Atmospheric Radiation Measurement
Climate Research Facility
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ARM CLOUD RADARS
A Year in Review and a Look to the Future

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Summary

A total of 7 zenith pointing Doppler cloud radars are in operation 24/7 at the ARM sites. We successfully addressed many hardware problems on all of the radars. Antenna refurbishment and procurement of a new digital transceiver are currently underway. We are also working on the next version of the signal processor to increase sensitivity and remove undesirable artifacts.

Cloud Radar Status

The table below shows the current status of the five fielded MMCRs and two WACRs.

Site	*Frequency*	*Installed*	*Processor*	*Upgrade*	*Modes*	*Polarization*	*Spectra GB/day*
SGP	34.86 GHz	11/8/96	C40	9/03	1,2,3,4,5,6	Yes	6.4
Barrow	34.86 GHz	3/25/98	C40	4/04	1,2,3,4	No	8.7
Manus	34.86 GHz	6/14/99	PIRAQ-III	6/06	1,2,3,4	No	15
Nauru	34.86 GHz	10/22/98	PIRAQ-III	8/06	1,2,3,4	No	15
Darwin	34.86 GHz	3/6/02	PIRAQ-III	11/05	1,2,3,4	No	15
SGP	95 GHz	12/13/05	Echotech	10/06	5,6	Yes	15
AMF	95 GHz	3/16/06	Echotech	-	5,6	Yes	15

Modes: 1 – boundary layer, 2 – cirrus, 3 – general, 4 – precip, 5 – co-pol, 6 – cross-pol

Data Availability Summary 1/2006 to present

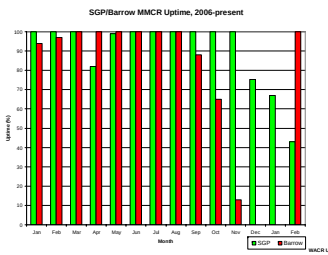
Failures of major components in the TWP are especially "costly" in terms of up-time. It takes time to get parts from the US to the remote sites and then time to schedule a technician visit. We are trying to alleviate this by procuring more spare parts to be staged in Darwin.

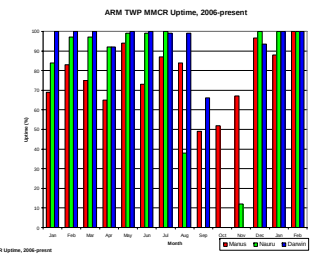
Major MMCR issues in 2006:

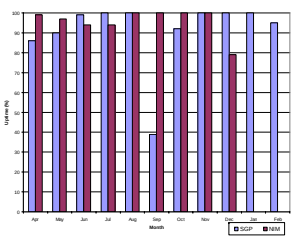
- PIRAQ software update removes spectral images - FIXED!
- Barrow receiver failure going back to 2005 caused by cold solder joint – FIXED!
- Barrow TWTA failure – FIXED!
- SGP TWTA faults with low filament voltage – REPLACEMENT PENDING!
- Manus intermittent sensitivity problems finally found as rf switch problem – FIXED!
- Nauru TWTA failure – FIXED!
- Darwin PIRAQ failure – FIXED!

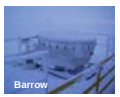
Major WACR issues in 2006:

- SGP software firmware upgrade – COMPLETED!
- AMF oscillator failure 1 week before end of Niger deployment – FIXED!
- Spare EIKA (transmitter & modulator) RECEIVED!





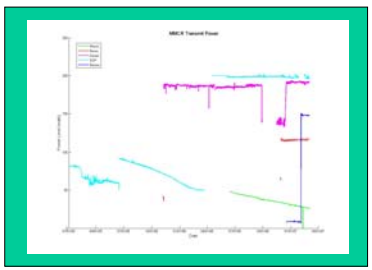




MMCR TWTA HISTORY

TWTs are expected to last for 28 months. We are currently on our 3rd TWT manufacturer after the first two manufacturers were unable to produce tubes that met ARM reliability requirements. The latest TWT has the added benefit of producing double the power for a 3 dB increase in sensitivity.

The plot below shows the transmitter power for each of the five MMCRs. Each hour, the transmitter power is monitored and if it is outside of acceptable limits, an email is sent to the instrument mentor and site operations to start fault finding.



Future Plans

- **Calibration comparison with WACR at SGP** tying to the WACR's corner reflector.
- **PIRAQ Upgrade to the Barrow MMCR** to minimize spectral images.
- **Antenna refurbishment** will begin in FY2007. This will result in replacing an antenna with a spare and having it refurbished and recalibrated on an antenna test range.
- **Advanced Radar Processor** procurement to provide a completely digital transceiver to further reduce range sidelobes. New hardware will also be installed.

Acknowledgements

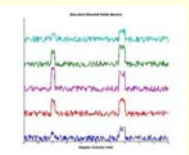
•We would like to thank and acknowledge the Operations staff at the SGP, NSA, and TWP sites. Their help and vigilance is essential in keeping these radars running.
•Thanks also to the ARM Data Quality Office for providing quicklook plots of the data. These are invaluable tools.
•We appreciate the continued support of staff at NOAA-ESRL-PSD for the MMCRs and ProSensing for the WACRs.

Radar 101 – Selected Topics

DOPPLER RADAR MOMENT ESTIMATE OVERVIEW

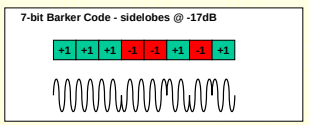
The cloud radars transmit narrow pulses of RF energy which reflect off vertically distributed targets such as clouds as well as point targets such as birds, insects, etc. These "echoes" are digitized, resolved in time, and several FFTs are averaged in order to estimate the velocity spectral signal for each range gate. The first three calibrated moment estimates of the spectra (reflectivity, radial velocity, and spectral width) are stored.

The figure below shows a simulation of a spectra plot. Current operational software estimates the spectra moments by computing the noise floor, finding/measuring the peak signal for each range gate, the Doppler velocity at which this peak occurs, and the width of this peak. It should be noted that in the event the spectra are bimodal, the software will pick out the largest reflection and ignore the other. Post analysis of the spectra must be undertaken to determine additional modes.



PULSE COMPRESSION OVERVIEW

In order to gain increased sensitivity, higher energy pulses are transmitted by increasing the pulse width. To prevent loss of range resolution, pulse compression techniques are used. The MMCR uses a binary phase code modulation technique in its cirrus mode. Unfortunately, high cross section returns can cause range sidelobes returns that contaminate data near these range gates.



Another modulation technique that we will be investigating uses nonlinear frequency modulation. This promises the possibility of not only reducing range sidelobes but increasing sensitivity since amplitude weighting is not required.