Site Characterization

(Presented by M. Sarazin)

OWL

Site Characterization: Parameter Space

- **Cloudiness**;
- Humidity, **Precipitable Water Vapour**;
- Atmospheric Extinction;
- **Seeing** or atmospheric coherence length;
- Ground temperature, air temperature gradient and microthermal **turbulence over the first 100 m**;
- **Structure of the atmospheric turbulence**, with a resolution not worse than +- 500 m in altitude up to ca. 20km;
- Isoplanatic angle;
- **Turbulence coherence time**;
- **Outer scale of the atmospheric turbulence**;
- Sodium layer density;
- Wind speed and direction;
- Precipitations (snow, rain, ice, fog);
- Airborne aerosols, including dust chemical composition, particle size distribution and abrasive characteristics;
- Site topology;
- Soil properties, including typical stiffness,
- **Seismicity;**
- Survival loads (earthquakes, wind, precipitations);
- Present and future potential light pollution; contrails;
- Access to pre-existing infrastructures (roads, harbour, etc.); development costs;
- To the foreseeable extent, long-term exposure to climate change;
- To the foreseeable extent, potential long-term political stability.
- Site-dependent operational costs.

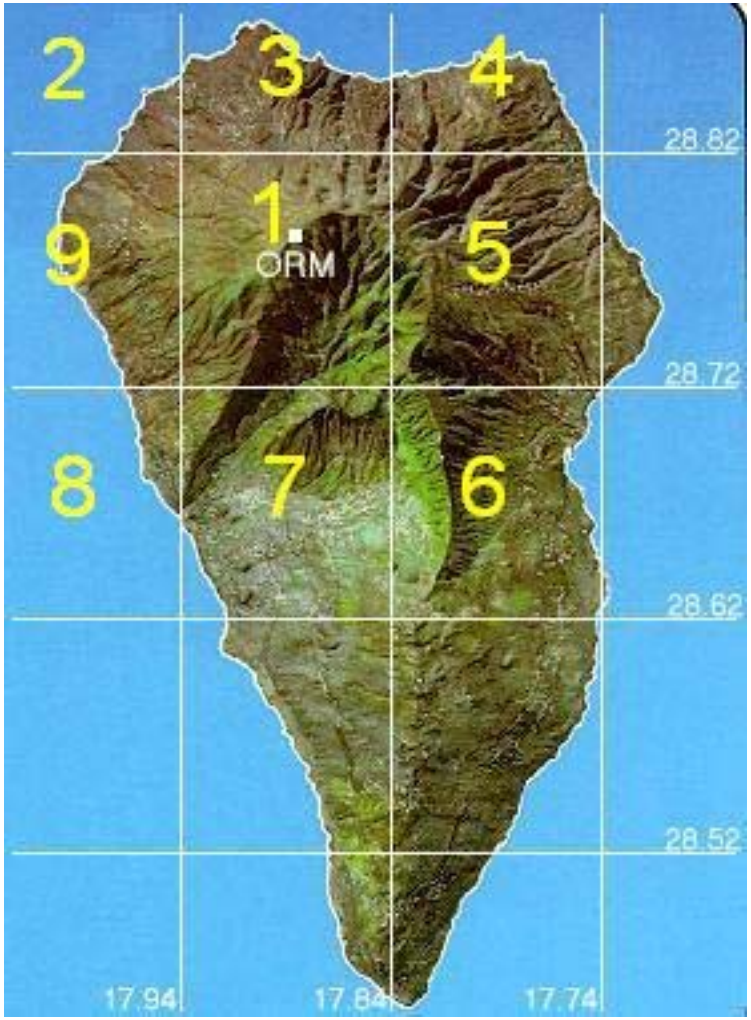
Site Characterization: Strategy

- Test site characterization instrumentation against science data at existing astronomical facilities

- Deploy identical instruments and methods on all candidate sites

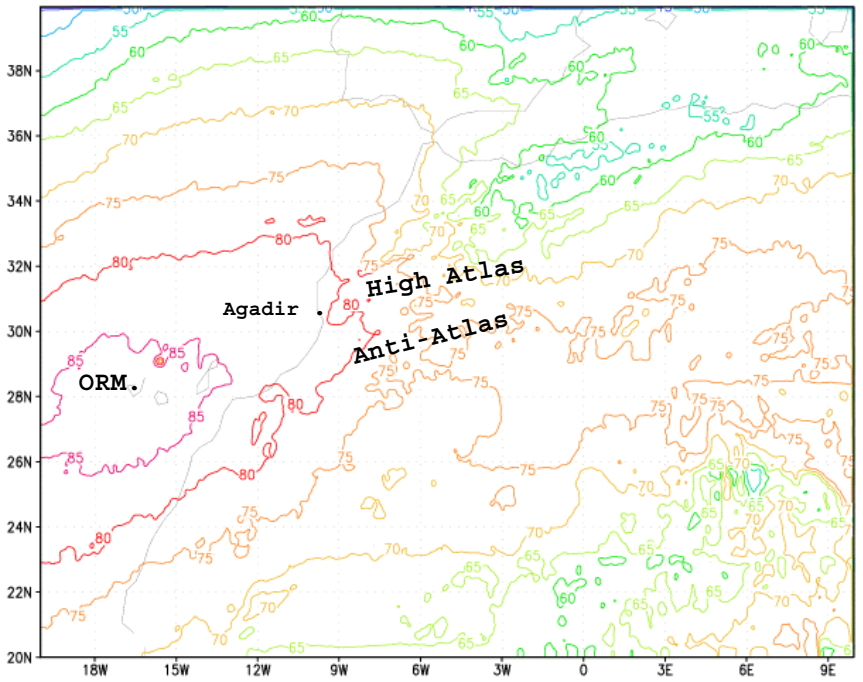
Site Characterization: Cloudiness

- Cloudiness: 7-years of Meteosat 3-hourly images are being analyzed
  - The satellite database is calibrated against ORM CAMC photometric records
  - The satellite resolution allows to distinguish the mountains from the coast
  - Local effects such as humidity rising from the caldera are missed
  - A previous study over US continental sites has shown an unexplained difference between the satellite and 2MASS clear/photometric fraction of about 8%



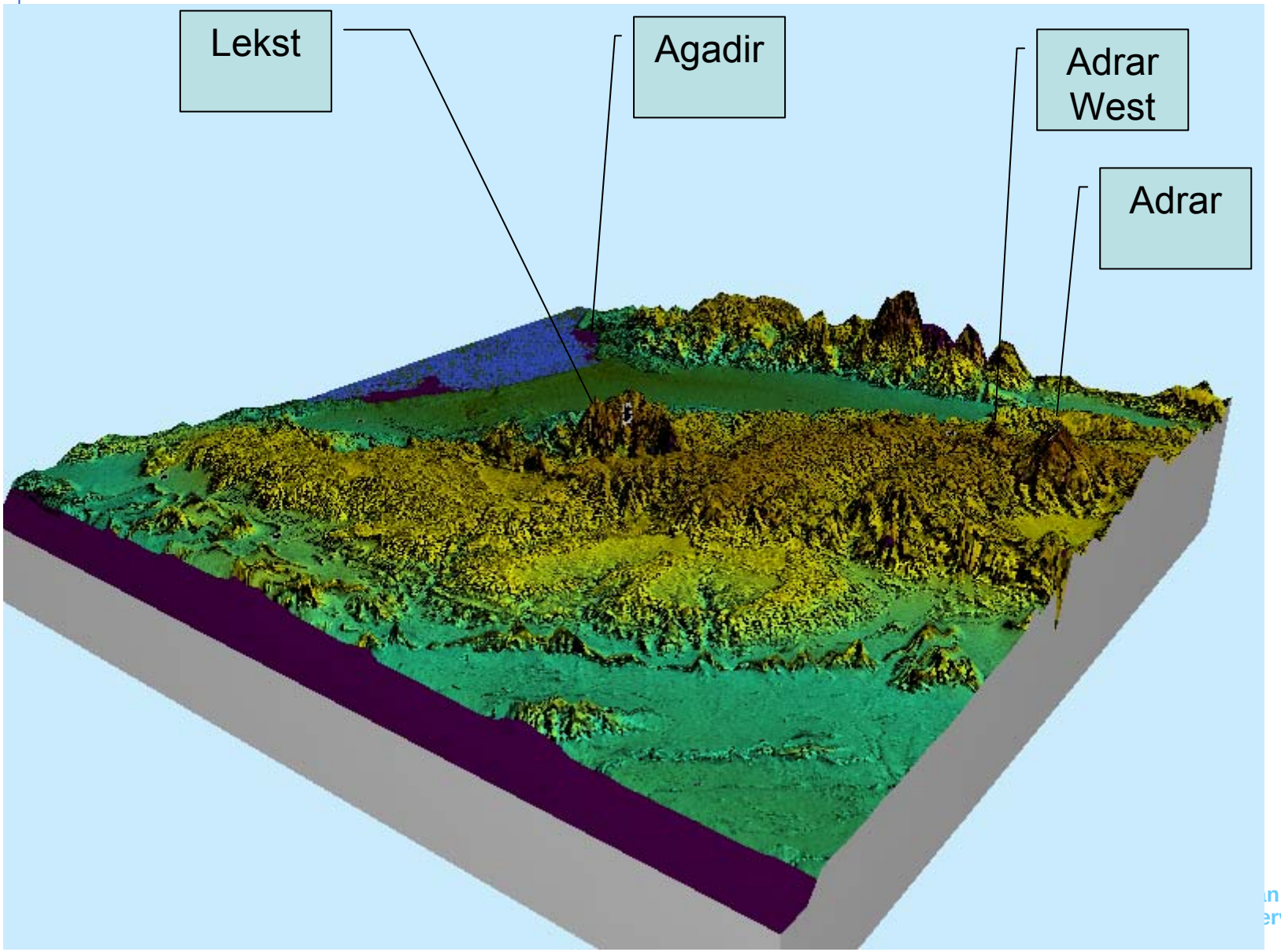
Site Characterization: Cloudiness

- Cloudiness: preliminary results are used for site selection in Morocco
  - Anti-Atlas summits have clearer weather that the high Atlas mountains
  - Morroco sites are expected to have less downtime during winter



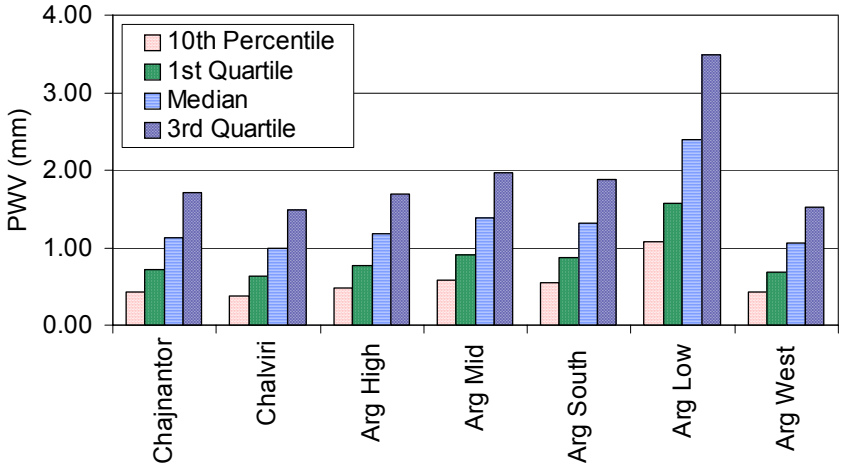
Caption: Fraction of time that skies are clear (%) at night for the years 1999 and 2000 over Canaries, NW Africa and Southern Spain (A. Erasmus, ESO Interim Report, Oct. 2004)

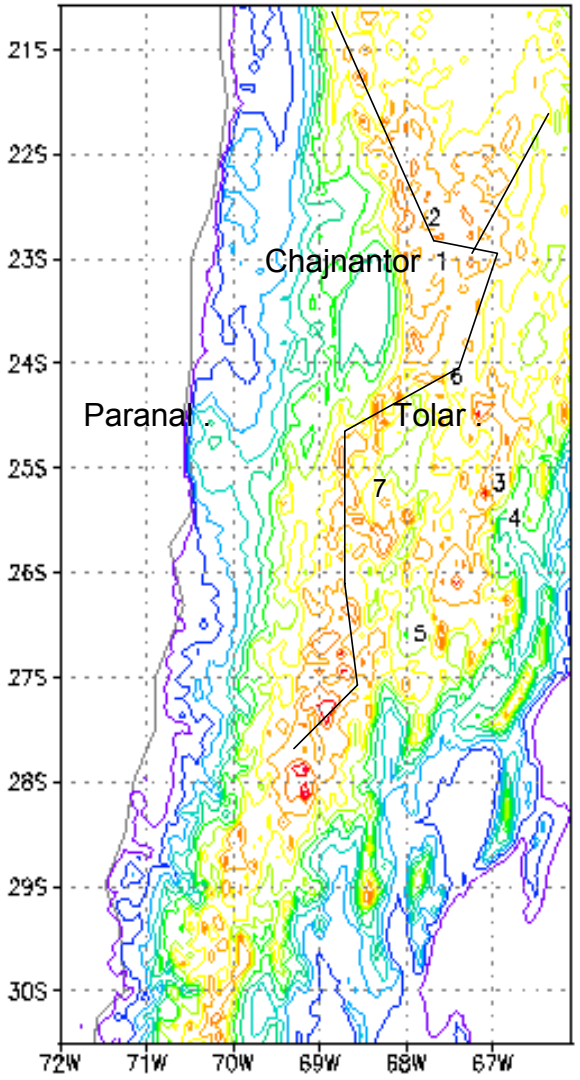
Site Characterization: Anti-Atlas prospection (ELT-DS)



Site Characterization: Precipitable Water Vapor

- PWV: Satellite remote sensing in North-West Argentina
  - A comparison of the results with ground based measurements at Paranal and Chajnantor have shown that the method could be accurate within 10% of the median even in the driest sites.



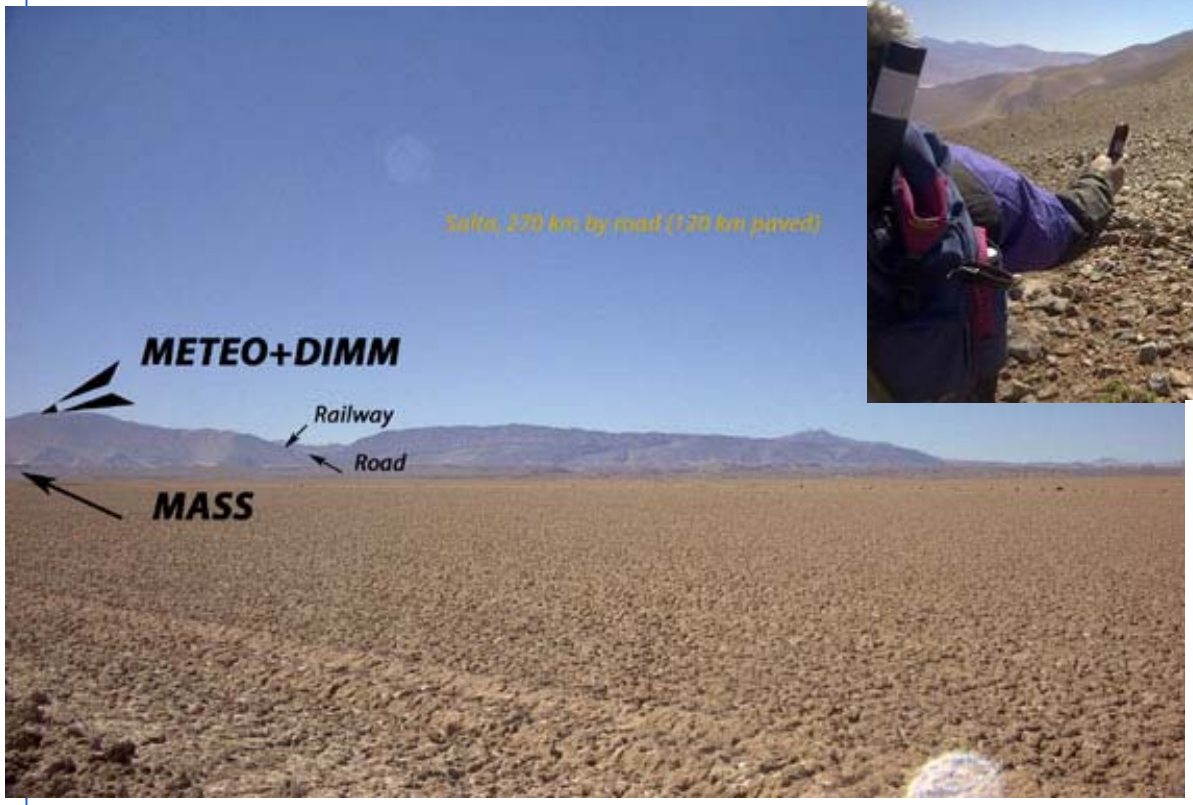


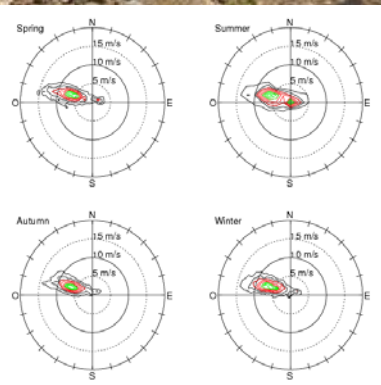
Site Characterization in Argentina

- Managed by IATE team, Cordoba Observatory
- Site: Macon Range

24.5S-67.25W, 4500-5500m

North view from the top





Site Characterization in Argentina

- Seismic risk is a major design parameter
- Selection of the Argentinean candidate site in a zone of lower Seismic Hazard

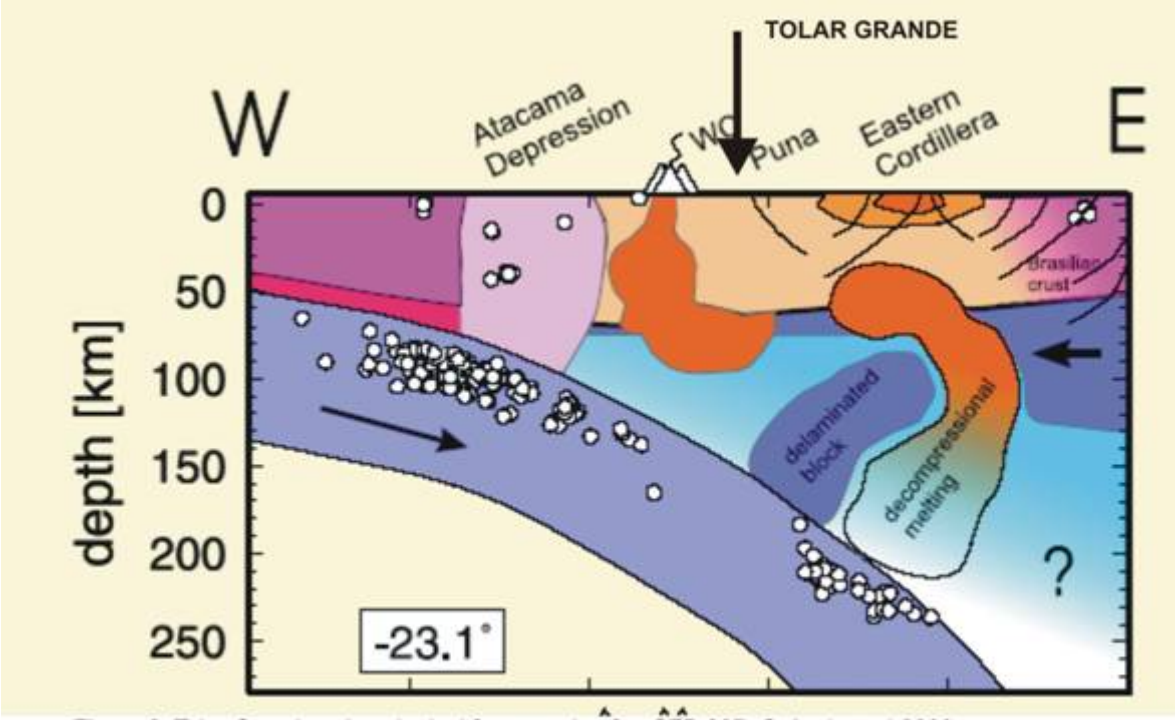


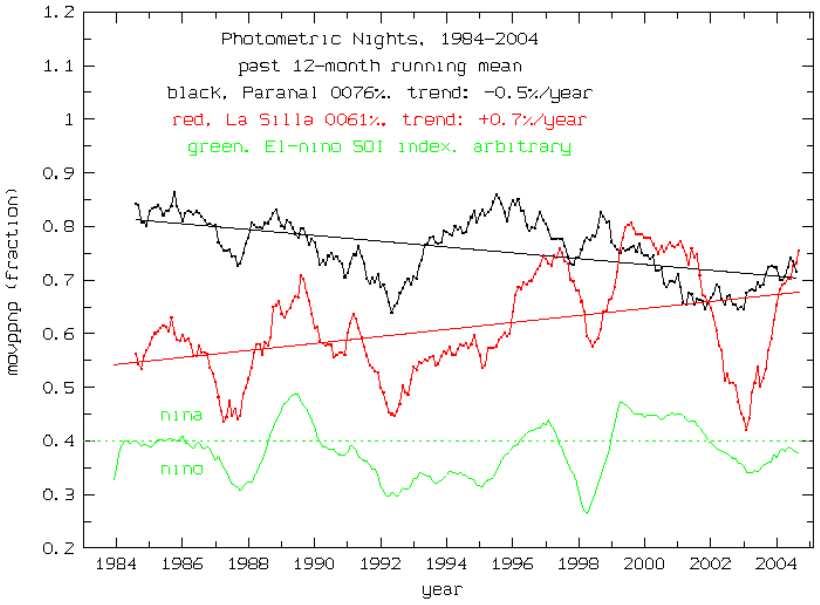
Figure 2. Tolar Grande seismological framework, after SFB 267. G. Asch et al 2003

Site	Acceleration (g)
Mauna Kea	0.40
Paranal	0.34
La Silla	0.30
La Palma	0.06

The site is localized east of the volcanic arc. The latter has partial melted rock underneath it (around 20km deep); this melted area attenuates “S” seismic waves, which are the most destructive ones.
(*J. Viramonte, Grupo Geonorte of the Universidad Nacional de Salta*)
On average, the NWA (Puna) has ground acceleration in the range 1.6 and 2.4m/s2 (USGS data).

Site Characterization: Climate Change

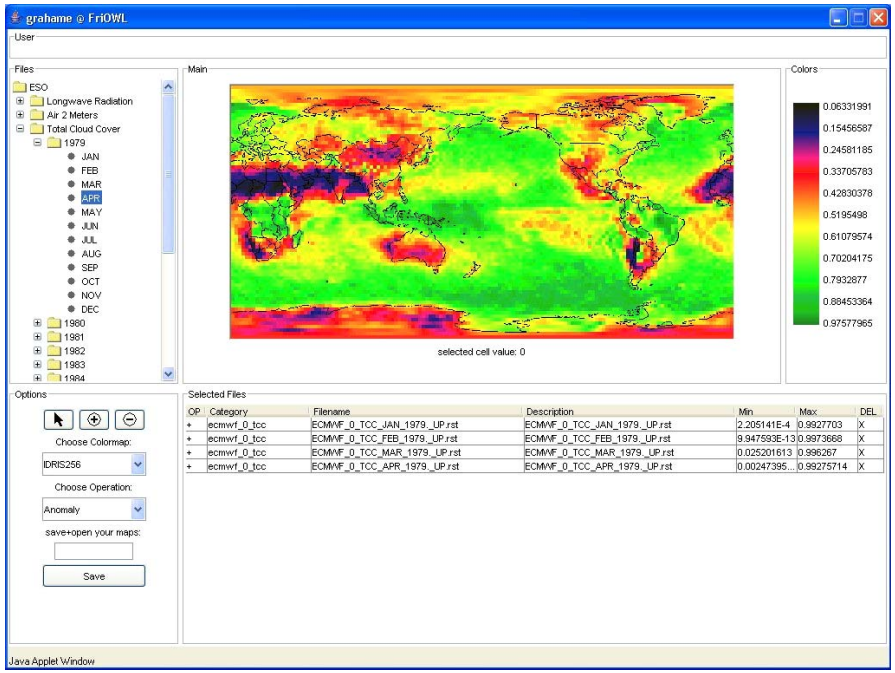
- Climate Change: a concern raised by ESO's experience in Chile
  - Large variations of cloudiness can take place in less than a decade
  - Reversibility of long term trends is not certain



Monthly statistics of photometric nights at Paranal and La Silla and their relation to El-Nino Southern Oscillation Index (source observatory log & VLT site survey)

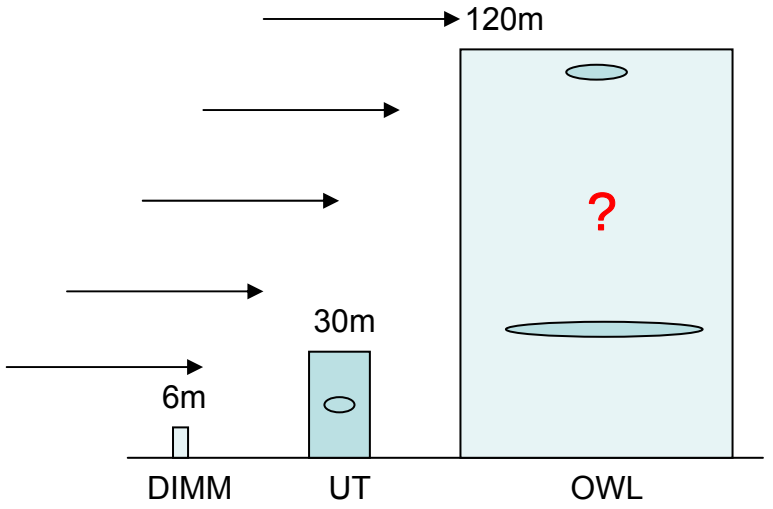
Site Characterization: Climate Change

- A dedicated tool has been developed for tracking climatic trends:
  - Locate the most promising areas worldwide
  - Analyze the variability of the relevant parameters
  - Time span 15 years (45 years possible)
  - Resolution Lat-Lon 2.5 degree, 300km
  - University of Fribourg, Dept of Geography

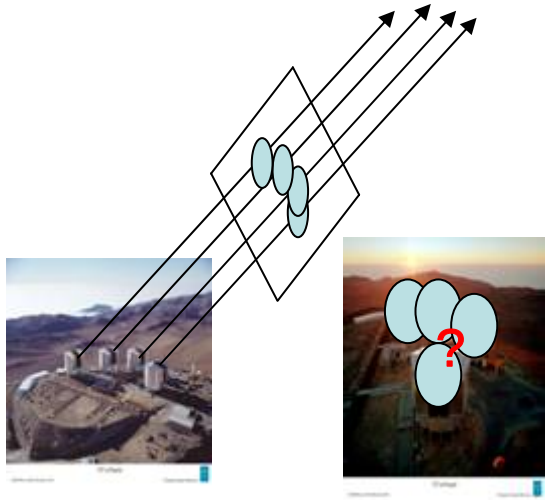


Site Characterization: Seeing Monitoring and ELT image quality

- Seeing conditions are monitored at lower height above ground:
  - Study of the surface layer turbulence properties in the first 100m
  - Modelling (e.g. E-ε turbulence model) of night time wind flow interaction with an open air structure

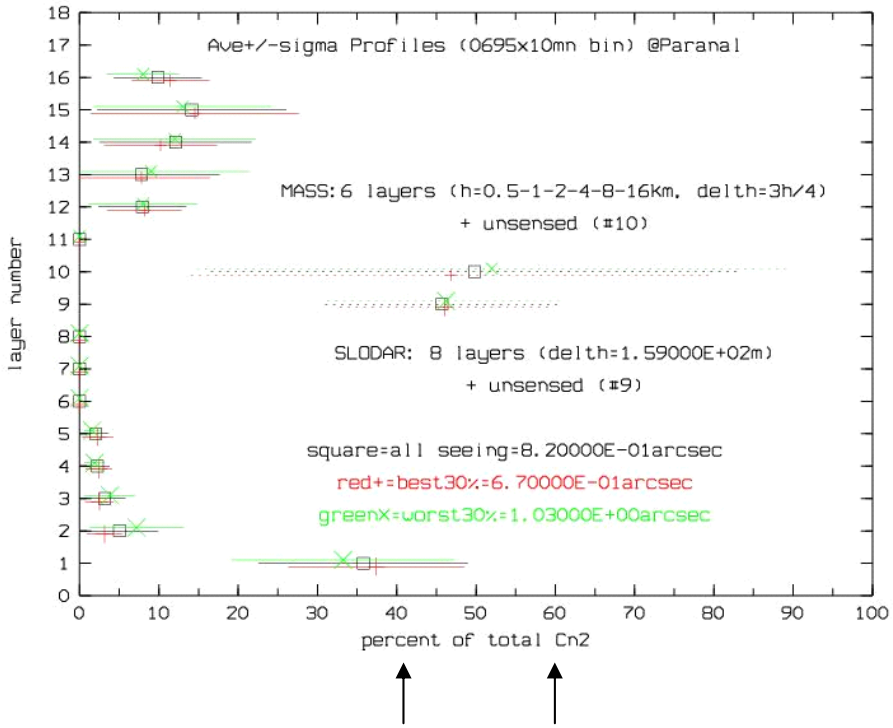


- Seeing conditions are monitored at smaller spatial scales and extrapolated to ELT aperture for various science wavelength:
  - 100m wavefront experiment (ELT-DS, R. Ragazzoni)



Site Characterization: Turbulence Profiling at Paranal

- For adaptive optics simulations: relative distribution along the path
  - Available portable instruments (MASS, SLODAR) are partial profilers

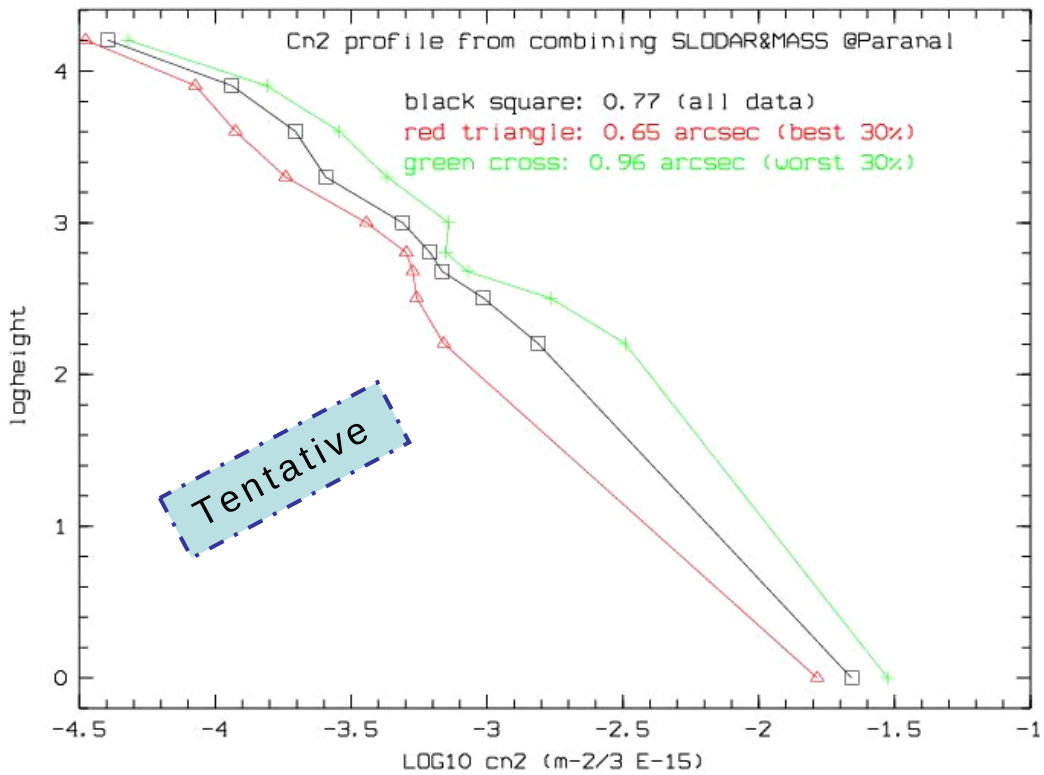


GLAO simulations: 200m 2000m

Foreground: SLODAR (U. of Durham)
Background: DIMM (ESO) and MASS (Moscow Sternberg Institute)

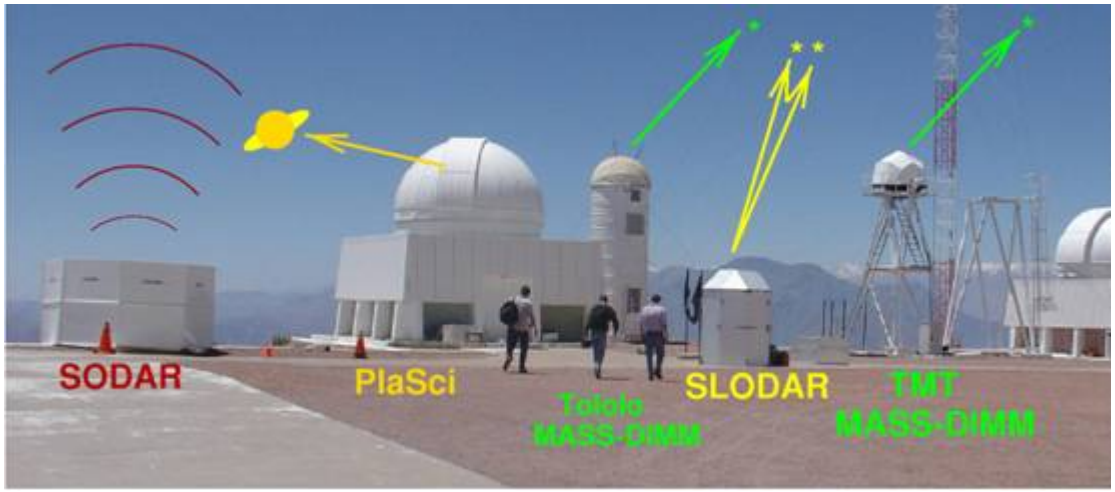
Site Characterization: Turbulence Profiling at Paranal

- Goal: full profile retrieval
  - Overlap area is not well defined in MASS lowest layer
  - Noise analysis is not yet mastered in SLODAR (ongoing)



Site Characterization: Turbulence Profiling

- Inter-calibration of instruments and methods used by ESO and TMT (NOAO-ESO agreement)

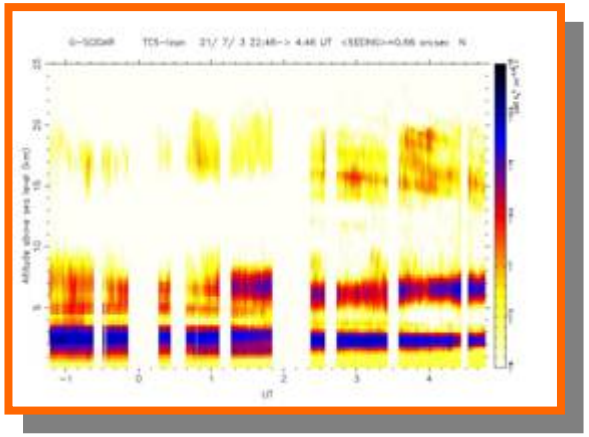


The Tololo SLODAR Campaign
(November 24-December 3, 2004)

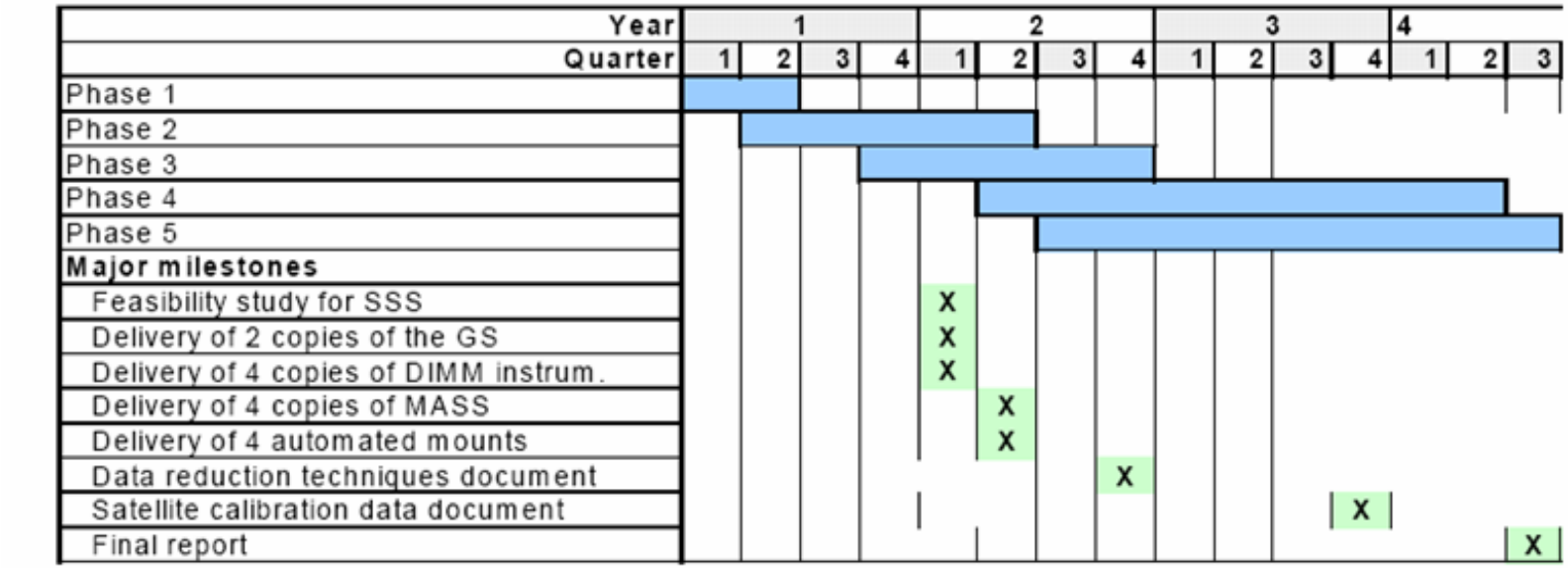
Site Characterization: Turbulence Profiling

- Next to come (ELT_DS):
  - Single Star SCIDAR developed by Nice LUAN (portable)

  - Currently at ORM, to be duplicated for Paranal: IAC Cute-SCIDAR



Site Characterization: ELS-DS Schedule



Year	1				2				3				4		
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3
Phase 1															
Phase 2															
Phase 3															
Phase 4															
Phase 5															
Major milestones															
Feasibility study for SSS					X										
Delivery of 2 copies of the GS					X										
Delivery of 4 copies of DIMM instrum.					X										
Delivery of 4 copies of MASS						X									
Delivery of 4 automated mounts						X									
Data reduction techniques document								X							
Satellite calibration data document												X			
Final report															X

Site Characterization: Conclusion

- **About 15 sites have been, are or will be studied for ELT projects worldwide**
  - ESO: Chile, Uzbekistan, Namibia
  - ELT-DS (ESO, IAC, Nice): Argentina, Canary Islands, Chile, Morocco
  - TMT (Caltech, NOAO): Hawaii, Mexico, Chile (3+)
  - Carnegy: Chile
  - Cornell: Chile
  - China: Tibet
- Duplication/Inter-calibration of instrumentation