西藏物玛观测站
大气水汽总量监测结果

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2010.12.20

大气水汽总量测量的意义

- 大气水汽总量的测量在天文台选址工作中是最重要的参量之一。
- 它不仅对红外和毫米波的天文观测，具有特殊重要的意义，而且对地面光学波段观测也很重要。

测量大气水汽的几种方法

1. 无线电探空技术探测
2. 卫星遥感反演
3. 运用GPS技术估算
4. 太阳光谱分析仪
5. 红外遥感反演

- 使用成本相对低廉
- 便携
- 数据直观准确，可和卫星遥感数据相互验证

SP型大气水汽仪

- 工作波段：750nm-1000nm
- 最小分辨率：1μW/cm^2·1 nm
- 水汽测量精度：±5%

优点：

操作简单，方便携带

缺点：

不能自动跟踪，需手动观测采集

大气水汽含量测量原理

- 仪器以太阳或月亮光谱在935nm波长剩余强度为R
- 按公式求出测量程上大气水汽总量W，垂直气柱上的水汽总量W_0

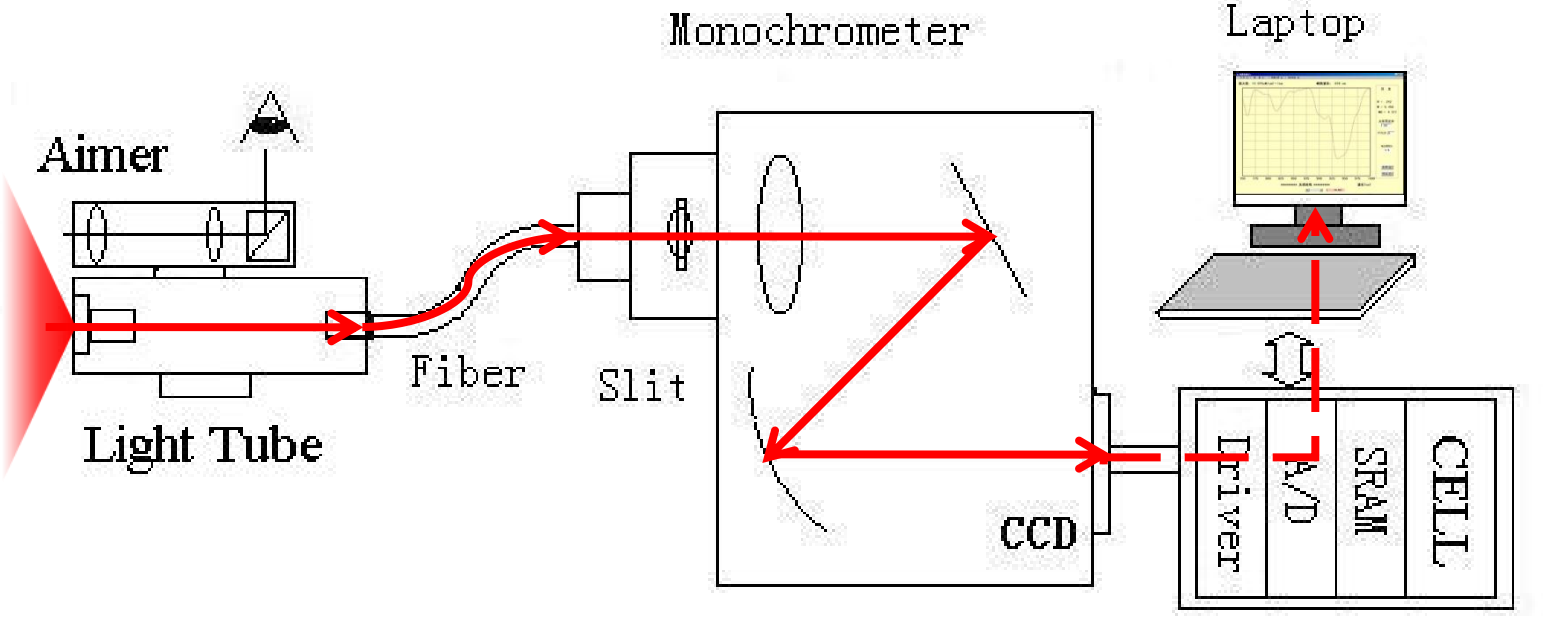
$$R=0.59^{\sqrt{W/cm}}$$

- 由W_0 =W/m求出，m为大气垂直路径的MASS.

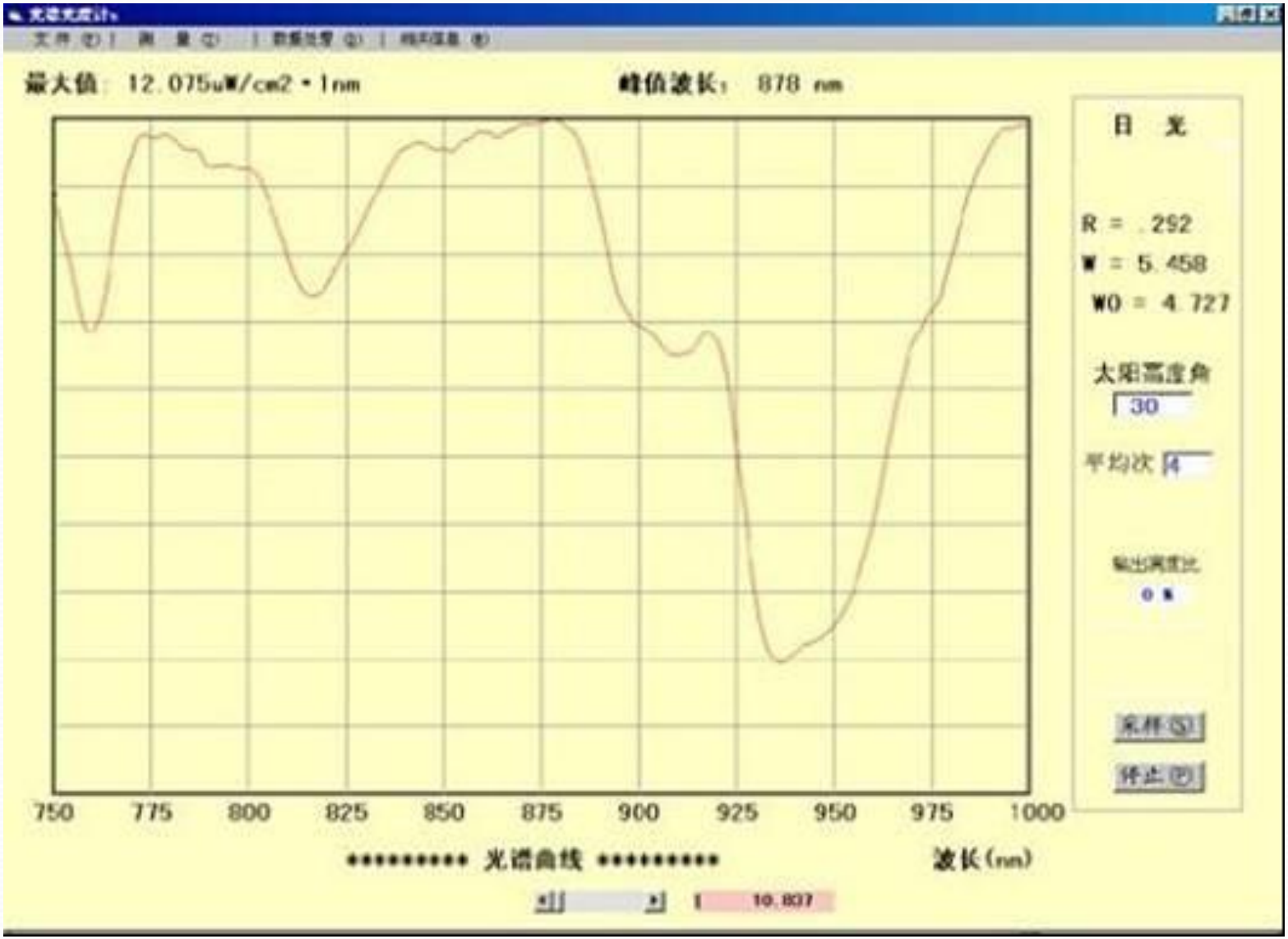
参考文献：郝允祥、王术军、张保洲《光学方法测定大气水汽总量的探讨》
北京师范大学学报1996，32(2)：195—98.

SP型大气水汽仪结构

- 光束从测光筒、光纤，照射在入射狭缝，在单色仪焦平面产生光谱。
- 线阵CCD将光谱变成模拟电信号。
- 电信号经过放大和A/D转换变成数字信号。
- 计算机通过并行接口采集数字信号，经过计算显示结果。



软件界面

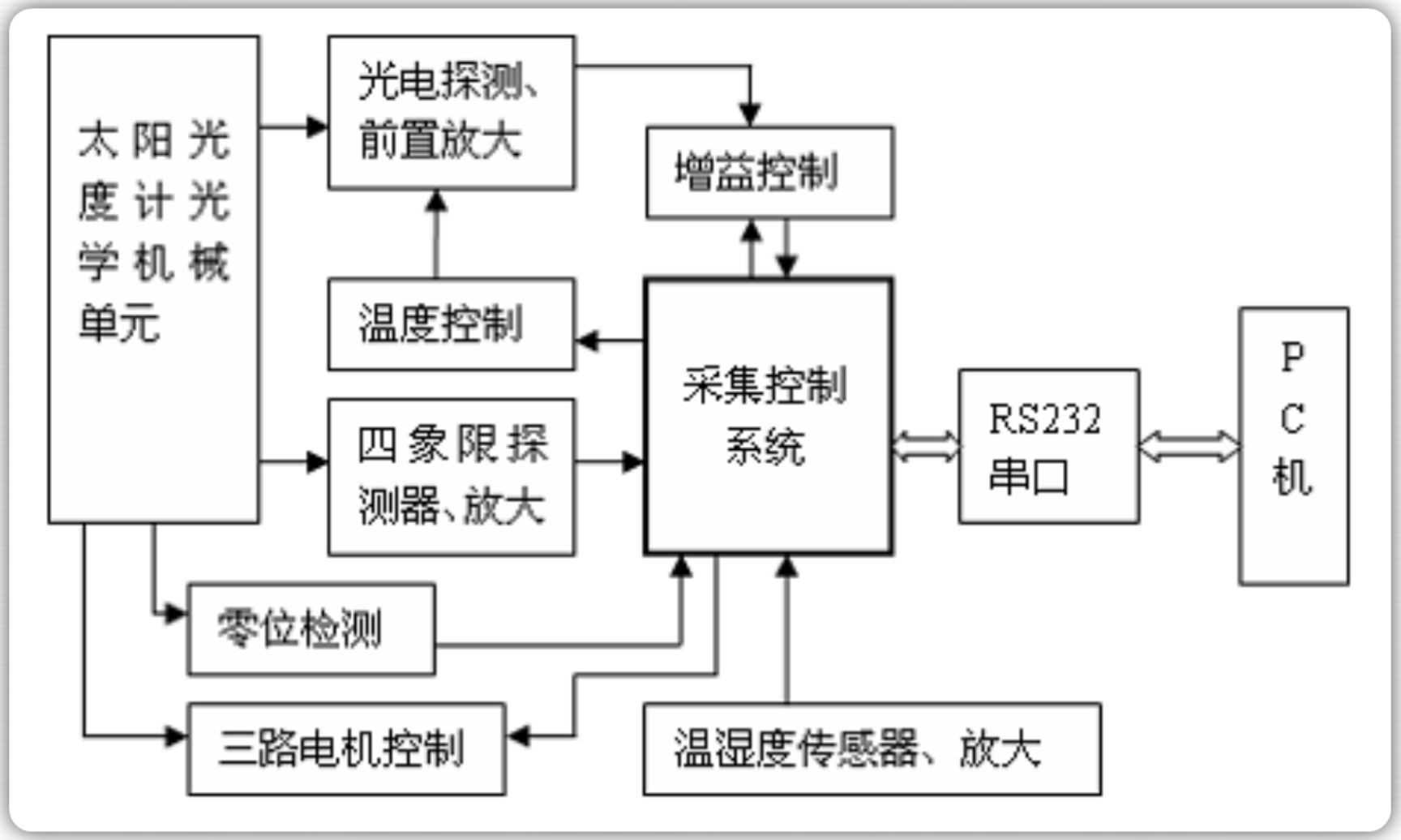

最大值: 12.075uW/cm2·1nm
峰值波长: 878 nm
日 光
R = .292
W = 5.458
W0 = 4.727
太阳高度角
30
平均次
750 775 800 825 850 875 900 925 950 975 1000
光谱曲线
波长(nm)
10.837

DTF-5多波长自动太阳光度计

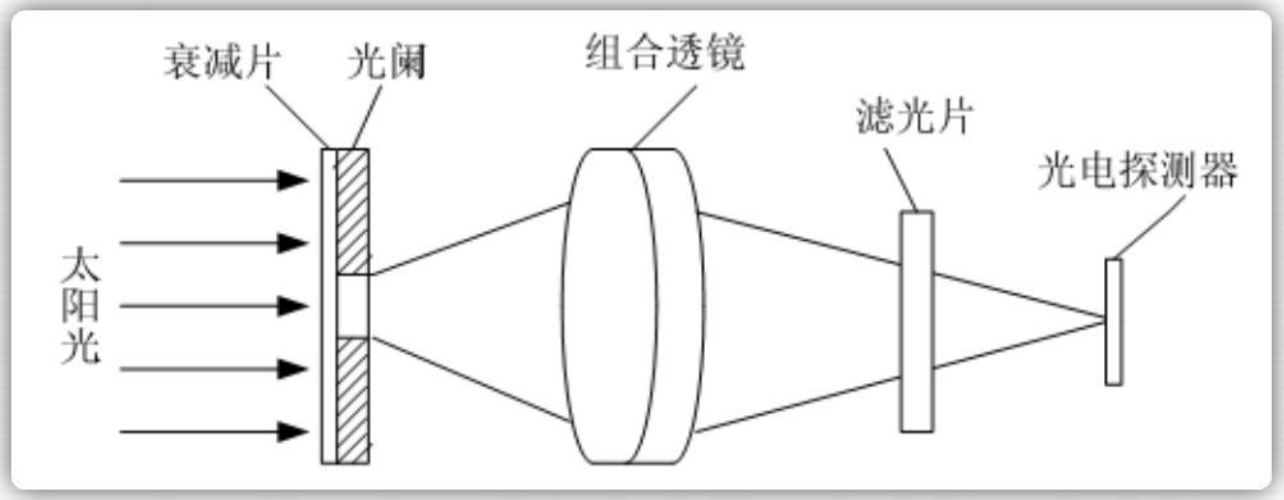
优点：

- 一体化设计
- 可视化操作
- 实时测量显示
- 全天候工作
- 长数据线传输

DTF-5硬件构成


太阳光度计光学机械单元
光电探测、前置放大
增益控制
温度控制
采集控制系统
RS232串口
PC机
四象限探测器、放大
零位检测
三路电机控制
温湿度传感器、放大

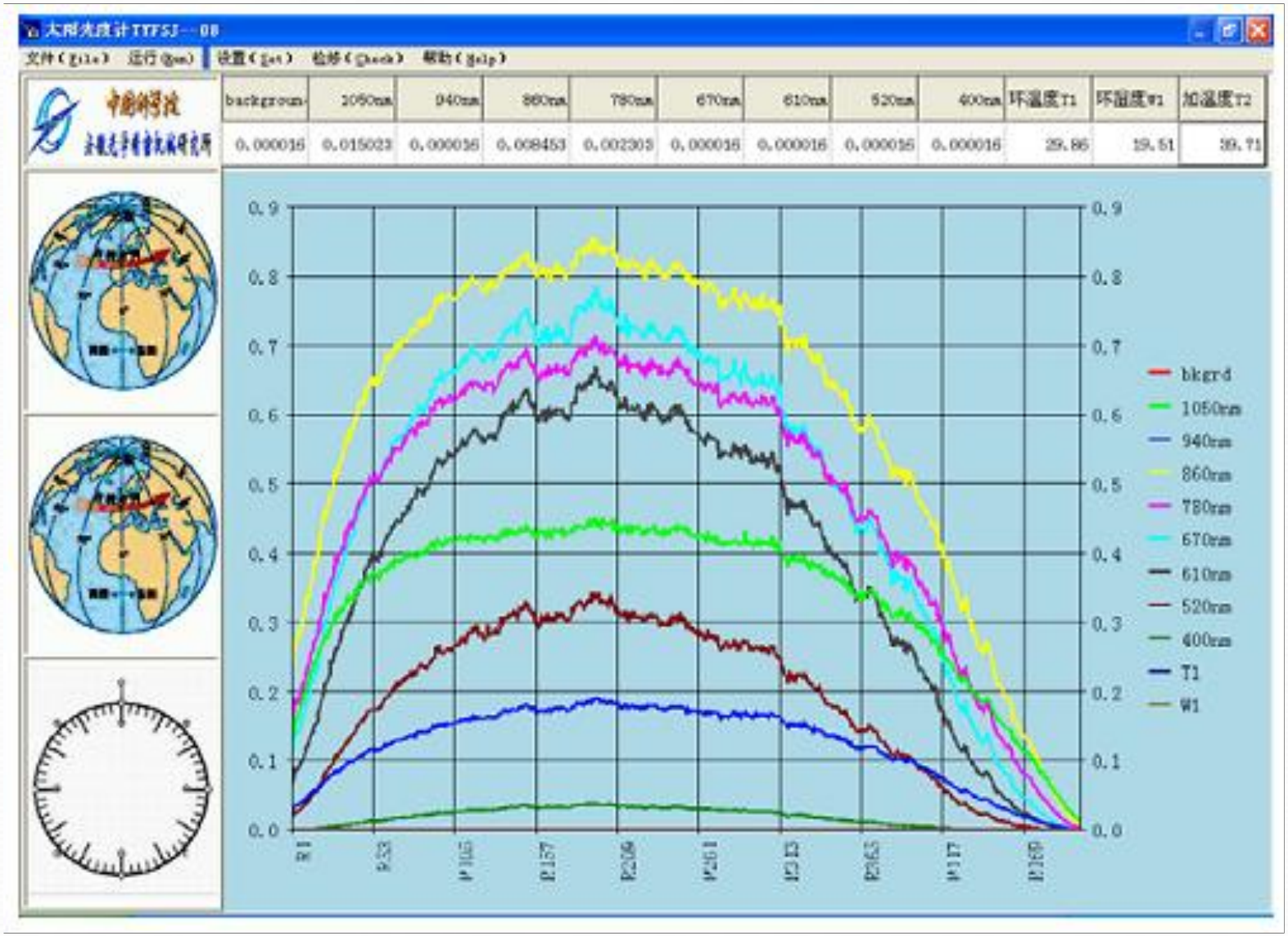
DTF-5光学系统设计



8个波段中心波长和半波宽度

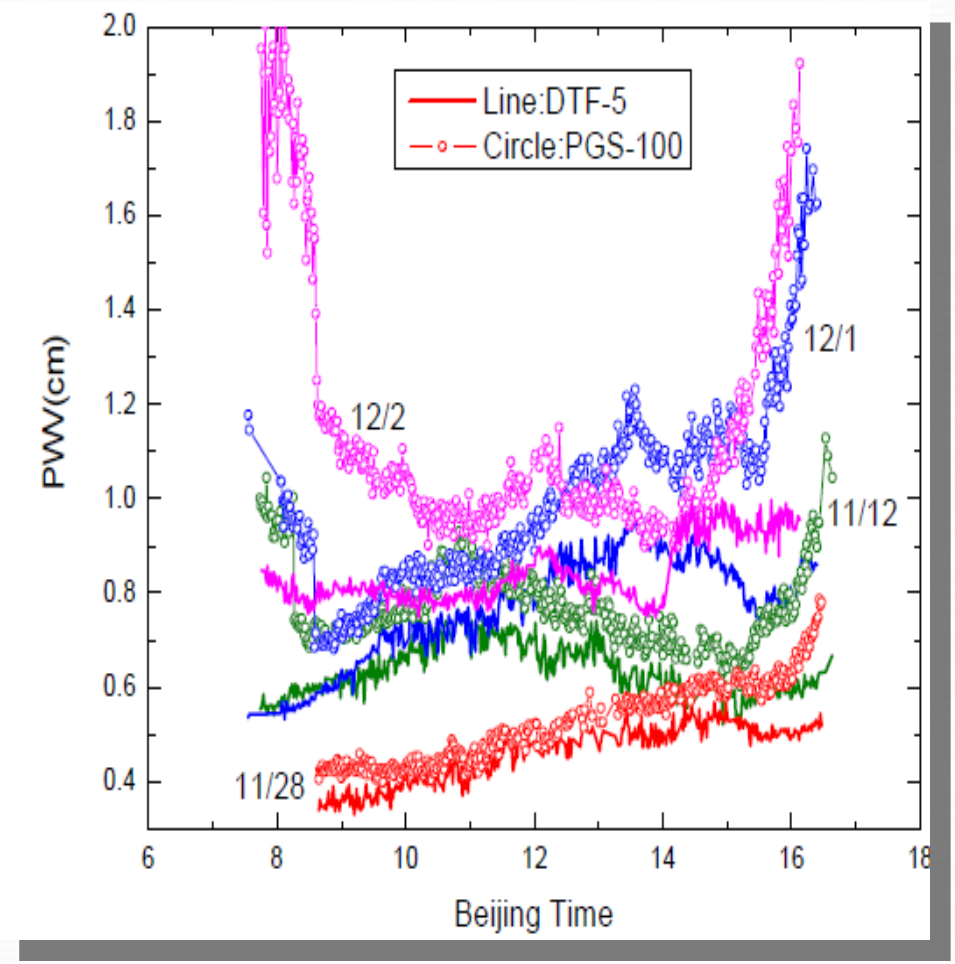
波段(nm)	400	520	610	670	780	860	940	1050
中心波长(nm)	400.19	519.55	610.30	670.13	780.40	860.60	938.90	1049.69
半波宽度(nm)	7.60	8.70	10.00	9.50	10.40	12.60	10.60	10.00

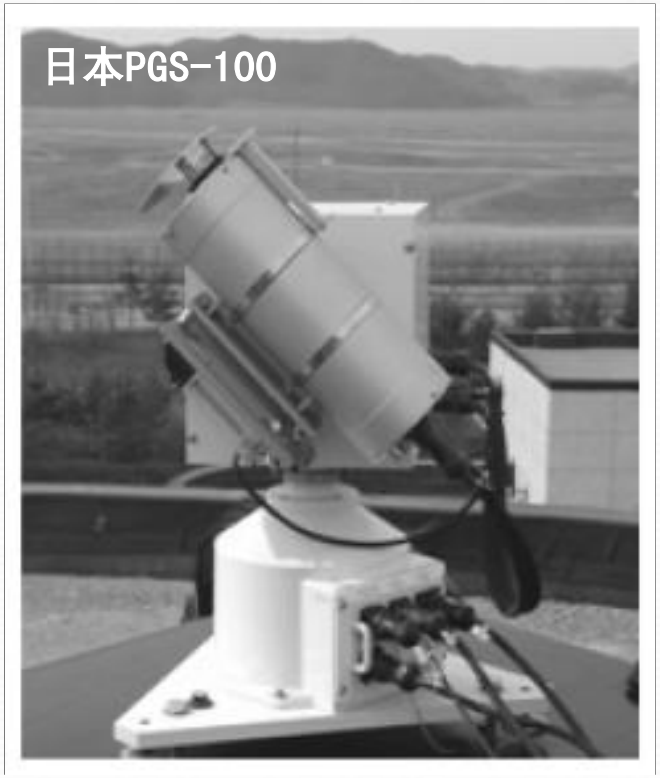
DTF-5软件界面


background
1050nm
940nm
860nm
780nm
670nm
610nm
520nm
400nm
环温度T1
环温度W1
加温度T2
0.000016
0.015023
0.000016
0.008453
0.002305
0.000016
0.000016
0.000016
0.000016
29.86
19.51
39.71
bkgrd
1050nm
940nm
860nm
780nm
670nm
610nm
520nm
400nm
T1
W1

与日本PGS-100设备对比

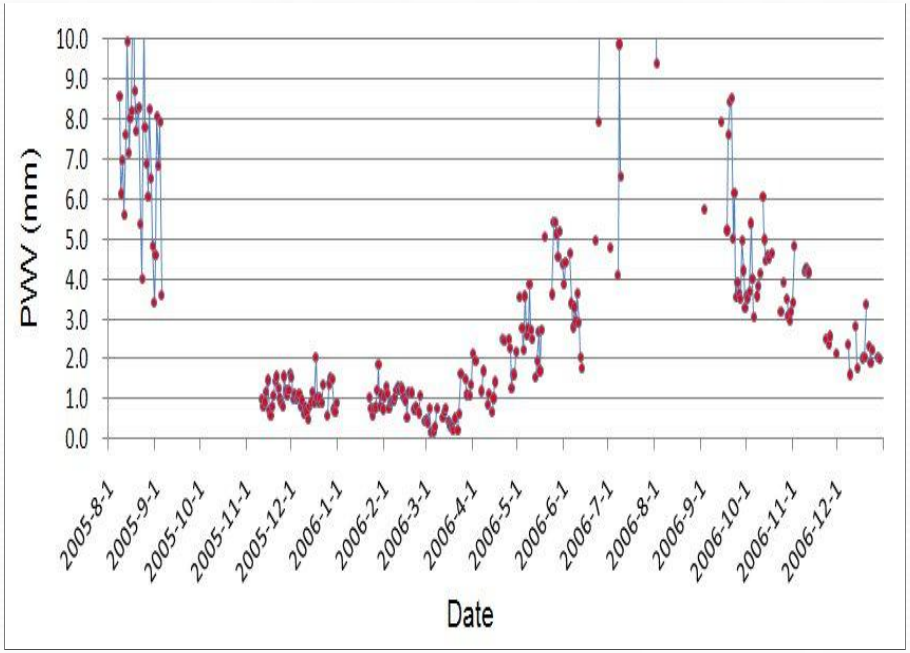
- DTF-5和日本PGS-100进行比较，在相同波段呈现趋势的一致性。

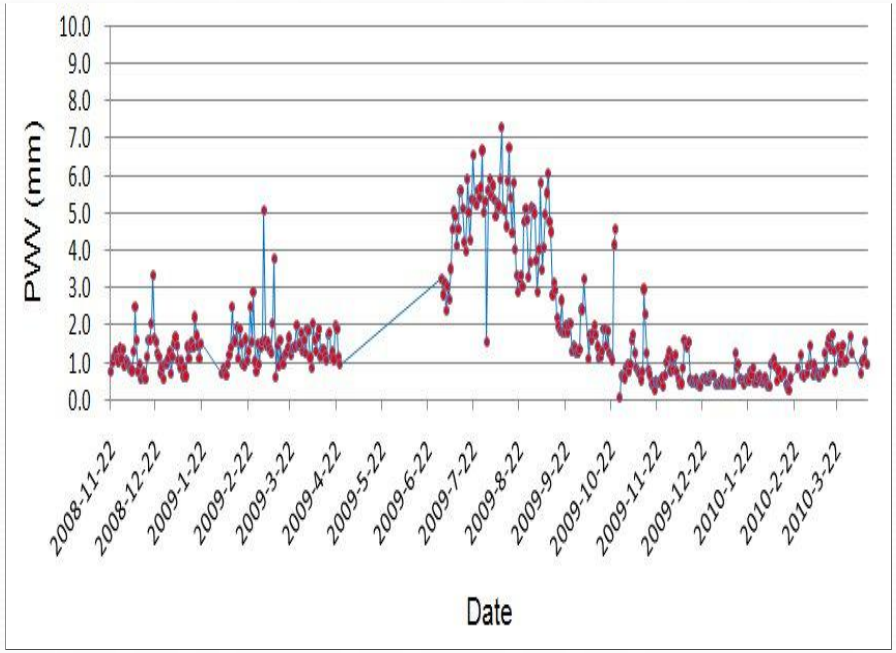




物玛监测数据结果

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





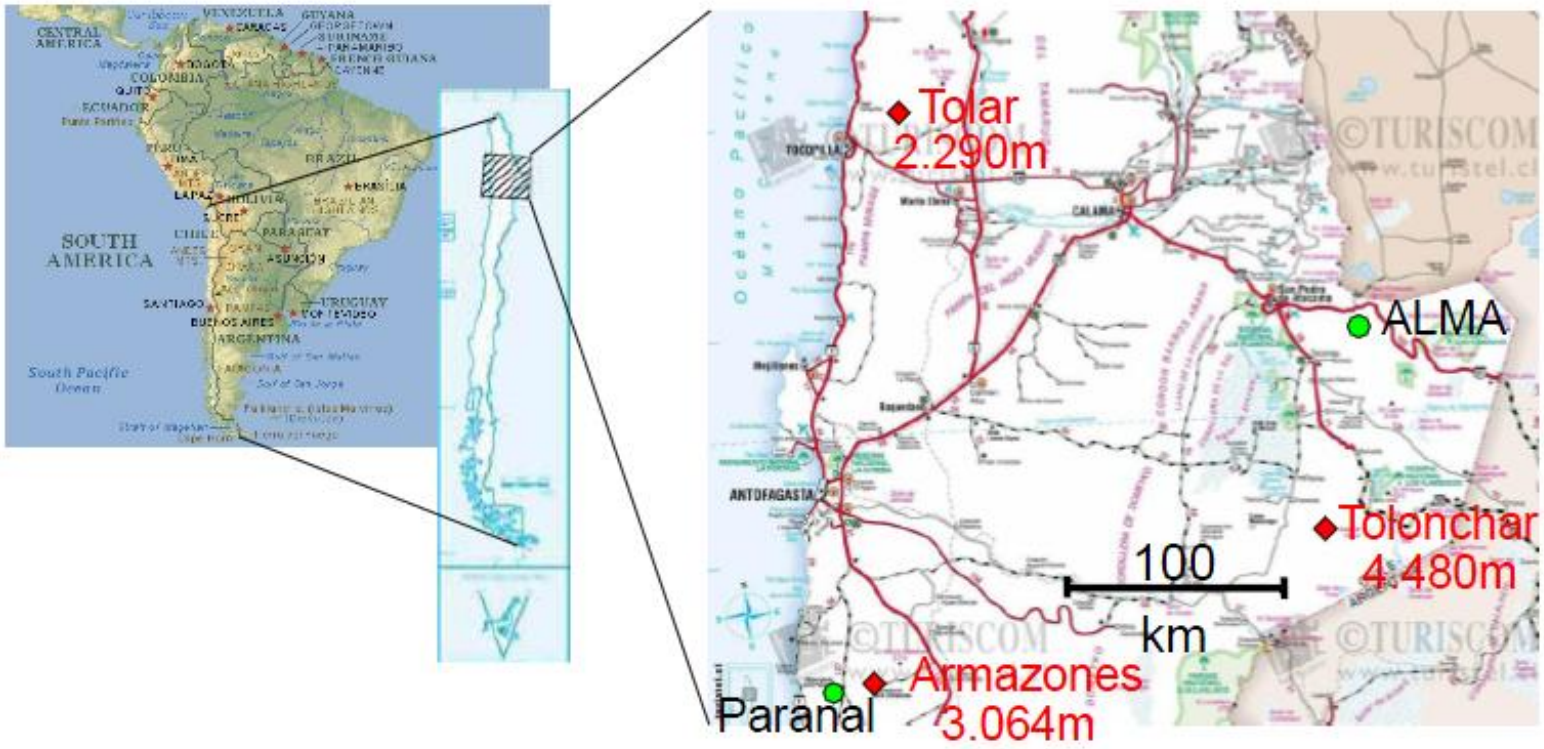
物玛水汽与国际台站比较. I

Characterization of Precipitable Water Vapor at the TMT Candidate Sites in Northern Chile: The Importance of Surface Data

- Monitoring of PWV at the TMT candidate sites
  - Satellite studies: Andre Erasmus and collaborators
  - Infrared radiometers (20 μm)
  - Radiosonde soundings from the Antofagasta station
  - Surface weather data: assuming an underlying PWVvertical profile model
- Results
  - Overall, seasonal, PWV: night time results

TMT
THIRTY METER TELESCOPE

Location of the TMT candidate sites in northern Chile



TMT
THIRTY METER TELESCOPE

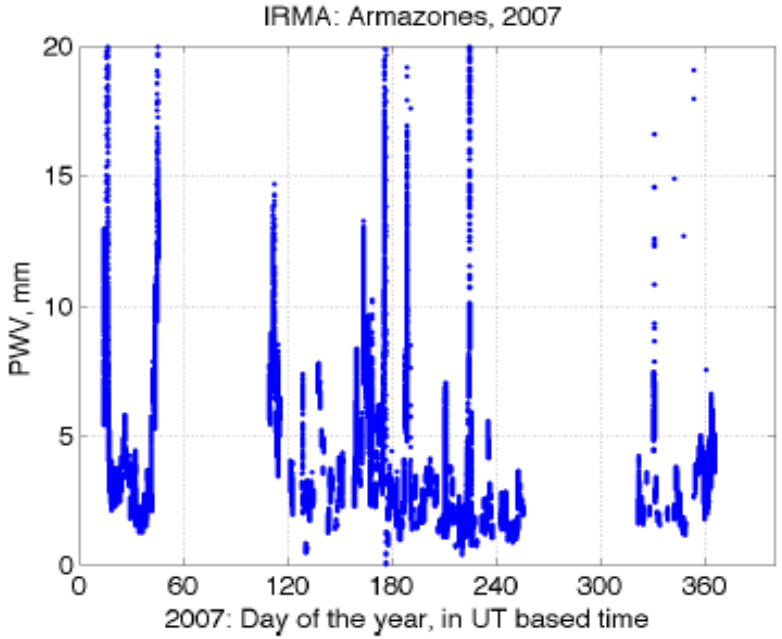
Results from the preliminary PWV studies of Erasmus & van Staden

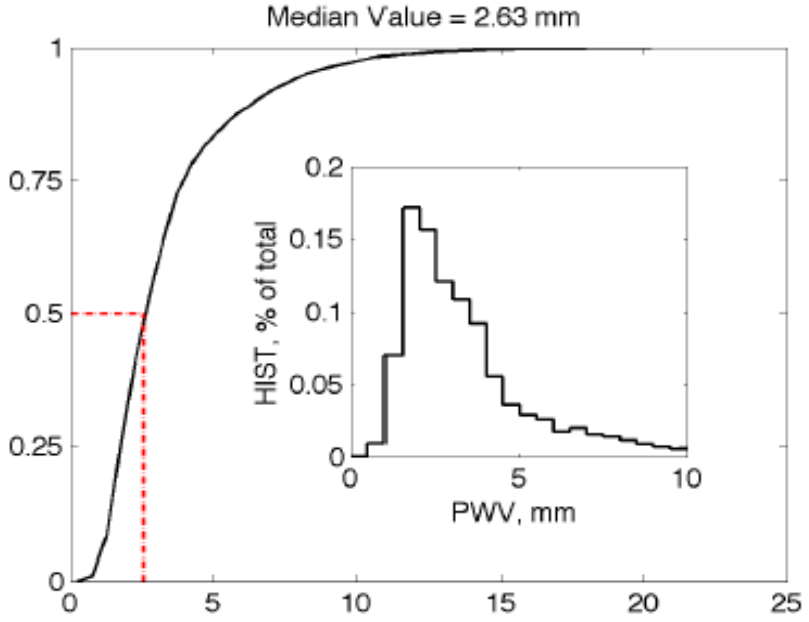
Caveats:
[1] Satellite studies emphasize the 300hPa-600hPa region

[2] The methodology produces sensible results for clear days; which might imply a bias towards relatively drier conditions.

Site	Elevation (m)	PWV Median (mm)	PWV 10% (mm)
Cerro Tolar	2290	4.02	1.59
Cerro Armazones	3064	2.87	1.15
Cerro Tolonchar	4480	1.70	0.70
San Pedro Mártir	2830	2.63	1.06
Mauna Kea 13N	4050	1.86	0.72

The Use of Surface Weather Data to Infer PWV





Caveats:

[1] The IRMA radiometers produced limited data: 172 days only Armazones

[2] The observations missed a good fraction of the Fall and Spring seasons

Reason: The remoteness of the sites conspired against keeping track of the calibration of these radiometers and keeping them operating at all times.

TMT
THIRTY METER TELESCOPE

Results: Overall & Seasonal

Site	Alt. (m)	PWV (mm) GOES	PWV (mm) Surf. D.	ΔPWV (mm)	ΔPWV (%)	PWV Night Time (mm)
Tolar	2290	4.02	4.73	+0.71	18%	4.2
Armazones	3064	2.87	3.19	+0.32	11%	2.9
Tolonchar	4480	1.70	1.83	+0.13	8%	1.7

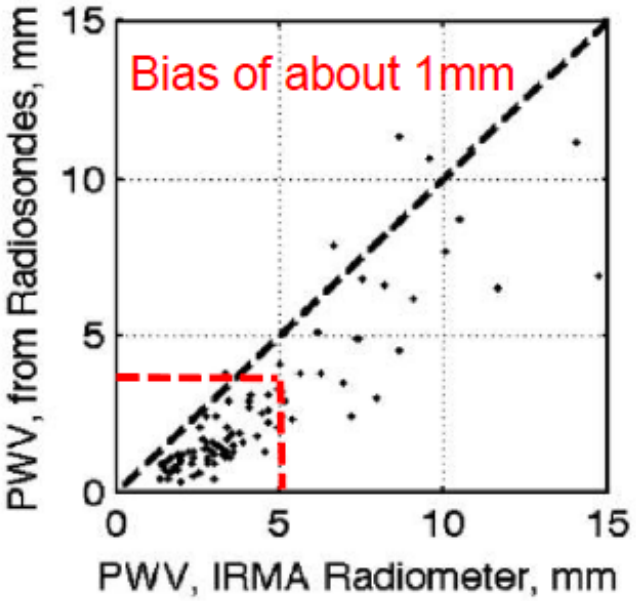
The global median values obtained from surface weather data agree within 20% with the results from the preliminary studies of Erasmus & van Staden

The difference decreases with altitude. This might be to the fact that the Satellite studies are more sensitive to the 300 hPa – 600 hPa region
300 hPa ~ 10 km a.s.l. and 600 hPa ~ 4 km a.s.l.

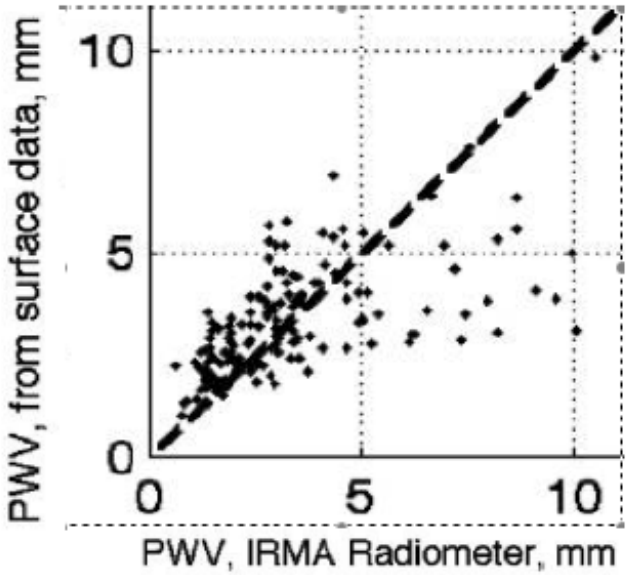
Comparison of PWV from Surface-data Radiosonde soundings and IRMA Radiometers

Florian Kerber
Results showed
No Bias
(Site-2010)

Reason:
He used In-situ
& night time
radiosondes



Obvious offset between
IRMA and Radiosondes (AFTA)



Less of an offset between
IRMA and PWV from surface data
But more scattering

Offset with radiosondes can be explained by a combination of factors:

1)There is a known dry bias in the radiosonde humidity sensors
2)Radiosondes are launched from about 100 km away from Armazones
3)Collocated data is very limited
4)Noise level in IRMA receivers ~ 0.25 – 0.5 mm

物玛水汽与国际台站比较. II

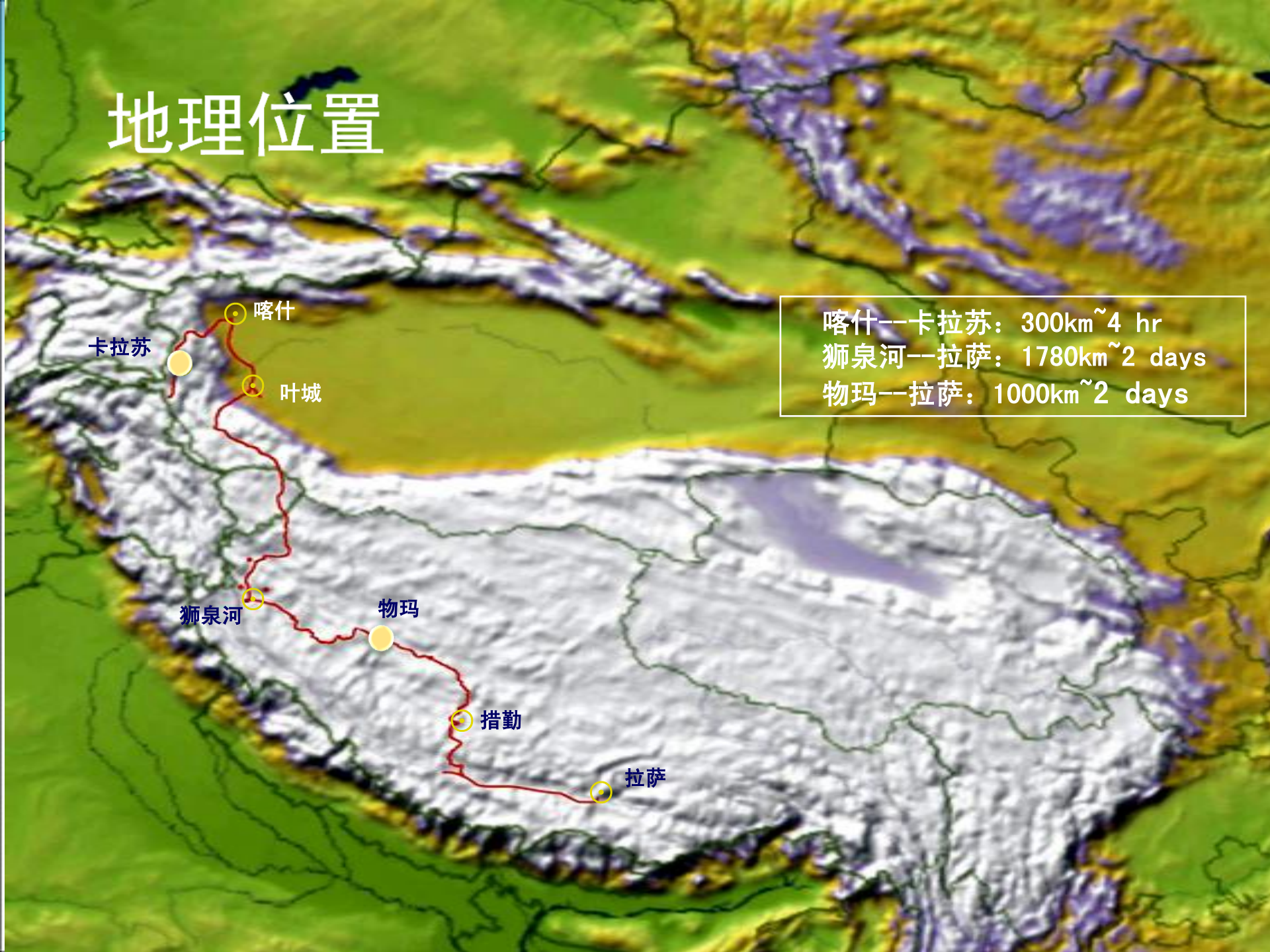
Las Campanas Observatory: The GMT Site

Joanna Thomas-Osip

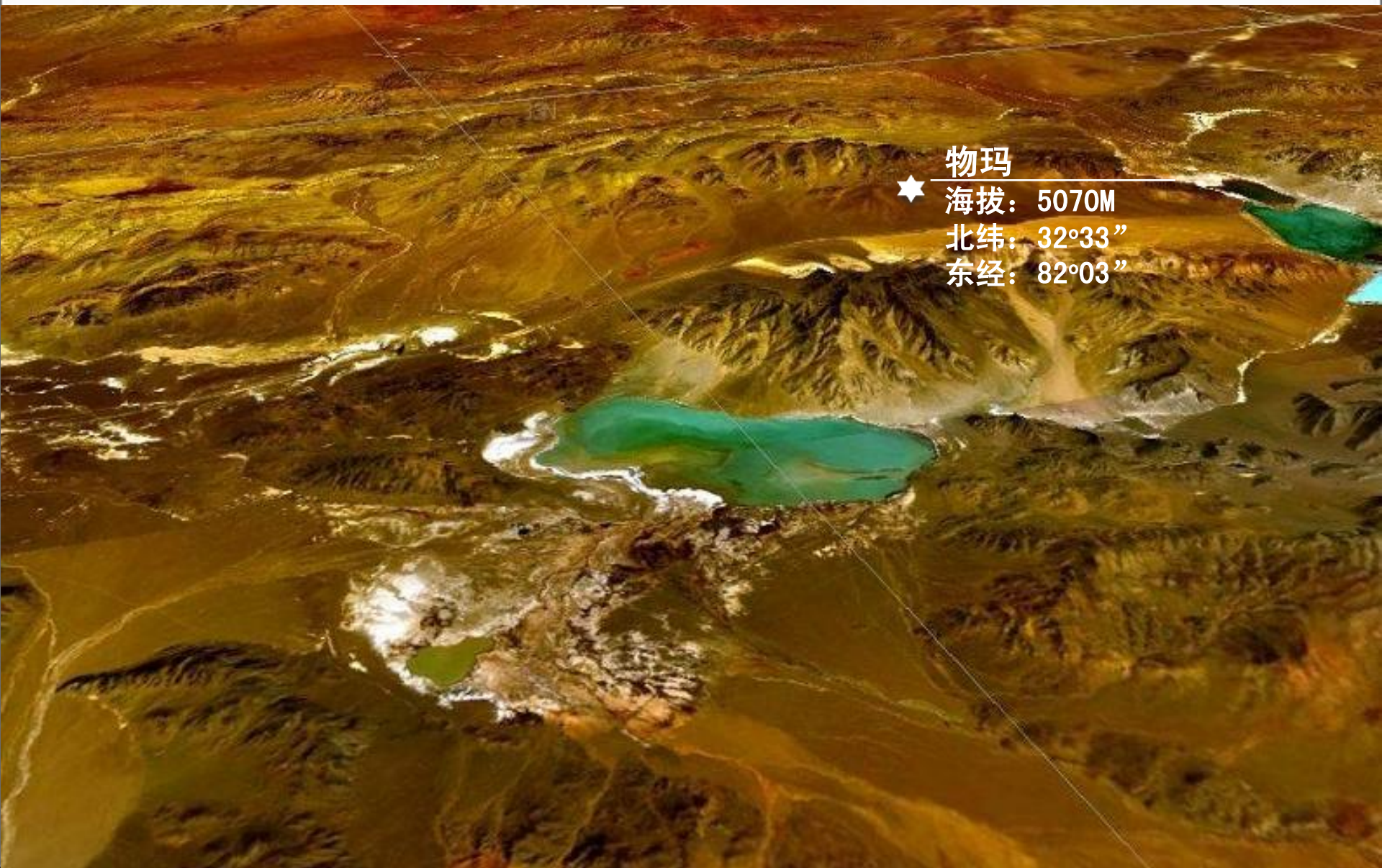
Season	10%	25%	50%	75%	90%	% < 1.5 mm	Samples
All	1.2	2.1	3.7	6.1	8.2	15	186300
Winter	0.5	0.9	1.4	2.0	2.7	55	13312
Spring	1.0	1.4	2.1	3.2	4.2	28	58594
Summer	2.0	3.0	5.1	7.1	10.0	4	48633
Fall	2.9	3.7	4.8	6.6	8.2	3	65761

Table 4: Clear nighttime calibrated IRMA PWV (mm) statistics. GMT Science Requirement: PWV < 1.5 mm for 10% of the clear time. 10% of clear winter nights are below 1.5 mm for the entire night

地理位置

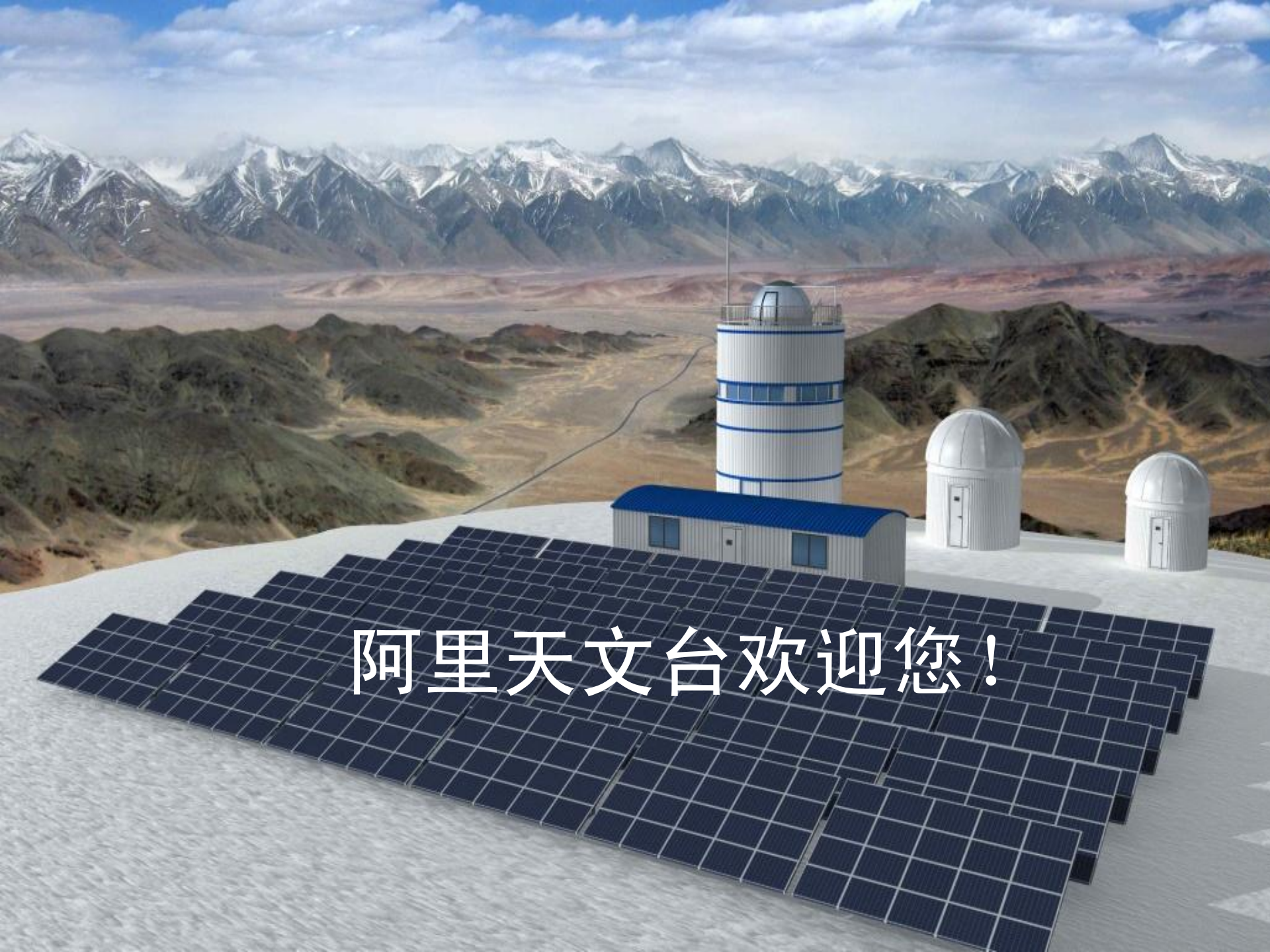

喀什
卡拉苏
叶城
狮泉河
物玛
措勤
拉萨
喀什--卡拉苏：300km~4 hr
狮泉河--拉萨：1780km~2 days
物玛--拉萨：1000km~2 days

物玛周边地形



物玛设备一览

2008. 11 物玛观测站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