The NASA Polarimetric Radar (NPOL)

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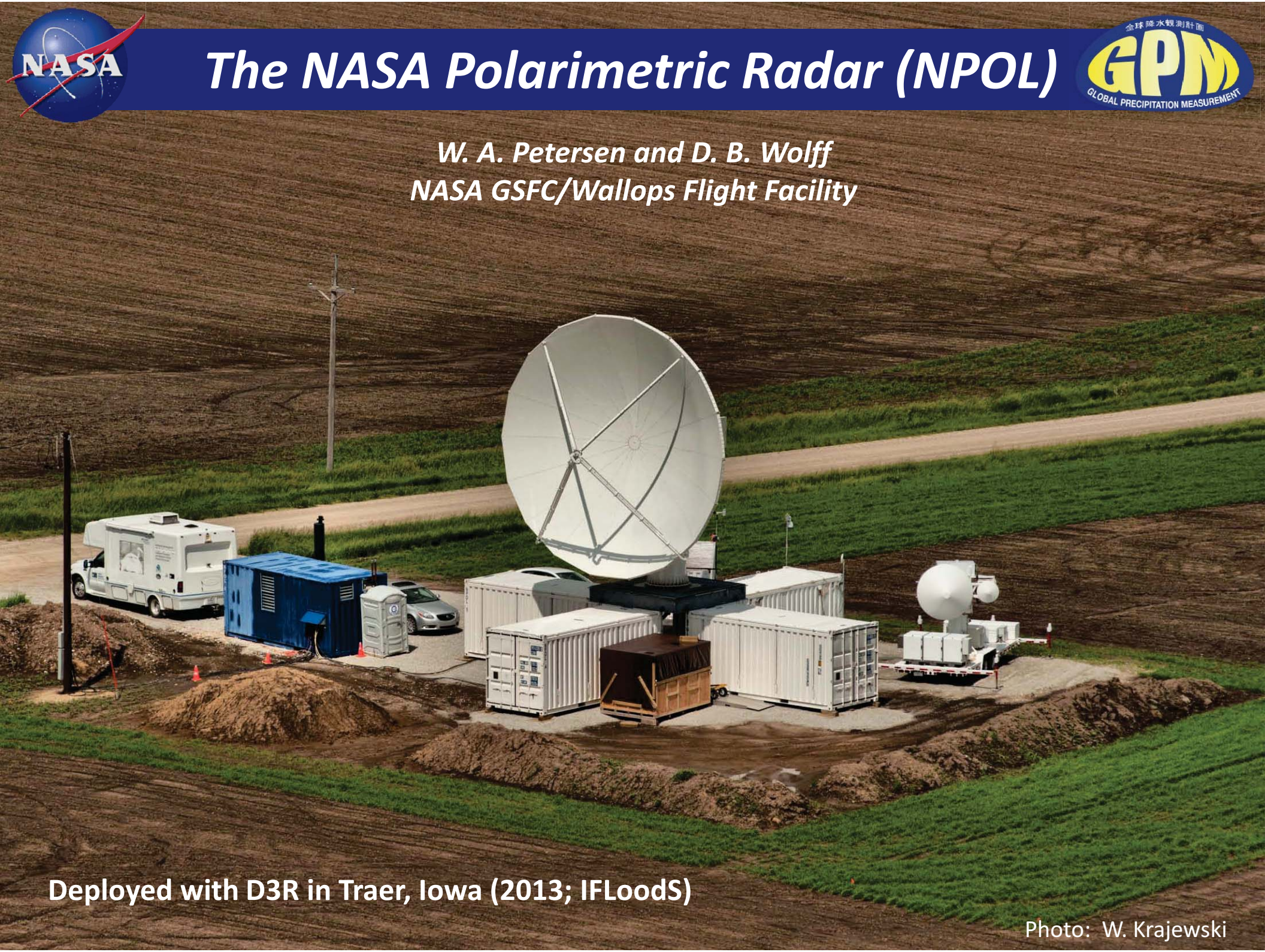
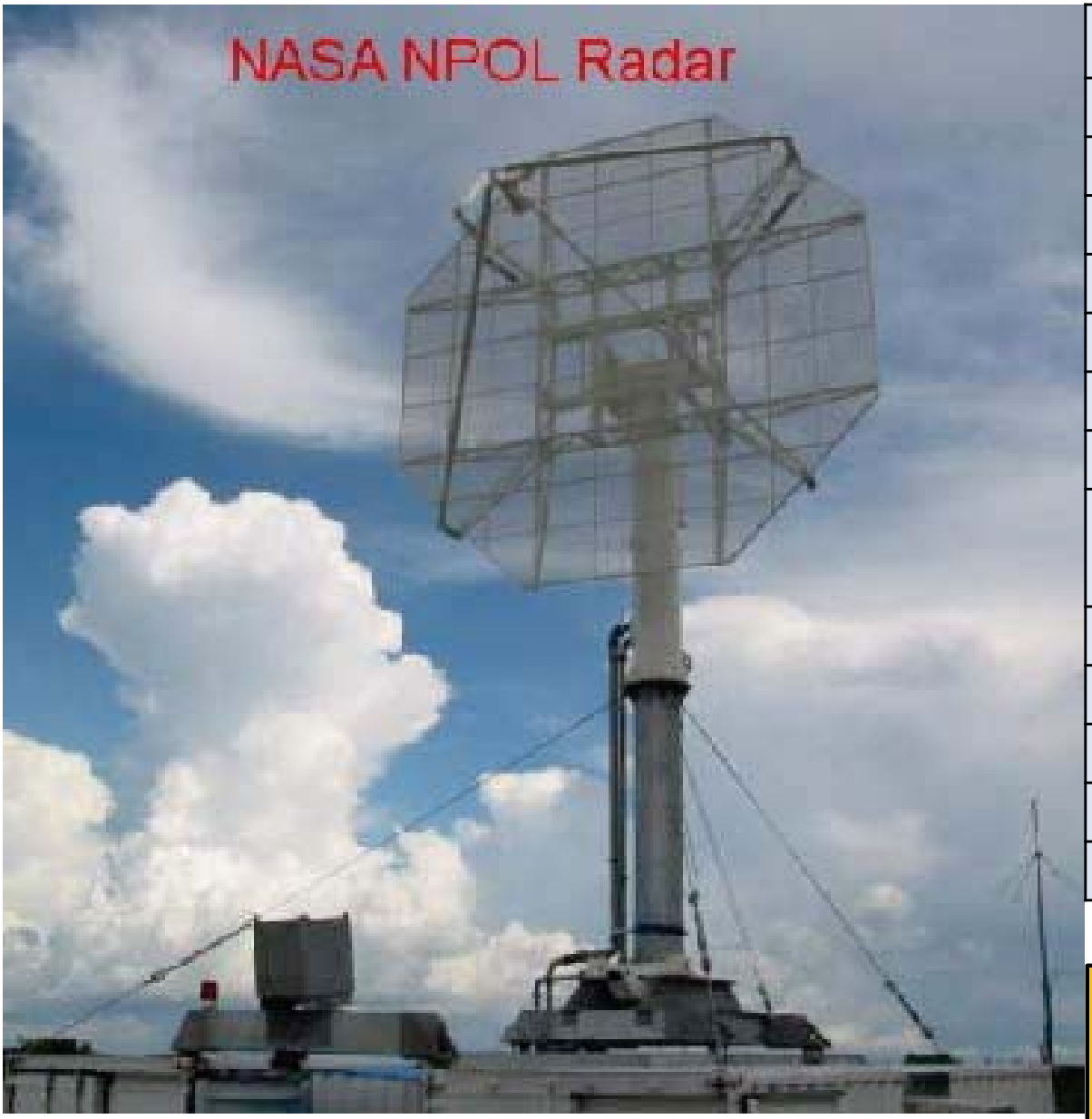


Deployed with D3R in Traer, Iowa (2013; IFLoodS)

Photo: W. Krajewski

History…..NPOL 2001 - 2008



Attribute	Specification
Frequency	2.7 – 2.9 GHz
Polarization	H, V, STAR, ALT
Receiver	Vaisala RVP-7
Variables	DP Moments, SQI, I/Q
Transmitter	850 kW, Magnetron
PW / PRF	0.8, 2.0 μs / 250-1200 Hz
Duty cycle	0.001 maximum
Antenna	5.5 m FLAPS (Passive Array)
Gain	39 dB
Pointing	0.1° accuracy
Beam width	1.3° H/ 1.4° V(dry)
Rotation rate	18° s^{-1} maximum
Sidelobe/X-pol	<-23dB V,-25dB H/ ?? dB

Issues:

- Data quality due to antenna performance (esp. when wet)
- Compromised research use.

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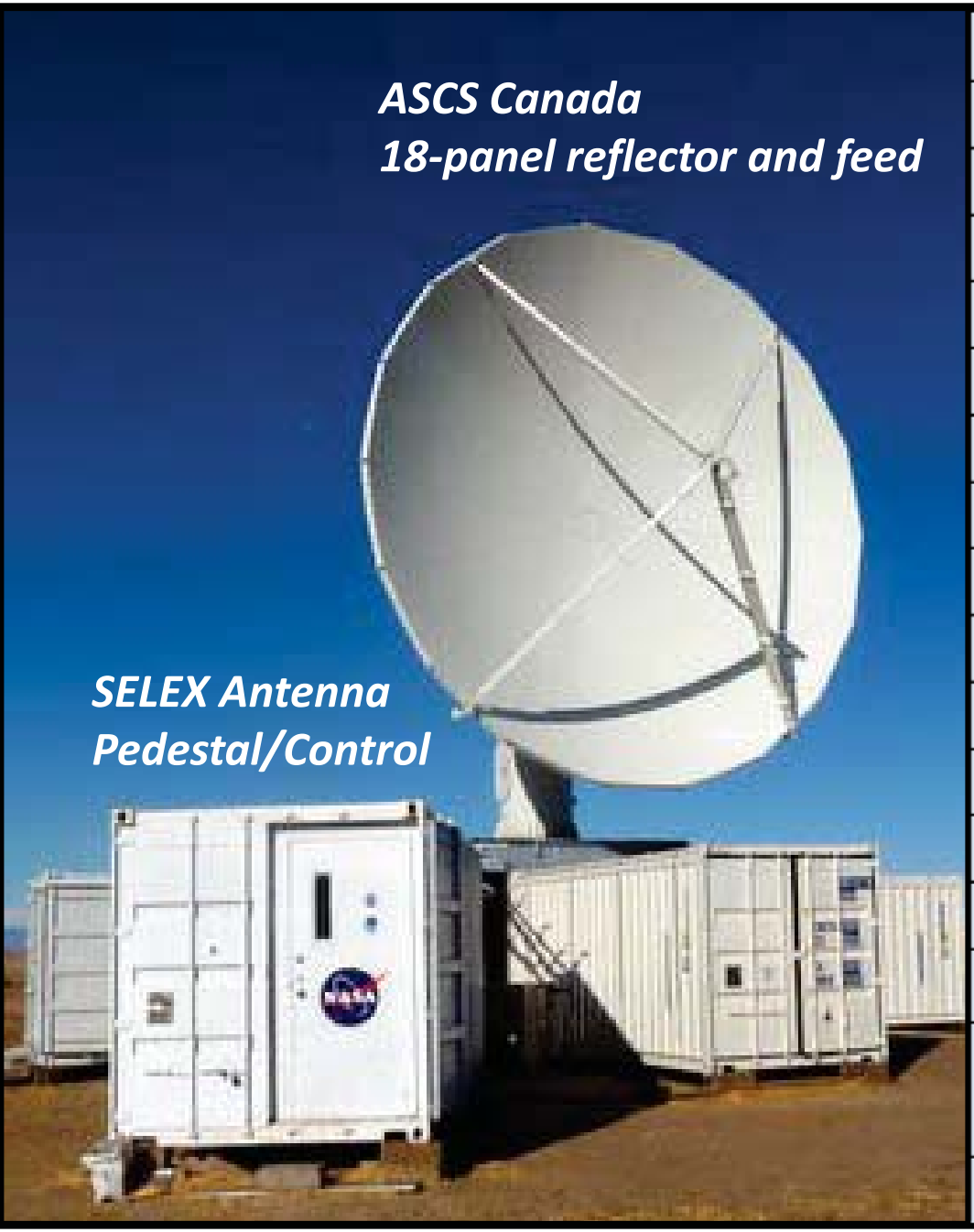
Upgraded NPOL: 2009 - Current



Attribute	Specification
Frequency	2.7 – 2.9 GHz
Polarization	H, V, (STAR, or ALT)
Receiver	Vaisala RVP-900
Variables	DP moments, SQI, I/Q
Transmitter	850 kW Magnetron
PW / PRF	0.8-2.0 ms / 250-1200 Hz
Duty cycle	0.001 max
Antenna	8.5 m, no radome
Gain	45.8 (+/- 0.3) dB
Pointing	0.1° accuracy
Beam width	0.9°
Rotation rate	18° s^{-1} maximum (typical)
Sidelobe/X-pol	<-27 dB, <-36 dB
Operational Limitations	
Wind/Ice	<60 mph (sustained) w/ 2.54cm accumulated ice
Hail	< 1 cm

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Radar Control and Scanning

Radar Control / Scanning / Data Software (format): SIGMET (Vaisala) IRIS

- Processing: Typically **PPP (dual-pol)**, FFT/DFT, Rphase, dual PRT,……

Remote / Continuous operations: Robust BITE system, Sensaphone monitoring

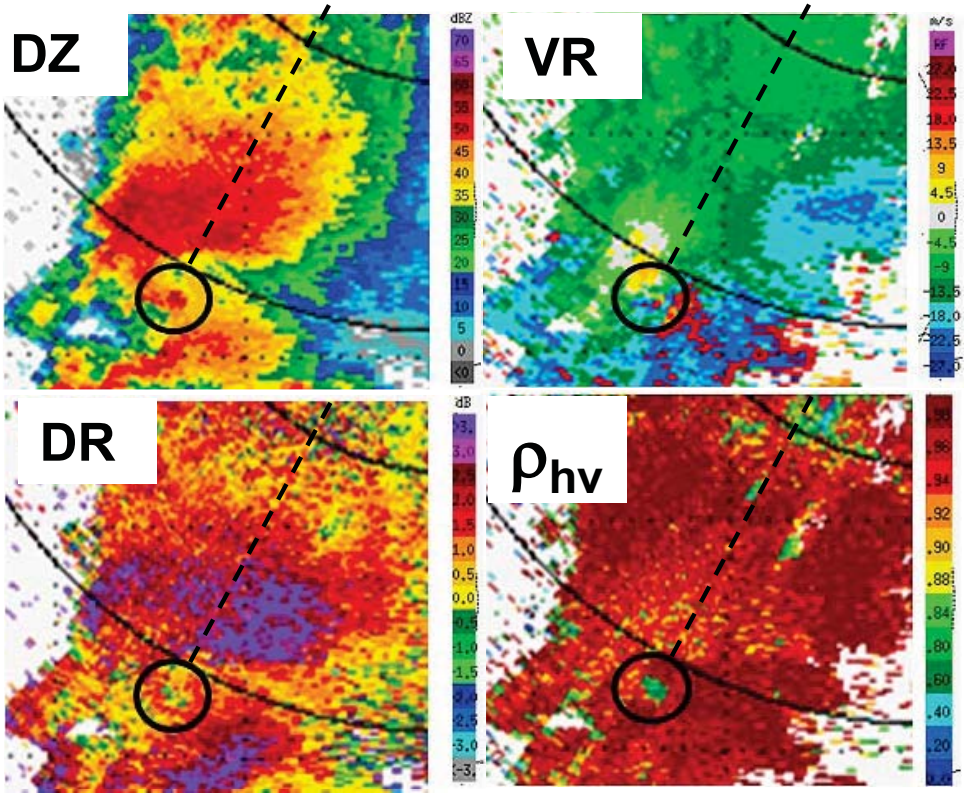
Scanning Flexibility (Temporal/Spatial sampling flexibility as needed)

- 360^{o} PPI Surveillance or Volumes
- PPI Sector Volumes: Azimuth sectors (0-360^{o}) and elevations (0-90^{o}) as desired
- Range Height Indicator (RHI): 0-90^{o} or other elevation as desired
- Vertically pointing: ZDR Calibration and/or Profiling mode
- Scanning scheduled and executed in repeating cycles as desired.

PPI Full/Sector Volumes (e.g., MC3E)

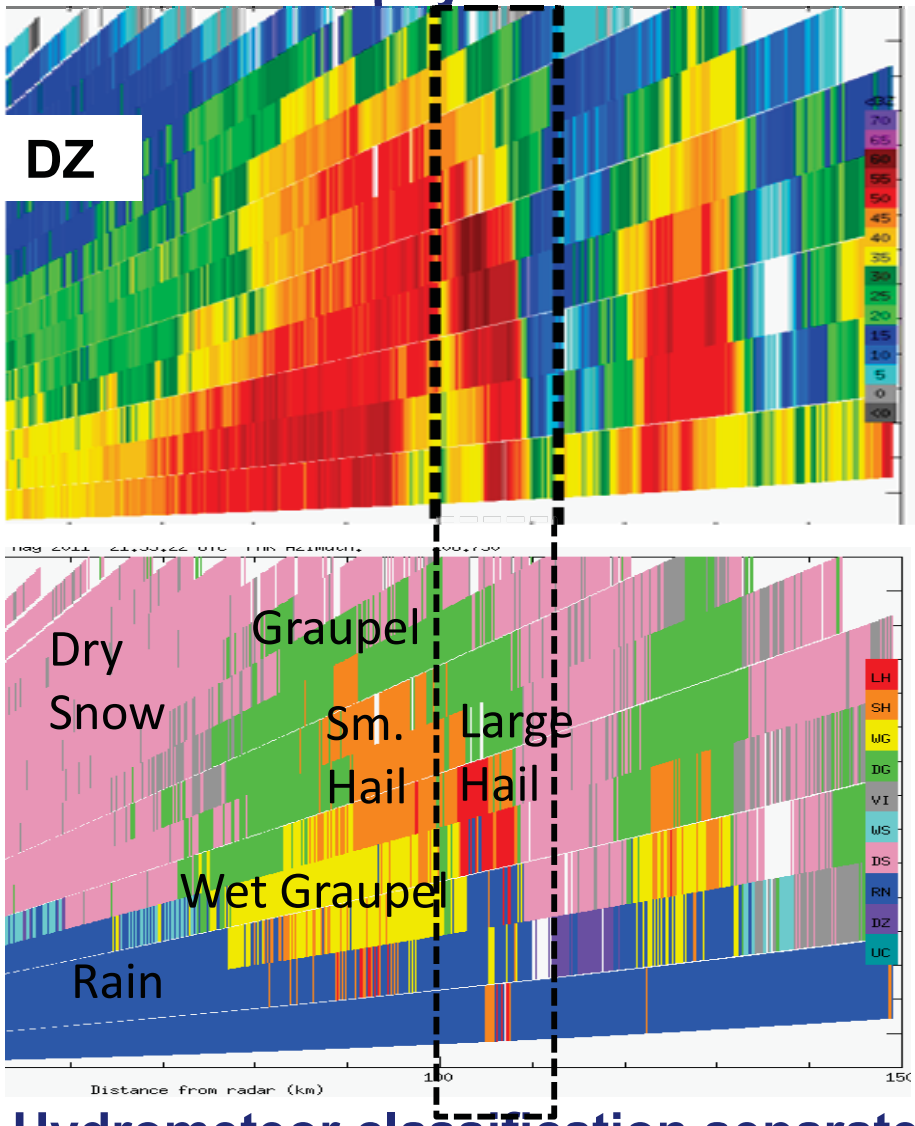
Sectors in MC3E Storms

24 May 2011: MC3E Sampling deep (tornadic) storms with NPOL



Dual-Pol mapping of hydrometeor types, debris

NPOL multi-parameter structure delineates microphysical characteristics



Hydrometeor classification separates ice and liquid particle types

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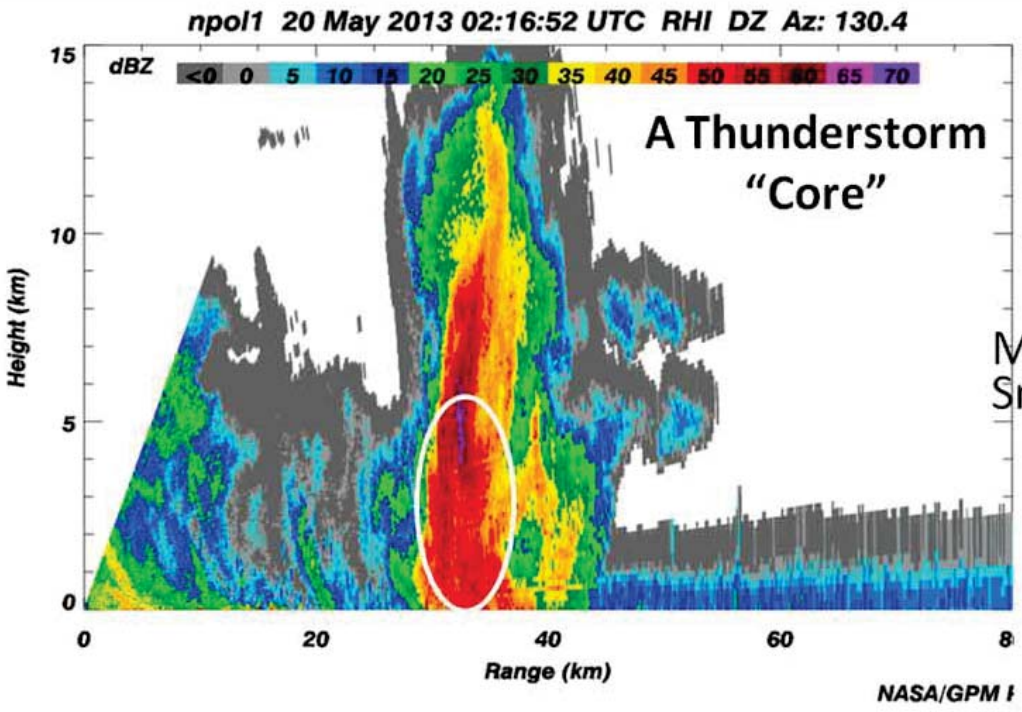
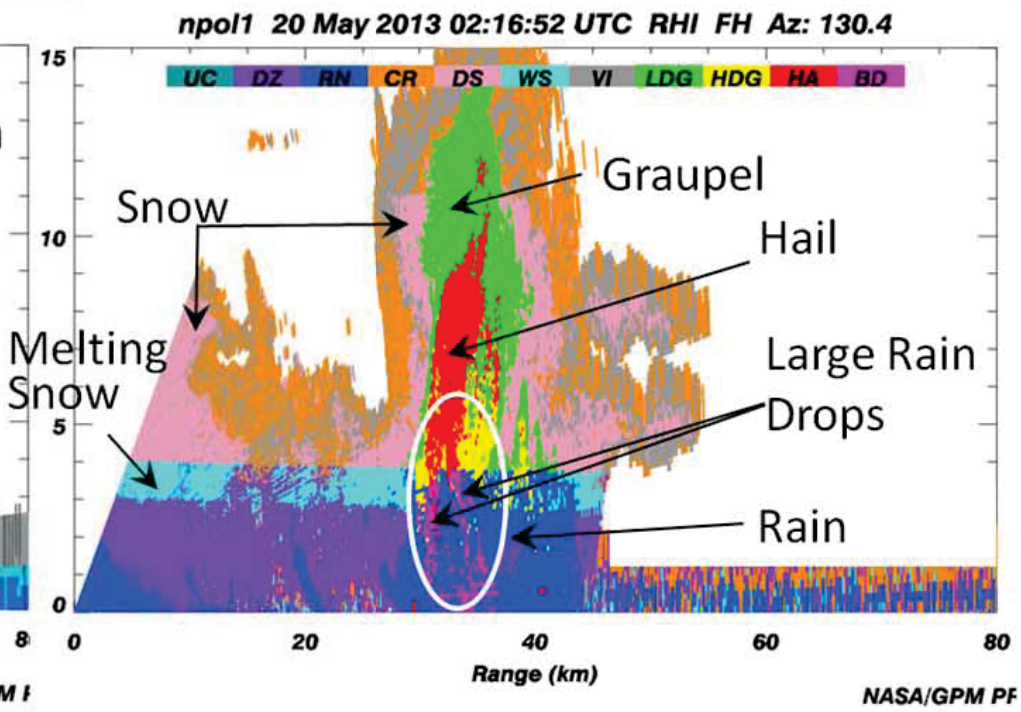
RHIs: Better-Resolved Column Process

Radar Reflectivity (returned power)



Diagnosed Precipitation Types



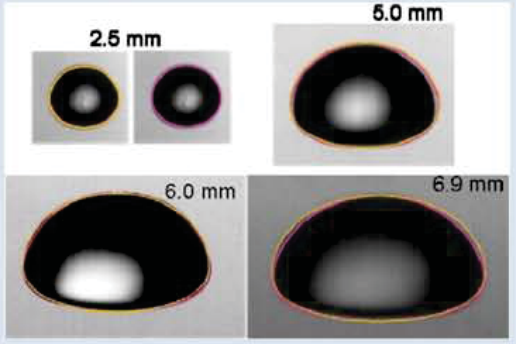
The "process" : Ice to Rain

Snow rimes

Graupel is formed

Graupel becomes *hail* and/or rain freezes and rimes to become hail

Rain drops (melting snow, hail, graupel)



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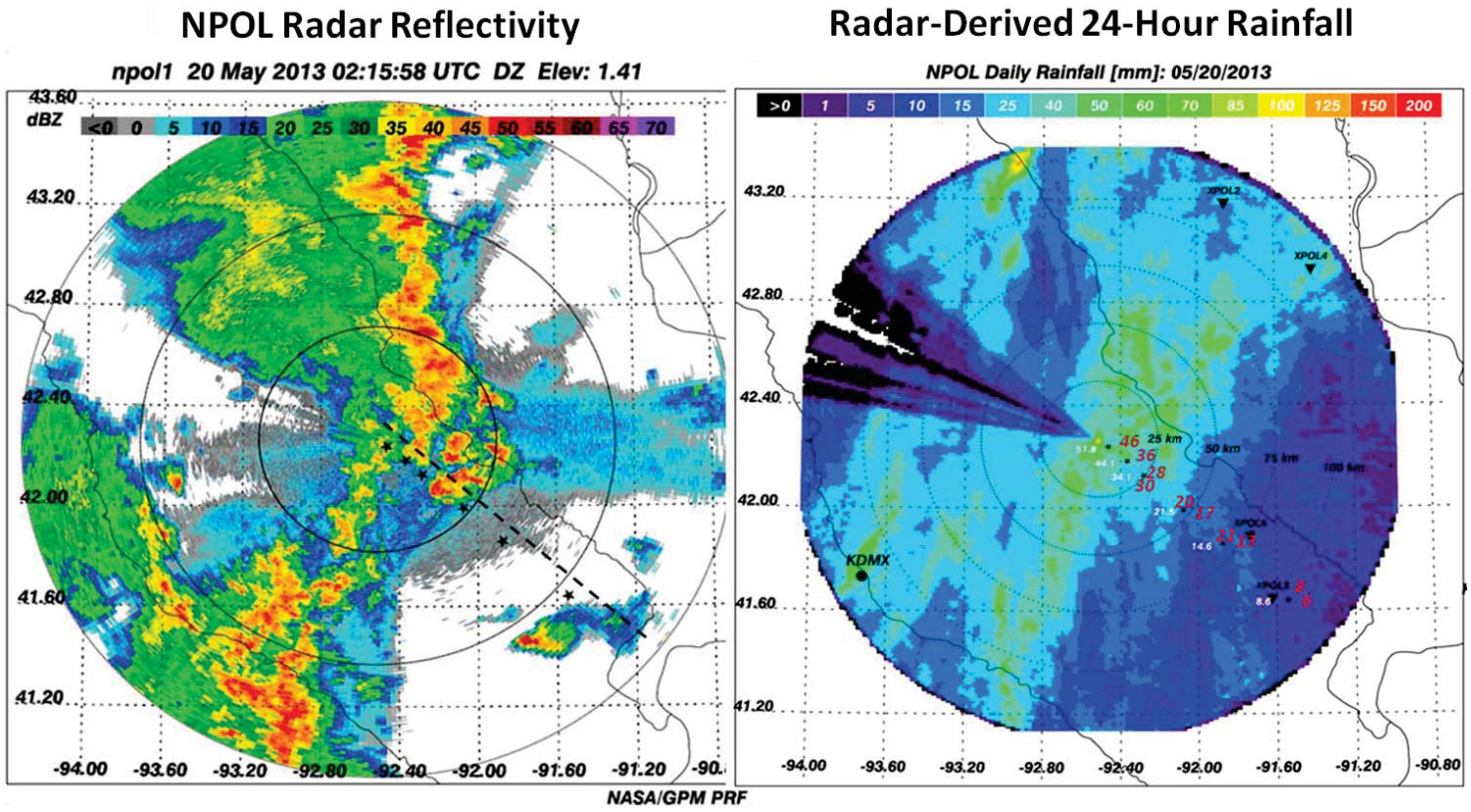
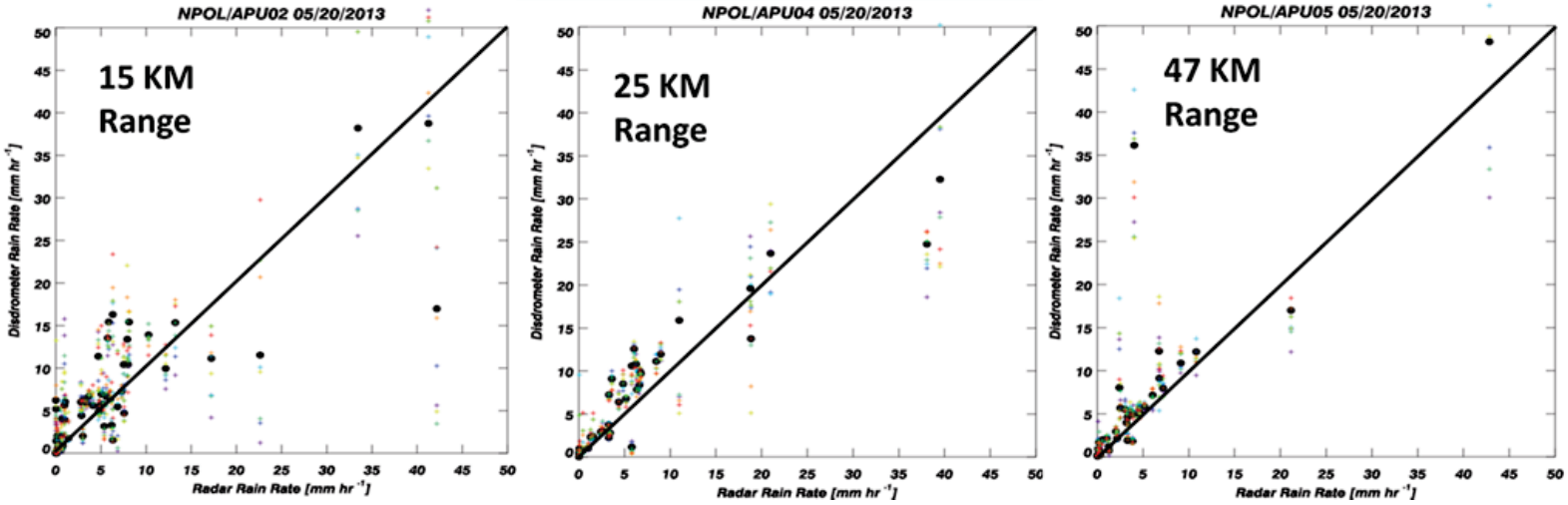
Rapid PPI Rain Scans: Rain mapping

Hybrid Dual-Pol Rain Estimator (DROPS)

Rapid Updates (< 3 min)

IFloodS DROPS 1-minute Parsivel-2 vs. NPOL rain rates





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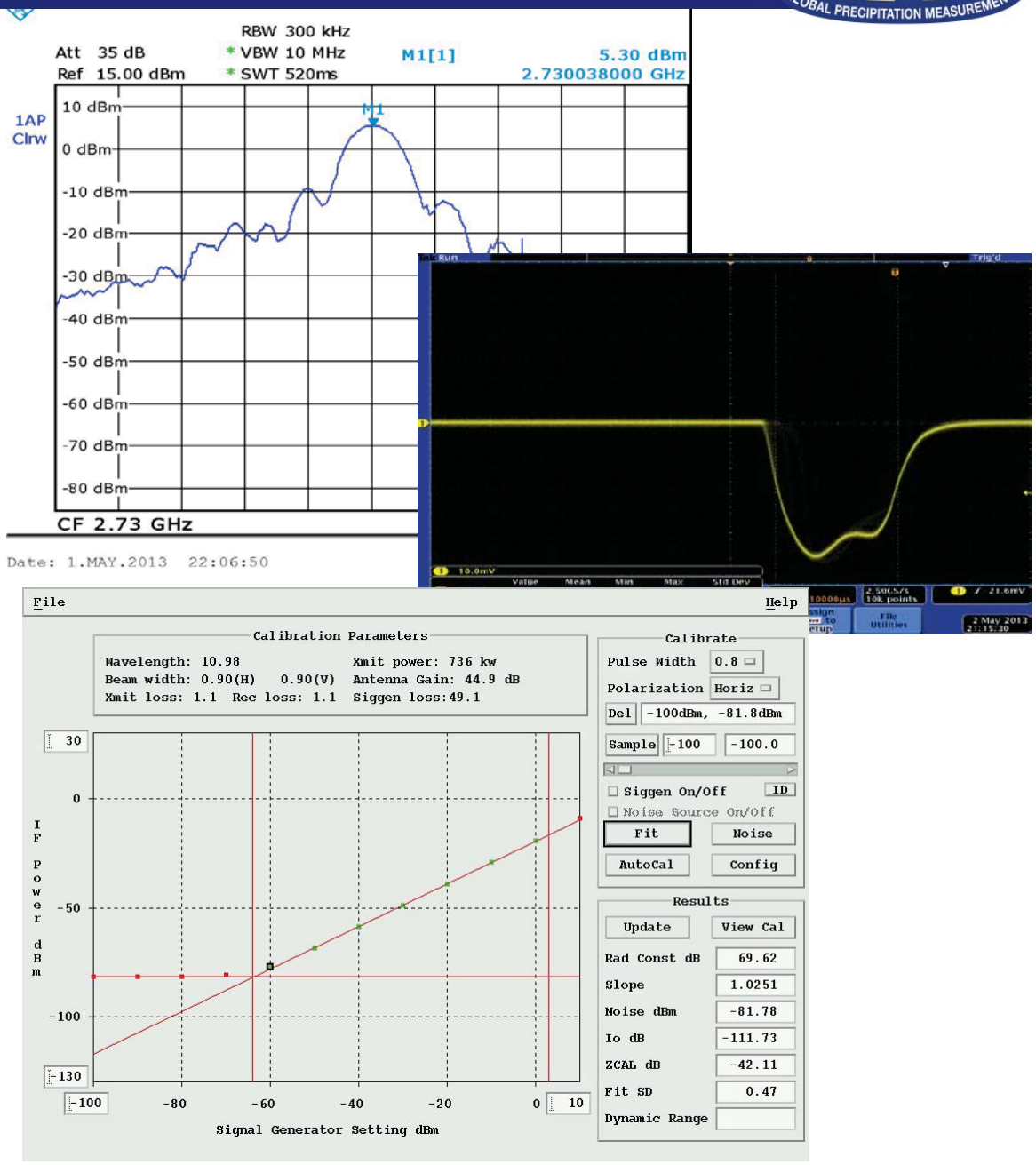
Standard Calibration Practices Employed

- Az/El. offsets (Solar Track w/A-Scope)
- Antenna Gain: Solar Cals, Sphere cal
- Transmitter: Measure/Monitor Average Power, frequency , PRF, and Pulse width
- Measure and adjust VSWR
- Receiver (IRIS ZAUTO utlility): Radar Constant, Noise, Z_0, SunCal (or Solar Scan utility)
- Use feed horn to verify polarization; also sun scans on receive end
- Bird-Bath scans to verify Z_{DR} offset
- Measure waveguide losses

Engineering and calibration log is maintained

All instrument test and measurement equipment is routinely calibrated at WFF



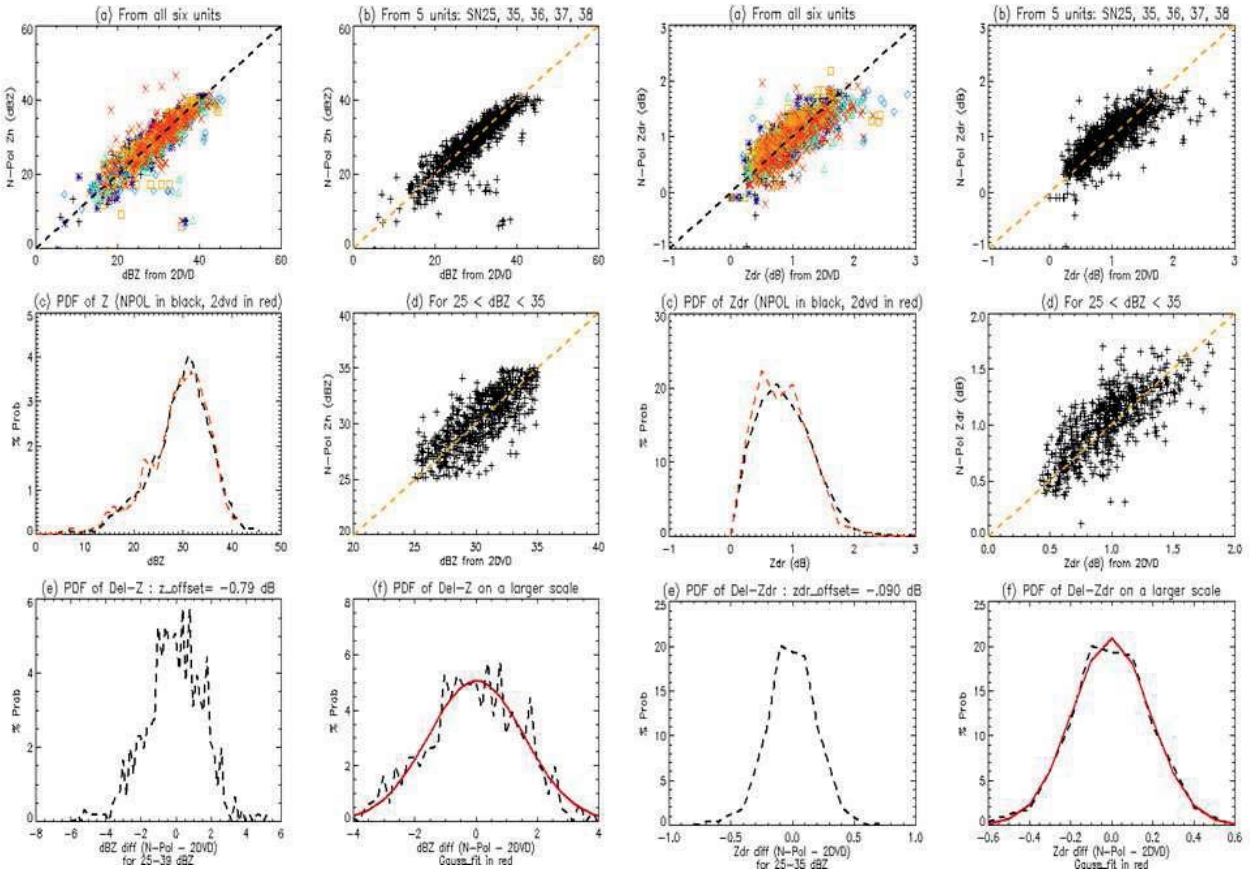
Calibration: Disdrometer , RCA

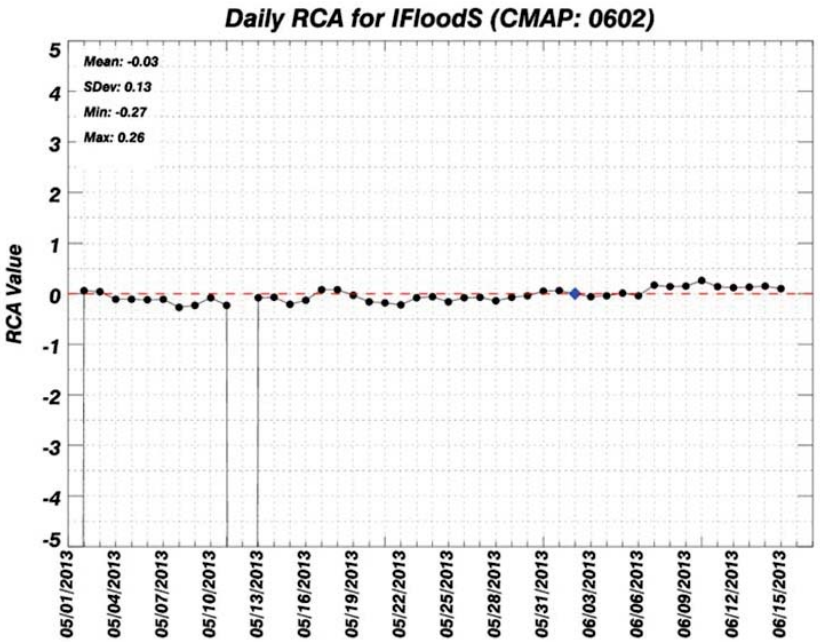
Assess Data Calibration (e.g., Z, ZDR bias) with 2DVD and scattering models (e.g., MC3E; Bringi et al., 2013)

Results similar to internal consistency methods and hardware-inferred

Z (NPOL) Vs. Z (2DVD)

ZDR (NPOL) Vs. ZDR (2DVD)





Having an "absolute" calibration, can then use known clutter statistics to monitor radar Relative Calibration Adjustment (RCA) stability with time for departures. (E.g., IFloodS, 2013 via D. Wolff et al.)

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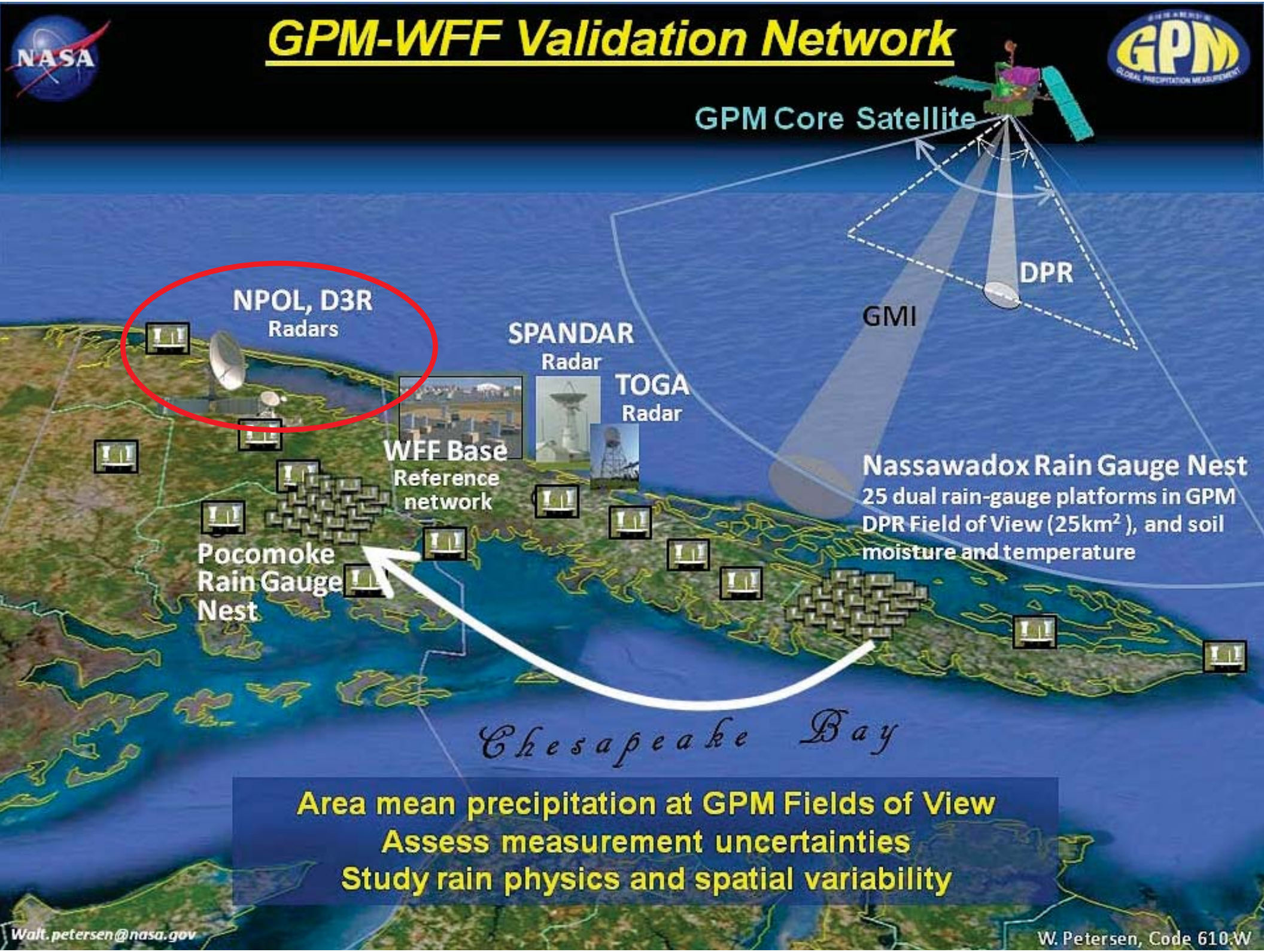
GPM-WFF Validation Network
GPM Core Satellite
DPR
GMI
NPOL, D3R
Radars
SPANDAR
Radar
TOGA
Radar
WFF Base
Reference
network
Nassawadox Rain Gauge Nest
25 dual rain-gauge platforms in GPM DPR Field of View (25km^2), and soil moisture and temperature
Pocomoke
Rain Gauge
Nest
Chesapeake Bay
Area mean precipitation at GPM Fields of View
Assess measurement uncertainties
Study rain physics and spatial variability
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Thank You!
NPOL “Home” Newark, Maryland