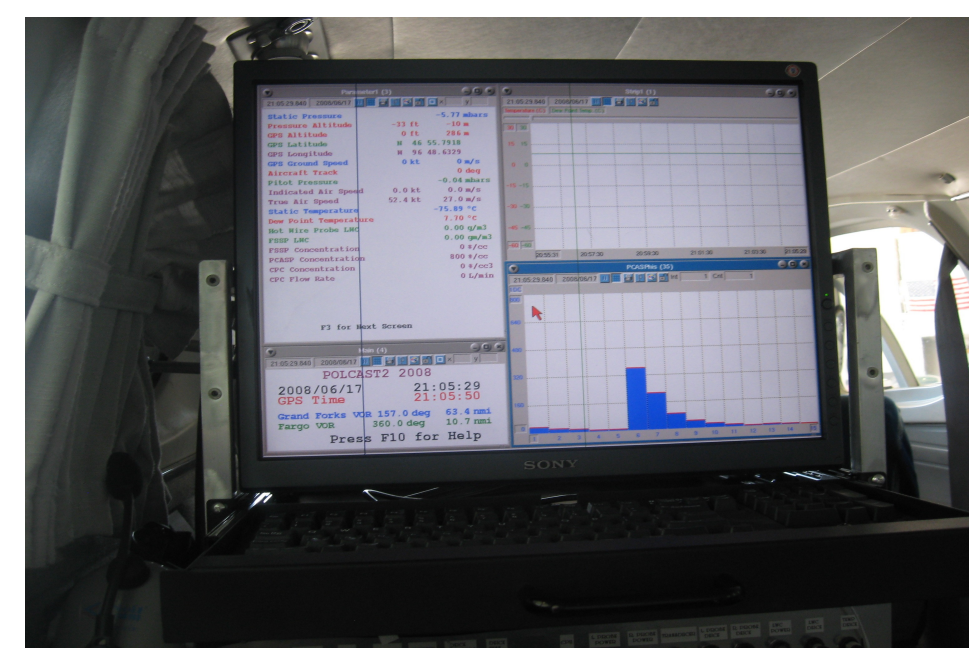
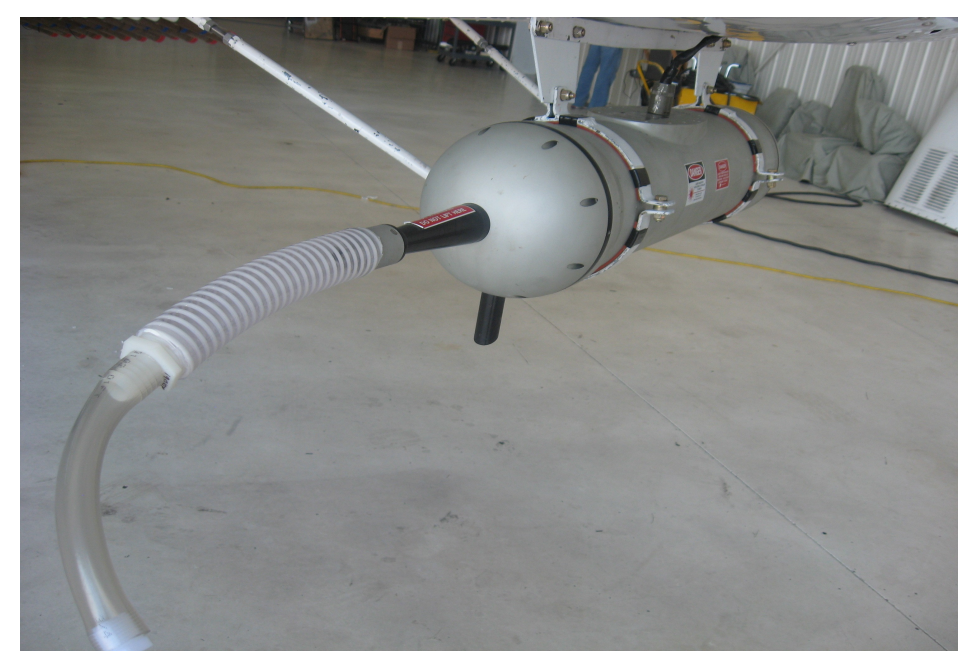


# Analysis of Aerosol Size Spectrum Measurements from North Dakota, Saudi Arabia, and Mali

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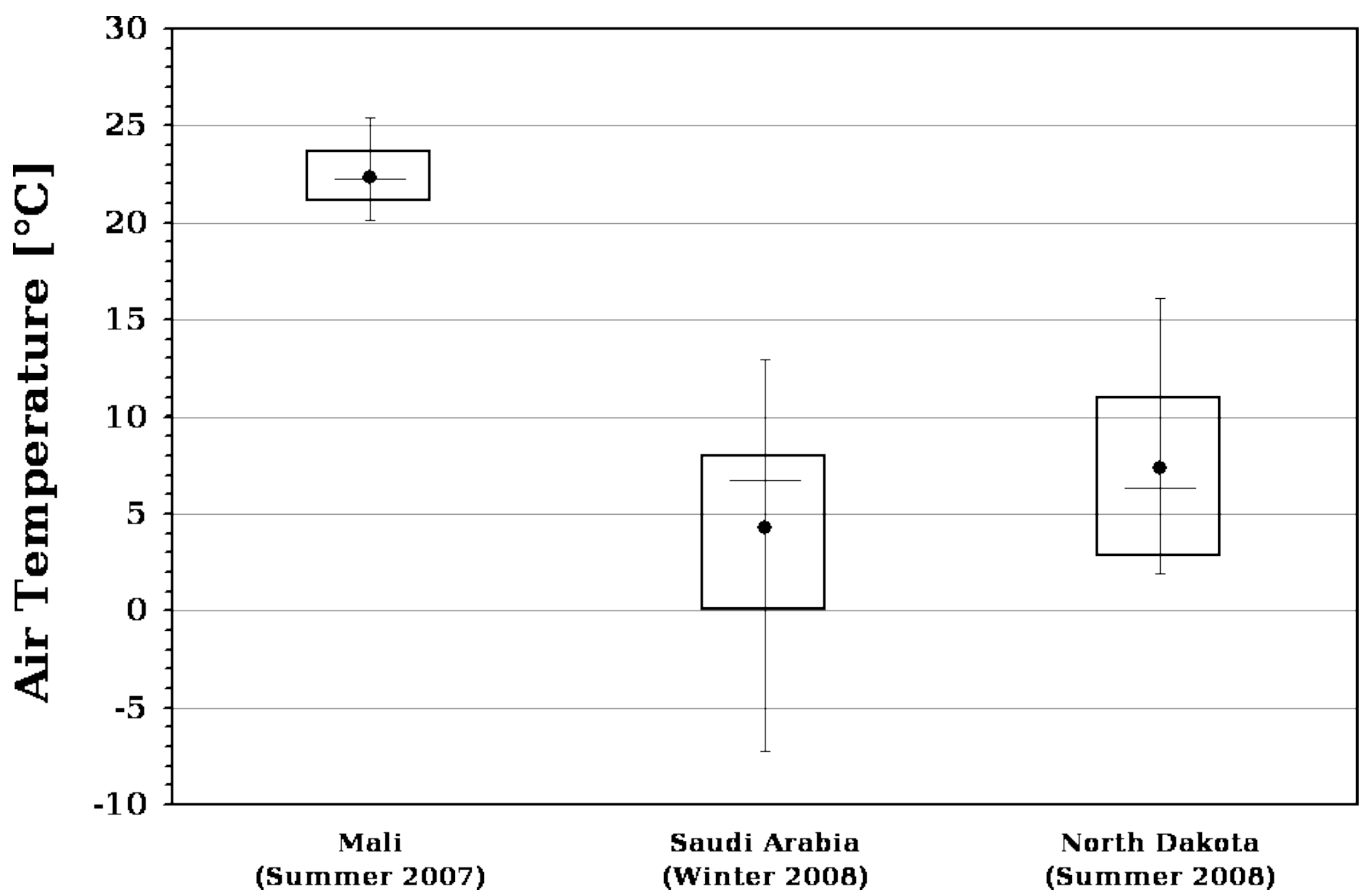
## Introduction

- Passive Cavity Aerosol Spectrometer Probe (PCASP) makes airborne aerosol size spectrum measurements in 15 channels in the size range of 0.1  $\mu\text{m}$  to 3.00  $\mu\text{m}$ .
- Uses a combination reflecting-refracting imaging system.
- Aerosol size spectrum is measured at 1Hz frequency by a data acquisition system.

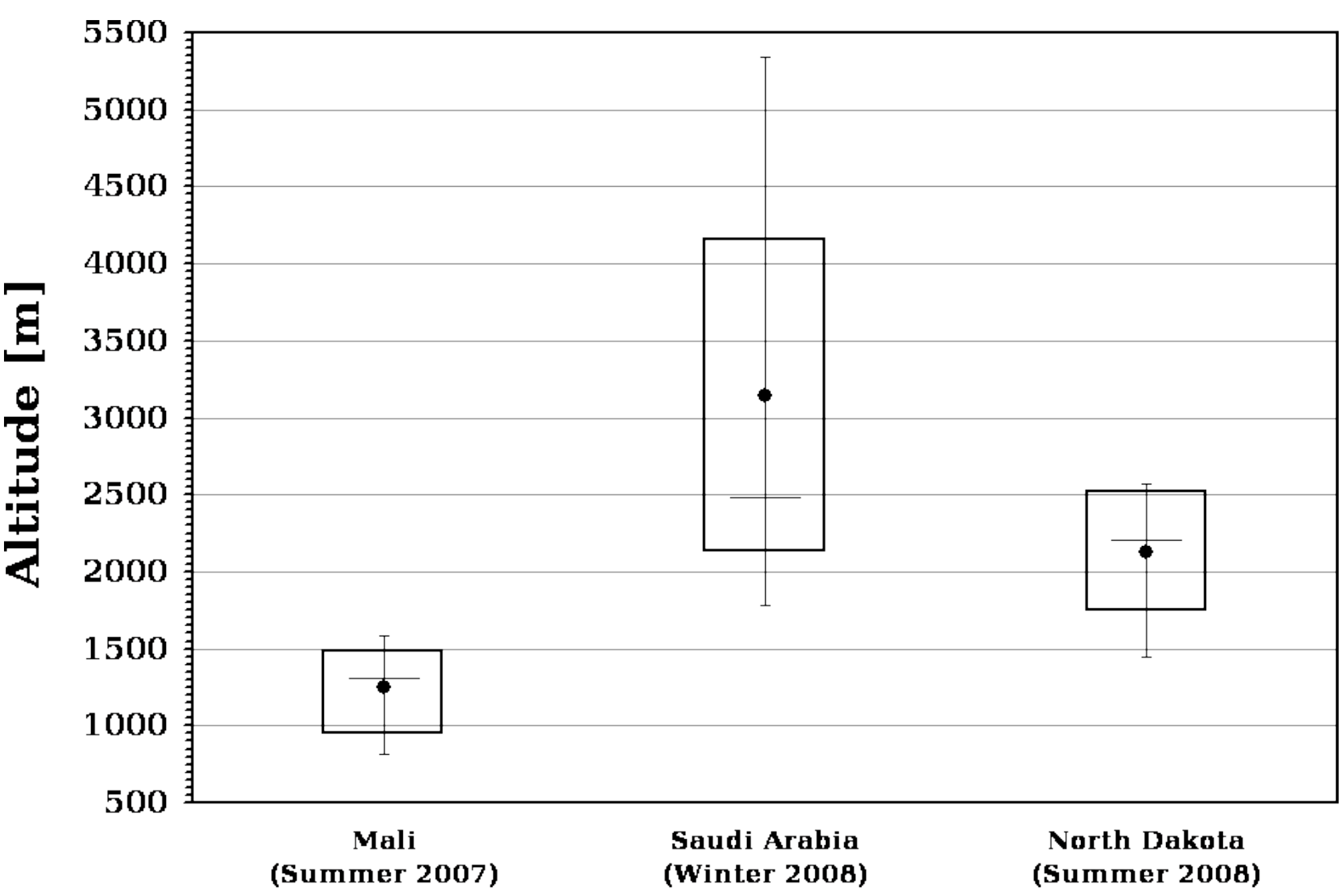


## Analysis

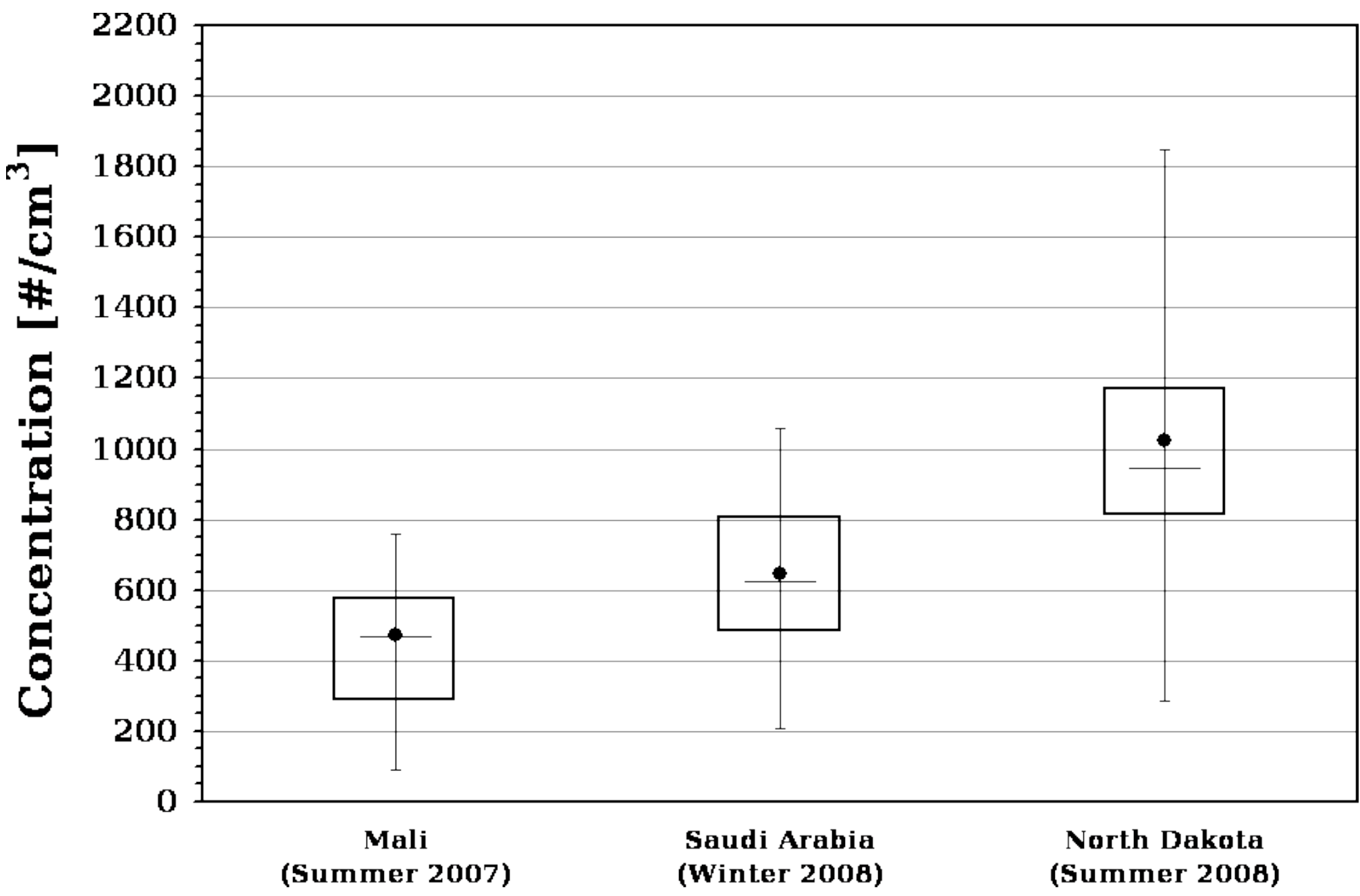
- Aircraft flight data was analyzed to determine clouds base based on airborne measurements of cloud droplet number concentration.
- The flight measurements were filtered to only include data between 100 and 400 m below cloud base.
- The table to the right shows the project locations and dates analyzed.



Air temperature in Mali, Saudi Arabia, and North Dakota below cloud base for the same period as other plots. The box-and-whiskers are similar to the altitude plot. Mean air temperature in Mali was 22.3°C, in Saudi Arabia was 4.3°C, and in North Dakota was 7.3°C.



Box-and-whisker plots of GPS altitude for the subset height interval for the all 1 Hz data from the flights given above. The solid circle is the mean value, the horizontal line is the 50 percentile, the top of the box is the 75 percentile, the bottom is 25 percentile, and the top and bottom of the whiskers are 95 and 5 percentiles, respectively.



Total PCASP Concentrations (in  $\#/\text{cm}^3$ ) below cloud base (subset 100-400m below base). The box-and-whisker plots are similar to the altitude plot. Mean concentration at Mali was 474.0  $\#/\text{cm}^3$ , at Saudi Arabia was 647.6  $\#/\text{cm}^3$ , and at North Dakota was 1023.6  $\#/\text{cm}^3$ .

### Mali – Summer 2007 (~400 m elevation)

Date (MMDDYY)	Cloud Base
08/04/07	1450m
08/05/07	1400m
08/07/07	3500m
08/08/07	1250m
09/08/07	1050m
09/09/07	1100m
09/13/07	1700m
09/14/07	1380m
09/18/07	1250m

### Saudi Arabia – Winter 2008 (~600 m elevation)

Date (MMDDYY)	Cloud Base
12/04/07	2780m
12/21/07	2000m
01/10/08	2450m
02/07/08	3000m
02/20/08	3630m
03/13/08	4400m
03/16/08	5250m
04/05/08	4800m
04/05/08	4500m
04/09/08	4000m
04/09/08	2000m
04/11/08	3600m
04/27/08	5650m
04/28/08	4300m

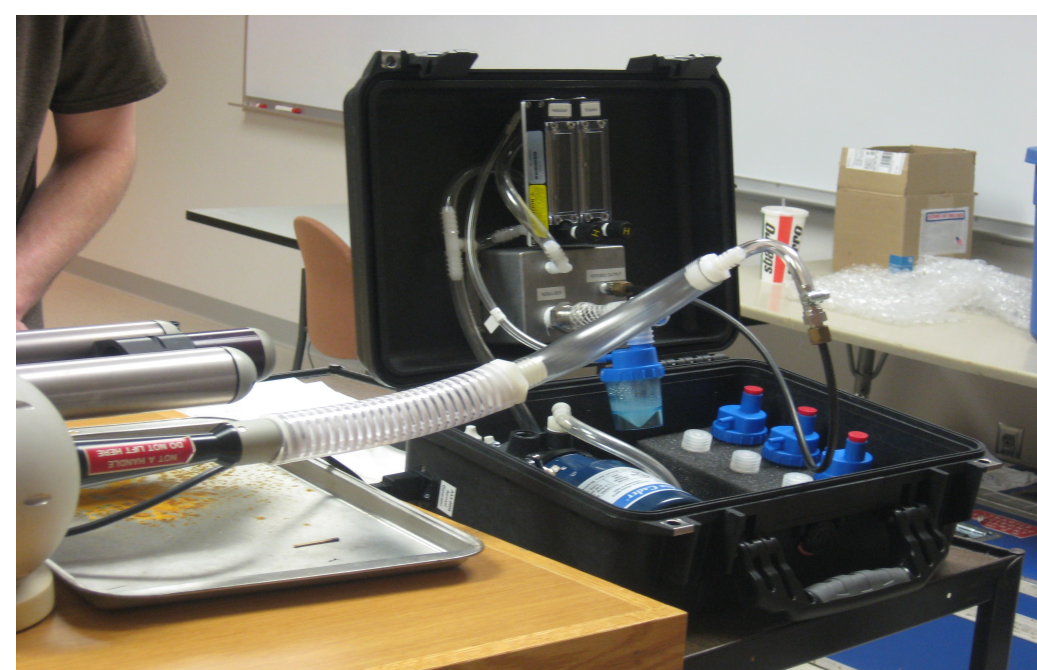
### North Dakota – Summer 2008 (~300 m elevation)

Date (MMDDYY)	Cloud Base
06/12/08	1700m
06/12/08	2100m
06/12/08	2600m
06/13/08	1600m
06/14/08	2400m
06/19/08	2200m
06/21/08	2750m
06/26/08	2350m
07/01/08	1650m
07/07/08	1880m
07/09/08	2300m
07/11/08	850m

## Calibrations

### Lab Calibration Methodology

- Send aerosols of a known size through the PCASP.
- The results are typically a Gaussian curve centered on a peak channel.
- Use the counts in the peak channel, pre-peak channel, and post-peak channel to calculate the average peak channel.
- Use Mie scattering theory to define channel size boundaries based on the average peak channel.

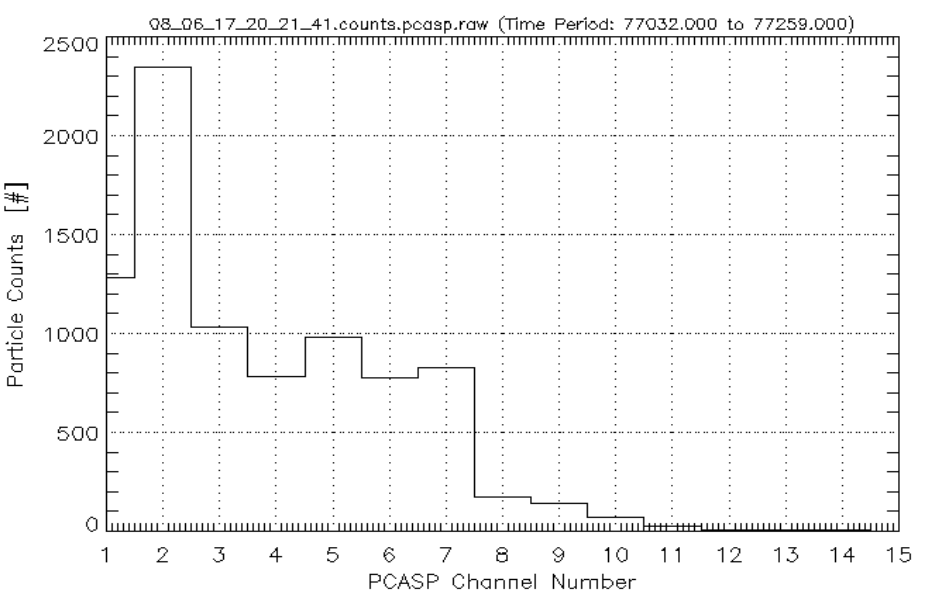


### Field Performance Check Methodology

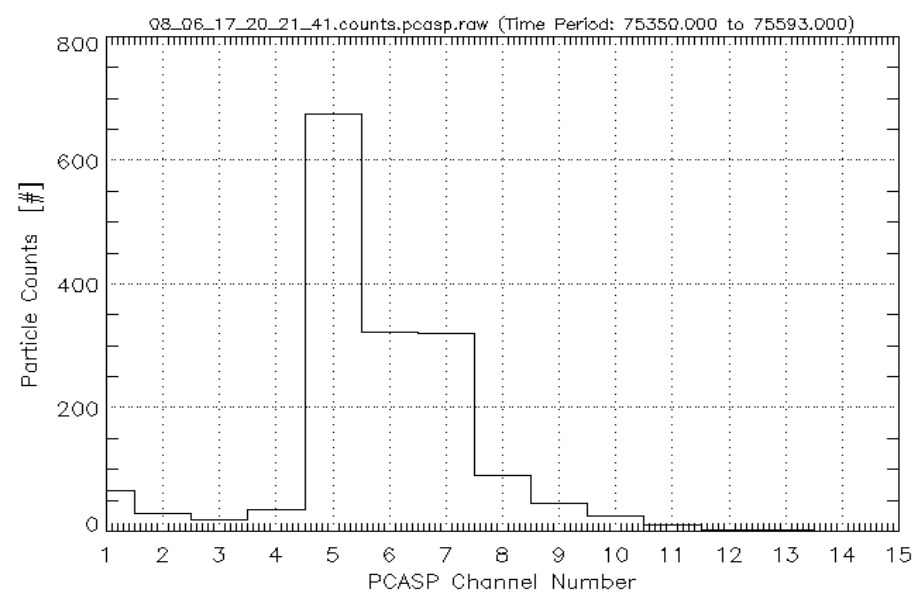
- Performance checks were conducted using a procedure similar to a lab calibration.
- The average peak channel is calculated and checked versus previous values.
- Set channel size boundaries are not changed based on performance checks.



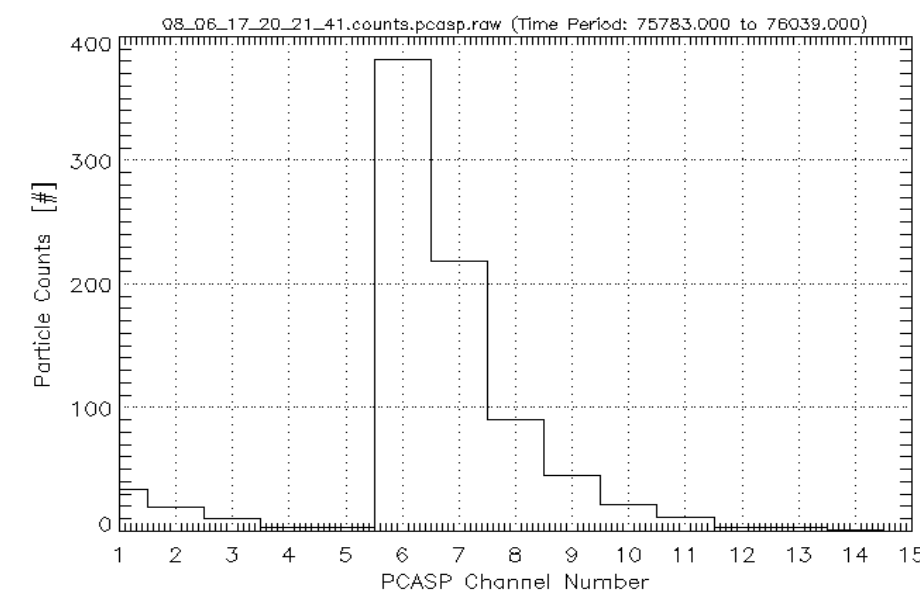
Date	Size (nm)	Peak Chnl	Pre-Peak Counts	Peak Counts	Post-Peak Counts	Avg Chnl
06/26/08	222	5	146.45	1203.80	525.91	5.20
06/26/08	300	6	17.45	1157.30	642.95	6.34
06/26/08	2000	13	0.48	8.42	5.14	13.33



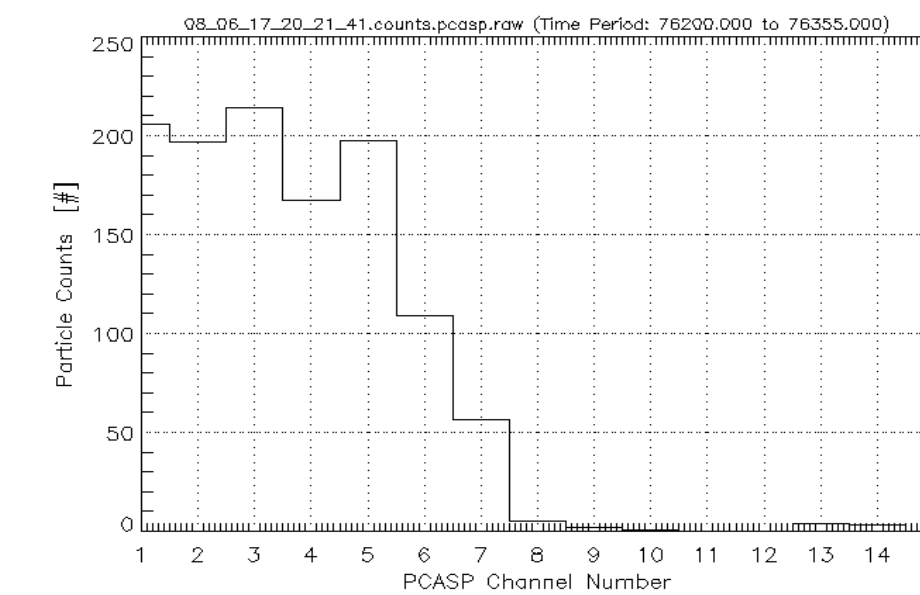
Histogram of the calibration for the 140 nm particle size. Time interval is 77032 seconds from midnight (sfm) to 77259 sfm. Calibration performed on June 6th, 2008 during the North Dakota project.



Histogram of the calibration for the 220 nm particle size. Time interval is 75350 sfm to 75593 sfm. Calibration performed on June 6th, 2008 during the North Dakota project.



Histogram of the calibration for the 300 nm particle size. Time interval is 75783 sfm to 76039 sfm. Calibration performed on June 6th, 2008 during the North Dakota project.



Histogram of the calibration for the 2000 nm particle size. Time interval is 76200 sfm to 76355 sfm. Calibration performed on June 6th, 2008 during the North Dakota project.

## Conclusions

- The lowest cloud bases were found in Mali and cloud bases did not vary much. Saudi Arabia had the highest cloud bases with the greatest amount of variance.
- The highest cloud base temperatures were found in Mali. The temperatures in Mali varied the least. The lowest cloud base temperatures were found in Saudi Arabia.
- The aerosol concentrations below the cloud base were lowest in Mali and greatest in North Dakota.
- The cloud base aerosol concentrations affect the cloud properties and hence precipitation formation. Higher aerosol concentrations below the cloud base will result in higher concentrations of cloud droplets and hence decrease the size of cloud droplets (assuming the same cloud liquid water).

## Future Work

- Extend data set to include Mali Summer 2006, Mali Summer 2008, Saudi Arabia Spring 2007, Saudi Arabia Summer 2008.
- Investigate high aerosol concentration days (smoke, dust) in Mali to determine source region.
- Analyze above cloud base properties.

## Acknowledgments

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