# Cloud Condensation Nuclei Retrievals at Cloud Base in North Dakota


- Mariusz Starzec

# Motivation

- Compare University of Wyoming (UWyo) and Droplet Measurement Technologies (DMT) cloud condensation nuclei (CCN) concentration retrievals from cloud base

- Develop a way that allows for retrieving the cloud condensation nuclei concentration (CCNC) at any supersaturation (SS)

# Background

- Aerosols act as nuclei for water to condense on, becoming condensation nuclei (CN)
- Rising parcels of air expand and cool creating a supersatured environment
  - Allows for more vapor to diffuse on the CN
  - Condensation releases latent heat, making parcels rise more
    - Creates positive feedback, allowing for more condensational growth
- When CN become large enough, they are “activated” and become CCN
  - Grow by condensation until they become cloud droplets

# Background

- Different particles become CCN at different SS
  - Size
  - Composition
  - Hygroscopic or hydrophobic

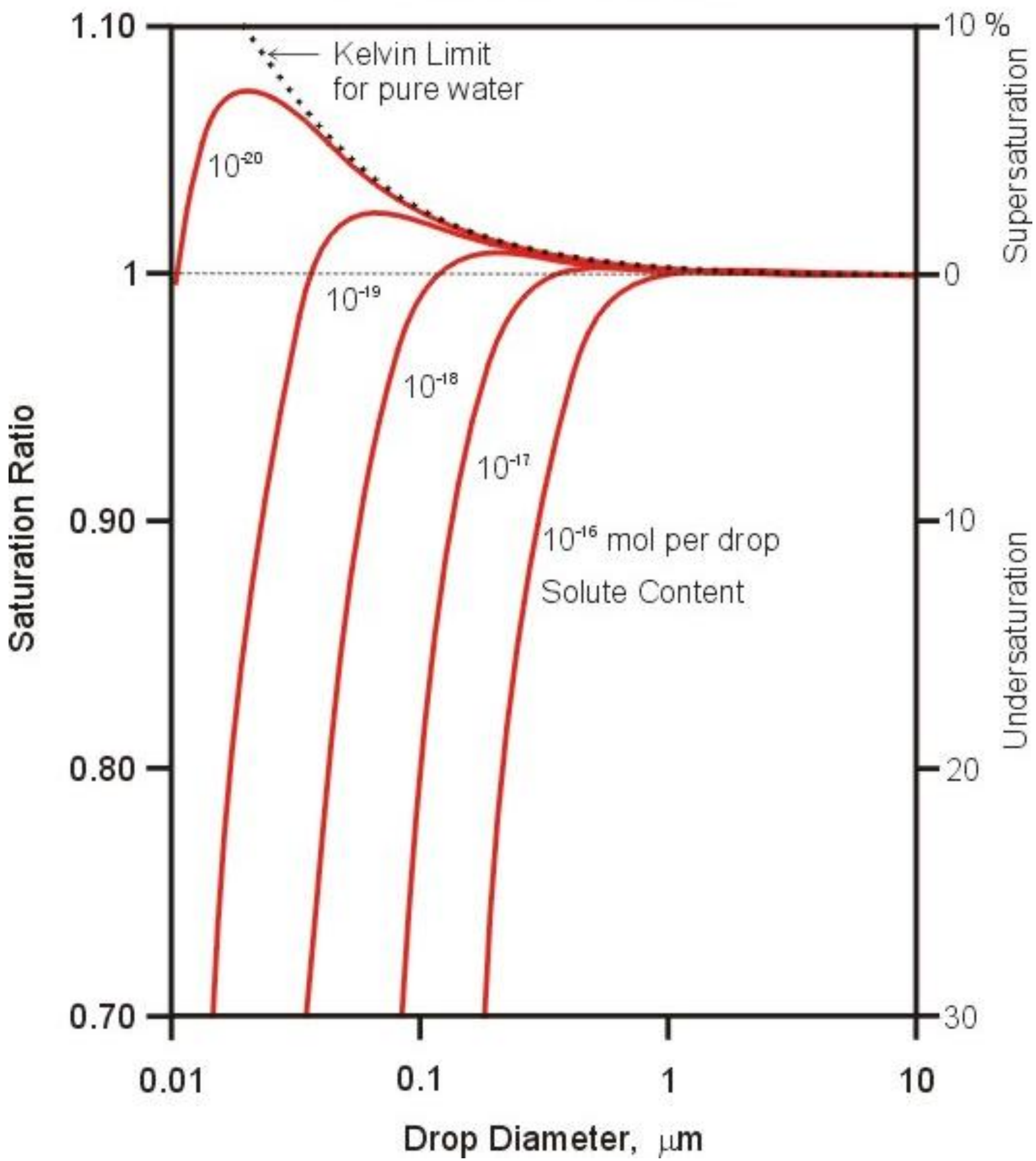
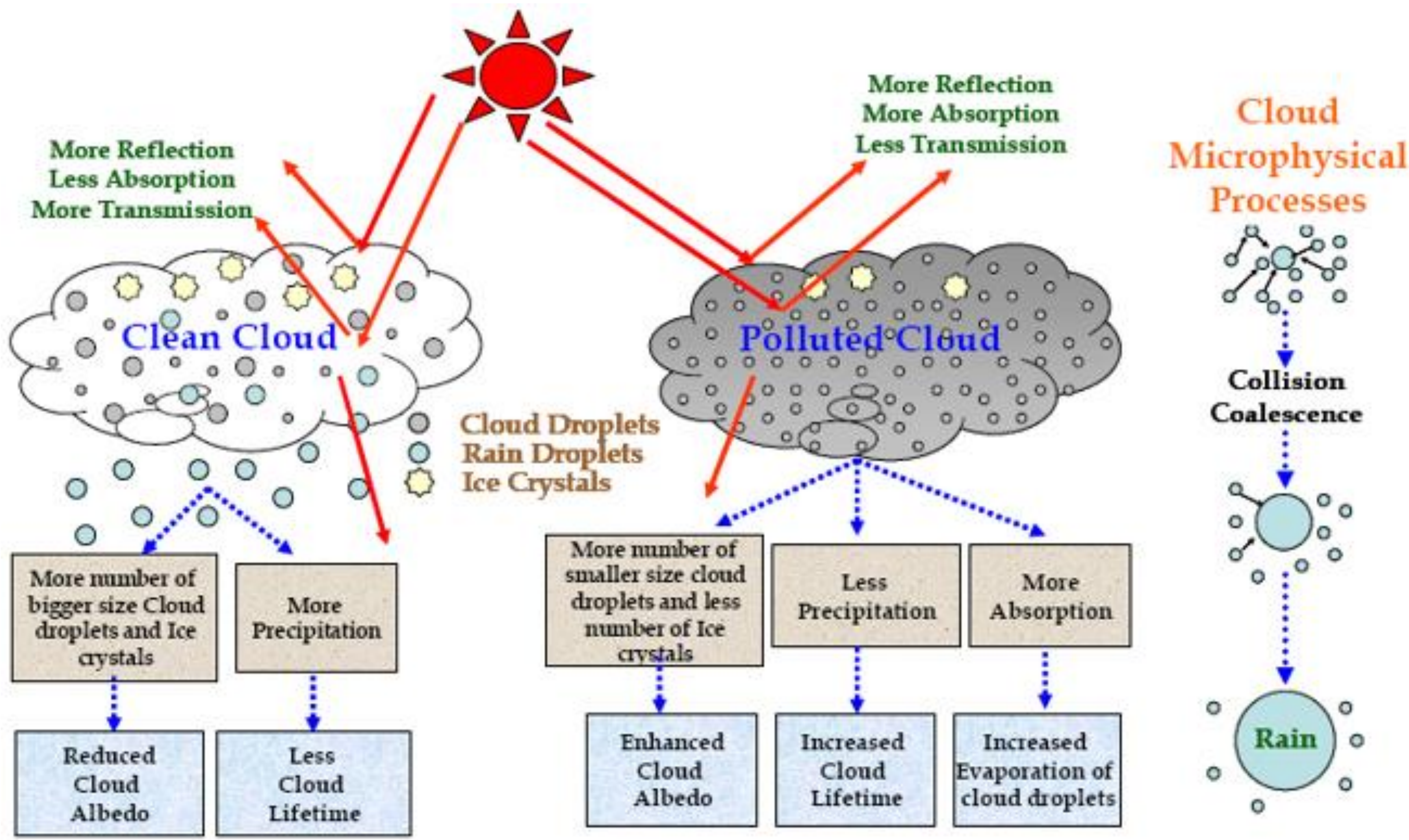
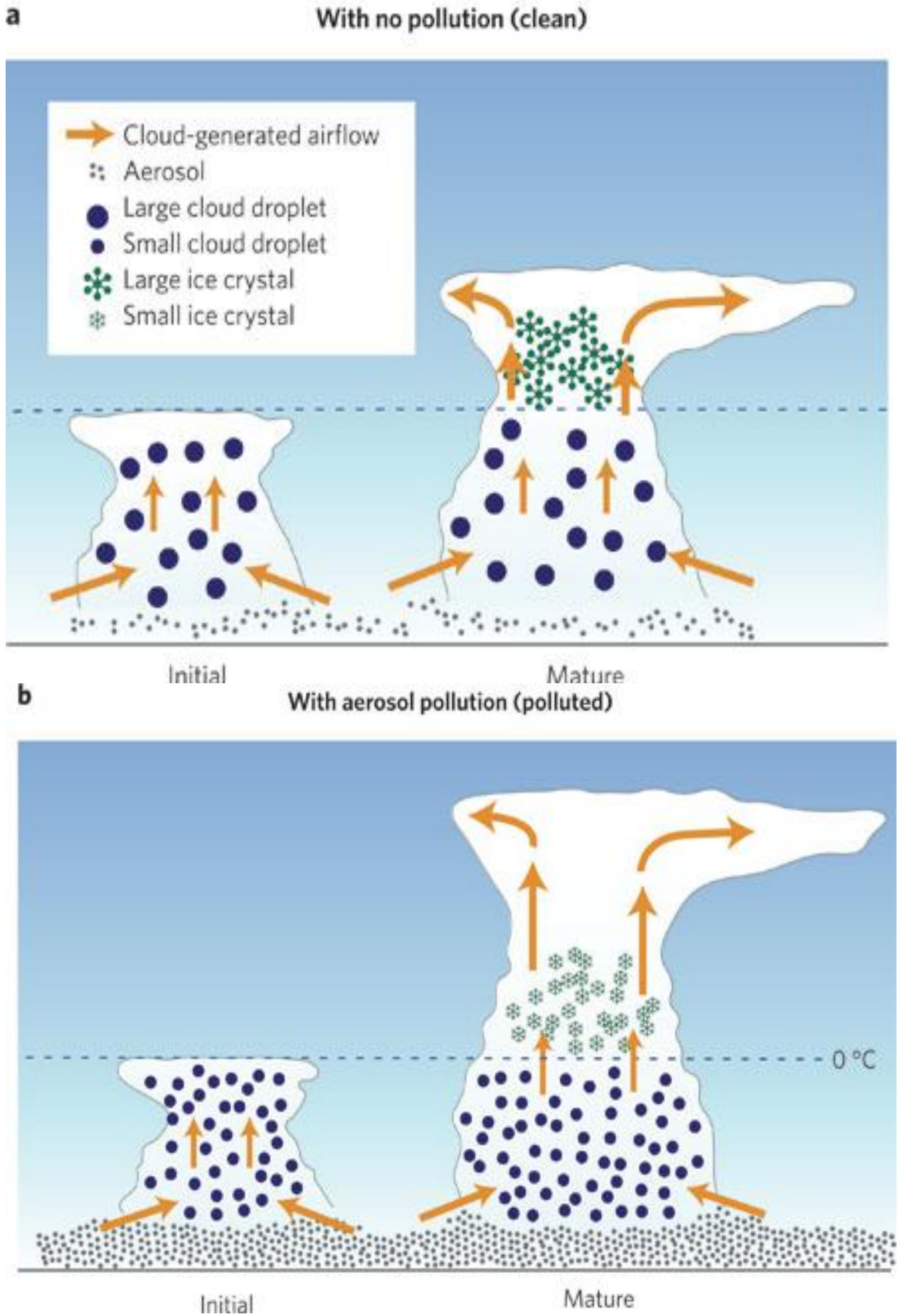


Image courtesy of Dennis Lamb, PSU




Picture Source: Dr. S. N. Tripathi, Department of Civil Engineering, Indian Institute of Technology Kanpur




**- Larger Drops:**

- Fall out quicker
- Increased loading on updraft early on
- More stay above freezing level, limiting latent heat release due to freezing

**- Smaller Drops:**

- "Competition" for water vapor allows updraft to sustain itself
- Lighter, more easily lofted below freezing level, where drops freeze allowing energy to strength updraft
- More of a "positive" feedback mechanism

Picture Source: Seoung-Soo Lee, Atmospheric science: Aerosols, clouds and climate., *Natural Geoscience*, **4**, 826–827,(2011).

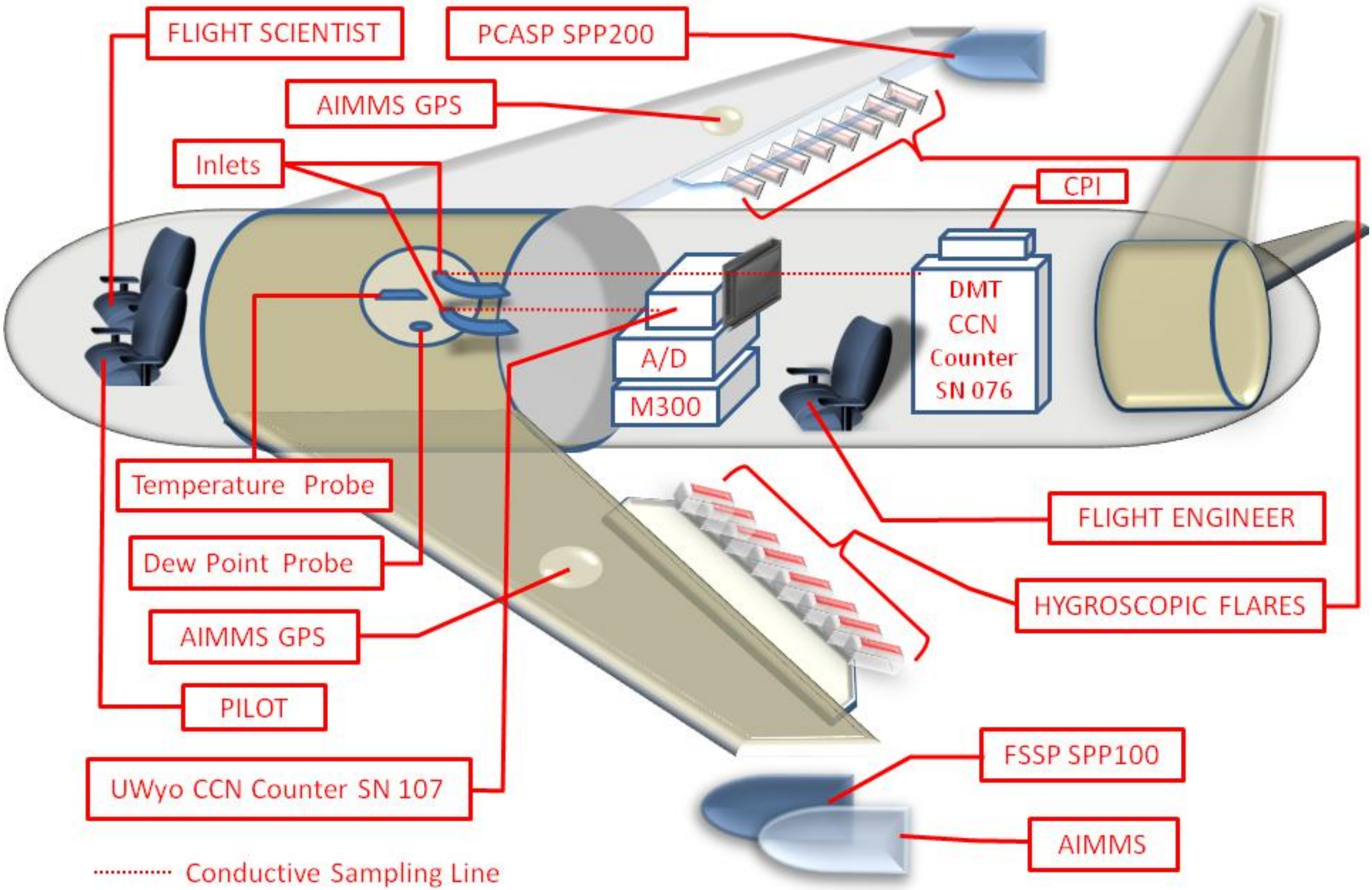
# Importance

- Climate Models
  - Parameterizations of convection and cloud
- Weather Prediction Models
  - Precipitation amounts
  - Convective initiation
- Satellite retrievals
  - Assumptions of surface reflectance and aerosol optical properties (e.g. single-scattering albedo) are made
    - May effect accuracy

# POLCAST4

- Polarimetric Cloud Analysis and Seeding Test 4
- Field campaign held in the summer of 2012
- Goal: Evaluate effects of hygroscopic seeding flares
- Aircraft equipped with two different instruments to measure CCN concentrations (CCNC)
  - Droplet Measurements Technology (DMT) CCN Counter
    - CCNC at supersaturations of 0.2, 0.3, and 0.6%
  - University of Wyoming (UWyo) CCN Counter
    - CCNC at supersaturations of 0.6%

# POLCAST4 Aircraft Instrument Configuration



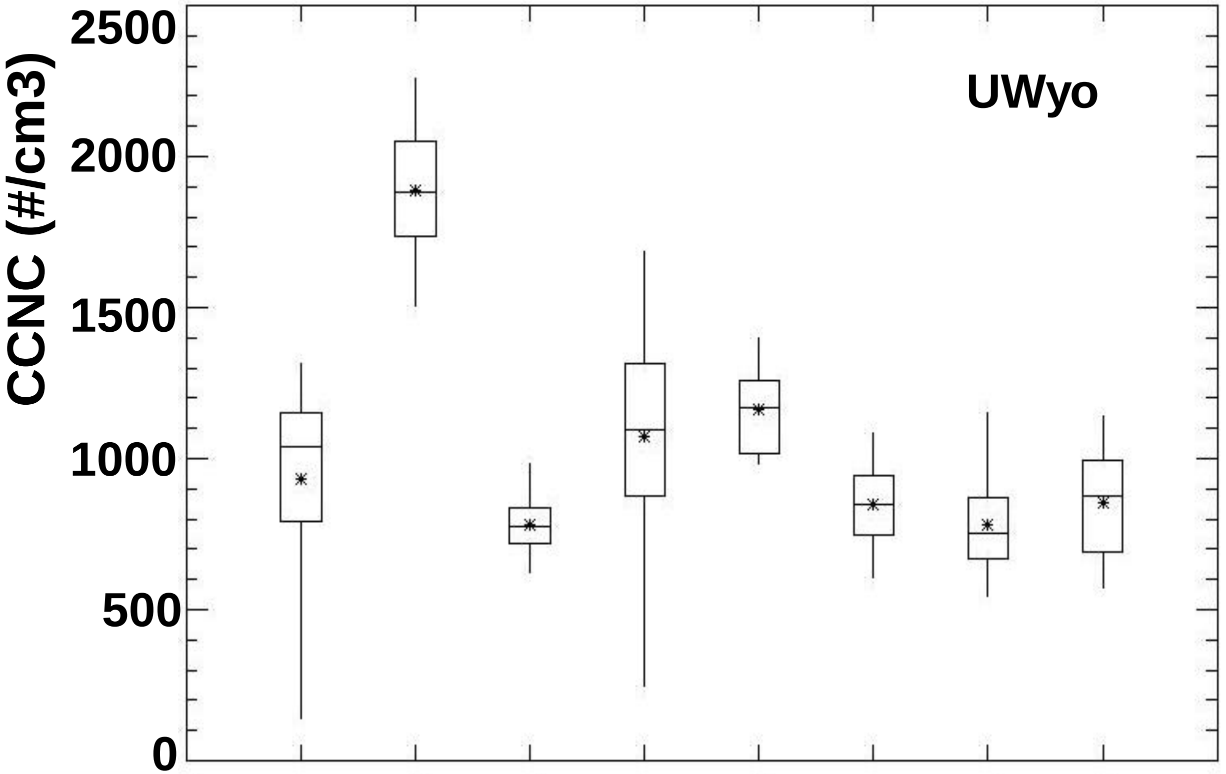

Courtesy David Delene

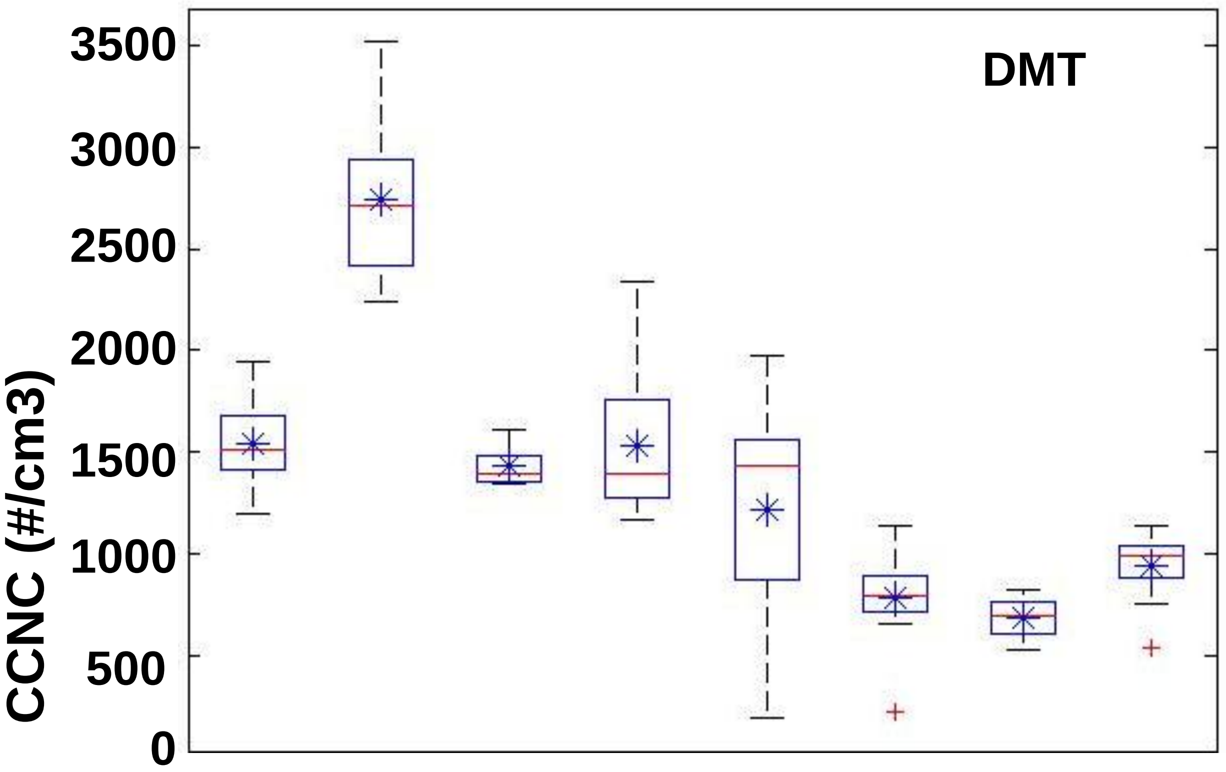
# Software

- Airborne Data Processing and Analysis (ADPAA)
  - Open-source software
  - Quality control and assurance checks
  - Contains a compilation of scripts that can be used on a variety of airborne instruments by different users
  - Allows for direct comparison of datasets

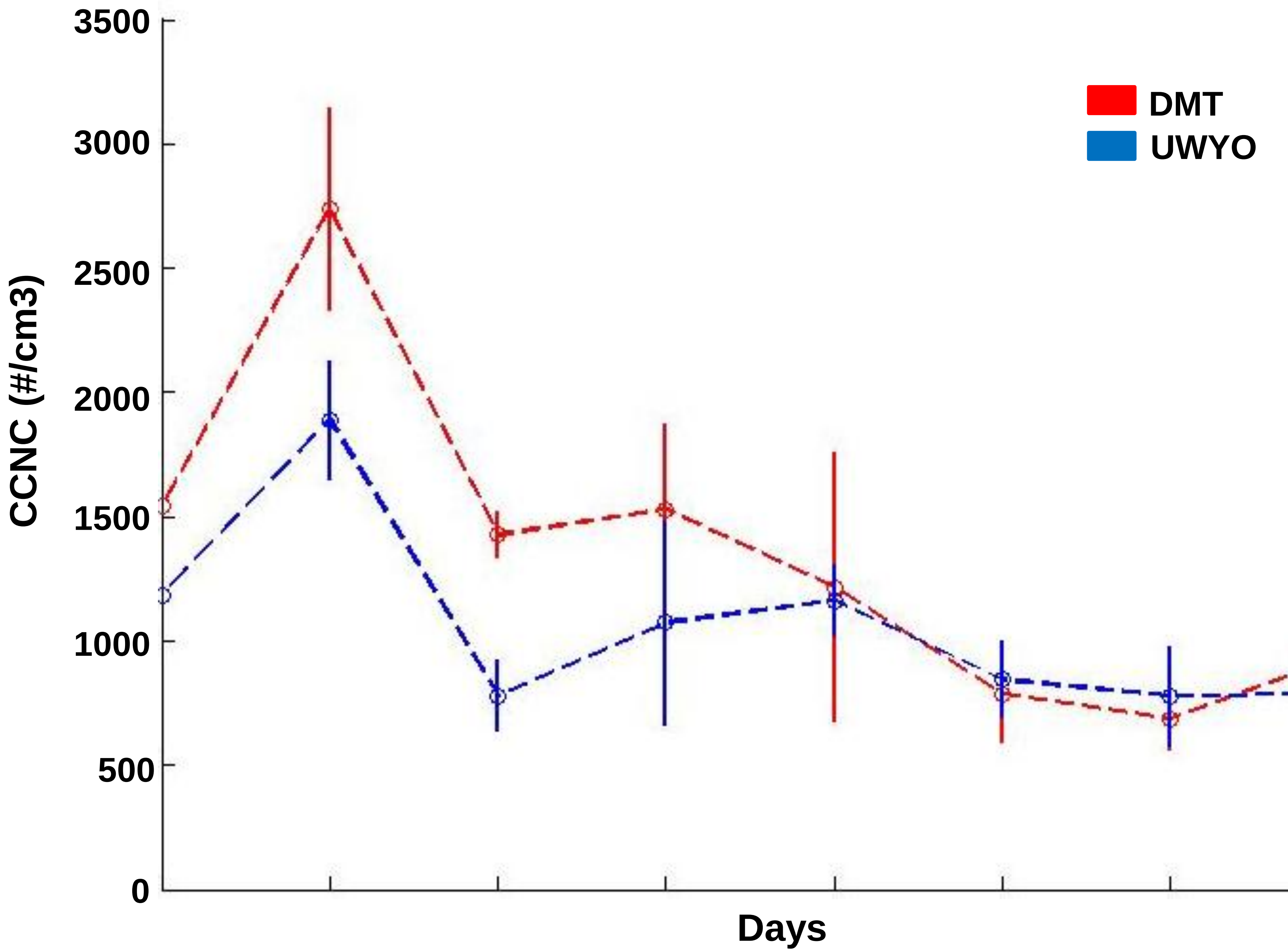
# Results: Counter Comparison

- 8 Days in July 2012
- CCNC at 0.6% SS
- On certain days, DMT counter has much higher values than UWyo counter



# Results: Counter Comparison



# Results: DMTCCNC Fits

- Three data points are given for a certain timeframe
  - CCNC at SS of .2%, .3% and .6%

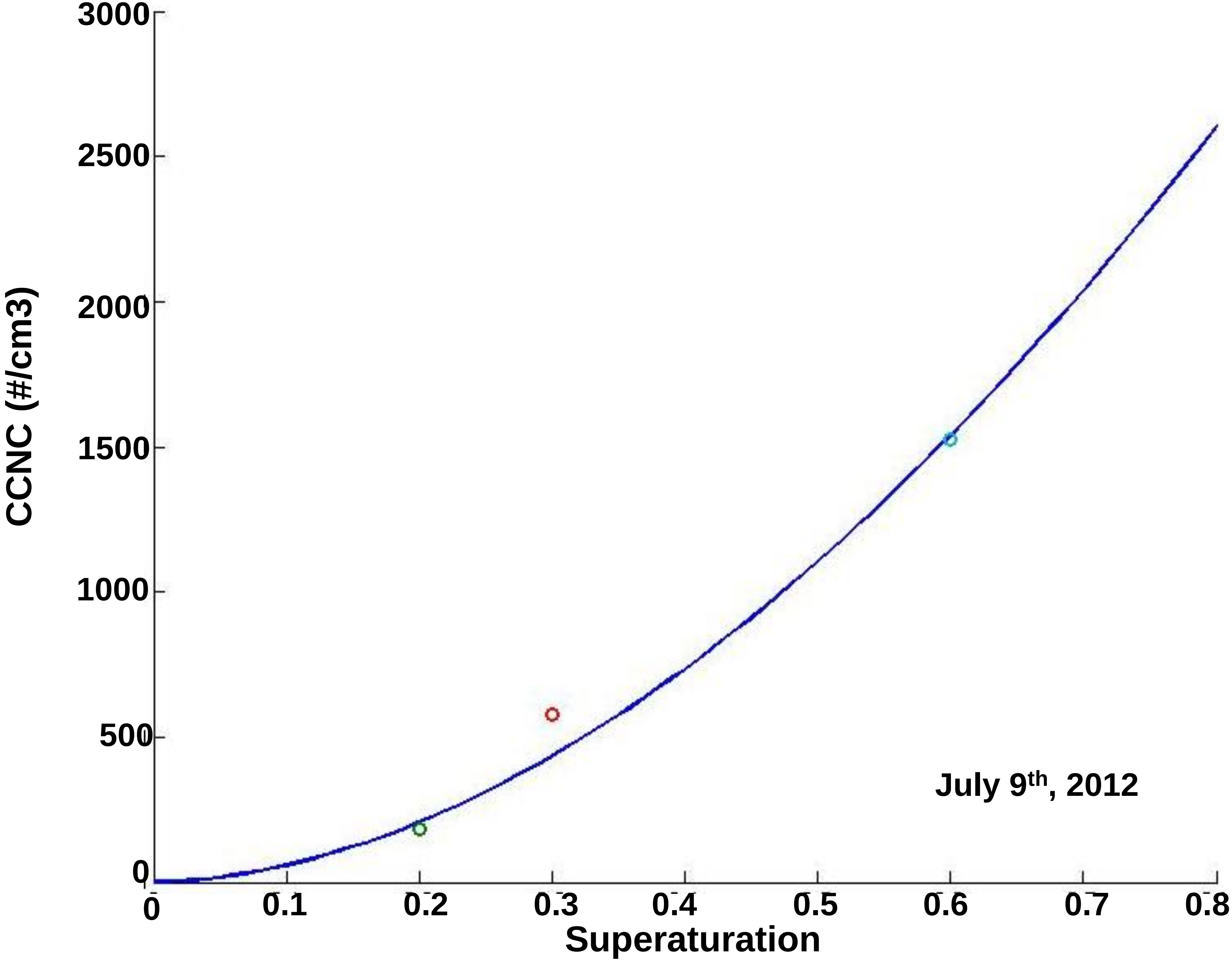
- Ability to apply a fit to the data

$$\text{CCNC} = cSS^k$$

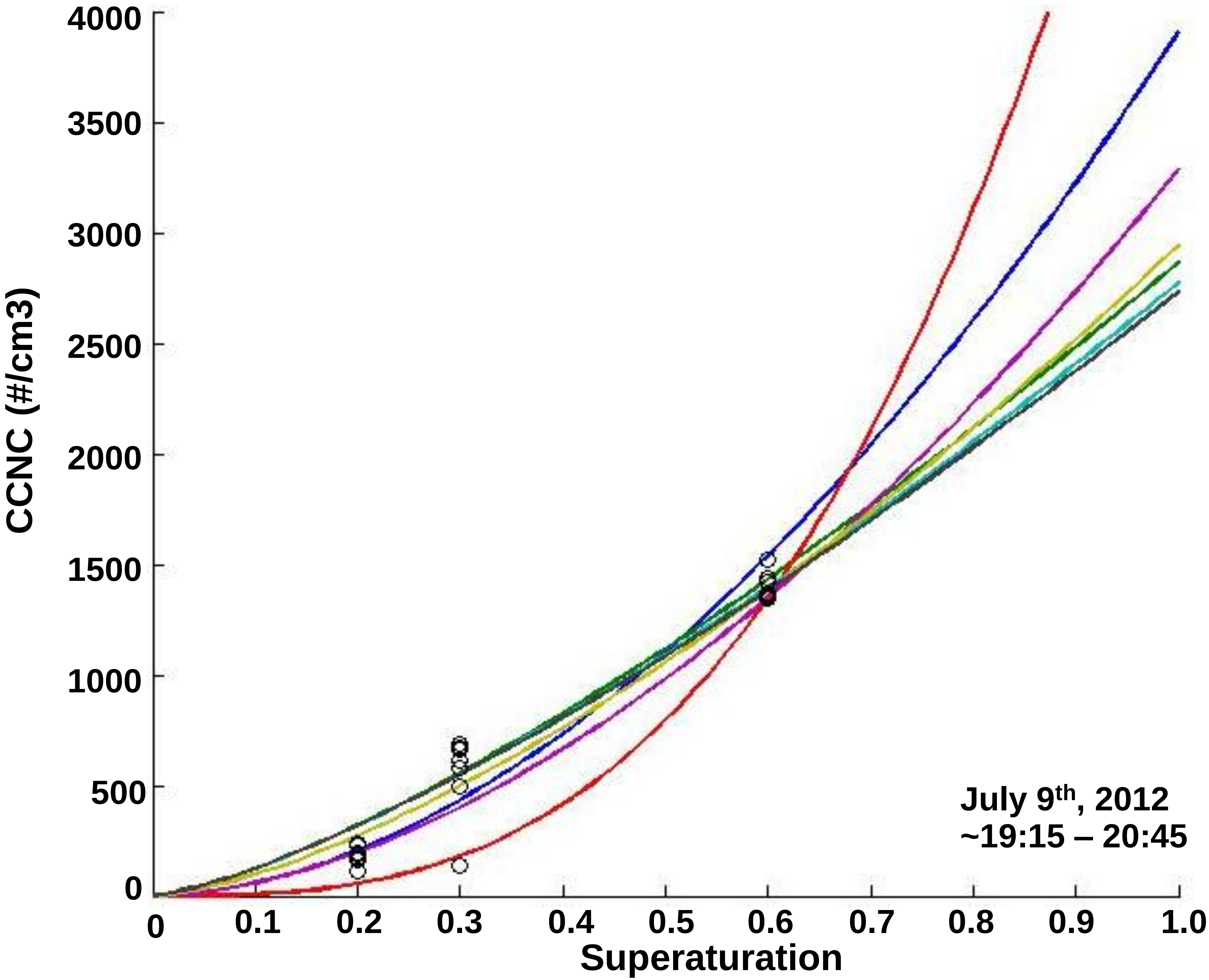
- Can generate a fit about every 10 minutes

- Statistical analysis can be performed on the fit parameters (c,k) across many cases/times

# Results: DMTCCNC Fit



# Results: DMTCCNC Fits



# Conclusions

- On certain days, the DMT counter had higher values of CCNC compared to UWyo counter at 0.6% supersaturation
- Fits allow the CCNC to be determined at any supersaturation
  - May be important for both climate and weather prediction models
- Fits may be compared to satellite retrievals
  - Studies: Aerosol retrievals → CCNC
    - Method allows for possible verification to studies
  - Correlate CCN effective radius vs. CCNC vs. SS

# Future Work

- Which CCN counter was right?
  - What caused the discrepancy?
  - Look into data from other airborne probes at the time

- Get statistics on fit parameters ‘c’ and ‘k’ such as mean, standard deviation, etc
  - Help see temporal variation in CCNC
- Apply fits to surface data
  - Taken continuously for over a month in summ er of 2012
  - Hourly/daily variations

- Compare to satellite retrievals

Questions?