G. Tovmassian (CTA-MX Representative)
SSC
Heidelberg, 3 April, 2013

CTA CANDIDATE SITE IN MEXICO

LOS VALLECITOS IN SAN PEDRO MARTIR

Introduction

- Mexico has a sound and internationally recognized astronomical community conducting research in a variety of directions.
- The astronomical tradition is ancient (Mayan calendar, Aztec pyramids), but a modern astronomy has been established after the WW II and quickly acquired international recognition thanks to studies conducted by Haro, Peimbert, Poveda and others.
- At the present there are two large institutions conducting astronomical research and several small groups affiliated to different state universities.
- Astrophysics of high and very high energies constitutes a small portion of the entire community but is ever present with the HAWC, a large gamma-ray project on the way, and participation of mexican physicists in the activities of the Pierre Auger Observatory.
- Mexico joined the CTA in 2011 with a desire to assist in this exciting international effort and, as a cornerstone of our contribution, is an absolutely excellent site, one of the four best sites on the Earth for ground-based astronomical research.
- The Institute of Astronomy of the UNAM, leading the mexican collaboration, runs the optical observatory at SPM from the end of 1960's.

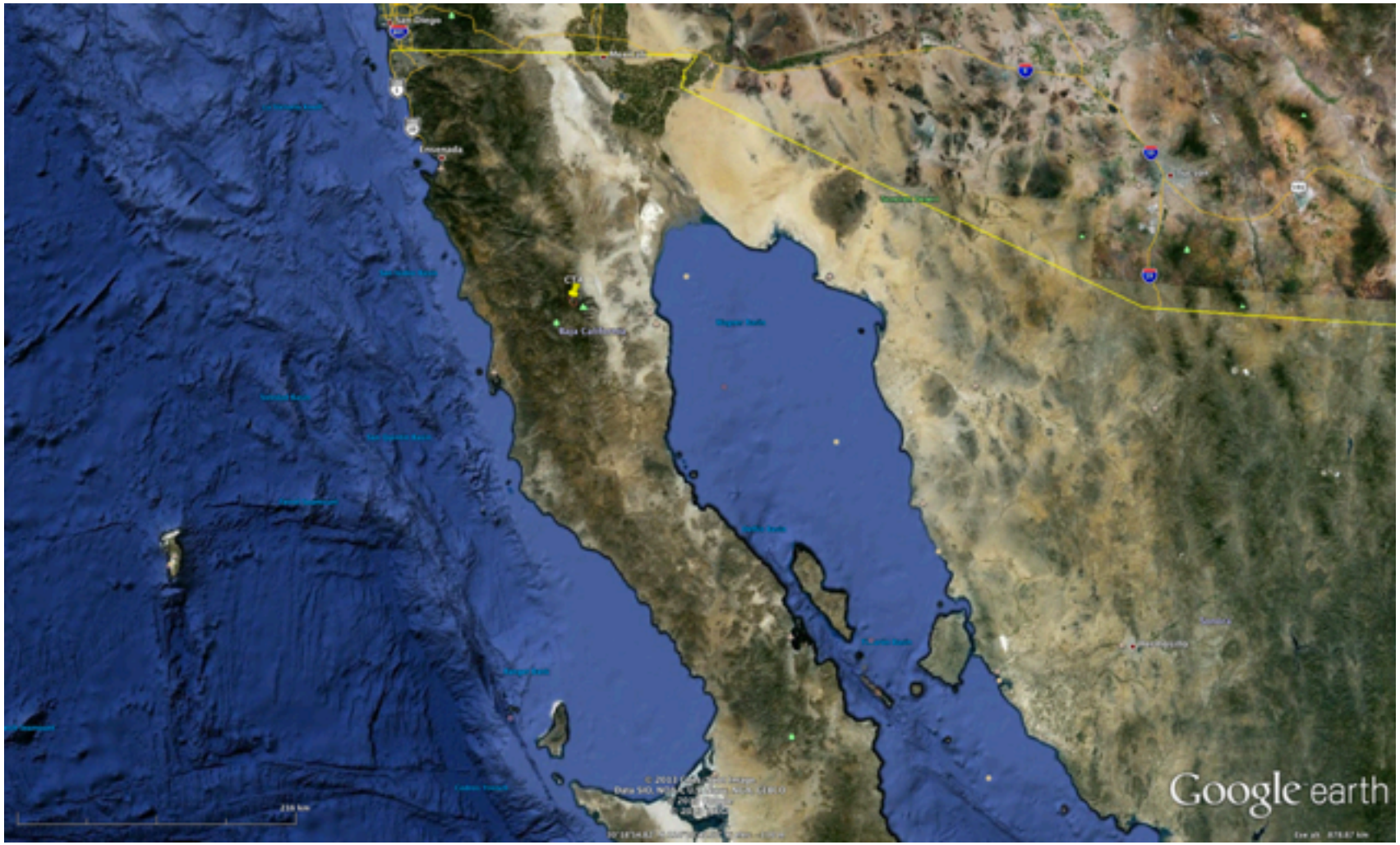
Site Location I

- Maps
- Orography of site
- Images

Site Location I

- Maps

Los Vallecitos, Sierra San Pedro Martir, Baja California, Mexico.



Site Location I

31° 0'56.00"N 115°28'39.00"W

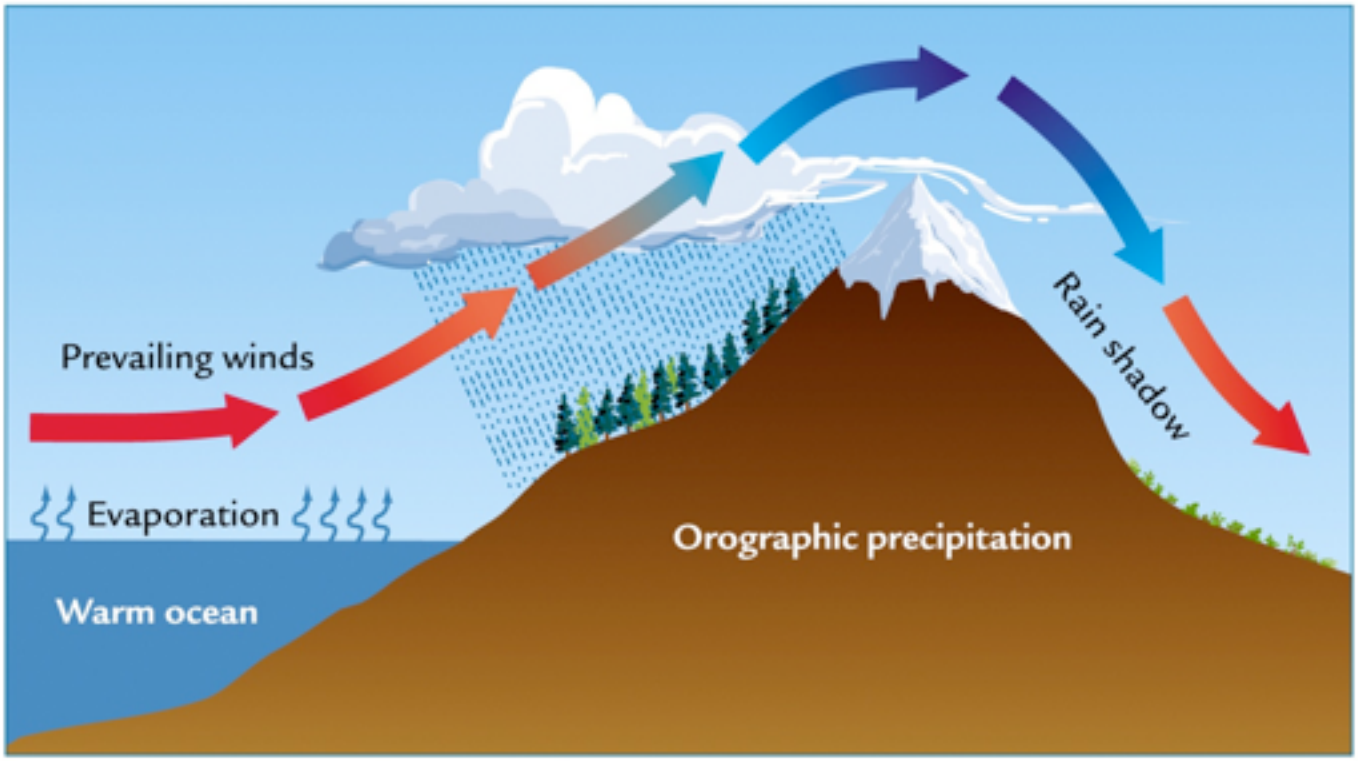
- Maps

The observatory is located within a National Park. The National Park is 72,900 hectares large. OAN occupies 500 hectares, but slightly more than 3,000 hectares are reserved exclusively for astronomy research.

Site Location I

- Orography of site

Encyclopedia Britannica



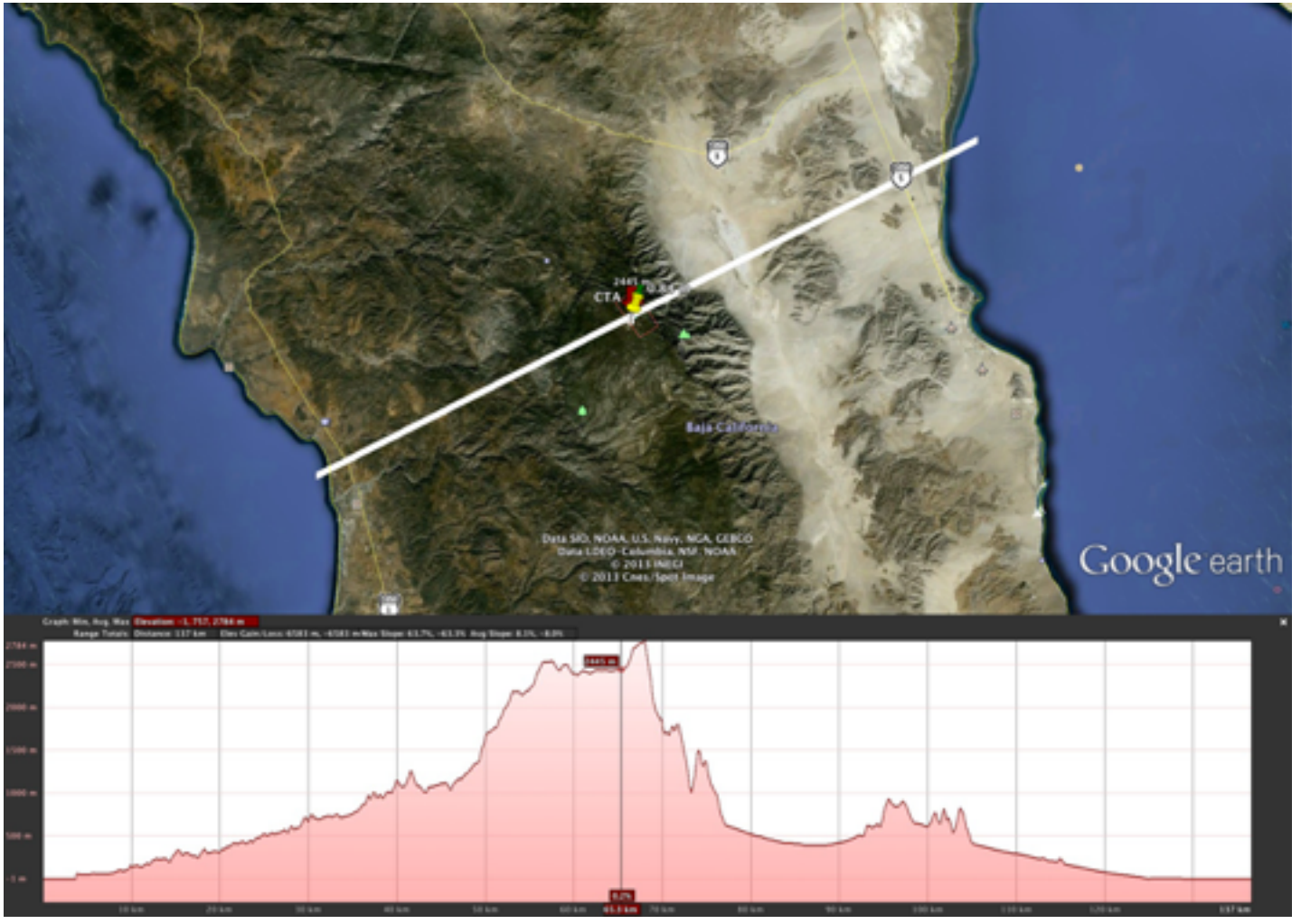
- Orographic

precipitation produced when moist air is lifted as it moves over a mountain range. As the air rises and cools, orographic clouds form and serve as the source of the precipitation, most of which falls upwind of the mountain ridge. On the lee side of the mountain range, rainfall is usually low, and the area is said to be in a rain shadow. The precipitation typically occurs upwind of a prominent mountain range that is oriented across a prevailing wind from a warm ocean.

Site Location I

- Orography

Transversal cut across the Baja California Peninsula, showing the steep gradient at both sides of the mountain. The orography of the mountain chain controls precipitation and helps to keep a stable atmosphere with an almost laminar air flow over the top of the San Pedro Martir Observatory.



Site Location I

- Orography

Álvarez et al., RevMexAA Conference Series, 31, 111, 2007

The previous slide shows a transversal cut of the BC peninsula through the SPM mountain tops: the Observatory is located on the eastern side of the mountain while on the western side there is a peak called a Corona. Most of the time the prevalent low velocity winds from the Pacific Ocean come from the west and the relatively steep gradient of the mountain insures homogeneous atmospheric layers on top of the Observatory, as can be seen from many of the astronomical observations made so far.
Temperature measurements of the climatological stations on the western side of the mountain, show a very clear temperature inversion layer present on the west side of the mountain range as shown by Alvarez & Maisterrena (1977). This temperature inversion layer (evident at 1000 m altitude), keeps most of the moisture out of the top layers of the atmosphere, helping to keep the top of the mountain clear and cloud less most of the time, having an important effect on the precipitation regime. The east side of SPM Sierra shows also an stable temperature regime that favors the sky quality of the SPM Observatory.

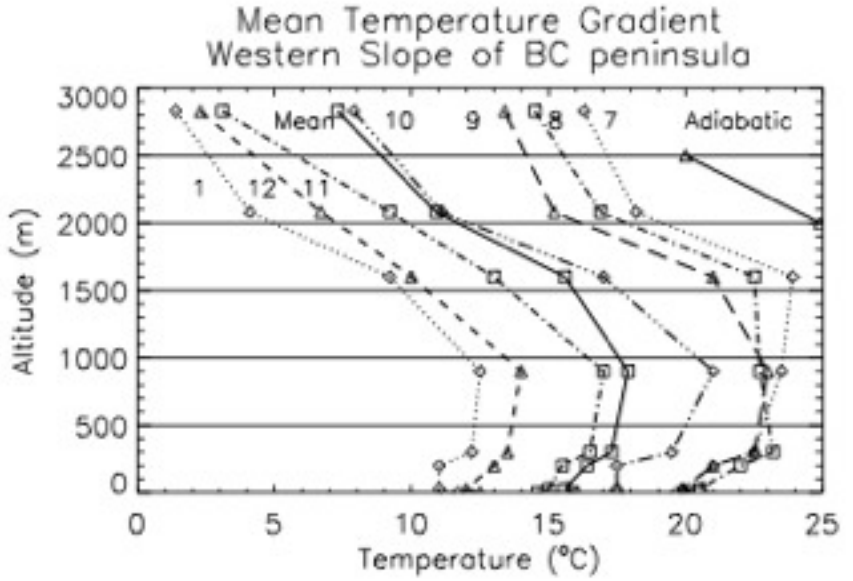
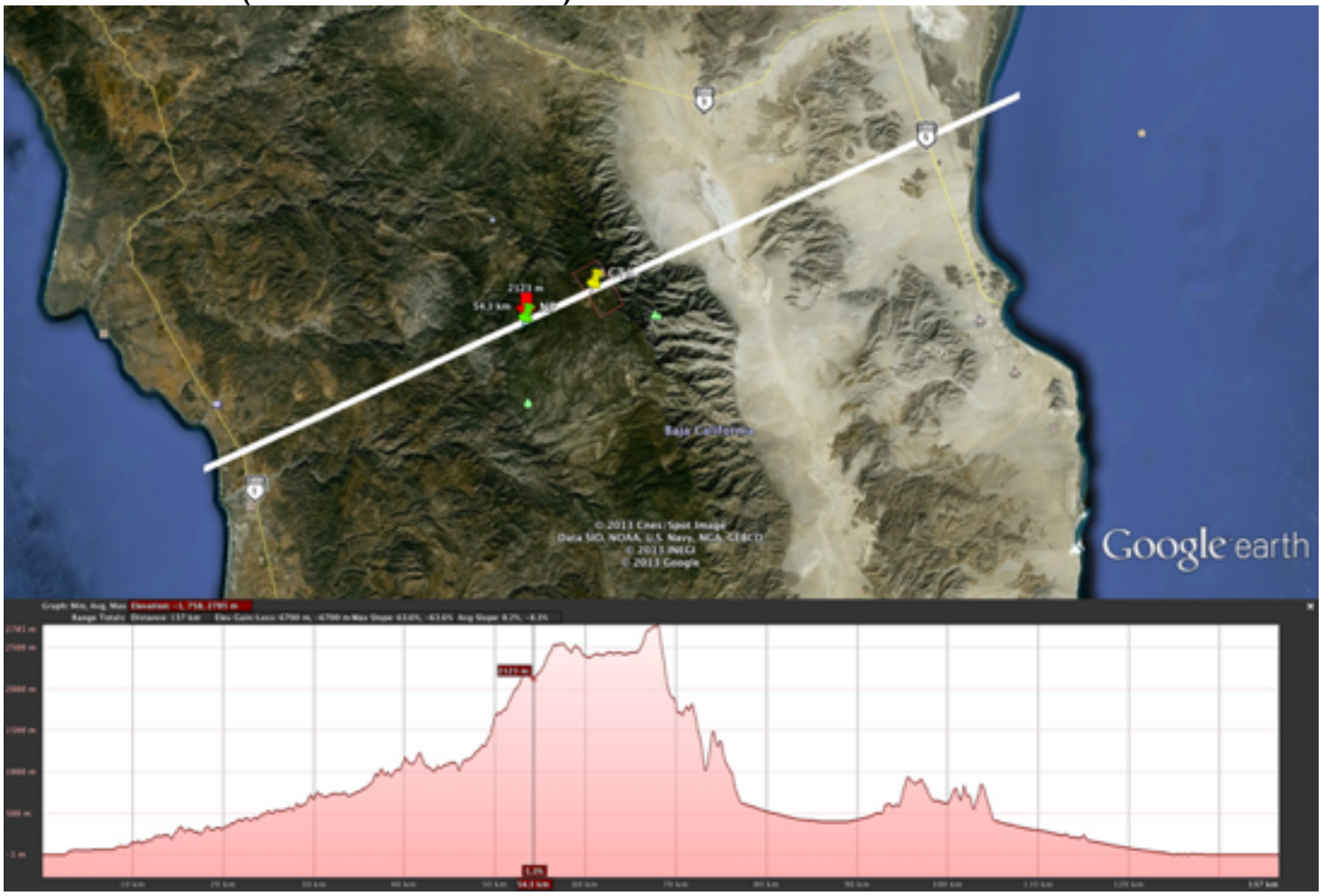


Fig. 4. Temperature Gradient - SPM Mountains. The average temperature of several climatological stations are plotted versus the altitude of the station showing the stability of the atmosphere. The humidity of the lower layers stays most of the time below 1000 m altitude. The adiabatic gradient of the atmosphere is also shown.

Site Location I

- Orography

In 1997 (a severe el Niño year) the Mean Precipitation (water) recorded by the observatory weather station was 173 mm, while at the entrance to the Park (altitude=2080 m) it was 449 mm.



Site Location I

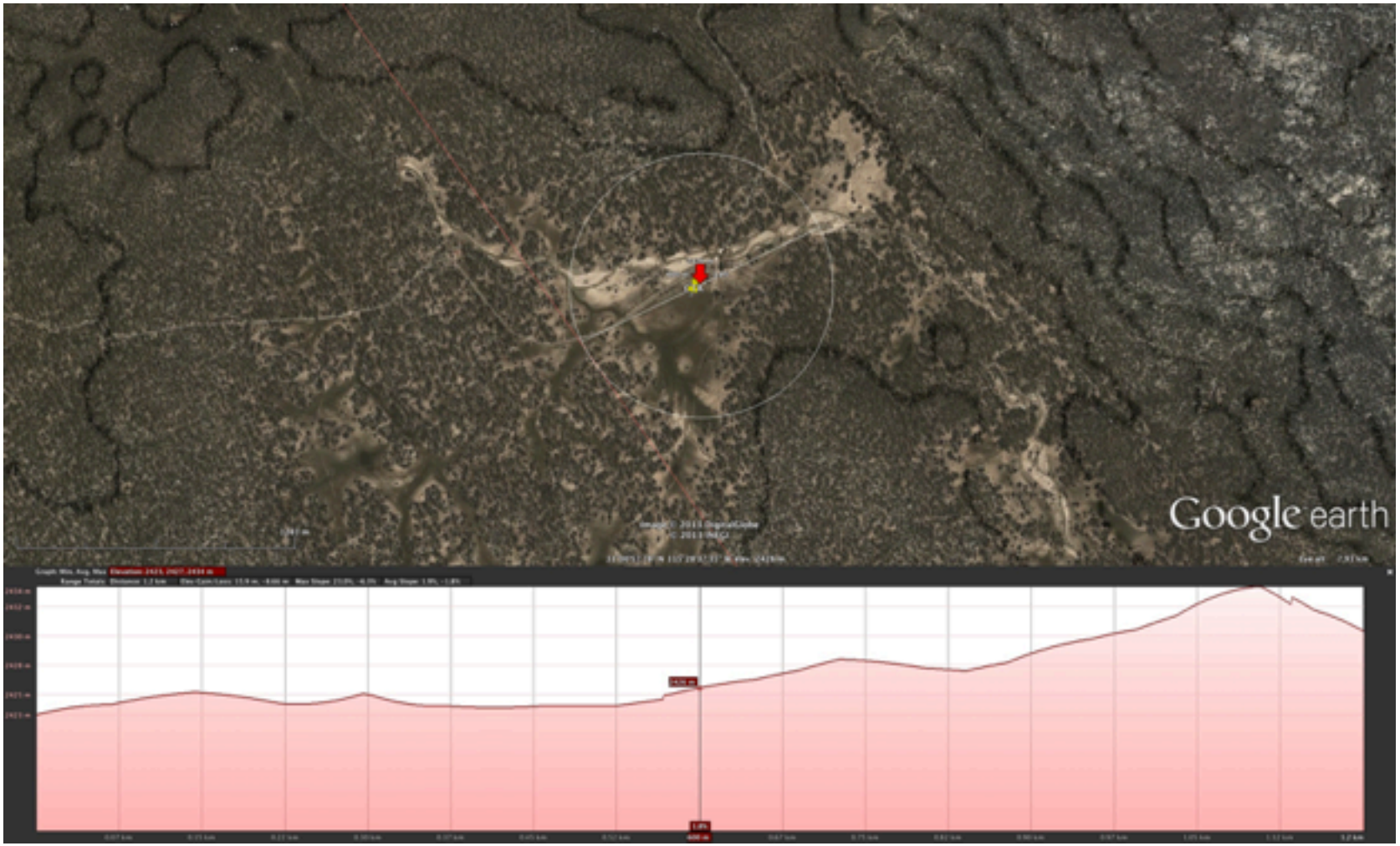
- Images

Site Location II

- Implantation of CTA array on site
- Conformity with Requirements

Site Location II

- Implantation of CTA array on site
- Conformity with Requirements

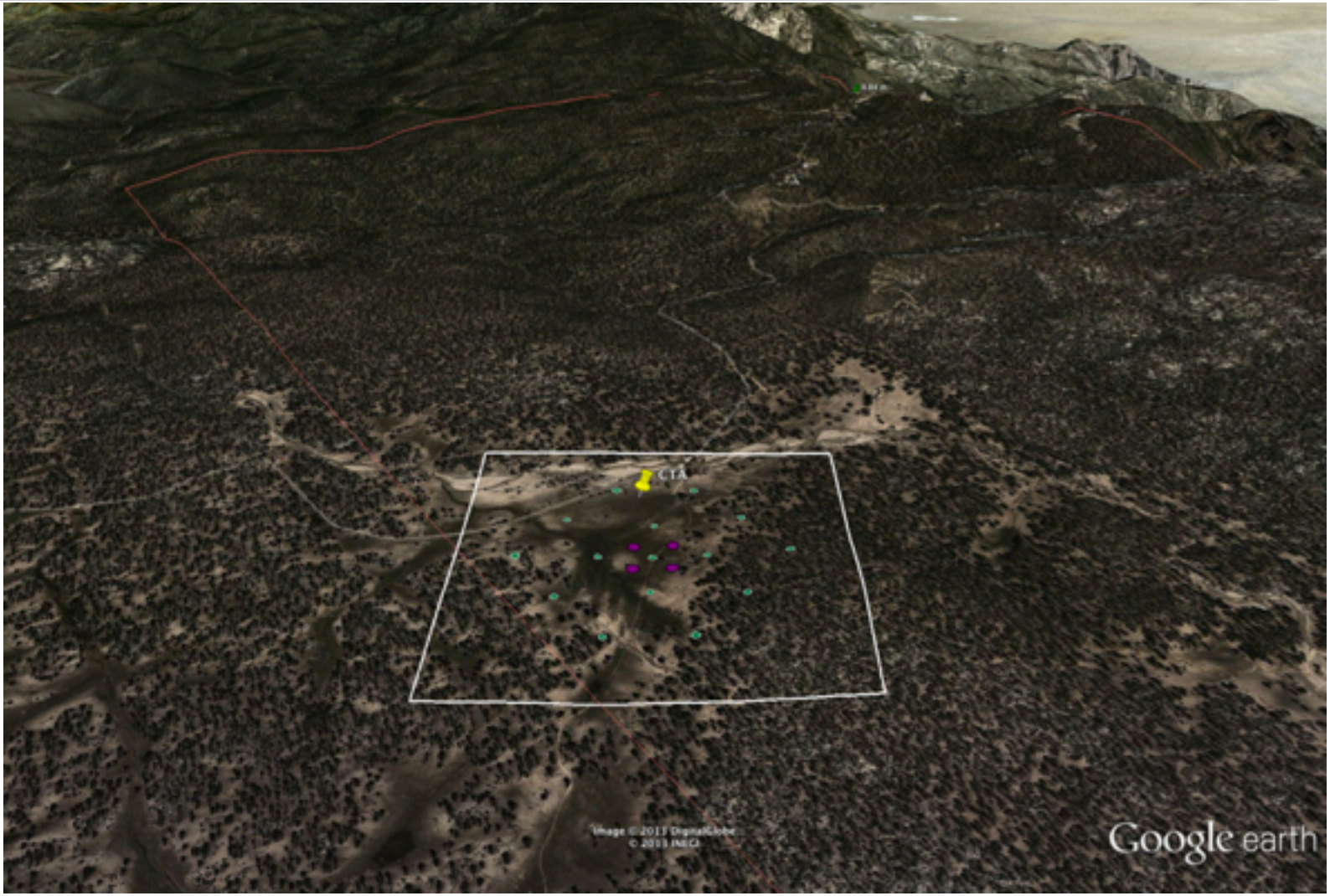


A D=1200 m circle is plotted over the area proposed to host the CTA.
The valley is remarkably flat. The altitude profile below the map has markers set at max=2434 m, & min=2423 m. Altitude isolines (20 m resolution) are also shown.

Site Location II

- Implantation of CTA array on site
- Conformity with Requirements

the box is 1050 m^2

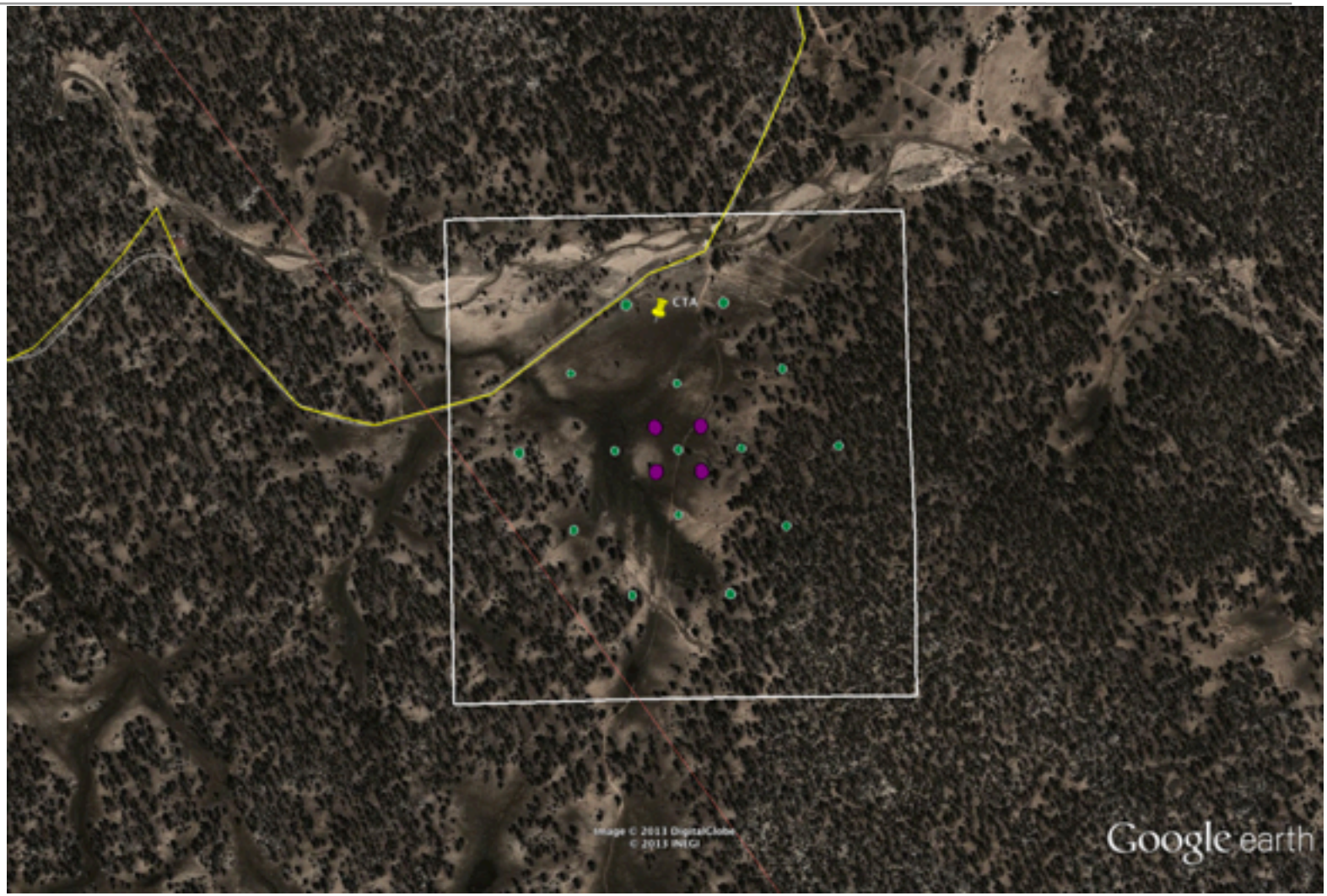


The latest layout presented by the CTA permits location of the array in a very comfortable way

Site Location II

- Implantation of CTA array on site
- Conformity with Requirements

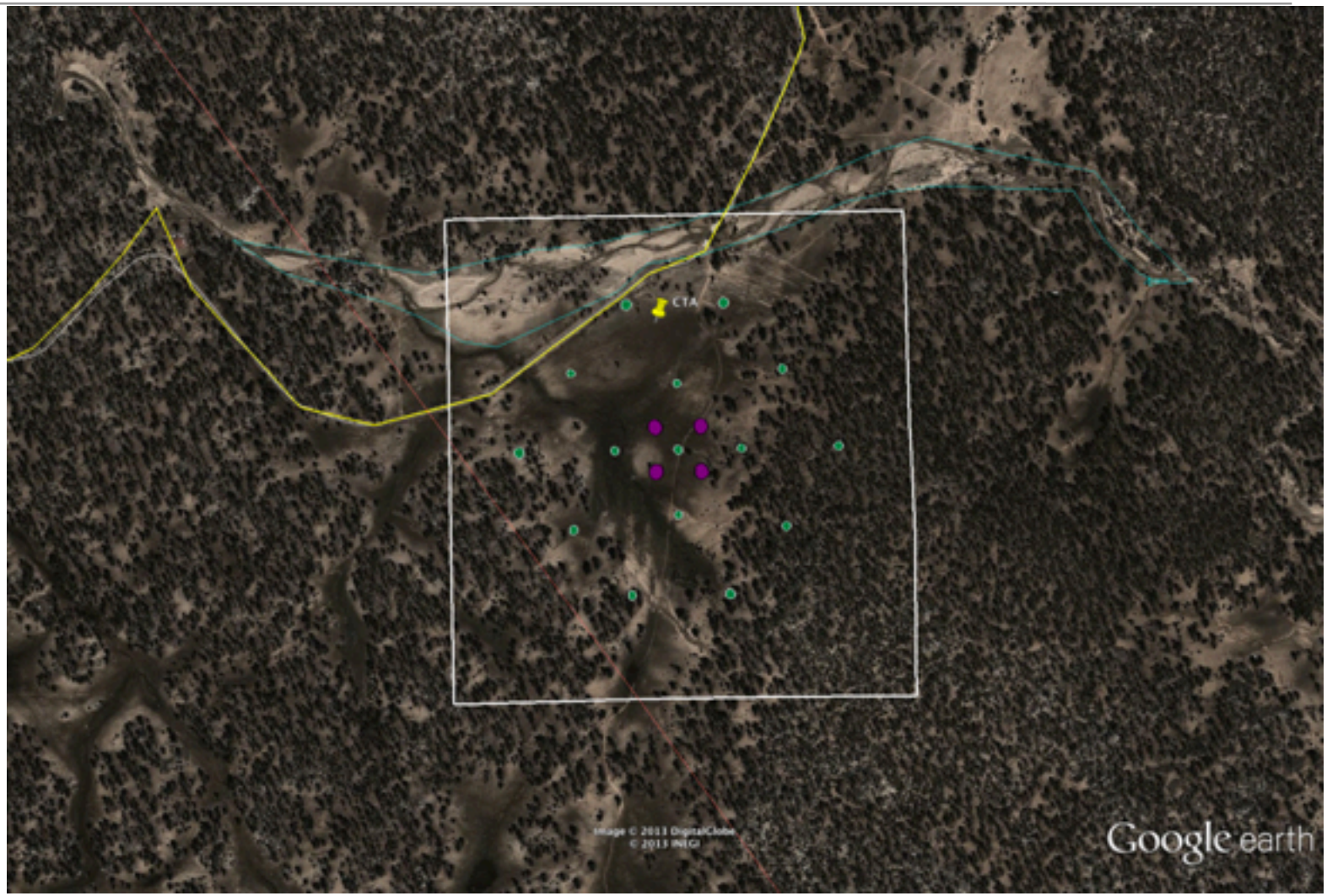
- Maps



without interference with the existing road

Site Location II

- Implantation of CTA array on site
- Conformity with Requirements



or the occasional water flow (happens once a decade).

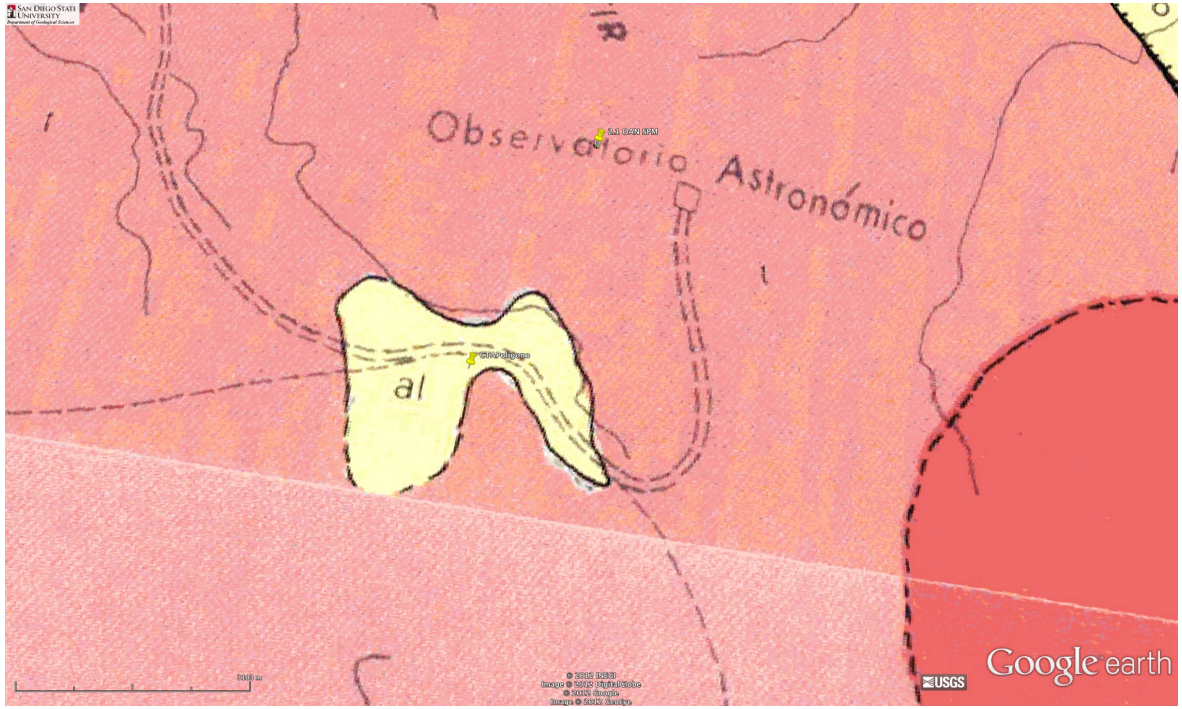
Site Location III

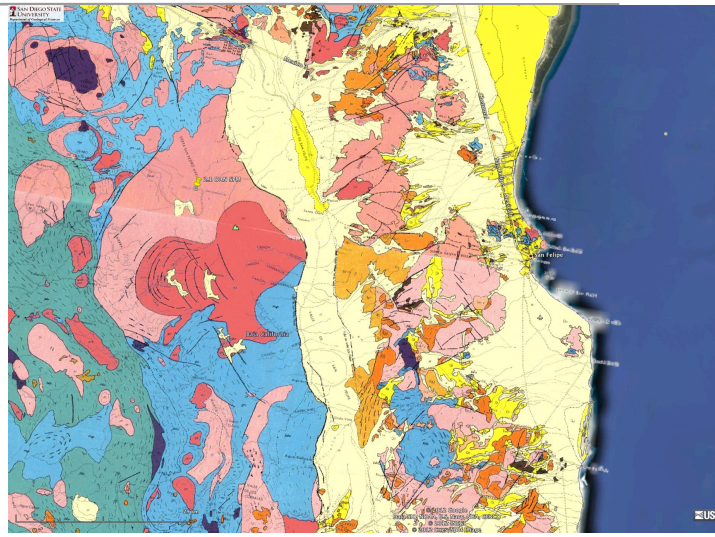
- Geotechnical conditions
- Any special considerations?

Site Location III

- Geotechnical conditions

The Sierra de San Pedro Mártir is a northwest-to-southeast oriented fault block feature consisting of massive granitic units that have been thrust during the past several million years to their present lofty position. Its geological history is closely related to the events that were responsible for the formation of the other peninsular range complex to the north.





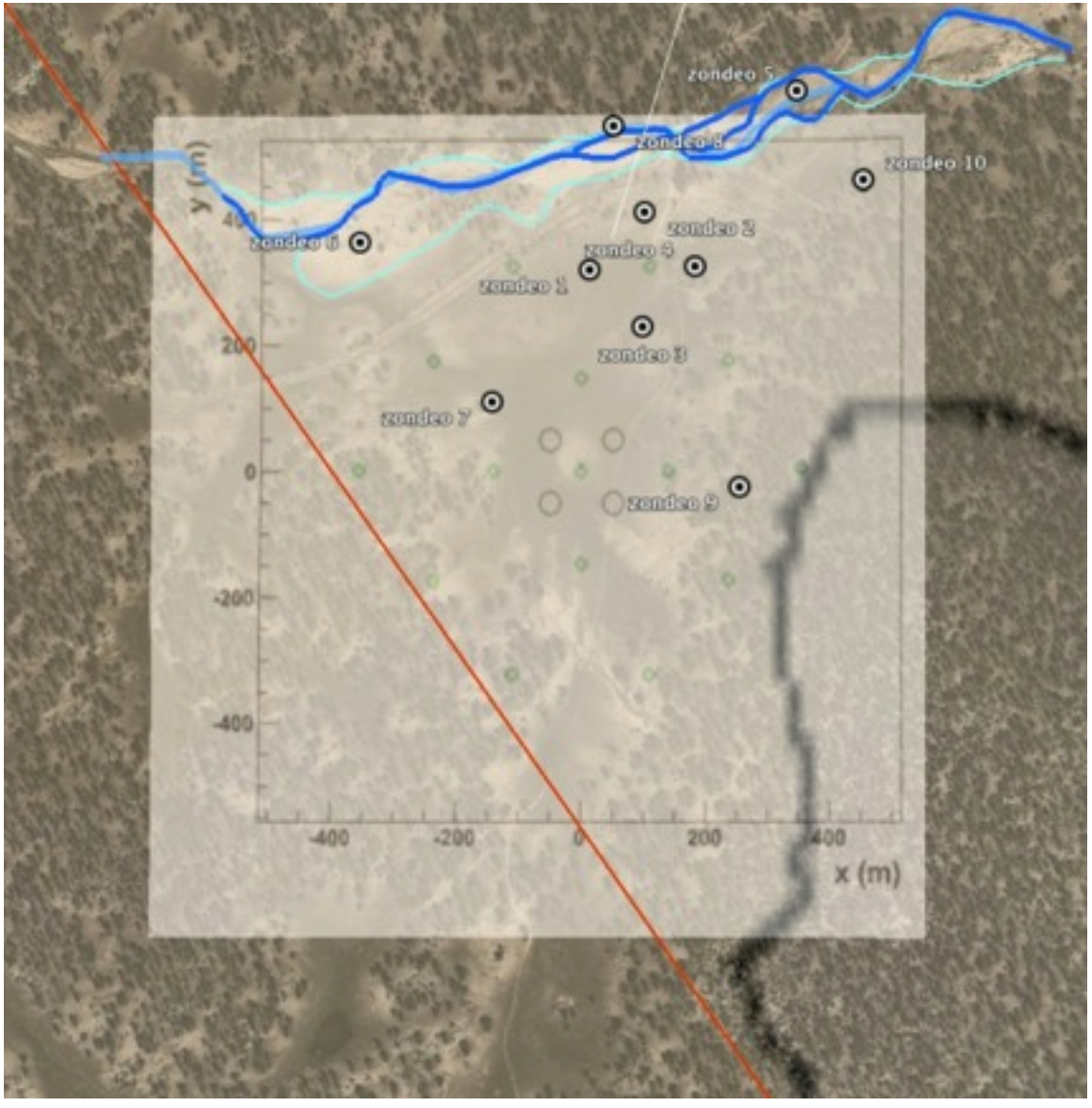
Tectonic plate movements caused the solidified batholith to break along pressure lines (faults) into gigantic blocks that were subsequently forced upward.
The mountain range's general configuration consists of a irregular but overall nearly flat surface, with elevations averaging 2400 m (8000 ft) in the north and slowly decreasing throughout its nearly 100 km (60 miles) length to the south.

Site Location III

- Any special considerations?

We planned to conduct a soil study of the area designated for CTA-N and will have exact composition and depth of water there. However, our plans were put on hold (since early December 2012) by the SDEV. They decided to develop a common procedure for all sites and we are waiting green light to start.

The study we commissioned intents to drill 10 holes, 15 m deep, distributed all over the area to have a good picture of what to expect and be able to plan construction.



Weather Conditions I : Cloud cover

- Percentage of completely clear nights (0% cloud cover)
- Percentage of partially clear nights (<20% cloud cover)

Weather Conditions I : Cloud cover

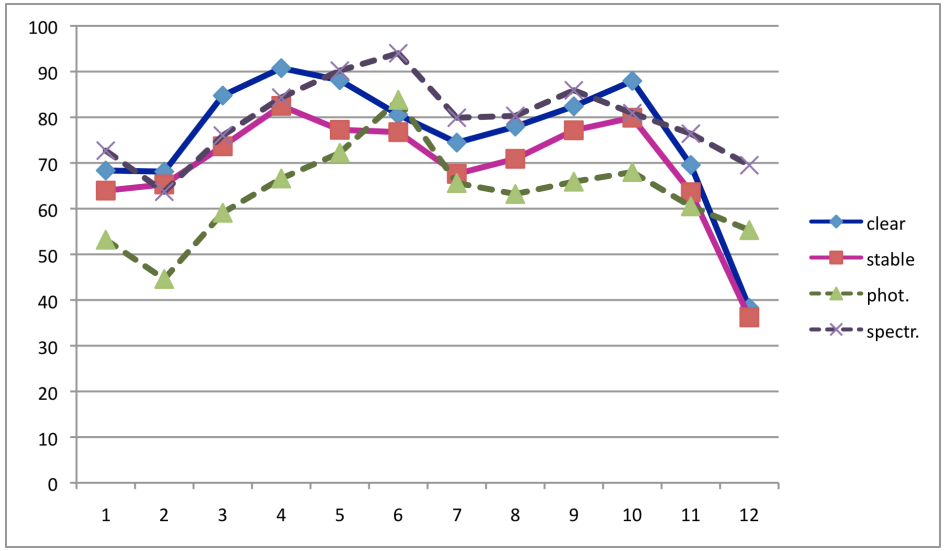
There are variety of studies of SPM based on different methods:

e.g., ***Erasmus & van Staedel 2003***, A Satellite Survey of cloud Cover and Water Vapor in the Southwestern U.S.A. and Northern Mexico, Second Report;
Usable nights 80.1%
Clear nights 73.2%

Tapia 2003, RMxAA(SC), 19, 75:
considering 1984-2002 period demonstrates very similar results with
80.8% spectroscopic nights and
63.1 photometric.
The number of clear nights averaged by month are
Jan 80%,
Feb 65%,
March 79%,
April 81%,
May 95%,
June 92%,
July 85%,
Aug 80%,
Sept 85%,
Oct 78%,
Nov 75%,
Dec 65%.

S. Cavazzani, V. Zitelli,
arXiv:1211.1520
Satellite available nights for SPM

	Clear		Stable	
	2008	2009	2008	2009
Mean	79.2	72.7	73.7	65.4

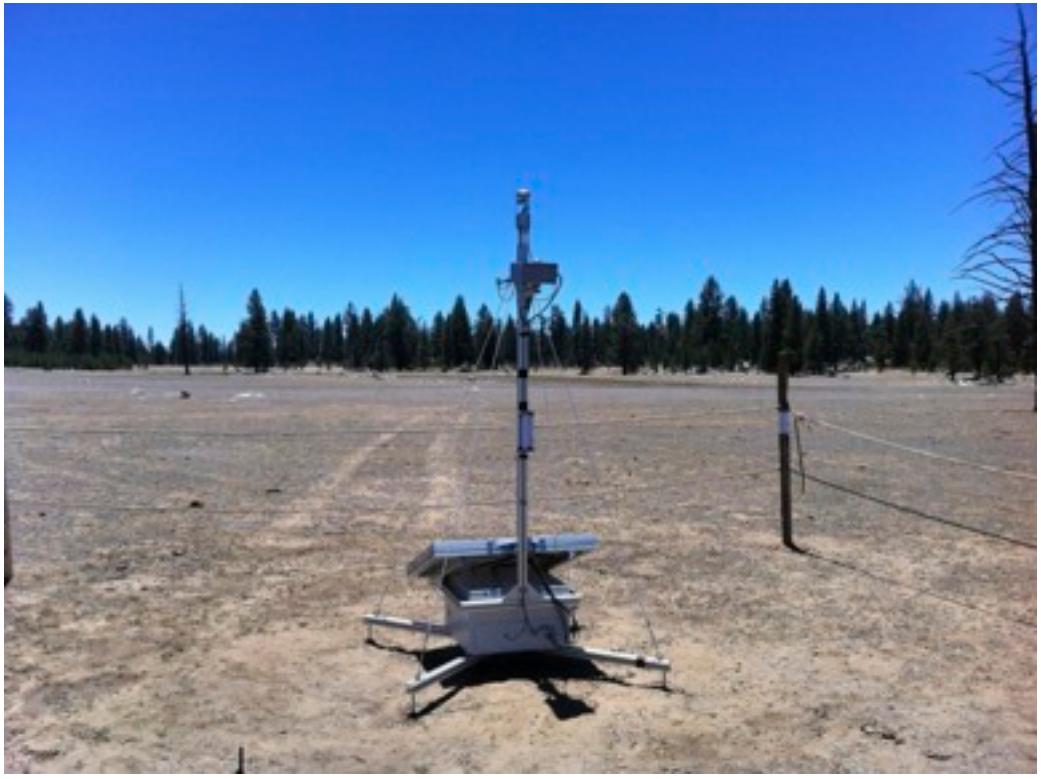


Weather Conditions I : Cloud cover

There are variety of studies of SPM based on different methods:

A larger number (**83%**) of cloudless skies was reported by TMT site explorative team (**Schock et al, PASP 121, 384, 2009)**, based on 3 year study. The TMT site-testing group developed a list of atmospheric parameters which were measured at each prospective site. According to these studies, the extremely cloud-free conditions exist at the western Atacama desert (Tolar and Armazones), with somewhat more clouds encountered at Tolonchar and SPM, followed by Mauna Kea.

Carrasco et al., 2012, MNRAS 420, 1273, in a recent study applied a novel method to solar radiation data to estimate the daytime fraction of time when the sky is clear of clouds. They find that **82.4%** of the time the sky is clear of clouds.



Weather Condition II: Wind

- Percentage of night hors wind < 36 km/hr (10 min average)
- Probability >200 km/hr (1 sec gust)

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- Percentage of night hors wind < 36 km/hr (10 min average)

Michel, Hiriart and Chapela, RevMexAA (Serie de Conferencias), 19, 99, 2003

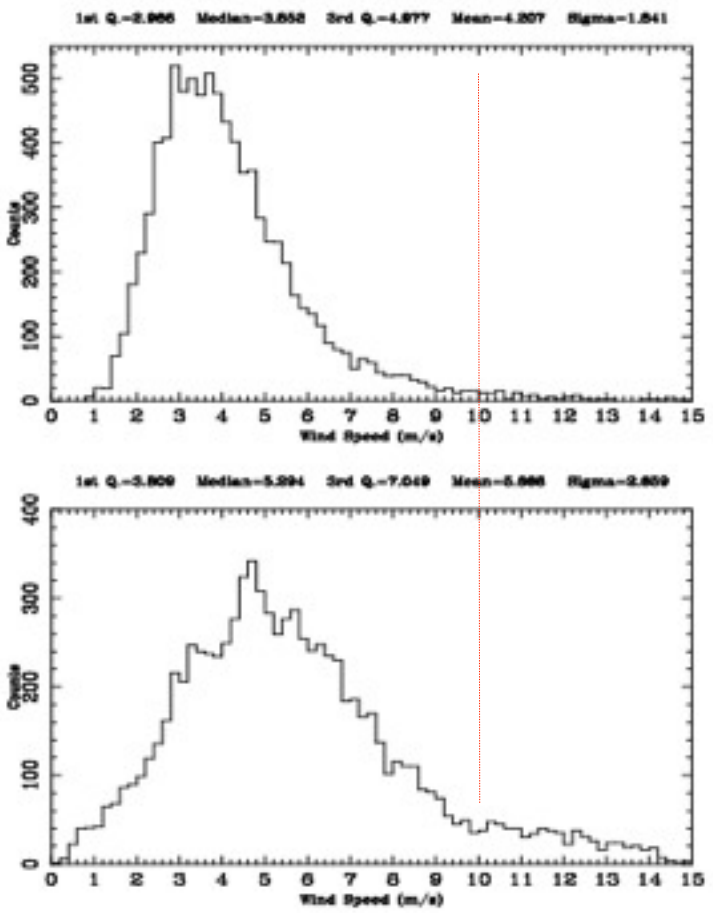


Fig. 8. Distribution of wind speed during day (top) and night (bottom).

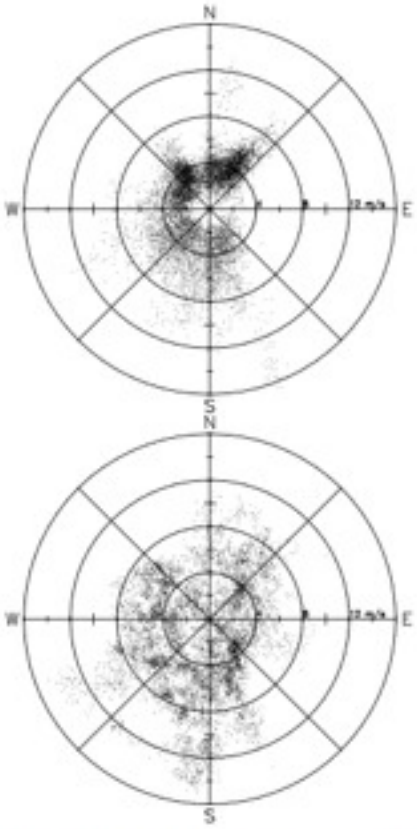


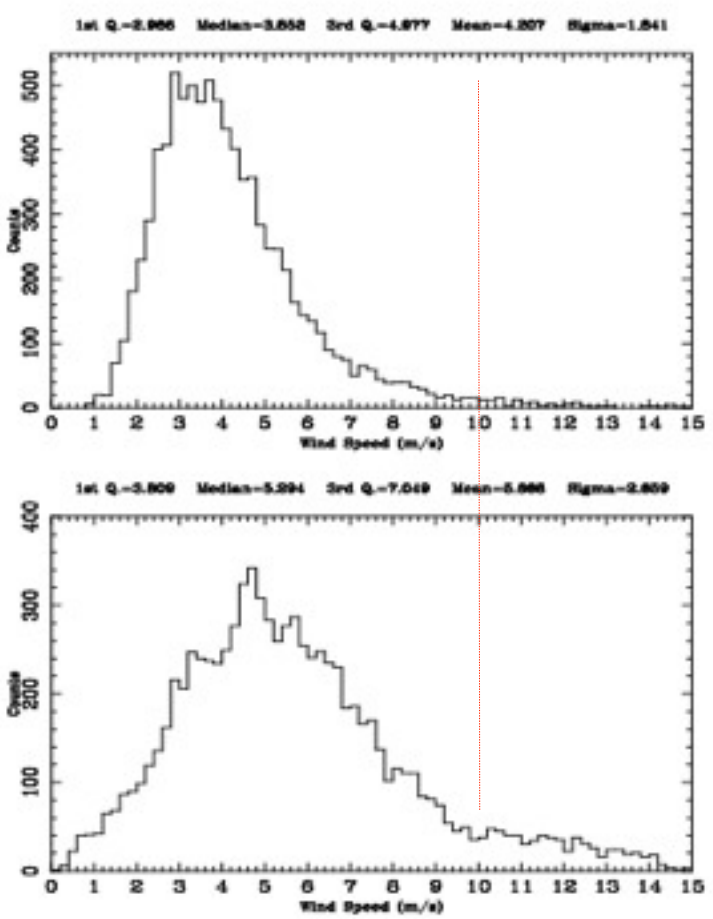
Fig. 7. Horizontal wind velocity during the day (top) and during the night (bottom). Each point represents the average in 5 minutes.

These are measurements by the weather station of the SPM conducted at the top of the mountain, on the edge of the eastern ridge.

The data was taken between Feb 2002 to Feb 2003. One sec measurements taken at 10 m height were averaged to 5 min in the figures. The wind speed exceeds 36 km/h limit 12 % of the night time.

Weather Condition II: Wind

- Percentage of night hors wind < 36 km/hr (10 min average)



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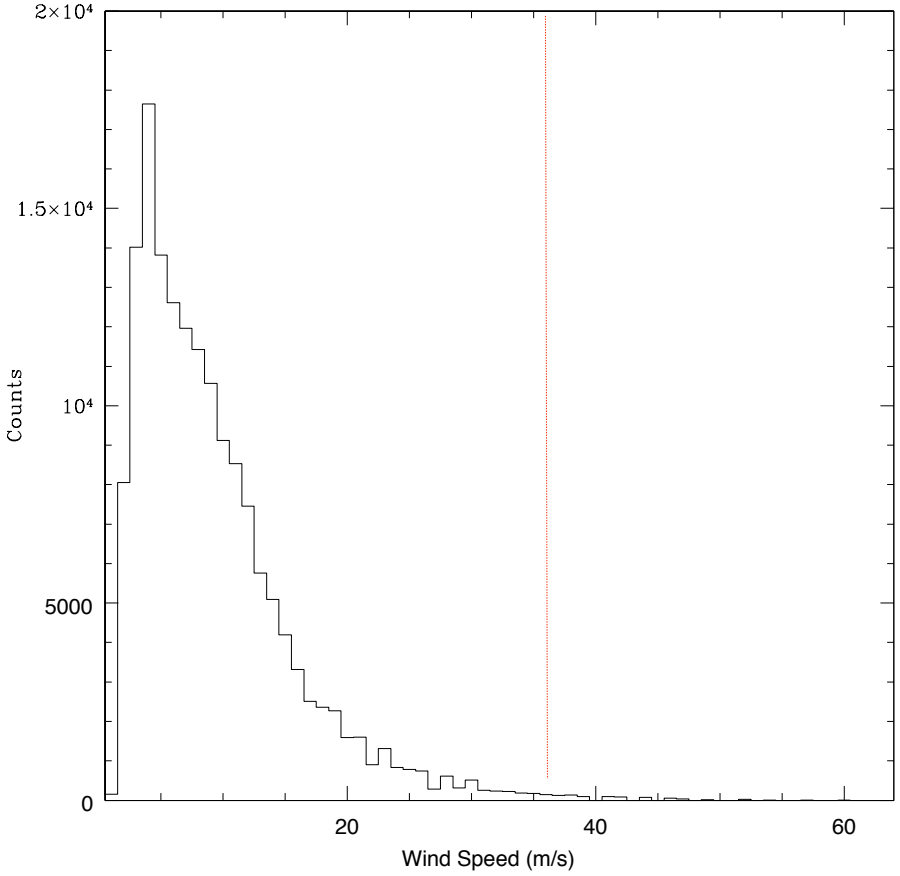
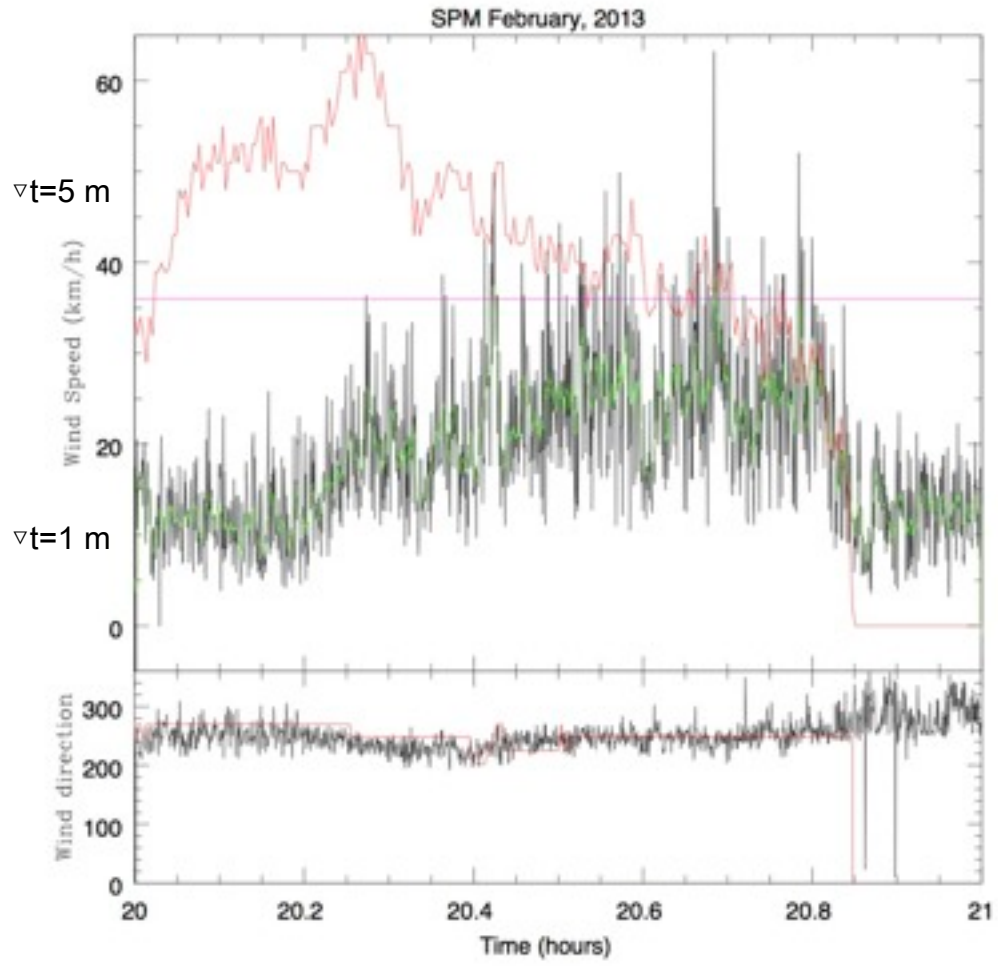


We can compare the distribution of velocities of OAN with the measurements of the Atmoscope (Sep, 2012 - March 2013) 1 min resolution

Weather Condition II: Wind

- Probability >200 km/hr (1 sec gust)



Winter Storm Pounds San Diego With Rain, Snow And Wind

Wednesday, February 20, 2013. City News Service

Sustained southwest to west winds of 25 to 35 mph and gusts around 60 mph were expected near ridge tops and along desert mountain slopes. .... During the time covered by the advisory, two to four inches of snow was expected to accumulate near the foothills, and wind gusts were expected to be around 35 mph. In the deserts, a high wind warning was scheduled until 8 p.m. In scheduling the warning, the weather service said winds in the deserts would be gusting up to 60 mph today.

Weather Conditions III: T, RH, precipitation

- Percentage of time temperature and humidity within operation range
- Percentage of night with snow on ground
- Conformity with extreme temperature, humidity and precipitation survival requirements

Weather Conditions III: T, RH, precipitation

- Percentage of time temperature and humidity within operation range

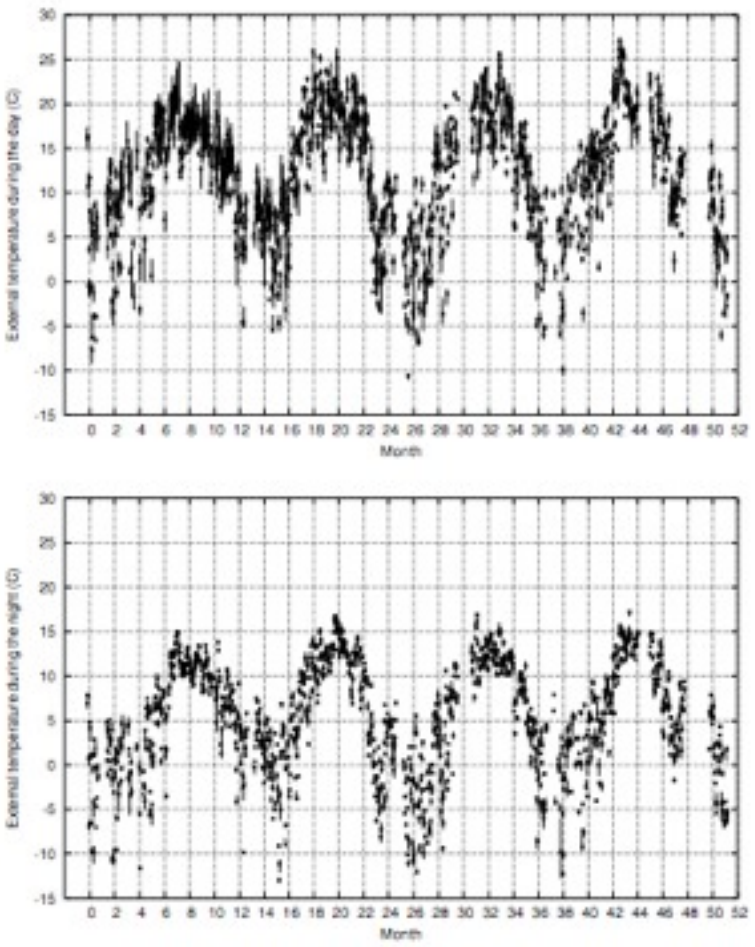


Fig. 2. Daily median outdoor ambient temperature.

Michel, Hiriart and Chapela, RevMexAA (Serie de Conferencias), 19, 99, 2003

Southern California and Northern Baja California are known for its warm, mild climate. The Sierra San Pedro Martir basically boasts the same type of weather, but because of high altitude the summers are cooler than at the sea level and in the winter there might be quite a few chilly nights. The temperature record of four and half years (1998-2003), shows that during a day the temperature stays below 28 C in the summer and at night in average reaches -5 C. However a few nights a year the temperature may drop down to -10 and occasionally to -15 C.

-10 C

Weather Conditions III: T, RH, precipitation

- Percentage of time temperature and humidity within operation range

TABLE 2

MONTHLY MEAN PRESSURE AND RELATIVE HUMIDITY[a] SAN PEDRO MÁRTIR OBSERVATORY

Month	Pressure (kPascal)[†]	Relative humidity (%)
Jan	560.6	50.17
Feb	559.3	56.30
Mar	558.0	58.42
Apr	560.1	46.72
May	561.1	39.71
Jun	558.0	50.69
Jul	563.9	57.74
Aug	563.3	61.12
Sep	562.1	61.06
Oct	560.6	55.86
Nov	561.1	52.63
Dec	560.8	49.61
Average	560.8	53.35

[†]Pressure in mm Hg and RH (%).

1 kPascal = 10 mb (milibar) = 7.5 mm Hg.

Michel, Hiriart and Chapela, RevMexAA (Serie de Conferencias), 19, 99, 2003

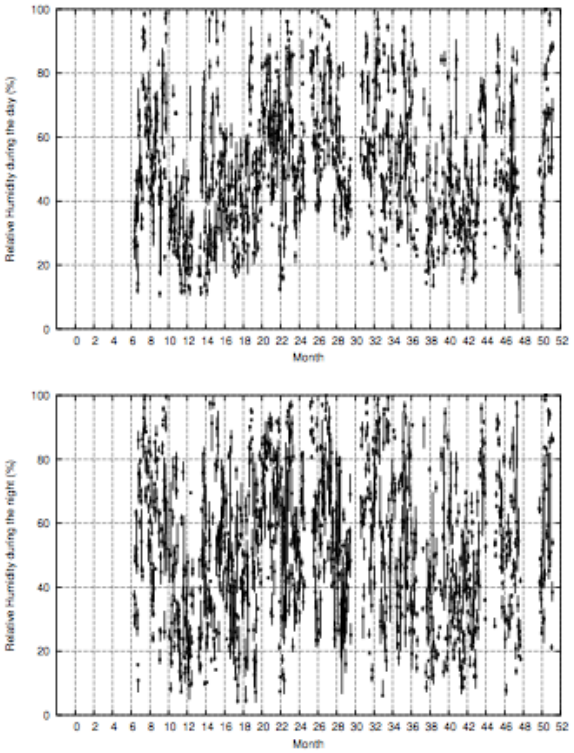


Fig. 4. Daily median relative humidity.

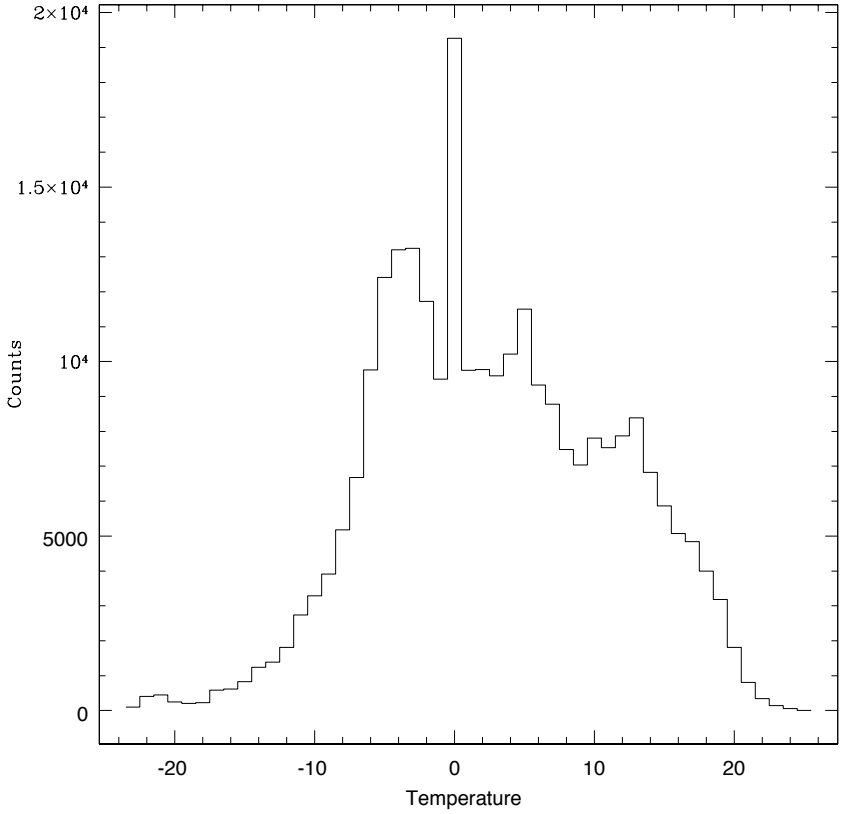
Figure shows the measured relative humidity as a function of time. To clarify its behavior data has been separated in night-time and day-time data.

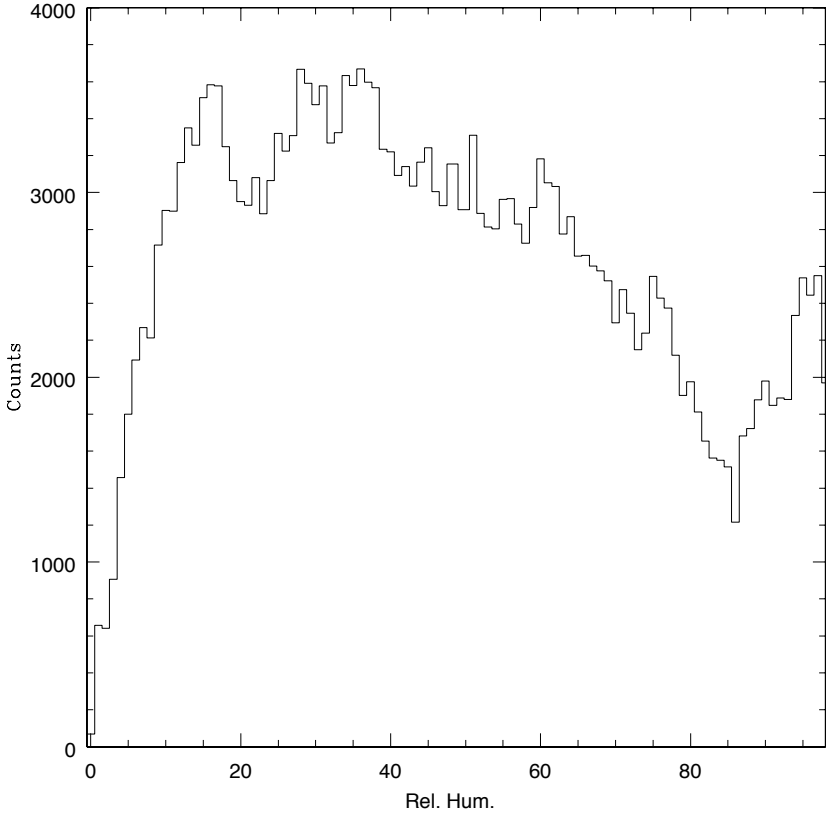
A clear seasonal pattern is obvious from the figure, although higher and more frequent values of relative humidity are measured during the summer. Measured values of the relative humidity show a great dispersion with the larger variations found during the night.

Alvarez, Michel, Reyes-Coca, Troncoso-Gaytan, RevMexAA (Serie de Conferencias), 31, 111–119, 2007

Weather Conditions III: T, RH, precipitation

- Percentage of time temperature and humidity within operation range

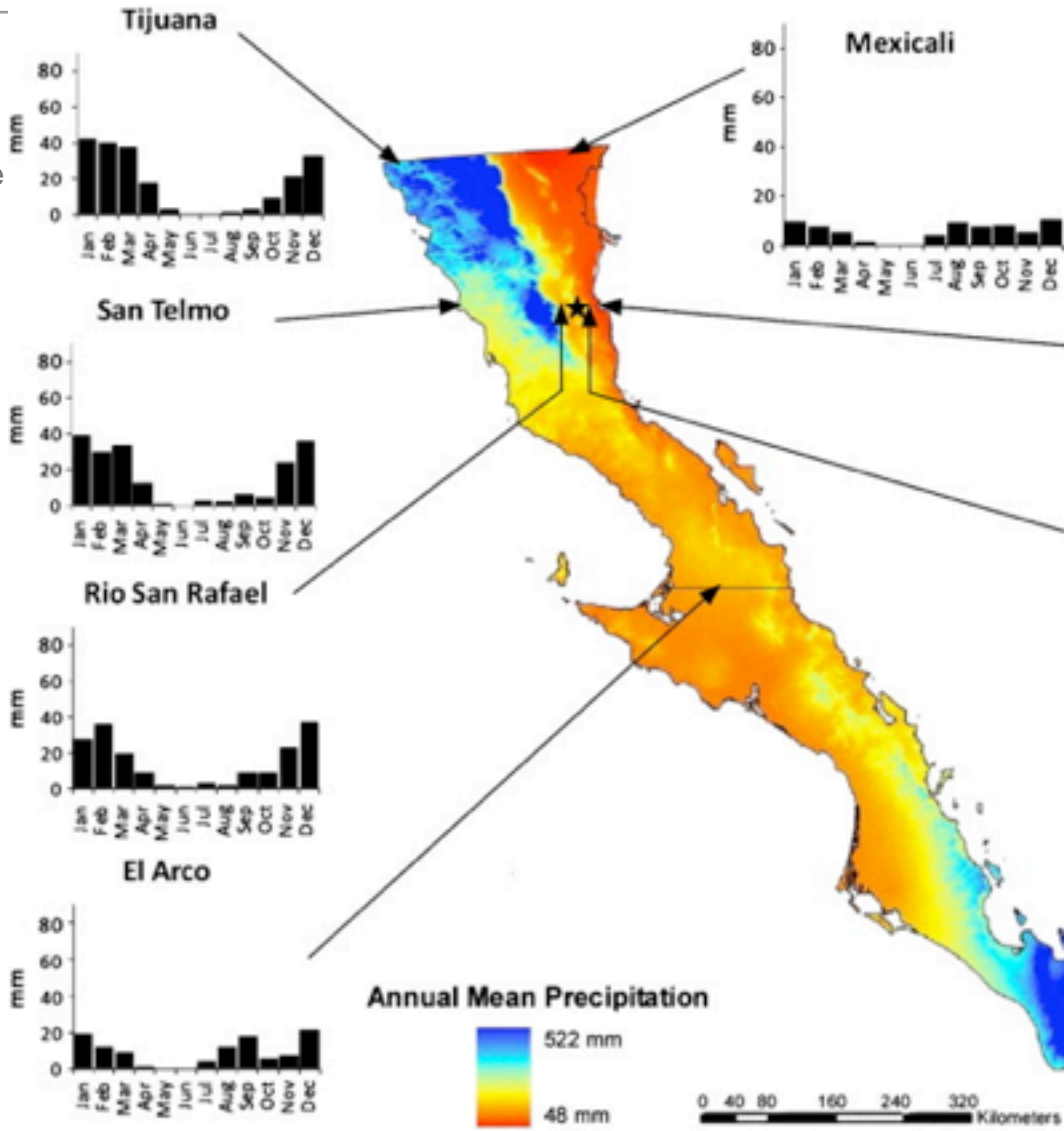




Distribution of Temperature and Humidity in the Vallecitos, as measured by the Atmoscope from 9/2012 to 4/2013

Weather Conditions III: precipitation general

Although most of the Baja California peninsula is extremely arid due to the nearly year-round influence of the North Pacific High, precipitation patterns vary sub-regionally and seasonally as a result of modulation by the mid-latitude westerlies in the winter and by the North American Monsoon system in the summer. During winter, the North Pacific High weakens and migrates to the southeast, while expansion of the Aleutian Low shifts the Pacific storm track southward and brings precipitation derived from mid-latitude cyclones embedded within the westerlies into northern Baja California (Hastings and Turner, 1965, Markham, 1972 and Woodhouse, 1997). Winter precipitation peaks in January and is greatest in northern Baja California along the Pacific coast and western slopes of the Sierra Juárez and SSPM; the combination of wet winters and dry summers here represents a southern extension of the classic Mediterranean climate found to the north in California. Winter precipitation decreases both to the south away from the influence of the westerlies, and to the east as moisture is blocked by the Sierra Juárez and SSPM. These mountain ranges represent a nearly continuous barrier that produces a moderate rainshadow effect and notably asymmetrical precipitation receipts between the eastern and western-facing slopes. For example, the northern Gulf of California and San Felipe Desert receive only about one-fourth as much precipitation as the Mediterranean region on the Pacific coast at the same latitude (Hastings and Turner, 1965), making it Baja California's driest area.



Camille A. Holmgren,Julio L. Betancourt,Kate A. Rylander
Quaternary Research, Elsevier, May 2011

Weather Conditions III: T, RH, precipitation

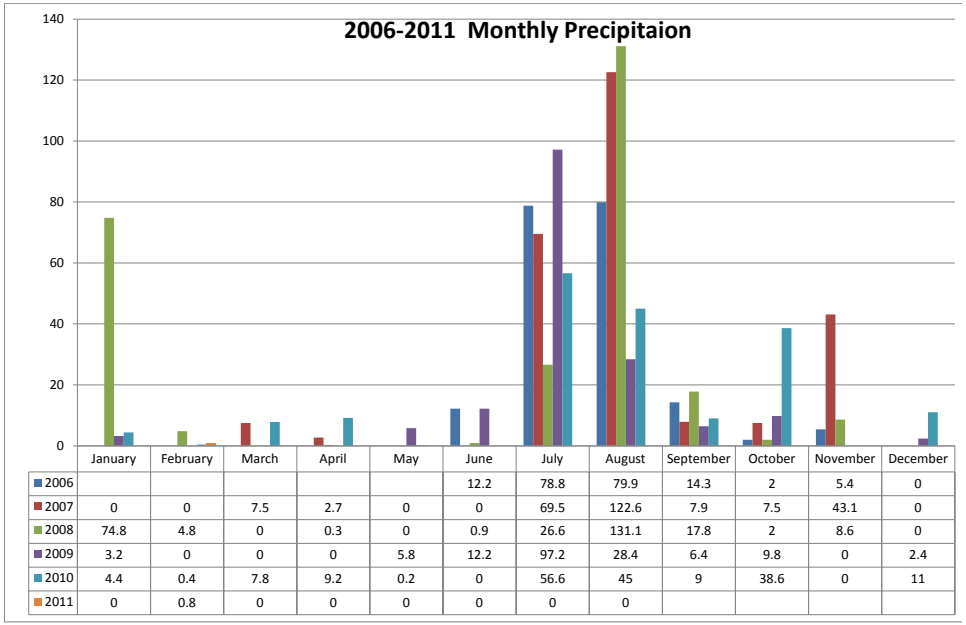
- Percentage of night with snow on ground
- Conformity with extreme temperature, humidity and precipitation survival requirements

The Snow Record for SPM from 2000 to 2009

	00	01	02	03	04	05	06	07	08	09
ENE.	5	6	--	1	5	6	--	3	1	2
FEB.	7	8	--	11	7	5	--	1	--	2
MAR.	4	2	--	7	3	3	5	1	1	--
ABR.	--	4	1	1	4	--	2	--	--	--
MAY.	--	--	--	--	--	--	1	--	--	--
JUN.	--	--	--	--	--	--	--	--	--	--
JUL.	--	--	--	--	--	--	--	--	--	--
AGO.	--	--	--	--	--	--	--	--	--	--
SEP.	--	--	--	--	--	--	--	--	--	--
OCT.	4	--	--	--	--	1	--	--	--	--
NOV.	--	--	1	--	7	--	--	1	1	1
DIC.	--	--	2	--	4	1	--	2	--	2
TOTAL	17	20	4	20	30	16	8	8	3	7

-- = No Snow

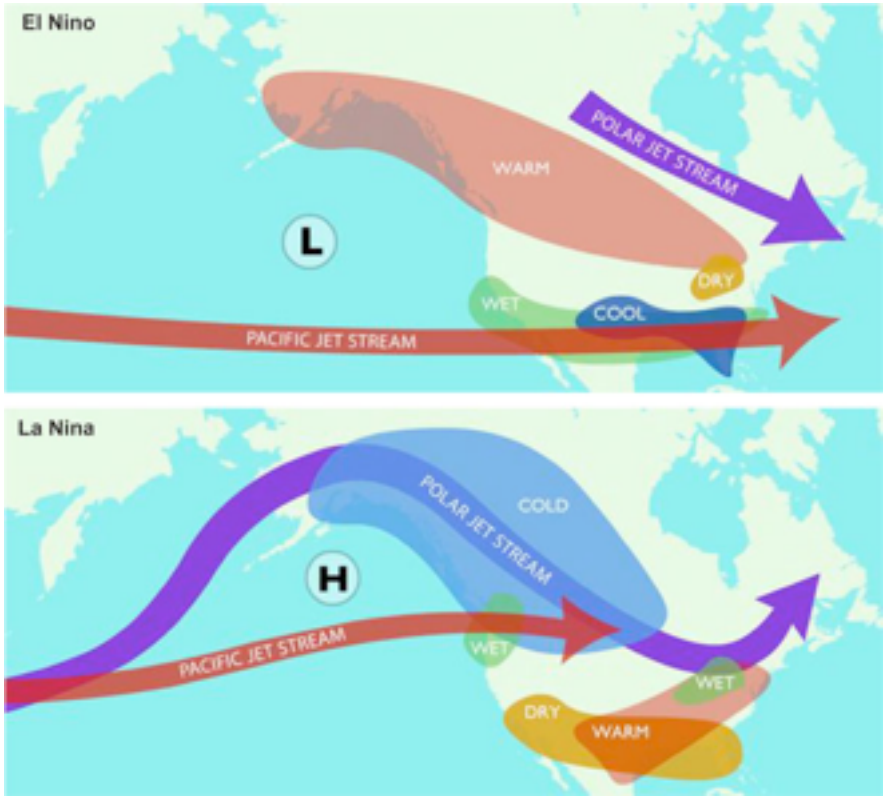
Notas: The table is compiled on the basis of written reports of OAN SPM supervisers from 2000 to 2003 and from 2003 to 2009 on webcam (SIMON) photo analysis.

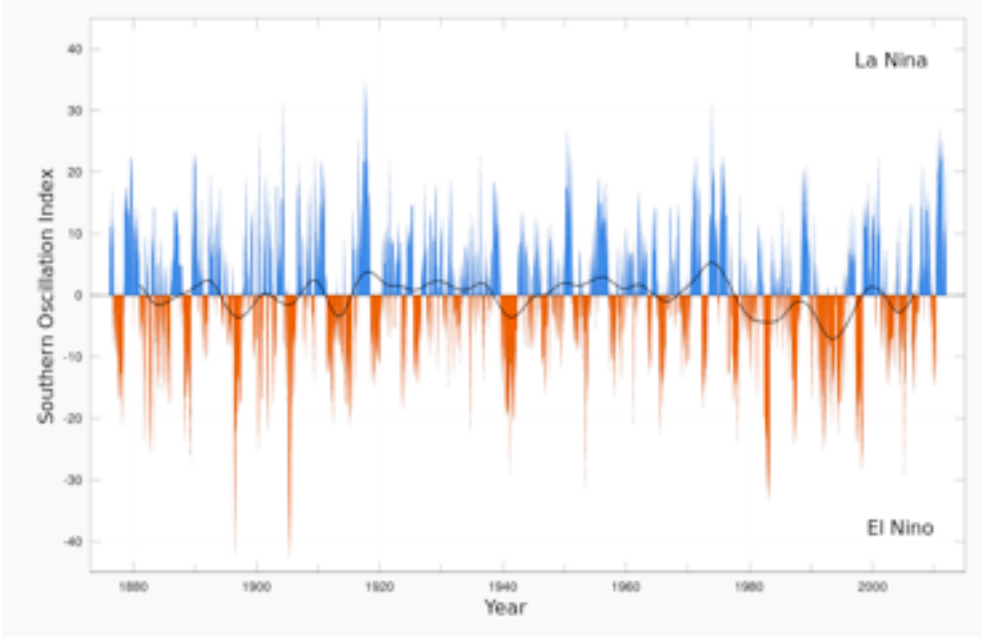


	January	February	March	April	May	June	July	August	September	October	November	December
2006						12.2	78.8	79.9	14.3	2	5.4	0
2007	0	0	7.5	2.7	0	0	69.5	122.6	7.9	7.5	43.1	0
2008	74.8	4.8	0	0.3	0	0.9	26.6	131.1	17.8	2	8.6	0
2009	3.2	0	0	0	5.8	12.2	97.2	28.4	6.4	9.8	0	2.4
2010	4.4	0.4	7.8	9.2	0.2	0	56.6	45	9	38.6	0	11
2011	0	0.8	0	0	0	0	0	0				

Weather Conditions III: T, RH, precipitation

- Conformity with extreme temperature, humidity and precipitation survival requirements





Analysis of the data, shows that there is a pattern of nearly 30 to 35 years showing periods of heavy rain following strong drought conditions, that extends through the whole interval of more than 100 years. The statistics of the 112 studied years give the following results: 62.5% show precipitation smaller or equal than the mean; 27.7% show extreme droughts (annual rain less than 100 mm below average); 37.5%,have rains heavier than the mean; 10.7%, showed strong rains (precipitation larger than 150 mm above the mean).

Night Sky Background

- Any knowledge and measurements other than LONS

Tapia,Cruz-Gonzalez, and Avila RevMexAA (Serie de Conferencias), 28, 9, 2007

SAN PEDRO MÁRTIR SITE CHARACTERIZATION

Sky transparency	Clear nights	Usable nights
June 1997 - May 1998[a]	69.8%	81.6%
June 1997 - May 1998[b]	67.5%	83.7%
June 1996 - Dec 2002[b]	74.6%	85.0%
June 1984 - Dec 2005	64.7%	81.3%
Integrated seeing[c]		
Annual (median)	0.″62	
Spring	0.″58	
Summer	0.″58	
Autumn	0.″68	
Winter	0.″69	
Water vapor content		
Mean PWV satellite[a]	2.63 mm	
Mean PWV radiometer[d]	2.55 mm	
Mean extinction k_y[e]	0.14 @ 549 nm	0.055 @ 800 nm
Sky brightness[f]	**Dark**	**Bright**
U	21.5	19.3
B	22.3	19.8
V	21.4	19.7
R	20.7	19.6
I	19.2	18.4
J	16.5	
H	14.1	
K'	14.9	

Nearly two-thirds of the photometric nights have k_y values equal or below mean 0.14, with a median and a minimum of about 0.13 and 0.11 mag/air mass, respectively. The extinction is low and very stable in autumn while in spring it is higher and less consistent. The rest of the year the extinction is intermediate.

Noche del 17 de febrero 2013
(0.84 m + CCD Marconi)

M(U) = 22.292 (Mag/arsec^2)

M(B) = 22.930

M(V) = 22.710

M(R) = 22.609

M(I) = 21.999

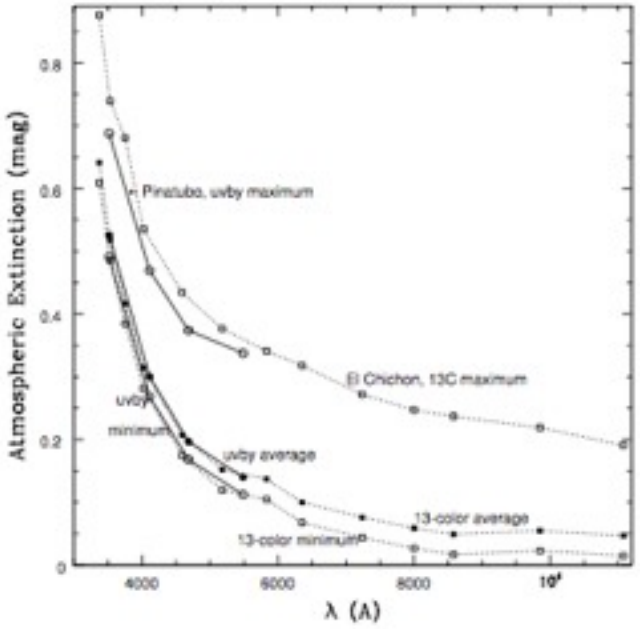


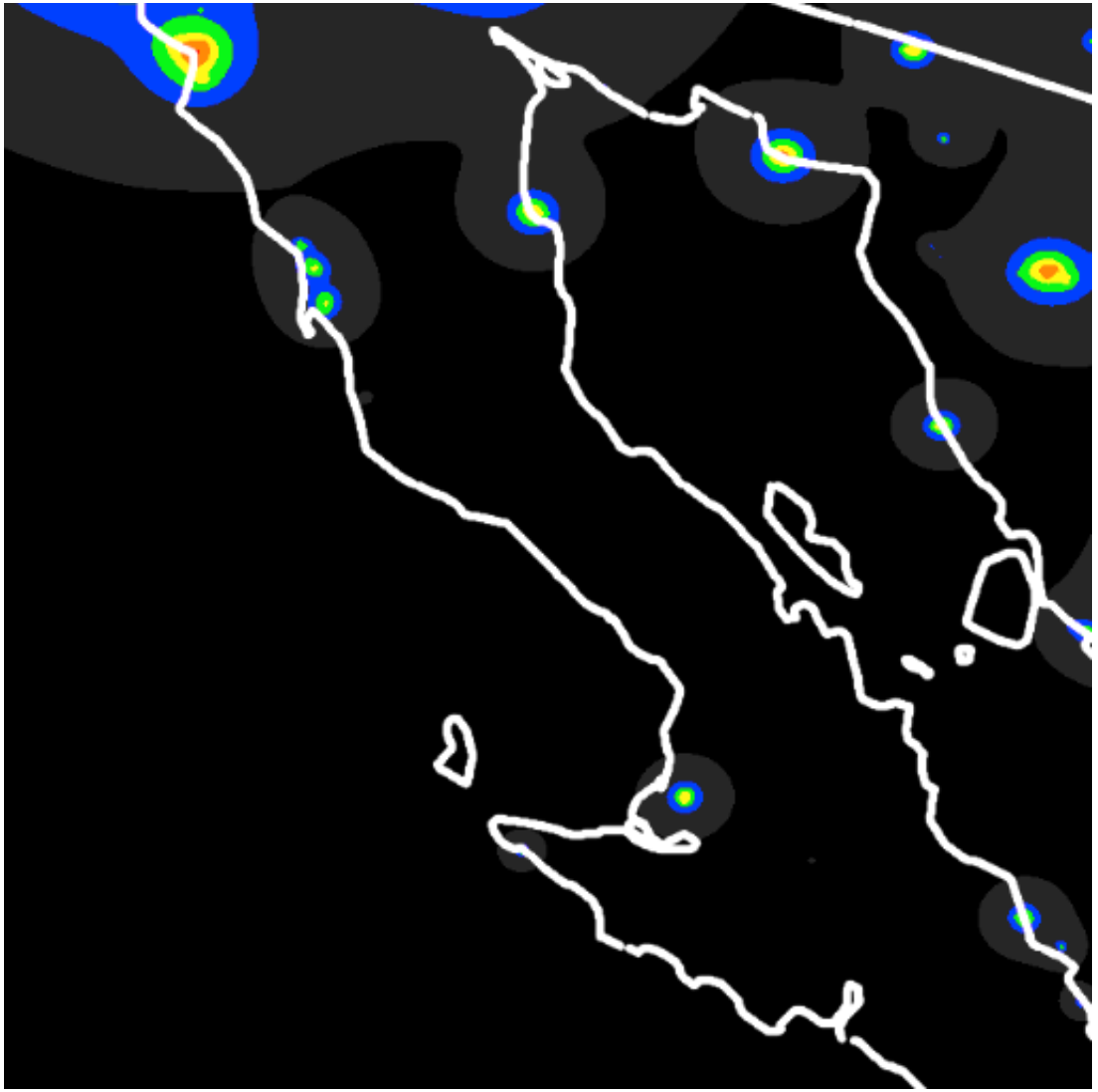
Fig. 4. Maximum, minimum and average atmospheric extinction curves for the 13C (dotted curves) and *uvbg* (solid curves).

Night Sky Background

- Any knowledge and measurements other than LONS

A state and municipal laws on light pollution have been adopted. No increase in light pollution is expected in years to come.

Los Vallecitos are shielded by the hill to the north (where the optical telescopes are located, therefore NO artificial light are on sight of view, which explains why the SPM is the darkest site in V among all candidates.

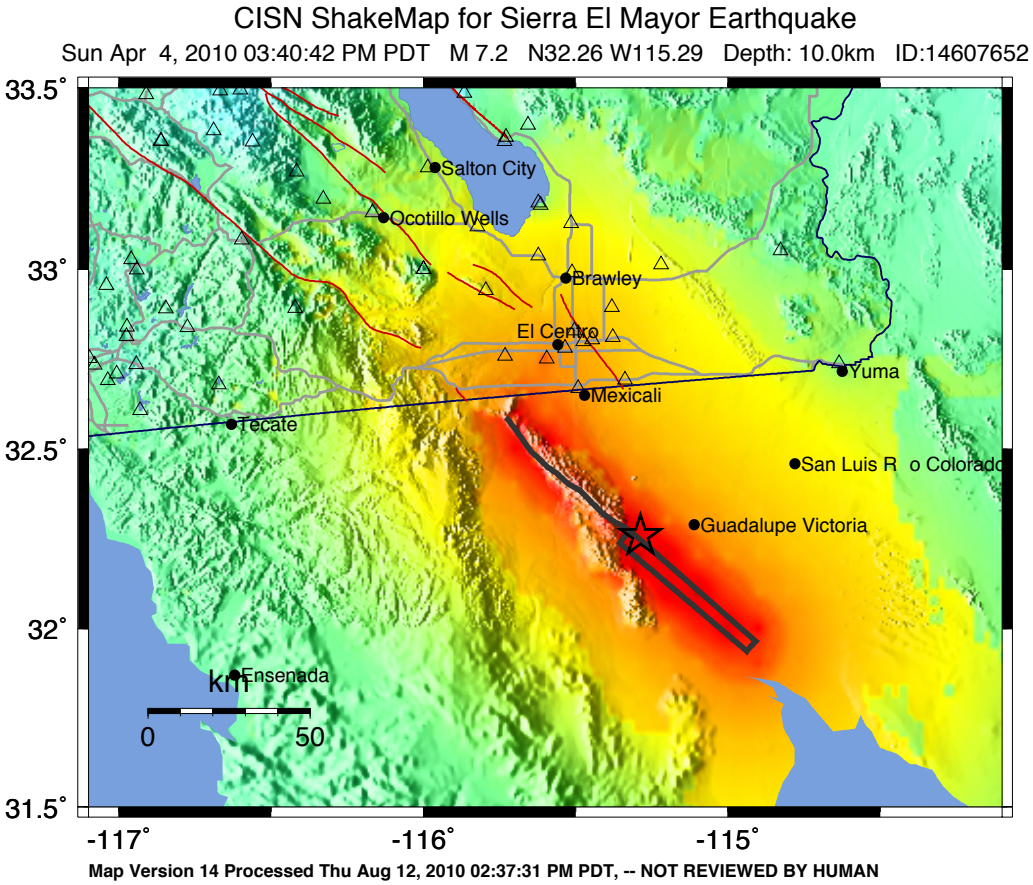


Natural Hazard Risks

- Earthquakes
- Wind storms
- Hail storms
- Sand storms
- Anything else

Natural Hazard Risks

- Earthquakes

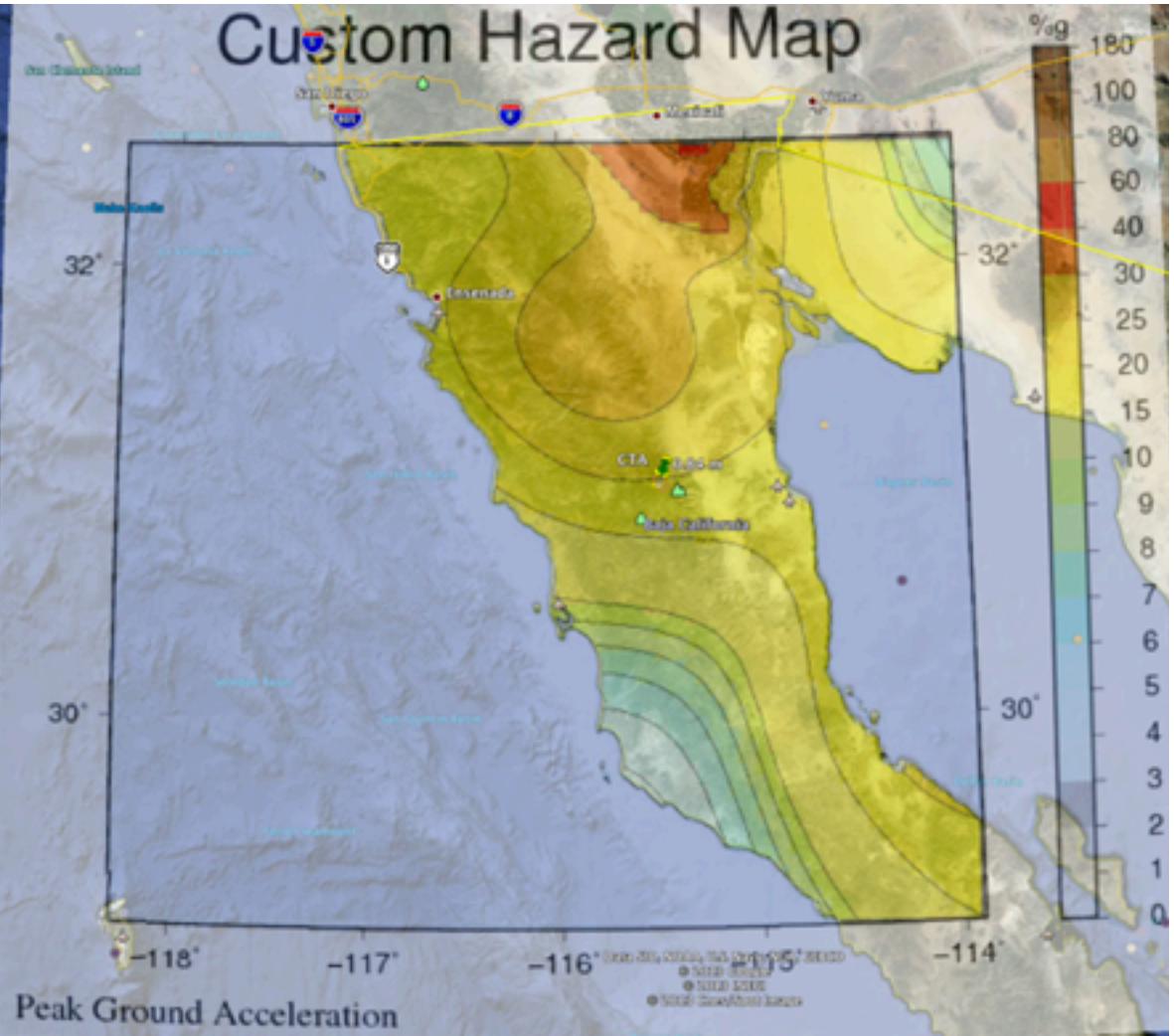


PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	*8.1-16*	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

California is known as earthquake prone zone. The majority of earthquakes are related to infamous San Andres fault. Here I show maps requested by us from **U.S. Geological Survey**, which demonstrate the extent of the fault in the area of interest and clearly indicates that the Observatory is in a safe zone, with GA level below the limit established by the CTA.

Natural Hazard Risks

- Earthquakes



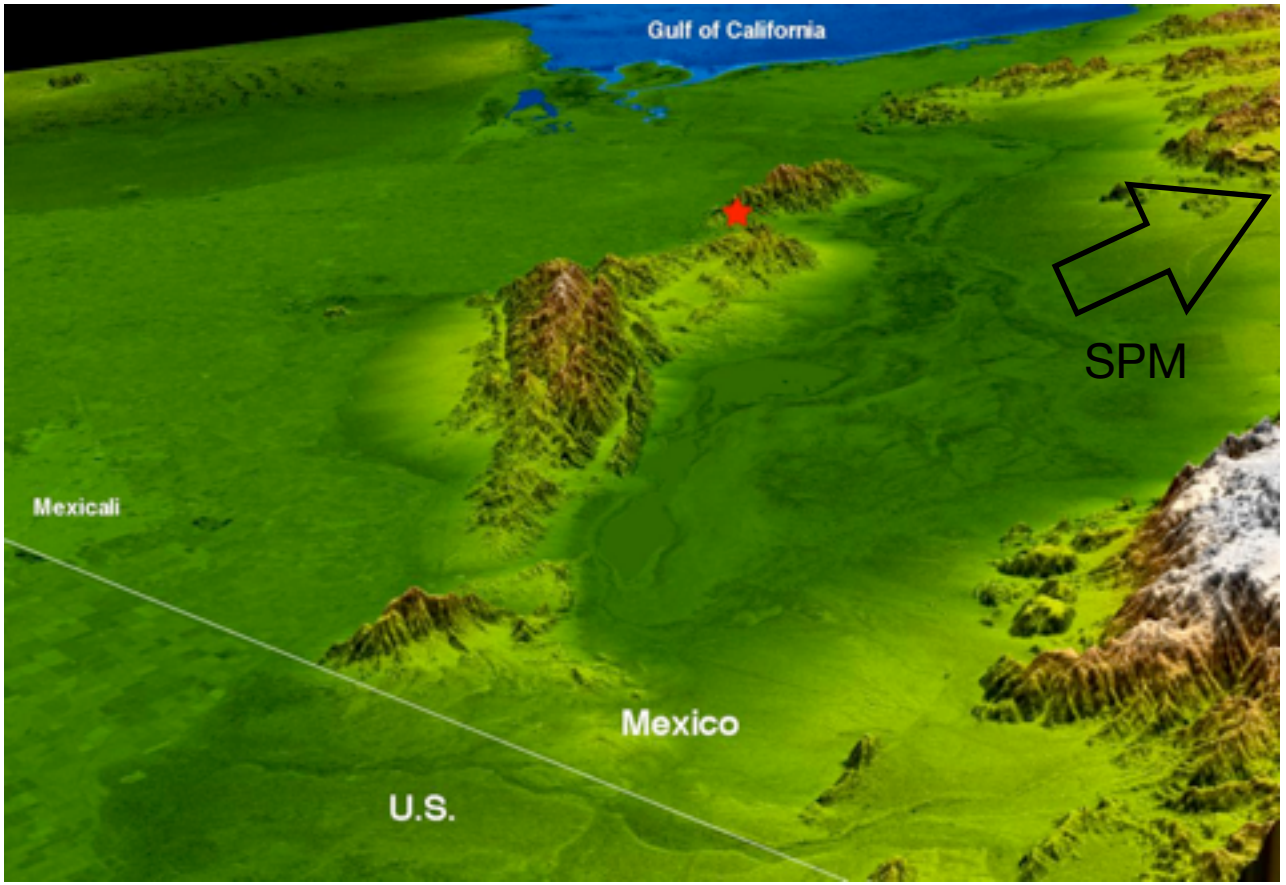
The area designated for CTA clearly falls into 15-20% g = 1.5 - 2.0 m/s^2 range, much below the requirements imposed by the Consortium.

Natural Hazard Risks

- Earthquakes

The topography surrounding the Laguna Salada Fault in the Mexican state of Baja, California, is well shown in this combined radar image and topographic view generated with data from the Shuttle Radar Topography Mission (SRTM).

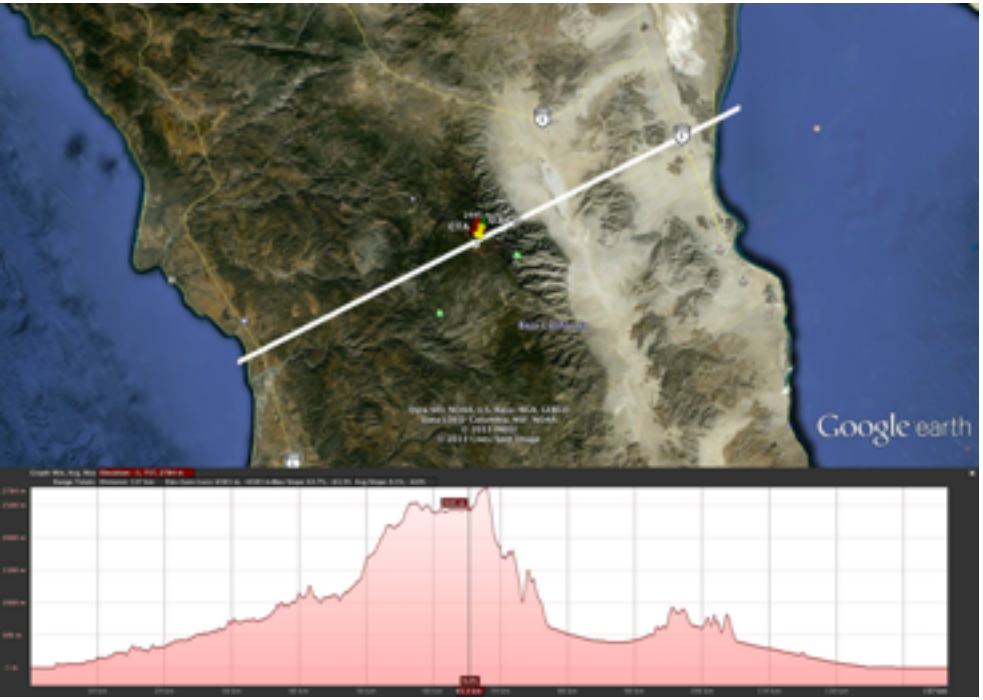
On April 4, 2010, a magnitude 7.2 earthquake struck along this fault about 64 kilometers (40 miles) south of the Mexico-United States border.

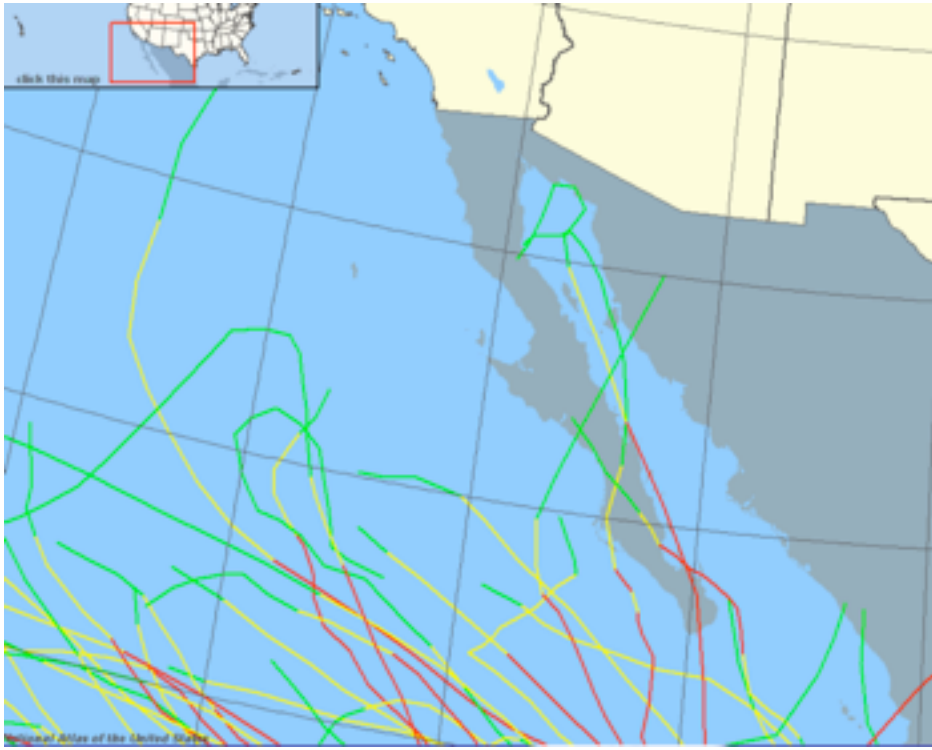


According to the U.S. Geological Survey, the earthquake was the largest event to strike this area since 1892. This fault is a probable southern continuation of the Elsinore Fault Zone in Southern California, and is related to the San Andreas fault zone complex. Aftershocks since the major event have appeared to extend in both directions along this fault system from the epicenter, marked by the red star. However, neither this, nor numerous other earthquakes happening along the fault has caused any distress to the Observatory during 30 years of existence.

Natural Hazard Risks

- Wind storms no serious treat



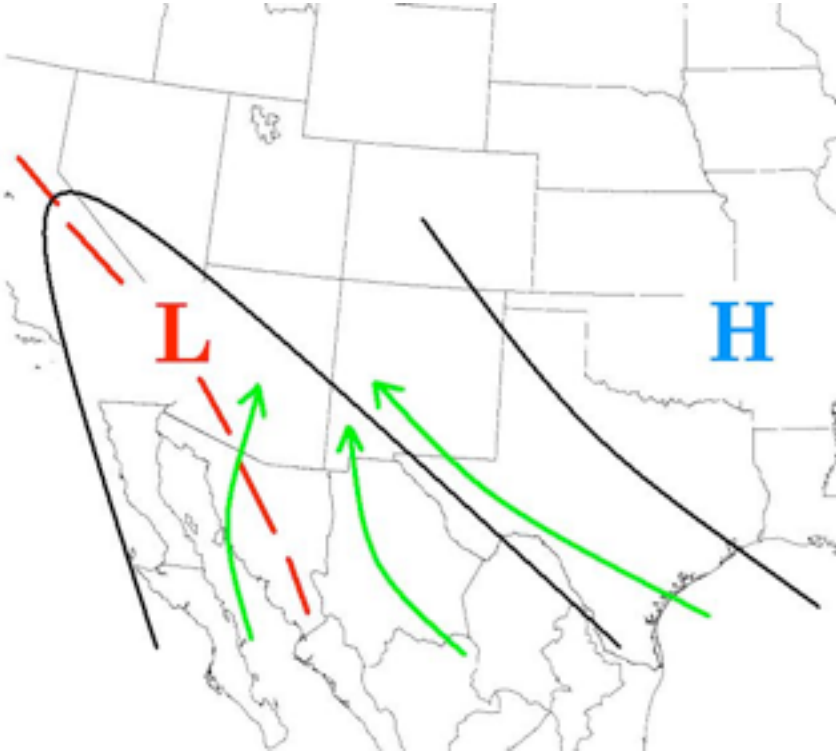


The paths of tropical cyclones and major hurricanes from 1851 to 2004.

Natural Hazard Risks

- Hail storms

In the summer monsoon precipitation prevails. It accounts for a substantial portion of annual precipitation in northwest Mexico and the Southwest US the southwest US is at the northern fringe of the monsoon, precipitation is less and tends to be more variable. Areas further west of the core monsoon region, namely California and Baja California, typically receive only spotty monsoon-related rainfall.



In SPM at altitudes above 2200 m the pattern is peculiar. In Jul-Aug the clouds gather at the top of the mountain ridge during a day accompanied often by rainfall and thunderstorms to clear out after the sunset and provide crispy clear sky at nights. Humidity can be high though.

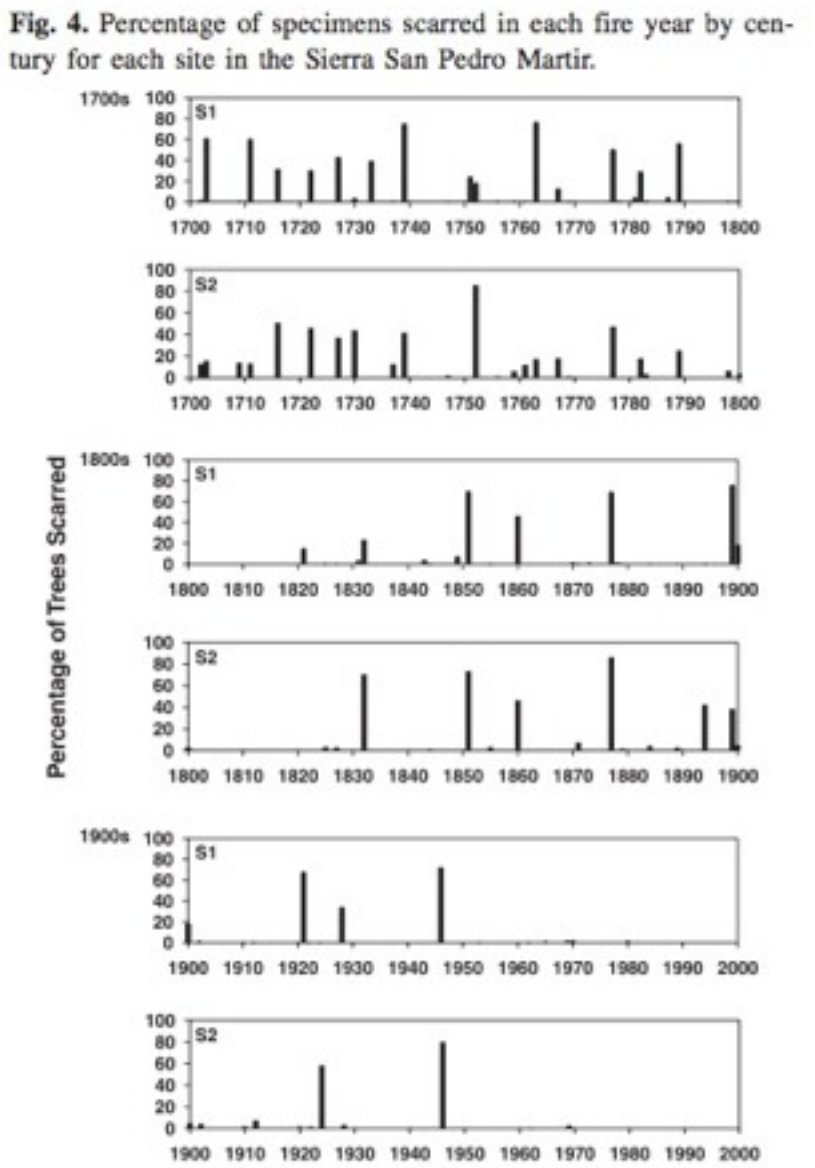
Lightnings often accompany summer thunderstorms. Hail is not very common, but is not excluded during this season

- Sand storms non existent

Natural Hazard Risks

- Forest Fires

During summer thunderstorms it is not unusual to have a lightening hit a tree and start a fire. However due to the sparseness of SPM forest, the fire rarely spreads to a large area. Quick response by the Observatory staff and park rangers has prevented any serious fires in the vicinity of the Observatory or the road leading to it. Los Vallecitos are particularly safe due to the lack of sufficient biomass and proximity of water deposit.



Stephens, Skinner, and Gill, Can. J. For. Res. 33: 1090, 2003

Social/Political Risks

- Political stability of country
- Crime
- Import regulations
- Any other important consideration

Social/Political Risks

- Political stability of country

Mexico is a stable democracy, and has one of the world's largest economies, and is considered both a regional power and middle power. In addition, Mexico was the first Latin American member of the OECD (since 1994), and a firmly established upper-middle income country. The elections in 1997 broke one-party-rule in Mexico, and since then several elections has passed with power changing hands on the federal level. Meanwhile, state governors nowadays come from three different parties. The elections since 1994 are conducted in a fairly good manner, praised by international observers. Protests take place in a democratic, non-violent way.

Mexico has the second-largest economy in Latin America and continues the robust growth in spite of the crisis in USA and Europe. Foreign direct investment climbed nearly 30 per cent in the first six months of 2010 from a year earlier. Newly elected politicians from PRI are more pro-growth than they have been in the past, singing the praises of the private sector. And wage growth in Mexico is flat, while it is rising in China. The population is young, so Mexico has a demographics edge that China does not have. Or Russia for that matter. Earlier this month, Nomura Securities even forecast that Mexico would overtake Brazil as the largest economy in Latin America.

Drug related violence and high level of corruption are still a big concern for Mexico, but they do not pose risk for political or social stability.

Source: Bloomberg, Forbes, BBC News

Social/Political Risks

- Crime

In the last few years articles in the business and world sections of the newspaper have often painted diametrically different pictures of Mexico's health as a country. International news stories often focus on the alarming reports of drug cartel related violence, and sometimes include commentary from security experts who don't hesitate to call the country a "failed state" or a "narco state."

The business section of the newspaper, by contrast, always includes articles on Mexico's impressive macro-economic management, and demonstrated track record at controlling inflation and promoting business investment and economic growth.

"Even as American TV anchors report on "the war on our border," the city's 285 maquiladoras-factories making goods for export are not fleeing. Each day, 9,000 managers cross the Rio Grande without incident from their homes in El Paso to the Juarez plants of Johnson Controls (JCI), Cummins (CMI), Emerson Electric (EMR), Visteon (VC), Delphi Automotive (DPHIQ.PK), and others. Travel to Monterrey, Guadalajara, ***Tijuana, Mexicali,*** *and Queretaro, where Whirlpool (WHR), Honeywell International (HON), Daimler (DAI), and Lenovo (LNVGY) have been expanding, and you'll think that talk of Mexico as a "failed state" seems absurd. "Not only are we not going anywhere, but more and more of our key suppliers are in Mexico," says Randy E. Wilcox, president for the Americas for Otis Elevator. "*

Although the number of violent deaths is alarming, it remains largely limited to the power struggle among drug trafficking cartels. The domestic crime rate is moderate and much better than in most other Latin American countries or elsewhere in the world. The ever large number of USA expats retiring in Baja California, and international businesses expanding here in addition to record number of tourists visiting Mexico each year are evidence of the media simply overreacting and rather seeking sensationalism when reporting on Mexico.

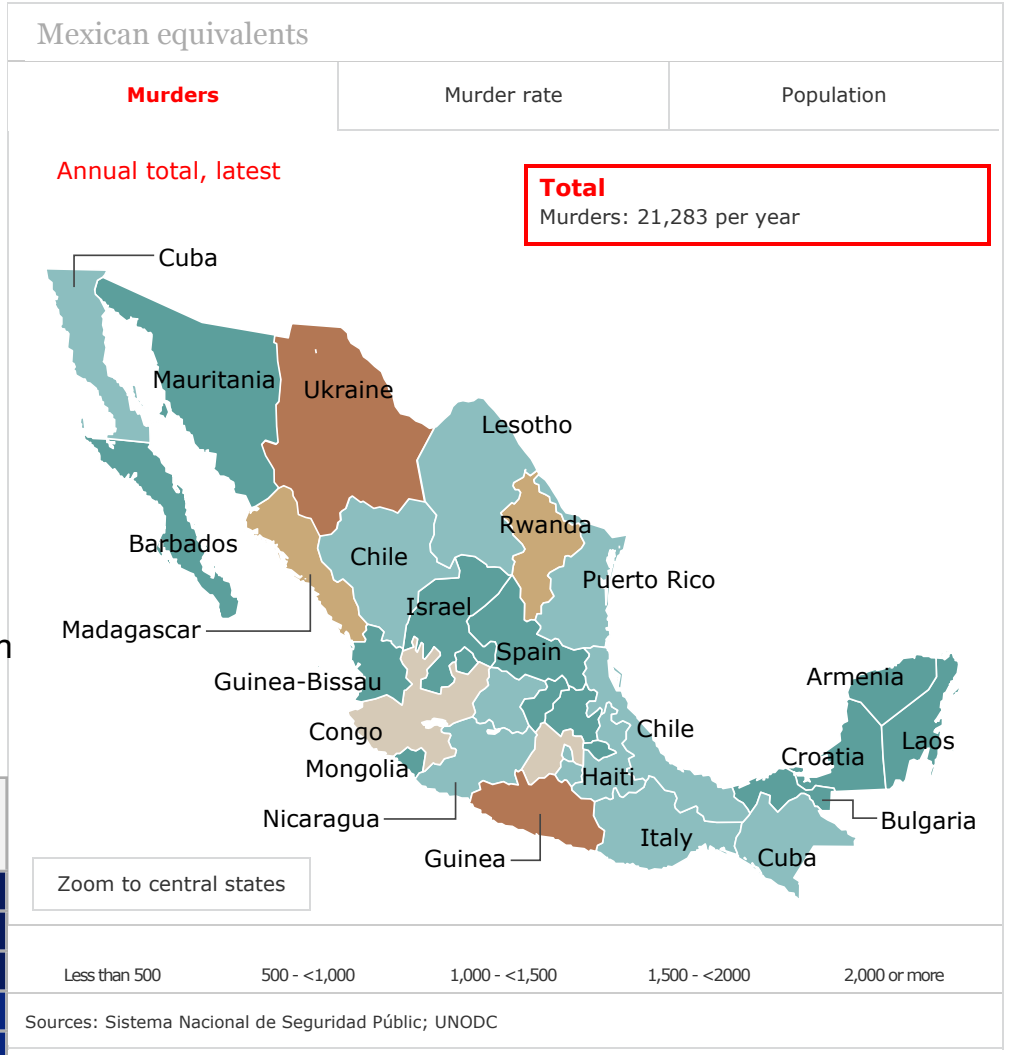
Social/Political Risks

Mexico

- Crime

MEXICO'S murder rate has doubled over the past five years, to nearly 19 per 100,000 people per year. But what does that really mean? To give an idea of how safe or dangerous the country's various states are, we have compared their crime statistics with those of whole countries. Visitors can relax in Yucatán, the safest state, which has about the same murder rate as Finland. Tlaxcala, not far from Mexico City, is about as safe as the United States. At the other end of the spectrum Chihuahua, the most violent state, has a murder rate equivalent to El Salvador, one of the most violent countries in the world.

Nov 22nd 2012, by Economist.com



Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Most recent
South Africa	50	48	48	43	40	40	41	39	37	34	34
Bahamas	21	16	16	16	14	17	19	24	22	25	25
Brazil	30	31	32	33	31	29	31	29	30	23	23
Mexico	14	14	13	10	11	11	11	10	12	15	15
Russia	28	30	31	29	27	25	20	18	17	15	15
Argentina	7.2	8.2	9.2	7.6	5.9	5.5	5.3	5.3	5.8	5.5	5.5
United States	5.5	5.6	5.6	5.7	5.5	5.6	5.7	5.6	5.4	5.0	5.0

Social/Political Risks

- Crime

http://www.numbeo.com/crime/compare_cities.jsp?country1=Mexico&country2=Germany&city1=Ensenada&city2=Heidelberg

Crime Comparison Between Ensenada and Heidelberg

Like 0 Tweet 0 0

Indexes	Ensenada	Heidelberg
Crime Index:	9.38	13.28
Safety Scale:	90.62	86.72

	Ensenada (Improve Data)		Heidelberg (Improve Data)	
Level of crime		0.00		25.00
Crime increasing in the past 3 years		50.00		25.00
Worries home broken and things stolen		25.00		12.50
Worries being mugged or robbed		0.00		12.50
Worries car stolen		25.00		0.00
Worries things from car stolen		25.00		12.50
Worries attacked		0.00		12.50
Worries being insulted		0.00		12.50
Worries being subject to a physical attack because of your skin colour, ethnic origin or religion		0.00		12.50
Problem people using or dealing drugs		0.00		12.50
Problem property crimes such as vandalism and theft		12.50		12.50
Problem violent crimes such as assault and armed robbery		0.00		12.50
Problem corruption and bribery		0.00		12.50
Reportees:		*2*		*2*
Last Update:		*March, 2013*		*November, 2012*

Safety comparisons Ensenada vs Heidelberg

	Ensenada (Improve Data)		Heidelberg (Improve Data)	
Safety walking alone during daylight		100.00		100.00
Safety walking alone during night		87.50		87.50
Reportees:	*2*		*2*	

Social/Political Risks

- Import regulations

The institutions of UNAM involved in CTA have gathered a valuable experience in a process of construction and development of number of international projects. Worth mentioning are the HAWC observatory and RATIR, an optical-infrared camera for an existing 1.5m telescope at SPM. In fact, in the context of RATIR we achieved at UNAM a modification of the existing federal law (with the Sistema de Administracion Tributaria, SSAT) for imports destined to carry out scientific research. We are now making use of this change also for the TAOS-II project (a collaboration with Taiwan at SPM).

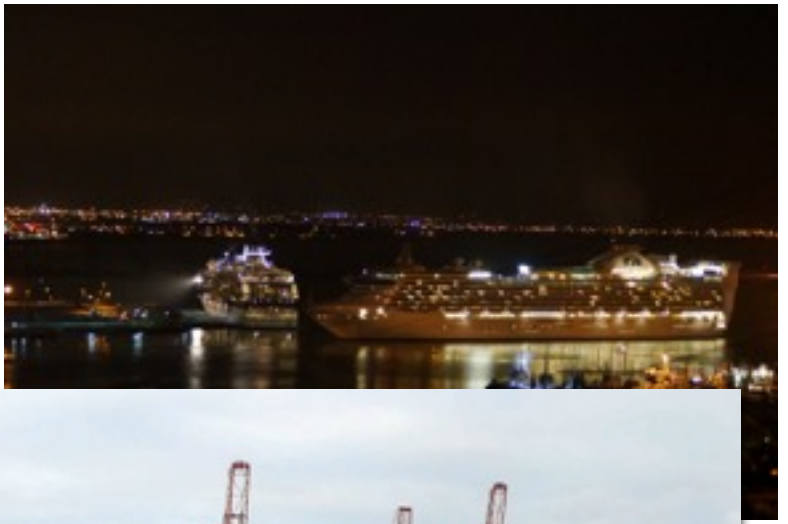
Now, according to the modified law, equipment imported for scientific research can be brought into the country with temporary status for one year, followed by a renewal for a period as long as necessary (10, 15 or 20 years, for example) with appropriate justification.

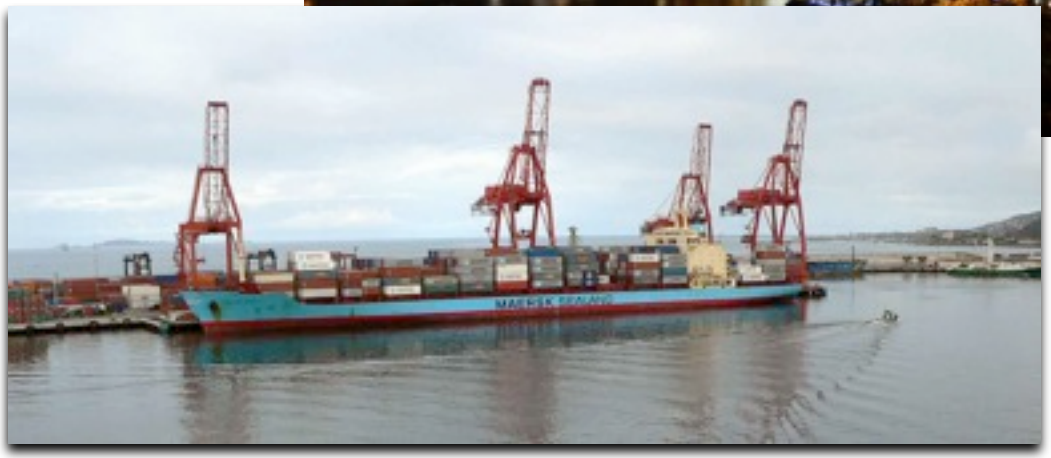
Since the equipment would remain the property of the original owner, no taxes associated to a change of ownership need to be covered, only the fees associated with the temporary import itself. We already processed the renewal of the RATIR camera and detector, and about to begin imports for the TAOS-II project and everything is going very smooth.

Social/Political Risks

- Any other important consideration

The city of Ensenada is also a major commercial and tourist port. It provides opportunity to receive loads of large shipments, and has experience in handling and delivering them. Presence of this port is certainly another important factor in order to keep low cost of construction of the CTA array.





Northern Baja California is an industrialized and prosperous part of the country. It can provide highly skilled work force for very affordable price. Many foreign commercial companies in electronic, automotive, biomedical and recently in aeronautic industry take advantage of this and establish production here. The state is very business-minded and works in sync with the northern neighbor, US state of California.

Infrastructure

- Electricity

An agreement between UNAM and the Mexican Federal Electricity Commission (Comisión Federal de Electricidad, CFE) was signed in October 2012 and financing for the project, of 107 million pesos, has been secured for the project. Preparatory work on the project has immediately started. Thus, we are getting a power and fiber optic line to the SPM regardless of whether CTA selects it as a northern cite or no. The signed agreement quotes the following parameters of the electric line:
Demanded power 1112 kVA 1000 kW
Voltage 33 kV +/- 10%
Frequency 60 Hz +/- 0.8%

The 1 MW power should not be a concern. According to the latest updates in requirements to the sites the demand is 0.7 MW with short spikes up to 2 MW dozen of times a day. The power company has a capacity to provide more than mentioned in the agreement, and is aware that our demand might increase. They have assured us that for such brief jumps in the consumption no additional modifications to the planned line would be necessary. Right now the project is in the preparatory phase, i.e. determining the precise route of the electric line, conducting environment impact study and processing the permit from the proper federal agency (SEMARNAT). We expect to have all necessary permissions by the end of summer 2013. The construction phase is projected to last 12 months.

The electric lines is projected to go underground along the road, so by the end of 2014 it would be available by the CTA site.

Infrastructure

- Data network

A fiber optic line would be laid and put into operation together with the electric line and will provide a high speed link of at least 100 Mbs. It is included in the cost of the electric power line construction and will be available at the same time.

Right now the observatory is connected to the WWW via microwave link followed by an optical fiber. The bandwidth for the entire connection is 2 Mbs, can be increased up to 10 Mbs without additional investment if necessary.

Infrastructure

- Water

Water at the Observatory is provided by a well some 4 km from the support compound (located in the edge of the Vallecitos). The well has been operating reliably for 30 years. A 17,000 l tanker truck is used to take water to two 20 m3 storage tanks in the support compound. These serve the residence and support buildings. Water in the support compound is distributed by gravity. Water in the new dormitory building is treated by inverse osmosis and UV radiation. Water is electrically heated. Current water use is approximately 3.4 million l/yr.

Accessibility

- Distance to airport

  LAX - SPM 565 km
  SAN - SPM 370 km
  ENS - SPM 235 km

- Nearest town to live

Base facilities for the Observatory are located at UNAM's Institute of Astronomy in Ensenada, which is 100 km south of the US California border. Normally it takes about 1.5 hours to drive to Ensenada from San Diego Airport by a highway. The OAN SPM is 250 km away by a paved road from Ensenada (150 km by direct line).
It is a port and touristic town with very developed touristic infrastructure (hotels, restaurants) and quite large scientific population. One of the campuses of University of Baja California is located in Ensenada. It is also a source of educated and inexpensive technical work force.

9/26/12 San Diego International Airport to Unknown road - Google Maps

Google

Directions to Unknown road
231 mi – about **5 hours 30 mins**
Usually people arriving from oversees, would stop in Ensenada overnight. The distance from Ensenada to SPM is 235 km or a four hour trip by car.

- Hospital

The trans-peninsular highway is 100 km away from the site and so is the primitive first aid ambulance. The nearest hospital is in San Quintin - 130 km away. Ensenada, 250 km away has several hospitals and medical establishments as well as specialized clinics. For extremely urgent cases an airlift by helicopter from the Vallecitos or a small plane can be organized from the airstrip at Rancho Meling, 40 min from the observatory. There is a doctor fulfilling her residency program at the OAN SPM

Site Ownership

- Procedure to obtain permission for use

The National Park “Sierra de San Pedro Mártir” was created in 1947 by the Federal Executive Branch, devoted to the preservation of the flora and fauna of the region. In 1951 it was declared a National Forest Reserve.

Since 2009, the Management Program of the National Park “Sierra de San Pedro Mártir”, a Federal and Baja California State Governments document, is in force, which establishes: As a general goal of the Park, the preservation of its respective eco-systems and the sustainable development ensuring the protection and maintenance of the flora and fauna in the long term.

Among its specific targets, it includes: “To guarantee and support a normal performance of long-term astronomical research activities of the UNAM’s National Astronomic Observatory, through the preservation of the environmental conditions”.

To acknowledge the existence of a concession title for the use of underground water on behalf of the UNAM.

A specific polygon, with a surface dimension of 3,048.06 hectares, denominated Preservation Subzone III (Observatory) is “foreseen to preserve eco-systems conditions and foster astronomical research, monitoring of eco-systems and environmental education”, within which the “construction of support facilities for scientific research and monitoring of environment will be permitted”.

Site Ownership

- Procedure to obtain permission for use

The land will remain in the possession of the federal government, as it is within the National Park.

However, in Februrary 2012 UNAM and SEMARNAT/CONANP (National Comission for Natural Protected Areas) signed an agreement stating:

"Under the present agreement CONANP grants UNAM the use and enyojment of the surface within San Pedro Mártir National Park, described in Appendix 1, so that UNAM can carry out scientific and astronomical research".

and

"The parties agree that the term of the present agreement ... shall be indefinite".

Thus, the area within the park is available for use by CTA through UNAM free of charge for the duration of the project.

Site Ownership

- Construction permits needed

Formally, UNAM is responsible for all environmental and construction permits in any astronomy project at OAN-SPM.

Environmental permits and authorizations are given by a federal agency, the “Secretaría del Medio Ambiente y Recursos Naturales” (SEMARNAT). Application for a permit, according to the General Law for Ecological Balance and Environmental Protection and the General Law for Sustainable Forestal Development, requires that UNAM submit a “Environmental Impact Statement” (MIA spanish abbreviation) and a “Technical Study Justification” (ETJ) in order to obtain a permit.

The MIA is fundamentally concerned with species that are under a special protection regime, and aims to prevent, mitigate and repair the damage to the environment and to avoid or reduce adverse impacts on the environment and human health. Authorization may require a process involving a public hearing, subject to the decision of SEMARNAT.
The ETJ lays out a plan and policies to eliminate and mitigate adverse environmental effects, and to reverse them whenever possible.

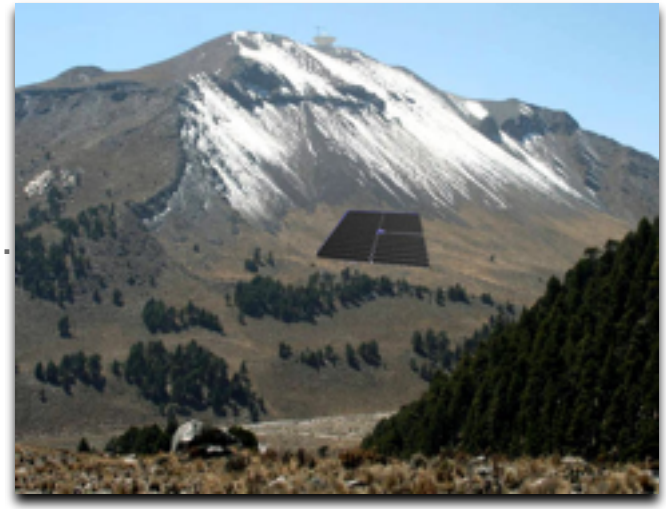
The construction and land use permits must be requested to the Municipality of Ensenada and the Baja California State governments. Among other things, the request must be accompanied by the environmental permit given by SEMARNAT, a geological study of the site and detailed construction plans following local construction standards and regulations. The construction permit depends on the area to be built and the complexity of the project.

Political support of Host Country

- Mexican government has traditionally supportive of astronomical research in the country. Only in the last decade a multimillion Large Millimeter Telescope was funded, Mexican astronomers got a 5 % share of time on Gran Telescopio Canarias through contributions in kind and development of instrumentation. And now the HAWC is being built also with a substantial financial support from Mexico.

- Similarly, the OAN SPM which is located in the state of Baja California enjoys support and attention of the local government

- The CTA-Mex involves the Instituto de Astronomia, Instituto de Física, Instituto de Ciencias Nucleares, Instituto de Geofísica of the UNAM, Coordinación de Investigación Científica-UNAM and the Instituto Nacional de Astrofísica, Optica y Electrónica. These establishments have great weight and are able to generate great administrative support.



- The newly elected President of Mexico has increased the budget dedicated to science by 18% and promised to achieve 1% of GNP destined for science by the end of his term.

Conclusion

“Hard variables”

Science performance

- Average annual observation time
- Instrument sensitivity
- Multiwavelength and multimessenger coverage

Cost (relative to Reference Site)

- Instrument construction costs
- Infrastructure construction costs
- Annual operating costs
- Decommissioning costs

“Soft variables”

Hazards and risks

- Hazards to be considered for personnel
- Risks to be considered for instrument/facility

Other issues

Mexico’s contribution to the CTA is not limited, but largely dependent whether los Vallecitos are selected or no. We already spending around 10 million on infrastructure and are willing to cover costs of construction of auxiliary buildings specified in the SDEV document.