ANTarctic Auroral and Radiation-belt Experiment Suite (ANTARES)

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Science Objectives

1. Pulsating Aurora and Substorm Injections

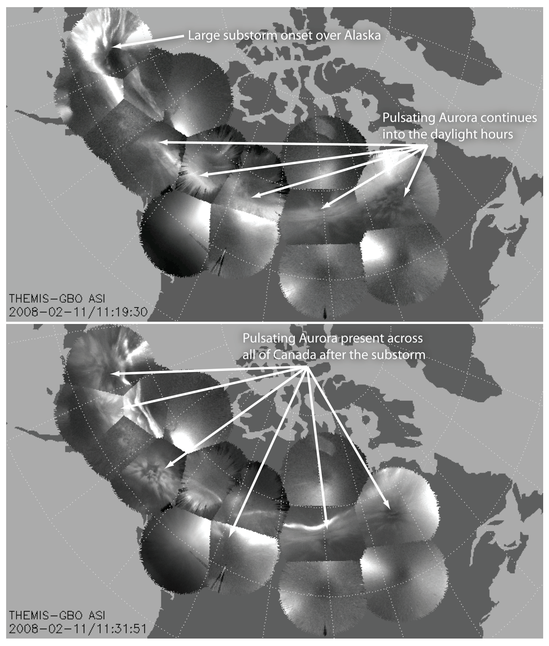


Figure 1. Pulsating aurora over all of North America during and after a substorm, 11 February 2008. Two snapshots from a 12-hour movie (http://mirl.sr.unh.edu/pulsating.html)

- Pulsating aurora seen in postmidnight sector following substorms
- Linked to energetic electron precipitation (20–80 keV)
- Associated with substorm recovery
- Proposed link to substorm injections
- Continues for many hours after substorm (even through next substorm)
- Can extend to MLT noon and beyond

See Figure 1 for an example

ANTARES would:

- Allow imaging of pulsating aurora at all local times
- Measure VLF chorus which precipitates energetic electrons
- Measure riometer absorptions
- Work with GOES-13 to show electron precipitation

2. Pi1B Pulsations and Wave Aurora at Substorm Onset

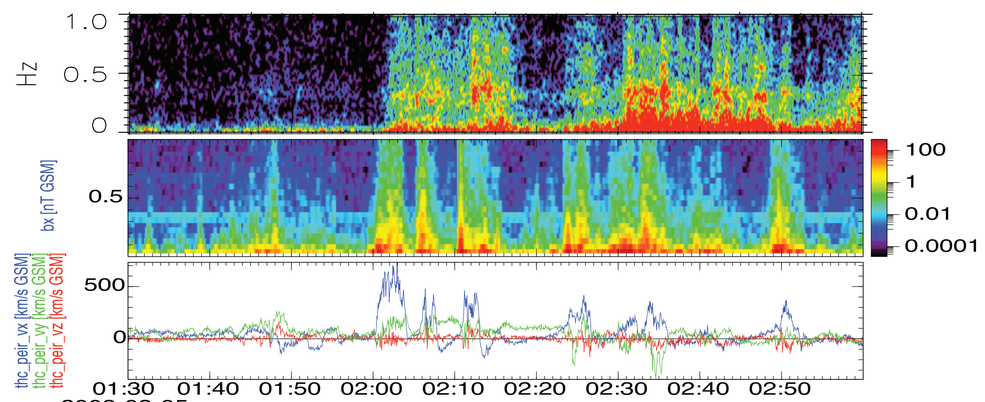


Figure 2. Pi1B pulsations observed at South Pole, with magnetic spectrogram and ion flow velocites from THEMIS-C, 5 March 2008

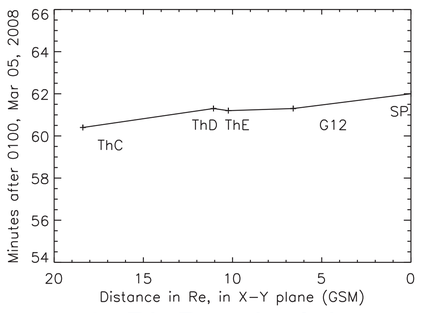


Figure 3. Pi1B arrival times at THEMIS, GOES, and South Pole

- Pi1B associated with substorm onset
- Visible on ground and in near-mid tail
- Associated with Alfvénic aurora

See Figures 2 and 3 for an example

ANTARES would:

- Estimate electron energy from 6300/4278 emission ratio
- Work with GOES-13 and THEMIS on timing fast flows and wave observations

3.Wave-Particle Interactions in Earth's Radiation Belts

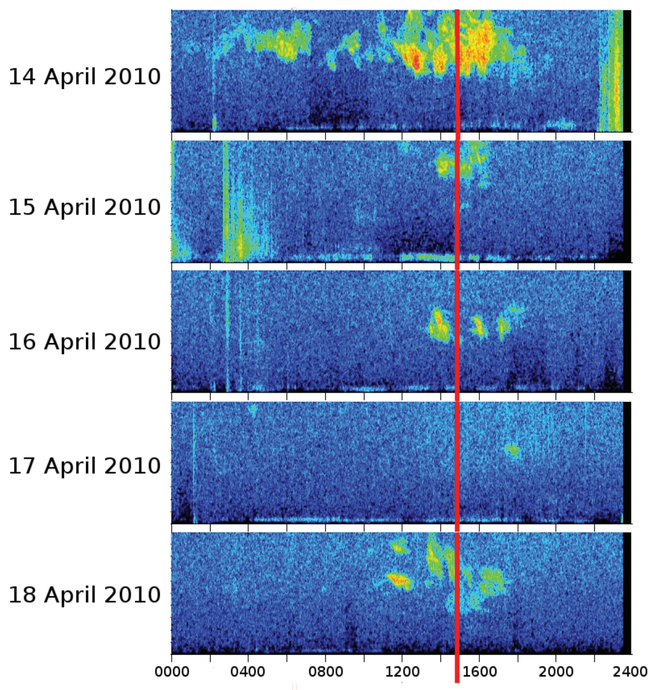


Figure 4. EMIC event at Halley Bay, persisting over several hours on the first day and several days near MLT noon.

Many different wave modes accelerate and precipitate energetic particles in the radiation belts:

- VLF chorus
- EMIC (see Figure 4)
- Global ULF (Pc5) modes

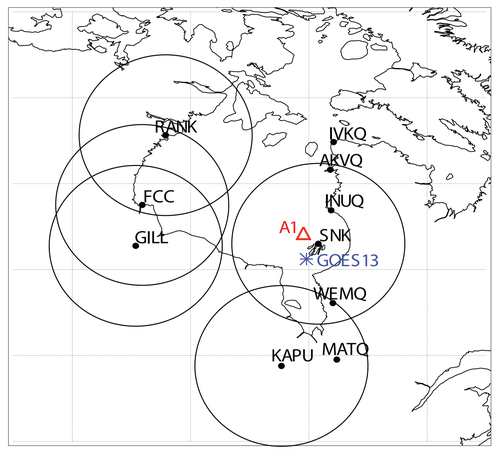
ANTARES would:

- Measure ULF, ELF, VLF waves
- Infer precipitation from all-sky camera images and riometer measurements
- Work with GOES-13 on particle measurements and Pc5 modes
- Work with existing stations (e.g.,Halley Bay, South Pole) on EMIC and VLF propagation
- Work with BARREL and RBSP with correlative measurements

Location and Instrumentation

Site: West Antarctic Ice Sheet (WAIS) Divide

79.28°S 112.12°W geographic; -67.0° ILAT; L=6.46



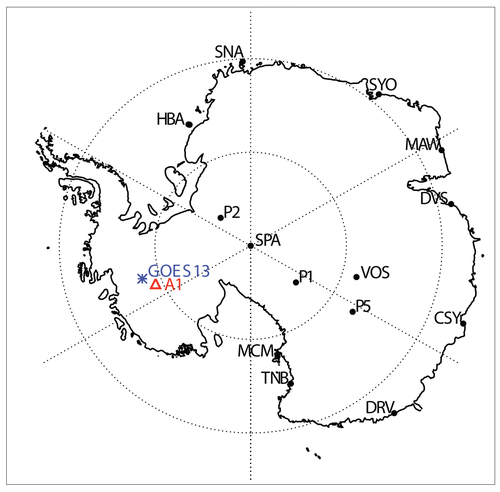


Figure 5. Existing ground stations, GOES-13 footpoints, and proposed ANTARES observatory/conjugate point in Canada and Antarctica

- Existing NSF ice coring operation
- Near southern footpoint of GOES-13
- Nearly conjugate to Sanikiluaq (near GOES-13 northern footpoint; see Figure 5)
- Dark at all local times during winter (not true of any existing station at this ILAT)
- Can support balloon missions such as BARREL (see Figure 6)
- Can support science objectives listed at left
- Can support triple conjunction studies (GOES-13 and both footpoints)

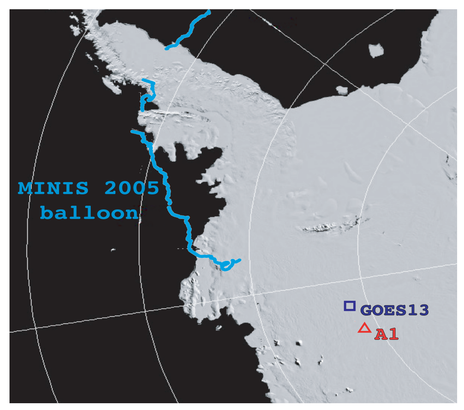


Figure 6. Proposed observatory site, GOES-13 footpoint, and trajectory of MINIS 2005 balloon

Instrumentation

Instrument	Description	Institution
Fluxgate Magnetometer	DC magnetic field, sampled at 1 Hz	NJIT
Induction Coil Magnetometer	ULF waves, sampled at 10 Hz	UNH
ELF/VLF Receiver	Amp. in 4 bands (0.5–8 kHz), Wideband at 20 kHz	Stanford
Riometer	Broad beam riometer, 60° FOV	UNH
Allsky Auroral Imager	557.7, 630.0, and 427.8 nm, sampled at 6 s	UNH
Proton Aurora Sky Imager	Multi-anode (8×8) PMT, 486.1 nm, 150° FOV, 1–10 s	NJIT

Table 1. Instrumentation to be provided with initial installation of ANTARES

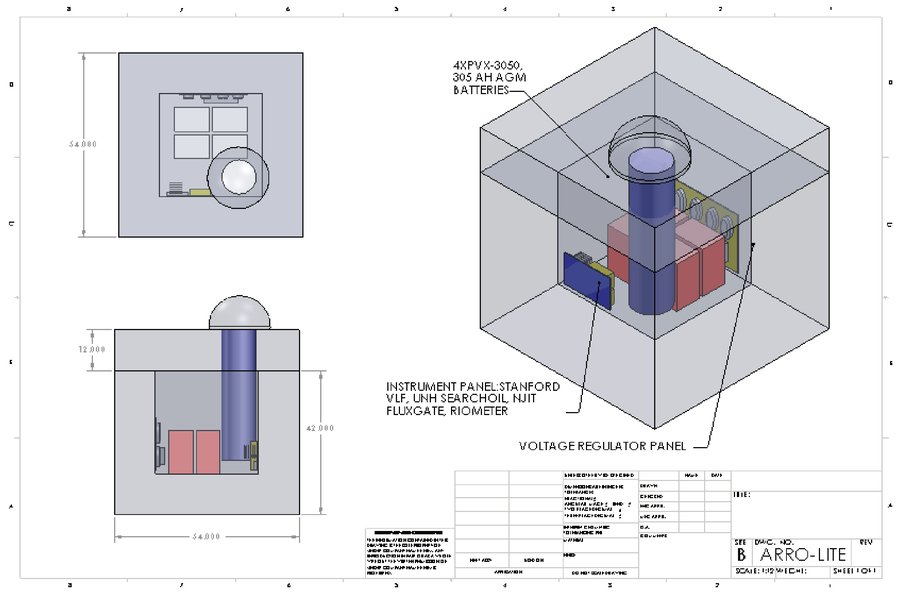


Figure 7. Mechanical drawing of 5'×5'×5' enclosure for ANTARES

Preliminary Performance Testing

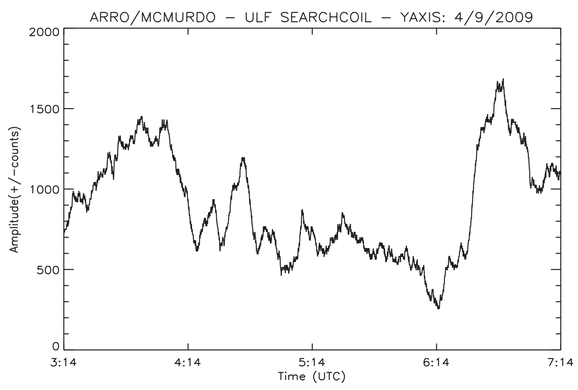


Figure 8. Magnetometer data acquired during performance test at McMurdo, April 2009

- Planned installation in 5'×5'×5' enclosure (Figure 7)
- Instrumentation listed in Table 1
- Tested 8'×8'×8' version at McMurdo for two seasons (2009-2010)
- Uptime 72% despite deliberately underpowered installation (to test cold soak)
- Sample of acquired data (Figure 8)
- ANTARES will use five Rutland 910 wind generators (100 W each)
- Predicted uptime of 85% based on 2010 observed weather at WAIS Divide