GRUAN Lead Centre
www.gruan.org

Deutscher Wetterdienst
Lindenberg Meteorological Observatory
Richard Aßmann Observatory

GRUAN site certification:

Instructions: This form is intended to guide existing or new stations through the GRUAN certification process. The goal of this form is to document the existing capabilities that are directly applicable to GRUAN or that may be relevant to future GRUAN developments.

Section 1 should give a detailed site description, which will be filed at the lead center and used in the description of all GRUAN sites. Currently, only one site has gone through this process and, therefore, we have this information on file for only one site so far. Please take the time to provide this information, even if you think we should have it.
Section 2 should list the existing capabilities and places them into the GRUAN context. This section will be of greatest essence in the site evaluation.
Section 3 should describe the data flow of the official GRUAN data products. Currently there is only a data stream for the Vaisala RS92; however, other data streams are currently being developed, namely: frostpoint hygrometer observations, ECC ozone profiles, GPS integrated precipitable water vapor and Raman LIDAR water vapor profiles. It is expected that these data streams will come online in the near future. Other data streams will be developed in the near future as well. Any site is encouraged to contribute to the development of these or other new GRUAN data streams.
Section 4 should confirm the GRUAN change management principles or discuss where deviations are to be expected.
Section 5 should list activities and other items listed in the GRUAN implementation plan, which may be of relevance to the application.
Section 6 should list the active participation in any of the ongoing GRUAN activities.
The text in italics gives more recommendations and should serve as a guideline to complete the GRUAN certification. It should help making clear what information the Working Group GRUAN is looking for and should ease the process of providing this information.

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GRUAN Site Certification:

Site

Latitude, Longitude, Elevation

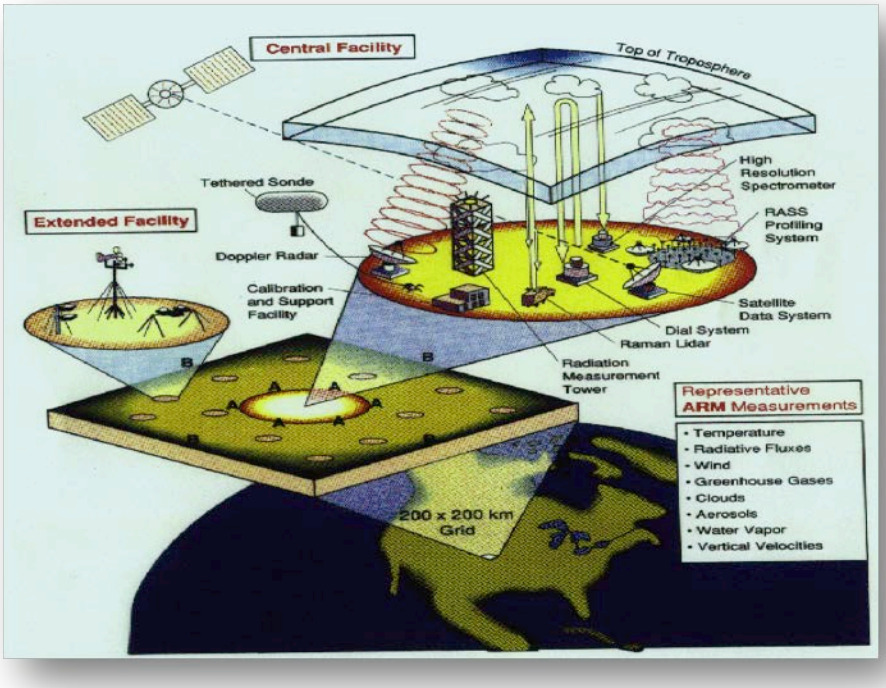
1. Description of the Site

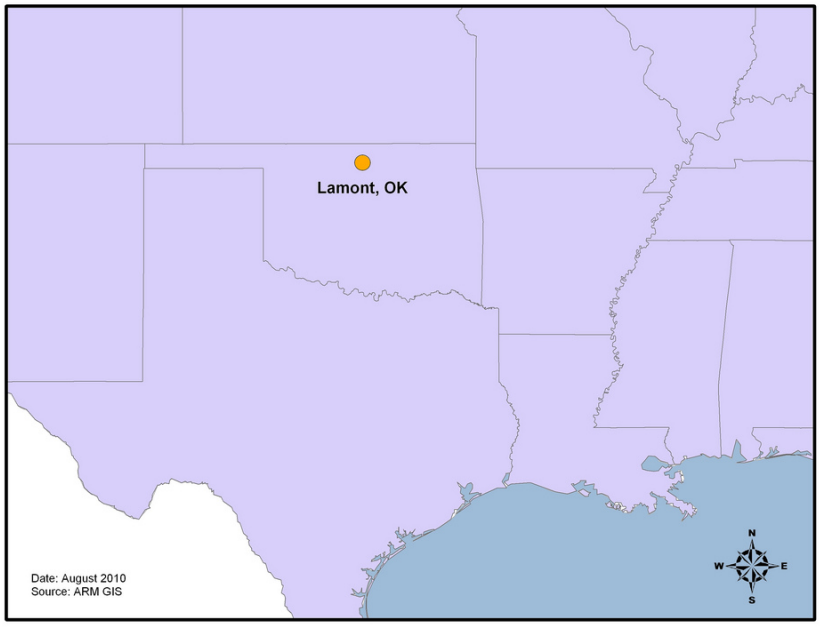
This should include:

- *A description of the history of the site,*
- *Governance and management of the site,*
- *Whether the site is a consolidated site or instruments are spread over a region,*
- *Sources of funding*
- *A high level vision of how the site will contribute to the goals of GRUAN.*
- *A description of the extent to which the site is capable of submitting measurements in near real-time on the GTS or WIS.*

Figure 1: Location of site

Please include at least a single photo or schematic of the site layout. Pointers to additional photographs of the site and instrumentation would be appreciated.




Lamont, OK
Date: August 2010
Source: ARM GIS
N
W
E
S


United States
KANSAS
MISSOURI
OKLAHOMA
ARKANSAS

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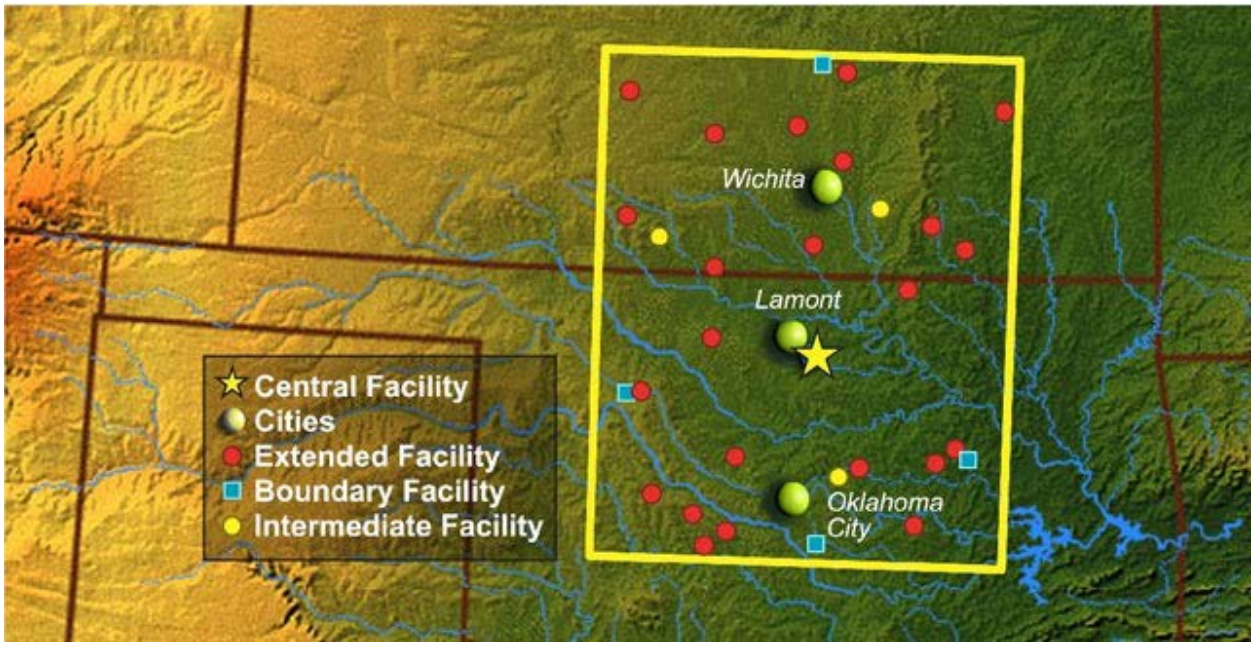
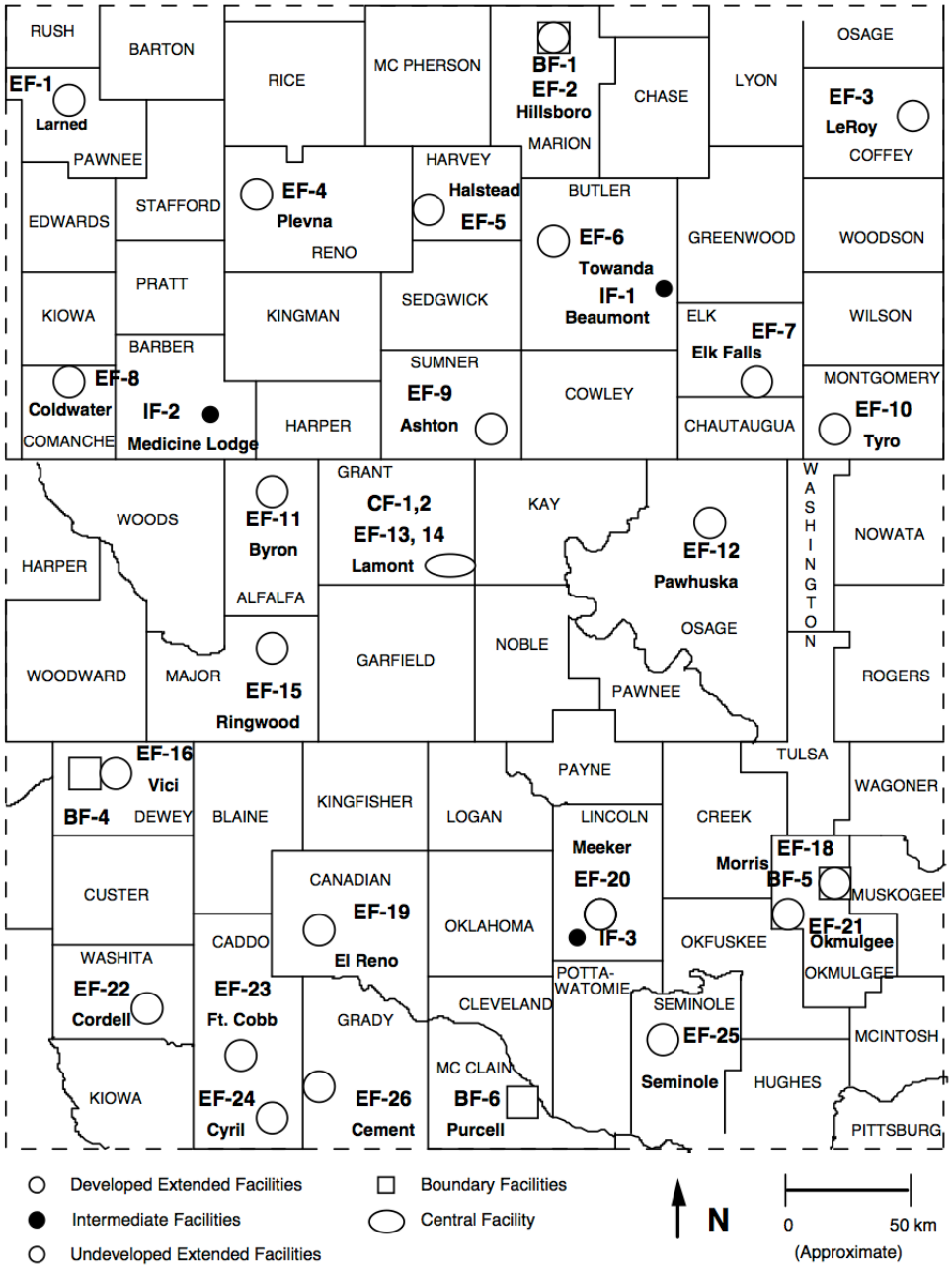
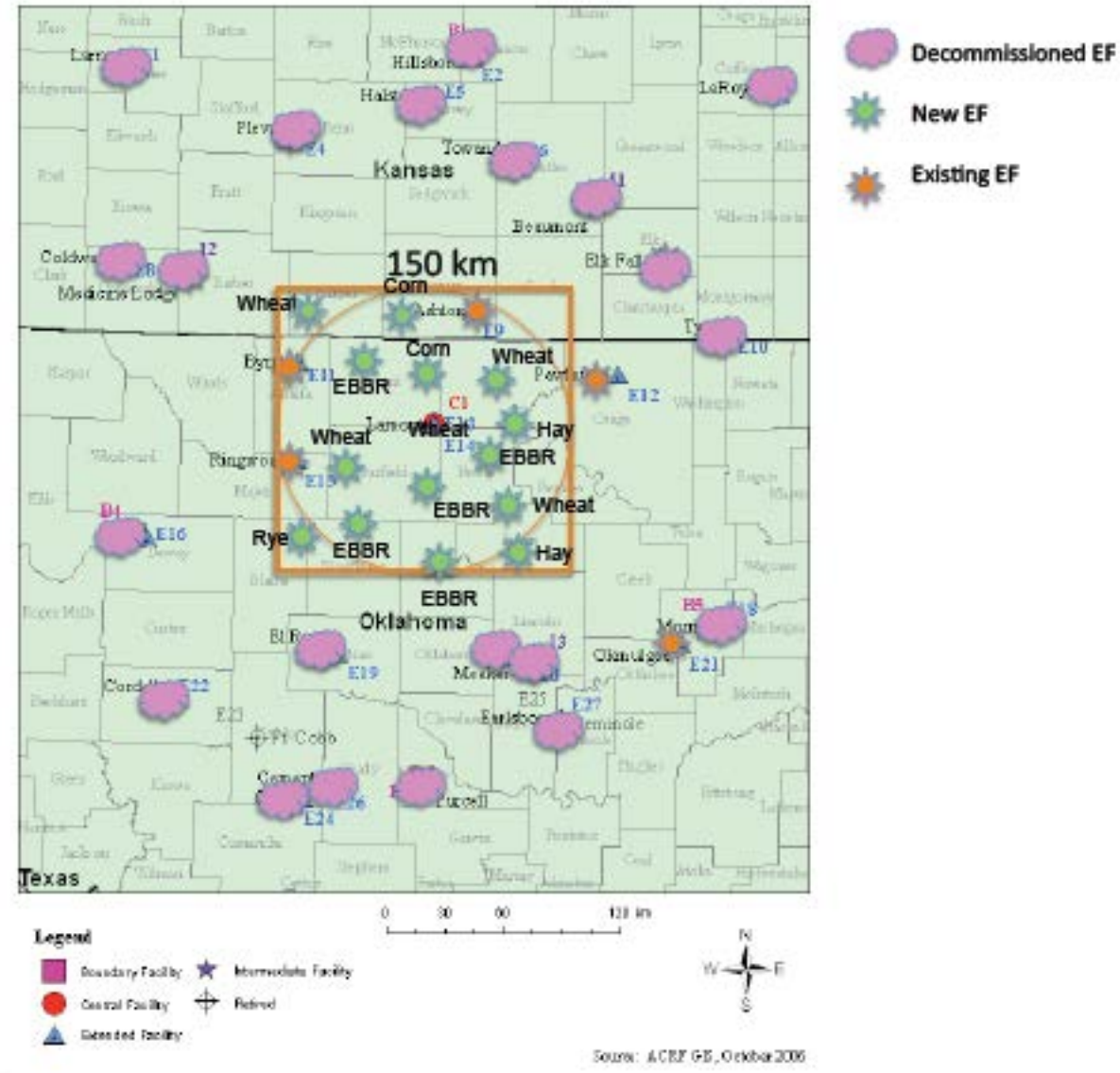
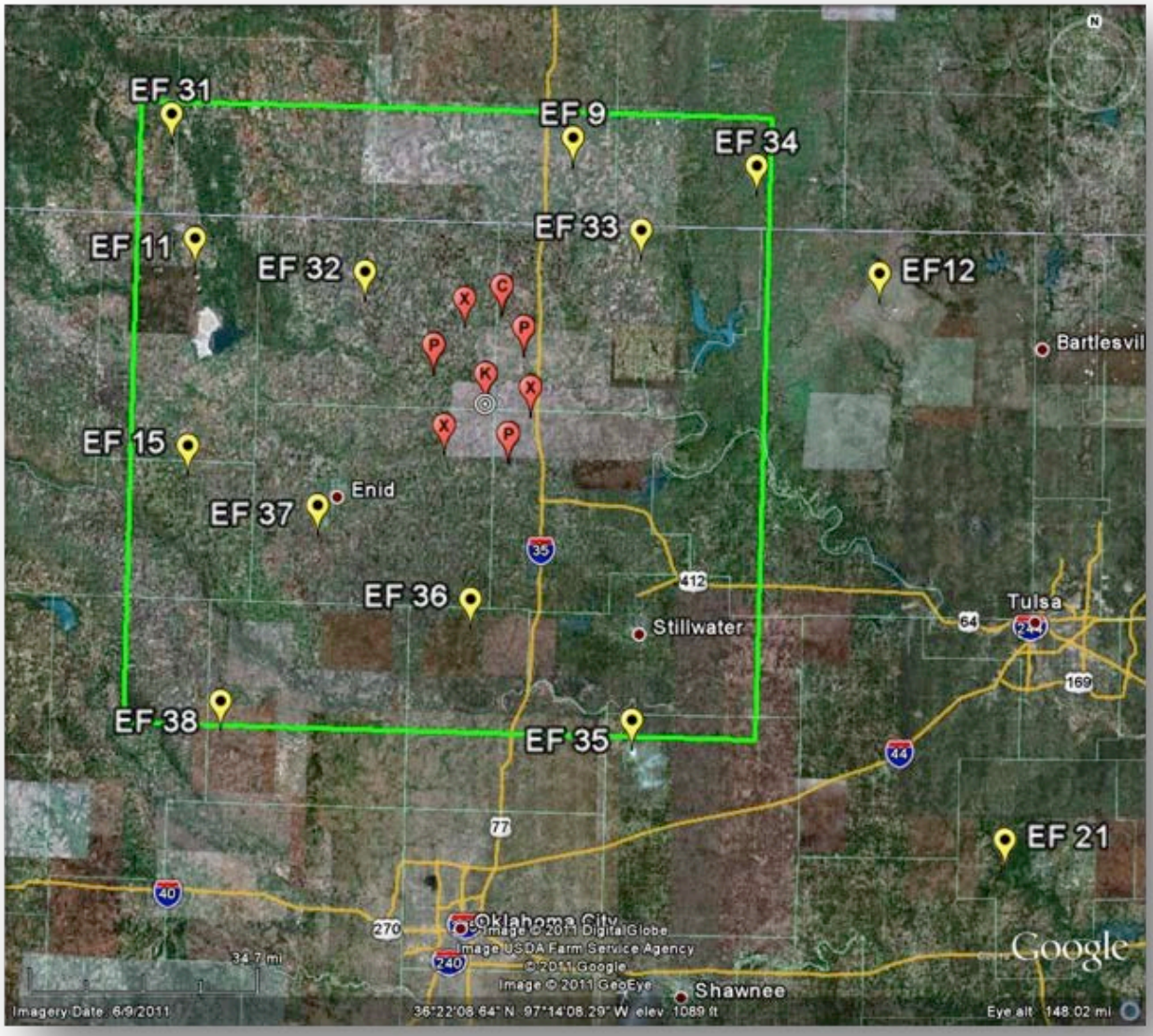
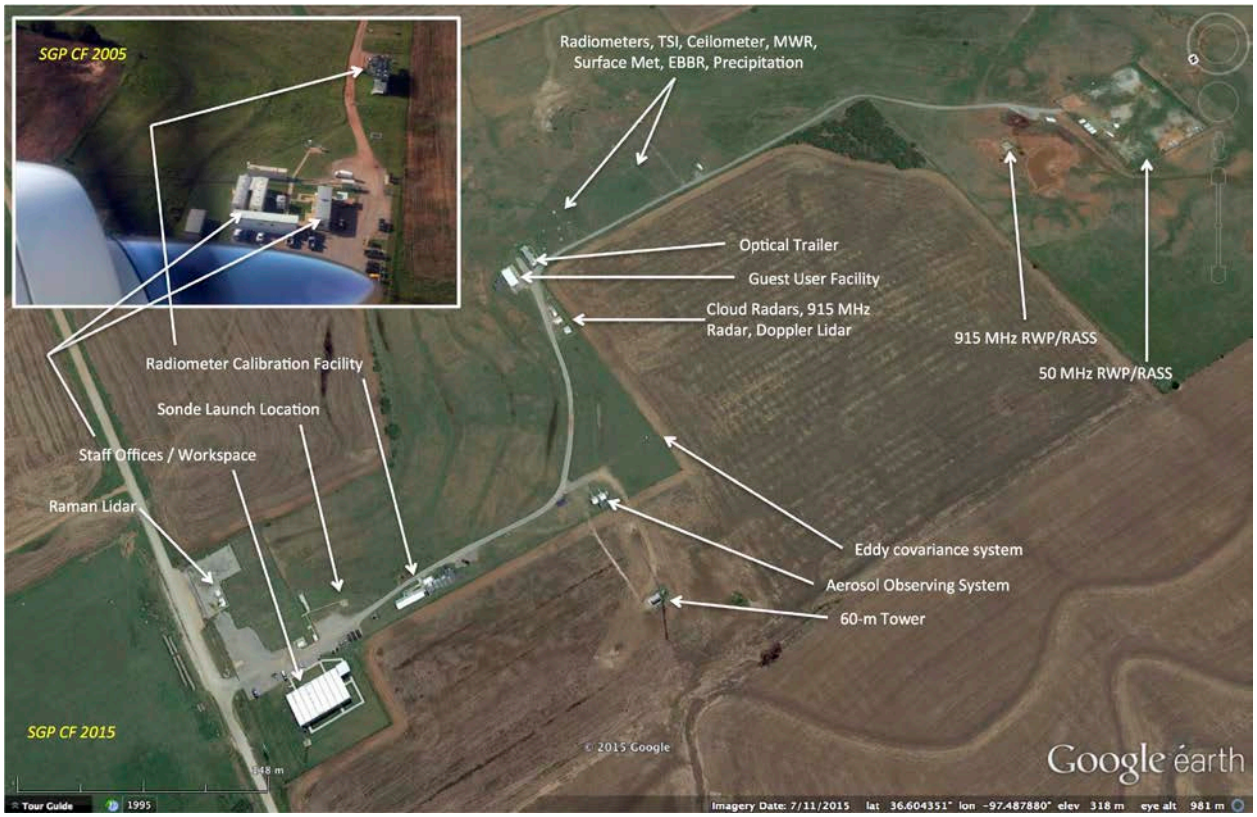



RUSH
BARTON
RICE
MC PHERSON
BF-1
EF-2
Hillsboro
CHASE
LYON
OSAGE
EF-1
Larned
EF-3
LeRoy
COFFEY
MARION
PAWNEE
HARVEY
Halstead
EF-5
EF-4
Plevna
BUTLER
EDWARDS
STAFFORD
EF-6
Towanda
GREENWOOD
WOODSON
RENO
PRATT
IF-1
Beaumont
KIOWA
KINGMAN
SEDGWICK
ELK
EF-7
Elk Falls
WILSON
BARBER
SUMNER
EF-8
Coldwater
IF-2
Medicine Lodge
EF-9
Ashton
COWLEY
MONTGOMERY
EF-10
Tyro
COMANCHE
HARPER
CHAUTAUGUA
GRANT
CF-1,2
EF-13, 14
Lamont
KAY
WASHINGTON
WOODS
EF-11
Byron
EF-12
Pawhuska
NOWATA
HARPER
ALFALFA
OSAGE
NOBLE
GARFIELD
WOODWARD
MAJOR
EF-15
Ringwood
PAWNEE
ROGERS
TULSA
EF-16
Vici
PAYNE
WAGONER
BF-4
DEWEY
BLAINE
KINGFISHER
LOGAN
LINCOLN
CREEK
Meeker
EF-18
Morris
BF-5
CUSTER
CANADIAN
EF-19
El Reno
EF-20
MUSKOGEE
OKLAHOMA
IF-3
EF-21
Okmulgee
CADDO
OKFUSKEE
WASHITA
EF-22
Cordell
EF-23
Ft. Cobb
POTTA-
WATOMIE
OKMULGEE
CLEVELAND
SEMINOLE
GRADY
EF-25
Seminole
MCINTOSH
MC CLAIN
KIOWA
EF-24
Cyril
EF-26
Cement
BF-6
Purcell
HUGHES
PITTSBURG
Developed Extended Facilities
Intermediate Facilities
Undeveloped Extended Facilities
Boundary Facilities
Central Facility
N
0
50 km
(Approximate)


Decommissioned EF
New EF
Existing EF
150 km
Kansas
Oklahoma
Texas
Corn
Wheat
EBBR
Hay
Rye
Legend
Source: ACRF GB, October 2006


EF 31
EF 9
EF 34
EF 33
EF 11
EF 32
EF12
Bartlesvil
EF 15
Enid
EF 37
EF 36
Stillwater
Tulsa
EF 38
EF 35
EF 21
Oklahoma City
Shawnee
Google
Imagery Date: 6/9/2011
Eye alt 148.02 mi



At the Southern Great Plains (SGP) site–

- Central Facility (CF) (C1) 36.61N, 97.49W, 315 m
  - *Production system: pcCORA* (May 27, 1992 – April 12, 1999*)*
  - *Production system: digiCORA-II s/n R48501* (April 13, 1999 – July 31, 2002)
  - *Production system: digiCORA-III s/n W09201* (August 1, 2002 – present)
  - *AIRS validation IOP system (S01): digiCORA-I s/n 574791*
  - *AIRS validation IOP system (S02): digiCORA-I s/n 708515*
  - System installed May 27, 1992
  - Started regular (19:30) soundings July 14, 1992
  - Started ground checks January 21, 1993
  - Changed to high resolution sampling (2-sec) May 20, 1993
  - Installed RESEARCH software March 30, 1994
  - Started RESEARCH mode soundings April 7, 1994
  - Stopped RESEARCH mode soundings May 21, 1994
  - Stopped ground checks August 3, 1994
  - Installed RAWDATA software November 15, 1994
  - Assigned WMO station identifier (646 block 74) August 19, 1996
  - Software upgrade to generate WMO-coded messages for NWS March 24, 1997
  - Installed MW-15 digiCORA-II September 1, 1997 for WVIOP

- Changed regular sounding schedule from 5 per day to 3 per day November 14, 1997
- Added 0530 Universal Time Coordinates (UTC) sounding to regular schedule (1130, 2030, 2330) November 30, 1998
- Updated PC-CORA and digiCORA-II and MF-12 for Y2K June 9, 1999
- Stopped RESEARCH mode for winds November 24, 2000
- Began operational use of RS-90 radiosondes May 1, 2001
- Changed sounding schedule to 0530, 1130, 1730, 2330 August 1, 2001
- Transferred PC-CORA to NSA June 24, 2002
- Began digiCORA-III (MW-21) transition IOP July 10, 2002
- Updated digiCORA-III to v3.12 and RB-21 antenna July 27, 2005
- Updated digiCORA-III to v3.51 September 19, 2006.
- Increased reported precision of RH from 1.0% to 0.1% (September 29, 2006)
- Updated digiCORA-III to v3.52 January 30, 2007

- Attached GC25 via cable June 17, 2009
- Applied Vaisala GPS Hotfix July 22, 2009
- Updated digiCORA-III to v3.61.1 November 30, 2009
- Installed new MW-31 DigiCORA-III system
- Updated DigiCORA-III software to v3.64.1 April 2, 2012

- Hillsboro, Kansas (boundary facility [BF]1) 38.30N, 97.30W, 447 m
  - *Production system: digiCORA-I s/n 530483* (January 18, 1994 – November 22, 1997)
  - Installed January 18, 1994
  - Started RESEARCH mode soundings April 7, 1994
  - Stopped RESEARCH mode soundings May 21, 1994
  - Installed directional antenna March 28, 1996
  - Assigned WMO station identifier (547 block 74) August 19, 1996
  - Started automatic generation of WMO-coded messages October 28, 1996
  - Added global positioning system (GPS) windfinding capability March 25, 1997
  - Suspended daily soundings at all BFs November 22, 1997
  - Updated digiCORA and MF-12 for Y2K June 11, 1999
  - Stopped RESEARCH mode for winds November 24, 2000
  - Updated digiCORA and RB-21 for RS92 July 27, 2005

- Vici, Oklahoma (BF4) 36.07N, 99.20W, 622 m
  - *Production system: digiCORA-I s/n 574791* (January 18, 1994 – November 22, 1997)
  - Installed January 18, 1994
  - Started RESEARCH mode soundings April 7, 1994
  - Stopped RESEARCH mode soundings May 21, 1994

- Installed directional antenna August 1, 1996
- Assigned WMO station identifier (641 block 74) August 19, 1996
- Started automatic generation of WMO-coded messages October 28, 1996
- Added GPS windfinding capability March 26, 1997
- Suspended daily soundings at all BFs November 22, 1997
- Updated digiCORA and MF-12 for Y2K June 11, 1999
- Stopped RESEARCH mode for winds November 24, 2000
- Updated digiCORA and RB-21 for RS92 July 27, 2005

- Morris, Oklahoma (BF5) 35.68N, 95.85W, 217 m
  - *Production system: digiCORA-I s/n 574792* (January 18, 1994 – November 22, 1997)
  - Installed January 18, 1994
  - Started RESEARCH mode soundings April 7, 1994
  - Stopped RESEARCH mode soundings May 21, 1994
  - Assigned WMO station identifier (650 block 74) August 19, 1996
  - Started automatic generation of WMO-coded messages October 28, 1996
  - Added GPS windfinding capability March 27, 1997
  - Suspended daily soundings at all BFs November 22, 1997
  - Updated digiCORA and MF-12 for Y2K June 11, 1999
  - Stopped RESEARCH mode for winds November 24, 2000
  - Updated digiCORA and RB-21 for RS92

- Purcell, Oklahoma (BF6) 34.97N, 97.42W, 344 m
  - *Production system: digiCORA-I s/n 708515* (October 13, 1994 – November 22, 1997)
  - Installed October 13, 1994
  - Removed borrowed directional antenna February 17, 1995
  - Installed new directional antenna October 2, 1995
  - Assigned WMO station identifier (651 block 74) August 19, 1996
  - Started automatic generation of WMO-coded messages October 31, 1996
  - Added GPS windfinding capability March 25, 1997
  - Suspend daily soundings at all BFs November 22, 1997
  - Updated digiCORA and MF-12 for Y2K June 11, 1999
  - Stopped RESEARCH mode for winds November 24, 2000
  - Updated digiCORA and RB-21 for RS92 July 27, 2005

2. Instrumentation and Target Essential Climate Variables

For each derived parameter please indicate, when the observations were started, who the PI is and when this data stream is proposed to be GRUAN certified. In the column 'certify' please indicate whether the site seeks GRUAN certification for this measurement programme now (now), once a GRUAN product has been defined for the measured parameter (later). Leave this column blank, if the observations are listed for informational purposes only to provide an overview over the sites capabilities.

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Table 1 shows the general attributes of each of the Atmospheric Radiation Measurement (ARM) Climate Research Facility (ACRF)-owned Vaisala ground stations as well as providing a guide to their deployment history during intensive operational periods (IOPs). The IOP designations at the bottom of the table refer to the facility identification code used in the standard ARM data file naming convention. For example, data produced during the AIRS IOP by the MW-11 serial number 574791 (normally assigned to SGP/B4) are named sgpsondewnpnS01.b1.YYYYMMDD.HHMMSS.cdf.

	Table 1: ACRF-owned Vaisala Radiosonde Ground Stations												
	Common Name												
	digiCORA-I				digiCORA-II				digiCORA-III				
Model	MW-11	MW-11	MW-11	MW-11	MW-15	MW-15	MW-15	MW-15	MW-21	MW-21	MW-21	MW-31	MW-31
S/N	530483	574791	574792	708515	T32102	S35304	S17401	R41204	W09201	W03202	Z15101	B31401	B31402
Base Location	SGP/B1	SGP/B4	SGP/B5	SGP/B6	AMF/M1	SGP/spare	SGP/spare	SGP/spare	SGP/C1	NSA/C1	AMF/M1	TWP/C1	TWP/C2
Current Location	SGP/IOP	SGP/spare	SGP/IOP	SGP/spare	SGP/C1	SGP/C1	SGP/C1	NSA/C1/GW)	SGP/C1	NSA/C1	AMF/M1	TWP/C1	TWP/C2
Loran equipped	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO
GPS equipped	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
RS08-H compatible	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
RS90 compatible	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
RS92 compatible	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Software version	8.35	8.35	8.35	8.35	8.35	8.35	8.35	8.34	3.61.1	3.61.1	3.61.1	3.61.1	3.61.1
IOP Name (site)													
AIRS (I-V)		SGP/S01		SGP/S02		TWP/C2			NSA/C1				
A-WEX-G (SGP)	SGP/S03	SGP/S01	SGP/S04	SGP/S02				SGP/S05		SGP/C1			
CLASIC (SGP)	SGP/B4	SGP/B1	SGP/B5	SGP/S06									
AIRS/IASI			SGP/S01	SGP/S02									

Data File Contents

With the exception of the early NSA data described in Section 5.3, the netCDF ARM radiosonde data files distributed by the ARM Archive are identical to one another regardless of site or ground station of origin. Some of the raw data files produced by the different ground station types are unique, however, and although most users will have no need or interest in accessing these files, they are archived and available by special request. The instrument-created data files

are listed in Table 2; examples of the ASCII files are available through the links provided in Section 5.2.

Table 1. Summary of data files created by ARM Vaisala ground stations

Radiosonde System	Filename	Description
pcCORA All files are created and stored on the local instrument computer and transmitted to the site data system when the sounding is completed. The local files are renamed after transfer.	PRT.CUR RAWDATA.CUR EDITED.CUR	Standard ASCII output with processed data: this file is passed to the ingest module to create the netCDF files distributed by the archive Binary raw thermodynamic data directly from the radiosonde Binary copy of processed thermodynamic and wind data
MW-11 and MW-15 (digiCORA-I and -II) The standard ASCII data is transmitted by a serial connection in real-time to the site data system where it is collected in an ASCII file. At the SGP and NSA, these files are recorded on floppy disk for each sounding and not usually archived; at the TWP they are recorded on hard disk, bundled, and sent to the archive. Note that raw files associated with GPS radiosondes will be named "GPSSND.xxx" rather than "LORANC.xxx."	PRT.CUR MPPPTU.RAW LORANC.EDT LORANC.PAR LORANC.DER LORANC.PHA GPSWND.RAW	Standard ASCII output with processed data: this file is passed to the ingest module to create the netCDF files distributed by the archive As defined above Binary copy of processed thermodynamic and wind data Binary position derivative data Binary raw Loran phase data Binary raw GPS wind data

Table 2. (contd)

Radiosonde System	Filename	Description
MW-21 (digiCORA-III) All files are created and stored on the local instrument computer and collected by the site data system when the sounding is completed.	SSSsonderawFF.YYYYMMDDHHMM.raw SSSsondeFF.YYYYMMDDHHMM.ptu SSSsondeFF.YYYYMMDD_HHMMSS.dc3db	Standard ASCII output with processed data: this file is passed to the ingest module to create the netCDF files distributed by the archive ASCII file with raw thermodynamic data directly from the radiosonde Binary sounding database file

Primary Variables and Expected Uncertainty

The following quantities are measured as functions of time during a free-balloon ascent:

- Pressure (hPa) netCDF name = “pres”
- Temperature (°C) netCDF name = “tdry”
- Relative Humidity (%RH) netCDF name = “rh”
- Wind speed (m/s) netCDF name = “wspd”
- Wind direction (deg) netCDF name = “dir”

Secondary (derived) quantities included in the data stream, also measured as functions of time, are:

- Altitude (gpm) netCDF name = “alt”
- Dew Point (°C) netCDF name = “dp”
- Ascent Rate (m/s) netCDF name = “alt”
- Latitude of Sonde (°N) netCDF name = “lat”
- Longitude of Sonde (°W) netCDF name = “lon”
- u-component of wind velocity (m/s) netCDF name = “u_wind”
- v-component of wind velocity (m/s) netCDF name = “v_wind”

Definition of Uncertainty

The manufacturer defines the cumulative sensor uncertainty at the 2-sigma (95.5%) confidence level. The uncertainty includes the following factors:

- Repeatability
- Long-term stability
- Measurement conditions
- Dynamic effects (e.g. time lag)
- Electronic effects

Repeatability is estimated from the standard deviation of differences between two successive repeated calibrations (2-sigma). Reproducibility is estimated from the standard deviation of differences in twin soundings.

The manufacturer’s specifications and stated uncertainty values for the thermodynamic sensors in each radiosonde type used by ARM are presented in Table 3.

Table 2. Technical specifications and manufacturer’s stated uncertainty for the meteorological sensors used in radiosondes employed by the ARM Program

	RS-80H			**RS-90 and RS-92 all types**		
	Pressure	**Temperature**	**Humidity**	**Pressure**	**Temperature**	**Humidity**
Range	1060 to 3 hPa	-90 to +60°C	0 to 100%RH	1080 to 3 hPa	-90 to +60°C	0 to 100 %RH
Resolution	0.1 hPa	0.1°C	1%RH	0.1 hPa	0.1°C	1%RH*

Response Time	n/a	<2.5 s	1 s (at surface)	n/a	0.4 s (1000 hPa) 2.5 s (10 hPa)	<0.5 s (20°C) <20 s (-40°C)
Repeatability	0.5 hPa	0.2°C	2%RH		0.15°C	2%RH
Reproducibility	0.5 hPa	0.2°C > 50 hPa 0.3°C > 15 hPa 0.4°C < 15 hPa	3%RH		0.2°C > 100 hPa 0.3°C < 20 hPa	3%RH
Uncertainty	n/a	n/a	n/a	n/a	0.5°C	5%RH
* Nominal resolution value – data collected using digiCORA-III ground station may be reported with higher precision.						

User Notes and Known Problems

General Problems with Radiosonde Data

Several situations may arise during a sounding that may affect the quality of the data but which may not be flagged or otherwise corrected, and the user should be aware of these. Among these are incorrect surface conditions, humidity sensor saturation or icing, interference, and signal confusion from other radiosondes. General data quality reports (DQRs) have been issued describing these conditions, which the user is urged to read and understand. Specific DQRs are issued for those cases when incorrect surface conditions are included in the soundings. Cases of sensor saturation, which may lead to unrealistic lapse rates or humidity values aloft, and cases of sonde-to-sonde interference, which may result in incorrect data values, are not generally called out in individual DQRs.

Dry Bias

A general problem with Vaisala RS-80H (the type used by ARM from May 1992 through spring 2002) radiosondes is that they seem to exhibit a dry bias; that is, the relative humidity values reported are too low. The amount of the error varies with several factors including the ambient temperature and relative humidity and the age of the radiosonde but may be as great as 10% relative humidity. The dry bias results from contamination of the humidity sensor during storage. Starting in August of 1998 (week 33), Vaisala changed their packaging to reduce the problem. Another packaging change was made in August of 2000 that substantially reduced the bias problem from the RS-80 series of sondes. Although more recent types of sondes (RS90, RS92) do not seem to suffer from the same type of contamination-related bias problem, they do seem to be biased dry during the daytime because of solar heating of the humidity sensor during flight. This effect depends on altitude and location and is most pronounced in the upper troposphere at lower latitudes where solar effects are greatest. More detailed information may be found in a frequently asked question in Section 5.4, called "**What is this about 'dry bias' in Vaisala radiosondes?"**

RESEARCH Mode Altitude

Another issue involves soundings that are done in so-called RESEARCH mode for PTU. These soundings, which may be identified by data platform name wXpr, were done regularly at the SGP from April 27, 2994, to May 21, 1994; other isolated cases may exist in the archived data. Soundings done using RESEARCH mode (for PTU) Vaisala processing have a negative bias in the calculation of sonde altitude. This bias results from neglecting the sensed relative humidity when calculating air density when integrating the hydrostatic equation. In essence, the Vaisala RESEARCH mode (PTU) processing assumes a dry atmosphere when calculating sonde altitude. The magnitude of the bias is cumulative with height and will depend on the vertical distribution of moisture, but it can be as much as 20 m at the tropopause (the RESEARCH-mode sounding altitudes will be smaller than altitudes calculated by using sensed relative humidity). This problem applies to all soundings done in 'WXPR' mode, where X is either R or N. In particular, all soundings done during the April 1994 (RCS) IOP (April 7, 1994, to May 21, 1994) are affected as well as those occasional inadvertent WXPR soundings. Note that the only variable affected is 'alt.'

Users interested in corrected data for this period should obtain filenames as listed below. They can be retrieved via the Query Interface at the Archive or by special request to Archive User Services (armarchive@ornl.gov).

- DsgpsondeptucalcB1.c1
- DsgpsondeptucalcB4.c1
- DsgpsondeptucalcB5.c1
- DsgpsondeptucalcC1.c1

STATUS Message

Soundings done at the SGP (BFs and CF digiCORA) and at the TWP include a STATUS message in the netCDF metadata. This STATUS message contains information about the overall quality of the sounding. Among the information included in the status message is the percent of good telemetry, and the percent of samples that did not pass the internal quality checks. For sounding data collected with one of our digiCORA-III ground stations, the message includes the type of radiosonde used. The format of the STATUS message is explained in Section 5.4.

Data Quality Flags

Some automated data quality checks are included in the processed BBSS netCDF file. Checks now used are based on predefined limits for maximum, minimum, and sample-to-sample change (delta) values of each raw variable. The limits used for BBSS are shown in Table 4.

Table 3. Data Quality Min/Max Limits

Variable	Name	Units	SGP	TWP	NSA

			Min	Max	Delta	Min	Max	Delta	Min	Max	Delta
pres	pressure	hPa	0.0	1100.0	10.0	0.0	1100.0	10.0	0.0	1100.0	50.0
tdry	dry bulb temperature	C	-80.0	50.0	10.0	-80.0	50.0	10.0	-80.0	50.0	50.0
dp	dewpoint temperature	C	-110.0	50.0	----	-110.0	50.0	----	-110.0	50.0	50.0
wspd	wind speed	m/s	0.0	75.0	----	0.0	75.0	----	----	----	----
deg	wind direc-tion	deg	0.0	360.0	----	0.0	360.0	----	----	----	----
Rh	relative humidity	pct	0.0	100.0	----	0.0	100.0	----	0.0	100.0	----

Table 4. (contd)

			SGP			TWP			NSA		
Variable	**Name**	**Units**	**Min**	**Max**	**Delta**	**Min**	**Max**	**Delta**	**Min**	**Max**	**Delta**
U_wind	eastward wind com-ponent	m/s	-100.0	100.0	----	-100.0	100.0	----	----	----	----
v_wind	northward wind com-ponent	m/s	-100.0	100.0	----	-100.0	100.0	----	----	----	----
wstat	wind status	none	0.0	----	----	0.0	----	----	----	----	----
asc	ascent rate	m/s	-10.0	20.0	5.0	-10.0	20.0	5.0	-10.0	20.0	5.0

Data Quality

Data Quality Health and Status

The following links go to current data quality health and status results:

- DQ HandS (Data Quality Health and Status)
- NCVweb for interactive data plotting using.

The tables and graphs shown contain the techniques used by ARM's data quality analysts, instrument mentors, and site scientists to monitor and diagnose data quality.

Click on one of the links below to look at the current/recent data quality or operational health and status of BBSS. These various sources will provide you with an idea of how ARM data quality analysts, instrument mentors, site scientists, and site operators closely monitor instrument performance in the real time.

- **SGP**

  Data Quality Health and Status
  Sounding Status Reports
  Prelaunch Logs
  DSView

Data Reviews by Instrument Mentor

The BBSS Instrument Mentors perform a number of tasks to assure the quality of BBSS data. Data quality control procedures for this system are considered **mature**.

- QC frequency: Daily
- QC delay: Real-time; weekly
- QC type: Min/max/delta flags; graphical plots; mentor reviews
- Inputs: Raw data files
- Outputs: Hard copy plot of every sounding
- Reference: None

Standard BBSS data are subject to several levels of quality control and quality assurance. The process of converting the raw 1.5-second PTU samples to values output every 2 seconds involves filtering, editing, and interpolation intended to provide the best estimate of the atmospheric state at every level. The details of the processing are not well documented. They are being analyzed by the instrument mentor and more information will be provided when it is available.

Daily logs that include operator comments regarding the system and a listing of DQ flags set during the ingest are sent to instrument mentor. He reviews these logs practically every day.

The mentor makes a hard copy plot of every sounding daily. He examines the plots for features that may suggest a DQ problem that did not set one of the automatic flags. The plots also are used to verify and evaluate the DQ problems identified by the automatic procedures. If a problem is significant enough to highlight, he writes and submits a DQR for data users and submits a DQPR to site operators (SGP) to initiate corrective maintenance.

The mentor receives weekly output from the ongoing Quality Measurement Experiment (QME) involving the BBSS and the MWR (QMEMWRCOL). He processes this output to evaluate the longer-term performance of the radiosondes by comparison with the MWR, with special attention to sonde calibration lot. If it appears that a particular calibration lot may have a DQ problem, he (1) issues a request to site operations personnel to hold all remaining radiosondes from the questionable lot, (2) issues a DQR related to all soundings done using radiosondes from the questionable lot, and (3) contacts the manufacturer to arrange for special retesting of the sondes from the questionable lot.

The mentor also does a weekly comparison of the surface values of pressure, temperature, and humidity for each sounding with the coincident measurements obtained by the collocated temperature, humidity, winds, and pressure system (THWAPS). These comparisons help to highlight operator data entry problems or calibration errors. Sample comparisons (left) and sounding profiles (right) are provided in Figure 1.

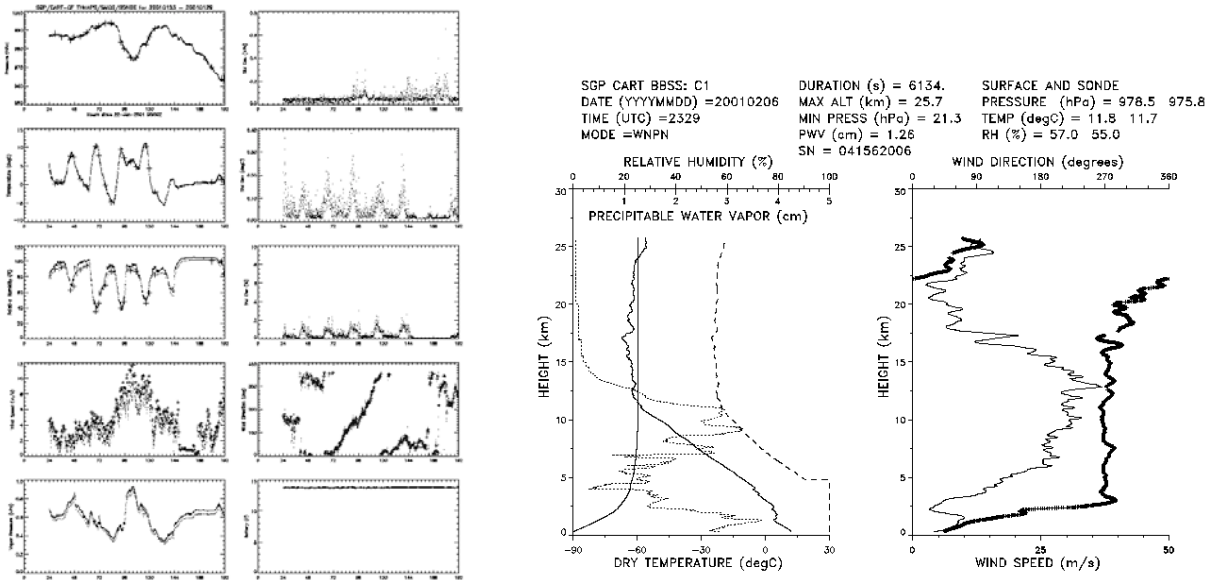

Figure 1. Sample Comparisons of Sounding Profiles

Data Assessments by Site Scientist/Data Quality Office

The **SGP Site Scientist Team and Data Quality Office** extract automated flag information from BBSS files to produce tables of color-coded flag status. It also performs visual inspections of Skew-T/log p plots (from the NSDL Quicklooks Website), comparisons of sonde and 60-m tower temperature and relative humidity (CF site only), and comparison plots of THWAPS, Surface Meteorological Observing Station, EBBR, and cloud mask for temperature, humidity, and pressure (CF only). A weekly assessment report is issued to the Instrument Mentor and SGP Site Operations in which data are verified as suitable for use, or irregularities are noted. Such mentor and site scientist results then trigger the writing of appropriate DQPRs (SGP) to initiate corrective maintenance and ARM DQRs for data users.

To see these color status tables and BBSS plots, go to the SGP Data Quality Health and Status site. Once there, you will see a color status table for the current month. To see the color status for the launches of a particular day, pick a site and day, toggle "Submit Request," and this will reveal the color status tables of the launches made that day. If you place your mouse over non-green boxes, a pop-up will reveal which flags were tripped and at what percentage. Click on "Diagnostic Plot" for the launch you are interested in to see its visuals and the NSDL quicklook for the Skew-T/log p.

Value-Added Procedures and Quality Measurement Experiments

Many of the scientific needs of the ARM Program are met through the analysis and processing of existing data products into "value-added" products. Despite extensive instrumentation deployed at the ACRF sites, there will always be quantities of interest that are either impractical or impossible to measure directly or routinely. Physical models using ARM instrument data as inputs are implemented as "value-added" products and can help fill some of the unmet measurement needs of the program. Conversely, ARM produces some "value-added" products not to fill unmet measurement needs, but instead to improve the quality of existing measurements. In addition, when more than one measurement is available, ARM also produces "best estimate" "value-added" products. A special class of "value-added" product called a QME does not output geophysical parameters of scientific interest. Rather, a QME adds value to the input datastreams by providing for continuous assessment of the quality of the input data based on internal consistency checks, comparisons between independent similar measurements, or comparisons between measurement with modeled results, and so forth. For more information, see the VAPs and QMEs Web page.

BBSS-related "value-added" products include:

- LSSONDEhttp://www.arm.gov/instruments/static/ /docs/research/vap_homepage/details/lssonde.html – Produces radiosonde profiles in which the moisture profile is scaled to match MWR total perceptible water vapor.

BBSS-related QMEs include:

- QMEMWRCOL – Results from this QME are used to evaluate the MWR and radiosondes.
- QMEMWRPROF – Comparisons of retrieved water vapor and temperature profiles from mwrprof with radiosonde profiles.
- QMEAERIPROF – This QME helps to assess the ability of the radiosondes and in situ tower measurements to observe moisture and temperature in the atmosphere.
- QMEAERILBLCLOUDS – Uses radiosonde pressure, temperature, and moisture data as input.

Instrument Details

Detailed Description

List of Components

The BBSSs consist of disposable radiosondes and fixed ground stations. All facilities use the same basic radiosondes, but the ground stations differ somewhat. Each ACRF site uses Vaisala ground stations.

Radiosondes:

ARM practice has been to adopt the most advanced radiosonde technology provided by Vaisala as soon as it has been proven. ARM was the first large-scale program to use the advanced H-Humicap in the RS80 family of radiosondes, the first research program to make the transition to the dual-humicap RS90 family, and the first program to use the RS92 family. Before making the change between radiosonde types, ARM conducted month-long transition IOPs during which the new type of radiosonde was flown alongside the type being replaced. Each of these experiments took place at the SGP.

- Manufacturer: Vaisala, Inc.

- SGP
  - RS80-15LH (Loran-C windfinding, H-Humicap, 403 MHz) through April 2001
  - RS90-AL (Loran-C windfinding, dual humicap) beginning May 2001
  - RS92-KL (Loran-C windfinding, dual humicap) beginning 17:30 UTC February 9, 2005

Ground Stations:

The essential attributes of the ground stations employed by ARM are reported in Tables 1 and 2.

System Configuration and Measurement Methods

Original sampling rate (May 27, 1992, to May 30, 1993):

The raw sampling rate of thermodynamic sensors is approximately 1.5 seconds. The rate at which processed data is output to the datastream is programmable. For the first several months of operation at the SGP site, we used a scheme in which PTU and wind data were output at three different rates, depending on the time into the sounding. These sampling rates were as follows:

- Sample output every 10 seconds from 0 to 120 seconds into the flight.
- Sample output every 30 seconds from 120 to 900 seconds into the flight.
- Sample output every 60 seconds from 900 seconds to the end of the flight.

Sampling rate (SGP/TWP) from June 1, 1993, to November 24, 2000:

- Thermodynamic variables (PTU) output every two seconds throughout the flight.

- Wind variables (speed, direction):
  - Output every ten seconds (SGP)
  - Output every two seconds (TWP).

Current Sampling rate (SGP):

- Thermodynamic variables (PTU) output every two seconds throughout the flight.
- Wind variables (speed, direction) output every two seconds throughout the flight.

Balloons and rate of ascent:

ARM uses 350-gal balloons at all sites. The nominal ascent rate is approximately 5 m/s, although this is variable during the flight. The data file includes a variable 'asc' which, for each sample, estimates the current rate of ascent. This rate is actually a 30-second average rise rate based on the calculated sonde altitudes.

Software Configuration of the SGP digiCORA Systems

The following links are to the current software configuration listings for the Vaisala MW-11 and MW-15 digiCORA systems now in use at the SGP. As shown in Table 1, the MW-11 systems are nominally assigned to BF1 (Hillsboro, Kansas), BF4 (Vici, Oklahoma), BF5 (Morris, Oklahoma), and BF6 (Purcell, Oklahoma). The configuration listings show the installed software applications as well as their version numbers.

SGP

BF1
BF4
BF5
BF6
Spare

Specifications

The manufacturer's specifications for the thermodynamic sensors are as follows:

```
PRESSURE
  Type:       Capacitive aneroid
  Range:      1060 hPa to 3 hPa
  Resolution: 0.1 hPa
  Accuracy:   0.5 hPa

TEMPERATURE
  Type:       Capacitive bead
  Range:      +60°C to -90°C
  Resolution: 0.1°C
```

```
  Accuracy:   0.2°C
  Lag:        <2.5 s (6 m/s flow at 1000 hPa)

HUMIDITY
  Type:       H-HUMICAP thin film capacitor
  Range:      0 to 100 %RH
  Resolution: 1 %RH
  Accuracy:   2 %RH (0 to 80 %RH)
              3 %RH (80 to 100 %RH)
  Lag:        1 s (6 m/s flow at 1000 hPa, +20°C)
```

Note that the "accuracy" figures given by the manufacturer represent the standard deviation of the differences obtained from repeated calibrations. As such, these values are more properly termed "precision." Operational experience at the SGP site (Lesht 1995) showed that the root mean square error in RH was approximately 1% RH at low humidity and surface temperature and that the root mean square error in temperature was approximately 0.3°C.

Winds

Wind information (SGP) is obtained by tracking the radiosonde's position using the Loran-C navigation system. The accuracy of the wind information depends on the configuration of the Loran-C stations that are used to locate the sonde. Loran-C coverage in the SGP area is fairly good, and we estimate the accuracy of the wind speed to be approximately 0.5 m/s.

We use GPS wind-finding at the TWP locations. This satellite-based navigation system is very precise and we estimate the accuracy of the wind velocity to be 0.2 m/s.

Calibration

Calibration Theory

Calibration Procedures

Calibration History

Operation and Maintenance

User Manual

Each site maintains its own radiosonde launch procedures. The Vaisala User's Manual for the digiCORA-III system may be accessed here.

Routine and Corrective Maintenance Documentation

The following link points to the General Preventative Maintenance Procedures in place for all sites

Software Documentation

This section is under construction.

Additional Documentation

This section is not applicable to this instrument.

Glossary

See the ARM Glossary.

Acronyms

See the ARM Acronyms and Abbreviations.

Citable References

Lesht, BM. 1995. An Evaluation of ARM Radiosonde Operational Performance. *Proceedings of the Ninth Symposium on Meteorological Observations and Instrumentation*, pp. 6-10. American Meteorological Society, Boston, Massachusetts.
Lesht, BM. 1999. Reanalysis of radiosonde data from the 1996 and 1997 water vapor intensive operations periods: Application of the Vaisala RS-80H contamination correction algorithm to dual-sonde soundings. Presented at the Ninth Atmospheric Radiation Measurement (ARM) Science Team Meeting. San Antonio, Texas. March 22-26, 1999.

Miller, ER, J Wang, and HR Cole. 1999. "Correction for dry bias in Vaisala radiosonde RH data." Presented at the Ninth Atmospheric Radiation Measurement (ARM) Science Team Meeting. San Antonio, Texas. March 22-26, 1999.

Bibliography

Lesht, BM, and JC Liljegren. 1996. Comparison of Precipitable Water Vapor Measurements Obtained by Microwave Radiometry and Radiosondes at the Southern Great Plains CART site. In *Proceedings of the Sixth Atmospheric Radiation Measurement (ARM) Science Team Meeting*. U.S. Department of Energy.

Mattioli, V, E Westwater, D Cimini, J Liljegren, BM Lesht, S Gutman, and F Schmidlin. 2005. "Analysis of Radiosonde and PWV Data from the 2004 North Slope of Alaska Arctic Winter Radiometric Experiment." Presented at the Fifteenth Atmospheric Radiation Measurement (ARM) Science Team Meeting. Daytona Beach, Florida. March 14-18, 2005.

Mattioli, V, ER Westwater, D Cimini, JS Liljegren, BM Lesht, S Gutman, and F Schmidlin. 2005. "Analysis of radiosonde and precipitable water vapor data from the 2004 North Slope of Alaska Arctic Winter Radiometric Experiment." In *Proceedings of the Fifteenth Atmospheric Radiation Measurement (ARM) Science Team Meeting*, U.S. Department of Energy, DOE/SC-ARM-0503.

Miloshevich, LM, BM Lesht, and M Ritsche. 2004. "New Surface Meteorological Measurements at SGP, and Their Use for Assessing Radiosonde Measurement Accuracy." Presented at the Fourteenth Atmospheric Radiation Measurement (ARM) Science Team Meeting. Albuquerque, New Mexico. March 22-26, 2004.

Miloshevich, LM, BM Lesht, and H Voemel. 2004. "Evaluation of ARM Radiosonde Humidity Measurements and Proposed Corrections Based on AMEX Radiosonde Intercomparisons." Presented at Fourteenth Atmospheric Radiation Measurement (ARM) Science Team Meeting. Albuquerque, New Mexico. March 22-26, 2004.

Soden, BJ, DD Turner, BM Lesht, and LM Milosevich. 2004. "An analysis of satellite, radiosonde, and lidar observations of upper tropospheric water vapor from the Atmospheric Radiation Measurement program." *Journal of Geophysical Research* 109:D04105.

Westwater, B, B Stankov, D Cimini, Y Han, JA Shaw, BM Lesht, CN Long, and ER Westwater. 2003. "Radiosonde humidity soundings and microwave radiometers during NAURU99." *Journal of Atmospheric and Oceanic Technology* 20:953-971.

Westwater, ER, BB Stankov, D Cimini, Y Han, JA Shaw, BM Lesht, and CN Long. 2003. "Radiosonde humidity soundings and microwave radiometers during Nauru99." *Journal of Atmospheric and Oceanic Technology* 20:953–971.

Derived Parameter	Start Year	Instrument PI	Certify[1]
Balloon-borne Observations			
Total Column Observations			
Surface Observations			
Other Profile Measurements			
Solar Radiation Observations			

Table 1: List of atmospheric measurements potentially related to GRUAN.

PLANS, AFFILIATIONS OF INSTRUMENTATION, COMMENTS ON MEASUREMENTS
For any instruments which provide vertical profiles extending from the surface which you wish to be considered within the application:

- *Describe the ground/instrument checks performed at the time of each profile measurement.*
- *Describe redundancy in measurement systems that can be used to validate the derived uncertainties on the primary measurements.*
- *Describe historical measurements available at the site that conform to the GRUAN standards.*
- *Describe the extent to which the site can commit to a multi-decade program of measurements.*
- *Describe the support of the home institution to maintain long-term reference quality measurements programs. Is this support dependent on a single individual within the organization?*

[1] This column should specify whether the site seeks GRUAN certification for this measurement programme now (now), once a GRUAN product has been defined for the measured parameter (later) or never (never).

- *Describe collaborative links to other monitoring networks.*

2.1 Priority 1 Variables

Surface Observations
DESCRIPTION OF PRIORITY 1 SURFACE OBSERVATIONS IN RELATION TO GRUAN.
In addition to the information provided above, describe how the measurements being made meet the requirements of reference quality measurements insofar as the calibration methods applied, traceability to fundamental standards, and other requirements for reference quality measurements, before the raw data are processed. Describe the procedures for documenting and tracing calibrations performed at the level of the collection of the raw data.

Upper Air Measurements
DESCRIPTION OF PRIORITY 1 UPPER AIR OBSERVATIONS IN RELATION TO GRUAN.
In addition to the information provided above, describe how the measurements being made meet the requirements of reference quality measurements insofar as the calibration methods applied, traceability to fundamental standards, and other requirements for reference quality measurements, before the raw data are processed. Describe the procedures for documenting and tracing calibrations performed at the level of the collection of the raw data.

2.2 Priority 2 Variables

DESCRIPTION OF PRIORITY 2 OBSERVATIONS IN RELATION TO GRUAN

2.3 Priority 3 and lower variables

DESCRIPTION OF PRIORITY 3 OBSERVATIONS IN RELATION TO GRUAN

3. Contributions to the GRUAN Data Stream

Available GRUAN Data Product: Vaisala RS92
DESCRIPTION OF HOW THE GRUAN RS92 OBSERVATIONS ARE BEING PROVIDED AND HOW THESE MEASUREMENTS ARE BEING OBTAINED.

Potential GRUAN Products
DESCRIPTION OF HOW THE SITE WILL PARTICIPATE IN PLANNED GRUAN DATA PRODUCTS OR DEVELOP THEIR OWN OBSERVATIONS INTO A GRUAN DATA PRODUCT.

Describe the facilities implemented for long-term storage of raw data. Note that NCDC can act as an archive upon request for non-GRUAN measurements.

4. Change management

PLEASE CONFIRM THAT YOUR SITE WILL ADHERE TO THE CHANGE MANAGEMENT REQUIREMENTS LAID OUT IN THE GRUAN GUIDE TO OPERATIONS:

- *Change events are announced to the Lead Center before they happen. The change event announcement contains a description of the intended change, a rough evaluation of the expected impact, a list of measures, that will be taken to minimize the impact of the change on the long term data series and an estimated time for the end of the change event.*
- *Studies within the change event are coordinated with the Lead Center such that any network wide impacts are evaluated network wide.*
- *Studies within the change event are conducted such that resources available elsewhere are utilized.*
- *A summary of all studies within a change event is published and archived at the Lead Center. The publication may be as simple as a technical note issued by the institution, a GRUAN technical document, or as detailed as a peer reviewed article. The level of publication depends on the magnitude of the change event.*
- *All data and metadata relevant to the change event are archived locally. These data and metadata are referred to in the final summary of the change event.*
- *All historical data are reprocessed to guarantee homogeneity of the long term data set.*

5. Implementation Plan

DESCRIPTION OF HOW (OTHER) GRUAN REQUIREMENTS, AS DETAILED IN THE GRUAN MANUAL AND GUIDE, ARE BEING IMPLEMENTED AT THE SITE

- *Describe the unique observational and/or analysis capabilities, if any, that align with GRUAN scientific objectives, which the site brings to the network as a whole. What is the likelihood of being able to propagate these capabilities across other sites in the network?*
- *Describe how the site will actively conduct research through intercomparisons, laboratory studies, collaboration with other GRUAN sites, and/or cooperation with manufacturers to improve measurement accuracy.*

6. Participation in GRUAN Task Teams / Working Group

DESCRIPTION OF HOW THE SITE PLANS TO ACTIVELY PARTICIPATE IN GRUAN TASK TEAMS, THE WORKING GROUP AND OTHER GRUAN ACTIVITIES.