A new Space Weather Observatory in Tamanrasset

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Centre de recherches en Astronomie, Astrophysique et Géophysique
CRAAG
Centre de Recherche Astronomie Astrophysique et Géophysique

Created in 1980 fusion of two institutions: the Algiers Observatory (1856) and the IMPGA (1930)

Three main areas of research

Seismology
Geophysics
Astrophysics
Astrophysics CRAAG

- Stellar and High Energy Astrophysics Division
  - Asteroseismology
  - High energy Astrophysics
  - Stellar variability
  - Data Analysis

- Solar Physics Division
  - Solar Activity studies
  - Helioseismology
  - Ionospheric research
  - High angular solar resolution
Algiers Observatory
1846: First observations in Astronomy started in Kouba (Algiers)

1880: Construction of the Observatory in Bouzareah: Highest point in Algiers

It is one of the first Observatory in the African continent

Four instruments:

1. La lunette méridienne de Gautier
2. La Lunette Coudé de Loewy
3. L'astrographe de Gautier
4. Le télescope de Foucault
Research Unit In Tamanrasset

Algeria: 16 in superficies

Algeria =3,7 France

Alger
Tamanrasset=2000Km
Alger Mali =2400Km
Space Weather in Algeria

Thru the ISWI (International Space Weather Initiative) the CRAAG participate to several research programs:

1. **AMBER**: One magnetic station in Medea (100 km south of Algiers)
2. **AWESOME**: One VLF station near Algiers
3. **INTERMAGNET**: One magnetic station in Tamanrasset (1900 Km south of Algiers)
4. **GPS_Africa**: one GPS station International GNSS Service in Tamanrasset

Tamanrasset host also a long range seismic station through the GEOSCOPE program
Scientific Needs

- Complete ignorance of ionospheric conditions in southern Algeria
- Very few data
- Proximity to the equatorial electrojet

**Figure 1.** Scintillation map showing the frequency of disturbances at solar maximum. Scintillation is most intense and most frequent in two bands surrounding the magnetic equator, up to 100 days per year. At poleward latitudes, it is less frequent and it is least frequent at mid-latitude, a few to ten days per year.
New Space Weather station in Tamanrasset

We have decided to install different instruments to follow up the activity of the sun as well as the ionosphere:

- Flare patrol telescope
- 10.7cm Radio Flux monitor.
- Radio spectrometer
- Digital Ionosonde
- TEC and scintillation Monitors
- VLF receiver

These instruments will complete the other instruments already in place. The data will be completed with satellite data.
Flare Patrol Telescope

Three solar telescopes of the CHAIN project

• Similar to the FMT Hida Observatory in Japan (in 1992, Peru in 2009, Saudi Arabia)
• Multiple refractors to observe the full disk sun at different wavelengths around H-alpha absorption line and in different modes
• 1 arcsec resolution with high rate of acquisition.
• Synoptic observations and the three-dimensional velocity field of moving features.
FMT Sample

- $\text{H}_\alpha - 0.8\,\text{Å}$
- $\text{H}_\alpha + 0.8\,\text{Å}$
- Red Continuum
- $\text{H}_\alpha$ Prominence
- $\text{H}_\alpha$ Line Center
# Flare Patrol Telescope

Specifications:

<table>
<thead>
<tr>
<th>Type</th>
<th>Line</th>
<th>Wavelength</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Refractors D 10mm, F:1600mm</td>
<td>Ha</td>
<td>6562.8/0.3 Å</td>
</tr>
<tr>
<td></td>
<td>Ha -0.8 A</td>
<td>6562.0/0.3 Å</td>
</tr>
<tr>
<td></td>
<td>Ha +0.8 A</td>
<td>6563.6/0.3 Å</td>
</tr>
<tr>
<td>1 Refractor + Filter Wheel D 10mm, F:1600mm</td>
<td>Continuum</td>
<td>6100.0/60 Å</td>
</tr>
<tr>
<td></td>
<td>Calcium II K line</td>
<td>3933.0/2.0 Å</td>
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<tr>
<td></td>
<td>Helium D3</td>
<td>5875.6 /0.4 Å</td>
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<td></td>
<td>H Alpha</td>
<td>6562.8/0.8 Å</td>
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<tr>
<td>1 Refractor 2xfocals</td>
<td>H alpha</td>
<td>6562.8/0.3 Å</td>
</tr>
<tr>
<td>Tracking telescope</td>
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</table>
CDD Cameras

Resolution 4 MPix 12bit
A frame rate of 7 frames/sec:
• Frame selection
• Record a flare event
Others instruments

1. **10.7cm Radio Flux monitor.**
   Measure 10.7cm radio flux (synoptic)

2. **Radio spectrometer:** diagnostics of solar activity, such as solar flares and CMEs, instrument type CALISTO

3. **Digital Ionosonde:** with 4 receivers: capability to measure ionospheric Doppler drift.

4. **TEC and scintillation Monitors**
   measure of the TEC and the scintillation of the GPS signal with network of GPS

5. **VLF receiver:** measurement of the D layer of the Ionosphere.
The solar radio flux at 10.7 cm (2800 MHz) is an excellent indicator of solar activity. The F10.7 correlates well with the sunspot number as well as a number of UltraViolet (UV) and visible solar irradiance records. The F10.7 has been measured consistently since 1947, first at Ottawa, and then at the Penticton Radio Observatory in British Columbia. Reported in “solar flux units”, (s.f.u.), the F10.7 can vary from below 50 s.f.u., to above 300 s.f.u., over the course of a solar cycle.
**IONOSPHERIC SCINTILLATION**

Ionospheric scintillation is the rapid modification of radio waves caused by small scale structures in the ionosphere. Severe scintillation conditions can prevent a GPS receiver from locking on to the signal and can make it impossible to calculate a position. Less severe scintillation conditions can reduce the accuracy and the confidence of positioning results.
From Amory-Mazaudier
June 2016

GPS stations available on the web-2015

Increase of GNSS stations in Africa
~50 to ~150
2010 to 2015
Mainly due to GEODESY

Many other GPS networks
Algeria (~60), Burkina Faso (~10), Egypt (~10), Morocco (~25)
Rwanda (~10), South Africa (~60)
DRC (~15) > 200
=> Work of AGS

Necessity TO SHARE
Permanent GPS Network: REGAT CRAAG
Scintillation index estimated from high frequency GPS phase fluctuations (30 s samples)
Day: 17/03/2016
Global TEC from GPS
Altitude
City of Tamanrasset - CRAAG
Tamanrasset climate

Record high °C
Average high °C
Daily mean °C
Average low °C
Record low °C

Source NOAA (1961-1990)
Tamanrasset climate

Source NOAA (1961-1990)
New site Assekrem 2.728 m
80 km from Tam
Assekrem
Thank you