Technical Support of NCore Implementation Meteorological Requirements

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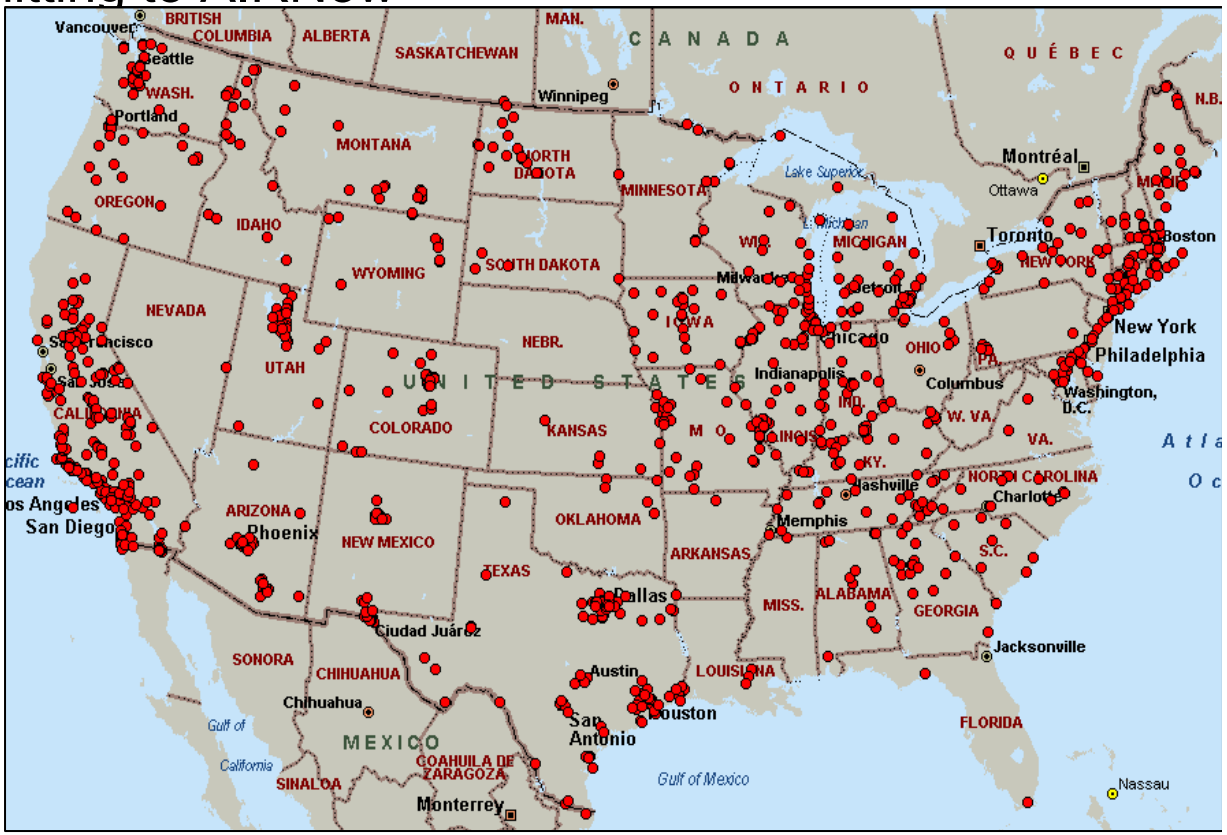
Outline

- Introduction
- Parameter Considerations
  - NCore Requirements
  - Types of Instruments
- Sensors (Calibrations and QA issues)
  - Siting
  - Sonic Anemometers
- Data Handling Issues
  - DAS Configuration Issues
- Overview of the Red Book

The State of Meteorological Monitoring

- Currently only required for PAMS sites
- However, many S/L/Ts measuring even without a requirement
  - Reporting to AQS and/or AIRNow
  - Around 31 users submitting to AIRNow

Take the initiative!



SLT Met stations actively reporting data to AQS through June 2005

What are some known S/L/T issues with Met.?

Primary Issue:

- Many State/Local agencies are hesitant to use the meteorological data they collect because of **uncertainty in data quality.**
- Several State/Local agencies have trouble **accessing meteorological data** both from their own agency and from neighboring agencies.
- Some traditional **meteorological monitoring methods** (e.g. siting criteria) are not appropriate for air quality applications.

Recommendation:

- Quality Assurance (QA) requirements at NCore multi-pollutant sites to promote better data quality.
- Enhance EPA's databases (e.g. AIRNow and AQS) to improve their capability for storing and sharing meteorological data.
- Create measurement methods specific to meteorological monitoring for air quality management. Specifically, investigate ways to appropriately use met data from a tower that may not be "perfect."

Who is using all this meteorological data?

- Modelers
- Data Analysts
- Forecasters

And why all the attention on meteorology now?

In a word…

NCore Design Criteria

- 40 CFR 58 Appendix D.3.b states, “The NCore sites must measure, at a minimum, PM2.5, ….wind speed, wind direction, relative humidity and ambient temperature.”
- Additional parameters may include:
  - Solar Radiation
  - Precipitation
  - Barometric Pressure
- Plus, we want vectors!

Doesn't NOAA already produce meteorological data?

Why do we now need State, Local, and Tribal folks to collect Met Data?

NOAA vs. S/L/T Met Data

- S/L/Ts provide hourly averaged data
  - NOAA data is a 2 minute average taken 10 to 20 minutes before the top of the hour
- S/L/T wind data can be vector averaged!
  - NOAA wind data is scalar only
  - Vector data is needed to follow (model) air parcel movements
- S/L/T met. data will be co-located with air pollution data
- S/L/T data may represent multiple siting scales
  - Regional, Neighborhood, Middle, & Microscale

Let's collect some data…

- Wind speed
- Wind direction

- Ambient Temperature
- Relative humidity

Additional Parameters

- Barometric Pressure
- Solar Radiation
- Precipitation

Now, let's get these things sited!

Siting and QA Issues

- Proper siting is important
- However, siting for pollution doesn't always work for Met parameters

The answer: site your met sensors at NCore sites and try to follow the new QA Handbook Siting guidance

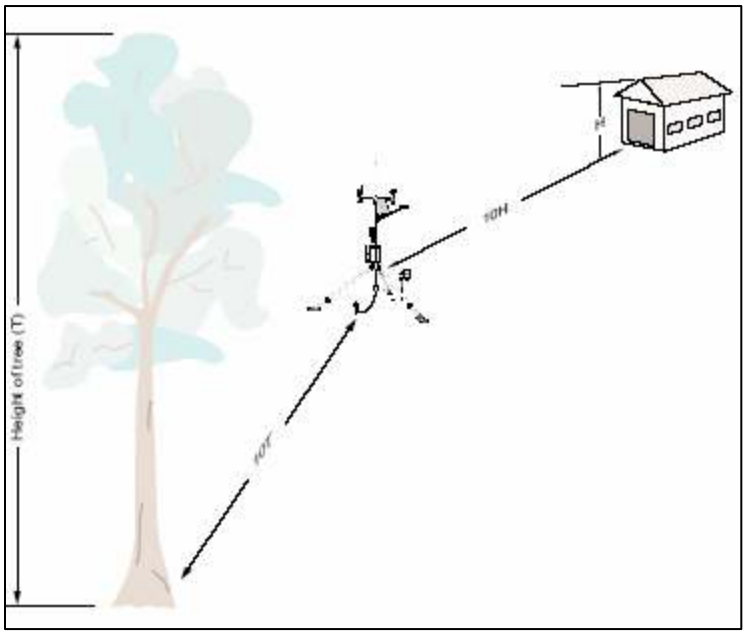
Siting and QA Issues

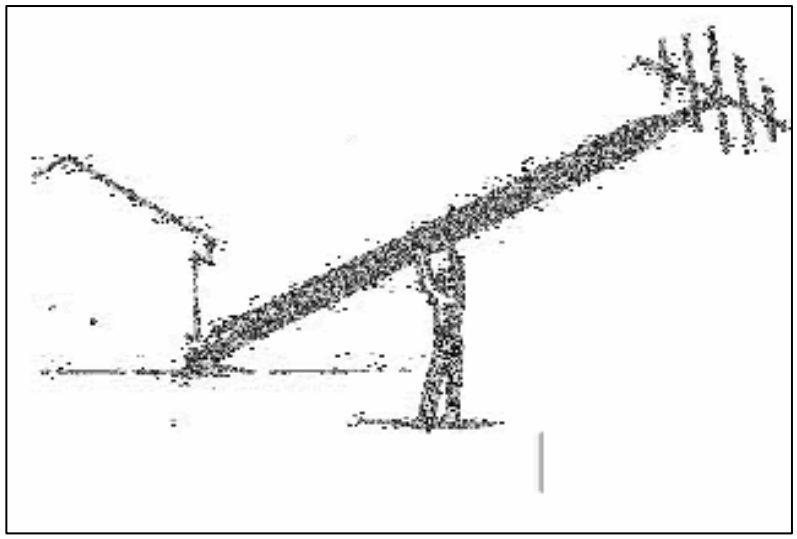
Measurement	Distance from Obstruction	Distance Above Ground	Recommended Group Cover	Comments
Wind Speed/Direction	10x the height of the obstruction	10 meters	Grass or gravel	The standard exposure of the wind instruments over level, open terrain is 10 meters above ground[11]
Temperature/Dew Point	1.5x the tower diameter	1.25 to 2 meters	Non-irrigated or un-watered short grass, or natural earth	The surface should not be concrete or asphalt or oil-soaked. Reflection from these surfaces may affect the performance of the sensor.
Vertical Temperature Difference	1.5x the tower diameter	2 meters and 10 meters	Non-irrigated or un-watered short grass, or natural earth	The surface should not be concrete or asphalt or oil-soaked. Reflection from these surfaces may affect the performance of the sensor.
Solar Radiation	2 meters	2 to 10 meters	No requirements	Sensor should be free from obstructions above the plain of the sensor. It should be located so that shadows will not cast on the device.
Barometric pressure	1 meter	1 to 10 meters	No requirements	The location should have uniform, constant temperature, shielded from the sun, away from drafts or heaters
Precipitation	2x to 4x the obstruction height	30 cm, minimum	Natural vegetation or gravel	Asphalt or concrete should be avoided to avoid splashing the gage. The gage should be high enough to avoid it being covered by snow.

[a]**Note: More details on siting and exposure are available in the individual sections of this Handbook. Please see the installation section of each chapter for more information.**

Siting and QA Issues

- Additional siting guidance on towers
- Section 2.4 of QA Handbook.





Siting and QA Issues

- In most instances, Met data are collected for:
  - Forecasting
  - Modeling
  - Data Analysis

- Since Met data is supportive, generally, DQOs don't need to be generated.

- Without DQOs, how do we get the Measurement Quality Objectives (MQOs)?

- The answer: QA Handbook has tables of MQOs for programs that recommend or require Met data

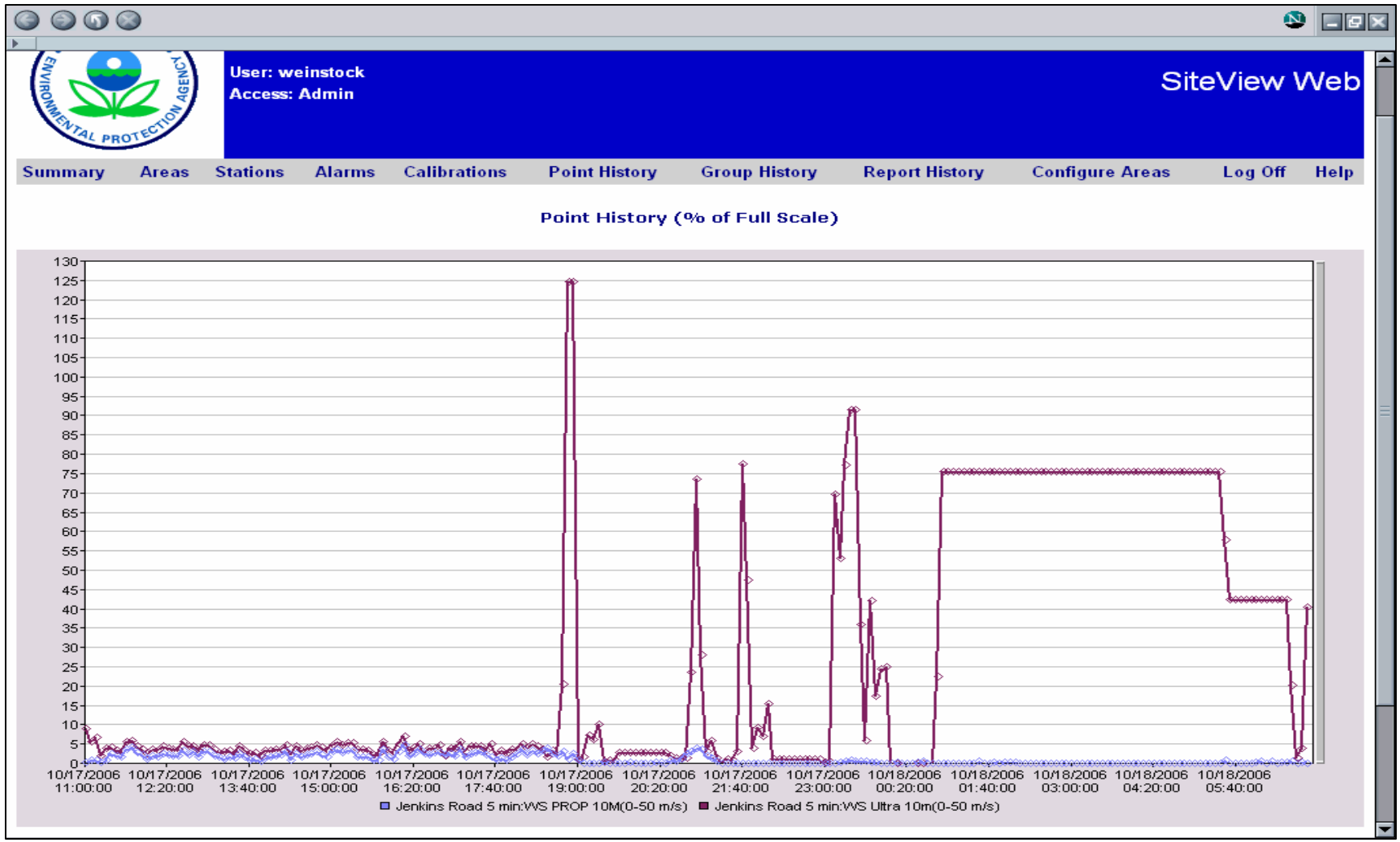
NCore Measurement Quality Objectives

Measurement	Method	Reporting units	Required Operating Range	Resolution	Minimum Sample Frequency	Raw Data Collection Frequency	Completeness
(Required)							
Ambient Temperature	Thermistor	ºC	-30 – 50	0.1	Hourly	1 minute	75%
Relative Humidity	Psychrometer/ Hygrometer	%	0 – 100	0.5	Hourly	1 minute	75%
Wind Speed	Cup, prop or sonic anemometer	m/s	0.5 – 50.0	0.1	Hourly	1 minute	75%
Wind Direction	Vane or sonic anemometer	Degrees	0 – 360 (540)[3]	1.0	Hourly	1 minute	75%
Vector Data Wind Speed Wind Direction	DAS Calculations	m/s degrees	0 – 50.0 0 – 360	0.1 1.0	Hourly	1 minute 1 minute	75%
(Optional)							
Solar Radiation	Pyranometer	Watts/m^2	0 – 1100	10	Hourly	1 minute	75%
Precipitation	Tipping Bucket	mm/hr	0 – 25 mm/hr	0.2 mm	Hourly	1 minute	75%
Barometric Pressure	Aneroid Barometer	mb	600 – 1100	0.5	Hourly	1 minute	75%

NCore Calibration/Audit Recommendations

Measurement	Calibration			Accuracy		
	Type	Acceptance Criteria	Frequency	Type	Acceptance Criteria	Frequency
Ambient Temperature	3 pt. Water Bath with NIST-traceable thermistor or thermometer	±0.5 ºC	Quarterly	3 pt. Water Bath With NIST-traceable thermistor or Thermometer	±0.5 ºC	Semi-Annually
Relative Humidity	NIST-traceable Psychrometer or standards solution	±7% RH	Quarterly	NIST-traceable Psychrometer or standards solution	±7% RH	Semi-Annually
Wind Speed	NIST-traceable Synchronous Motor	±0.25m/s ≤5m/s; 5%>2m/s not to exceed 2.5m/s	Quarterly	NIST-traceable Synchronous Motor	0.25m/s ≤5m/s; 5%>2m/s not to exceed 2.5m/s	Semi-Annually
Wind Direction	Solar Noon, GPS Magnetic Compass	±5 degrees; includes orientation error	Quarterly	Solar Noon, GPS or Magnetic Compass	±5 degrees; includes orientation error	Semi-Annually
Solar Radiation	NIST-traceable Pyranometer	±5% of mean observed interval	Quarterly	NIST-traceable Pyranometer	±5% of mean observed interval	Semi-Annually
Barometric Pressure	NIST-traceable Aneroid Barometer	±3 mb	Quarterly	NIST-traceable Aneroid Barometer	±3 mb	Semi-Annually
Precipitation	Separatory funnel and graduated cylinder	±10% of input volume	Quarterly	Separatory funnel and graduated cylinder	±10% of input volume	Semi-Annually

Sonic Anemometer Issues



Data Handling

Data Handling

- Once we're sited, QA'ed and running, it's time to deal with the data
- Many sensors providing analog data to a translator (esp. wind data)
- Translators typically can output digitally or analog

- Vector averaging requires conversion from scalar (by translator or data acquisition system)

Organize & move that data…

The goal: *Timely reporting of high quality, highly time-resolved ambient monitoring data.*

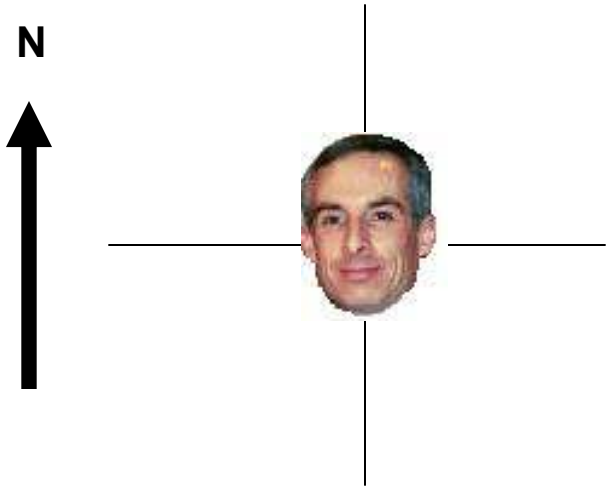
- Data acquisition system is key
  - Digital or analog (we like digital! )
  - Disseminate locally and/or nationally
- Move it where?
  - AIRNow-Tech
  - AQS
  - Local users (AQ forecasters, etc.)

Scalar vs. Vector

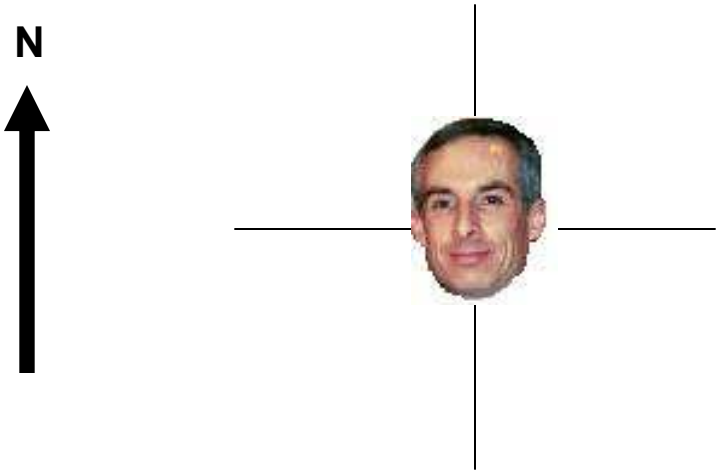
- Overall difference is more apparent at lower wind speeds
  - Scalar: using arithmetic average
  - Vector: either directly obtain or derive orthogonal components from scalar values
- In the case of wind speed, vector-averaged speeds are never larger than the scalar-averaged values and generally are lower
- Example: 10 minute total average
  - North wind at 5 m/s for 5 minutes
  - South wind at 5 m/s for 5 minutes
  - ➢ Scalar average: 5 m/s
  - ➢ Vector average: 0 m/s

Scalar vs. Vector (cont.)

- Same example, now visualize the wind directions too…
  (From the North for 5 min. and then the South for 5 min. at 5 m/s)



Vector Average Result
NO NET DISPLACEMENT



Scalar Averaging Results
Where IS he going?

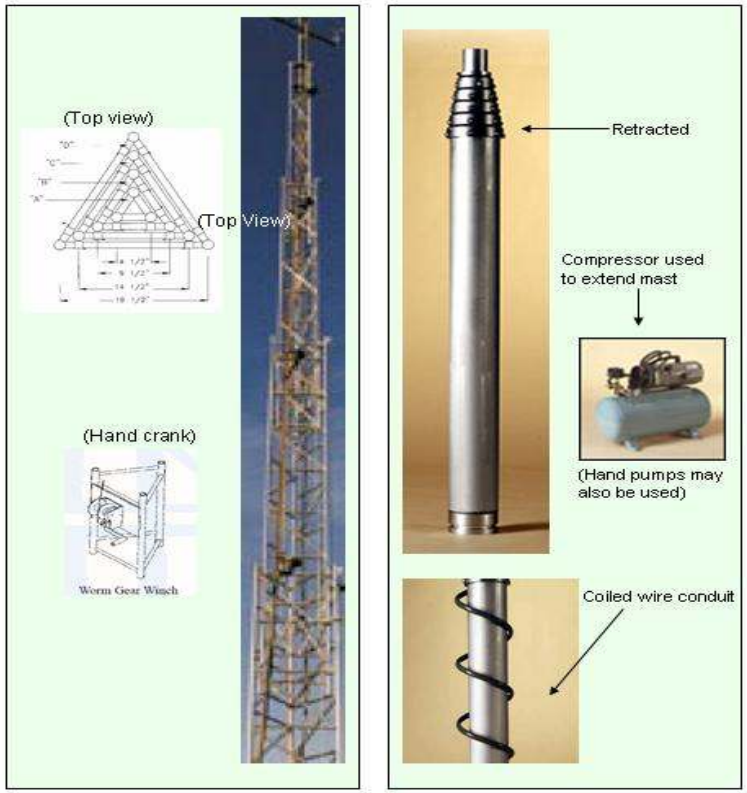
Why the difference?
Remember that the scalar average of 0 and 180 is 90!!

Overview of the Red Book

- There was a strong need to update the older QA Handbook Volume IV
  - Newer technologies
  - Digital Data Acquisition
  - New 40 CFR 58 Requirements (i.e., NCore)

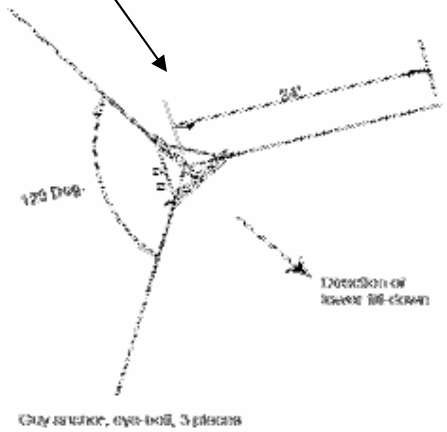
What's New: Towers

Types of Towers Available

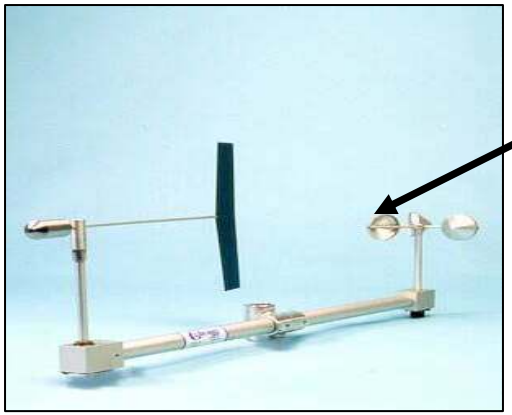


Installations of Towers

Tower Support



What's New: Wind Systems

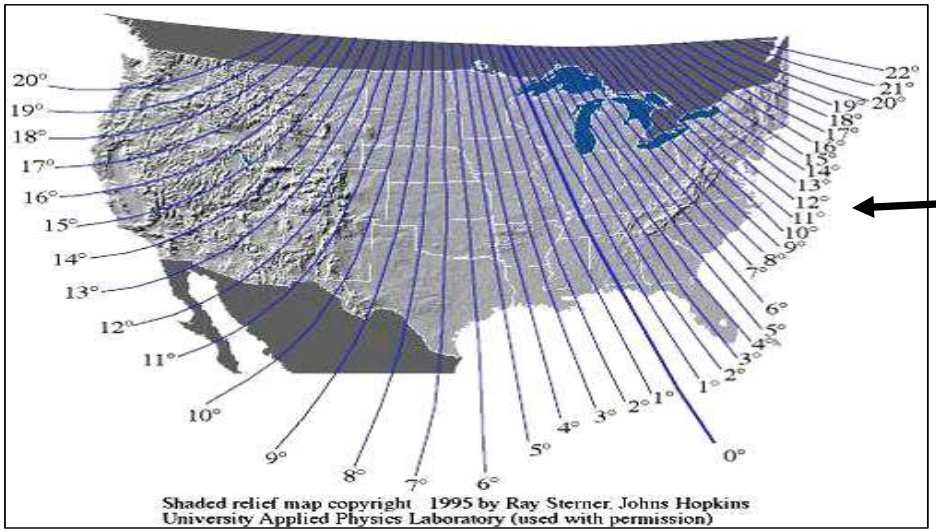


Section 2 discusses Cup and Vane Systems

Calibrations, torque test and distance constants

Section 2 discusses Propeller and Vane Systems

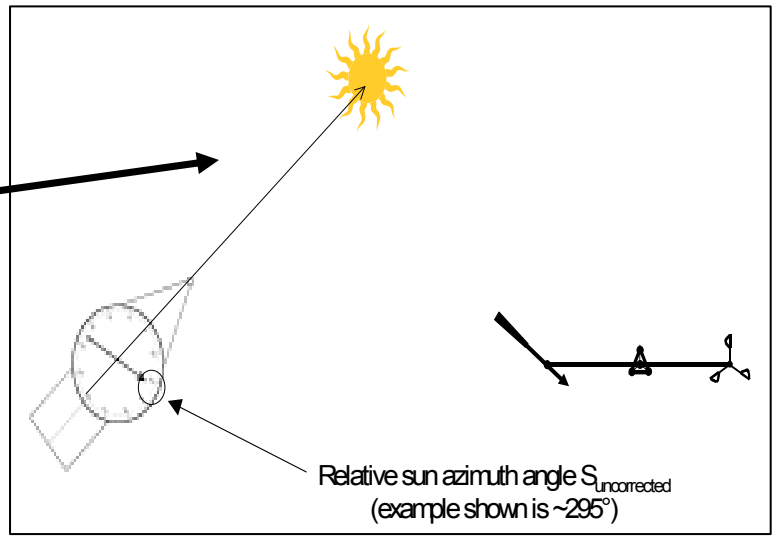
What New: Wind Systems



Shaded relief map copyright 1995 by Ray Sterner, Johns Hopkins University Applied Physics Laboratory (used with permission)

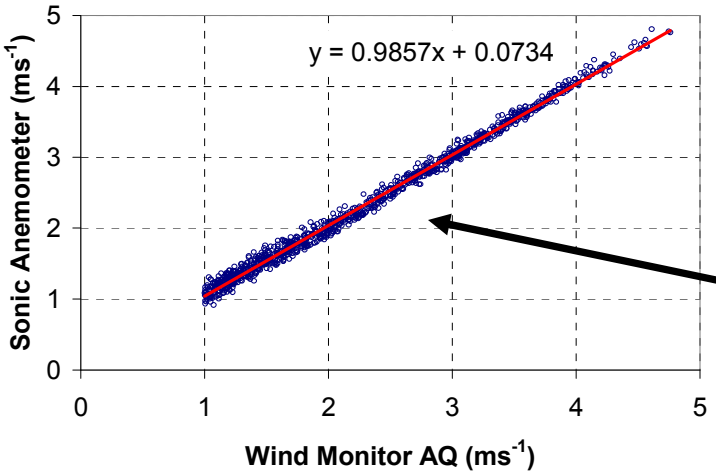
There is a great discussion on Magnetic Declination for wind direction traceability

Detailed discussion on Solar Noon method for wind direction traceability



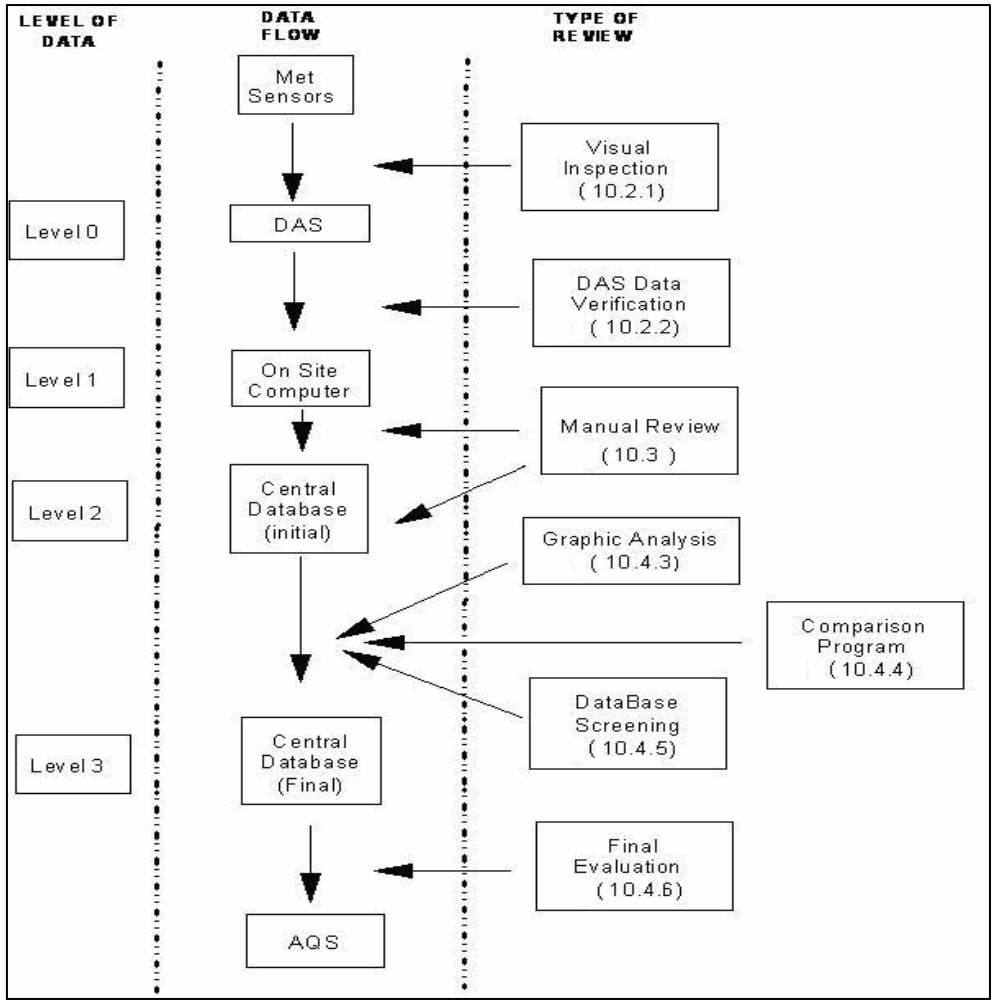
What's New: Wind Systems

Section 2 has in-depth discussion of sonic anemometers



The Handbook illustrates some side by side comparisons of prop vs. sonic

What's New: Data Validation



In-depth discussion of data validation

Section discusses validation and verification

Discusses how to "link" met data to pollution data

Each "type of review" has a section number

Other Features of Volume IV

New QA Handbook Volume IV is in 1st Draft.

- **MQOs**
- **Towers**
- **Wind systems**
- **Data acquisition and validation**
- **Upper Air Systems**
- **Audio/Video Enhancements**