The Arm Climate Research Facility Instrument and Measurements - Process and Constraints

Jimmy Voyles

Instrument and Field Campaign Coordination

Atmospheric Radiation Measurement Climate Research Facility U.S. Department of Energy

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Acknowledgements

- Operations Team
- Data System Engineering
- Instrument Mentors
- Data Quality Office
- Science Translation
- Science Team

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Presentation Summary

- Mission
- Introduction
- Process
- Core Instrumentation
- Constraining Measurements, An Example
- Complimentary Products and Research
- Conclusion

Mission

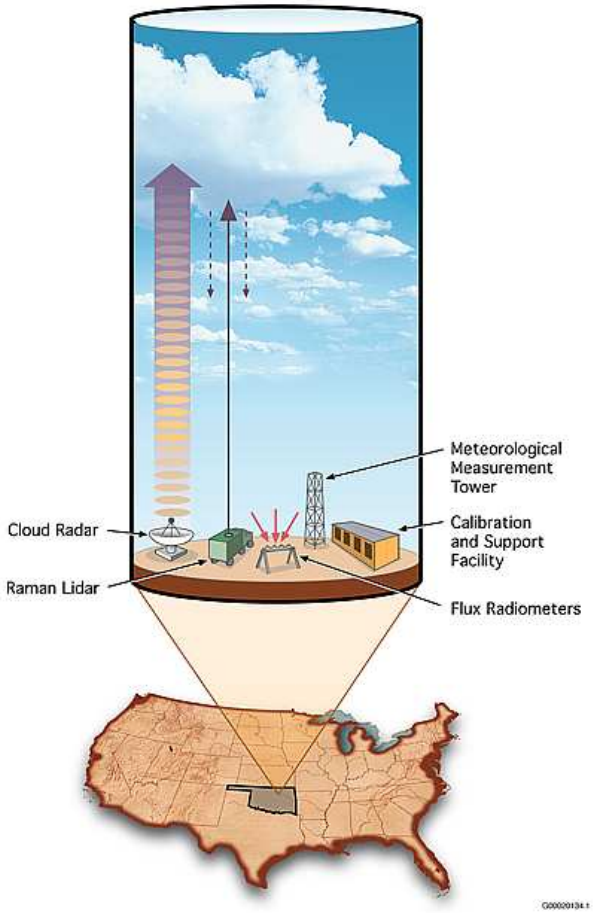
Clouds and Radiative Feedback

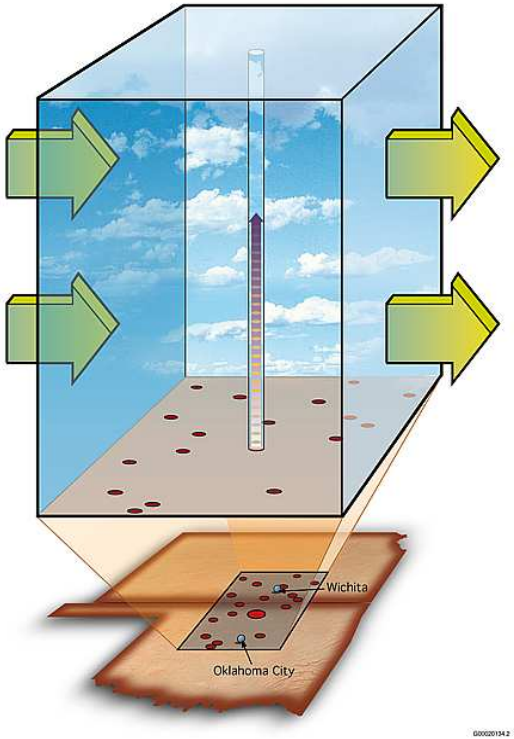
- Improve the scientific understanding of the fundamental physics related to interactions between clouds and the radiative feedback processes in the atmosphere.

Continuous Field Measurements

- To provide data products that promote the advancement of climate models.

Mission





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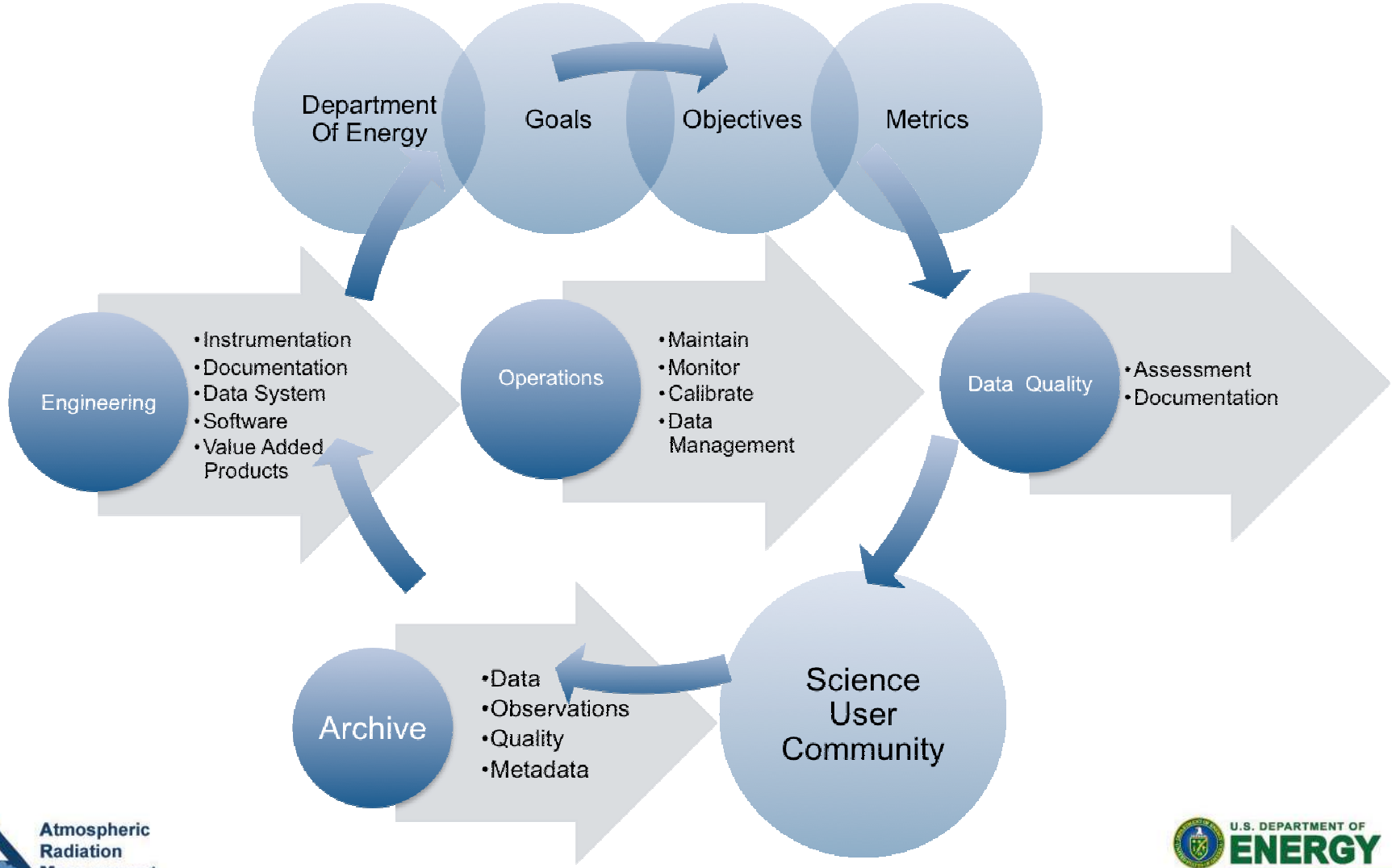
Introduction

- Operate established baseline instruments and measurements
- Manage changes and additions to instruments and measurements
- Archive all data and metadata
- Review and document all data product (measurement) information and quality
- Provide access to measurement data and quality information

Introduction

- Address priority - science questions, data products, and instrumentation
- Infrastructure includes - Operations, Engineering, Science Translators, and Data Quality
- Management and Objectives - Infrastructure Management Board
- Input and Consultation - Science Team, Science Working Groups, and Science and Infrastructure Steering Committee

Introduction



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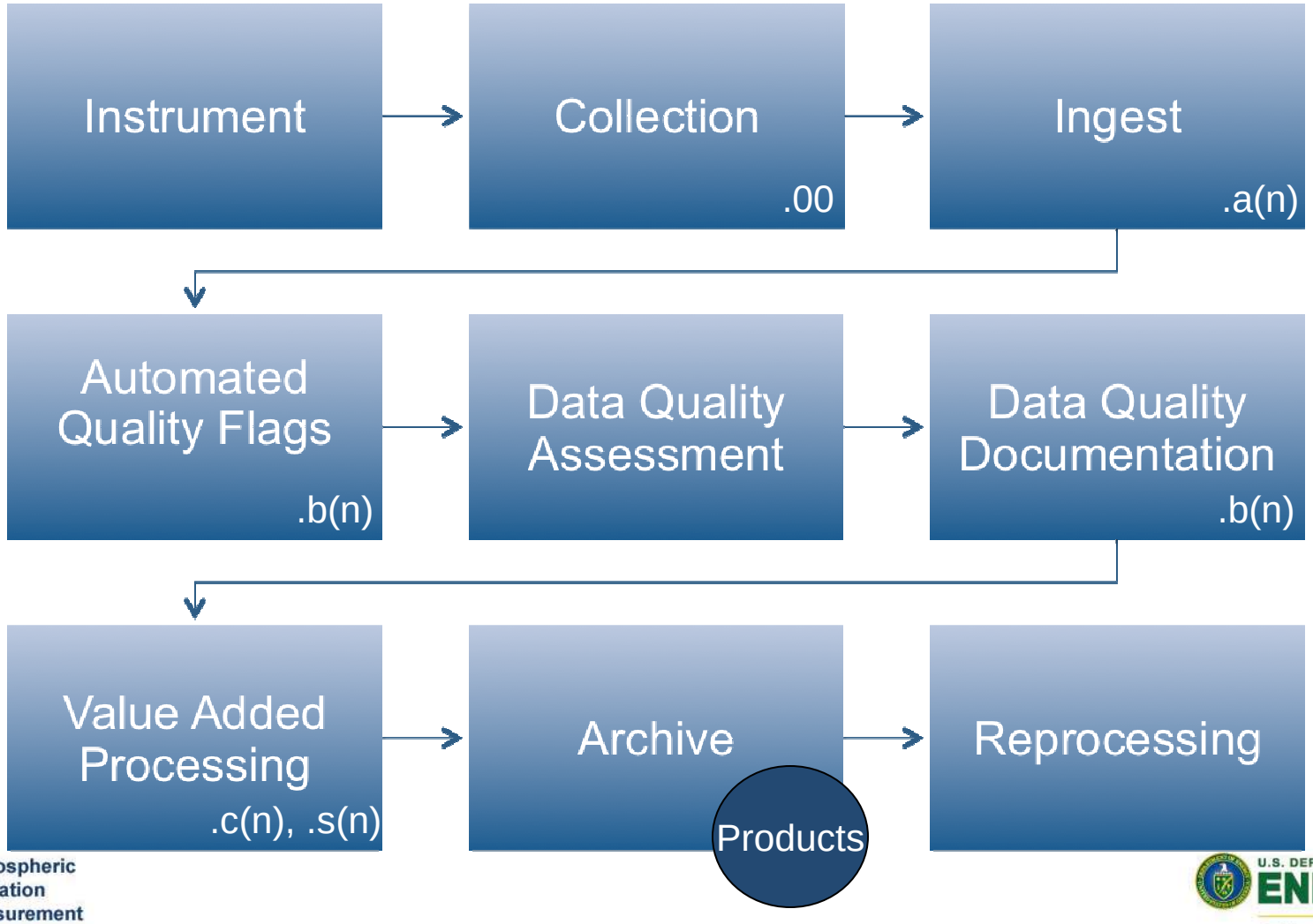
Process

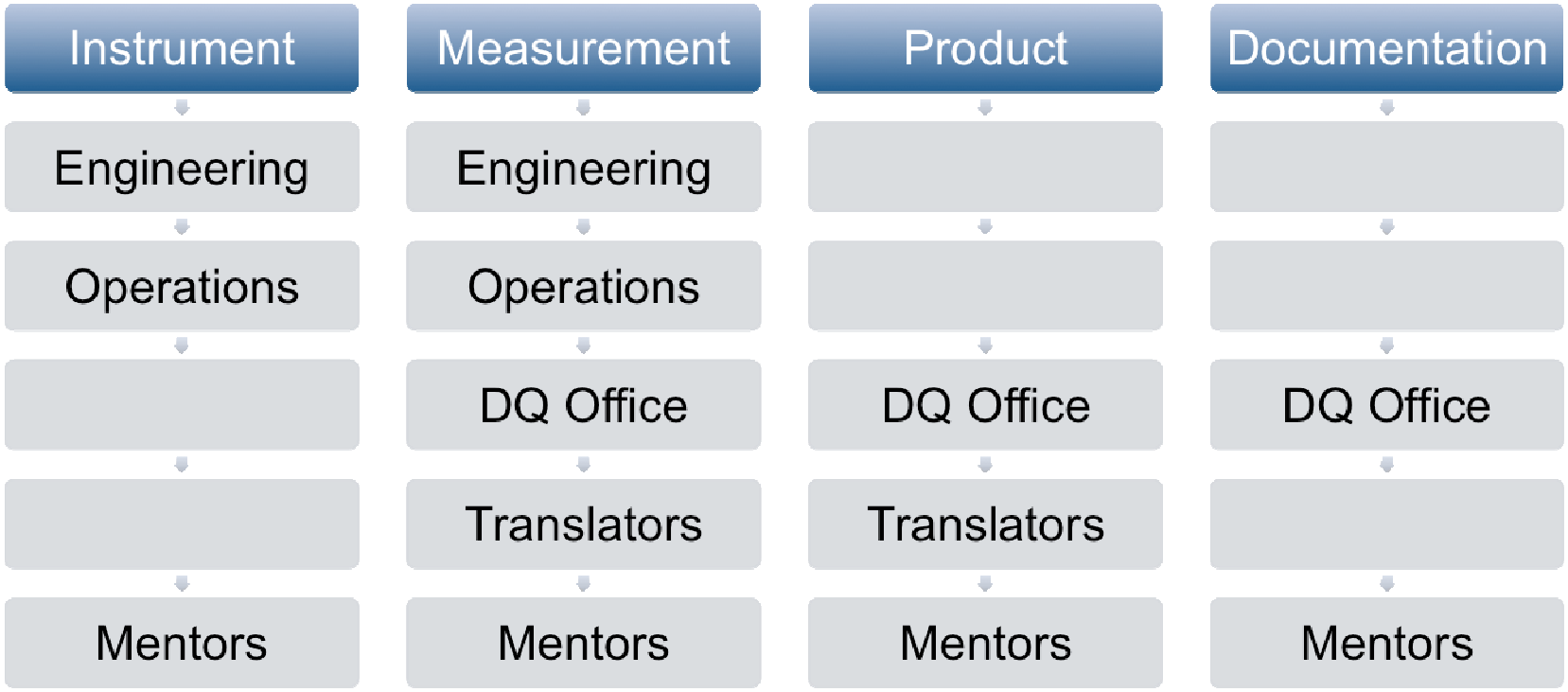

Data Levels
Raw (.00)
Engineering Units {.a(n)}
Data Quality Flags Added {.b(n)}
Value Added Processing {.c(n)}
Summary of {.c(n)} With Quality Flags {.s(n)}

Process

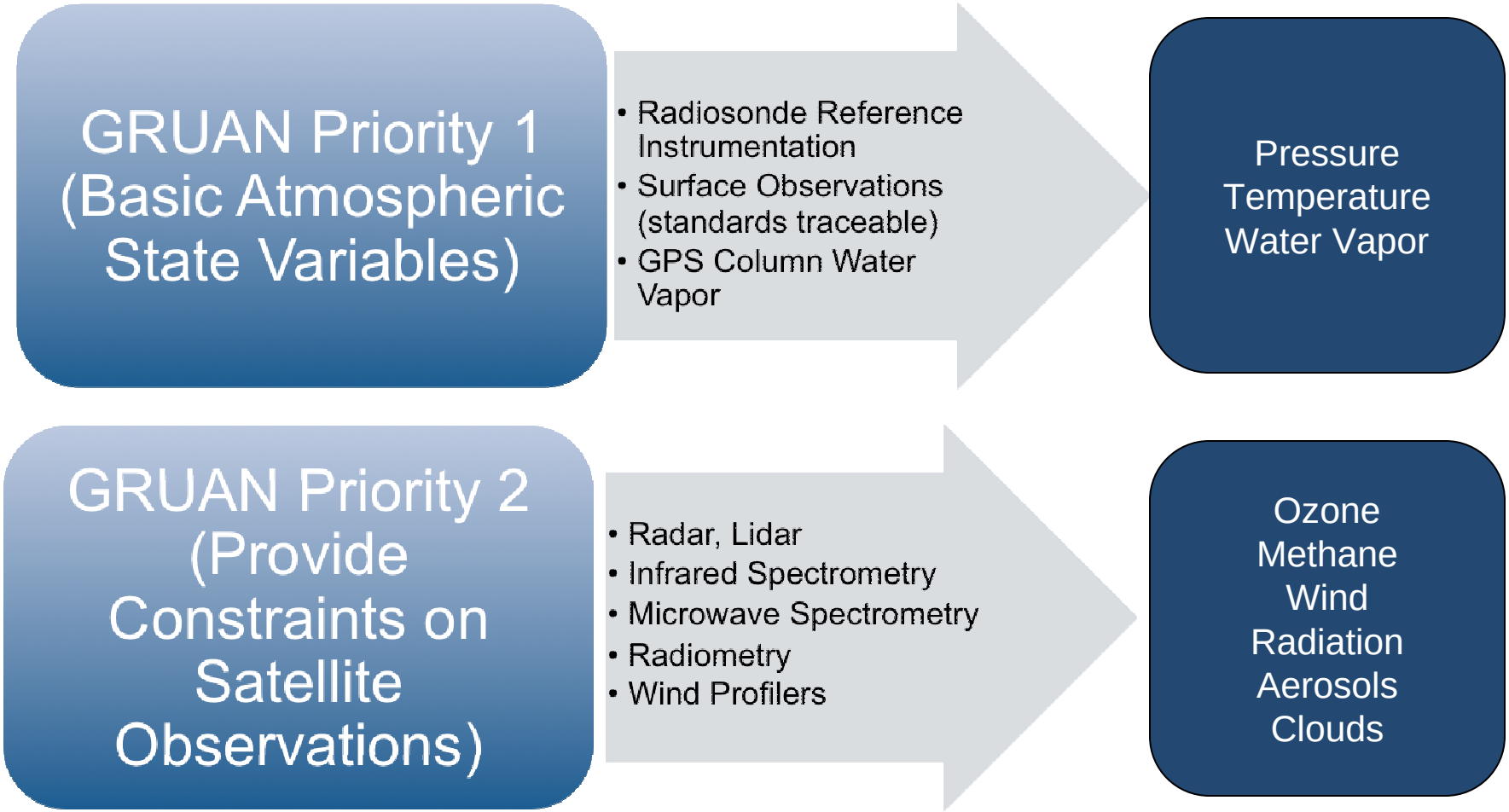

Instrument
Collection
.00
Ingest
.a(n)
Automated Quality Flags
.b(n)
Data Quality Assessment
Data Quality Documentation
.b(n)
Value Added Processing
.c(n), .s(n)
Archive
Products
Reprocessing

Process

- Instrument, Measurement and Product Management – Key Roles



Core Instrumentation - GRUAN



Core Instrumentation - ACRF

- Instruments Grouped By Classification
  - Aerosols
  - Radiometric
  - Atmospheric Profiling
  - Cloud Properties
  - Surface Meteorology
  - Surface/Subsurface Properties
- Approximately 50 types of instruments—with ~160 installed at research sites, and growing

Core Instrumentation - ACRF

Surface Temperature and Humidity Reference System for Sondes

Temperature, Humidity, Wind, and Pressure Sensor

Surface Meteorological Instruments

Balloon-Borne Sounding System

SuomiNet Global Positioning System – Value Added Product

GRUAN Priority 1 – Pressure, Temperature, Water Vapor

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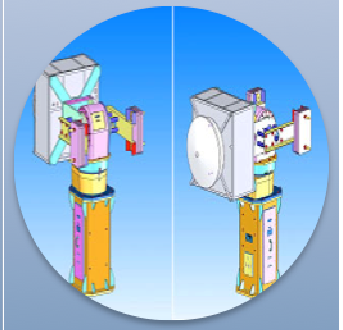
Core Instrumentation - ACRF

Atmospherically Emitted Radiance Interferometer, Vertical profiles of temperature and water vapor mixing ratio

Raman Lidar, Vertical profiles of water vapor mixing ratio, cloud, and aerosols related quantities

Radar Wind Profiler, Horizontal winds, vertical velocities, and virtual temperature

Microwave Radiometry, Vertical profiles of precipitable water vapor and liquid water path



Radars, Ka-Band, W-band, Vertical profiles of cloud reflectivity and velocity

GRUAN Priority 2 – Ozone, Methane, Wind, Radiation, Aerosols, Clouds

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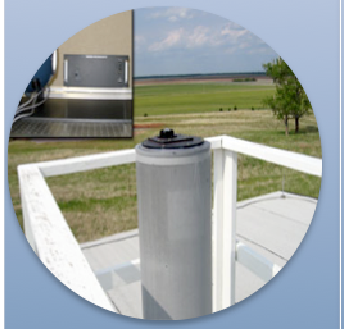
Core Instrumentation - ACRF

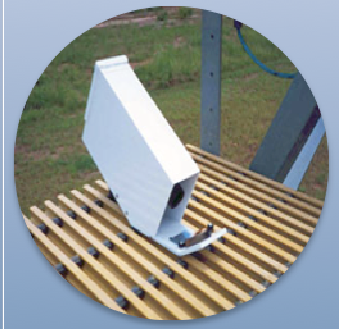
Shortwave Radiometry, downwelling and upwelling direct, diffuse, and global irradiance

Longwave Radiometry, downwelling and upwelling irradiance

Shortwave Spectroscopy, direct, diffuse, and global irradiances and optical depth



Shortwave/Near Infrared Spectroscopy, zenith radiance-cloud optical depth, particle size and water path



Infrared Thermometer, sky and surface brightness temperature

GRUAN Priority 2 – Ozone, Methane, Wind, Radiation, Aerosols, Clouds

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Core Instrumentation - ACRF

Aerosol Observing System, aerosol single scattering albedo, asymmetry parameter, mass scattering efficiency, and hygroscopic growth

Lidars, Vaisala Ceilometer and Micropulse Lidar, cloud properties, cloud base and top, and aerosol extinction

Cimel Sunphotometer (AERONET), aerosol optical thickness and extinction

Total Sky Imager, cloud fraction and imagery

Eddy Correlation, surface/ subsurface- vertical fluxes of momentum, sensible and latent heat, and CO2

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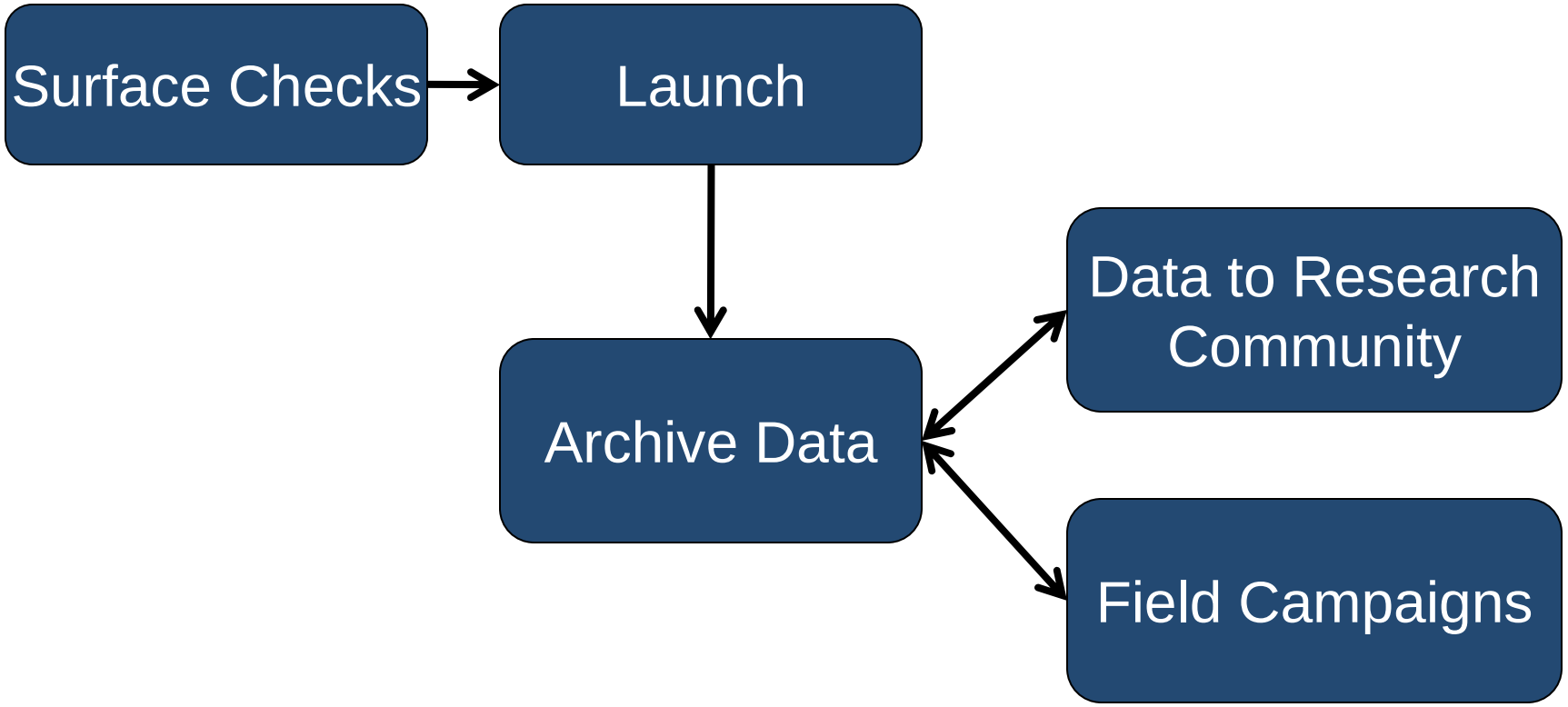
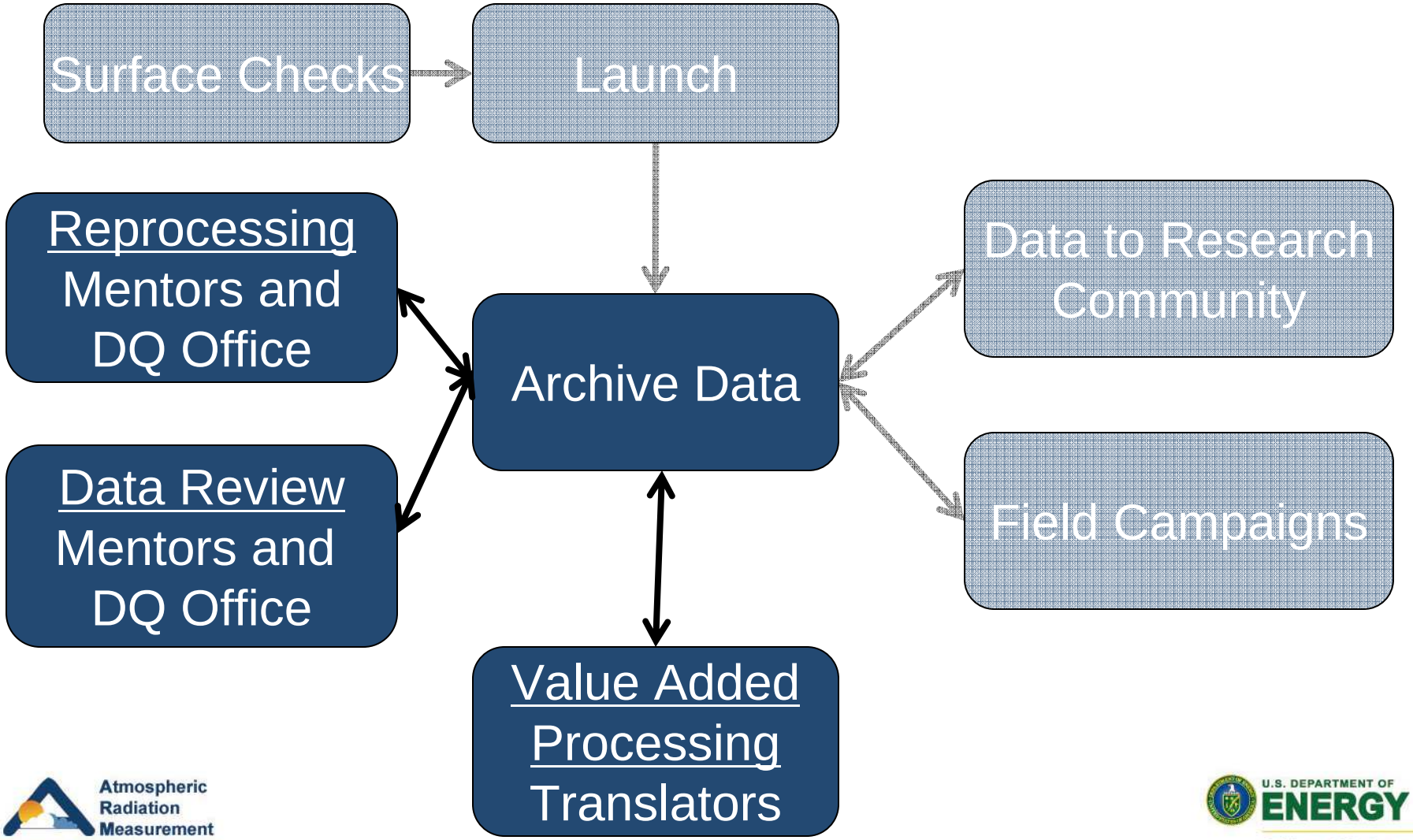
Constraining Measurements, An Example

Southern Great Plains	North Slope of Alaska	Tropical Western Pacific, Manus	Tropical Western Pacific, Nauru	Mobile Facilities	Field Campaigns
RS92 Loran	RS92 GPS	RS92 GPS	RS92 GPS	RS92 GPS	RS92 GPS
4 per day	2 per day	2 per day	2 per day	4 per day	As Required

Constraining Measurements, Sonde Data Flow



Constraining Measurements, Sonde Data Flow



Constraining Measurements, Sonde Prelaunch

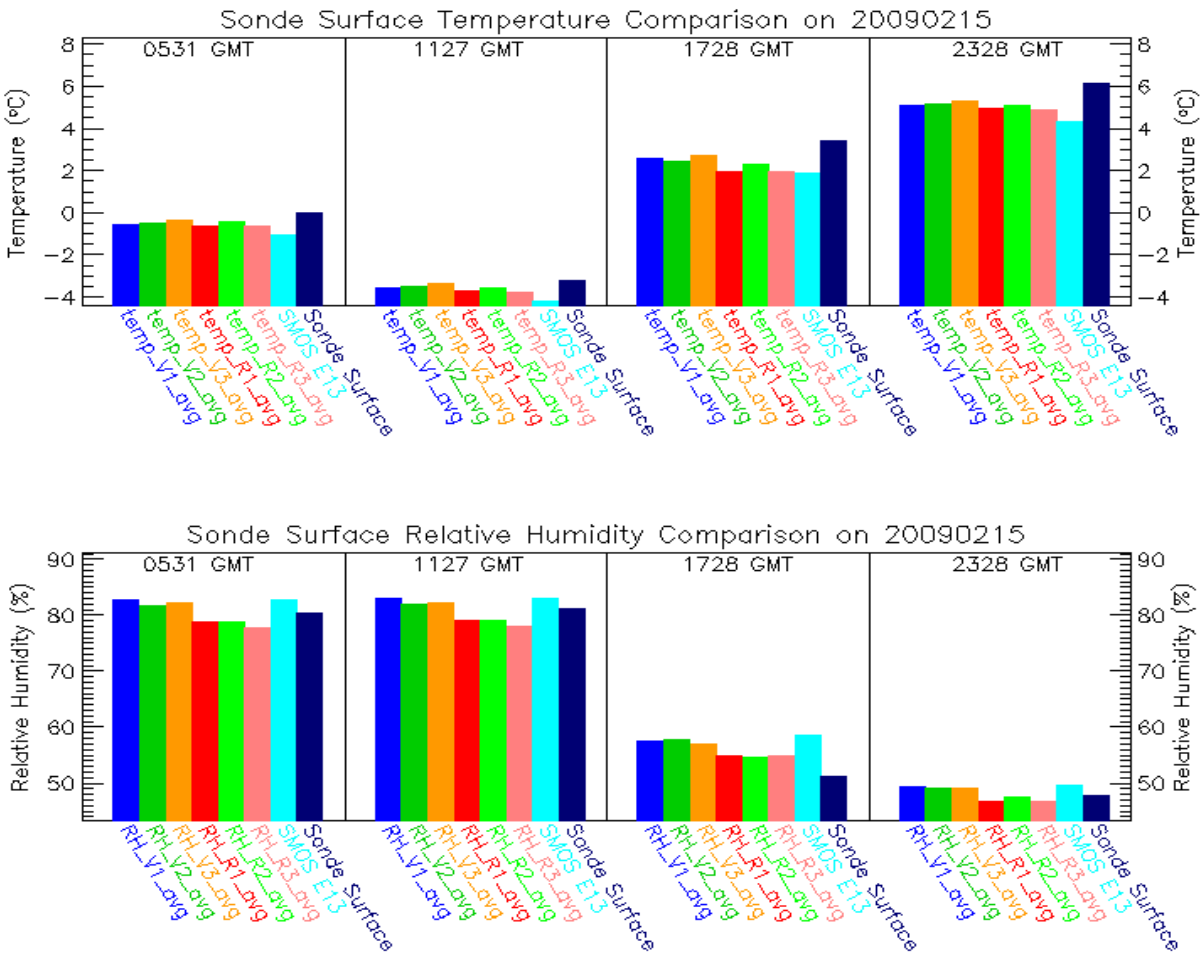
Visual Inspection

Vaisala GC25 Ground Check Station, Reconditioning, corrections for temperature (25 degC) and Relative Humidity (0%)

Surface Temperature and Relative Humidity (SURTHREF, THWAPS, MET)

Prelaunch

Constraining Measurements, Sonde Prelaunch



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Constraining Measurements, Sonde Post-Launch

- Near-surface temperature and relative humidity checks
- Data Quality Office provides near surface values to mentor daily
- Soundings may be reprocessed if T or RH are unreasonable when compared to the first reported height

Constraining Measurements, Sonde Post-Launch

sgpsondewnpnC1.b1.20090215.053100.cdf

Field	1st value	2nd value	difference	sgp1smos Value	sgp1smos Diff
RH (%)	80.76	80.76	0.00	82.90	-2.13
Temp (C)	0.02	-0.20	0.23	-0.96	0.99
Pres (hPa)	983.14	982.28	0.85	983.49	-0.35
WSPD (m/s)	1.70	2		2.36	
WDIR (deg)	26	29		24.28	
Alt (m)	315	322	-7	318	-3

sgpsondewnpnC1.b1.20090215.172800.cdf

Field	1st value	2nd value	difference	sgp1smos Value	sgp1smos Diff
RH (%)	51.43	53.56	-2.13	58.75	-7.32
Temp (C)	3.45	2.38	1.06	1.96	1.48
Pres (hPa)	989.82	988.59	1.22	990.19	-0.37
WSPD (m/s)	7.80	7.69		5.94	
WDIR (deg)	353	354		0.32	
Alt (m)	315	324.89	-9.89	318	-3

sgpsondewnpnC1.b1.20090215.112700.cdf

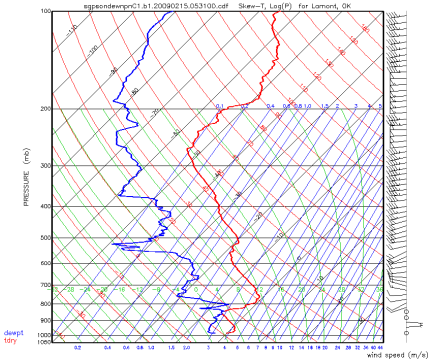
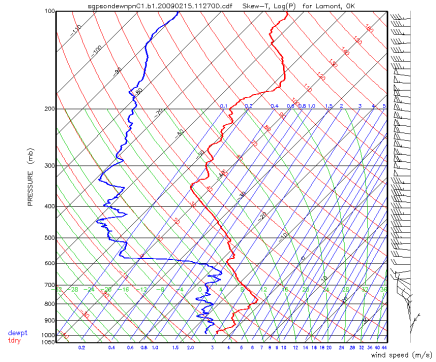
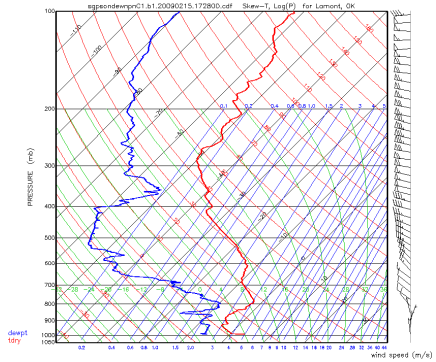
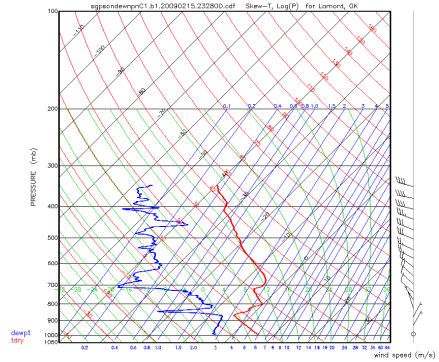
Field	1st value	2nd value	difference	sgp1smos Value	sgp1smos Diff
RH (%)	81.55	81.48	0.06	83.19	-1.64
Temp (C)	-3.18	-3.20	0.01	-4.09	0.91
Pres (hPa)	985.85	984.73	1.11	985.99	-0.13
WSPD (m/s)	5.30	5.5		5.23	
WDIR (deg)	17	19		21.34	
Alt (m)	315	324	-9	318	-3

sgpsondewnpnC1.b1.20090215.232800.cdf

Field	1st value	2nd value	difference	sgp1smos Value	sgp1smos Diff
RH (%)	47.90	47.27	0.63	49.79	-1.88
Temp (C)	6.17	5.96	0.21	4.37	1.80
Pres (hPa)	990.15	988.64	1.51	989.89	0.25
WSPD (m/s)	2.59	2.59		3.75	
WDIR (deg)	63	61		48.33	
Alt (m)	315	327.60	-12.60	318	-3

Data Quality Office- launch summary to Mentor
February 15, 2009

Constraining Measurements, Sonde Post-Launch

February 15, 2009 – SGP Central Facility Soundings

Move the cursor over any bold cell to identify failures

C1	Status for 053100 launch on 20090215								
< 50mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
50-100mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
100-200mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
200-300mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
300-400mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
400-500mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
500-600mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
600-700mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
700-850mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
850-925mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
925mb-sfc	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
Diagnostic Plots	NCVweb Interactive Plots								
Data Source: sgpsondewnpnC1.b1 for 20090215									

= Metric Passing 100% = Metric Passing < 75% = Missing Value (-9999)
= Metric Passing 75%-100% = Data Not Available

C1	Status for 112700 launch on 20090215								
< 50mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
50-100mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
100-200mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
200-300mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
300-400mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
400-500mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
500-600mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
600-700mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
700-850mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
850-925mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
925mb-sfc	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
Diagnostic Plots	NCVweb Interactive Plots								
Data Source: sgpsondewnpnC1.b1 for 20090215									

= Metric Passing 100% = Metric Passing < 75% = Missing Value (-9999)
= Metric Passing 75%-100% = Data Not Available

C1	Status for 172800 launch on 20090215								
< 50mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
50-100mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
100-200mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
200-300mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
300-400mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
400-500mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
500-600mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
600-700mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
700-850mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
850-925mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
925mb-sfc	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
Diagnostic Plots	NCVweb Interactive Plots								
Data Source: sgpsondewnpnC1.b1 for 20090215									

= Metric Passing 100% = Metric Passing < 75% = Missing Value (-9999)
= Metric Passing 75%-100% = Data Not Available

C1	Status for 232800 launch on 20090215								
< 50mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
50-100mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
100-200mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
200-300mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
300-400mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
400-500mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
500-600mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
600-700mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
700-850mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
850-925mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
925mb-sfc	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
Diagnostic Plots	NCVweb Interactive Plots								
Data Source: sgpsondewnpnC1.b1 for 20090215									

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Data Quality Metrics

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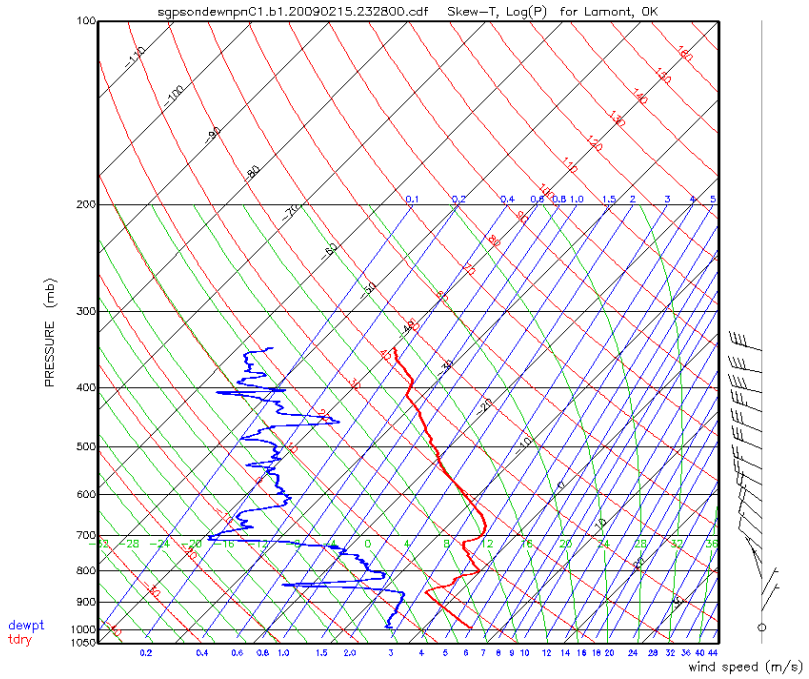
Constraining Measurements, Sonde Post-Launch



C1	Status for 232800 launch on 20090215								
< 50mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
50-100mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
100-200mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
200-300mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
300-400mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
400-500mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
500-600mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
600-700mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
700-850mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
850-925mb	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd
925mb-sfc	asc	deg	dp	pres	rh	tdry	u_wind	v_wind	wspd

Diagnostic Plots | NCVweb Interactive Plots

Data Source: sgpsondewnpnC1.b1 for 20090215

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= Metric Passing 75%-100% = Data Not Available

- Daily inspection of profiles by Mentor may trigger a Data Quality Report
- Weekly Data Quality summary, used by Mentors and Scientist to assess sounding performance

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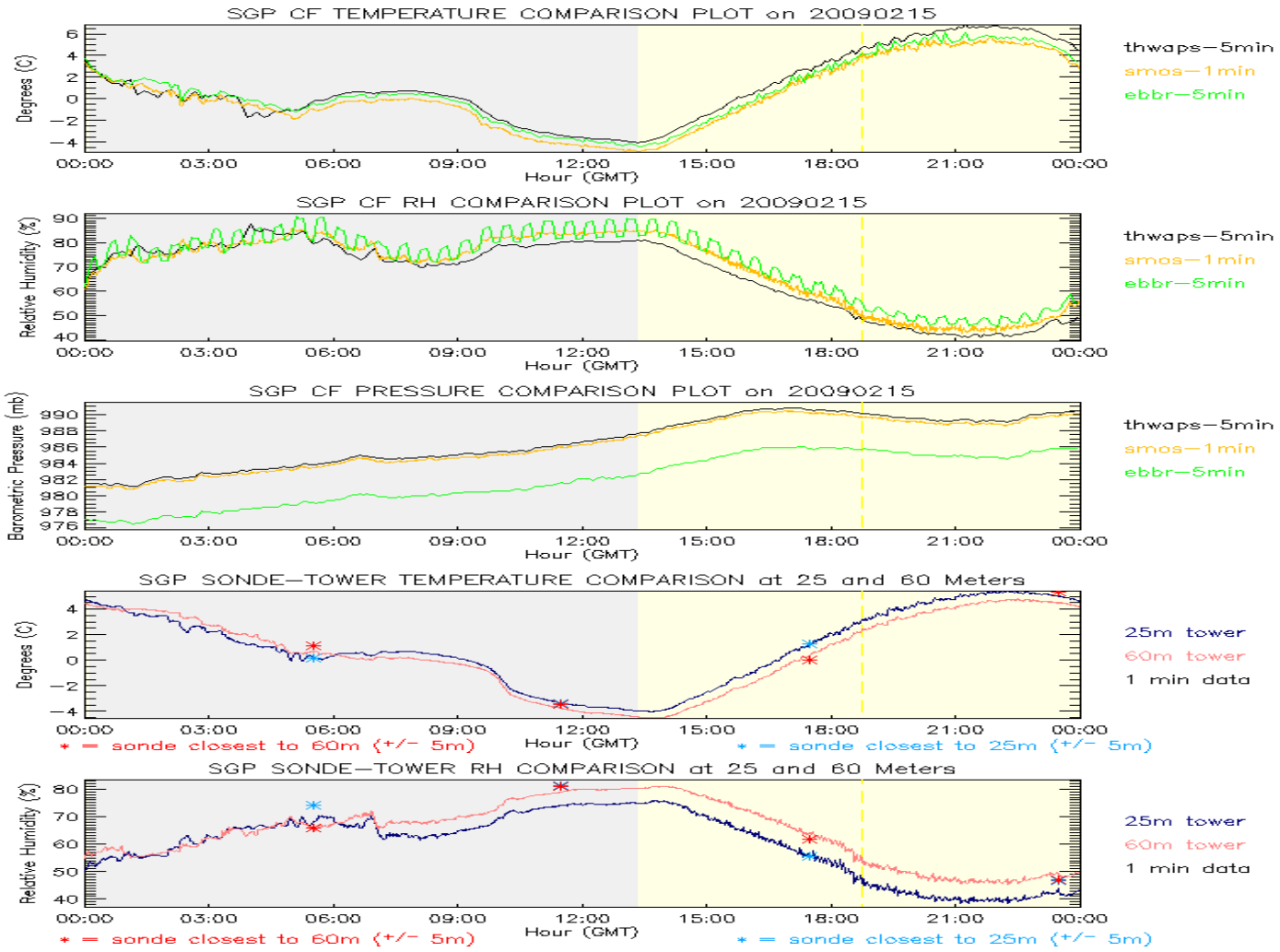
Constraining Measurements, Sonde Post-launch



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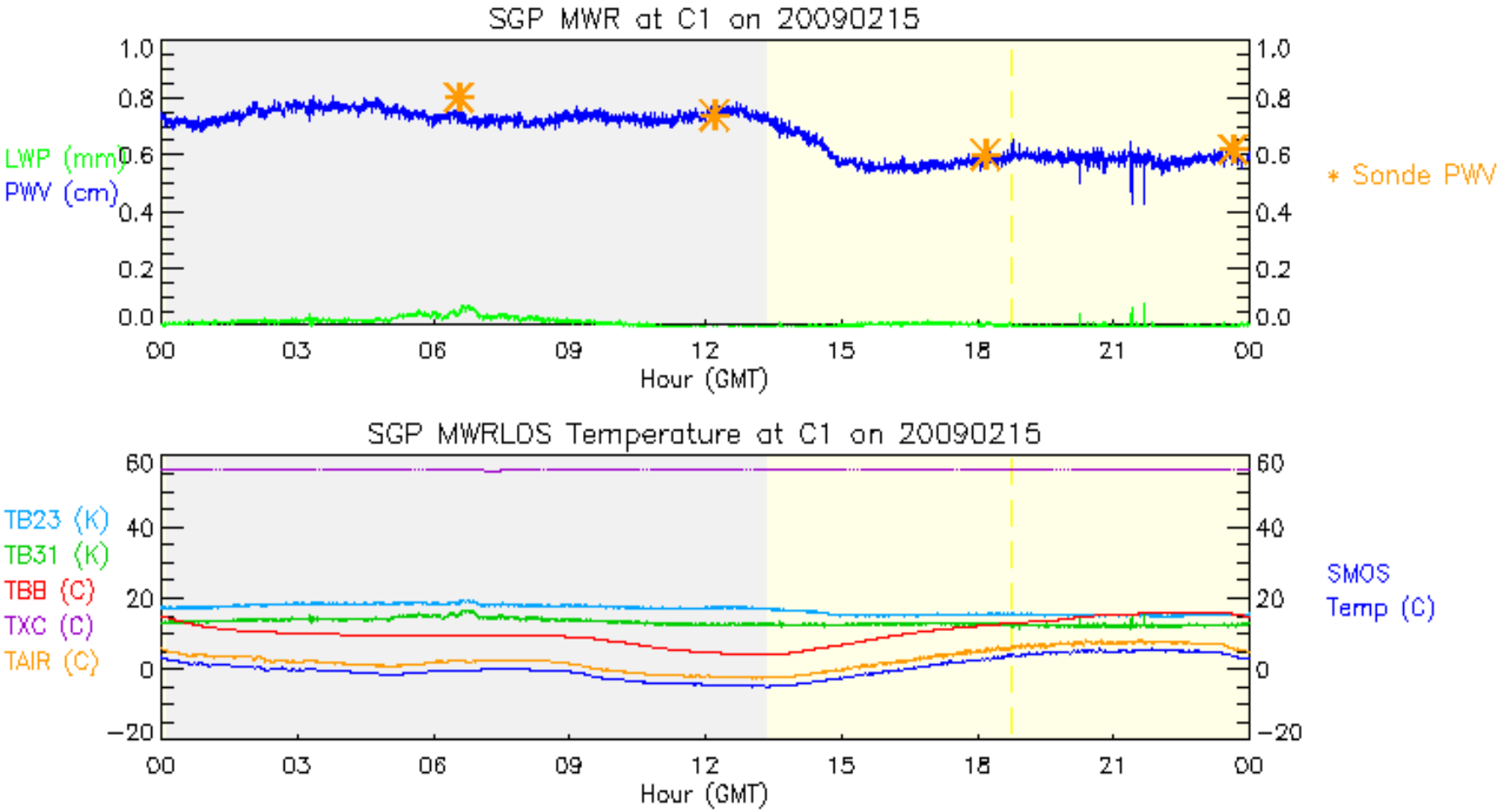
Constraining Measurements, Sonde Post-Launch



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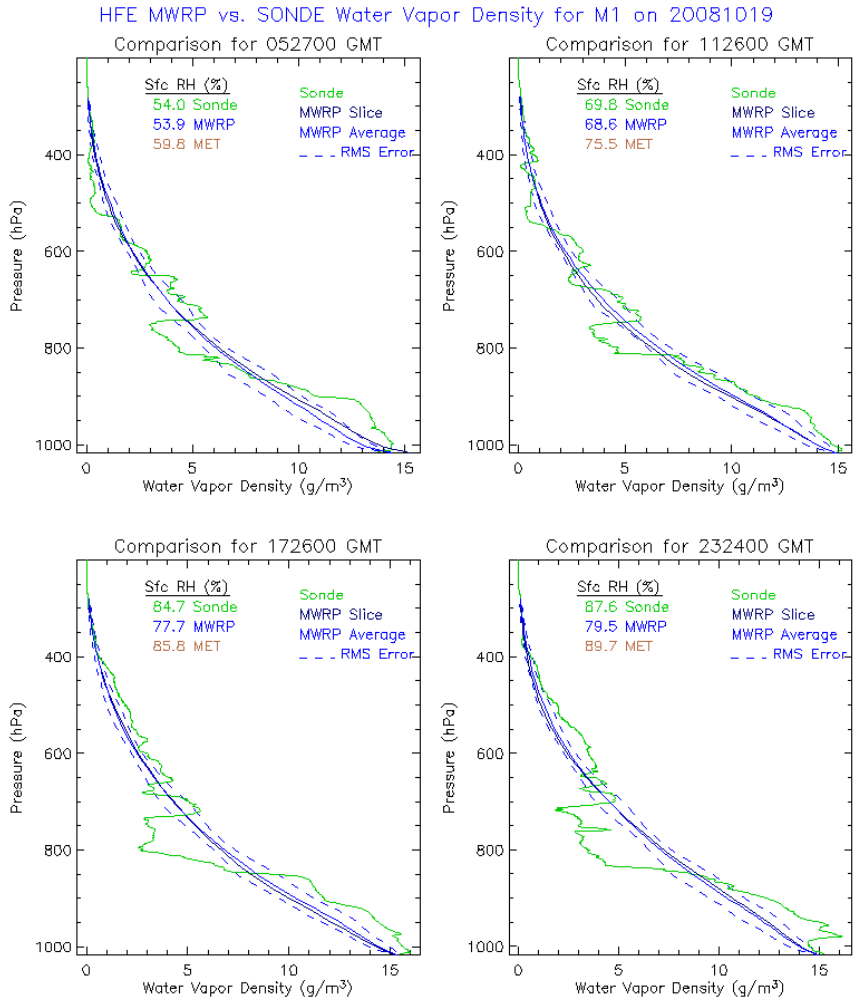
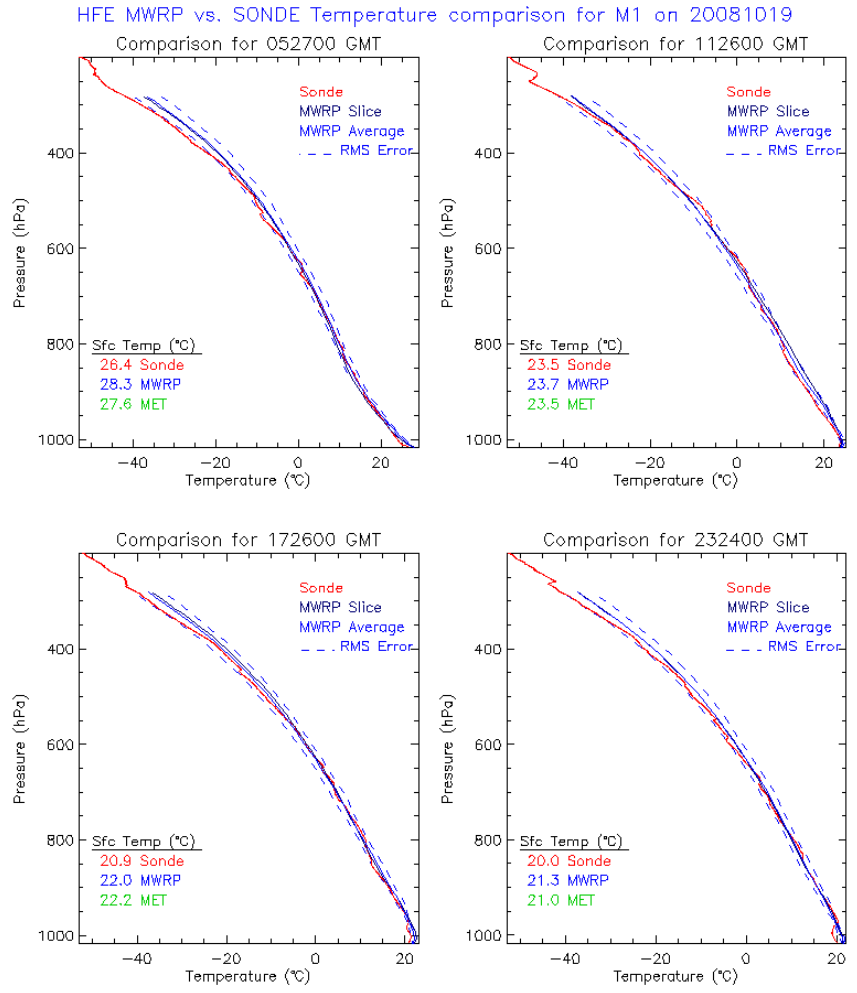
Constraining Measurements, Sonde Post-Launch





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China AMF Deployment, October 19, 2008
Sounding Comparison to MWR-Profiler

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Complimentary Products and Research

- Value Added Products
  - Geophysical quantities unavailable by direct means
  - Apply corrections or calibrations to data
  - Perform comparisons of geophysical quantities
  - Best estimates of geophysical quantity
- Knowledge and physical understanding can be applied through processing to provide the best representation and highest quality measurement products

Complimentary Products and Research

- Field Campaigns (Intensive Operating Periods)
  - Inter-comparisons – Water Vapor IOPs', RS-92 Sonde bias studies
- Feedback of results to improve measurement calibration or performance

Conclusion

- Understand and document the initial conditions
- Archive all data and related metadata
- Review the performance of each measurement – and, document quality
- Reprocess – and, document quality
- Perform Value Added Processing and Field Campaigns – and, apply knowledge
- Provide process, technical, and scientific support
- Continuous improvement

Thank You

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