



Juan Cortina on behalf of CTA-Spain
SSC
Heidelberg, 4 April, 2013

CTA CANDIDATE SITE IN Tenerife, Spain

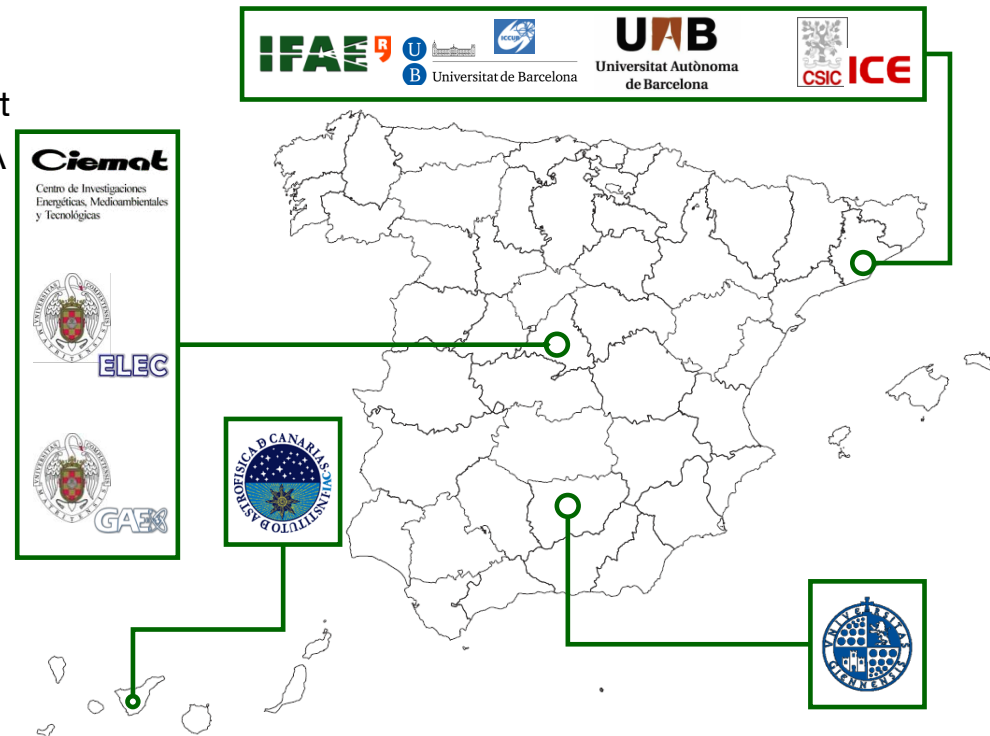
Introduction



- **CTA-Spain:** stable collaboration inside CTA
- **Among the founding members of CTA**
- Regularly applies for funds in coordinated projects
- Recognized consortium by the Spanish government
- Represents ~10% of current total workforce of CTA

9 Spanish institutes forming CTA-Spain:

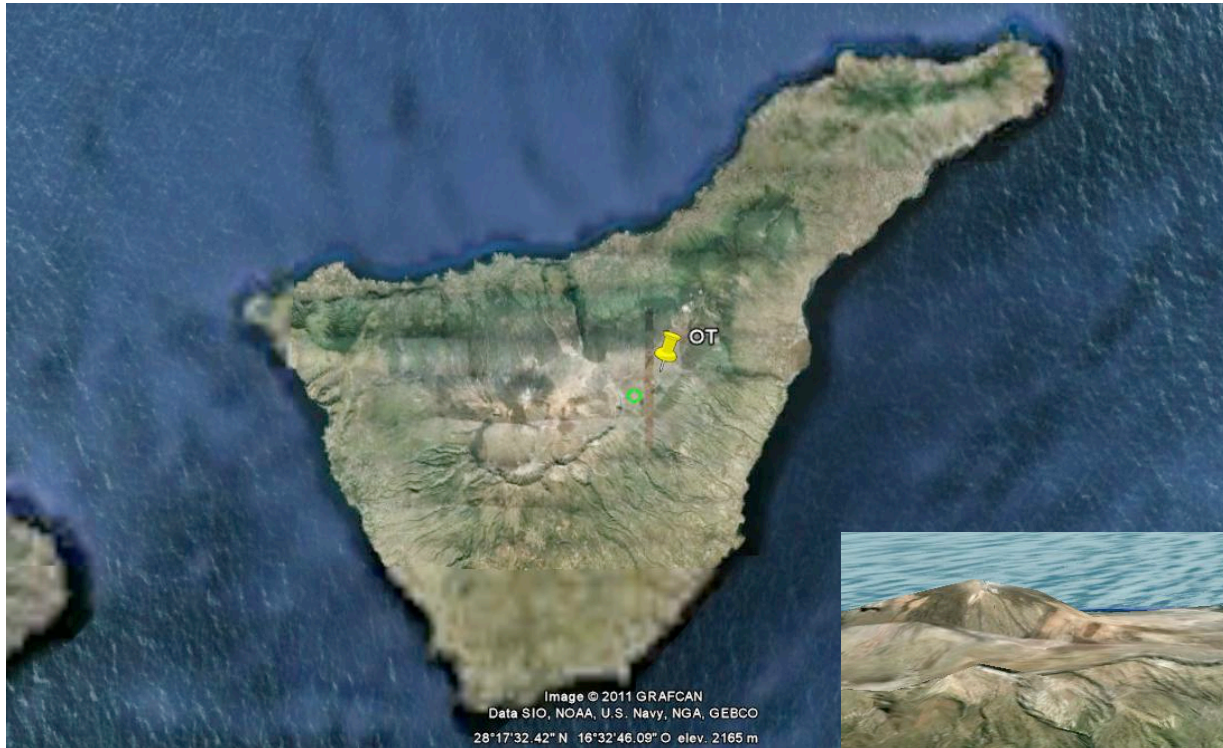
- Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (CIEMAT)
- Instituto de Astrofísica de Canarias (IAC)
- Institut de Ciències del Cosmos (ICC-UB) Universitat de Barcelona (IEEC-UB)
- Instituto de Ciencias del Espacio (ICE) Consejo Superior de Investigaciones Científicas (IEEC-CSIC)
- Institut de Física d'Altes Energies (IFAE)
- Universitat Autònoma de Barcelona (UAB)
- Universidad Complutense de Madrid (UCM-ELEC), Electronics group.
- Universidad Complutense de Madrid (UCM-GAE), High energies group.
- Universidad de Jaén (UJA), Escuela Politécnica Superior de Jaén.



Introduction

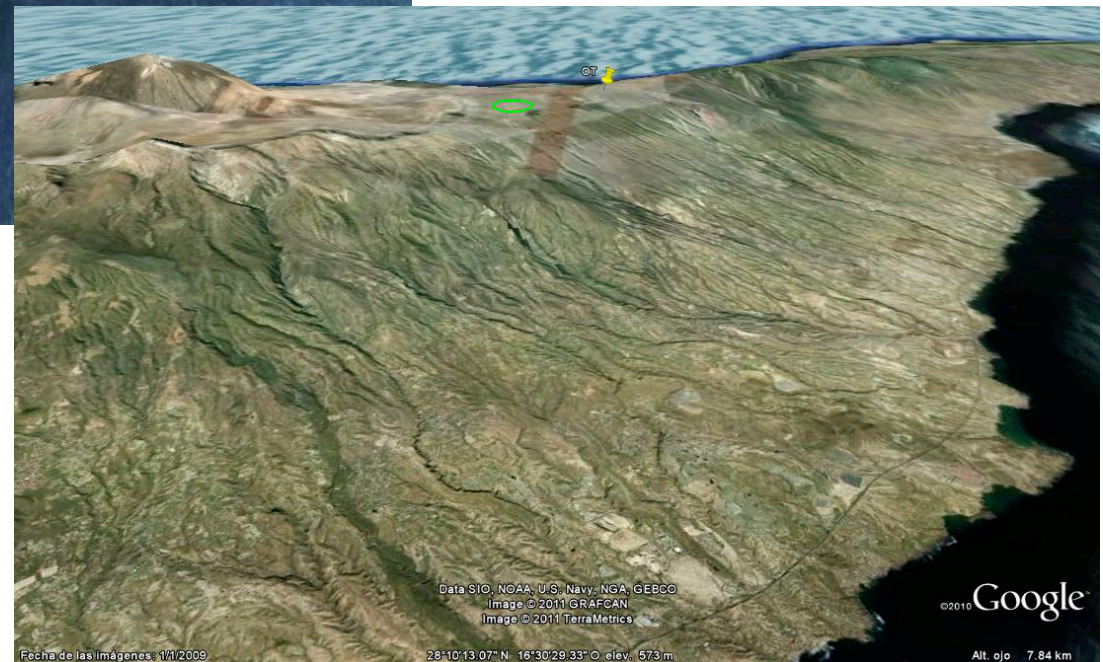
- We propose to host CTA-North at the **Teide Observatory** in the Canary Islands, where the sky conditions, available infrastructures, legal and administrative regulations, local support and the proximity of the Instituto de Astrofísica de Canarias (IAC) constitute a unique ensemble of advantages that would strongly benefit the operation and scientific return of CTA-North
- **This proposal is based on:**
 - Strategic location
 - An astronomical observatory has been in place for the last 50 years
 - Atmosphere is characterized for 100 years
 - Sky protected by law
 - Low seismic and volcanic hazards
 - Safe place in every aspect
 - Excellent communication & scientific infrastructure
 - Excellent social infrastructure (hospitals, schools, water,..)
 - Support from central and local governments

Site Location I

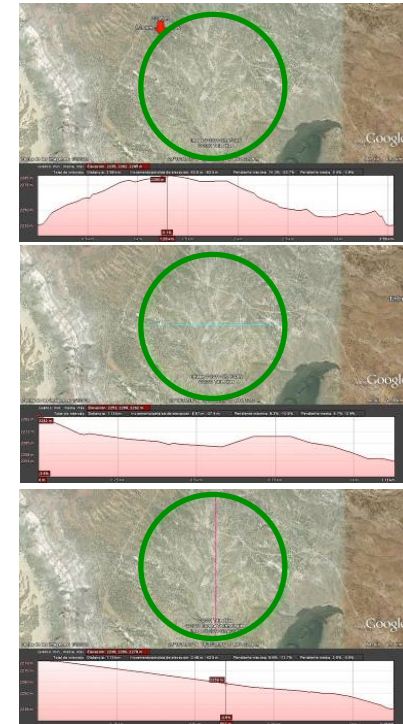
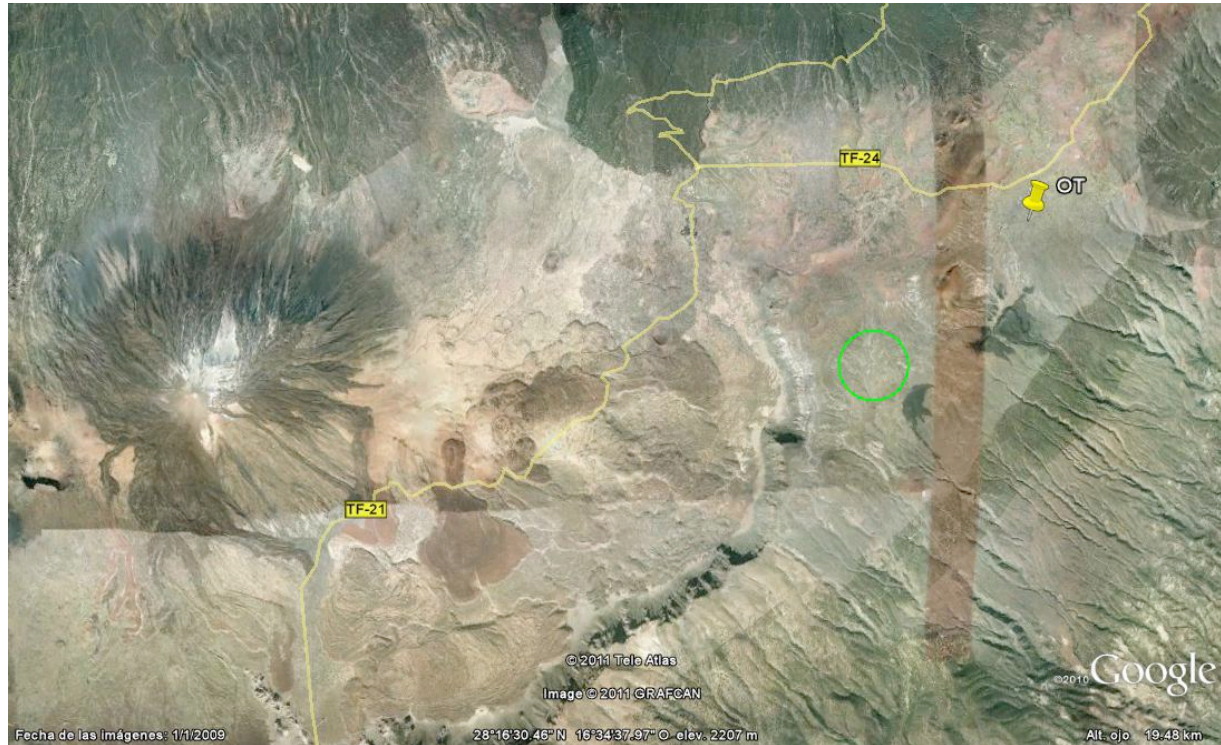


Maps: proposed site on the island of Tenerife

The proposed site is 4km from the Teide Observatory and in the “pre-National Park” area



Site Location I



Orography:

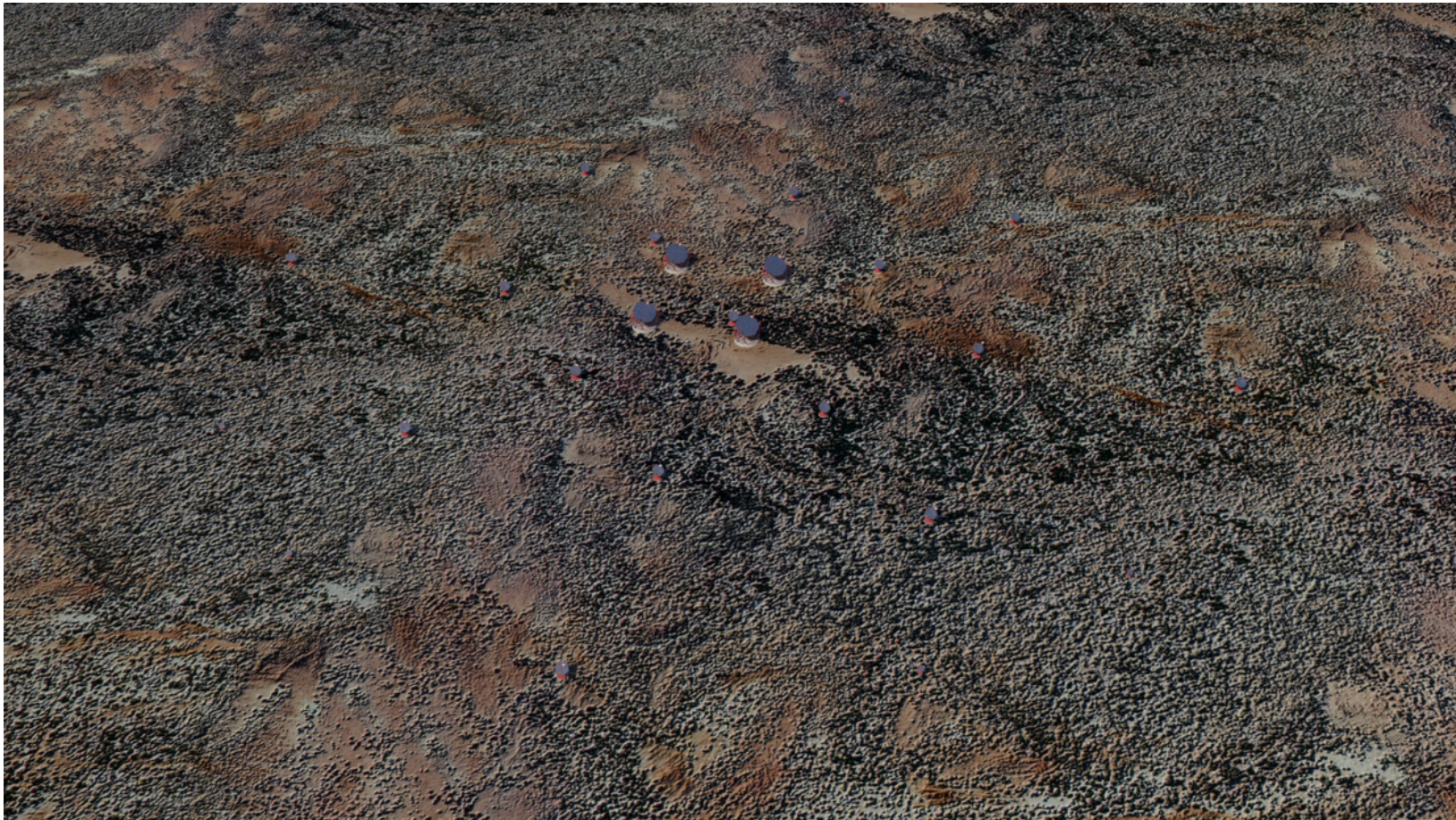
It is a plateau at
28°16'36" N, 16°32'08"
W, 2260 m a.s.l.

Max slope=4.5%



Site Location II

Implantation of CTA array on site:



There is enough space to locate the proposed layout and future enlargements

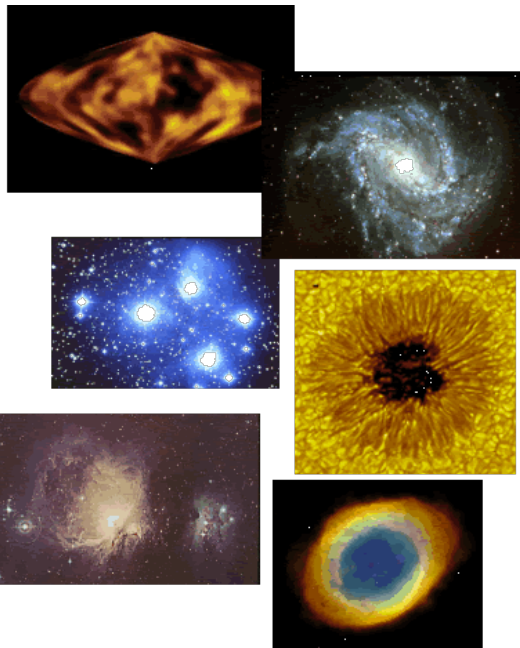
Site Location III

- The site is located in one of the older areas of the island, with very stable geotechnical conditions: strong basaltic layers
- The proposed site must have an age of at least 35,000 years, since this is the approximate age of most volcanic cones found in the area, but the plain is certainly much older.



Site Location III

- **Special considerations:**
 - Very near (less than one hour) SINERGIES: Teide observatory (3.5 km), IAC facilities equipped with workshops and laboratories (40 km), University of La Laguna (leader in Astrophysics in Spain -40 km-), Science Museum...
 - The Teide National Park is visited by millions of people every year. Tenerife as a “Starlight Initiative” international location



Site Location III



•Special considerations:

Sky protection law protects site against:

Light pollution

Radio electrical pollution

Atmospheric pollution

Air routes

In force across the islands of **Tenerife** (75% of the island) and **La Palma** (100%). IAC's Sky Quality Protection Office (OTPC) enforces the law
<http://www.iac.es/servicios.php?op1=28&lang=en>

Also:

The Sky Quality Group

(a warranty on sky quality qualification and monitoring)

<http://www.iac.es/proyecto/site-testing/>



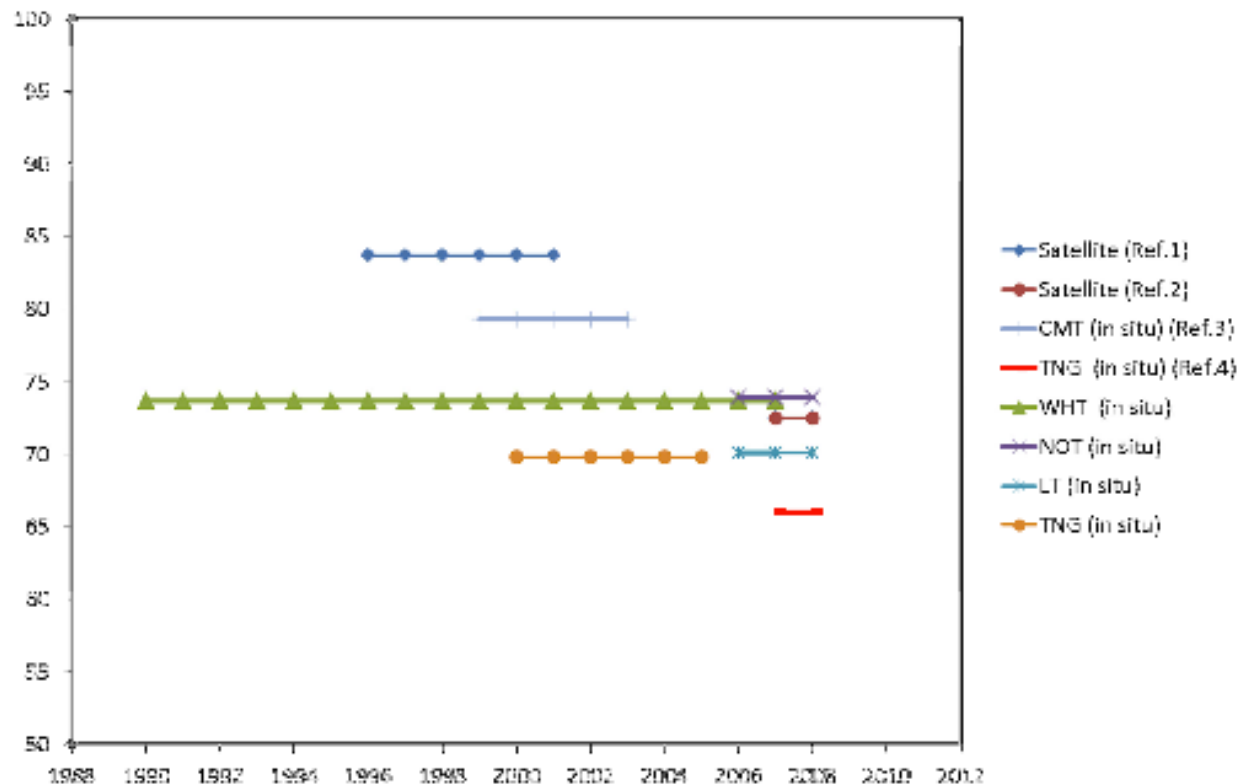
Weather Conditions I : Cloud cover

- Close to equator, but basically out of range of tropical storms
- Observatory located **above the thermal inversion layer**, where atmosphere is clear, clean and free of turbulence.
- **“Trade wind inversion” is present 78% of the year :**
 - Below: moist marine boundary layer (“sea of clouds”)
 - Above: dry free troposphere
- **IZO:** Izaña Atmospheric Observatory,
Located 5 km from the proposed site and with a record of 100 years of data



Weather Conditions I : Cloud cover

- Clear time vs. useful time
- **Total weather downtime** from telescopes at ORM and OT (including humidity, strong winds, clouds, rain, etc.): **16.3% - 27.5%**
- **Non-biased best estimates provided by WHT and CMT at ORM**

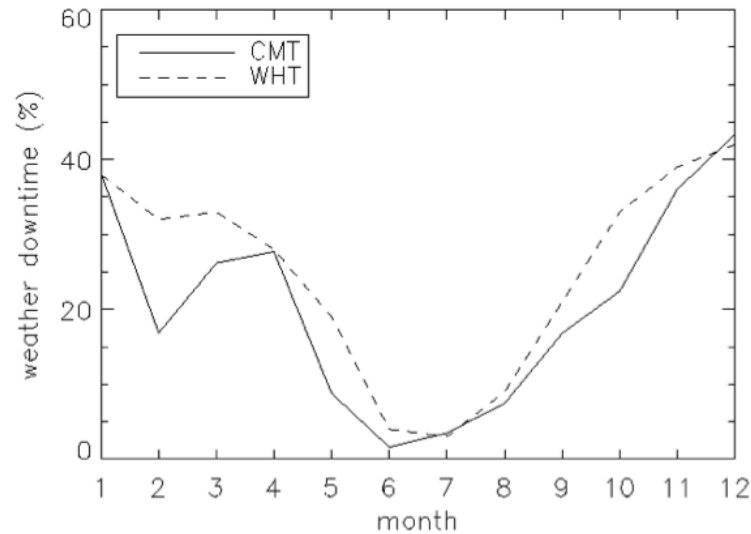


References:

1. Erasmus & Van Rooyen 2006, A Satellite Survey of Cloud Cover and Water Vapour in Morocco and Southern Spain and a Verification using La Palma Ground-based Observations, using EUMETSAT-ISCCP satellites.
2. Cavazzani et al. 2010, MNRAS 411, 1271 & Della Valle et al. 2010, MNRAS 401, 1904, using GOES 12 (NOAA).
3. García-Gil et al. 2010 PASP 122, 1109.
4. Cavazzani et al. 2010, MNRAS 411, 1271

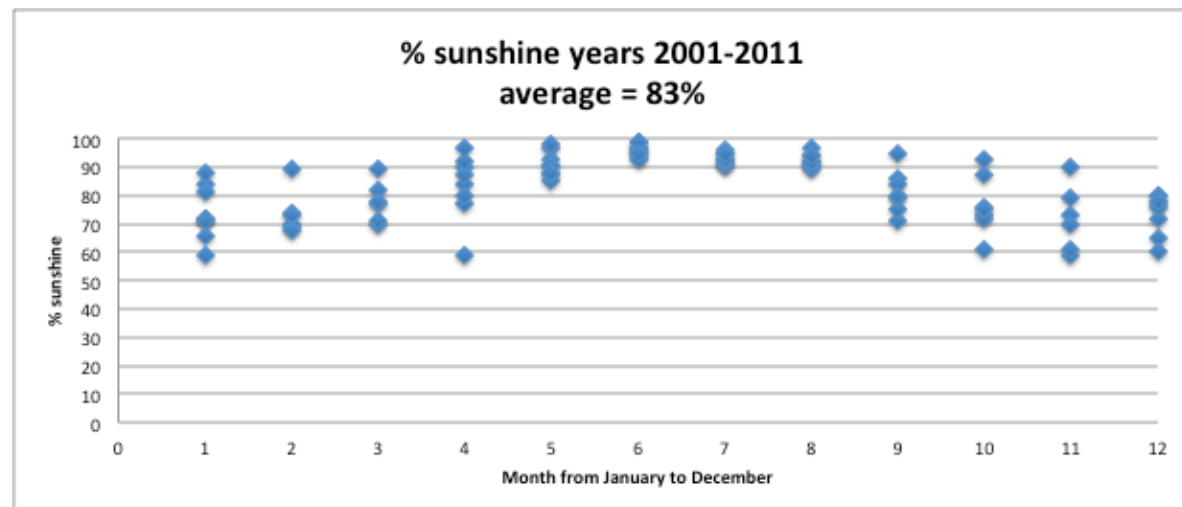
Other in situ results have been retrieved and provided by different telescope institutions and compiled by García-Gil et al. 2010 (3).

Weather Conditions I : Cloud cover



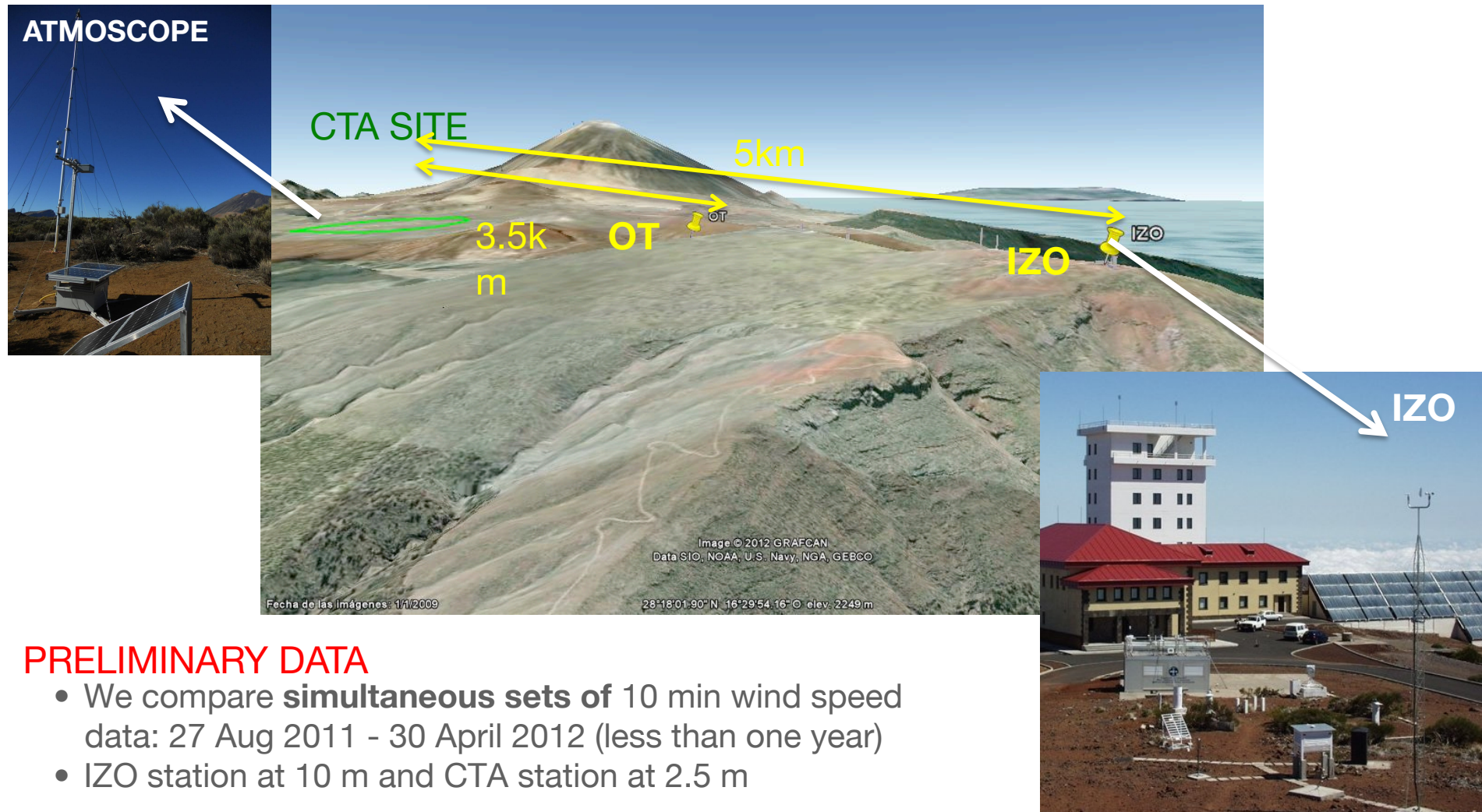
- Weather downtime from two well behaved telescopes in La Palma

- IZO shows **83%** sunshine on average

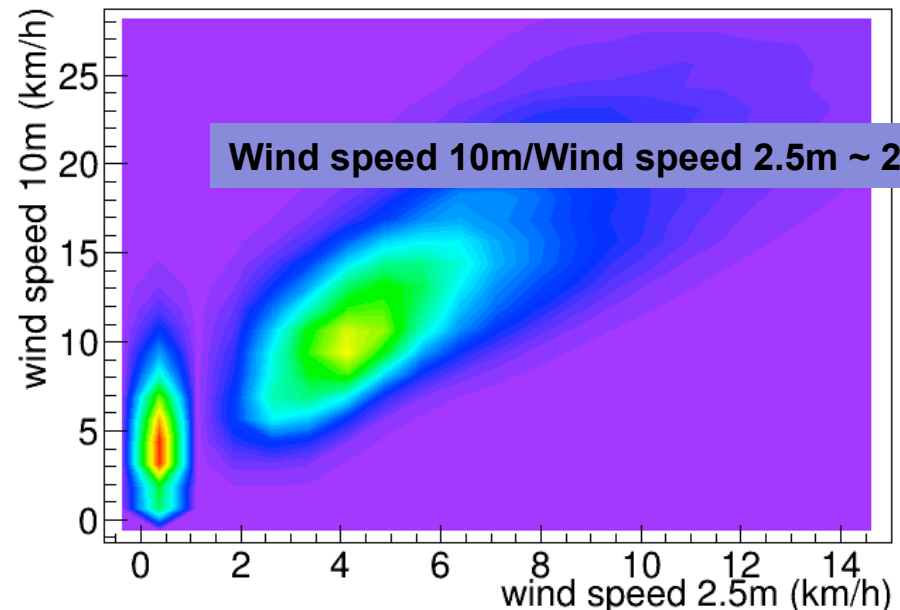
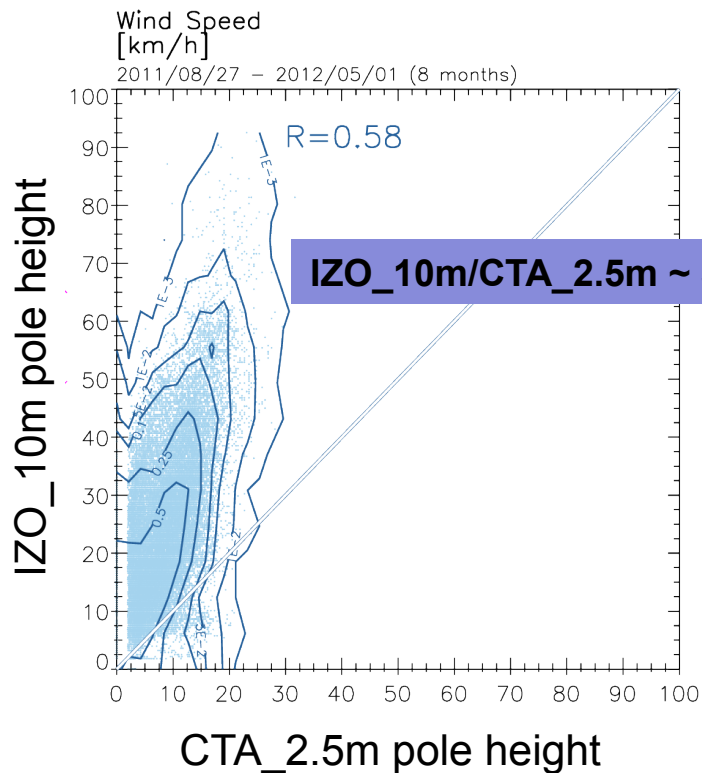


Weather Conditions II: Wind

~100 yr long time series at IZO, 5 km apart but with very different orography. How to compare with CTA site?



Weather Conditions II: Wind

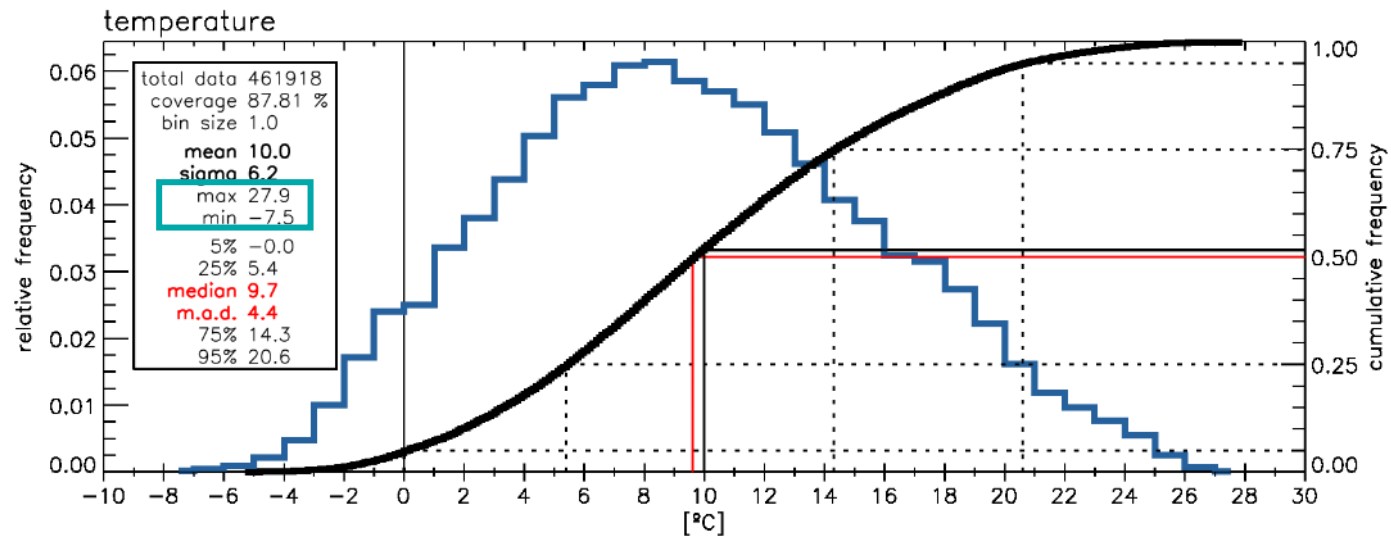
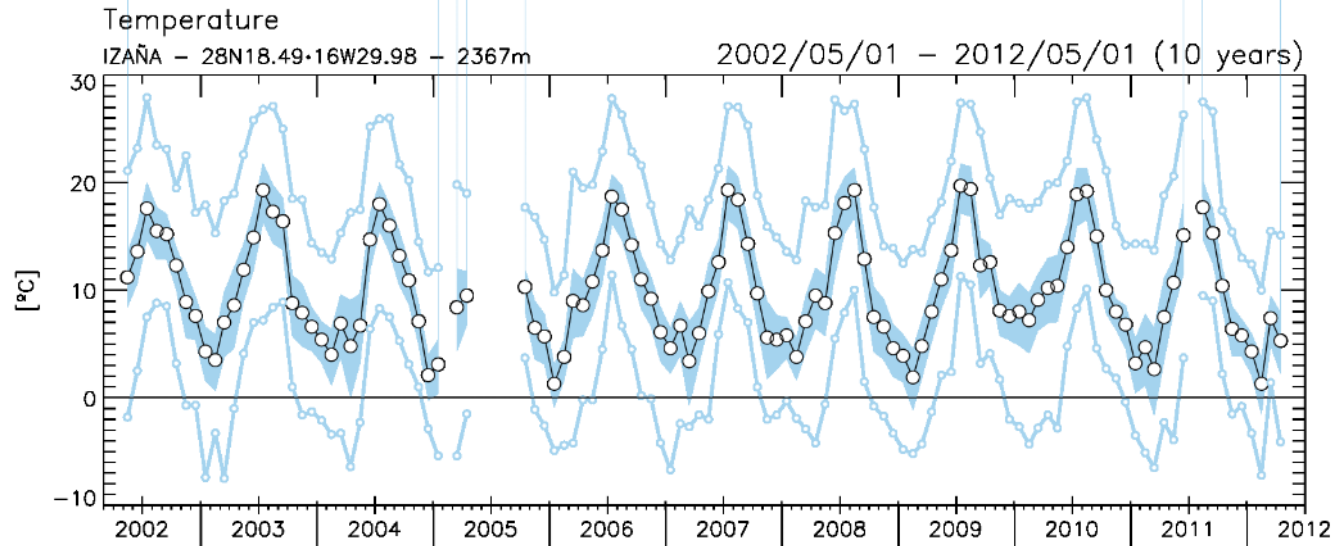


Wind speed data at IZO must be reduced by a factor 2/3 to compare with CTA site

95% CTA 2.5m data < 16.5 km/h → CTA 10m < 33 km/h (CTA limit: 36 km/h)

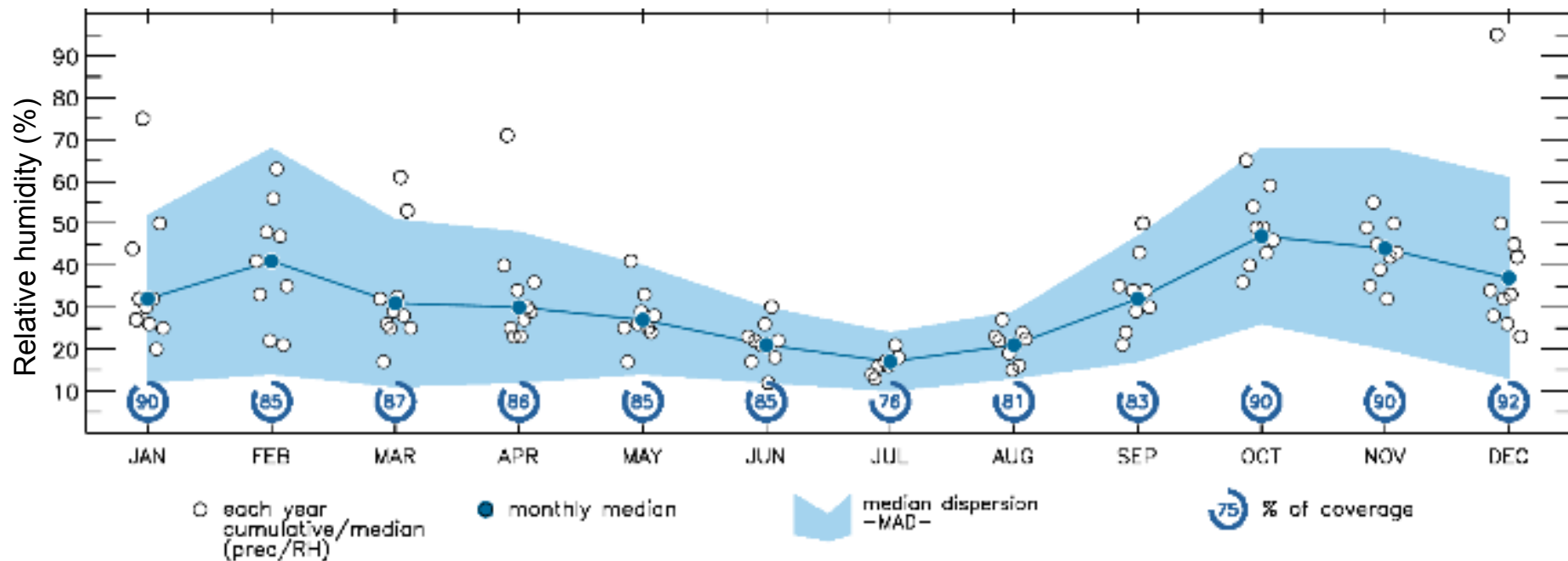
Absolute max CTA 2.5 m data= 31.7km/h → max CTA 10m= 63.4 km/h

Weather Conditions III: Γ , RH, precipitation

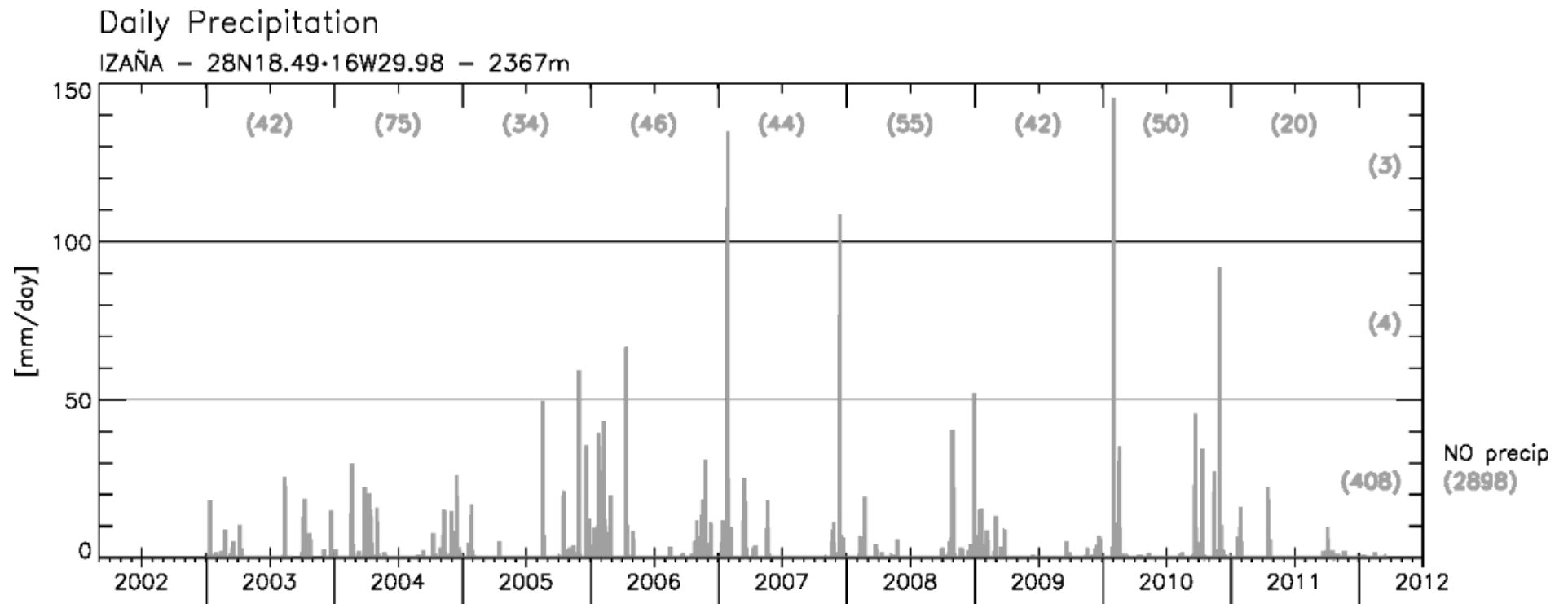


Weather Conditions III: T, RH, precipitation

- Data taken at IZO from May 2002 to April 2012
- 10 min data
- Median relative humidity during those 10 years: 29%



Weather Conditions III: T, RH, precipitation



Night Sky Background

- Measurements in V band with different instruments:

Instrument	All Data	From 2011
AstMon (From 2012)	$21,41 \pm 0,15$	$21,41 \pm 0,15$
IAC80 (From 2006)	$21,24 \pm 0,34$	$21,39 \pm 0,38$
SQM (From 2006)	$21,25 \pm 0,23$	$21,21 \pm 0,16$

- Measurement in B and V band (no Milky Way correction applied):

	B	V
IAC80	$22,34 \pm 0,25$	$21,11 \pm 0,33$

- Preliminary ATMOSCOPE measurements (analyzed like ASTMON):

	B	V
ATMOSCOPE	$\sim 22,3$	21,2

Natural Hazard Risks

- **Earthquakes:** The Canary Islands' astronomical observatories are in volcanically active areas. However **they show both very small seismic activity.** The entire islands are classified as “**low seismic hazard**” (**PGA=0.06g**, Global Seismic Hazard Assessment Program –GSHAP-; see references at the Tenerife candidacy proposal)
- **Wind storms:** Very rare, no damage produced on big IACTs at La Palma
- **Hail storms:** Very rare, of small size
- **Sand storms:** Dust-loaded Saharian air mass intrusions occur, but not in a form of storm
 - **Using 20 years of data at ORM:** $K_v=0.13$; 90% of winter time free of dust; 75% in summer time (García-Gil et al. 2010)

Social/Political Risks

- **Political stability of country:** Excellent
- **Crime:** Very secure place
- **Import regulations:** No customs for astronomical infrastructure. Tax exemptions to import goods.
- **Any other important consideration:** Access to FEDER developing funds



Infrastructure



- **Electricity:** up to 1 MW on site right now (0.3 MW in use right now). Easy to increase: power line is there
- **Water:** by truck (town is 30 km away)
- **Data network:** 10 Gbps to central Europe (more 10 Gbps lines are available)
- **Residence:** on site
- **Other Cherenkov telescopes:** the two 17m MAGIC telescopes are located at the ORM observatory, just 150 km away
- **Other wavelength regions available:** there are several large-size optical and infrared night-time telescopes operating at both observatories



Tenerife seen from La Palma

Accessibility

TENERIFE AS A PLEASANT AND ATTRACTIVE PLACE TO LIVE (everything within about one hour)

- Distance to airport: 40 km (and 50 km to harbour, roads are in very good condition and well maintained; no problem for trucks)
- Large experience in building infrastructures for astronomy at the observatory
- Nearest towns to live:
 - 30 km to La Orotava (40.000 inh)
 - 40 km to La Laguna (200.000 inh)
 - 50 km to Santa Cruz (250.000 inh)
- Hospital: 40 km (two large fully-equipped hospitals)



Site Ownership



- Ownership: **Public** (Spanish Ministry of Defense)
- Until 80's: Used as a shooting range

Cleaning of the site already started

Official permission available in order to access the site

Transfer of ownership to IAC if the Observatorio del Teide is selected to host CTA-North

Construction permission needed, but it is an usual procedure within the observatory

Political support of Host Country

- The **population** of Canary Islands **supports the observatories** and its present and future facilities. It sees in them and in the quality of the sky the **differentiating factor** that attracts quality tourism based on activities for observing the sky
- **Regional Government of Canary Islands** supports the candidacy
- **Spanish Central Government** supports the candidacy



La Palma as a potential candidate site

- **If there is a new baseline configuration of CTA-North**, with less telescopes and a smaller layout, the IAC, under the auspicious of the community of CTA-Spain, offers both observatories, OT and ORM, to host CTA-North
- The **ORM** is a very **well known** and very well characterized observatory which could host CTA-North in that potential new situation
- **MAGIC** has been operational very successfully in ORM since 2004
- **ORM** also offers excellent infrastructure and accessibility



Conclusions

Excellent infrastructure in Tenerife

First-class observatory in operation for 50 years

Site will be managed and supported by the IAC

Management prepared (CTA would not be the first that arrives)

Suppliers prepared

Tradition in astronomical observations

Excellent atmospheric conditions

Very well characterized place – no surprises

100 years of meteorological data available

Very safe place

Excellent accessibility from Europe and close time-zones

Tenerife as a lively environment for CTA personnel

La Palma as a backup option if considered

Backup

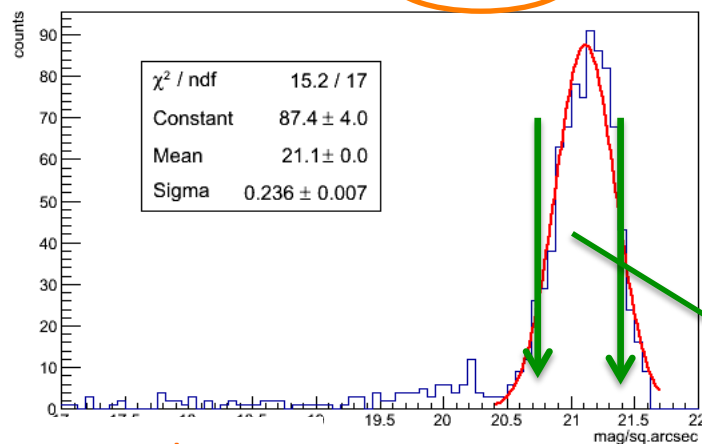


NSB: ASTMON/ATMOSCOPE (M. Gaug)

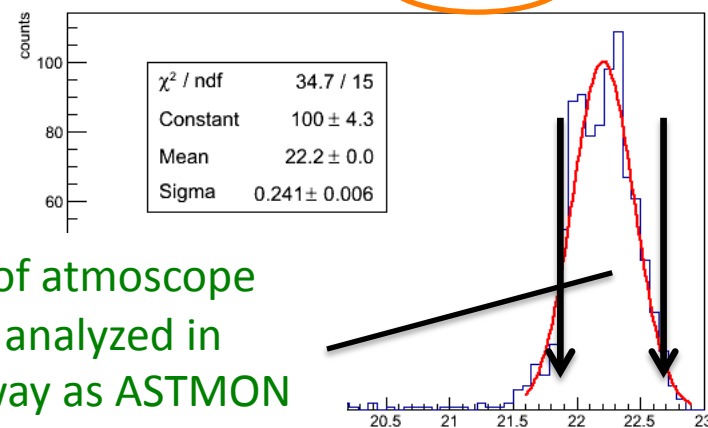


ASTMON at the OT is an specialized all-sky camera, dedicated to measure NSB in the Johnson filters. Values are averaged over 20 deg. Diameter FOV, re-scaled to average starlight background, out of Milky Way, no zodiacal light correction, no airglow correction.

ASTMON NSB at OT (V-Filter)

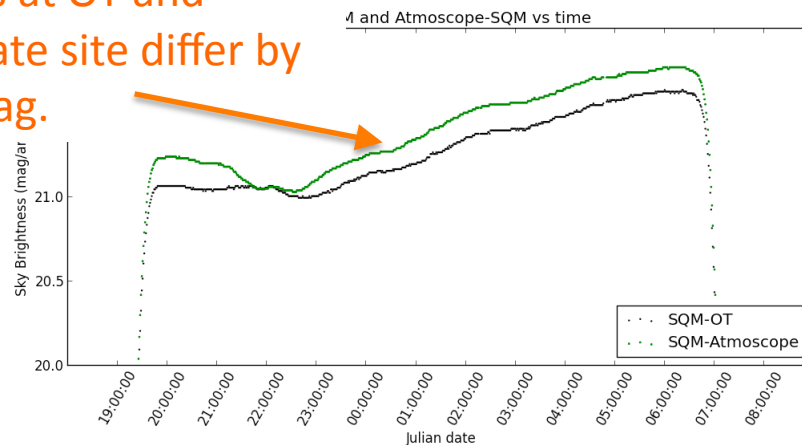


ASTMON NSB at OT (B-Filter)



Range of atmosphere values, analyzed in same way as ASTMON

2 SQMs at OT and candidate site differ by 0.15 mag.



Atmoscope Tenerife residual light (corr. for ASTMON code)

