Scientific and Engineering Aspects of the Automatic Geophysical Observatories

Polar
Technologies
Conference

April 2009

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New Jersey
Institute of
Technology

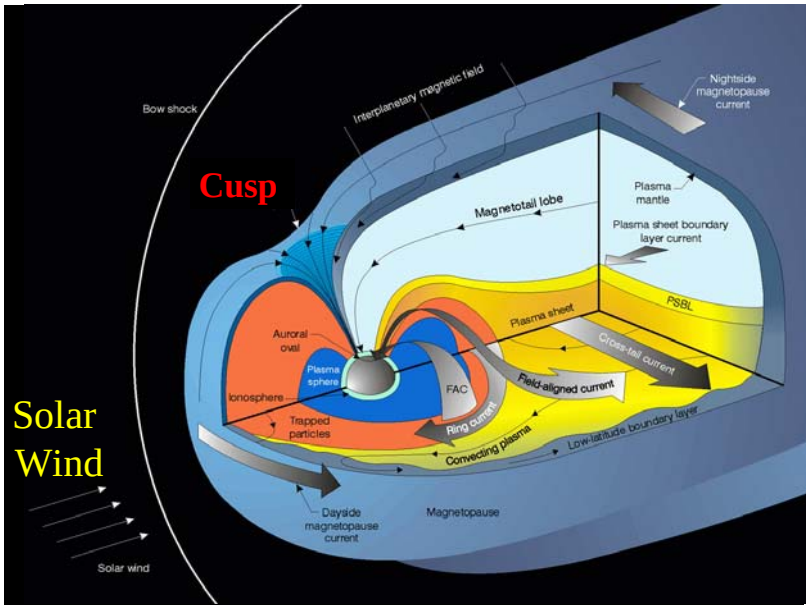
The people (in no particular order …)

- **SCIENCE**
- Al Weatherwax (Siena)
- Steve Mende (Berkeley SSL)
- Andy Gerrard (NJIT)
- Lou Lanzerotti (NJIT)
- Mark Lessard (UNH)
- Mark Engebretson(Augsburg)
- Umran Inan (Stanford)
- Harald Frey (Berkeley)
- Maria Spasojevic (Stanford)
- Jim LaBelle (Dartmouth)
- Noel Petit (Augsburg)
- Ted Rosenberg (U. Maryland)
- Jack Doolittle (Lockheed)

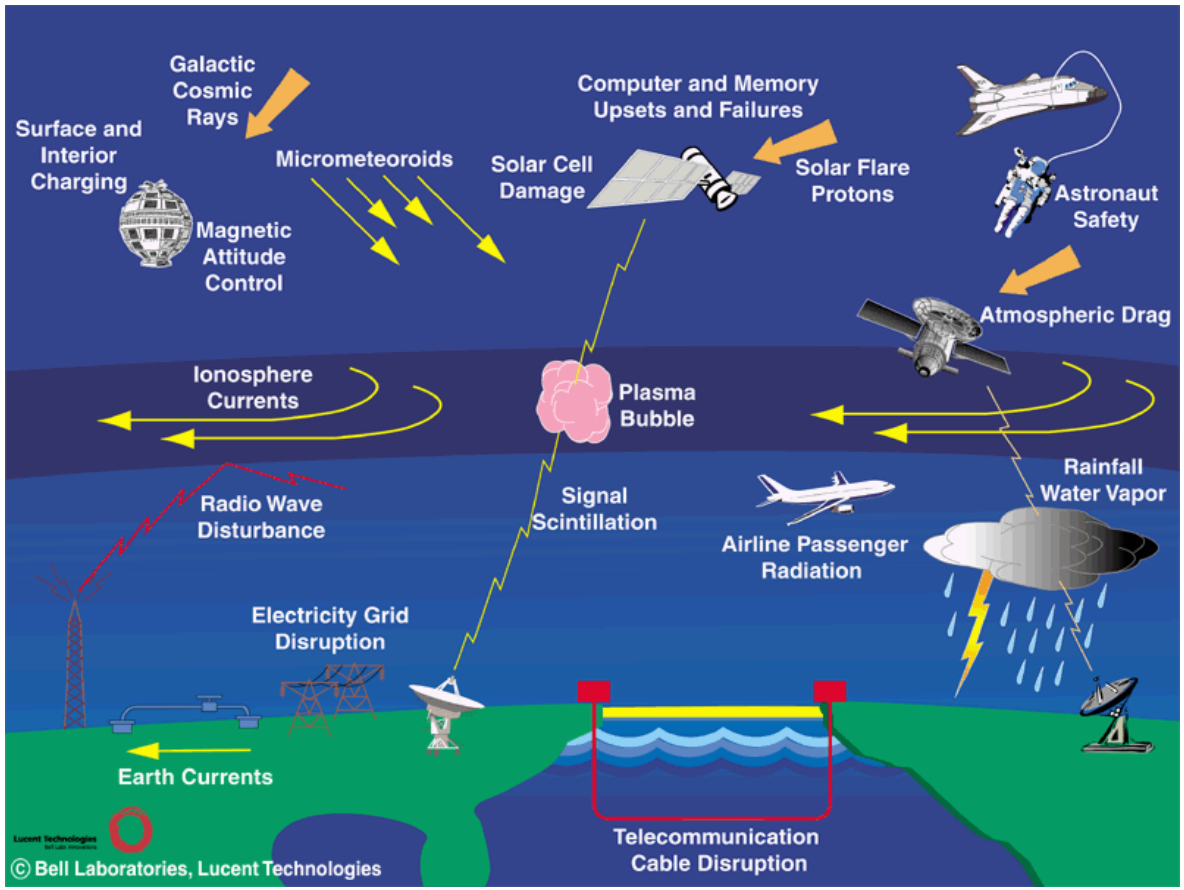
- **ENGINEERING**
- Will Rachelson (Berkeley SSL)
- Dan Detrick (U. Maryland)
- Jeff Chang (Stanford)
- Kevin Graff (Stanford)
- Bob Melville (NJIT)
- **FIELD SUPPORT**
- August Allen
- Cara Ferrier
- Amy Serrano
- Martha Story

Space weather

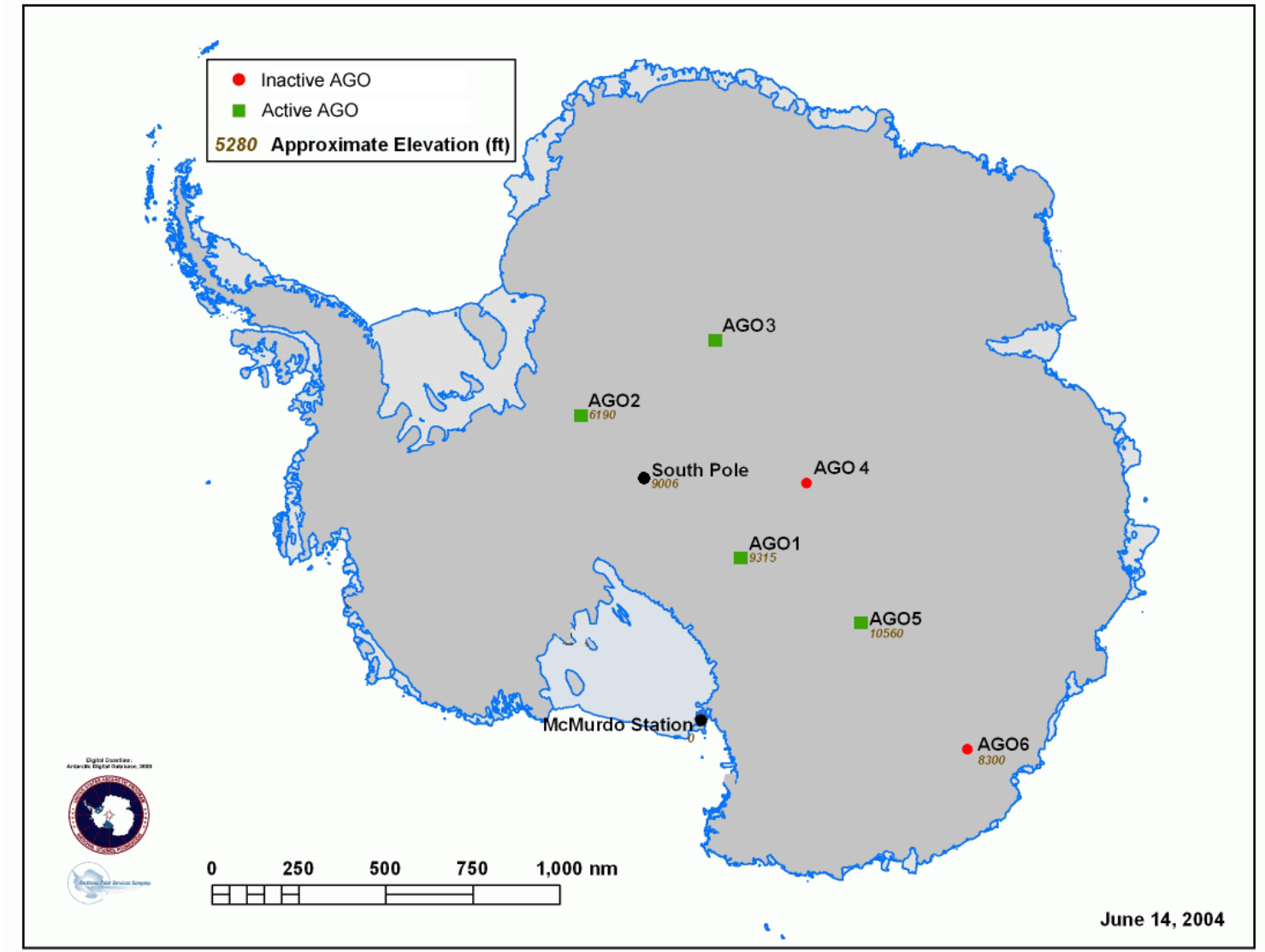
- Ionosphere and magnetosphere
- Interaction of magnetic fields of the Sun and Earth
- Aurora
- The *Solar Wind*
- Study the impact on ground resources, aircraft, satellites, communications, the power grid, etc.



Practical impact of Space Weather phenomena



AGO Locations



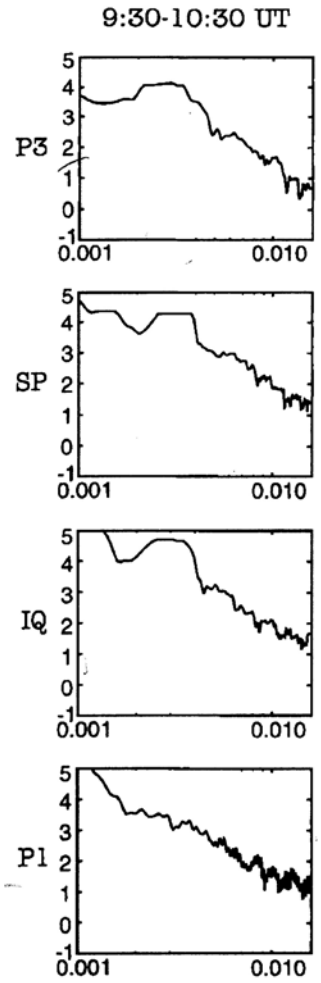
Scientific impact of AGO observatories

- Carefully chosen and stable locations in high geophysical latitudes
- Provides *ground truth* to computer models and complements satellite platform observations*
- Simultaneous observations accurately synchronized via GPS
- Nearly continuous observations over several *years*
- Immediate reporting of science data via Iridium
- Power budget allows extension with additional science instruments

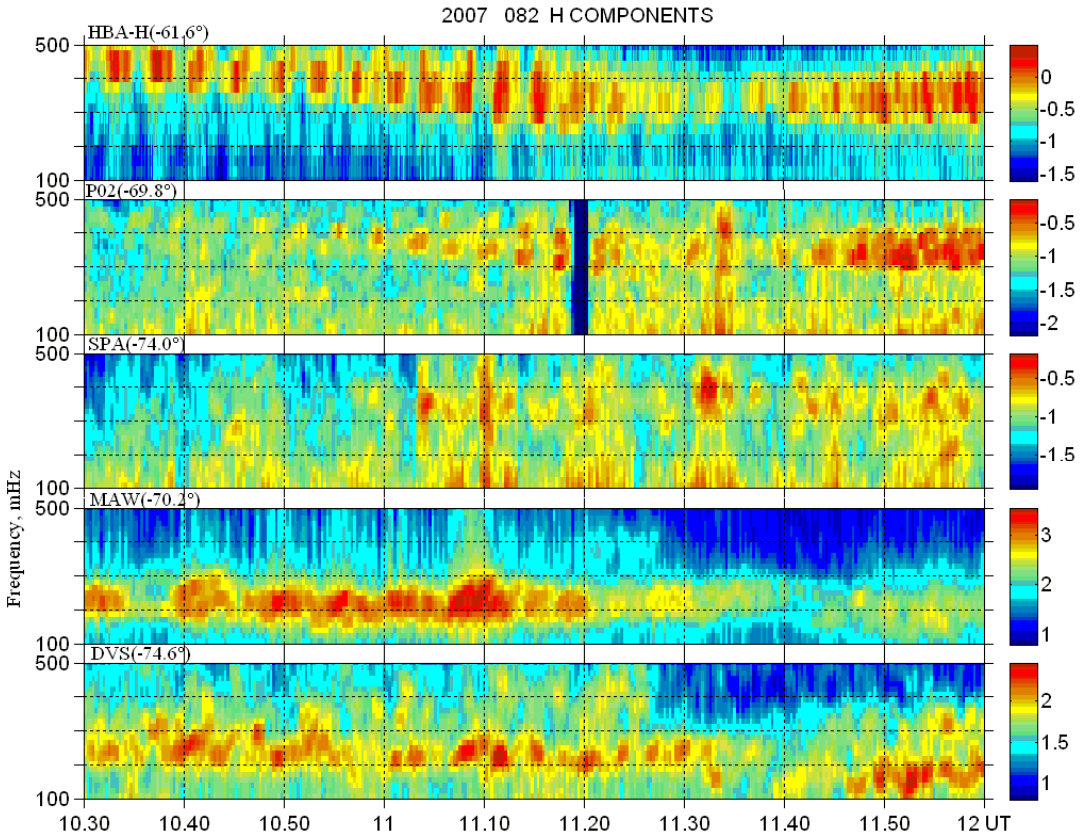
*See, e.g., PENGUIn multi-instrument observations of high-latitude injections during the March 23, 2007 substorm; Lessard, et. al., JGR, Vol. 14, A00C11

Two examples of AGO observations …

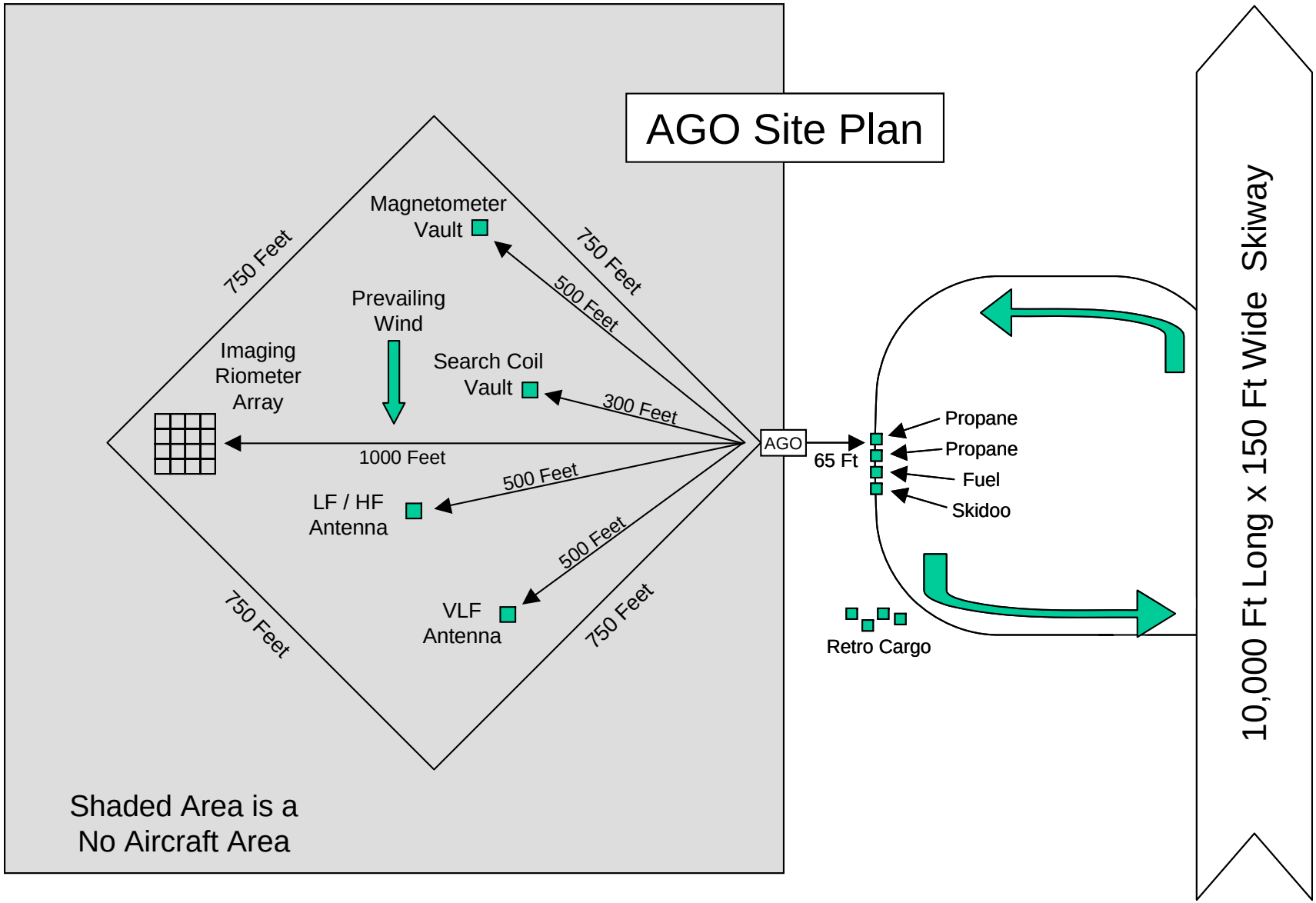
- Observe in Antarctica because boundary of magnetosphere touches down on the continent
- Accurate location and timing of boundary gives information about space weather
- Space-based platforms (satellites or sounding rockets) are moving (fast), hence do not stay in one place long enough to get a good picture
- Ground-based stations are ideal for such measurements, and must be spaced closely enough to bracket the boundary of the magnetosphere



ULF magnetic waves at various sites in Antarctica



Site Layout / Instrumentation



Science Instrumentation

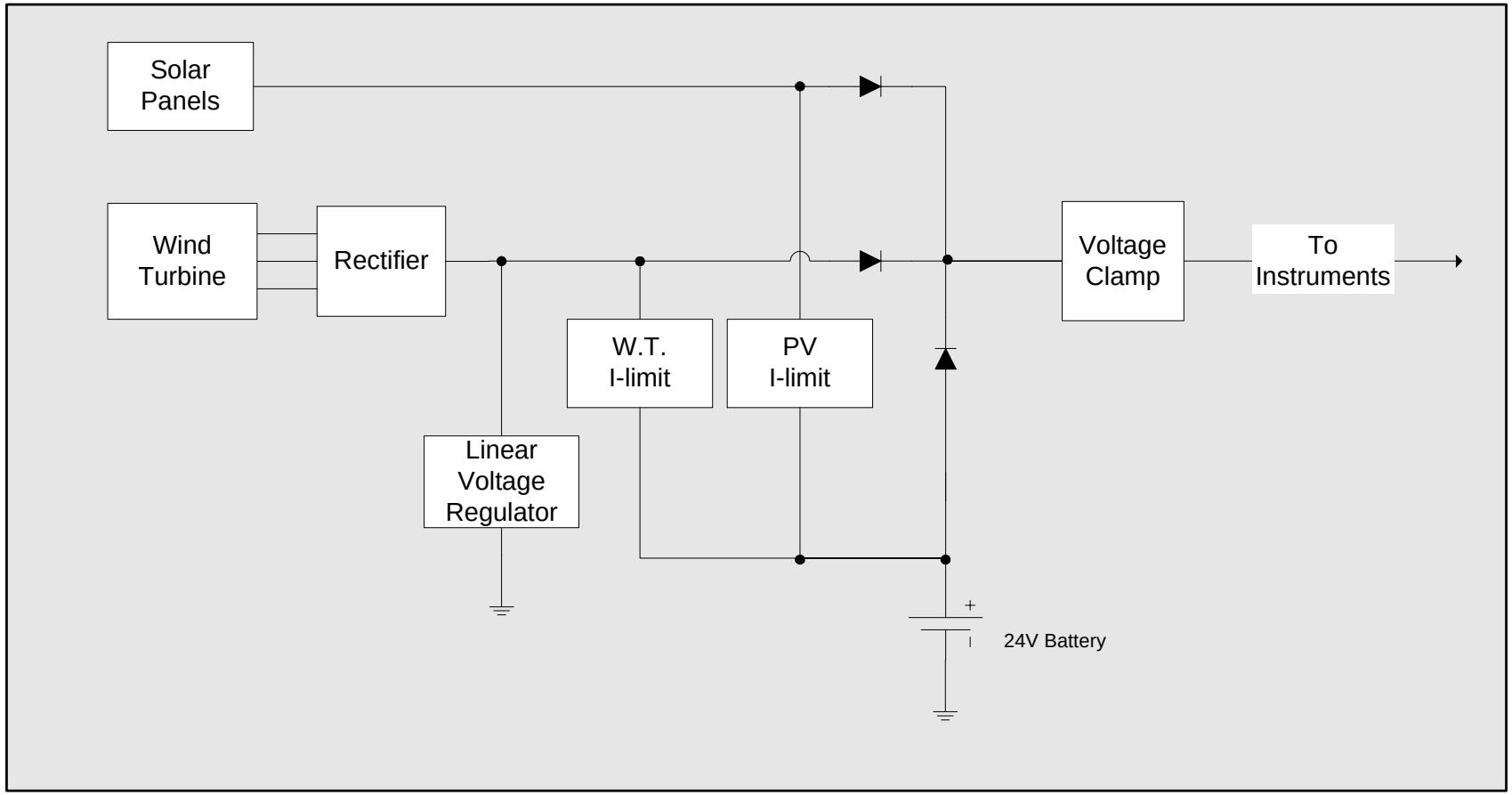
1. Allsky Camera
2. Data Acquisition Unit
3. Iridium Comms
4. VLF

5. Fluxgate Magnetometer
6. Imaging Riometer
7. LF/HF
8. Searchcoil Magnetometer

Current power system

- Final result of several years of experimentation and tweaking
- Solar and wind turbine
- Highly reliable and clean
- Provides 100+ W of regulated DC at 28 V
- Excess power from wind turbine heats shelter to > -40 F even in winter

Power System – Top Level 2

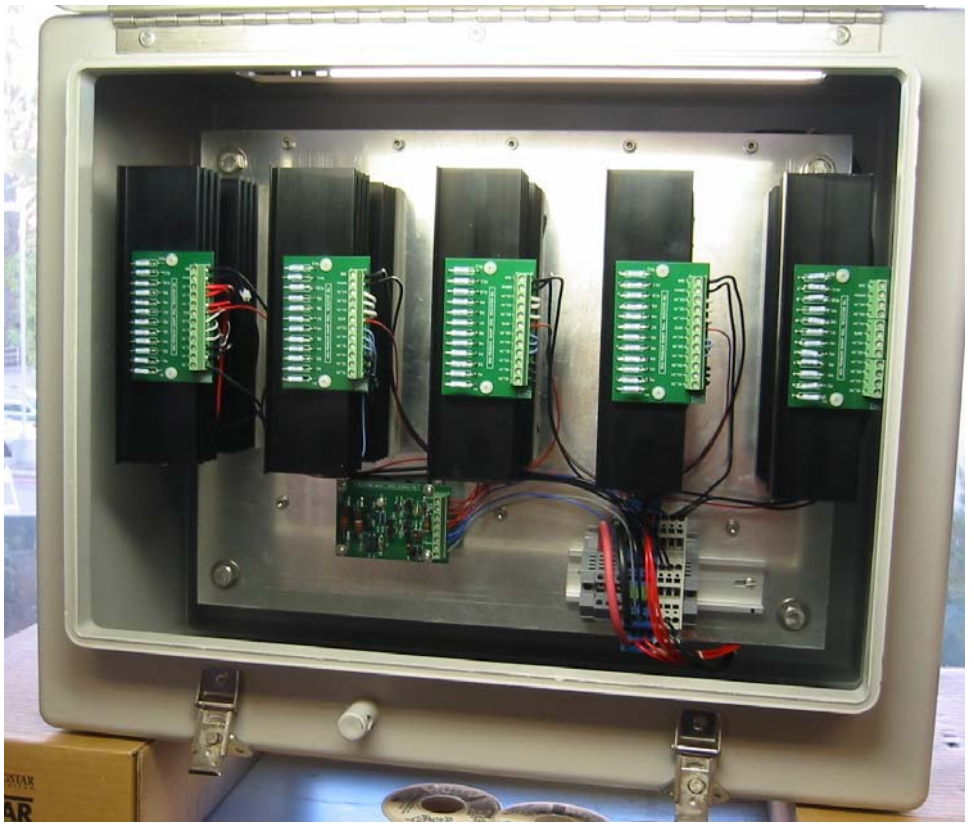


African Wind Power 3.6

- 3.6m^2 Swept Area
- 24V, ~1000W @ 23mph
- Low cut-in speed (~6mph)
- No slip-rings or brushes
- Indestructible
- Cheap ($2500 USD)
- Hard to acquire

Voltage Regulators

- 30Vdc Regulated output
- 1500 Watts Max
- Switched among 3 locations:
  - Rack
  - Hut
  - Outside



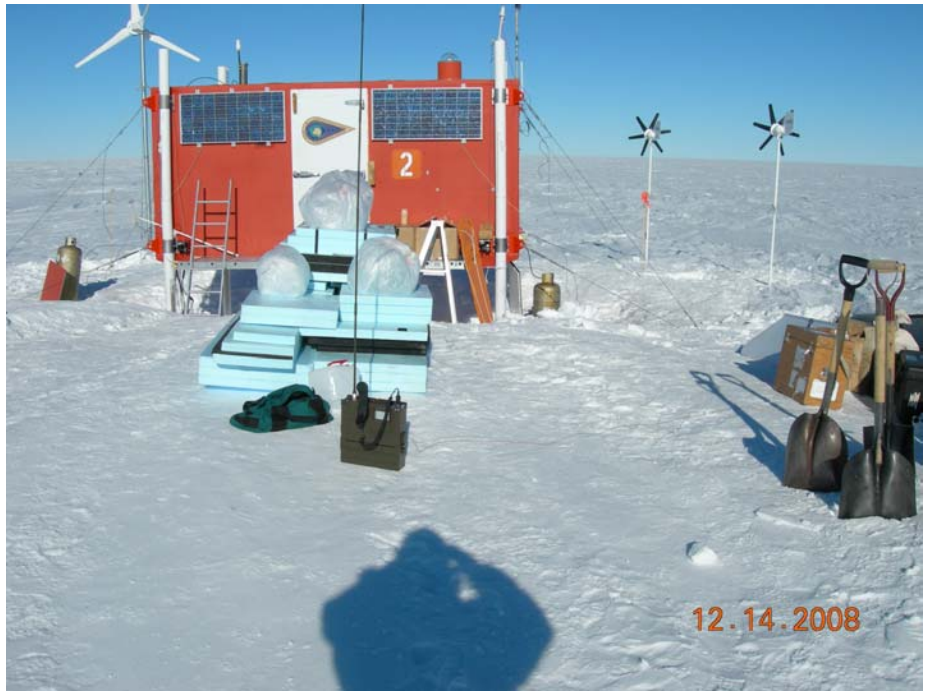
15 IRFP250 FETs, 300W per heatsink

Field season 08-09

- One of the most comprehensive to-date
- Visited four sites - AGO2,AGO3,AGO5,AGO1
- Extensive work required at AGO5, which had not been visited for 2+ years
- Required coordination of logistics, cargo (at both Pole and McMurdo), flight resources, food, etc.
- Crew between two and four people: RPSC and grantees

AGO2 and AGO3

- Jeff Chang, Kevin Graff (Stanford grantees), Martha Story (RPSC), Bob Melville (NJIT)
- Mechanical and electronic repairs
- Calibration of science equipment



16 fun-filled days at AGO3(!)

Full-on blizzard at AGO3

- Flight resources with tight this year
- We had to wait for a “window”: weather at McMurdo, possibly at Pole and the AGOs
- Weather observations required 6 hours before launch

Some fun stuff

- Used military-surplus HF radio with ruggedized laptop to capture “WSPR-mode” transmissions (K1JT) from US (once a nerd, always a nerd …)
- Martha practiced her kite skills

Fuel cache management …

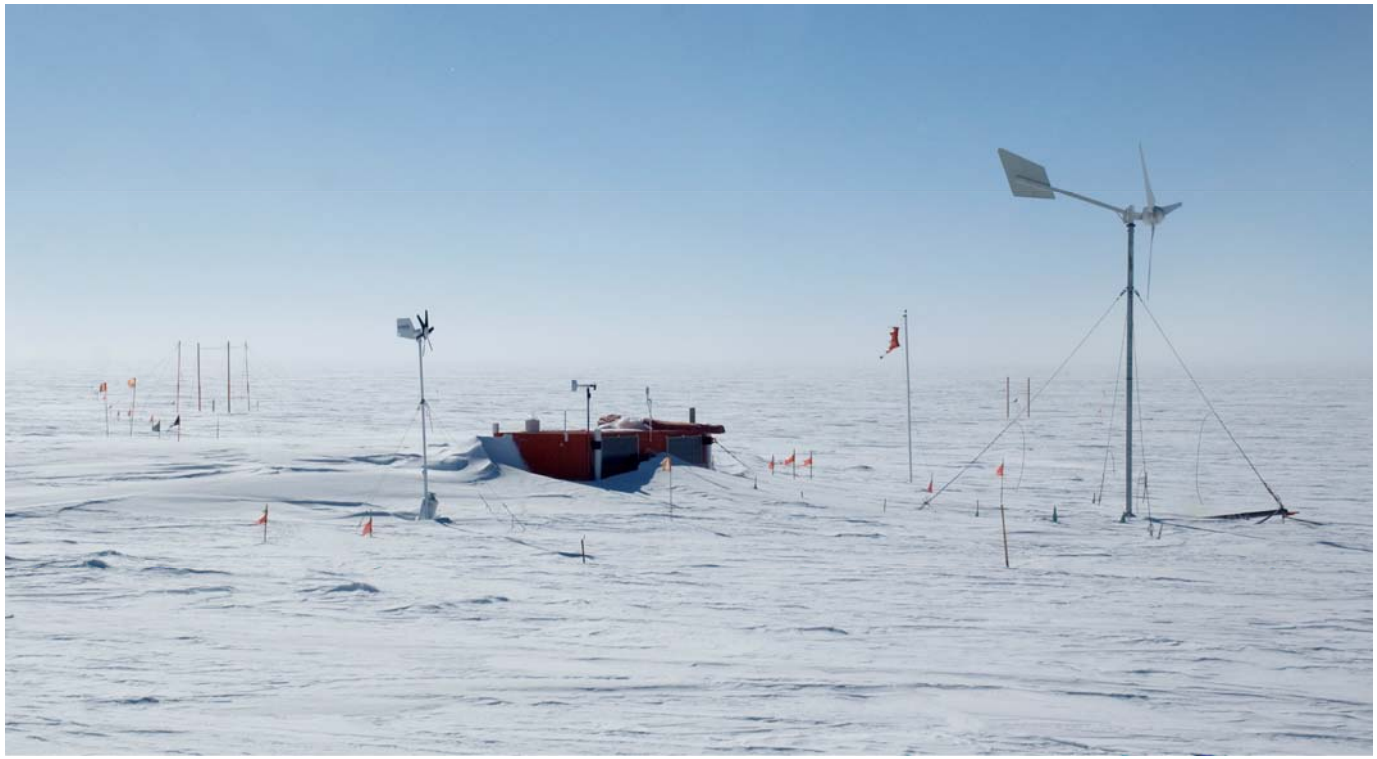
On to AGO5 (!)

- Scientifically important station, because it is near geomagnetic pole
- Careful acclimatization required
- Off-line for close to a year
- Fly-over last year revealed nothing due to heavy fog (“ping-pong ball” conditions)
- Logistically difficult – required put-in flight followed by a re-supply flight

The AGO5 crew

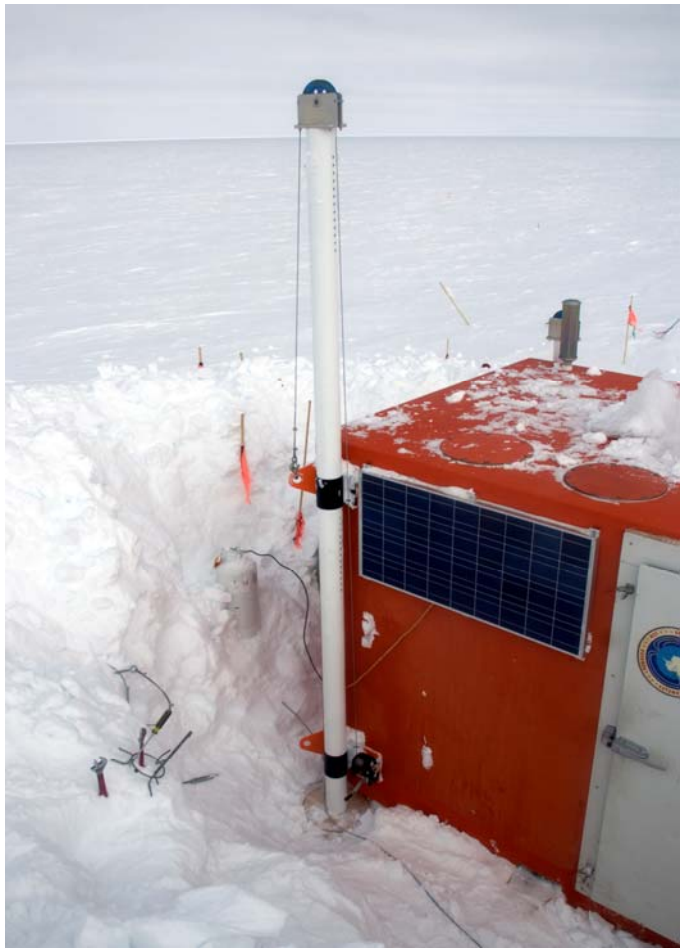
- Cara Ferrier and Amy Serrano (RPSC, BFC)
- August Allen (RPSC, FSTP)
- Bob Melville (Grantee, team lead)

First task: raise the hut …



Raising continued …

Raising …



Success!

Engineering issues …

- Voltage regulator failed
- Iridium modem failed (cold-soaking)
- Battery protection circuit failed
- All sky camera replaced

Current status

- AGO2,AGO1 operational continuously for 2+ years
- AGO3 on-line for about 2 months after site visit, but has just shut down
- AGO5 restored after field season; currently operational

The future

- Evolutionary fixes and improvements to the power system
- Goal: simplify logistics. Same or better science with fewer resources
- Possible additional science: seismo, photometers
- Increase data rate over Iridium
- Resurrect P4 (?!)