Deployable Radars

Stephen Frasier
U. Massachusetts

NSF Community Workshop on
Radar Technologies

27-29 Nov 2012, Boulder, CO

Deployable Radars: Present & Future

de·ploy'a·ble *adj.* -- 1. transportable but not mobile, 2. usually container-based or trailer-mounted, 3. set-up time may vary from hours to several days, 4. operational periods may vary from days to months.

Overview of Deployable Radars

Large	Medium	Small	Zenith Pointing
NCAR S-Pol	ARM X/Ka	U. Iowa X-Pols	ARM KaZR (MMCR)
CSU CHILL	ARM Ka/W	OU PX-1000	ARM WACR
NASA N-Pol	NASA D3R (Ku/Ka)	CASA IP-1	ESRL W-band
	UMass AMFR (Ku/Ka/W)		
	ARM C-Band		

Big weather radars

Cloud & precip radars

Small weather radars & radar networks

Clouds/microphysics

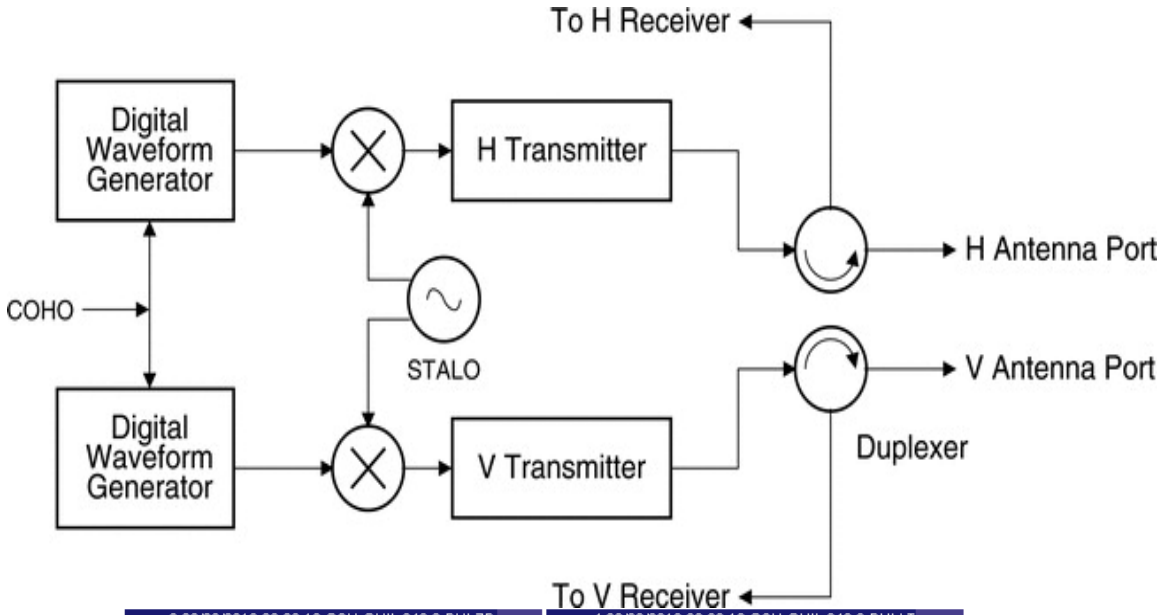
NSF/NCAR S-Pol

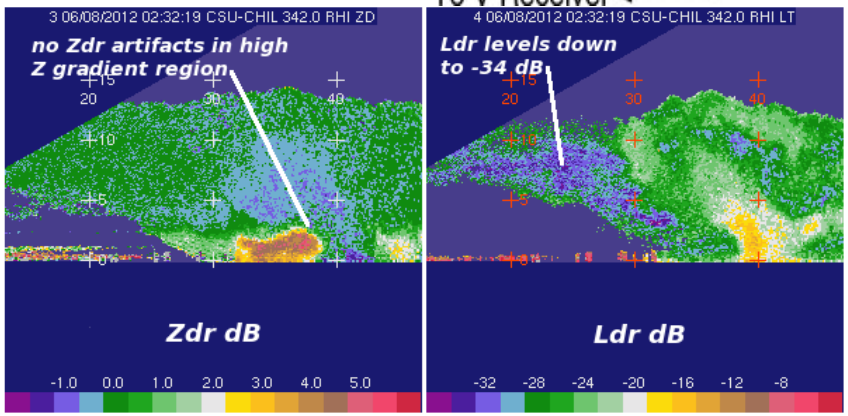
CSU-CHILL
Advanced Fully Polarimetric Research Radar

- Click to edit the outline text format
  - Second Outline Level

Very high polarization purity antenna

Coherent dual transmitter, dual receiver system





- Fourth level
  - Fifth level

NASA N-Pol

Characteristics of S-Bands

	S-Pol	CHILL	N-Pol
Antenna	Parabolic	Offset Gregorian	Parabolic
Digital Receiver	NCAR VITAQ	CSU	RVP900
Pulse Scheme	ATSR/STSR	ATSR/STSR	STSR
Primary Freq.	S-band	S-band	S-band
Aux. Freq	Ka-band	X-band	
Maintainer	NCAR/NSF	CSU/NSF	NASA GSFC

ARM Mobile Facilities (AMF)

- ARM currently has 2 mobile facilities and a 3rd one under development.
- Each AMF is a complete climate observatory with meteorological, radiometric, and remote sensing instruments.
- Deployment is determined by annual call for proposals open to researchers internationally.

AMF Scanning Cloud Radars (cont)

- X/Ka-band Scanning ARM Cloud Radar (X/Ka-SACR)
  - Dual frequency on common pedestal,
  - Beam matched antennas at 0.3°
  - ~ 2 KW transmitter Ka, 20 KW transmitter X-band
  - Single pol transmit (H), dual pol receive Ka-band, simultaneous transmit and receive (STSR) X-band

AMF Scanning Cloud Radars

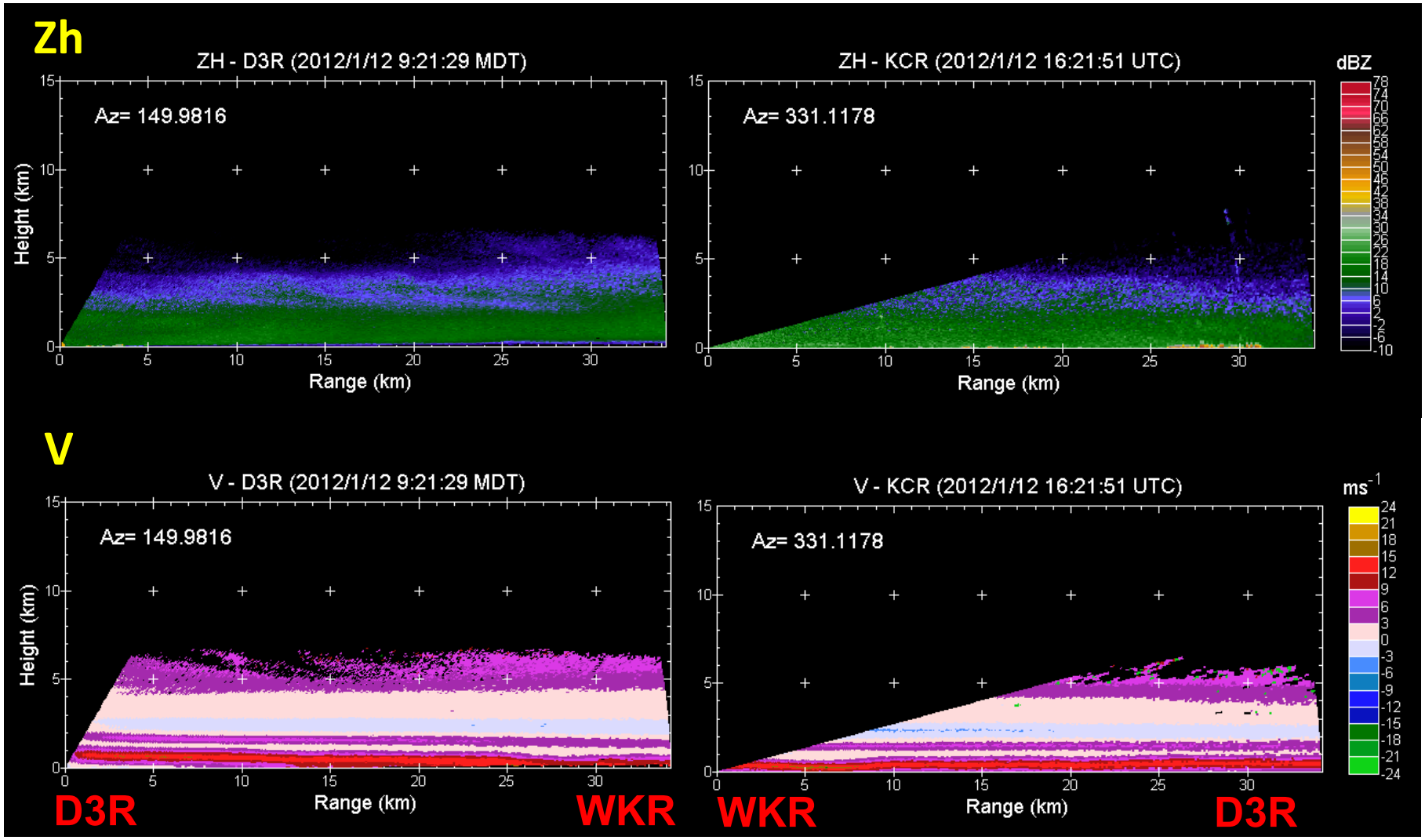
- Ka/W-band Scanning ARM Cloud Radar (Ka/W-SACR)
  - Dual frequency on common pedestal
  - Beam matched antennas at 0.3°
  - ~ 2 KW transmitters
  - Single pol transmit (H), dual pol receive
  - Currently deployed on Cape Cod

NASA Dual-Frequency Dual-Polarized Doppler Radar

- Ground Validation radar for Global Precipitation Mission
- System design parameters
  - Sensitivity: -10 dBZ at 15 km to enable snow measurements
  - Maximum unambiguous range =30 km
  - Precipitation measurements at frequencies (Ku-band: 13.91±.25GHz, Ka-band: 35.56±.25GHz)
  - Dual linear polarizations with both simultaneous and alternate transmission
  - Maximum unambiguous Doppler = 25 m/s
  - Ground clutter suppression for non-uniform sampling

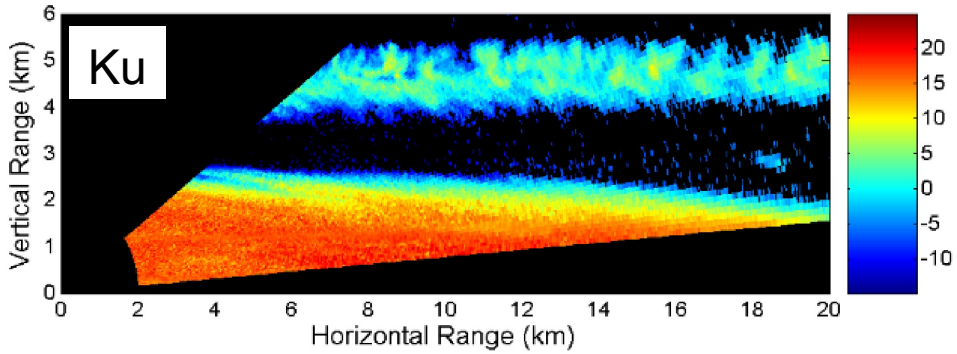
D3R deployed at ARM Southern Great Plains site during GPM Midlatitude Continental Convective Clouds Experiment (MC3E) (05/28/2011)

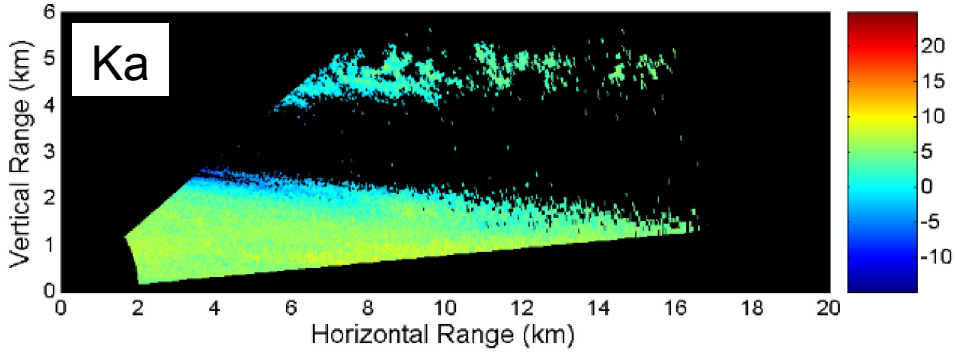
Example data from GCPEx campaign: Comparison between D3R and C-band WKR radar (Jan 17, 2012)

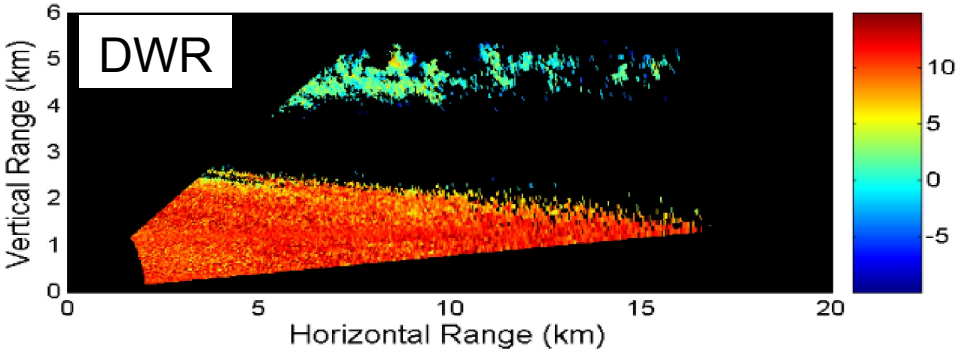


Since D3R and WKR are looking towards each other, the sign of D3R velocity has been reversed

UMass Advanced Multi-Frequency Radar







AMFR Radar Specifications

Transmitters	Klystron
Frequencies GHz	13.4, 35.6, 94.92
Peak power kW	5, 1.5, 2
Pulse widths	0.2–40 us.
Range res.	30--150 m
Beamwidth	0.7◦
Pulse scheme	ATSR

ARM Mobile C-band Radar

- Currently in procurement
- Expected delivery mid-2014
- Dual polarization, simultaneous transmit/ receive
- Trailer mounted
- 1° beamwidth, 500 kW transmitter

Iowa Mobile X-POL Radar Network

Manufacturer	ProSensing, Inc.
Frequency	X-band
Polarization	H,V, simultaneous
Peak power	25 kW
Scanning	Horizon-to-horizon, 360°
Software	Custom in-house, in progress

The University of Iowa

Cedar Rapids

USGS Station

X-POL 1

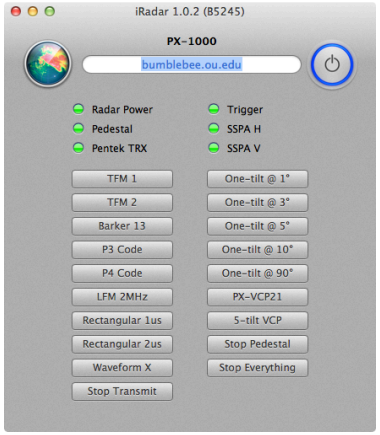
X-POL 2

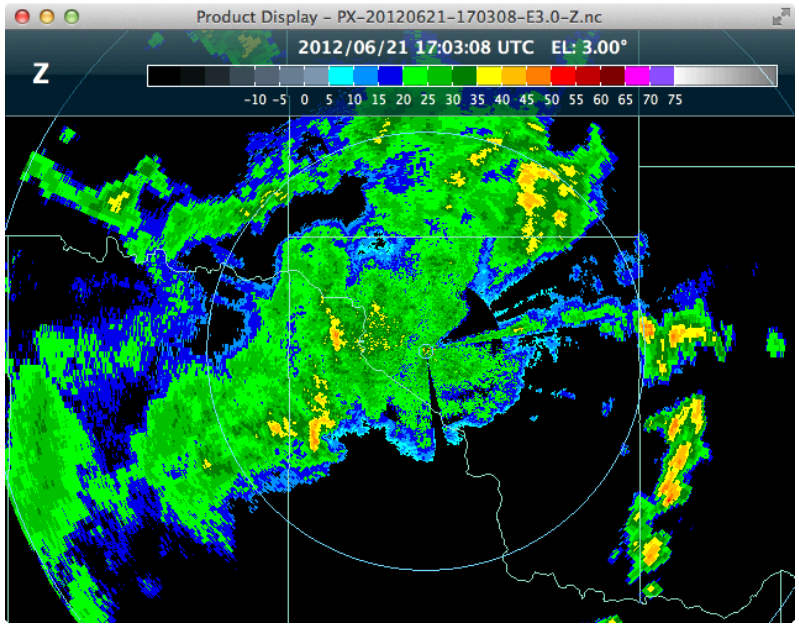
X-POL 3

X-POL 4

Iowa City

OU Deployable Radar: PX-1000





Operating Frequency	9.55 GHz (X-band, 3cm)
Peak Power	100W (SSPA) dual channel
Pulse Width	0.1-100 μs
Polarization	Dual-Linear, Simultaneous
PRF	Up to 2 kHz
Range	60 km (typical)
Antenna Size	1.2 m
3-dB Beamwidth	1.8°
Max Scan Rate	50°/s
Receiver Bandwidth	5 MHz

CASA IP-1 Network

Re-deployed to Dallas-Ft. Worth metroplex 2012
rechristened DFW Urban Testbed

AMF Zenith Pointing Cloud Radars

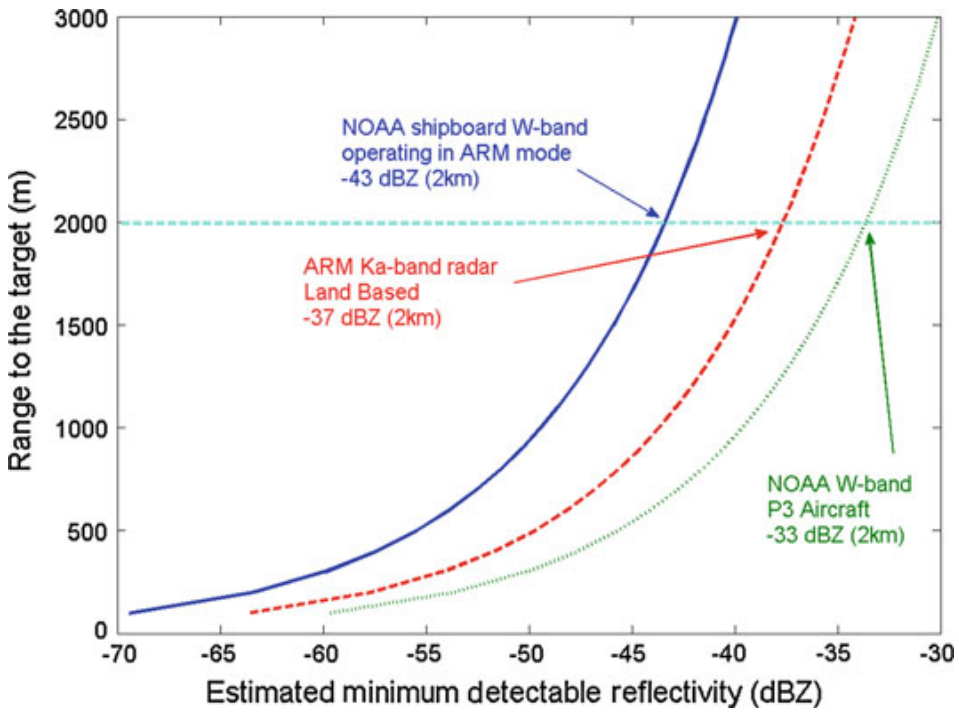
- Ka-band ARM Zenith Radar (KAZR)
  - 35 GHz with 2 meter antenna
  - Peak power 150 watts with 25% duty cycle
  - Frequency diversity pulse compression transmit/ receiver system
  - Currently deployed on cargo ship sailing to/from LA and Honolulu

AMF Zenith Pointing Cloud Radars (cont.)

- W-band ARM Cloud Radar (WACR)
  - 95 GHz with 1.2 meter antenna
  - Peak power 1.5 KW with 1% duty cycle
  - Currently deployed on Cape Cod
  - Will redeploy to Brazil in Fall 2013 for GOAMAZON campaign.

NOAA ESRL W-band

Shipboard Installation on a stabilized mount.



Moran, K et al. 2011, A motion stabilized w-band radar for shipboard observations of marine boundary-layer clouds, *Boundary-layer Meteorol*, doi:10.1007/s10546-01109674-5.

Overview of Deployable Radars

Large	Medium	Small	Zenith Pointing
NCAR S-Pol	ARM X/Ka	U. Iowa X-Pols	ARM KaZR (MMCR)
CSU CHILL	ARM Ka/W	OU PX-1000	ARM WACR
NASA N-Pol	NASA D3R (Ku/Ka)	CASA IP-1	ESRL W-band
	UMass AMFR (Ku/Ka/W)		
	ARM C-Band		

Big weather radars

Cloud & precip radars

Small weather radars & radar networks

Clouds/microphysics

Thoughts for the future?

- Of deployable radars, only S-Pol and CHILL are administered by NSF.
  - Others: NASA, DOE, Universities, NOAA.
- Seeing a proliferation of small/medium size radars and radar networks.
  - Also noting S-Pol/CHILL/KFTG “FRONT Network”
- Deployable network(s)
  - Modular, scalable, reconfigurable, modest siting req.