

Atmosphere Sciences Instrumentation Lab

Organized by David Delene - November 20, 2008

Overview of Instruments – 3:00 Clifford Hall 470

Lab Demonstrations – 4:00 - 6:00 Clifford Hall 423



Currently there are many state of the art scientific instruments set up in the Atmospheric Sciences Instrumentation Lab (CH 423). Many students are currently working with these instruments, either as part of the Measurement System course (AtSc 535) or as student researchers.



Instruments and Presenters

Cloud Particle Imager (CPI) – Andrea Neumann

Passive Cavity Aerosol Spectrometer Probe (PCASP) – Kelsey Watkins

King Hot Wire Liquid Water Probe – Robert Mitchell

High Volume Precipitation Spectrometer (HVPS) – Matt Ham

Dew Point Temperature Sensor – Angelle van Oploo

Pressure Transducer – David Keith

Mass Flow Controller – Tim Logan

Rain Gauge – Dan Adriaansen

UWyo Cloud Condensation Nuclei Counter (CCNC) – Gokhan Sever

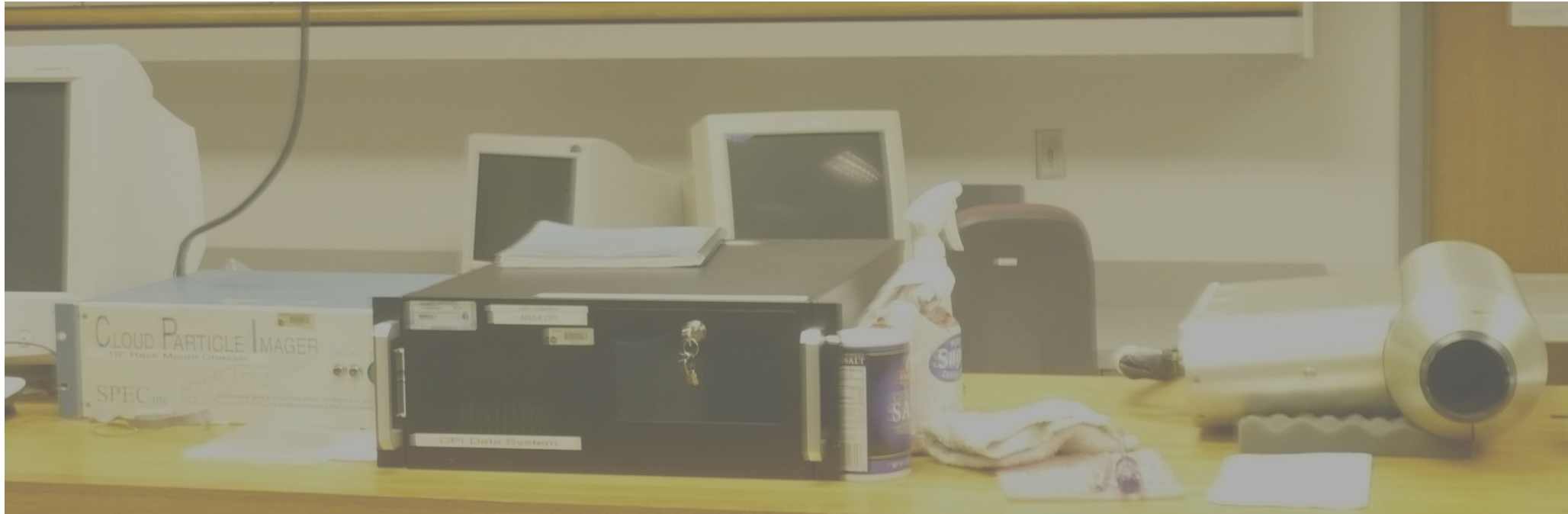
Condensation Particle Counter (CPC) – Zhe Feng

Aircraft Data System (M300) – Randall Johnson

Forward Scattering Spectrometer Probe (FSSP) – Christopher Kruse

Cloud Particle Imager (CPI)

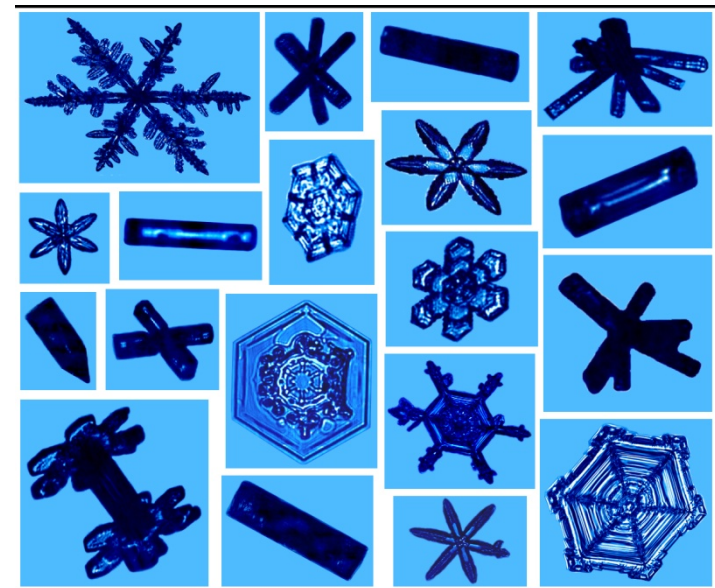
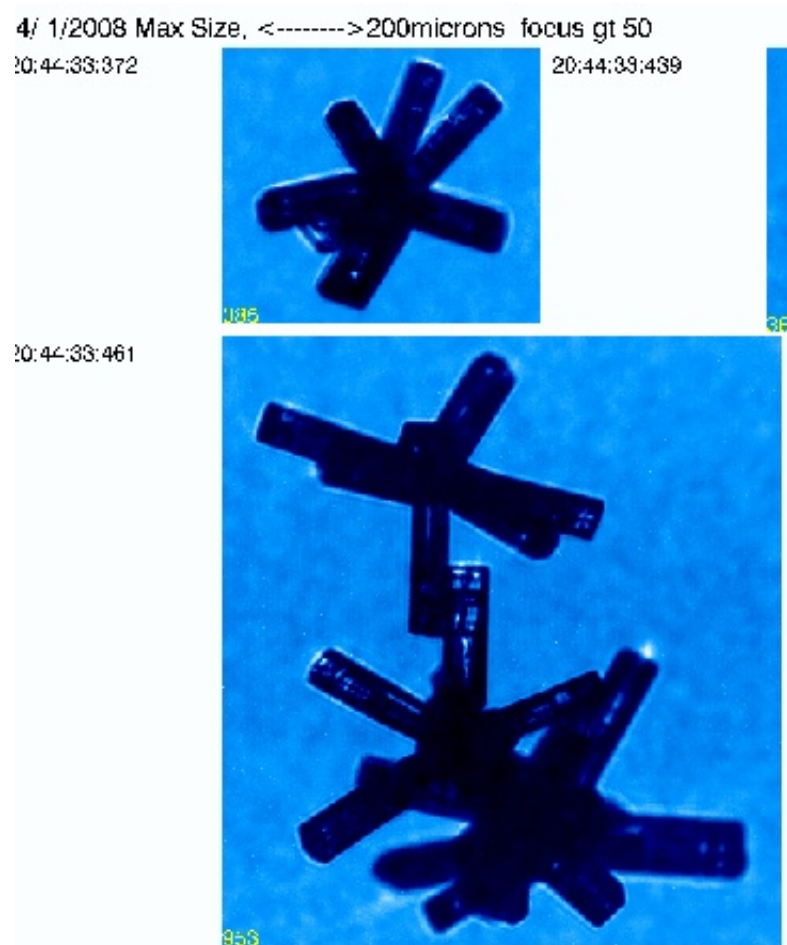
Andrea Neumann



- The CPI uses two lasers to detect a particle and then uses a 3rd laser to take a picture.
- Each picture is 1024 x 1024 pixels with each pixel representing 2.3 microns.

Cloud Particle Imager (CPI)

Example Pictures



Pictures courtesy of:

Atmospheric Radiation Measurement program:

http://www.arm.gov/images/isdac_cloudparticle.jpg

SPEC Inc. http://www.specinc.com/images/cpi_images.jpg

Passive Cavity Aerosol Spectrometer Probe (PCASP)

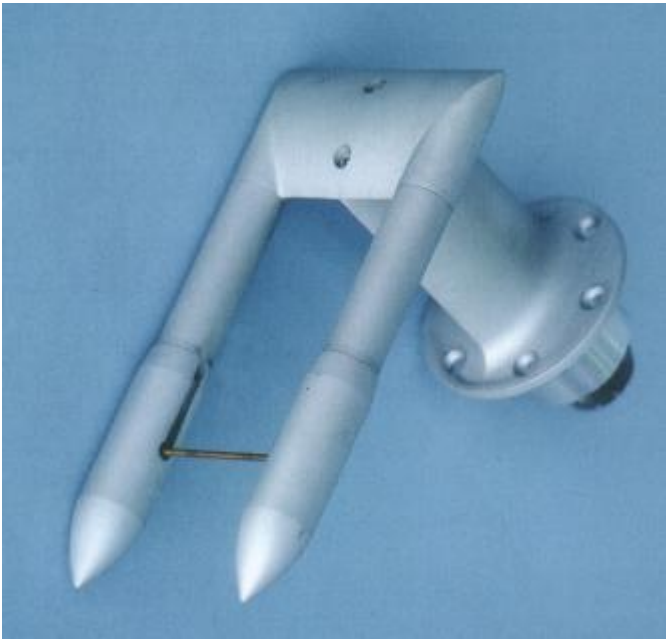
Kelsey Watkins



- Makes aerosol measurements of particles from 0.10 - 3.00 μm , with a resolution in the smallest channels of 0.02 μm
- Aerosol size spectrum is measured at 1 Hz frequency, using a combination reflecting-refracting imaging system
- Worked with the PCASP, doing calibration checks and data analysis.

King Hot Wire Liquid Water Probe

Robert Mitchell



Heated wire in free air stream (125°C , 165 [King])

Conductivity of air removes heat in dry conditions.

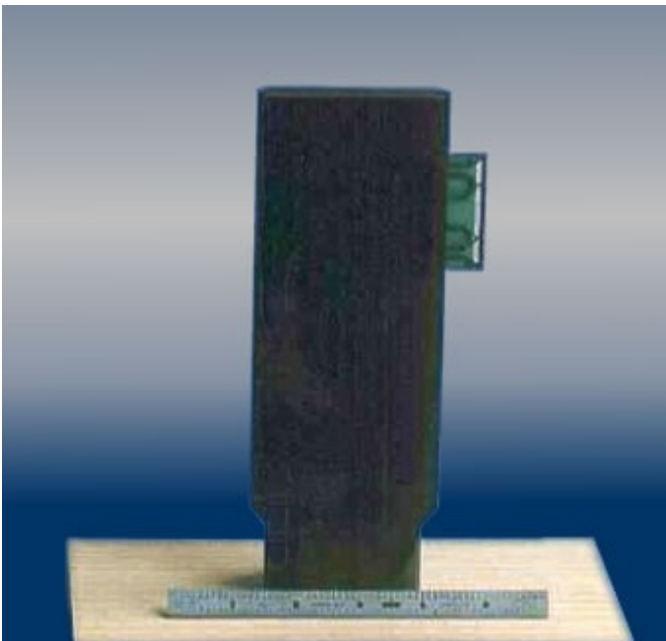
Additional heat is removed due to vaporization of liquid water when in cloud.

Difference in energy is computed into a liquid water content.

Accurate from $.1\text{g/m}^3 - 5\text{g/m}^3$

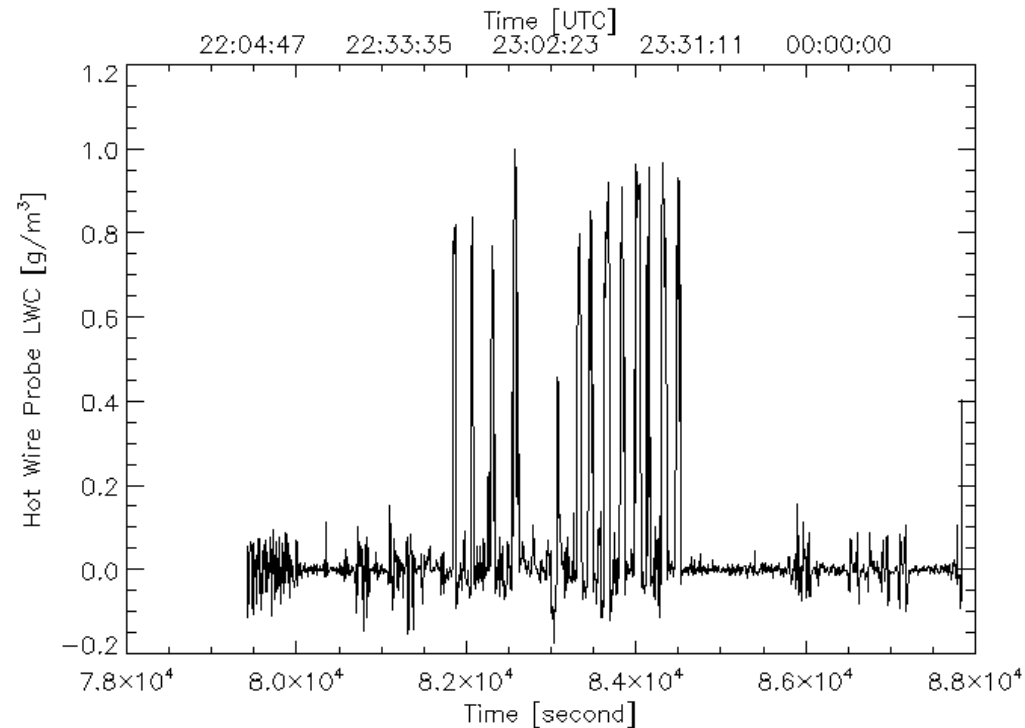
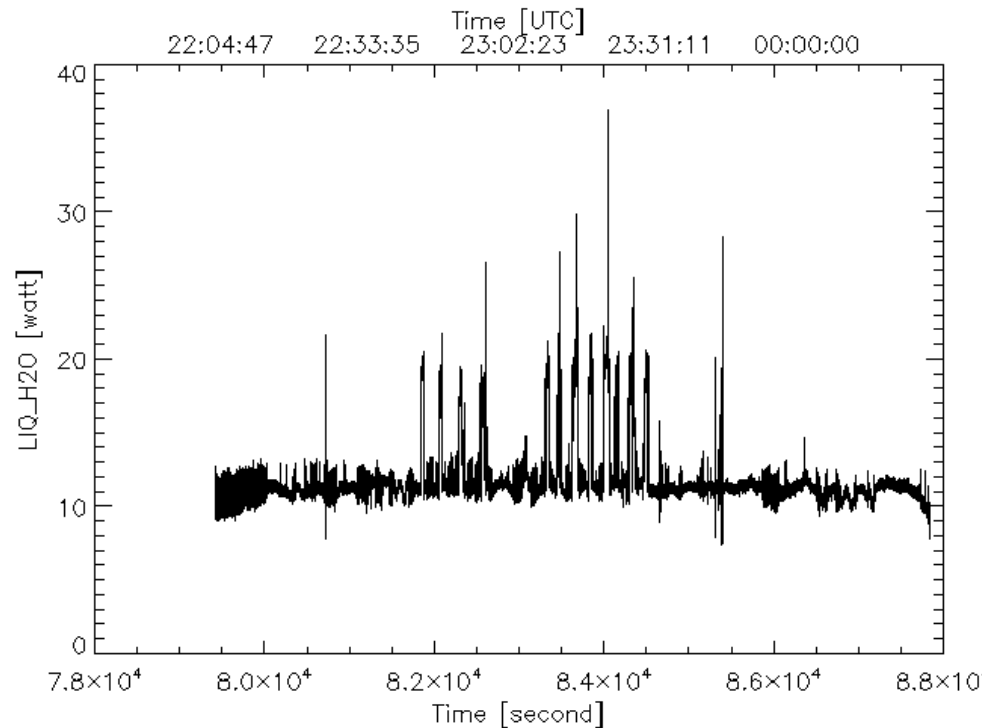
- Issues:

- Large drops splash off prior to vaporization
- Ice drops may bounce off or not vaporize completely
- Very small drops deflected around probe due to slipstream.



King Hot Wire Liquid Water Probe

Robert Mitchell



Challenge:

- Power varies with Temperature, Pressure, Airspeed, and Others?
- Very sensitive to Grounding issues and “Noise”

High Volume Precipitation Spectrometer (HVPS)

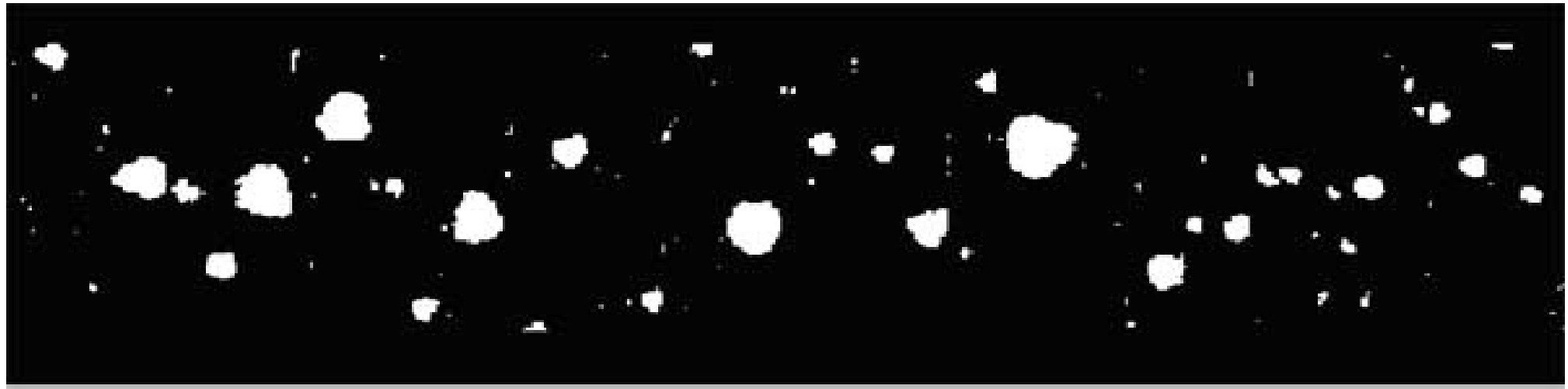
Matt Ham

- Measures size, shape and concentration of precipitation sized particles
- Particles create shadows which are converted to binary ones
- Electronically compatible with PMS 2D-P
- Samples at rate proportional to aircraft speed
- 4.5x20 cm opening

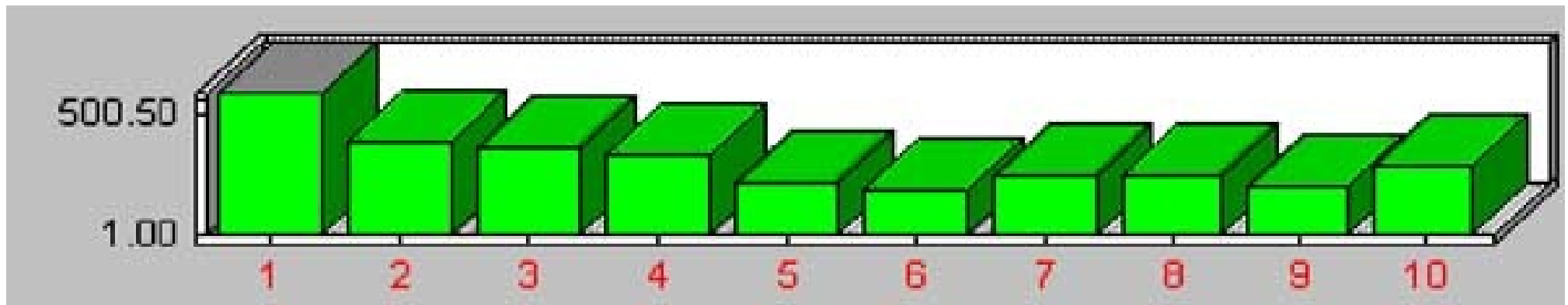


High Volume Precipitation Spectrometer (HVPS)

Sample Output



1 cm



Dew Point Temperature Sensor

Angelle van Oploo

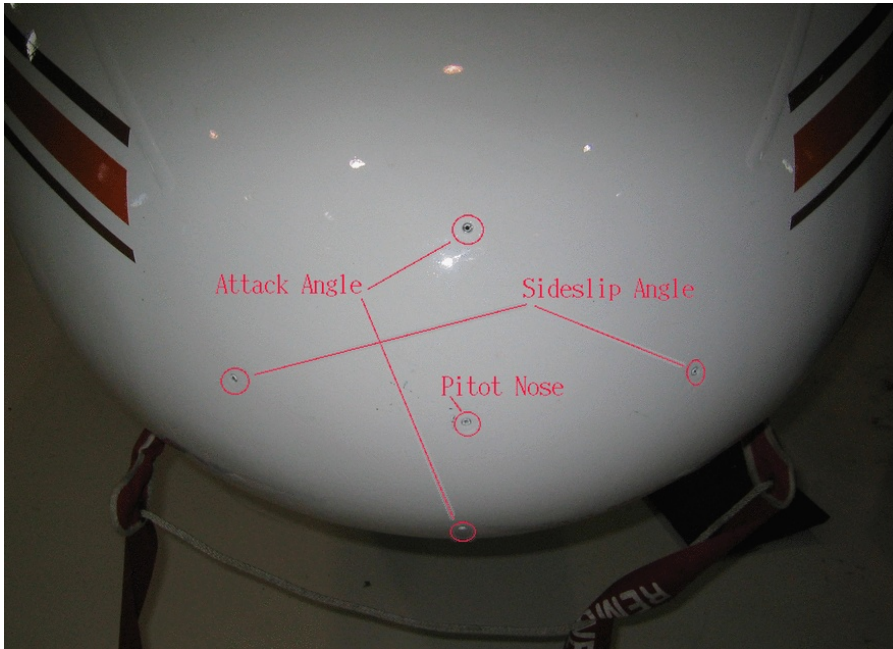


- External Sampling Probe
- Optical Chilled Mirror primary measurement of dew point temperature.
- Control Unit - Data Collection and Automatic Balance Cycle
- Down Points - Frost/Dew Temperature



Pressure Transducer

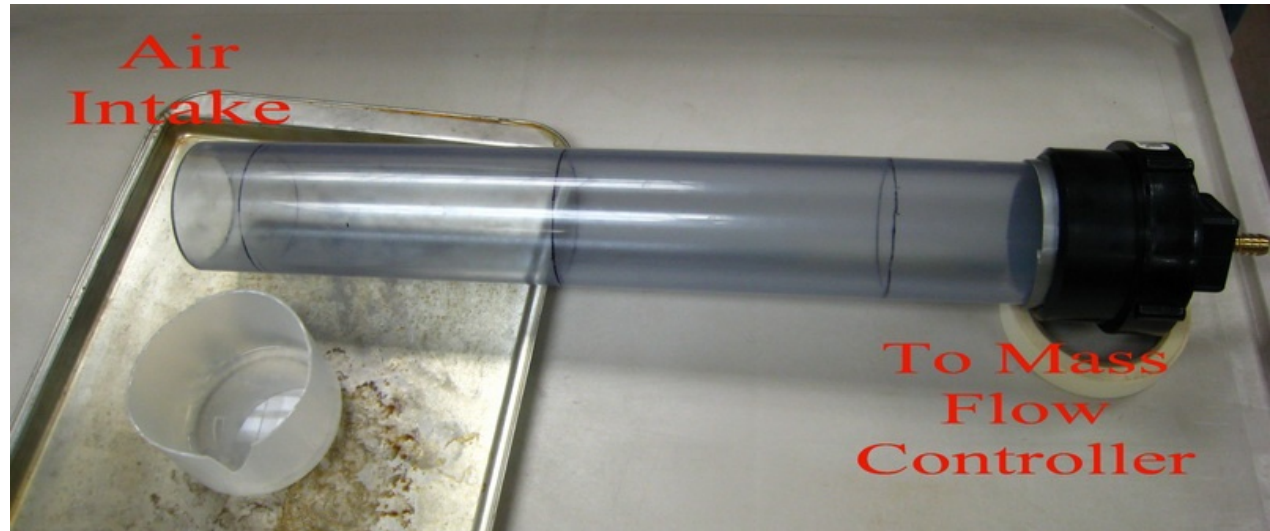
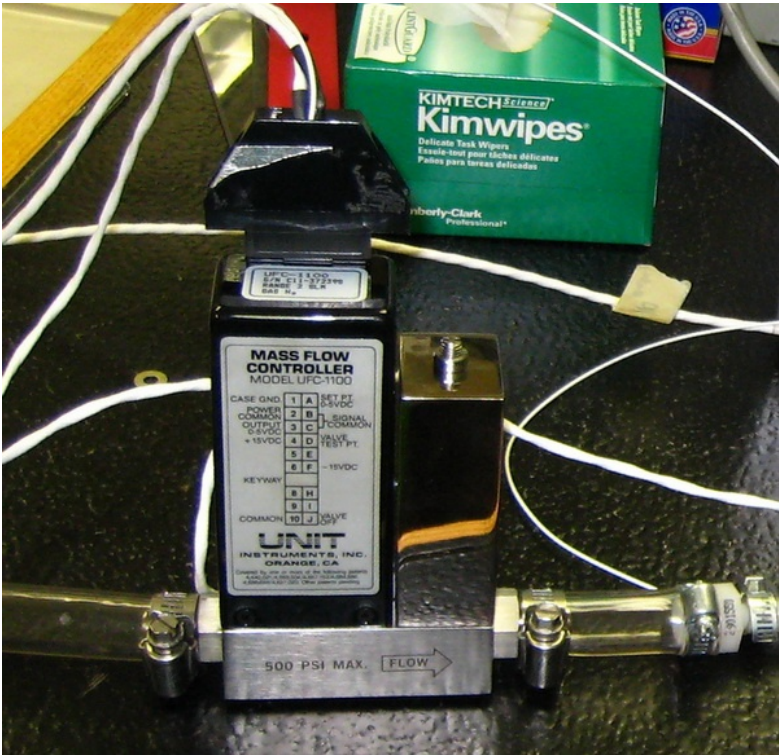
David Keith



- Pressure sensing diaphragm and two coils oriented normal to the diaphragm's axis determine output voltage used to calculate voltage.
- Validyne P55 differential pressure gauge has output range of +/- 5v DC.
- Aids in determining 3 dimensional wind field.

Mass Flow Controller

Tim Logan

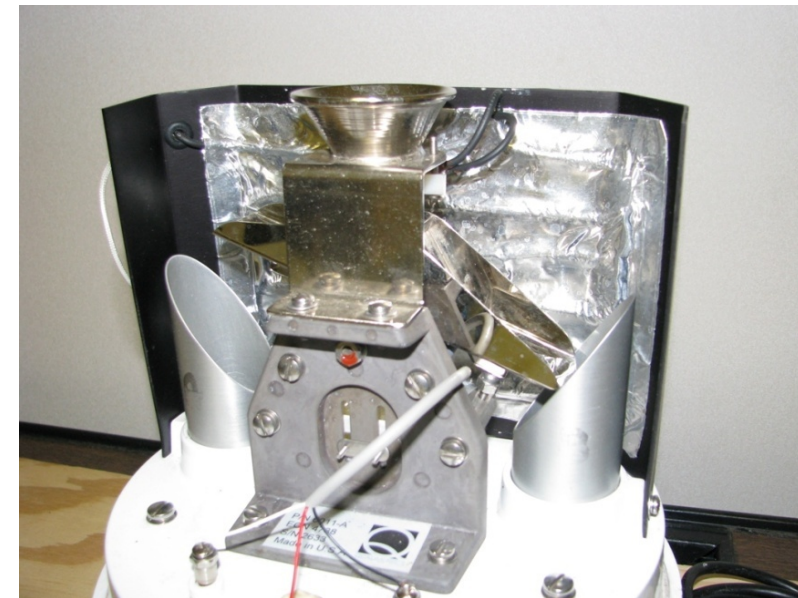


- Mass Flow Controller regulates the flow of air to maintain a set flow rate.
- Calibration of mass flow controllers can be performed using a bubble flow meter.

Tipping Bucket Rain Gauge

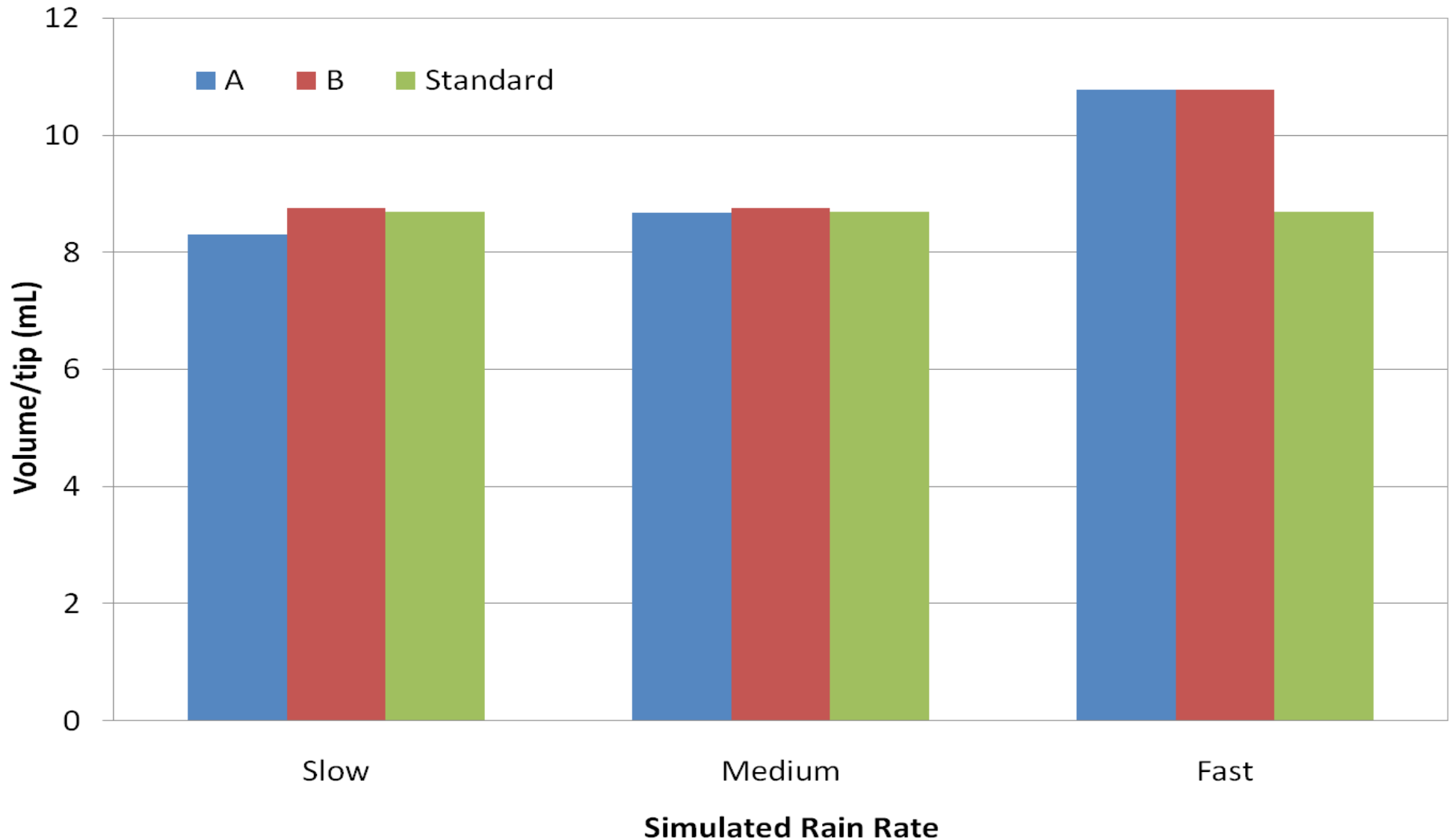
Dan Adriaansen

- Measures rainfall and rain rate in 0.01" (0.25mm) increments
- 8" diameter funnel provides large sampling area while still allowing small tipping mechanism
- Funnel helps prevent evaporation inside instrument
- Each tip creates a 100ms switch closure
- Closure can be recorded as 'tip'
- Accuracy of 0.5% at 0.5"/hr



Tipping Bucket Rain Gauge

Tipping Bucket Performance SN 2633



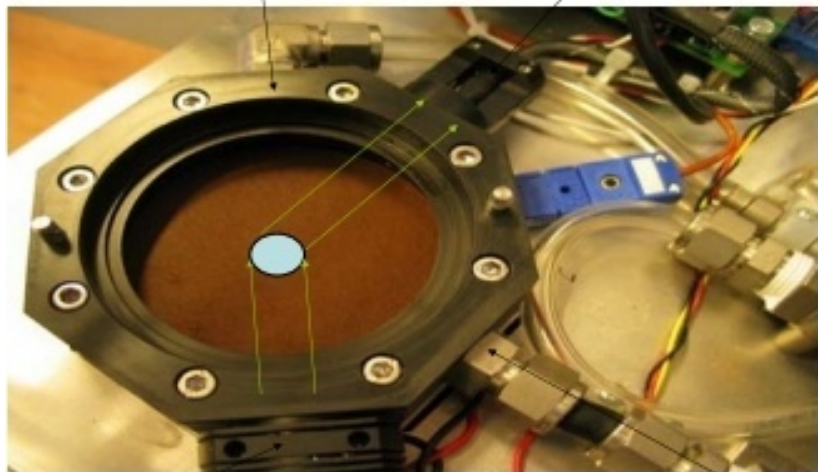
UWyo Cloud Condensation Nuclei Counter (CCNC)

Gökhan Sever



Aerosol Outlet

Photodiode



670nm Laser

Aerosol Inlet

- CCN; particles capable of forming cloud droplets under supersaturation conditions.
- Measures droplet formation ability of aerosol particles.
- Supersaturation is created by means of temperature gradient between two plates.
- Supersaturation range is $\sim 0.2\%$ - 2.0% .
- Supersaturation values are adjusted step-by-step.
- Activated particles are counted as a function of SS
- Activated droplets are counted in chamber by measuring the scattered light.
- Analysis of data from S. Arabia and Mali Rainfall Enhancement projects.

Condensation Particle Counter

Zhe Feng

- Air sample drawn continuously, mixed with alcohol vapor (heated saturator)
- Cooled condenser makes supersaturation → alcohol condense on particles
- Condensational growth makes larger droplets, pass through optical detector
- Laser source and photodetector measures scattered light from particles
- Detects airborne particles
 - **$D > 10 \text{ nm}$** at 1.0 L/min flow rate, concentration up to **10 cm**
 - Flow rate controlled using an internal critical orifice



Aircraft Data System (M300)

Randall Johnson

- Data Acquisition System to gather data from instruments
- Based on QNX operating system
- Real-time computation and display
- Interfacing with M300 is easy
- Support for: analog, digital, 1D probes, 2D probes, GPS ... etc.
- Versatile: user configurable probe channel tables
- PCASP calibration check



Forward Scattering Spectrometer Probe (FSSP)

Christopher Kruse



- Droplets are sized by measuring the amount of light scattered during interaction through a focused laser beam.
- Nominal range for cloud droplet sampling is 2 – 47 μm .
- Measures the cloud droplet spectrum (typically in 15 or 20 bins) in developing liquid water clouds.

Question

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