

National Aeronautics and Space Administration



Jet Propulsion Laboratory
California Institute of Technology

Soil Moisture
Active Passive
Mission
SMAP

ComRAD Active / Passive L Band Instrument System

Peggy O'Neill

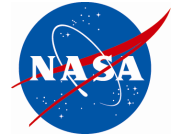
NASA Goddard Space Flight Center

3rd Cal/Val Workshop

Nov. 14-16, 2012



ComRAD Active / Passive L Band Instrument System



Frequency: 1.403-1.424 GHz L radiometers;
1.25-1.3 L band radar

Polarization: dual pol radiometers (LH and LV)
quad pol L radar (HH,VV,VH, HV)

Antenna: 1.22 m parabolic dish w/broadband
feed

Incidence Angle Range: 0° - 175°

Azimuth Angle Range: 0° - 300° autonomous
 0° - 360° manual

Platform: 19-m hydraulic boom truck

Power: standard AC line power

TIR sensor installed for scene temperature

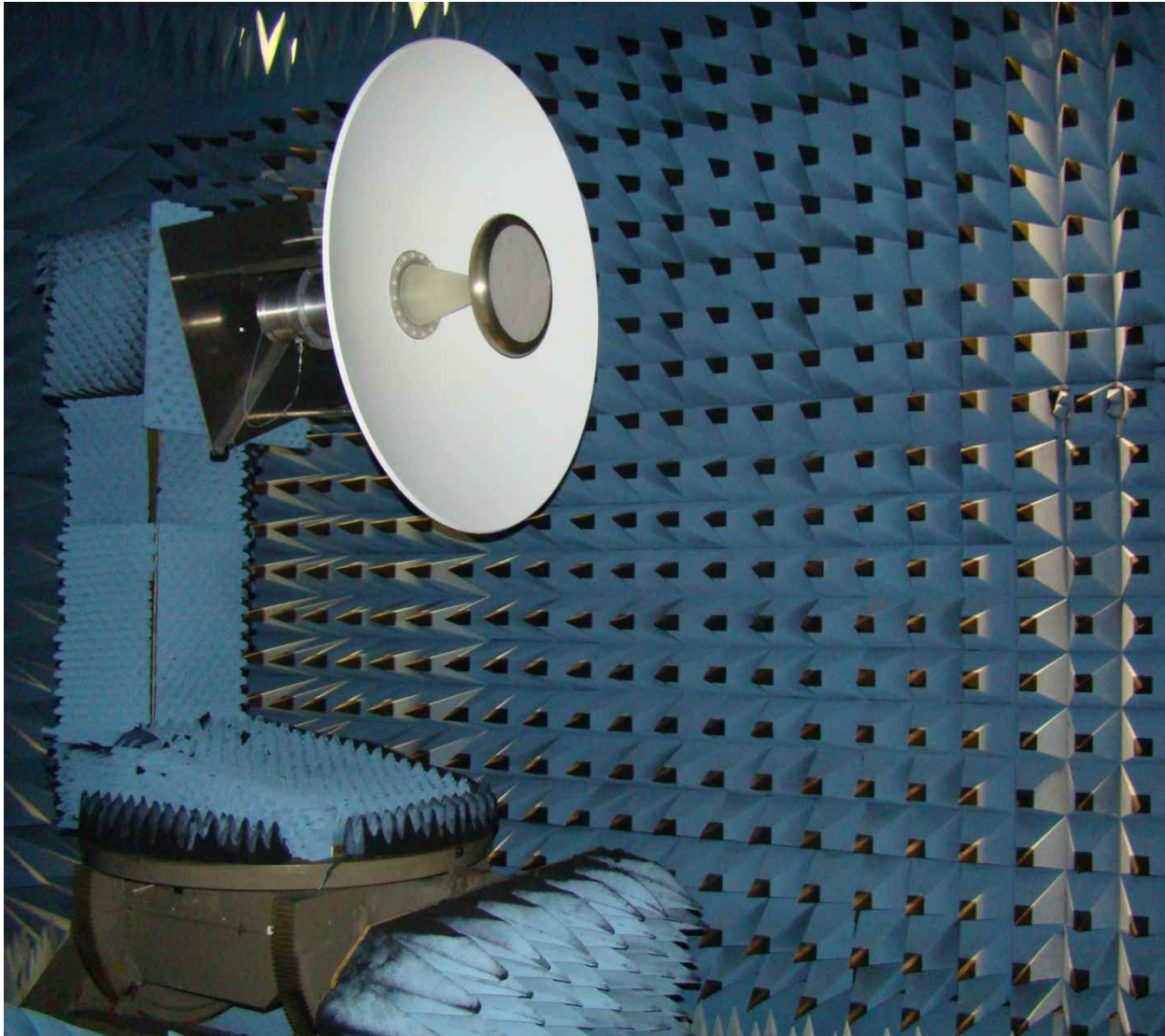
Can accommodate CropScan VISIR sensor



Deployed Over Corn Stubble During SMAPVEX08 (Oct. 2008)



Anechoic Chamber Tests

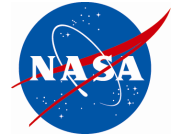


*Performance check
of new antenna
reflector and feed
system in GSFC's
anechoic chamber
on February 24, 2012*

- new system is
very low loss*
- additional pattern
measurements
made in March
2012*



ComRAD Crop Active / Passive Experiment [APEX12]

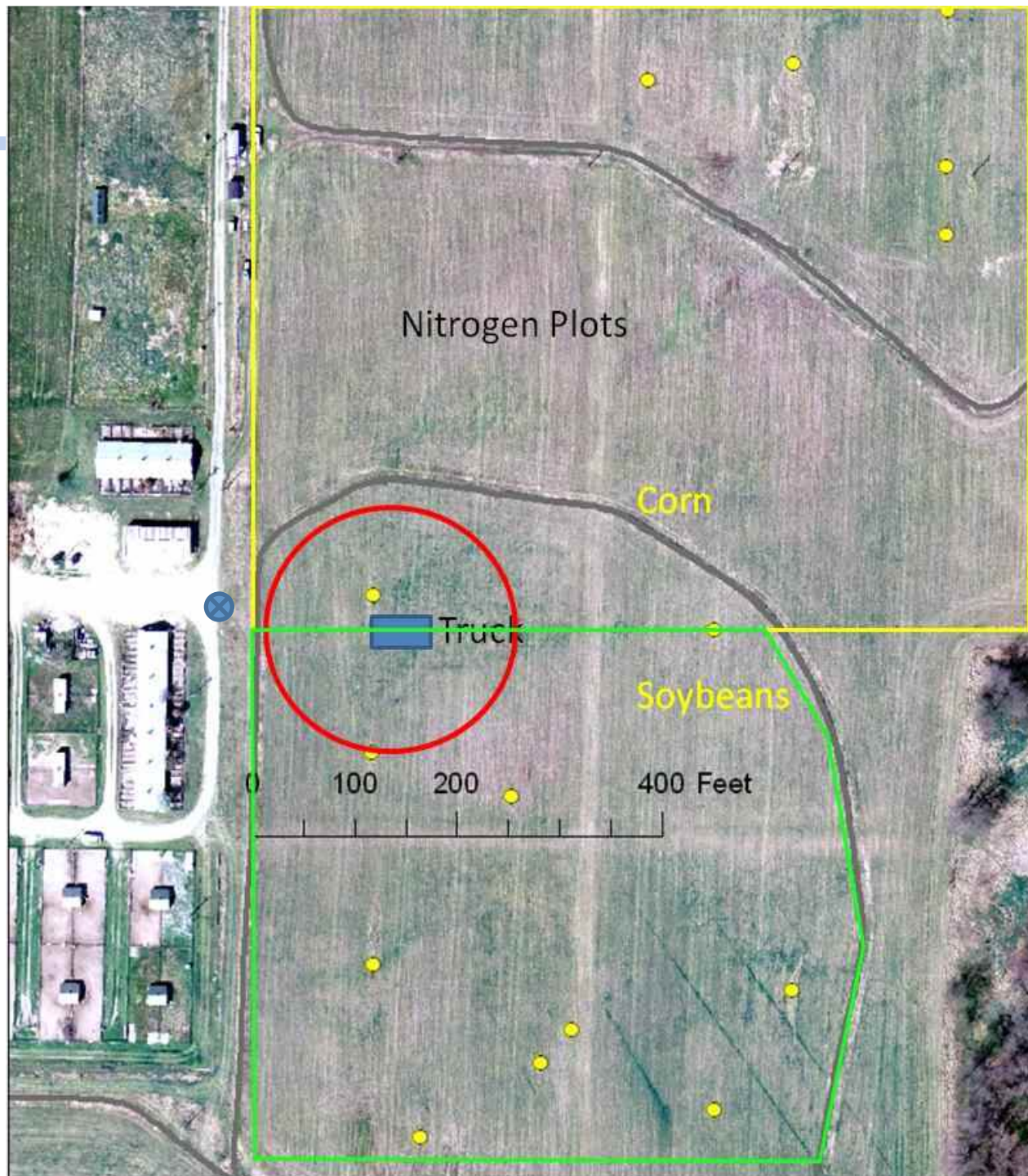


- **Objective** – to obtain a continuous active/passive L band data set over an entire growing season for use in refining SMAP algorithms
- **Location** – USDA OPE3 test site a few miles from GSFC
- **Crop Cover**
 - measure two crops simultaneously (corn to north of truck staging area, soybeans to the south)
- **Autonomous data collection to maximize efficiency**
 - manual external radiometer calibration once per week (sky, absorber)
 - truck boom stowed & measurement series temporarily interrupted whenever rain/thunderstorms were forecast -- frequently, though overall field conditions were very warm and dry all summer; corn canopy stunted due to drought
- **Use of new very low loss antenna system and thermal control to maintain system calibration and to resolve small signals**



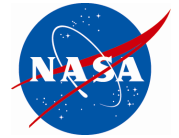
USDA OPE3 Test Site Subwatershed C

- site is a few miles down the road from GSFC
- N-S rows
- corn to north of truck, soybeans to south
- AC power installed at site
- corn planted ~ May 16, sprayed May 24, harvested October 17-18
- soybeans planted June 14, harvested October 26
- SCAN station to SW; flux tower to NE

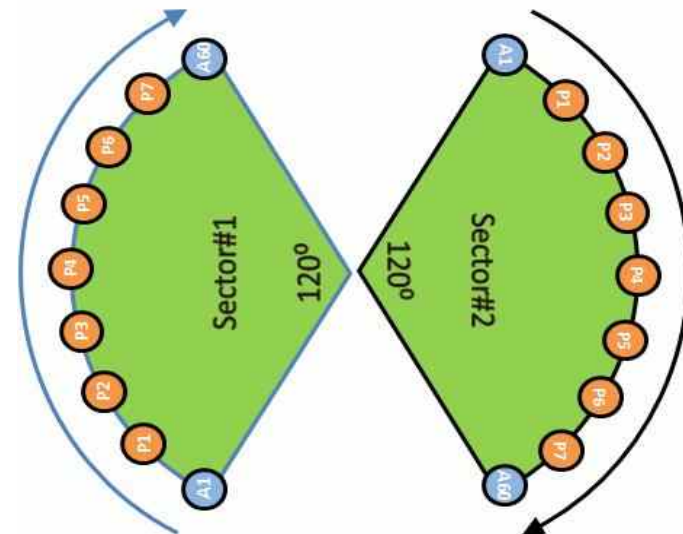




ComRAD L-band Active/Passive Measurements Summer 2012



- **Vegetation Types:** Corn and Soybeans planted
- **Duration:** June 1 to mid-October, 2012 (planting to harvest)
- **L-band Active/Passive** data were acquired at a look angle of 40° from nadir at both horizontal & vertical polarization
- **Radar** - 120° azimuthal scan in 4 min. (60 independent measurements)
- **Radiometer** measurements every 15° in azimuth in a span of 120° in 20 min. (7 independent measurements)
- **Plant** architectural measurements of stalk and leaf sizes, orientations and densities on each field (weekly)
- **In situ** soil moisture, soil temperature & leaf wetness measurements made (also TIR measurement from ComRAD)





APEX12 Calendar [■ = data taken]



~ June 2012 ~						
May	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
						1
						2
	3	4	5	6	7	8
	9	10	11	12	13	14
	15	16	17	18	19	20
	21	22	23	24	25	26
	27	28	29	30	31	

~ July 2012 ~						
June	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
	1	2	3	4	5	6
	7	8	9	10	11	12
	13	14	15	16	17	18
	19	20	21	22	23	24
	25	26	27	28	29	30
	31					

~ August 2012 ~						
July	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
				1	2	3
				4	5	6
	7	8	9	10	11	12
	13	14	15	16	17	18
	19	20	21	22	23	24
	25	26	27	28	29	30
	31					

~ September 2012 ~						
August	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
						1
	2	3	4	5	6	7
	8	9	10	11	12	13
	14	15	16	17	18	19
	20	21	22	23	24	25
	26	27	28	29	30	31



APEX12 Cover Crops



Corn



060112



070312



071012



081112



091712



101812

Soybeans



060112



070312



071012



081112



091712



101812

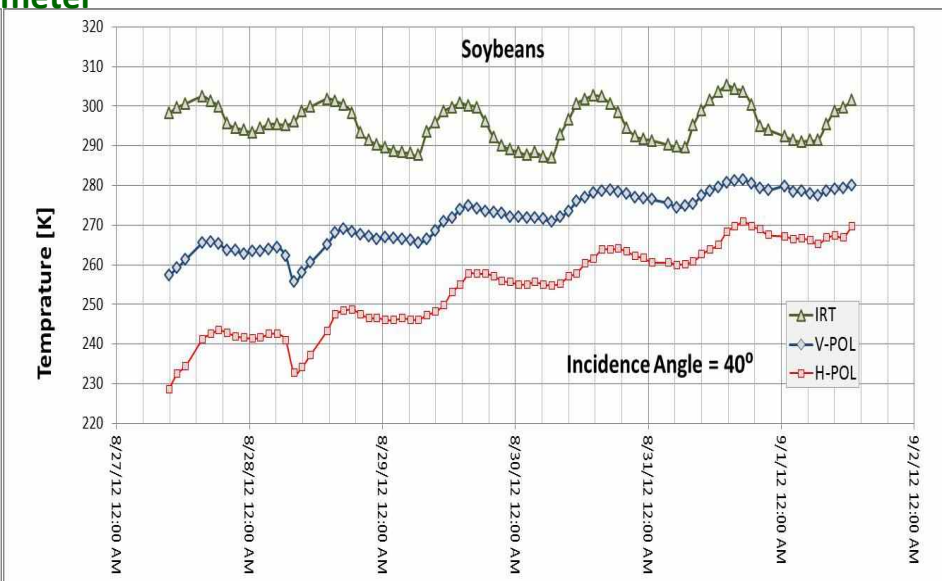
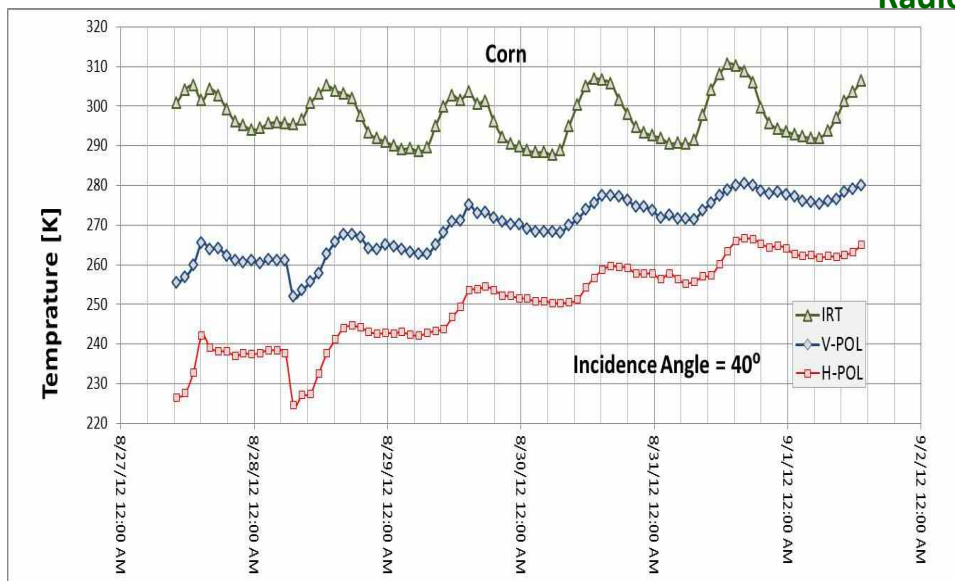


Example of ComRAD Time Series Data

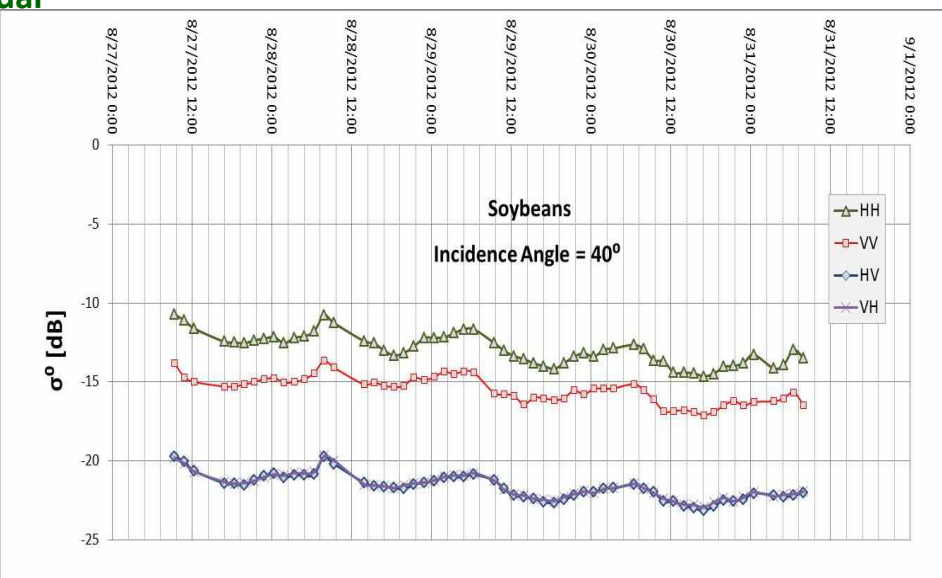
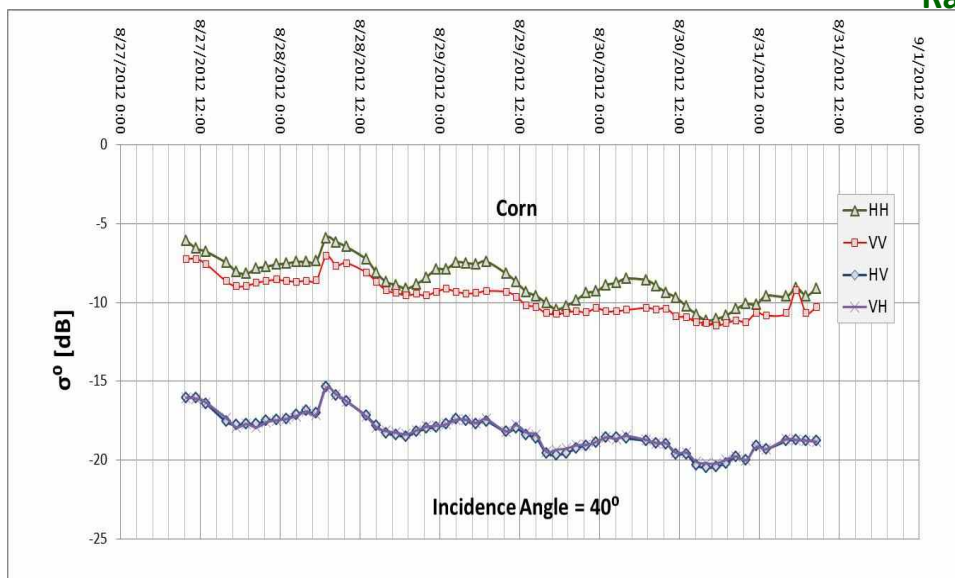
August 27 – September 1, 2012



Radiometer



Radar

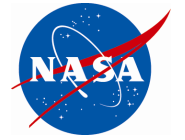




Summary



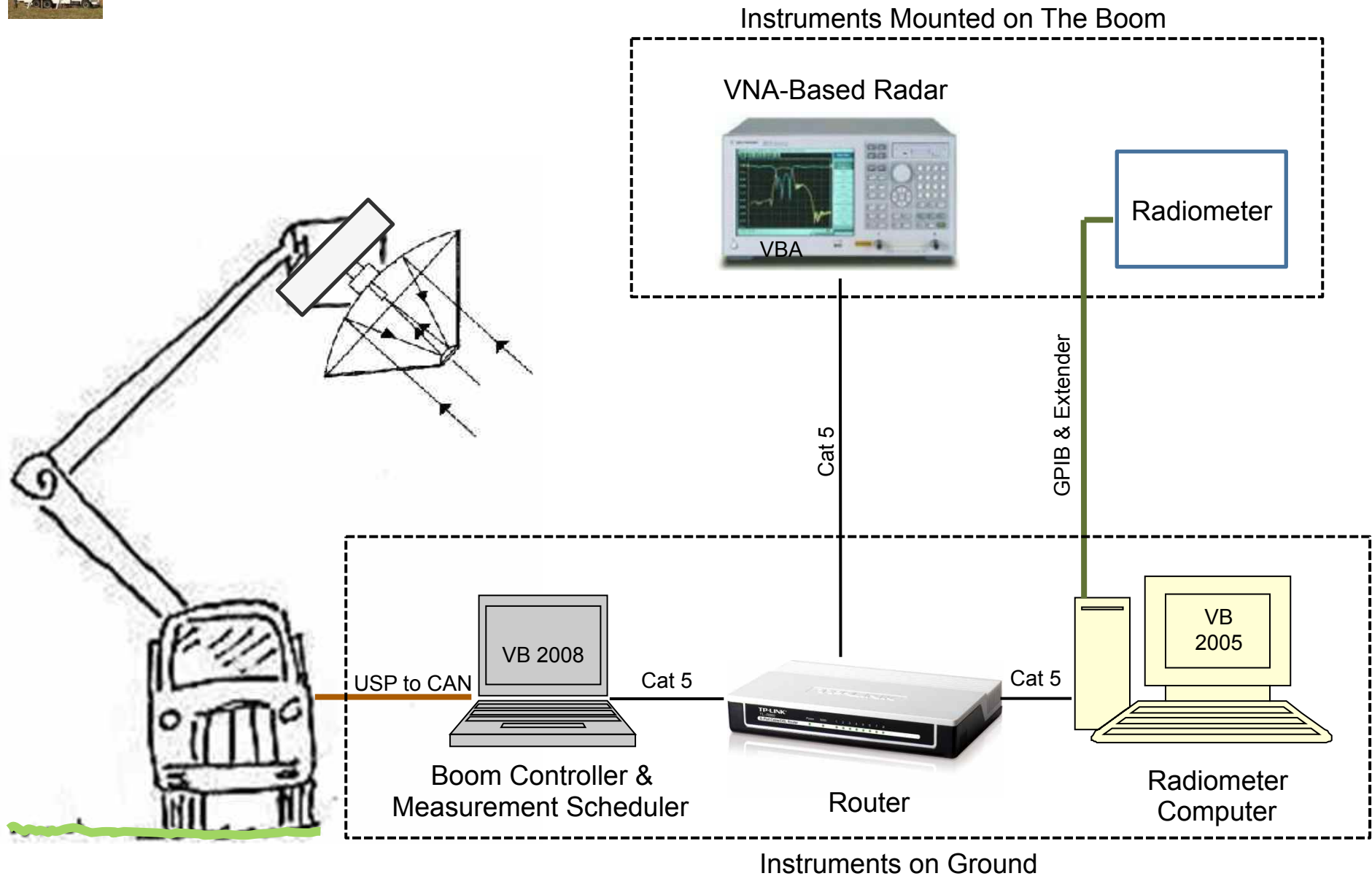
- corn planted 5/16, sprayed 5/24, and harvested 10/17-18; soybeans planted 6/14 and harvested 10/26
- ComRAD measurements June 1 – Sept. 26, plus additional measurements in mid-October with corn harvested & soybeans at full senescence
- Final external radar calibration has been completed and instruments removed for the winter [we just beat Hurricane Sandy!]
- Three months of preliminary ComRAD and ground truth data have been delivered to JPL so far
- Complete final data set will be delivered when all data files have been checked (~ end of November)
- Mike Cosh / USDA will do quality check and calibration of all ground truth data before delivery to JPL



BACKUP

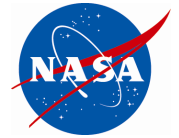


New Communication/Control Set-up





ComRAD Automated Boom Motion



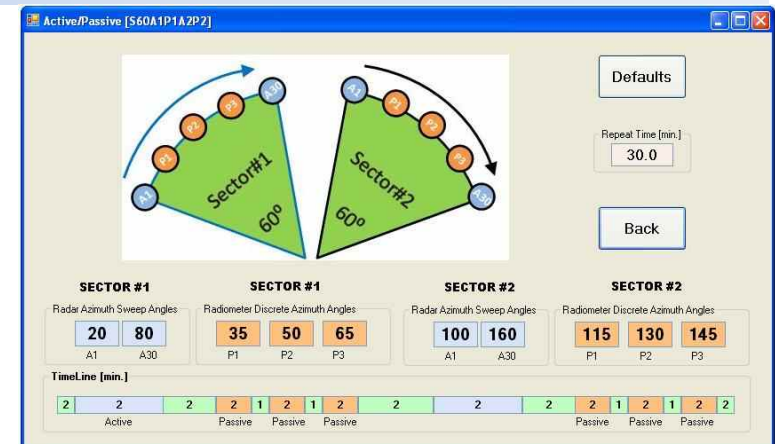
- A Controller Area Network (CAN) computer controls boom motion.
- CAN computer is connected to hydraulic actuators and position sensors via the CAN network.
- CAN computer is controlled remotely from a laptop computer via a serial port.
- The motion program resides on the laptop computer.
- Boom motion is fully automated for area sweeps and stationary look angles.
- Automation is fully functional.



Boom Controller & Measurement Scheduler



Screen shots of new autonomous control program



Boom Controller

Rotation Command
Absolute Angular Position: 80
Steady State Angular Velocity: 2
Send
☒ Motion Enabled

Rotation Feedback
Current Angular Position: 20.50
Instantaneous Angular Velocity: 1.90
Motion Status: Moving
Position Status: Out of Position
Velocity Status: At Speed
Function Status: Normal
Stop

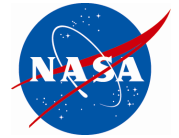
Inclination Command
Absolute Angular Position: 0.00
Steady State Angular Velocity: 0.00
Send
☒ Motion Enabled

Inclination Feedback
Current Angular Position: 0.00
Instantaneous Angular Velocity: 0.00
Motion Status: Stopped
Position Status: In Position
Velocity Status: Not at Speed
Function Status: Normal
Stop

Select Modes
☐ S60A
☐ S60P
☐ S60AP
☒ S60APAP
☐ S60AAP
☐ S60AA
☐ S60PP
☐ S120A
☐ S120P
☐ S120AP
☐ S120APAP
☐ S120AAP
☐ S120AA
☐ S120PP
☐ Single P.
Set Mode

Mode Command
Two 60-Degree Sectors
Active->Passive->Active->Passive
Enable Stop

Measurement Feedback
Radar Status
Currently: Measuring...
Remaining Time: 1 min 36 sec
Elapsed Time: 0 min 24 sec
Radiometer Status
Currently: Sleeping...
Remaining Time: 3 min 36 sec
Elapsed Time: 2 min 24 sec
Measurement Status
Completed Days: 0 day(s)
Completed Cycles: 0 of 48 cycles
RepeatTime: 30 minutes
Remaining Time: 27 min 36 sec



Schedule [APEX12]

- **February / March:**
 - first test of new antenna and feed in anechoic chamber on 2/24/12
 - finish matched network
 - additional tests as needed in chamber to fully characterize performance of new antenna system
 - standard linearity test of radiometer components in GSFC lab (done every year)
- **April:**
 - reinstall all equipment on truck instrument platform
 - build instrument sun & rain shades as needed and install on truck platform
 - do final balancing of autonomous movement and calibration of program parameters
 - perform external calibration of radar & radiometer at GSFC
- **Beginning of May**
 - farm manager at USDA plants corn at OPE3 test site (depends on weather & other factors)
 - deploy ComRAD to OPE3 just after corn planting
 - might have to temporarily remove truck from field during atrazine spraying
- **Beginning of June**
 - farm manager at USDA plants soybeans at OPE3 test site (depends on weather & other factors)
 - might have to temporarily remove truck from field during soybean planting
- **Nominal science measurements May - October**
 - from planting at beginning of May to harvest in mid-October
 - manual calibration once per week (more often if needed)
 - truck boom will be stowed & measurement series temporarily interrupted if heavy rain/thunderstorms are forecast
- **Already completed:**
 - autonomous boom movement program & measurement control program & interfaces written
 - power installed at USDA OPE3 site



October 3-5, 2012

SDT #9

UMD Tobacco Farm Corn Dew Experiment 2007



Weather / Field Conditions Affect Crop Cover, Scheduling, Logistics, etc.



Impossible field conditions at OPE3 Subwatershed C in Fall 2011 prevented planting of winter wheat

