Astronomical Site Testing in West China

Yongqiang Yao

(National Astronomical Observatories of China)

- **CAST** is a critical step for Chinese community to advance observational facilities in coming decades

- **CAST** also enhances collaboration for East-Asian communities to construct large and medium-size telescopes

Comprehensive characterization of astronomical sites, Kislovodsk, Russia, 4-9 Oct. 2010

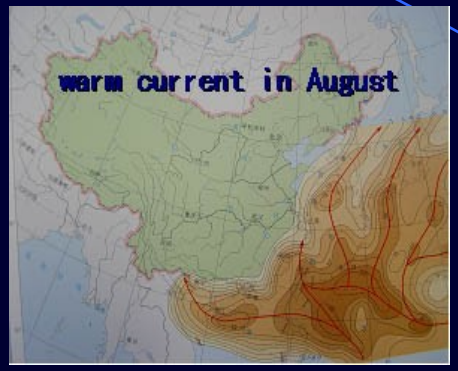
Review of the China Astronomical Site Testing

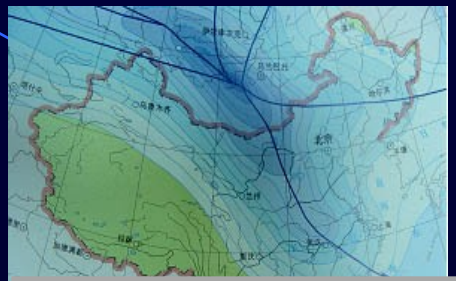
Phase 1, 2003-2004: Remote study and local survey
Phase 2, 2005-2006: Candidate sites and monitoring
Phase 3, 2007-2008: Instrument setup and campaign
Phase 4, 2009-2010: Project review and future plan

Outline of the talk:

Progress review
Monitoring results
Recent activities
Future plan

CAST 2003-2004 : Remote Study



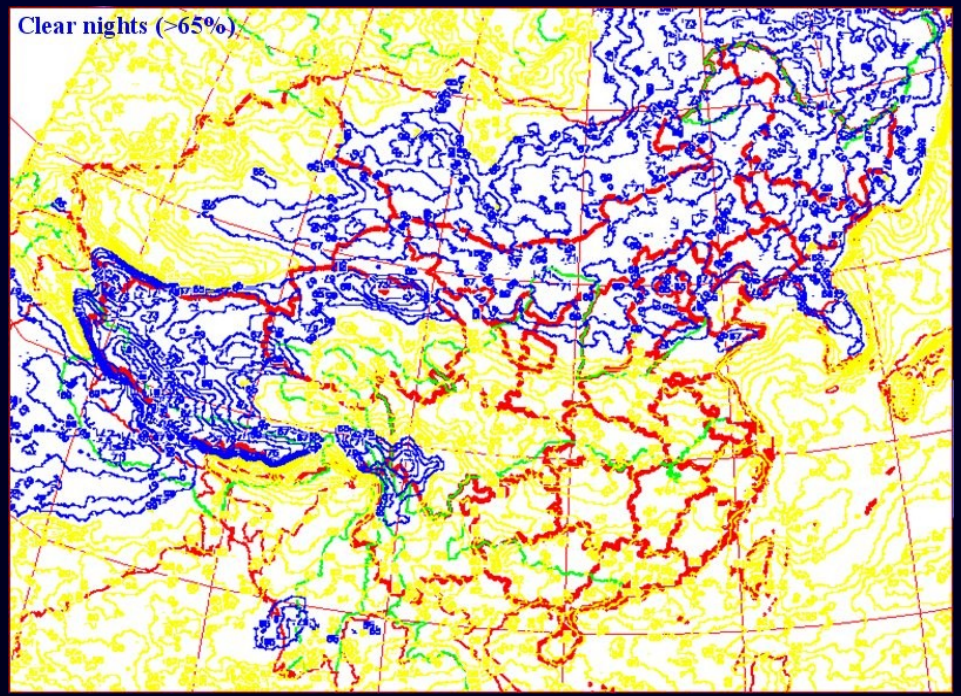


High Vast Land
Less cloudy
Clean Dilute Air
Cold, Dry
Dark, Quiet

→ Potentially good areas

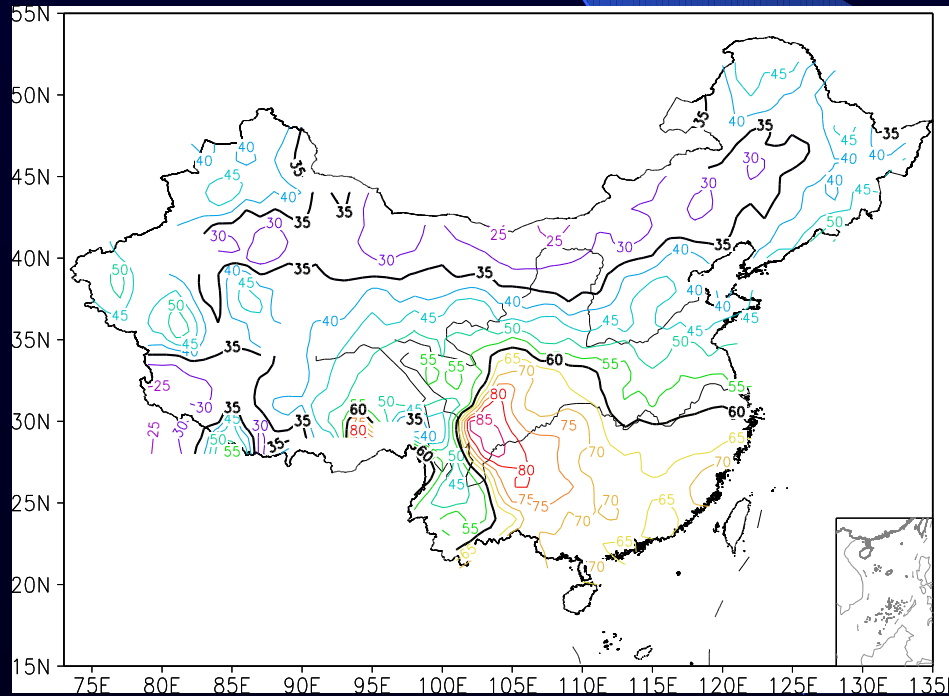
Distribution of clear nights

GMS + NOAA 1996 -2003, J. Mao et al 2004



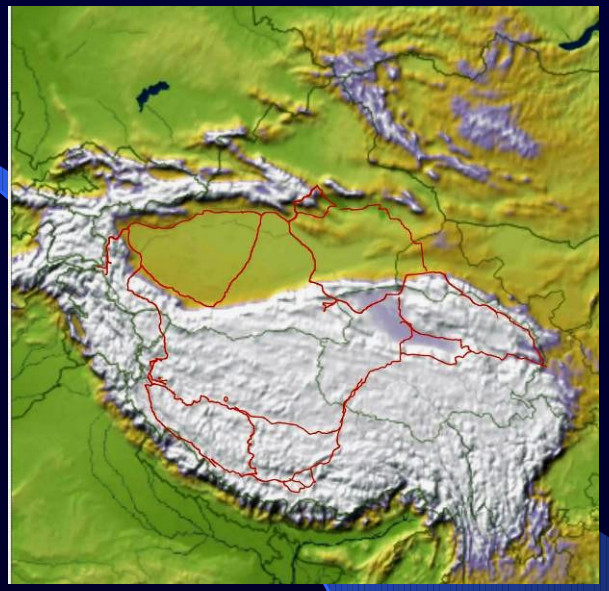
Cloud distribution at 2:00BJT

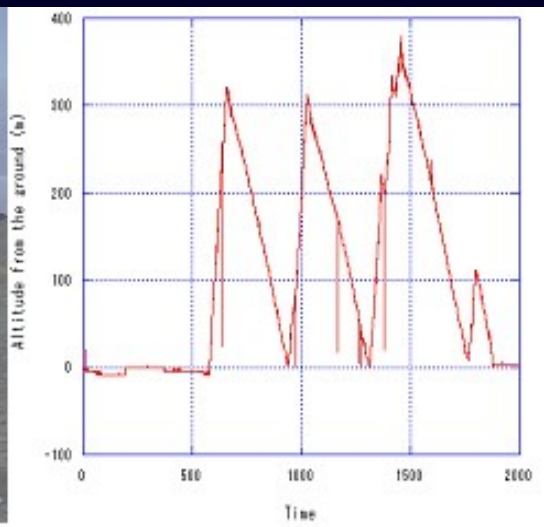
CMA 2425 stations 1961-2008, Y. Zhang et al

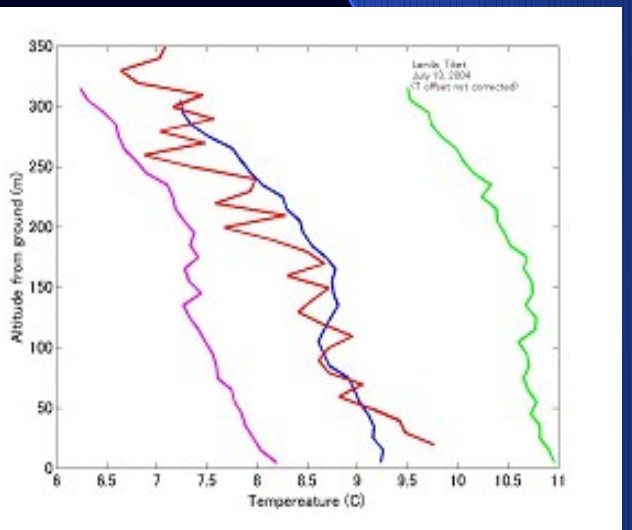


CAST 2003-2004 : Local Survey

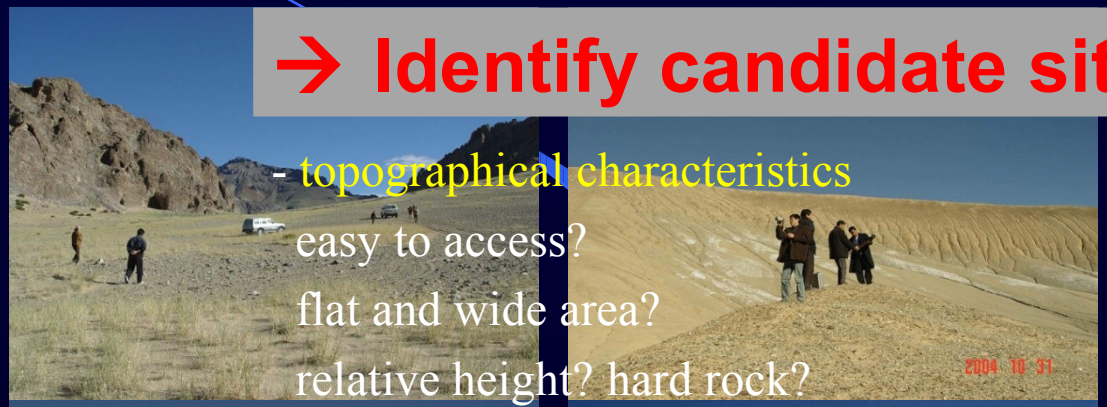
High mountain and plateau in Qinghai, Gansu, Xingjiang, Sichuan-Yunnan-Tibet





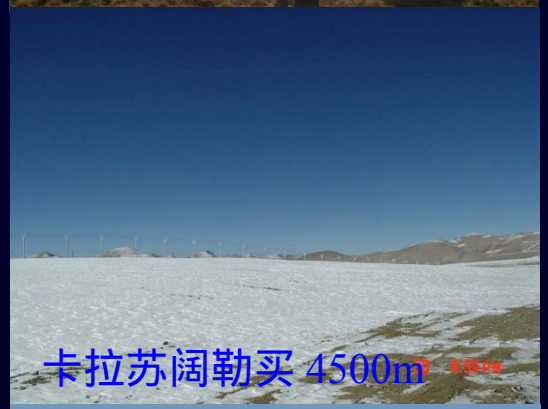


CAST 2003-2004 ： Local Survey

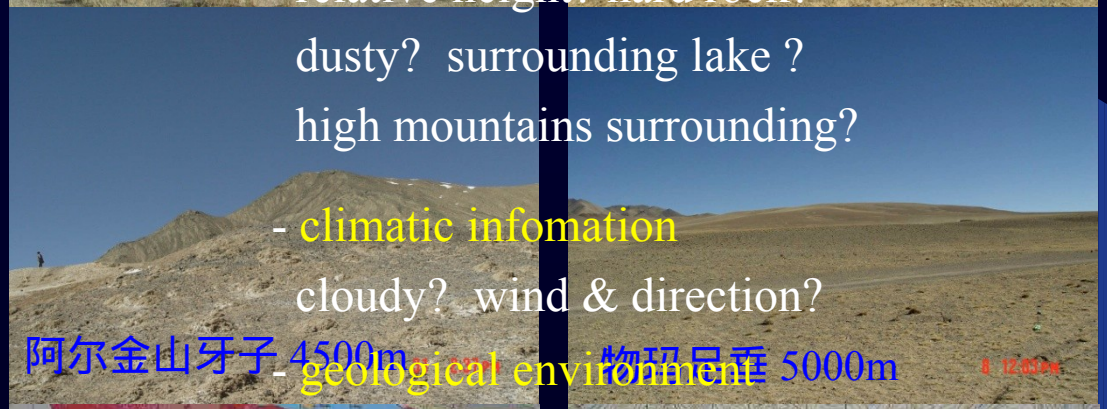


→ Identify candidate sites

- topographical characteristics
  easy to access?
  flat and wide area?
  relative height? hard rock?
  dusty? surrounding lake ?
  high mountains surrounding?
- climatic infomation
  cloudy? wind & direction?
- geological environment

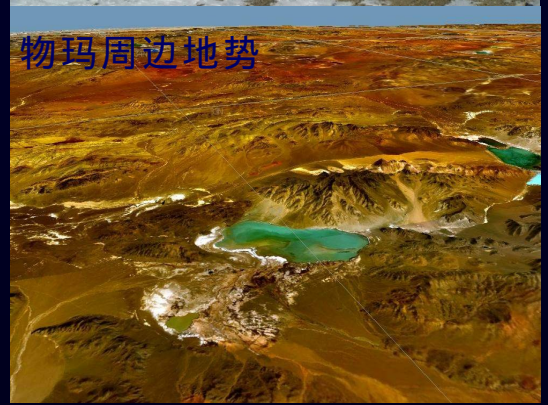


卡拉苏阔勒买 4500m

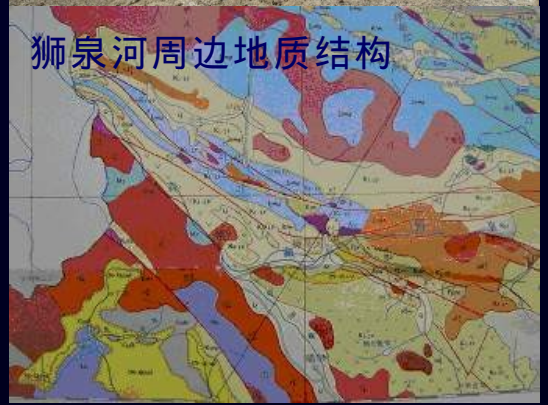


阿尔金山牙子 4500m

物玛周边地势

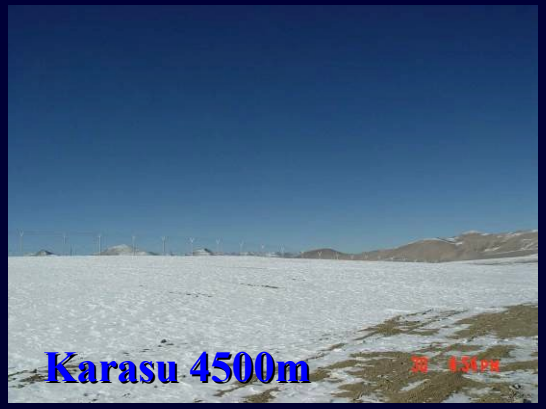


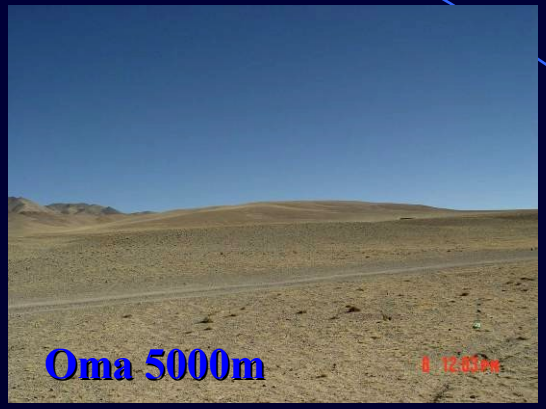
狮泉河周边地质结构

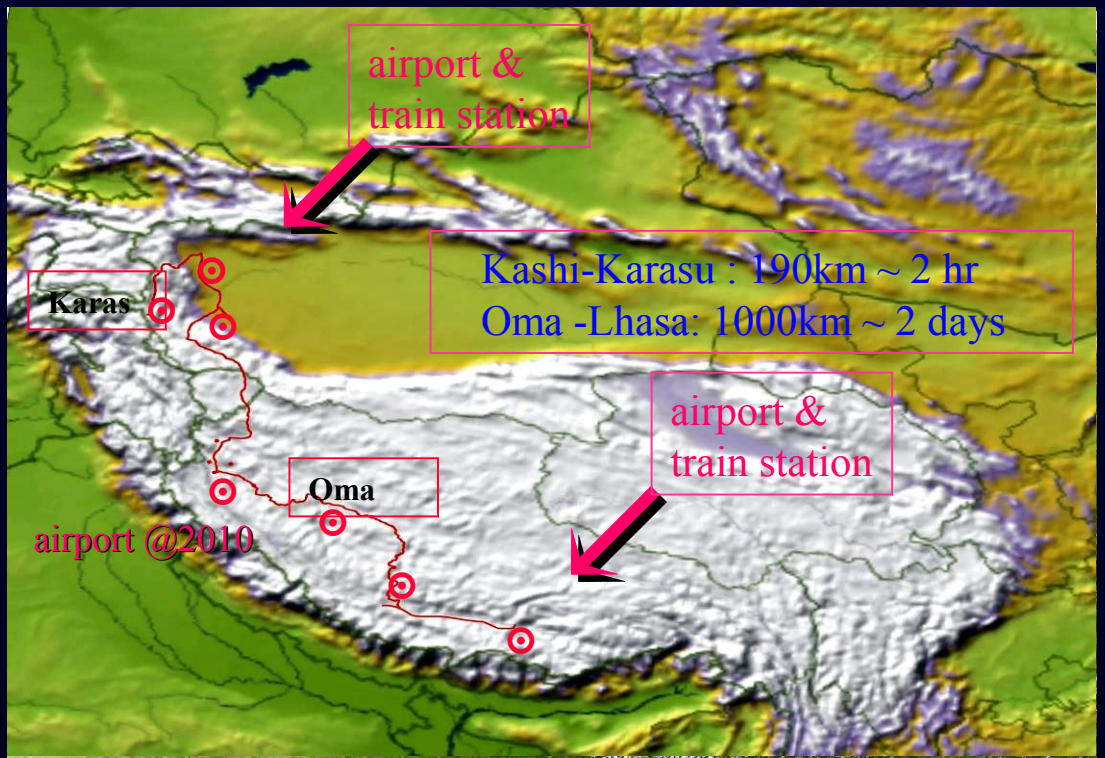


扎独顶地形图

CAST 2005: Candidate Sites







CAST 2005-2006: Infrastructure & monitoring

Site Characteristics:
Clear night, less Cloudiness
Seeing, precipitable water vap

Wind strength
Scale height of ground-layer t
dust, earthquake, accessibility

Instruments:

weather station;
fisheye-camera, SBIG_CCD & MIR cloud monitor ;
water-vapor monitor, night brightness monitor,
DIMM_seeingMonitor, SBIG_PolarisMonitor
micro-thermal CT^2 system

CAST 2005-2006: monitoring results

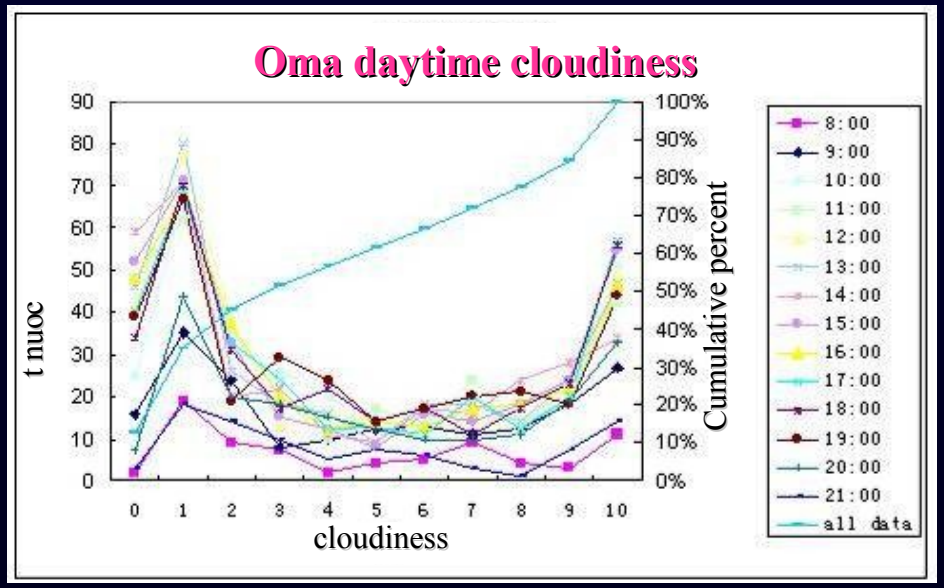
Daytime Cloudiness

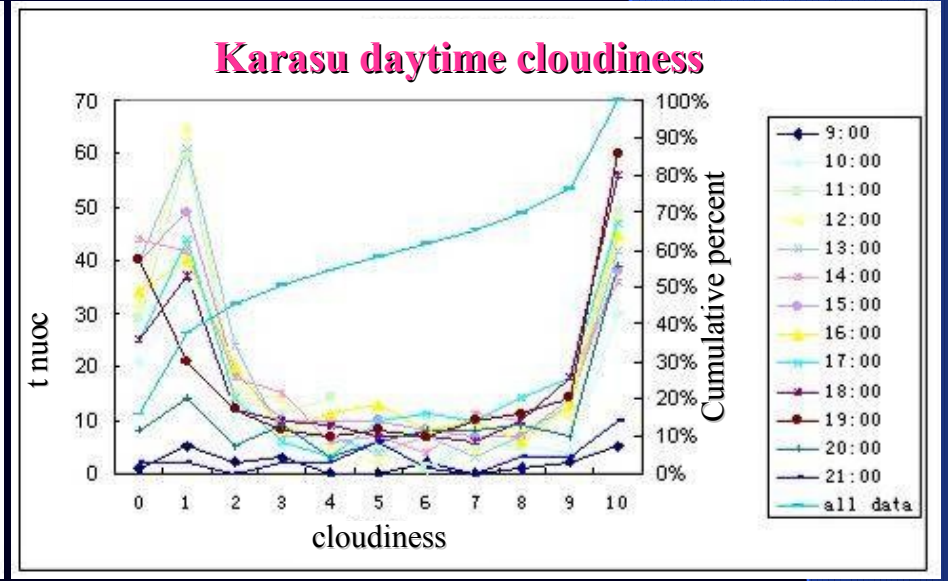
Oma: 20050801--20061229,
516 days, 82.4% coverage

Median 2.8, C≤2 45% ， C≥8 23%

Karasu: 20050720--20061205,
504 days, 71.8% coverage

Median 2.9, C≤2 45% ， C≥8 30%

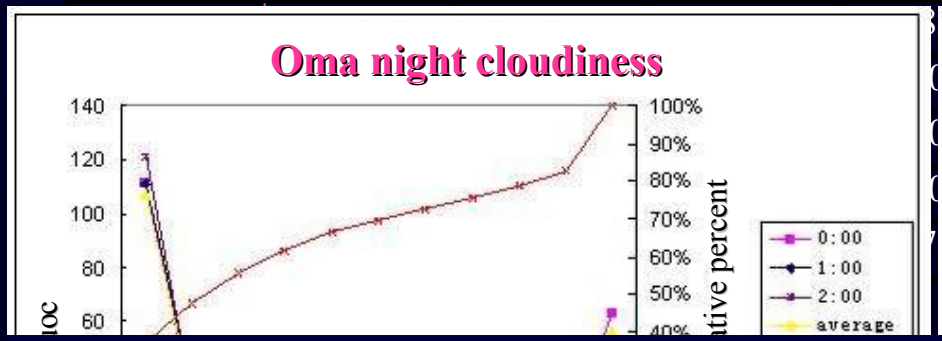




CAST 2005-2006: monitoring results

Nighttime Cloudiness

BJ Time	Oma Cloudiness				Karasu Cloudiness			
Median ~1, C≤2 58% , C≥8 23%					Median ~4, C≤2 41% , C≥8 32%			
23:00	4.3	336	63	54	5.2	309	50	44
0:00	**3.8**	**308**	**67**	**58**	**4.9**	**305**	**53**	**44**
1:00	**3.4**	**300**	**70**	**62**	**5**	**297**	**51**	**43**
2:00	**3.3**	**312**	**71**	**64**	**5**	**288**	**51**	**43**

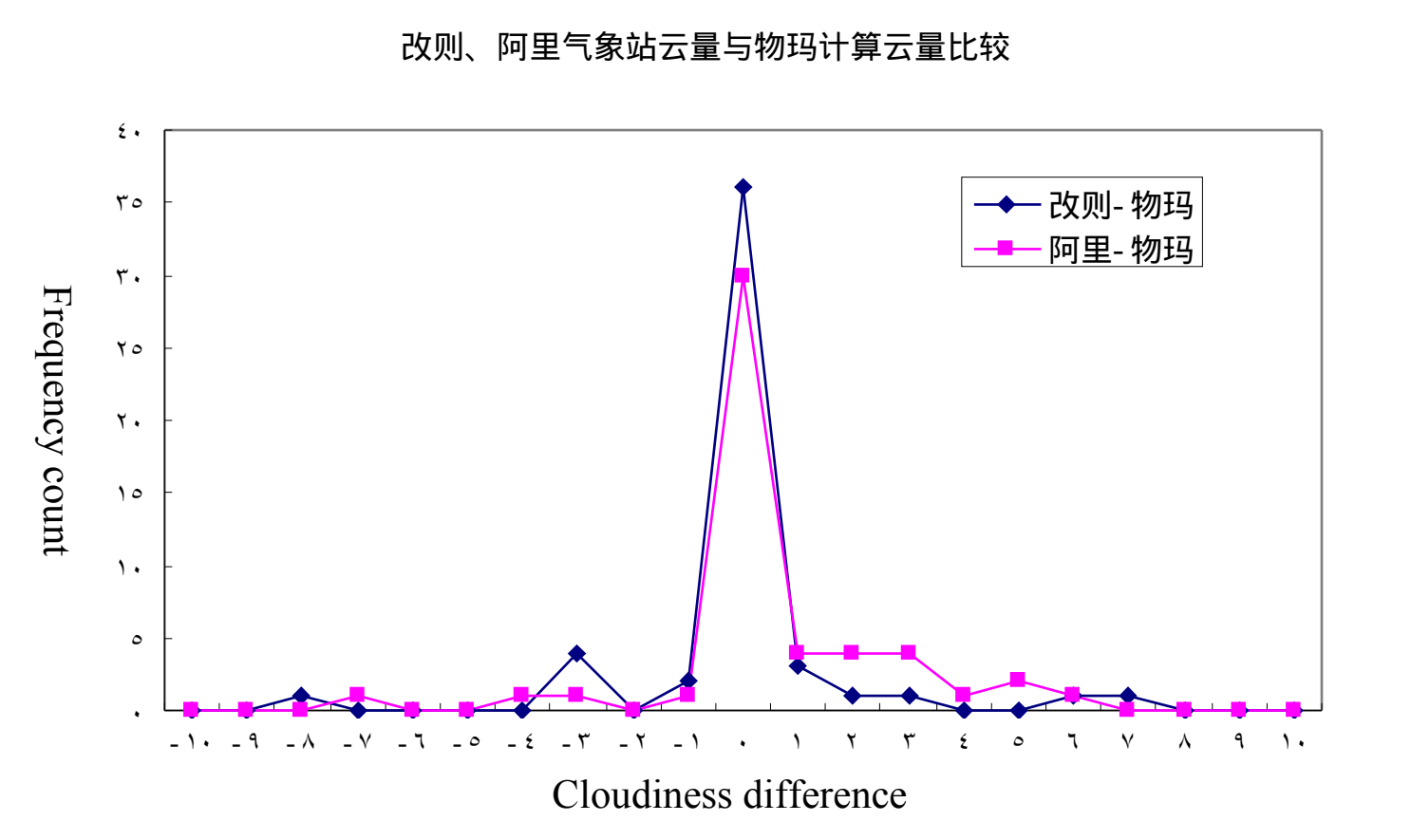


	Oma	Karasu	Oma_night	Karasu_nit
median	2.8	2.9	<1	<4
C ≤2	45%	45%	60%	45%
C ≥8	23%	30%	20%	30%

Usable night （ C ≤6 ）	
Oma	Karasu
75%	58%

CAST 2005-2006: monitoring results

Comparison of monitoring Cloudiness with nearby meteorological stations



CAST 2005-2006: monitoring results

Comparison of ground-based Cloudiness with analysis of satellite database

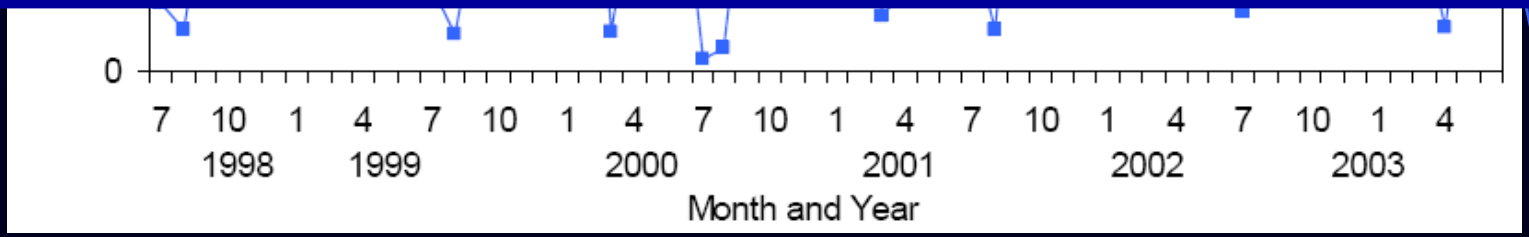
	clear night fraction for	Hanle	and	Yangbajing
Andre Erasmus ,	1998-2003 Meteosat:	76.8%		64%
Mao et al.,	1996-2003 GMS:	73%		65%

Judgement:

- Monitoring cloudiness is consistent with those of nearby meteorological stations, and the long-term datasets can be used to evaluate the sites in the Ali area.

- The cloudiness of GMS database is consistent with the ground-based datasets,

  and also consistent with the Meteosat-E analysis by A. Erasmus,
  so that the cloudiness analysis in Ali can be compared to other oversea sites.



CAST 2005-2006: monitoring results

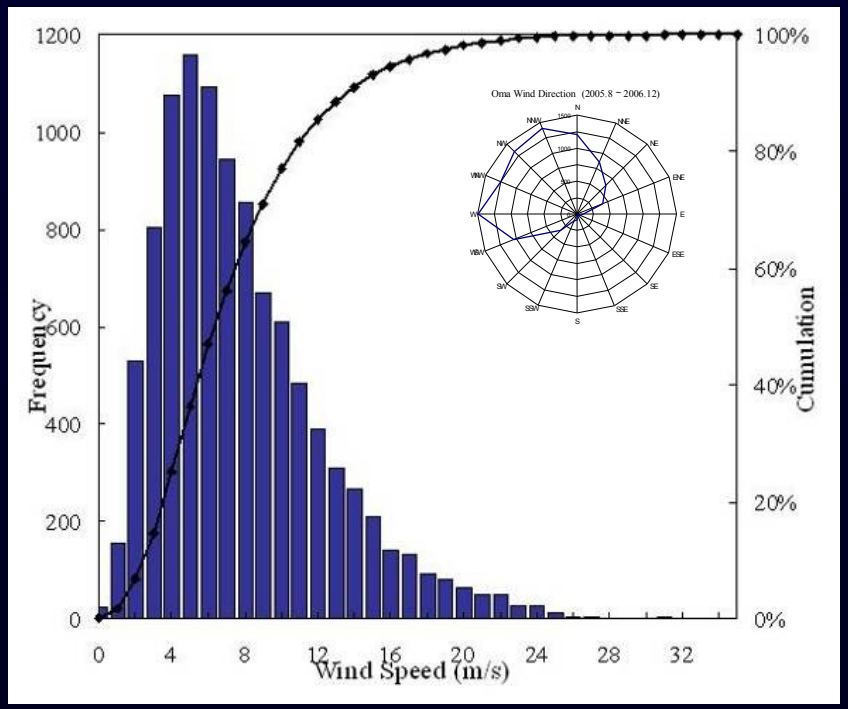
Wind speed & direction

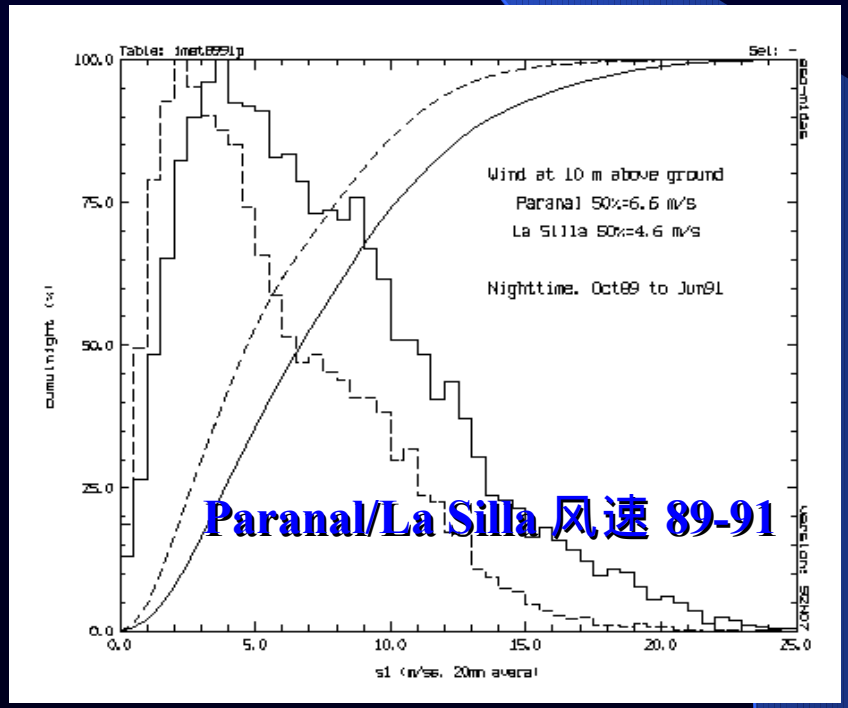
Oma: 2005.08—2006.12,
450 days, 87% coverage

median 6.4m/s, max 34.7m/s
cumul. 80% speed 11m/s

Karasu: 2005.08—2006.12,
407 days, 81% coverage

median 5.8m/s, max 23.3m/s
cumul. 80% speed 10m/s





CAST 2005-2006: monitoring results

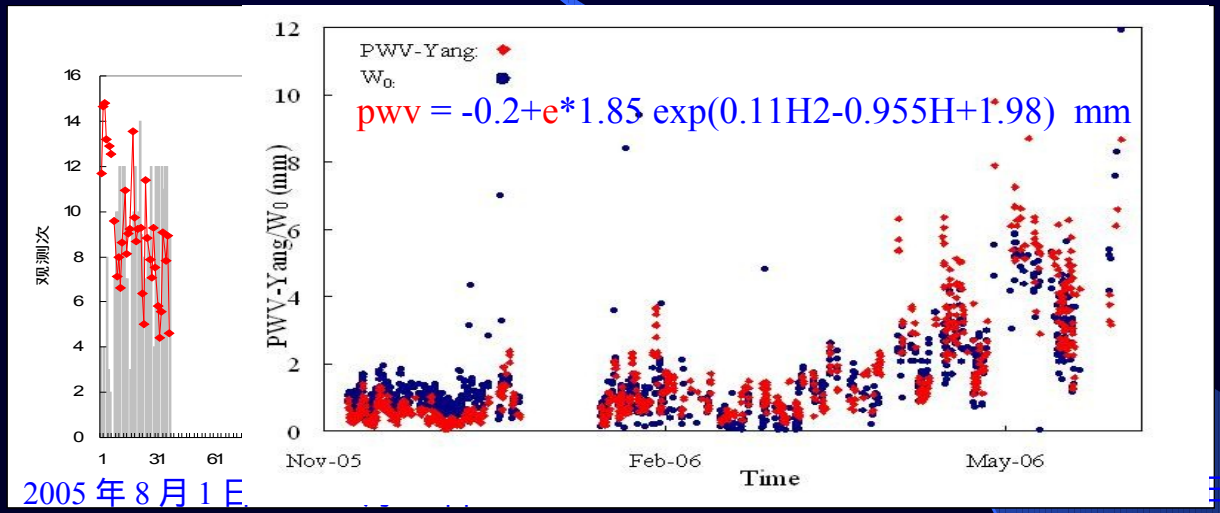
Precipitable Water Vapor

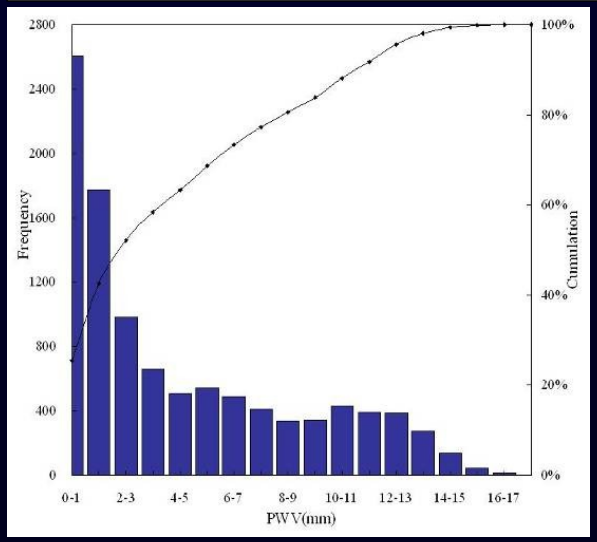
Oma:
2006.01-2006.12

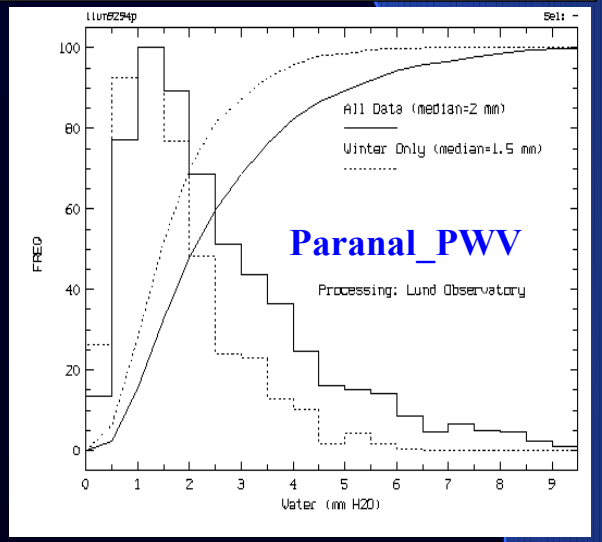
median 2.7mm,
44% pwv<2mm
59% pwv<4mm

Karasu:
2006.01-2006.12

median 3.3mm,
21.6% pwv<2mm
64.6% pwv<4mm

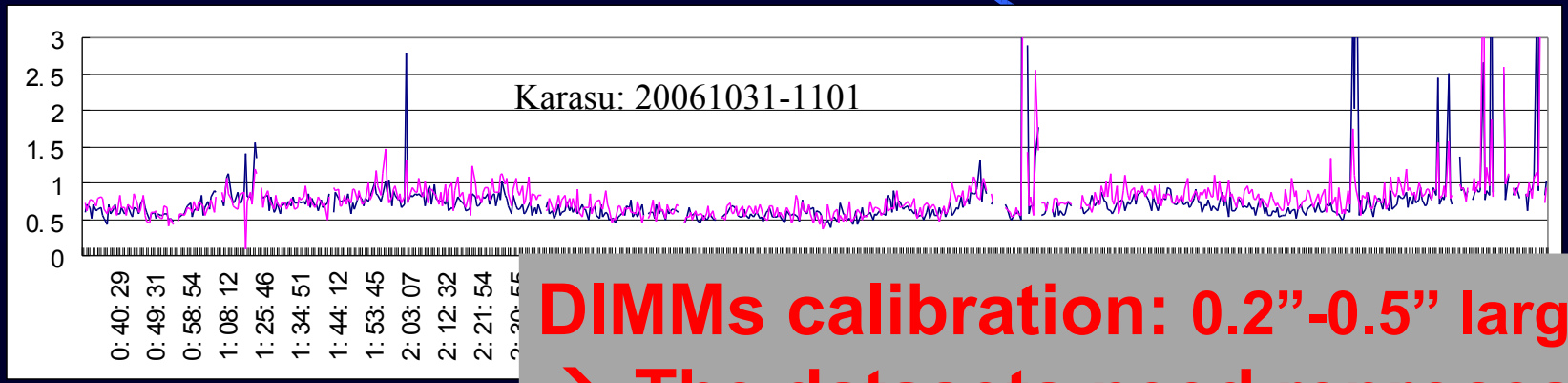






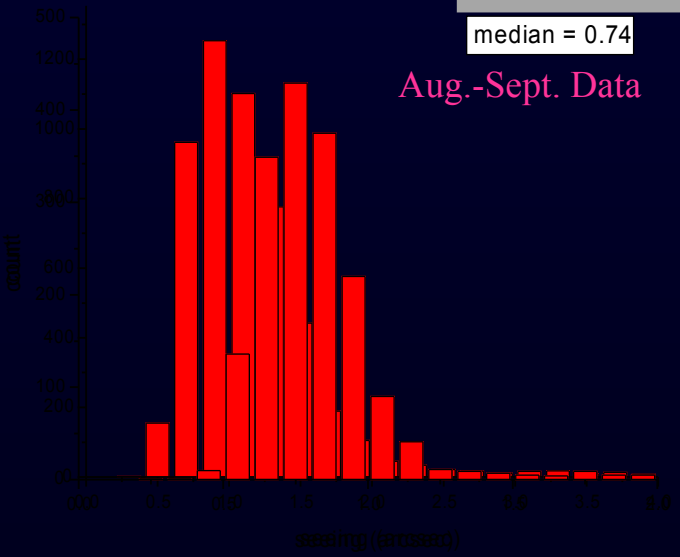
CAST 2005-2006: monitoring results

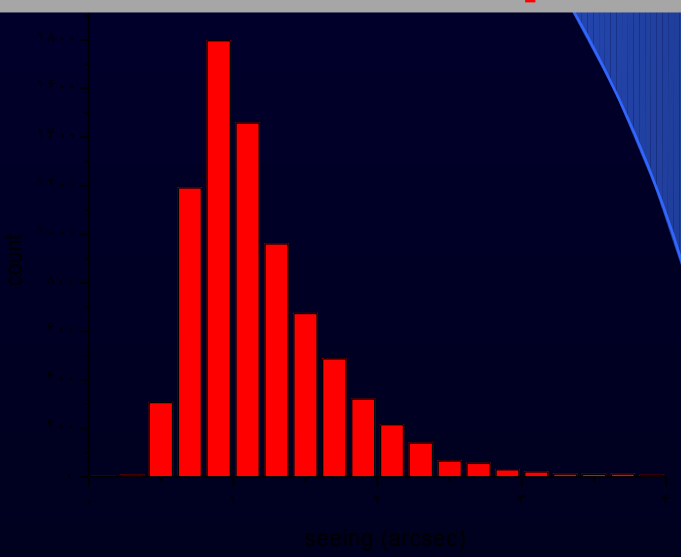
DIMM Seeing



DIMMs calibration: 0.2”-0.5” larger

→ The datasets need reprocess!





CAST 2005-2006: monitoring results

Phase 2 Short Summary

- Two candidate sites, Oma and Karasu, have been selected and run monitoring for 1.5 yrs.

- Oma site appear to be better than Karasu, and can be really superior and worth proceeding with further facilities for comprehensive characterization.

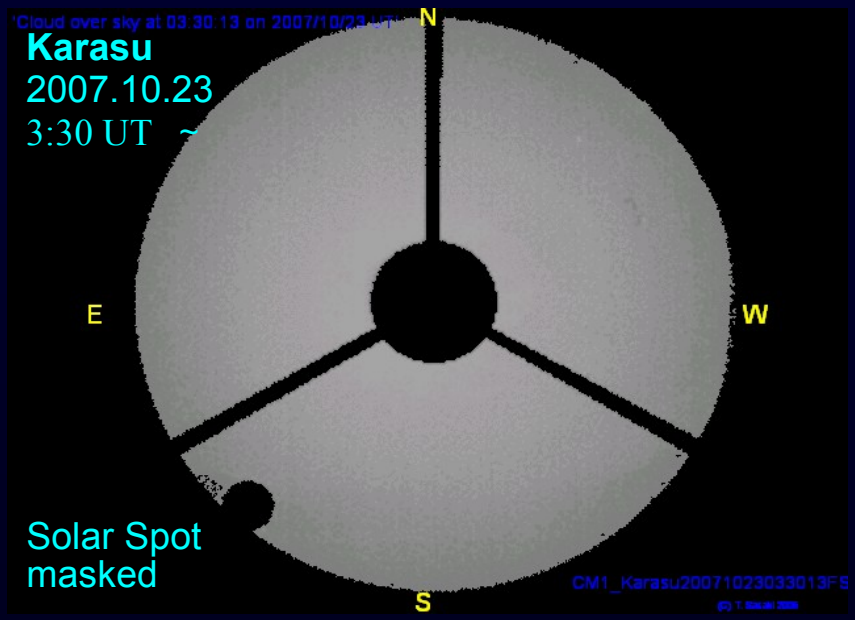
- The facilities for nighttime observations to seeing, cloudiness and water vapor should be improved, and should put more attention to turbulence profile on the sites.

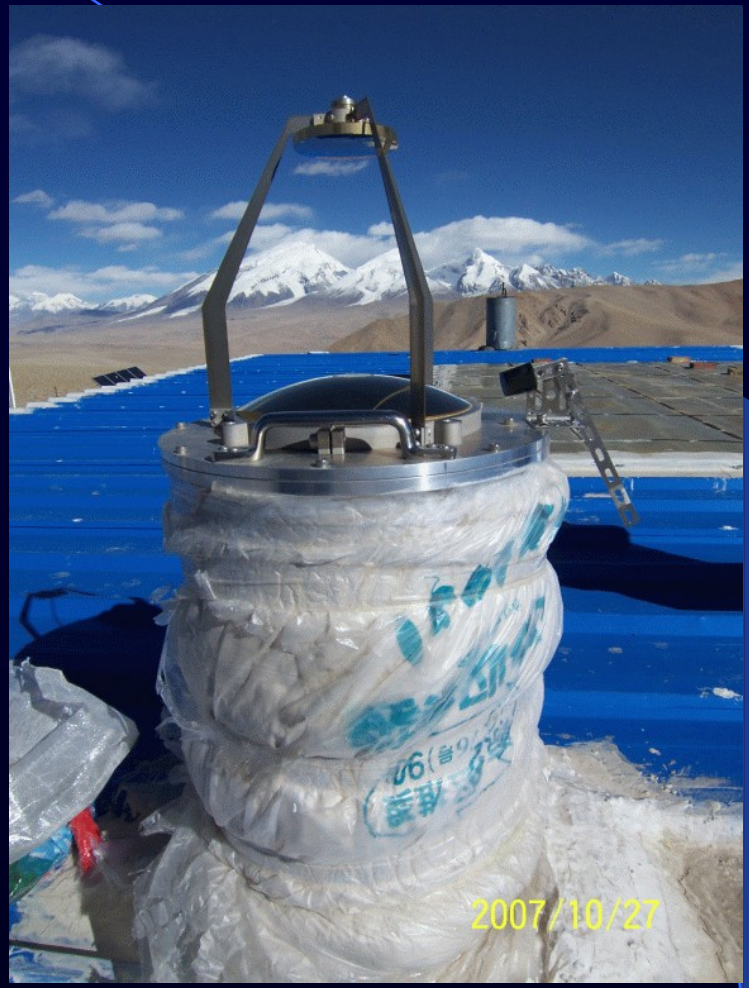
CAST 2007-2008 : Instrument setup & campaign

CAST 2007-2008 ： Instrument setup & campaign

MIR CloudMonitor at Karasu

+ with FLIR A40M camera
（ 7.5um~13um ）
+ all-sky image every 1 min continuously
+ clouds are detected as bright images
+ calibrated with Solar image intensity

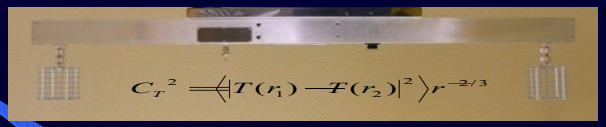


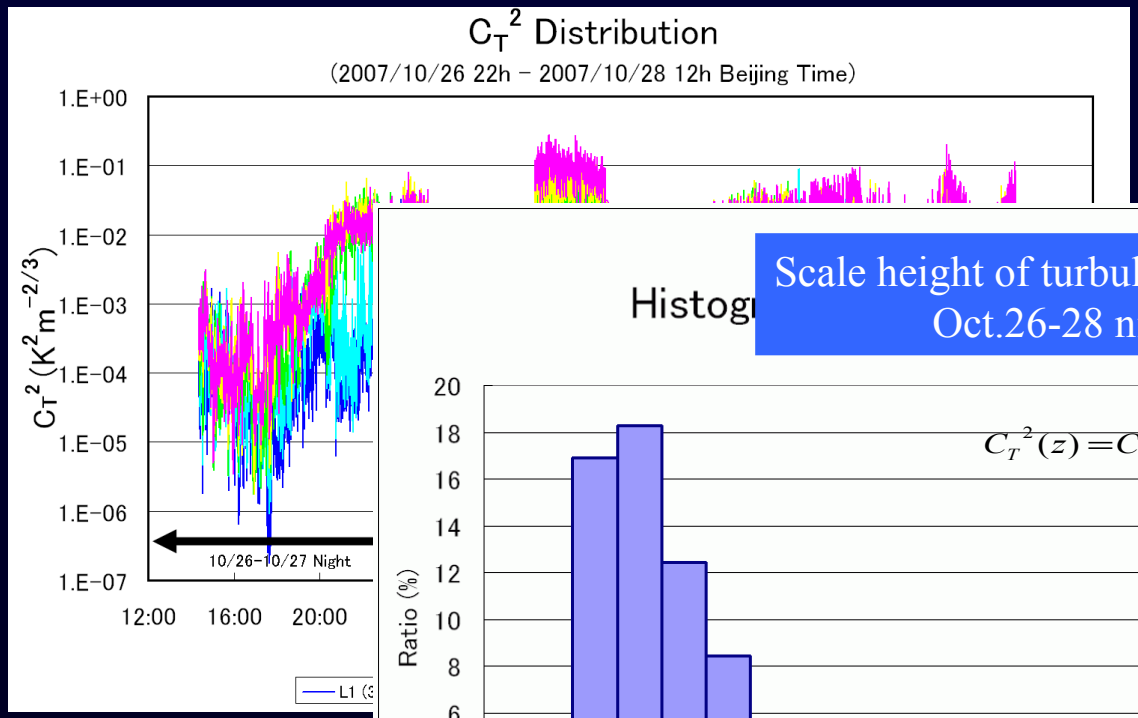


CAST 2007-2008 : Instrument setup & campaign

C_T^2 system at Karasu

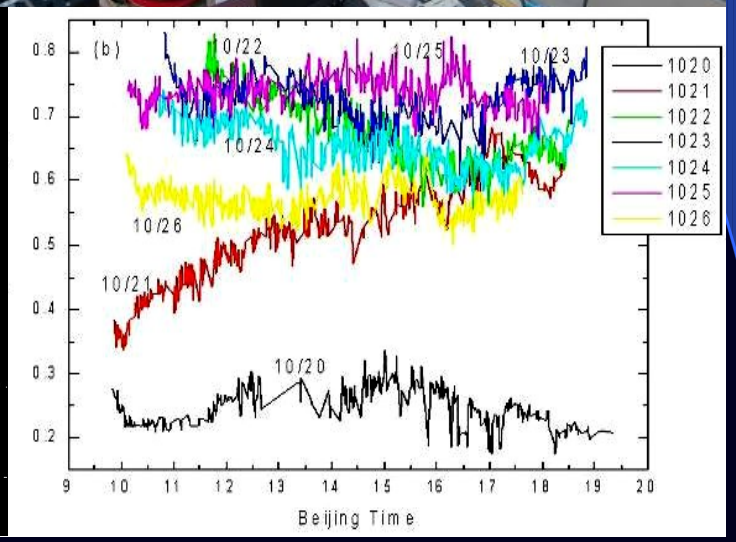
for surface layer turbulence





CAST 2007-2008 : Instrument setup & campaign

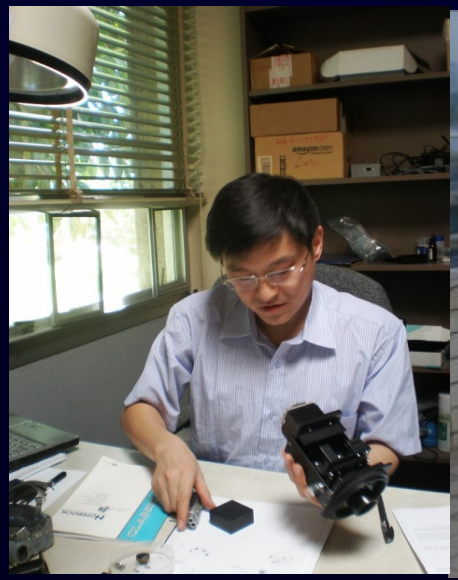
Instrument upgrade for night cloud and water vapor



CAST 2008-2009 : Instrument upgrade & campaign

Instruments for turbulence profile

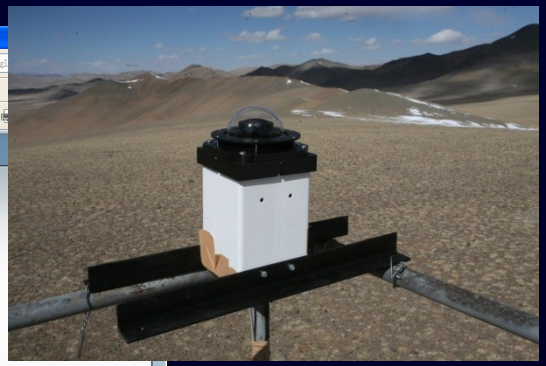
DIMM seeing, measuring integrated turbulence of whole atmosphere
CT^2 measuring for surface layer turbulence and its scale height
MASS low-resolution measurement for 6 layer turbulences
DIMM-MASS simultaneously, for turbulence of boundary and free…
SODAR high-resolution turbulence profile of inversion layer
SS_Scidar developing for detailed turbulence profile of whole atmosphere



2009 CTIO_MASS experiment

2010 NICE_SCIDAR experiment

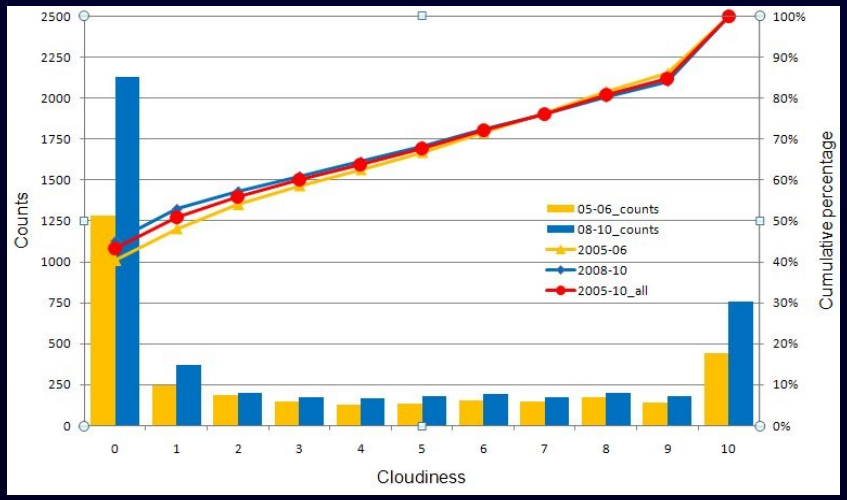
CAST 2008-2009 : Instrument upgrade & campaign

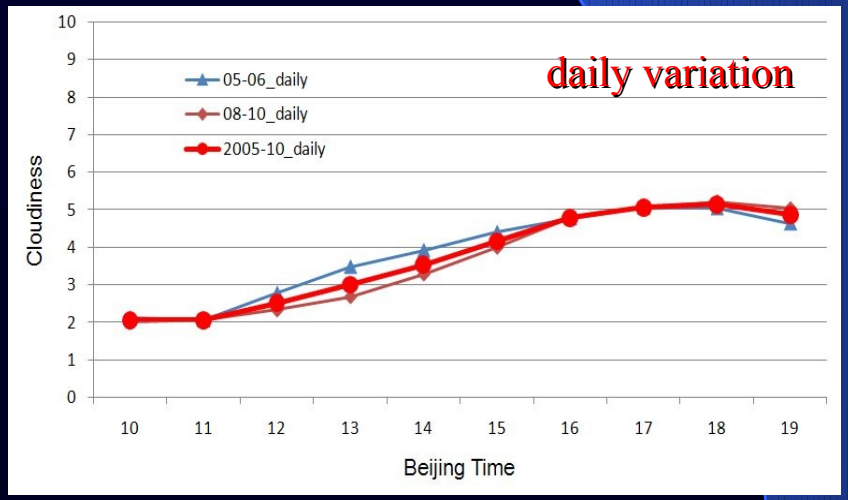


CAST 2009-2010 : project review_Oma

Oma: day time cloudiness

Period	Clear day c<1	Partly cloudy c<3	Usable day c<7	Num. days
2005-2006	40.3%	54.0%	71.6%	425
2008-2010	45.1%	57.2%	72.4%	481
average	42.8%	55.7%	72.0%	906

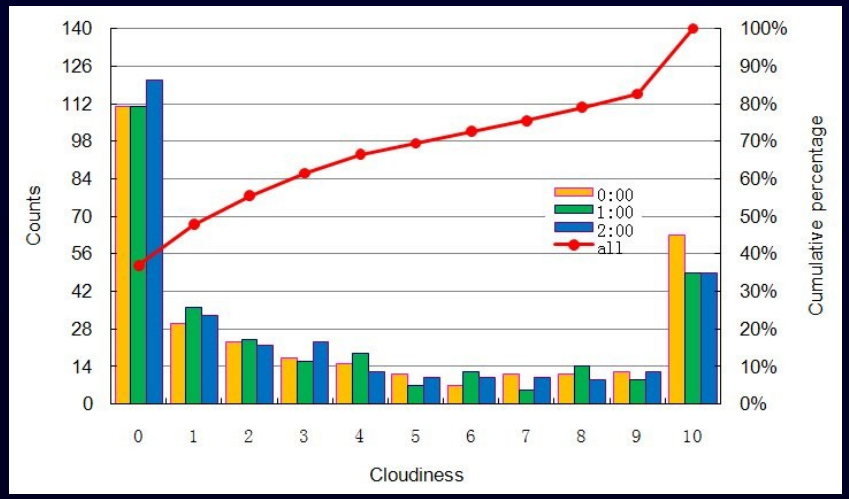


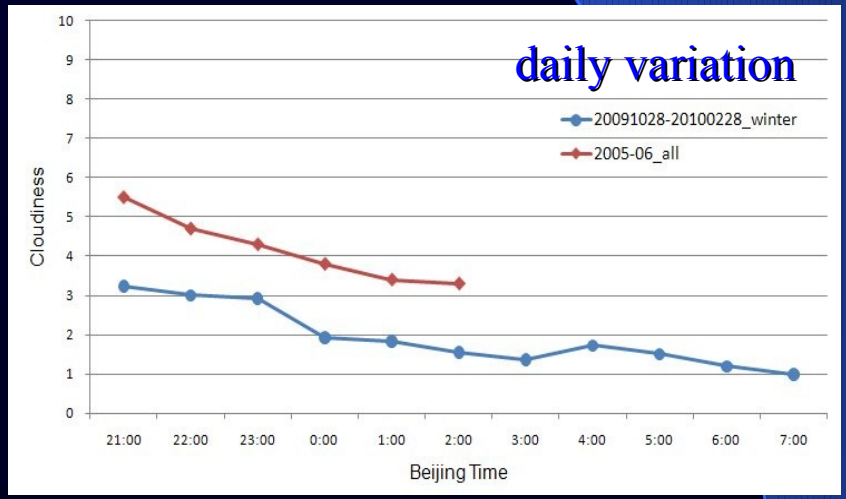


CAST 2009-2010 : project review_Oma

Oma: night time cloudiness

Period	Clear night c<1	Partly cloudy c<3	Usable night c<7	Num. nights
2005-2006	42.7%	69.0%	75.4%	310
2008-2010	47.8%	66.5%	75.4%	480
average	45.8%	67.5%	75.4%	790

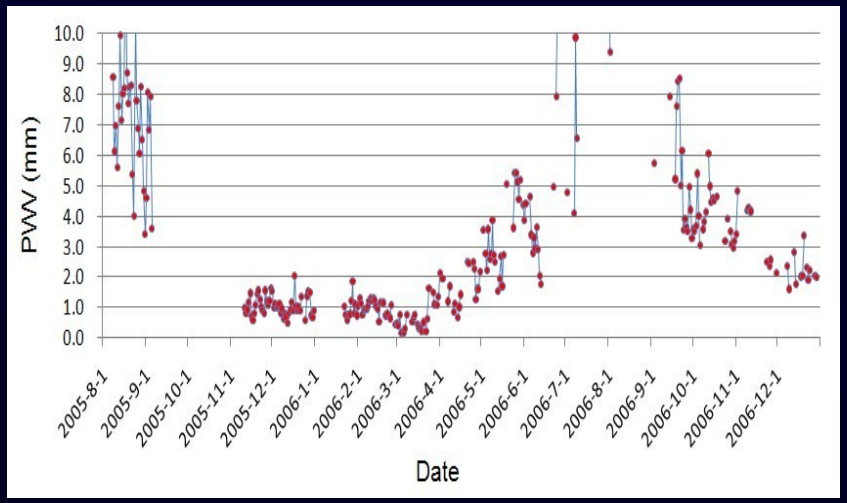


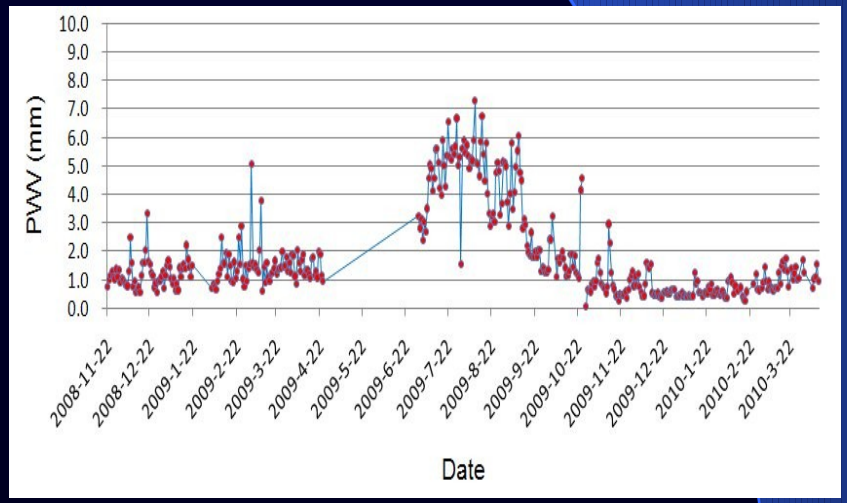


CAST 2009-2010 : project review_Oma

Oma: Precipitable Water Vapor

Period	Median (mm)	Percent. PWV<0.5	Percent. PWV<1.0	Percent. PWV<1.5	Percent. PWV<2.0	Num. days
200508-200612	2.2	5.0%	23.1%	39.2%	46.5%	260
200811-201003	1.3	10.1%	37.4%	61.8%	75.1%	406
average	1.6	8.1%	31.8%	53.0%	63.9%	790

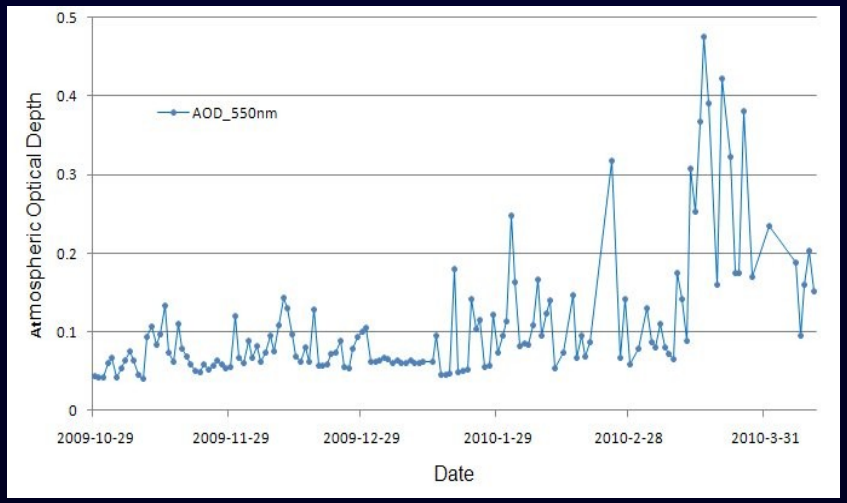


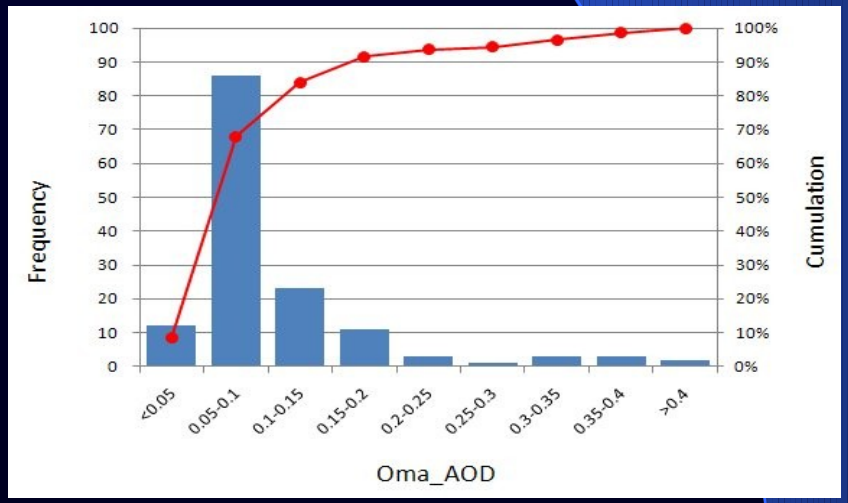


CAST 2009-2010 : project review_Oma

Oma: Atmospheric Optical Depth

Period	Median	Average	Percent. AOD<0.05	Percent. AOD<0.1	Percent. AOD<0.2	Num. days
200811-201003	0.08	0.11	8.3%	68.1%	91.7%	144





CAST 2009-2010 : future plan

ShiQuanHe_25km South: newly selected site near the Ali airport

for simultaneously monitoring and small telescope project

CAST 2009-2010 : future plan

ShiQuanHe_25km South: newly selected site near the Ali airport
for simultaneously monitoring and small telescope project

view Shiuanhe to the north

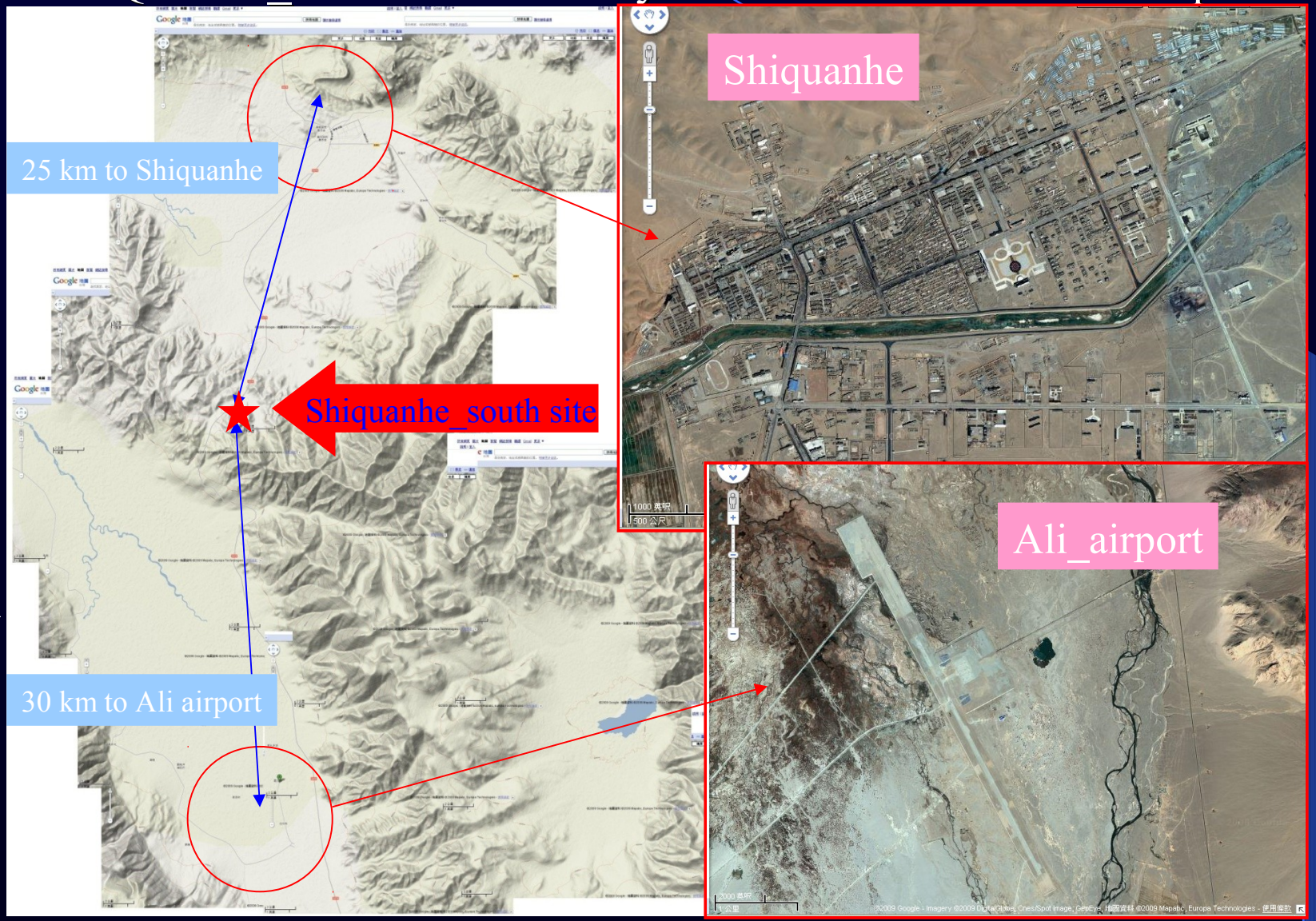
summit of the site

simple road to summit

Topography	A NW-SE ridge, above 5000m
Meteorology	Cloudiness and wind speed may be better than Oma site
Traffic conditions	Paved road from Lhasa or Kashi, Ali airport open in 2010
Road to summit	Simple constructed
Electric power & communication	Pass-way on summit to the airport
Geology for construction	Bed rock underlying less than 1m, common solidity

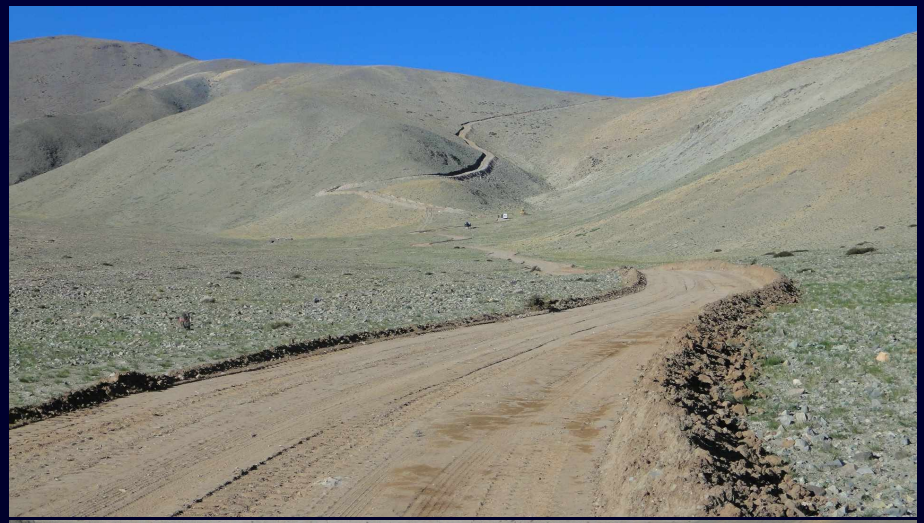
CAST 2009-2010 : future plan

ShiQuanHe_25km South: newly selected site near the Ali airport



CAST 2009-2010 : future plan

ShiQuanHe South: newly selected site near the Ali airport



CAST 2009-2010 : future plan

ShiQuanHe South: newly selected site near the Ali airport

CAST 2009-2010 : future plan

ShiQuanHe South: newly selected site near the Ali airport

Site is one of the key factors for future telescopes, and
Sites in Ali area can be the best choice over the East Asian regions.

Welcome your attention to and collaboration with the CAST !