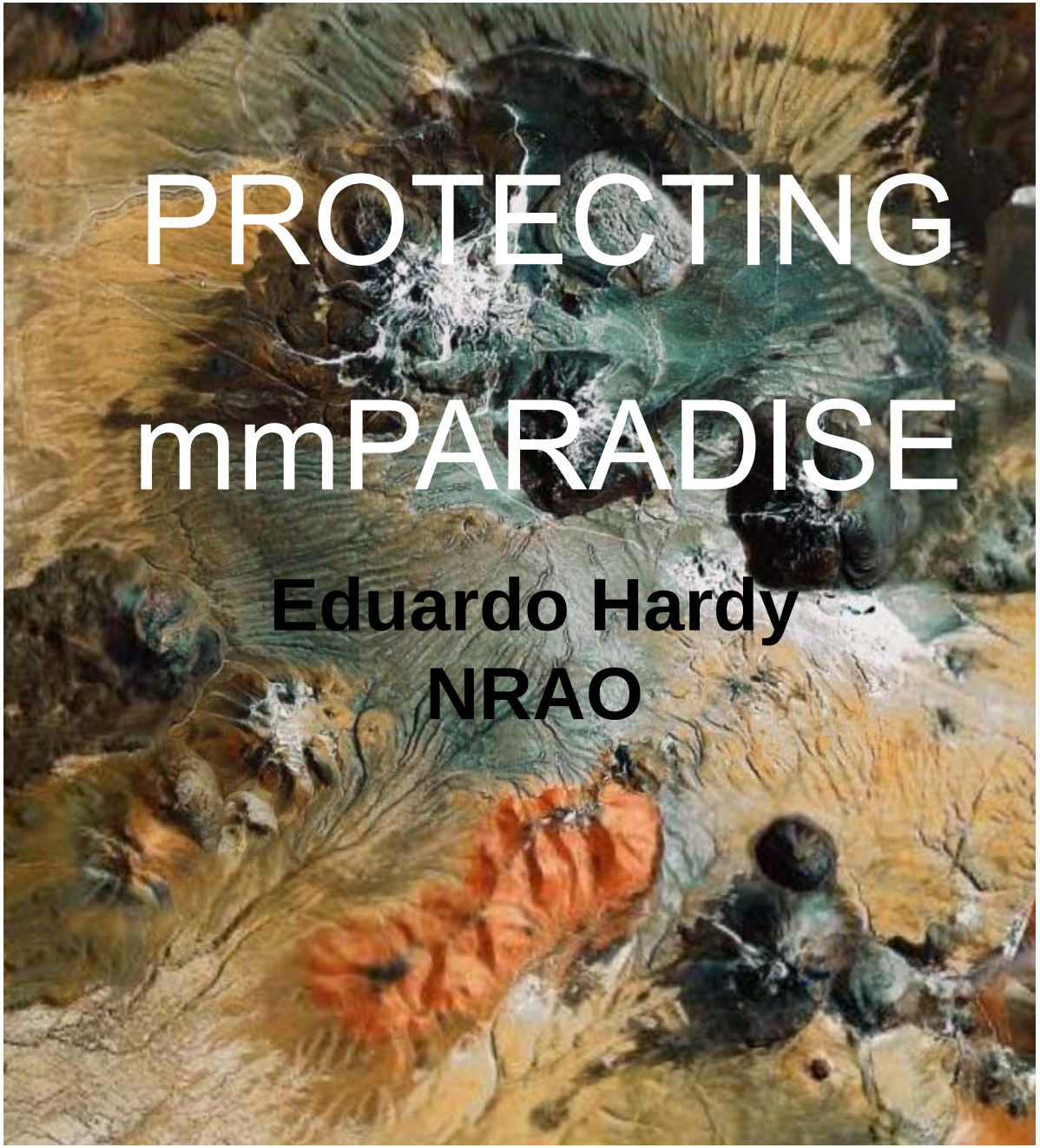


PROTECTING mmPARADISE

Eduardo Hardy
NRAO

CORF-Santiago, 10 August 2009

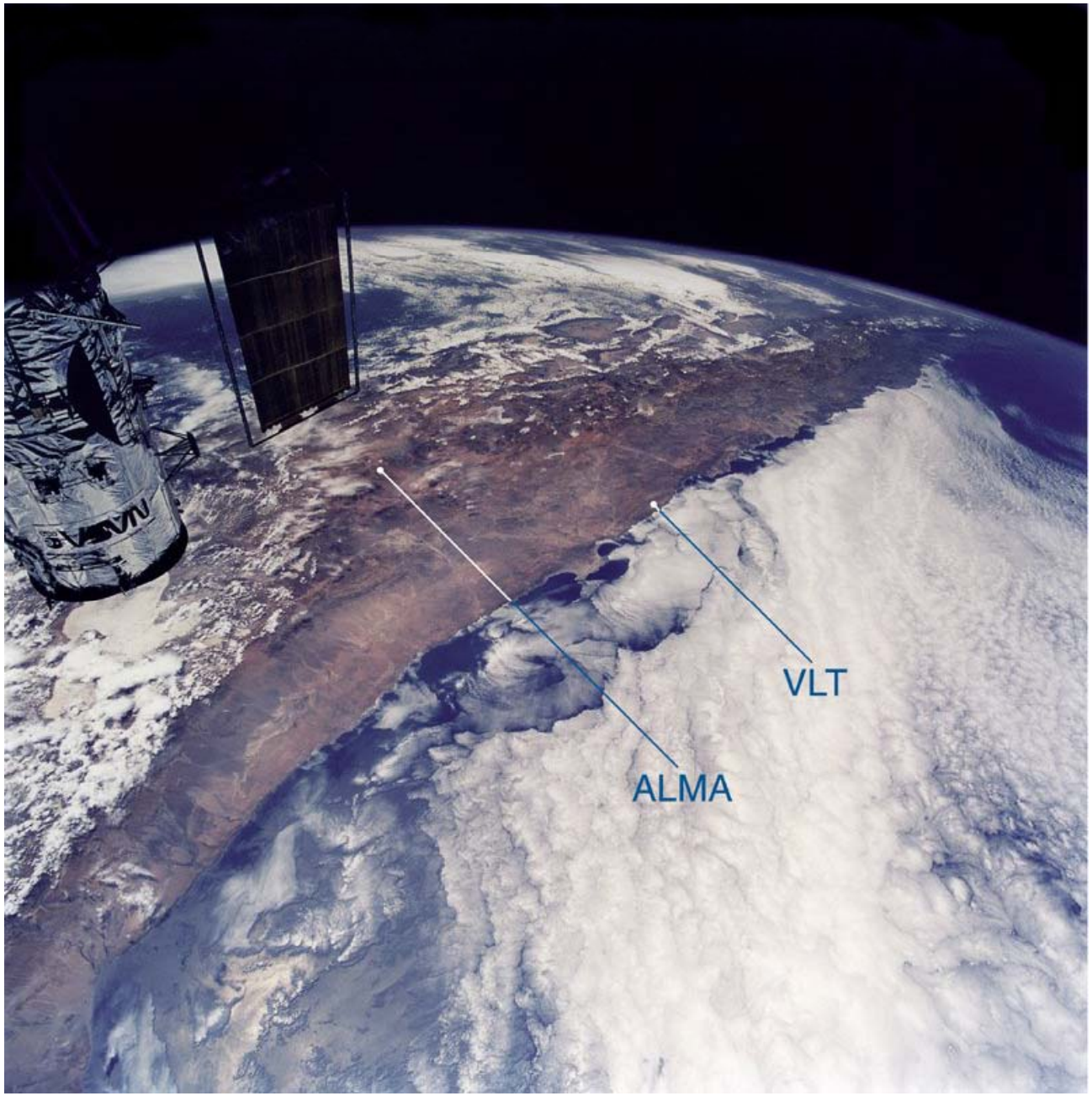
OBJECTIVES

- Clarify the nature and status of RFI protection in the Chajnantor area
  - Our SUBTEL colleagues are here (Mónica…), so is our Chile RFI advisor (Benjamín) and Tom!
- Promote discussion on potential needs for modifications
  - e.g., CORF and Intern. Community: plans to extend frequency coverage? Geographical area?

The site


PERU
BOLIVIA
Arica
South
Pacific
Ocean
Iquique
Atacama Desert
Antofagasta
PARAGUAY
Isla San
Ambrosio
Chañaral
Isla
San Félix
Coquimbo
Valparaíso
SANTIAGO
San Antonio
Rancagua
Archipiélago Juan
Fernández
ARGENTINA
Concepción
Talcahuano
Lebu
Temuco

From space



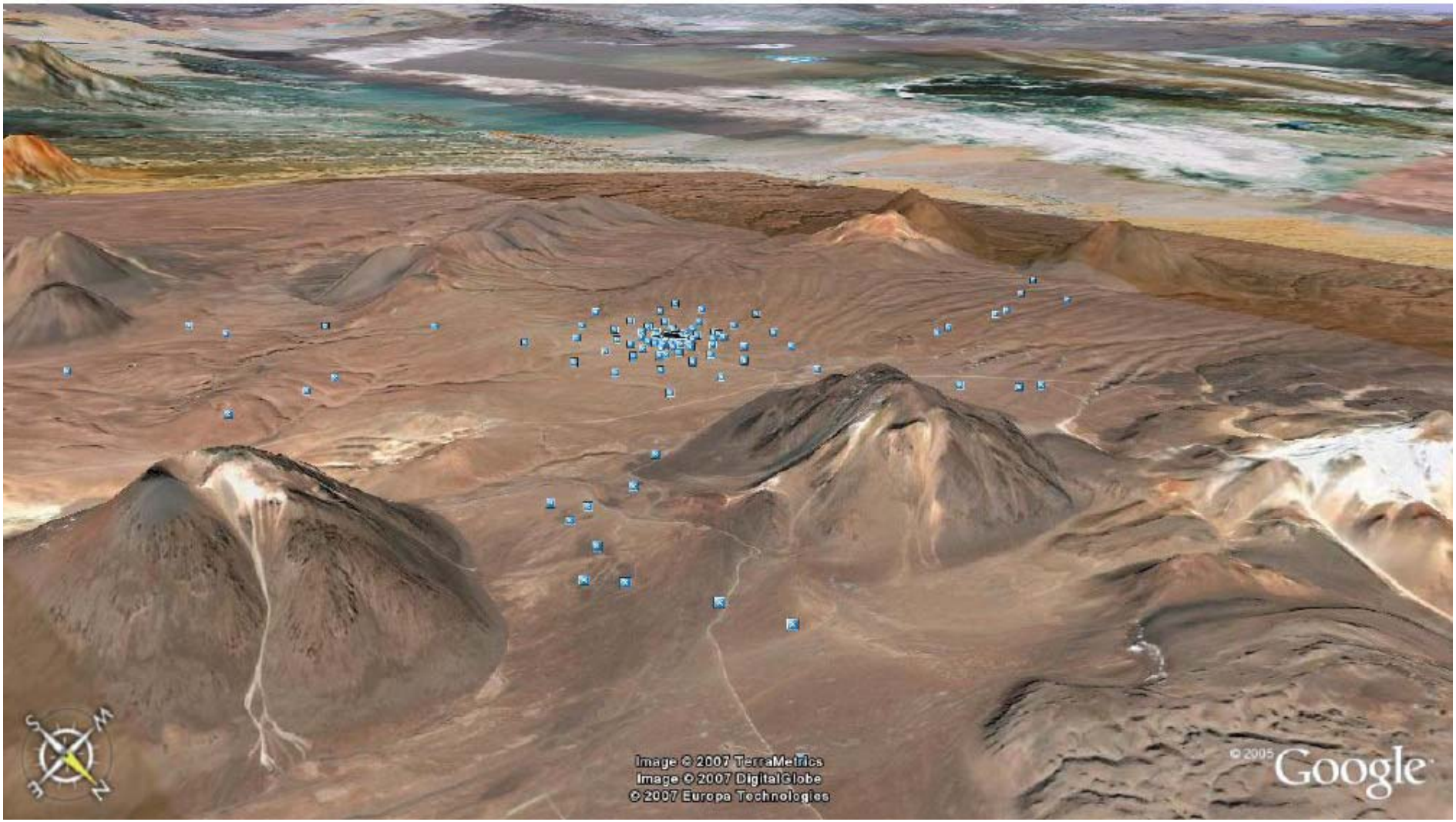


Image © 2007 TerraMetrics
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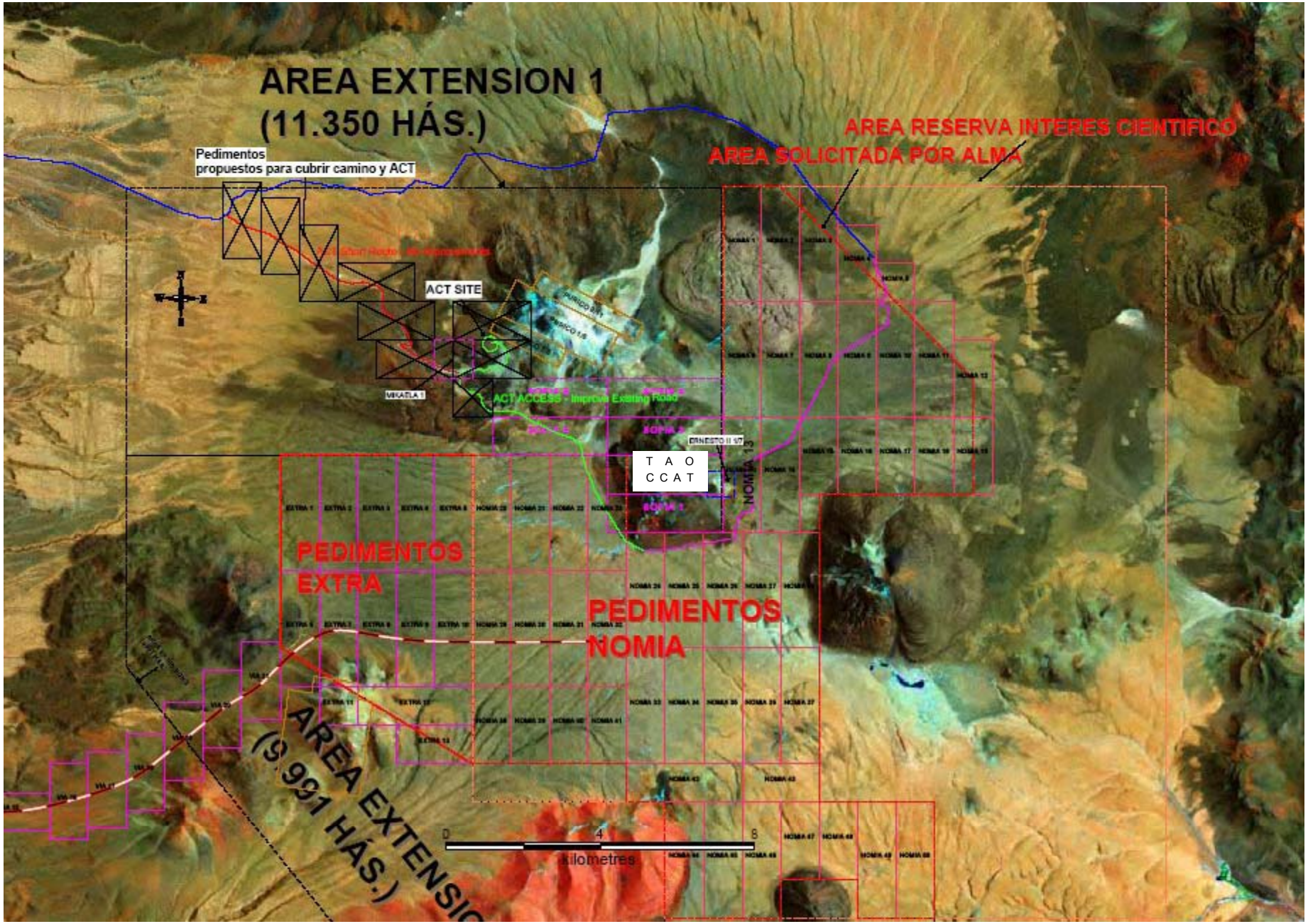
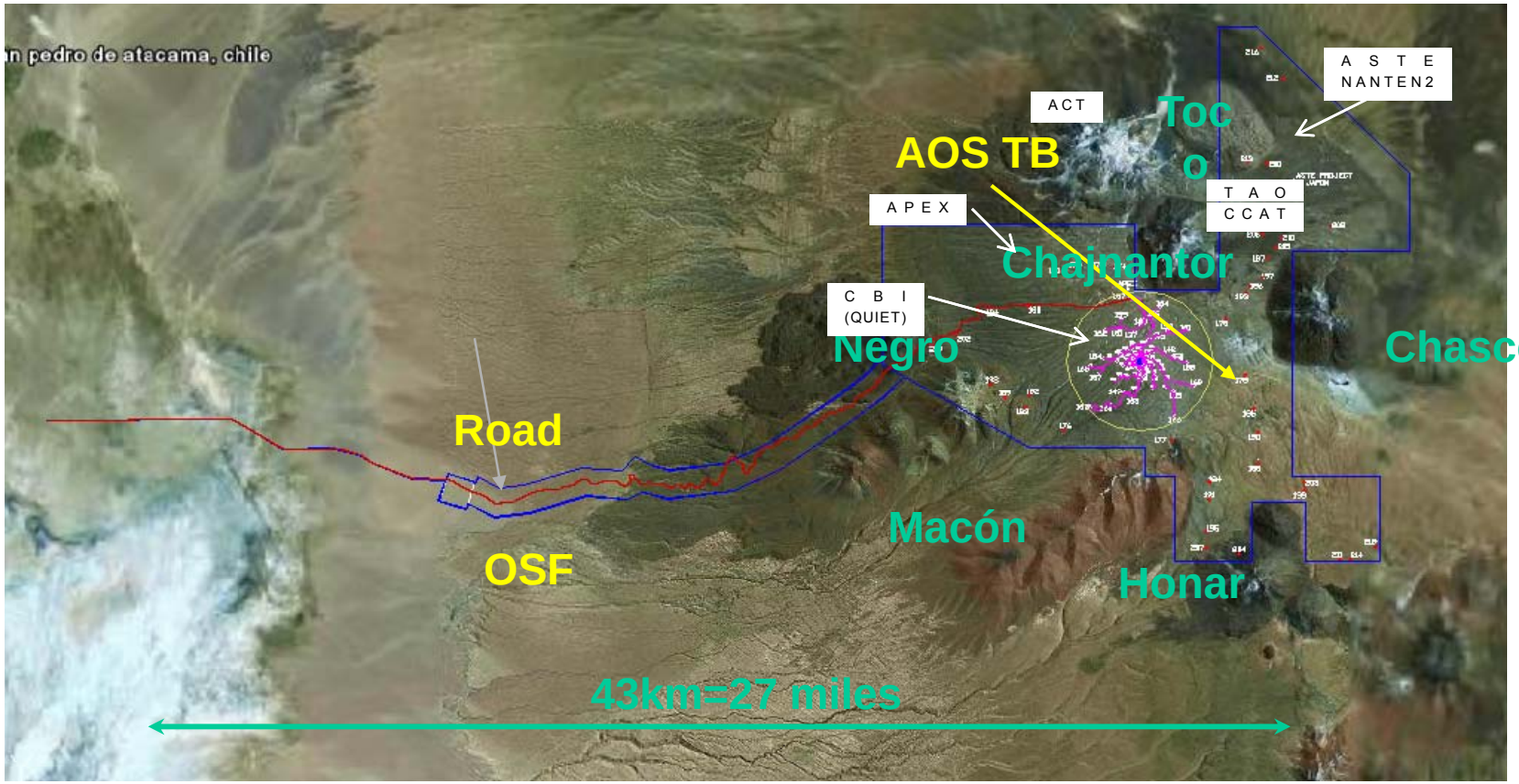

AREA EXTENSION 1
(11.350 HÁS.)
AREA RESERVA INTERES CIENTIFICO
AREA SOLICITADA POR ALMA
Pedimentos
propuestos para cubrir camino y ACT
ACT SITE
ACT ACCESS - Improve Existing Road
T A O
C C A T
PEDIMENTOS
EXTRA
PEDIMENTOS
NOMIA
AREA EXTENSIO
(9.991 HÁS.)
0
4
8
Kilometres

ALMA Science Preserve and Concession & AstroPark



ALMA bandpasses

Bandpasses, ALMA SAC Recommendations March 2000

λ(mm) = 300/ν(GHz)

RECEIVER	$\Delta\nu$ (GHz)	$\Delta\lambda$(mm)	Detector	prior.	Driver (incomplete…)
1	30-40	7.5-10.0	HFET	2	SZ; redshift.-line; continuum of planets,Sun, stars;non-th.gal&extrag.
2	67-90	3.3-4.5	HFET	2	masers (SiO J=2-1)
3	**89-116**	**2.6-3.3**	**WR-8 HFET or SIS**	**1**	**HCO+, HCN, HNC, SO2 H2CO;methanol, stellar water maser @96MHz; CO(1-0)**
→ 4	125-163	1.8-2.4	WR-6 SIS	2	lowest transitons of CO at z~1 …
5	163-211	1.4-1.8	WR-5 SIS	3	monitoring atmosphere
6	**211-275**	**1.1-1.4**	**n-sc SIS**	**1**	**Sc. Most important.Fund. molec. transitions, strong dust em., stellar masers; CO(2-1)**
7	**275-370**	**0.8-1.1**	**n-sc SIS**	**1**	**Formalehyde, H3O+, H2D+; CO(3-2)**
→ 8	385-500	0.6-0.8	WR-2.2 SIS	3	lines from evolved stars
9	**602-720**	**0.4-0.5**	**n-sc SIS**	**1**	**"; Higher exc. Transitions of abundant molecules, Dust emission cold dust, water maser**
→ 10	787-950	0.3-0.4	n-sc SIS	3	cold dust, etc.

CO	GHz	mm
CO(1-0)	115	2.6
CO(2-1)	230	1.3
CO(3-2)	345	0.9

RFI Protection

- SUBTEL(Telecomm. Secretariat) is the State organization that regulates use of the EM Spectrum, passive or active. It has attributions to enforce protection. SUBTEL has created in 2004 its first protected area in Chile, and the second in the world!

REPUBLIC OF CHILE

MINISTRY OF TRANSPORTATION AND TELECOMMUNICATIONS
SUB-SECRETARIAT OF TELECOMMUNICATIONS

MODIFIES PERMIT FOR LIMITED TELECOMMUNICATIONS SERVICE

EXEMPT RESOLUTION N° **1055**

Santiago 17 AUG 2004

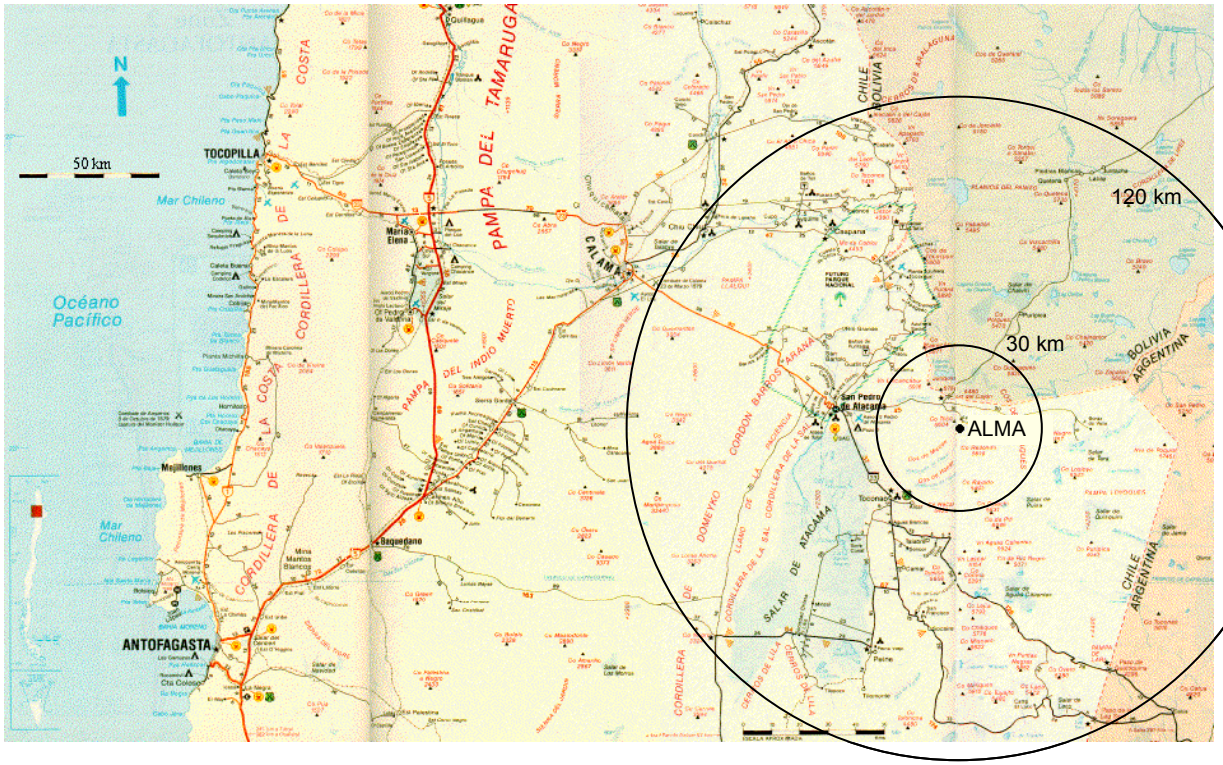
On this date the following has been resolved:

NOTE

SUBTEL has shown flexibility and a willingness to help RA in Chile. Its legal Resolutions can be dynamic in that changes to norms can be considered on a periodic basis.

It would be extremely useful if we could come out of here with some recommendations for future changes in the present Resolution.

Protection & Coordination zones



Chile (via SUBTEL) has created a Quiet Zone (R=30 km) and a Coordination Zone (R=120 km) both for 31GHz ≤ ν ≤ 275 GHz. In addition protection is provided for ALMA IFs. Chilean Gov. decrees issued 2003 and 2004. Registration of ALMA with ITUR in December 2004.

An International Radio QZ?

ALMA Quiet Zone: Elements

SUBTEL's Resolution No. 1055, 17 August 2004 (Second such Zone in the world).

Provides Protection for primary allocated bands, via zones:

a) 30-km radius **Protection Zone**: no transmitters in RA bands used by ALMA.

b) 120-km **Coordination Zone**: transmitters in RA bands only by negotiation/coordination.

- Limits to unwanted emissions based on Recomm. RA.769-1.
- Plus EIRP limits on all transmitters in Coordination Zone operating below 31.3 GHz (power density at site $<2 \times 10^{-6}$ W/m^2)
- No protection from satellites or HAPS (High Altitude Platform Stations), or airplane radio communications with installations authorized outside the Protection Zone and using mobile stations. Status of mobile radars?

Coordination Process

- According to SUBTEL's Resolution, coordination is being understood as the process whereby the opinion of of ALMA will be sought regarding requests by third parties that SUBTEL deems could interfere or affect the operation of the radio telescope.

- Likewise, in case ALMA detects any emissions that affect its operation, it will notify SUBTEL for its coordination.

- The deadlines involved for each coordination process will depend on each case. Example: mobile radars

ARRAY OPERATING SITE (AOS)

- Chajnantor, Atacama, CHILE
- Altitude 5000m
- Longitude: 67° 45’ W
- Latitude: 23° 01’ S

ALMA Registration

- In December 2004, ALMA was registered by SUBTEL in the ITU-R Master International Frequency Register (MIFR) with ID: CHL259
- ALMA's frequency bands are:

Band	Frequency Range (GHz)
1	31,3 – 45
2	67 – 90
3	84 – 116
4	125 – 163
5	163 – 211
6	211 – 275
7	275 – 370
8	385 – 500
9	602 – 720
10	787 – 950

WRC-10 Agenda

- 2.2 “to consider frequency allocations between 275 GHz and 3000 GHz taking into account the result of ITU-R studies in accordance with Resolution 950 [COM7/1](WRC-03)”

resolves

- 2 “That administrations may submit for inclusion in the Master International Frequency Register details on systems which operate between 275 and 3000 GHz”.

- Currently Footnote 5.565 of ITU-R Radio Regulations identifies frequency bands within the range 275-1000 GHz that are used by passive services for spectral line measurements.

ALMA RFI Protection Zone

- Protection Zone centered on 23º 01’ S by 67º 45’ W and with a radius of 30 km within national territory.

- Inside the Protection Zone the installation of any other radio communications system will not be authorized to any third parties operating on the receiving frequency bands of the observatory allocated to radio astronomy on a primary basis.

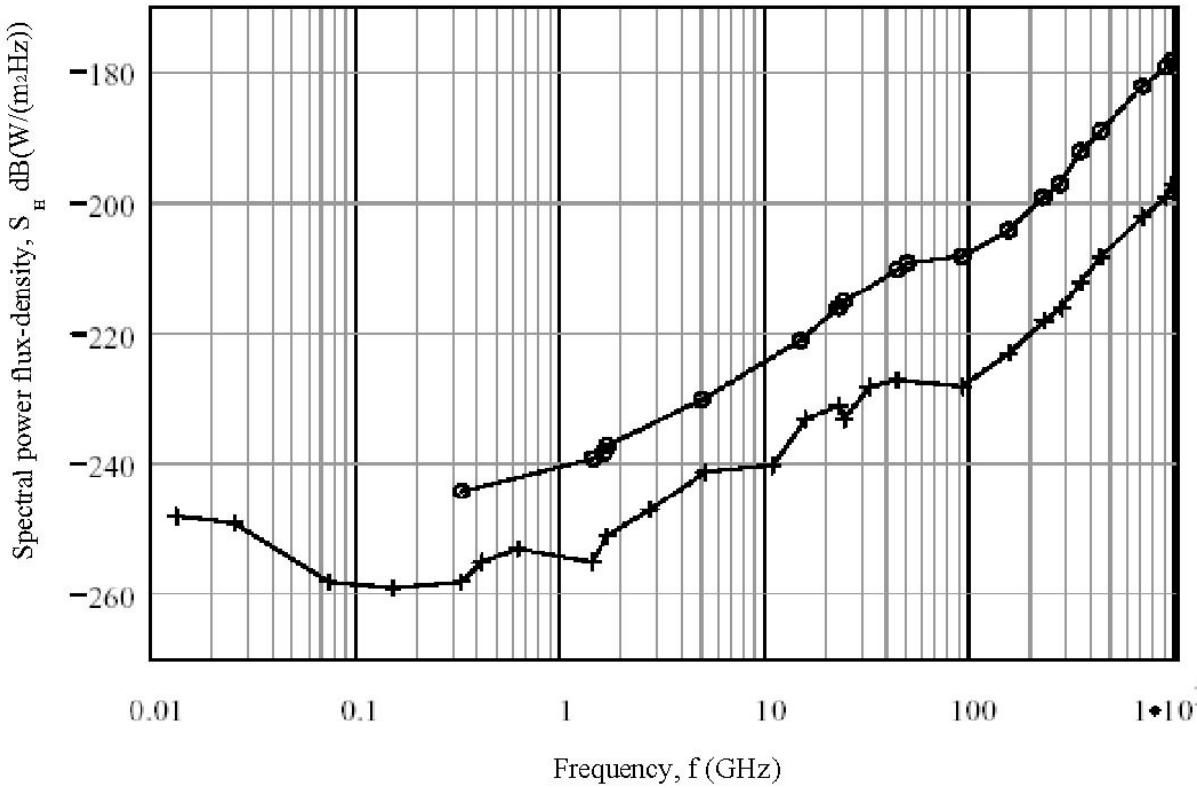
The Areas

- PROTECTION: quiet zone 30 km in radius, protected in addition by Concession itself.
- COORDINATION: (a) 120 km in radius. SUBTEL will reject applications violating its Resolution, and (b) submit for ALMA's consideration all applications deemed marginal or dangerous: Modus Operandi to be established in practice. Monitoring under ALMA, SUBTEL to take action.

ALMA Coordination Zone

- The coordination zone will be centered at 23º 01’ S by 67º 45’ W with a radius of 120 km inside national territory. Within this zone, any emissions by other petitioners or licensees will be limited, bearing in mind the following cases:
  - Any emissions from each equipment authorized to third parties and which transmit on frequencies lower than those of the radio telescope’s reception (<31.3 GHz), will limit their radiated power flow density to 2×10^{-6} W/m^2 within the observatory area.
  - Such equipment shall limit any out-of-band and non-essential emissions within the range of receiving frequencies authorized for the radio telescope, for which the protection criteria established in recommendation ITU-R RA.769 will apply.
  - At frequencies higher than 31.3 GHz, any equipment authorized to third parties shall limit their in-band, out-of-band and non-essential emissions, so as not to produce any harmful interference in the reception frequencies authorized for the radio telescope, for which the protection criteria established in recommendation ITU-R RA.769 will apply.

Detrimental Threshold Levels vs. Frequency (Rec. ITU-R RA.769)



Threshold values of spectral power flux density for continuum (crosses) and spectral line (circles) plotted as a function of frequency (Rec. ITU-R RA.769).

Recommendations of IAU Commission 50

- In Report and Recommendations of IAU Commission 50 (Identification and Protection of Existing and Potential Observatory Sites), first issued by the IAU and the CIE jointly in 1978 (http://www.jb.man.ac.uk/~rjc/1978report.htm), Recommendation 3 states that the flux of radio frequency power from transmitters located close to an optical observatory should be restricted so that the free space flux, calculated from the radiated power of the transmitter and the directional characteristics of its antenna, but not including the local effects of terrain or buildings, will be less than 2 x 10-6 W/m2 at any part of the observatory, its buildings and other apparatus.
- The above power density limit is used in SUBTEL's Exempt Resolution No. 1055 to protect ALMA against interference at frequencies below 31.3 GHz (IF).

RFI Survey at the ALMA Site at Chajnantor

- A Radio Frequency Interference survey covering 10 MHz – 18 GHz was conducted at Chajnantor, Chile, the site of the ALMA project, on 2002 December 6 – 9. The survey provides a “snapshot” view of existing RF activity in the area. The detected signals fell into these categories: noise from nearby electronic equipment, broadcast TV and FM radio, and terrestrial and satellite radio services.
- With the sensitivity of the measuring system at the time of this survey, no interference was detected above 2.5 GHz.
- 70% of the noise detected in this study can be attributed to unintentional radiation from instruments operating near the survey antenna.
- At frequencies <2.5 GHz the interference was well below the 2x10-6 W/m2 power density limit used in SUBTEL’s Exempt Resolution No. 1055.