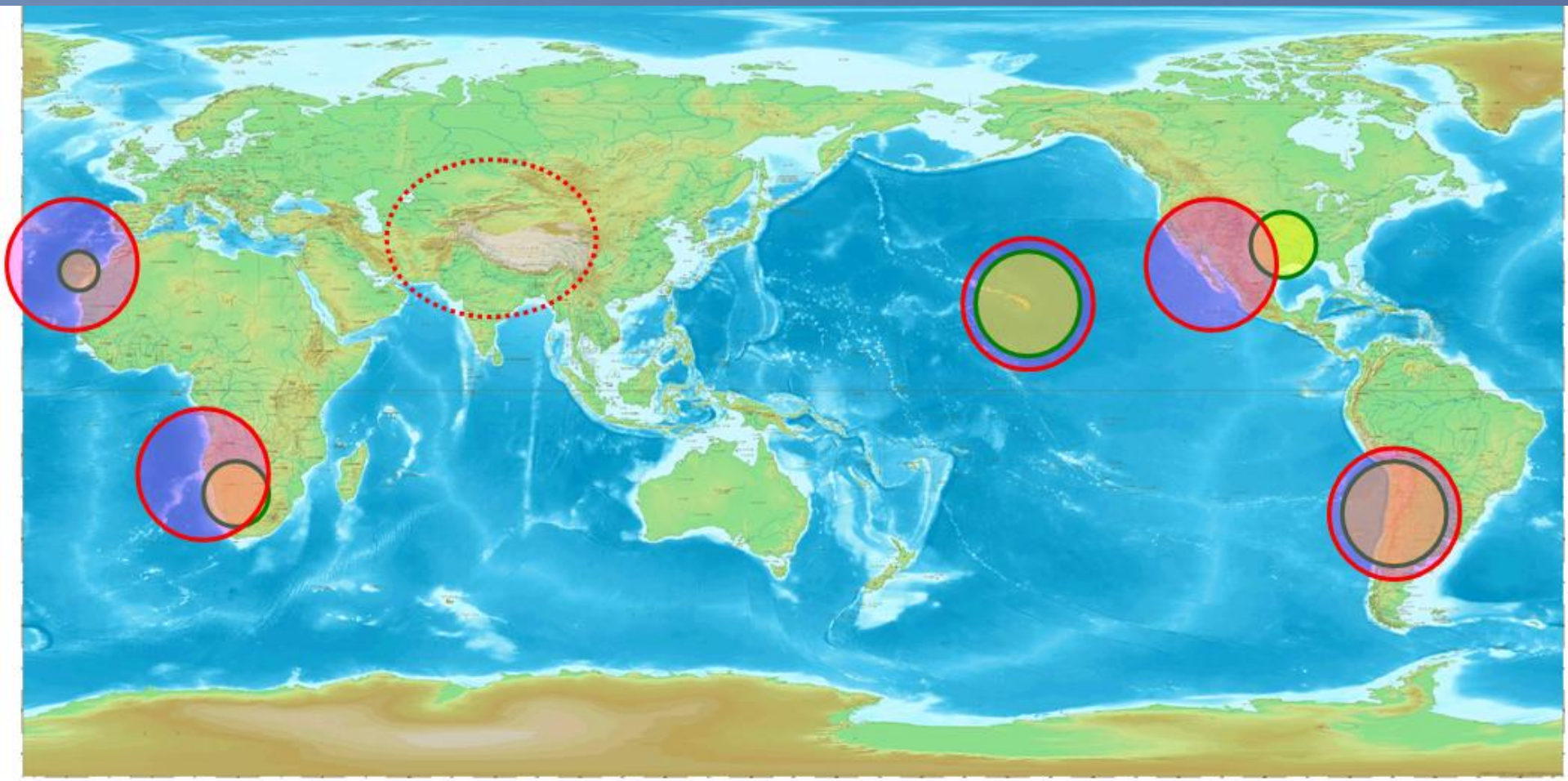
夜間天候



Observational Conditions at OAO, Japan

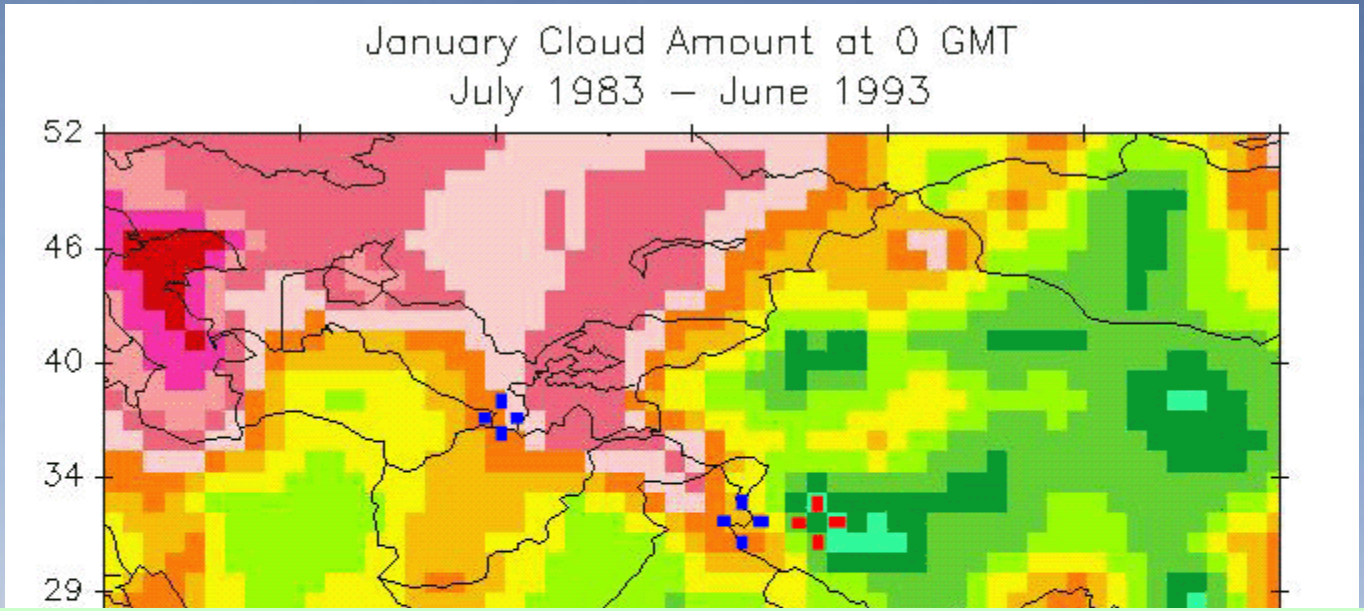


Current and planned sites for giant telescopes



Cloud map around west China

Arranged only for night data.
Two blue crosses show *Hanle* (India) and *Maidanak* (Uzbekistan). Red cross shows candidate site, Oma, 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 Tibet is so interesting site in searching a good site for OPT/IR telescope.

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

MASS


SODAR


DIMM

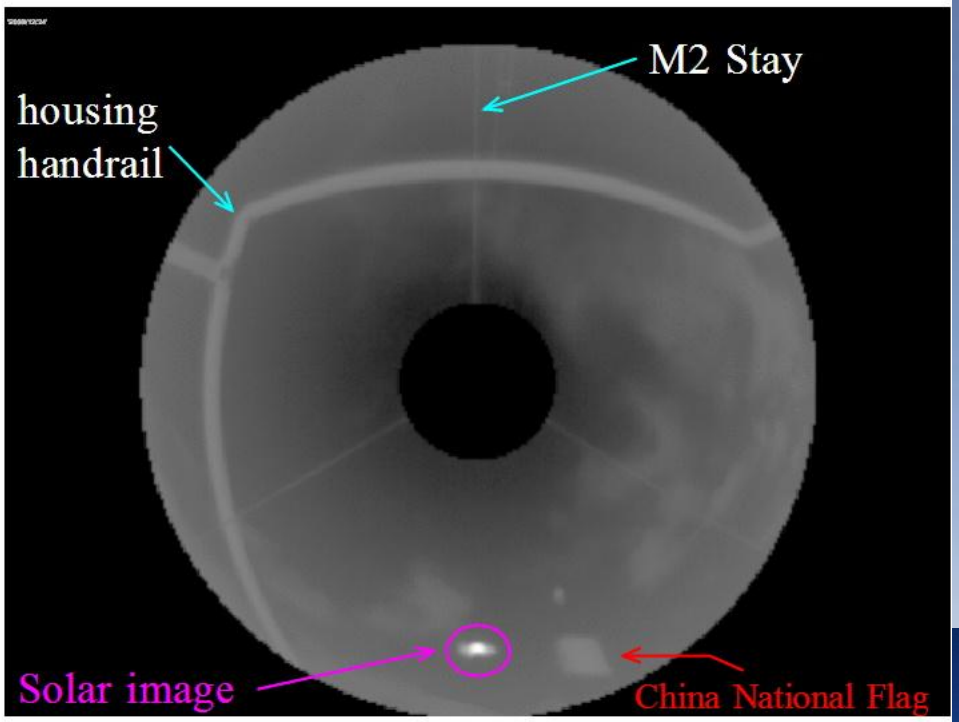

Cloud Monitor


Weather Tower

Cloudiness observed w/ CloudMon at Oma in 2008 and 2009

A Cloud Monitor
on housing roof
at Oma, Tibet

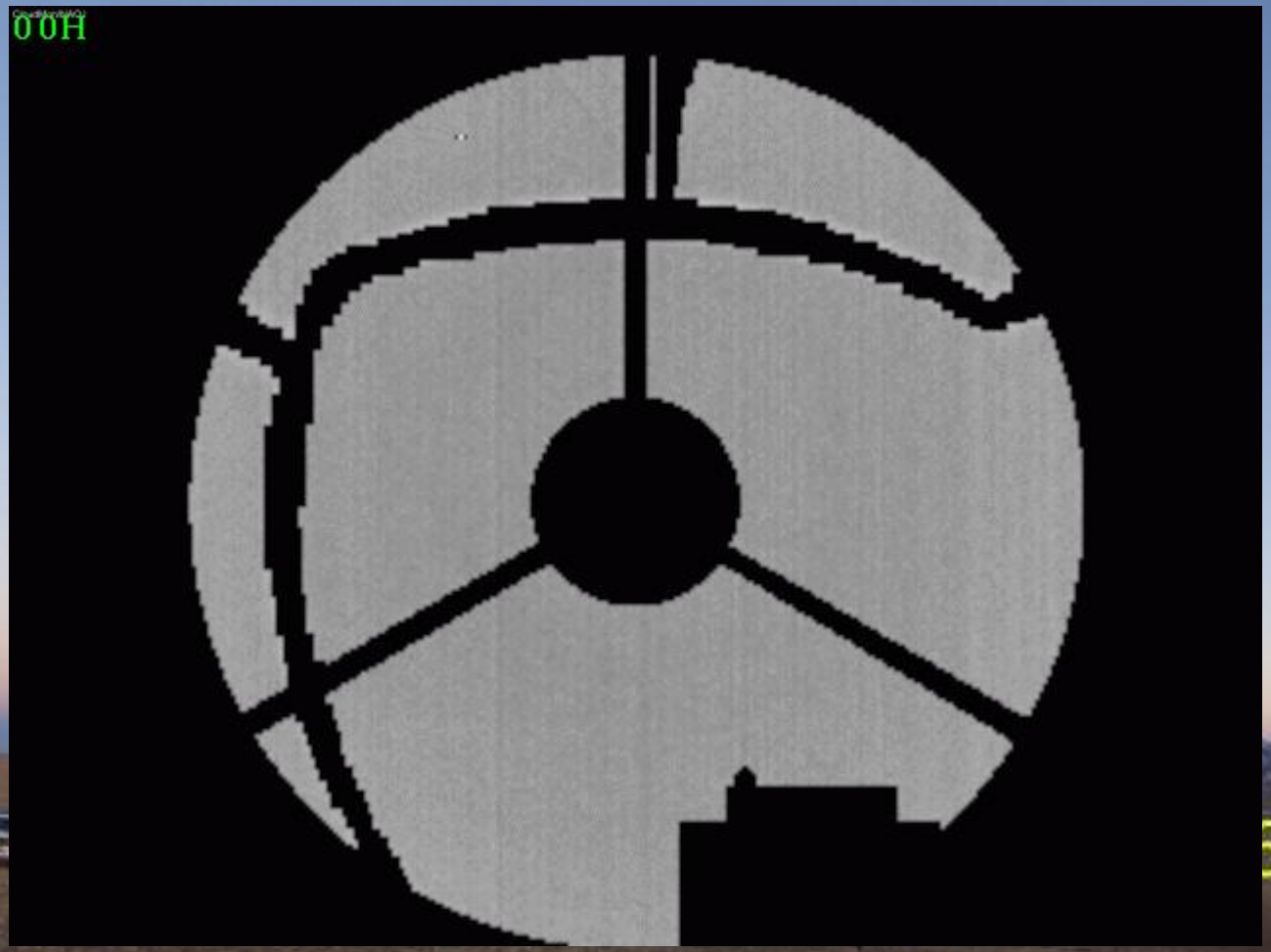
FOV of Cloud Monitor



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 clear
		△	雲あり a bit cloud
		×	降雨 rainy

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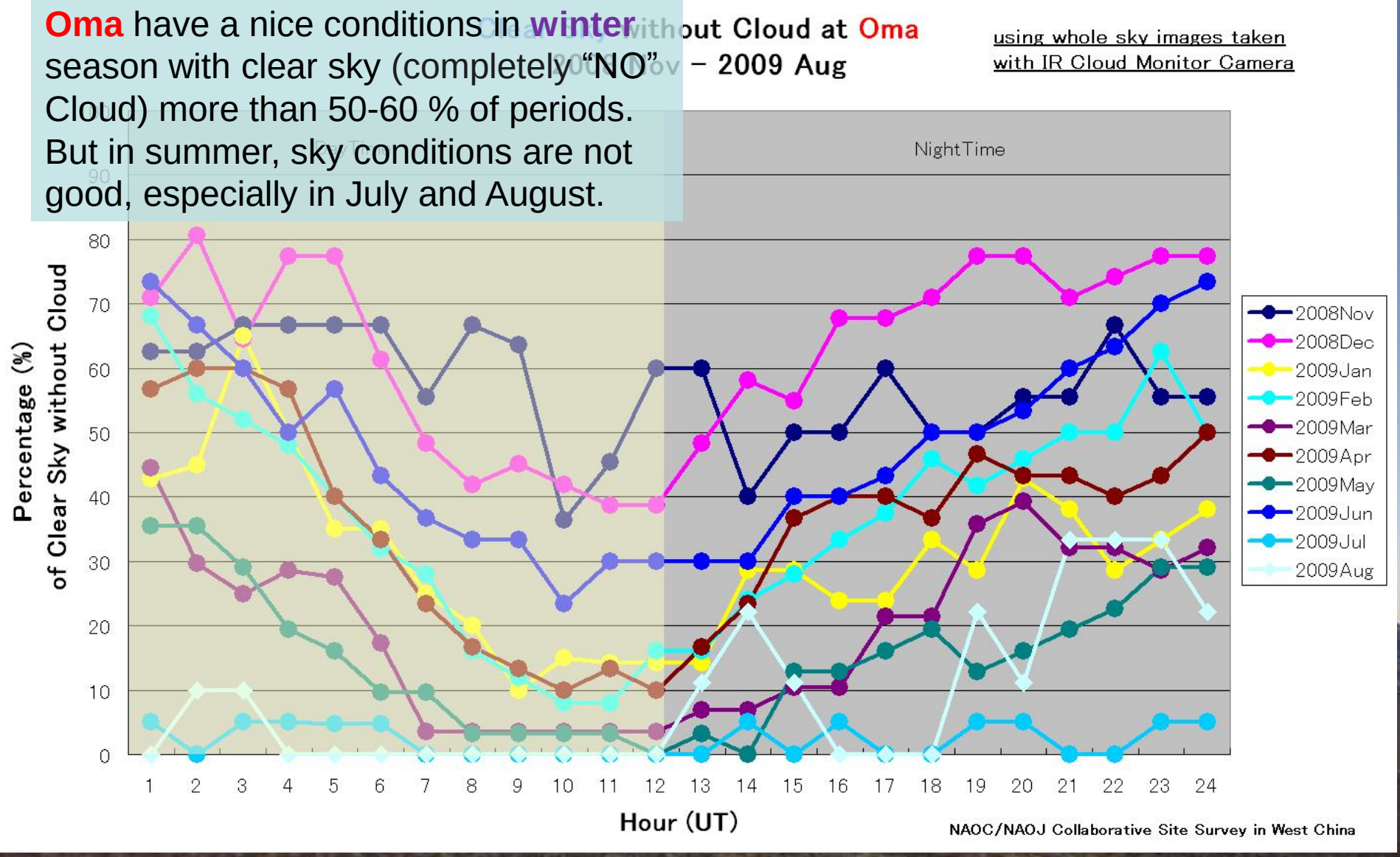
UT	0h	1h	2h	3h	4h	5h	6h	7h	8h	9h	10h	11h	12h	13h	14h	15h	16h	17h	18h	19h	20h	21h	22h	23h

Percentile of Clear sky at Oma in 2008 and 2009

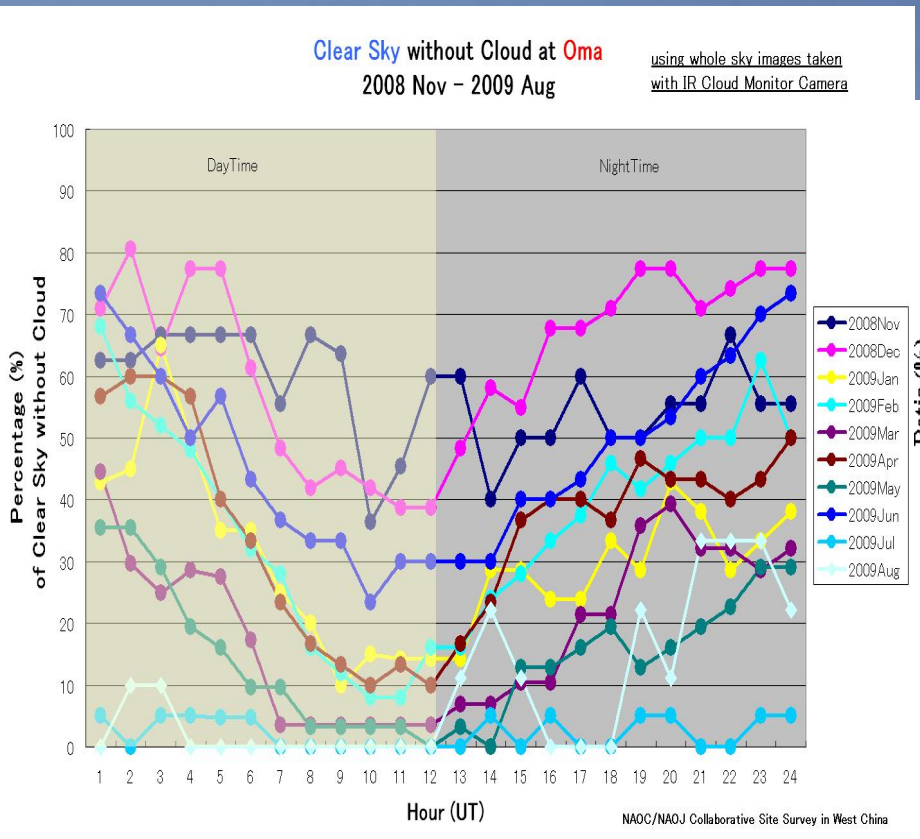
Clear sky means exactly "NO" cloud in the sky in this viewgraph.

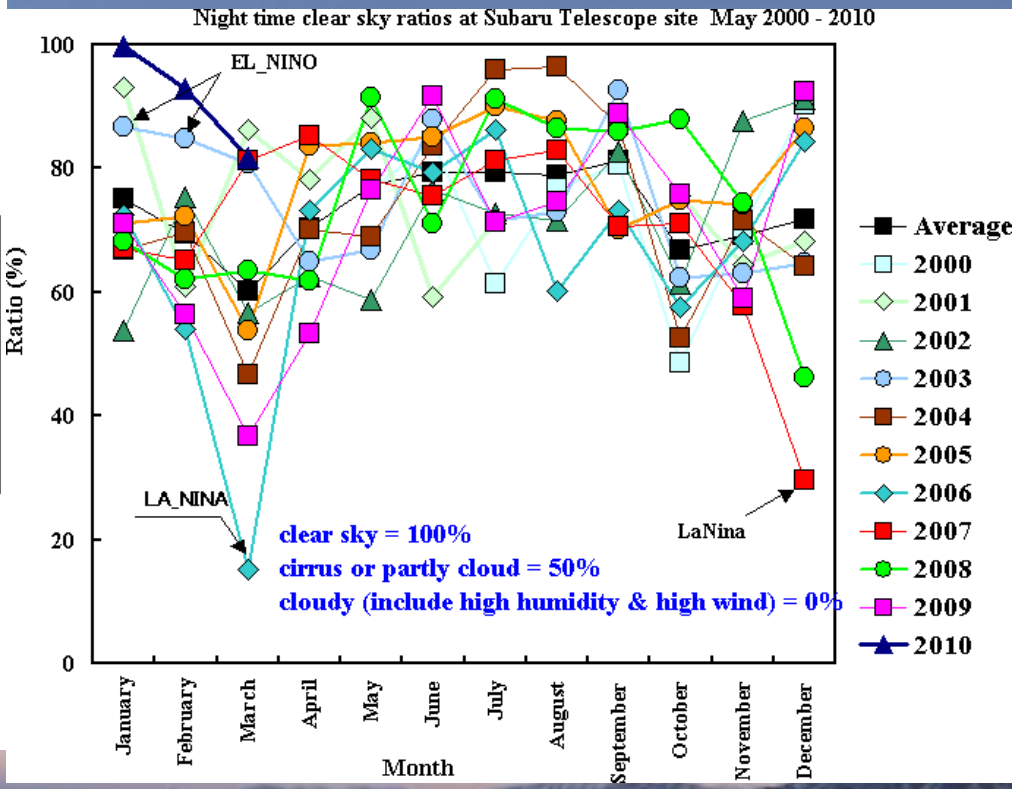
Oma have a nice conditions in **winter** season with clear sky (completely "NO" Cloud) more than 50-60 % of periods. But in summer, sky conditions are not good, especially in July and August.



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%.





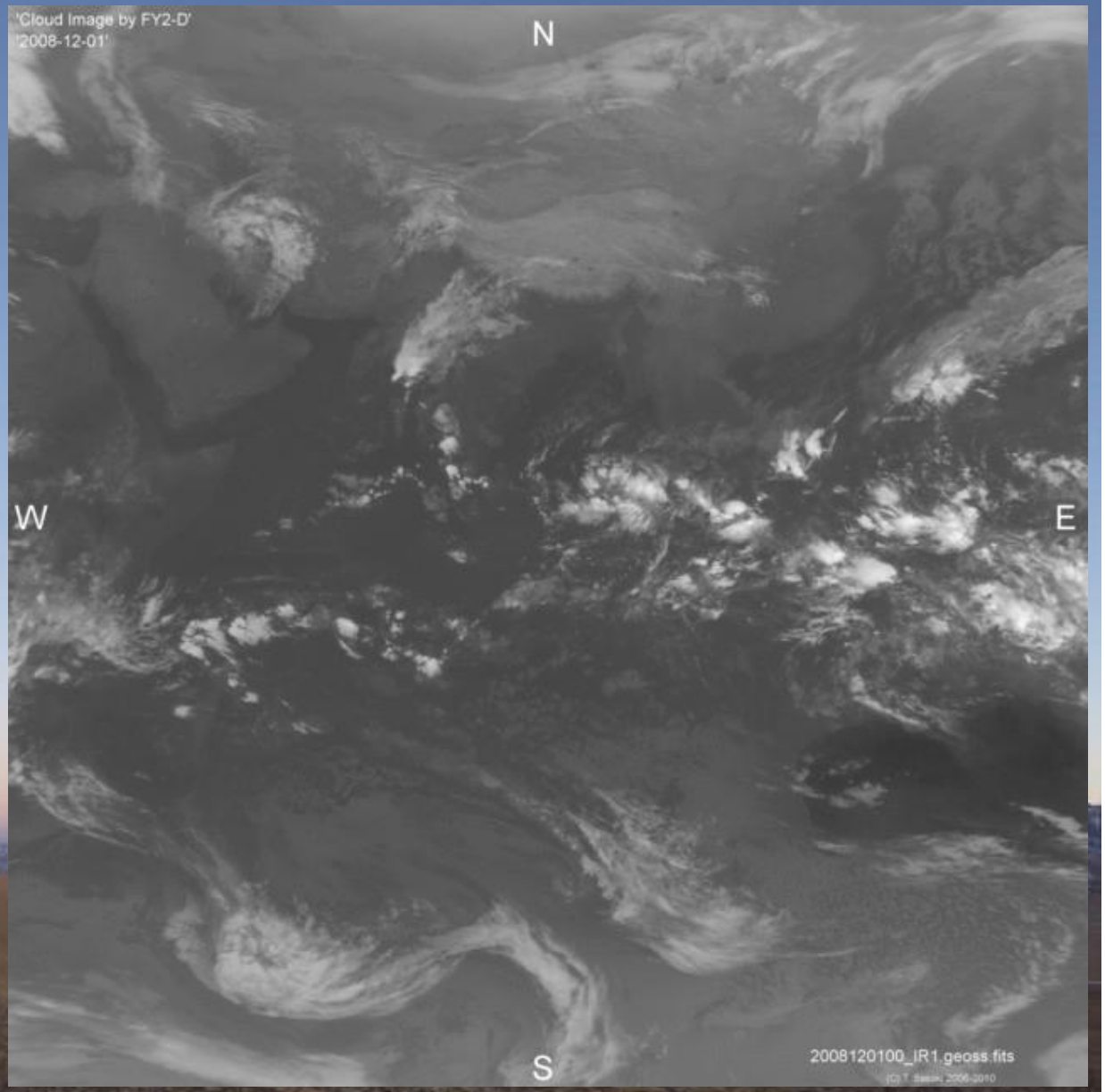
Oma have a nice conditions in winter season comparable to Subaru case. But sky conditions are not good in summer.

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,

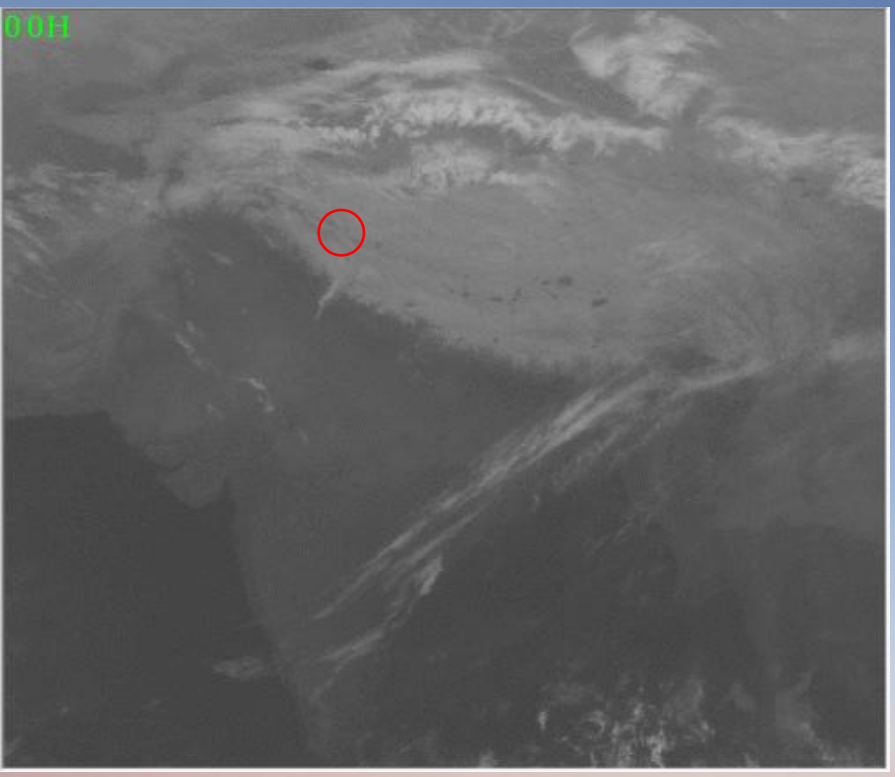
ftp://fy.cr.chiba-u.ac.jp/

(Resolution = 0.04˚ ～ 4km)

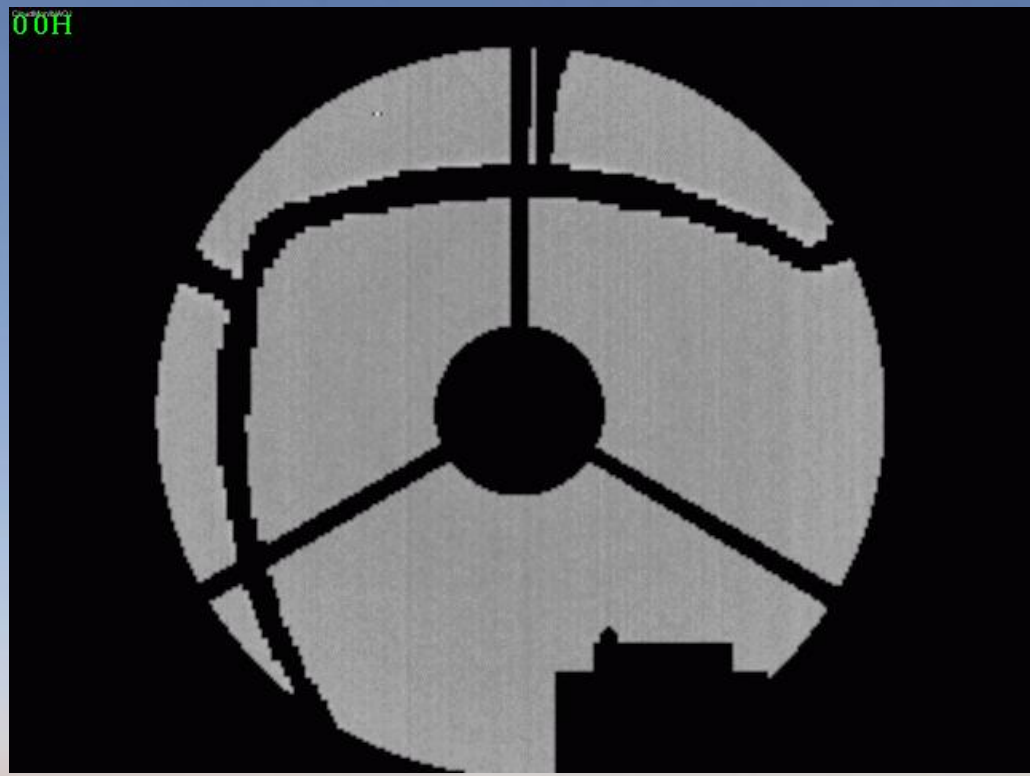


Clouds observed w/Weather Satellite and ground-based CloudMon

Weather Satellite, **FY2**-D in IR(10μm)



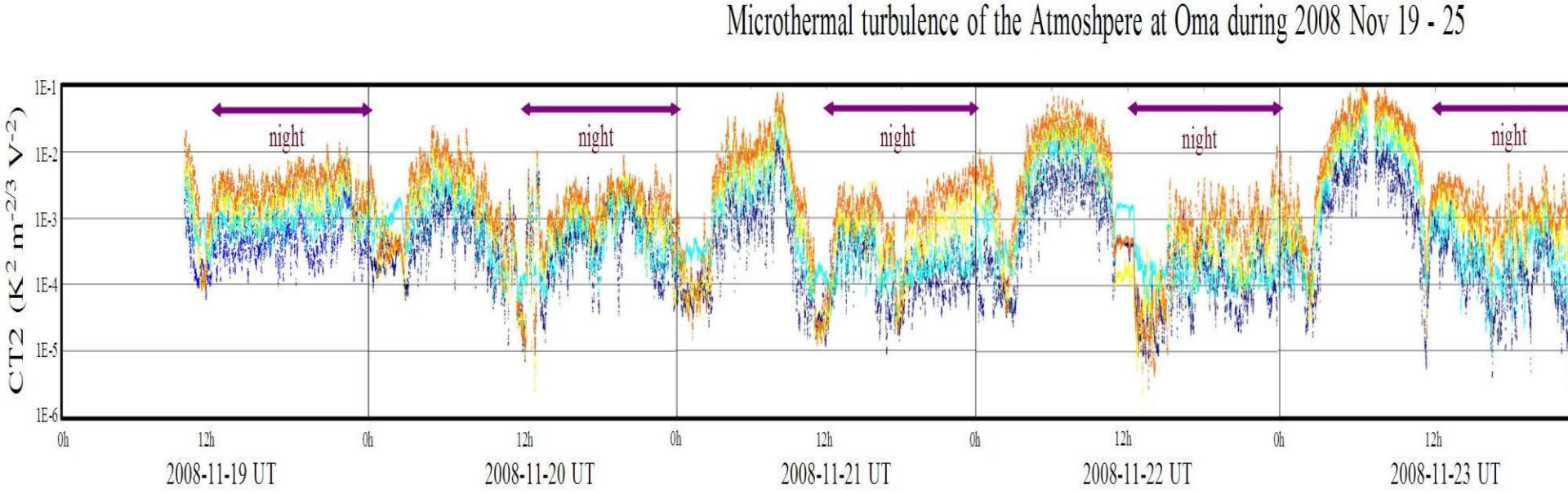
MIR Cloud Monitor Camera (7-14μm)

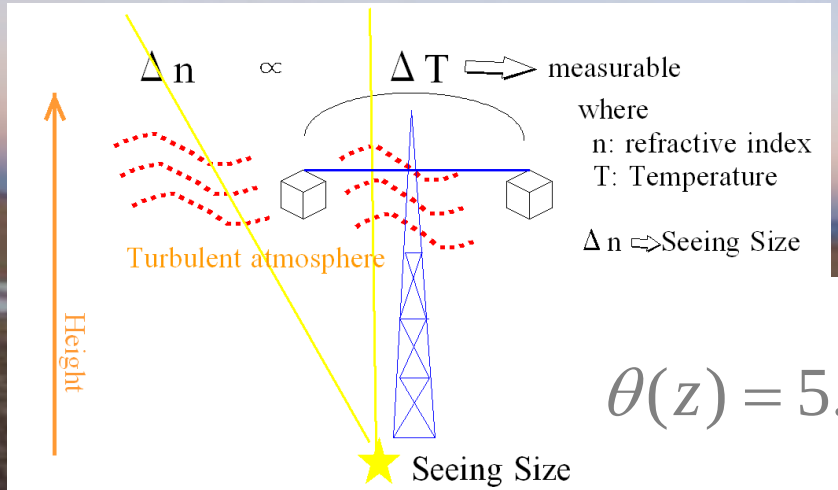


Ground-based Monitoring of Clouds in the sky is very useful to evaluate the site, as weather satellite data is difficult to clarify localized cloud behaviors.

10/26/2009

Local Seeing at Oma estimated from Micro-Thermal Turbulence





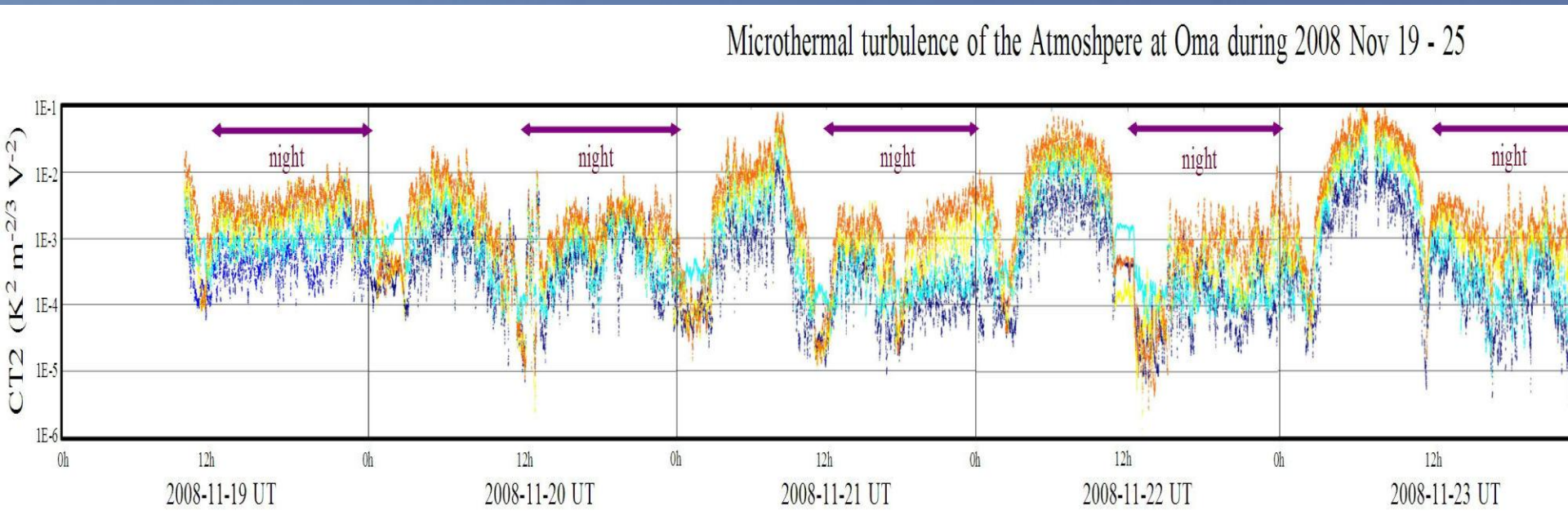
$$C_T^{\,2} = \left\langle \left| T(r_1) - T(r_2) \right|^2 \right\rangle r^{-2/3}$$

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

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

Seeing : FWHM @ Zenith
(λ = 0.73 μm)

Local Seeing at Oma estimated from Micro-Thermal Turbulence



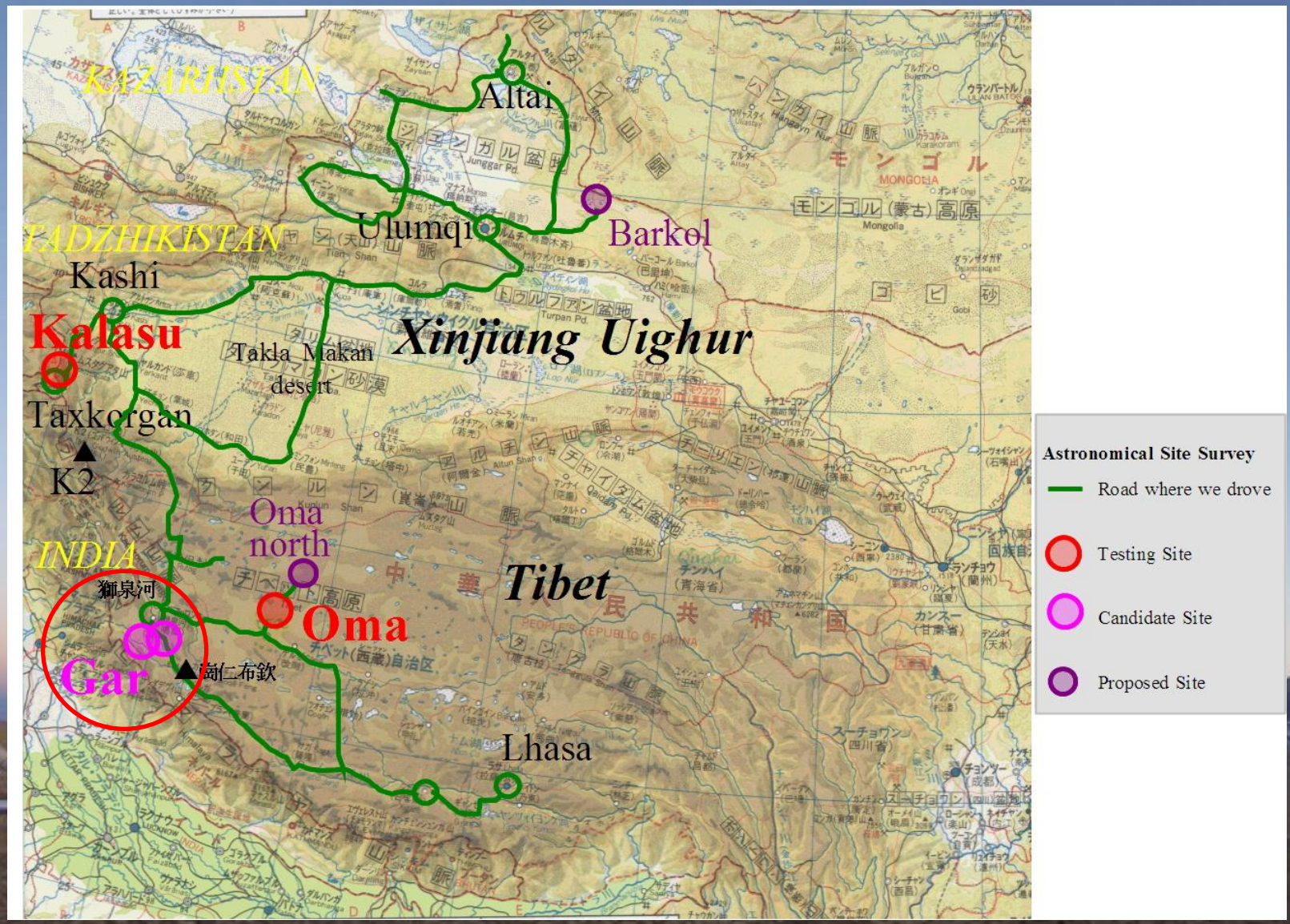
$$\theta(z) = 5.3\lambda^{-1/5}\left(\frac{7.9\times10^{-5}P}{T^2}\right)^{6/5}\left[C_T{}^2(z)z_h\right]^{3/5}$$

Oma Seeing during 2008-11-19 ∽11-25

Layer#1 at height 36.65m : 0.02"
Layer#2 at height 27.65m : NG
Layer#3 at height 19.15m : 0.03"
Layer#4 at height 14.15m : 0.05"
Layer#5 at height 9.65m : 0.07"

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

4. Possibly best site near Ali in west Tibet



5. Possible Telescope plan at Ali site

After we evaluate and confirm the good condition around Ali,
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.)

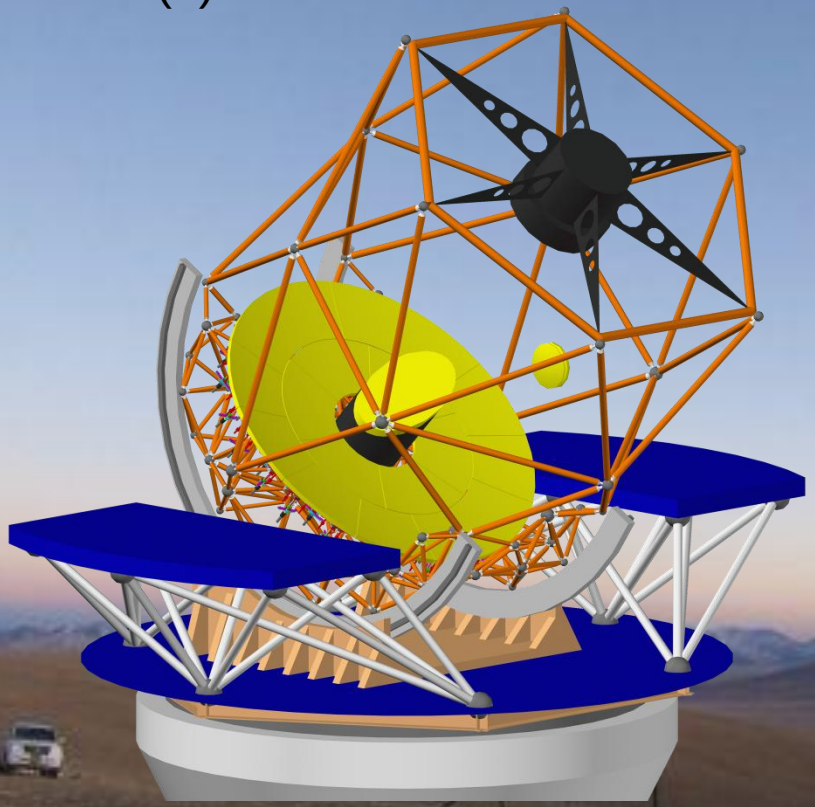
And also we like to introduce a possible **4m telescope** near Ali.

- 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.

Kyoto 3.8m telescope, possibly installed in west Tibet

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

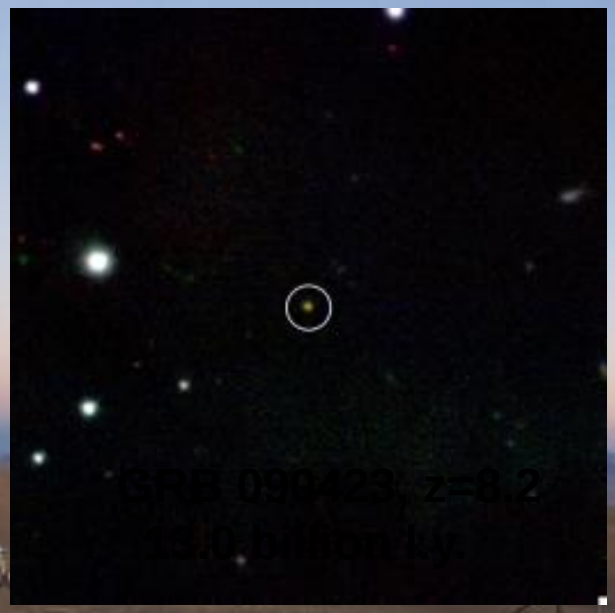
- **Fan-shaped segmented 18 mirros**
- **light-weighted truss structure**
- **1st light in** 2012(?)



Possible Telescope plan at Ali site

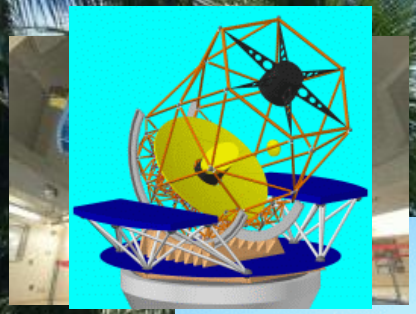
Telescope located covering global telescope network

- **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**



10/26/2009

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



~1m Tel

for Asian Astronomers in coming era

⇒~4m Tel

TMT in near future

Ali/Oma

> 5000 m

Mauna Kea

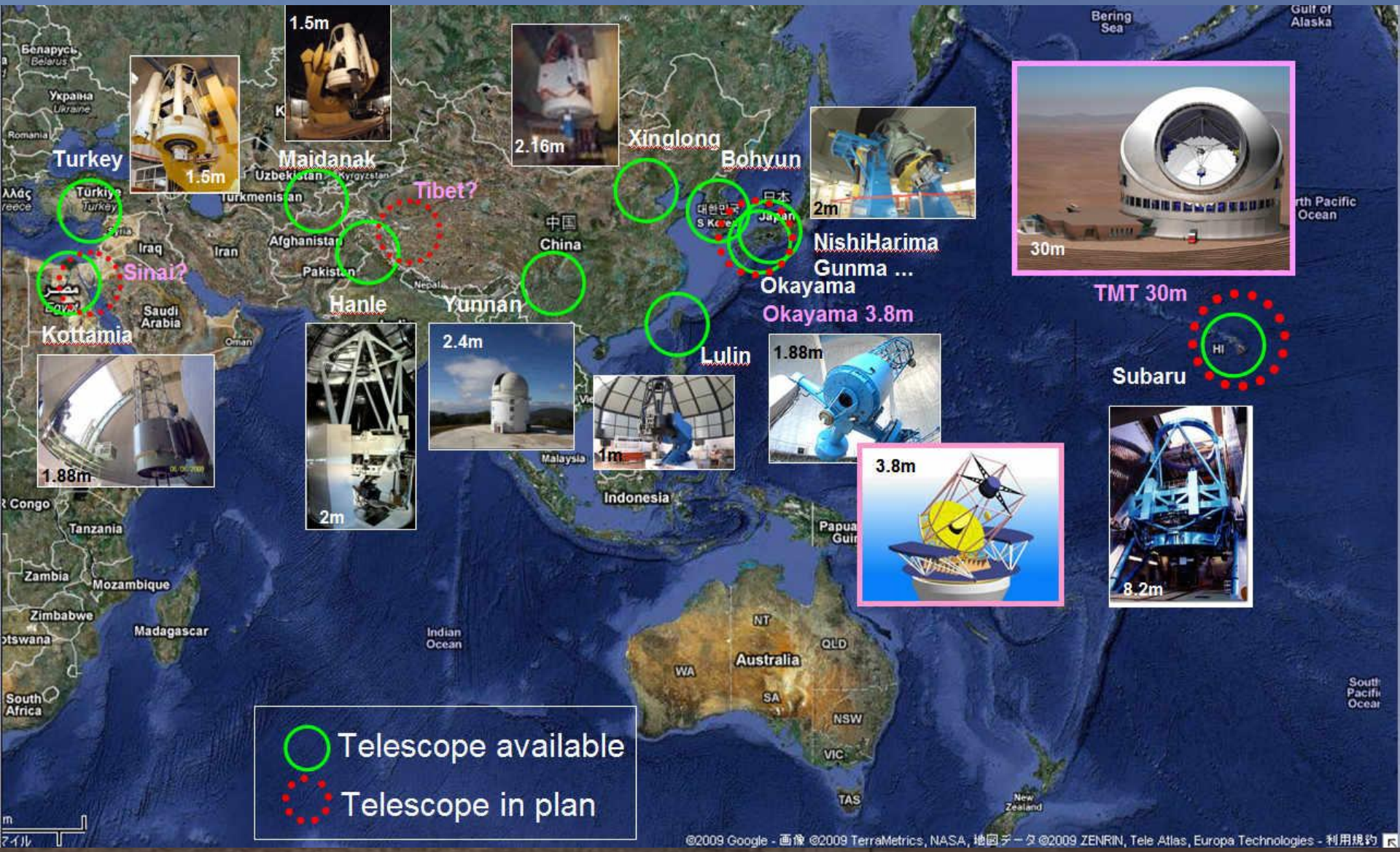
4200 m

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
Maidanak
Turkey
Xinglong
Bohyun
2m
NishiHarima
Gunma ...
Okayama
30m
TMT 30m
Tibet?
Sinai?
Kottamia
Hanle
Yunnan
Okayama 3.8m
Lulin
1.88m
2.4m
1m
Subaru
3.8m
1.88m
2m
8.2m
Indonesia
Australia
Telescope available
Telescope in plan
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