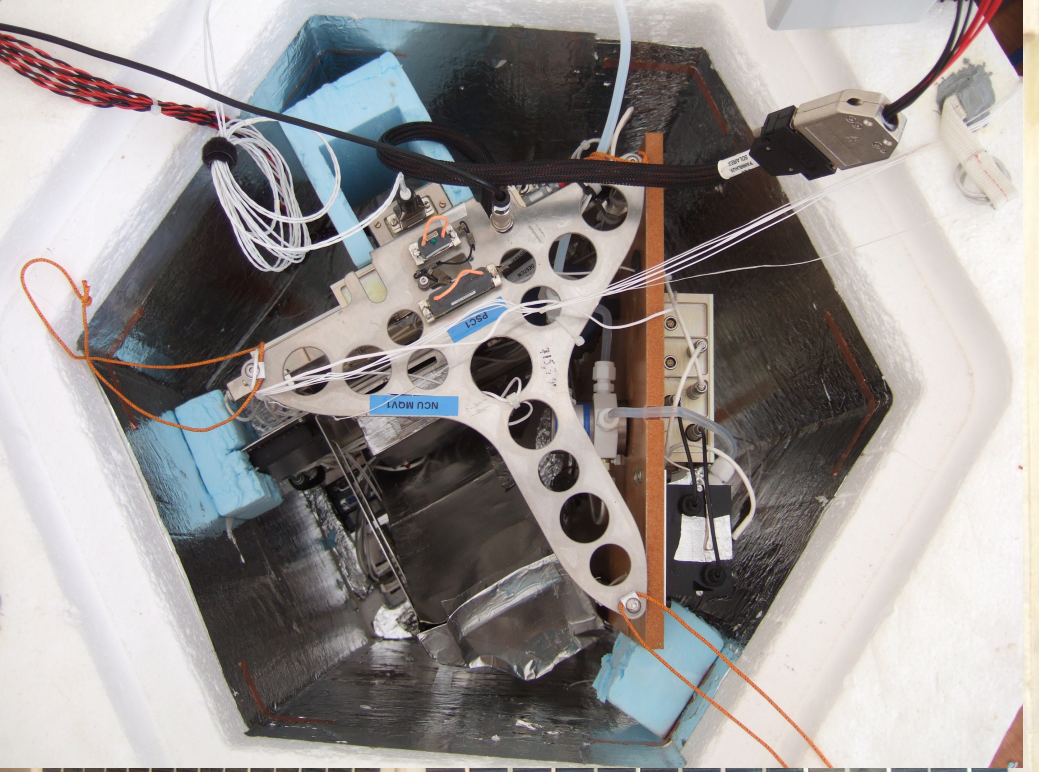
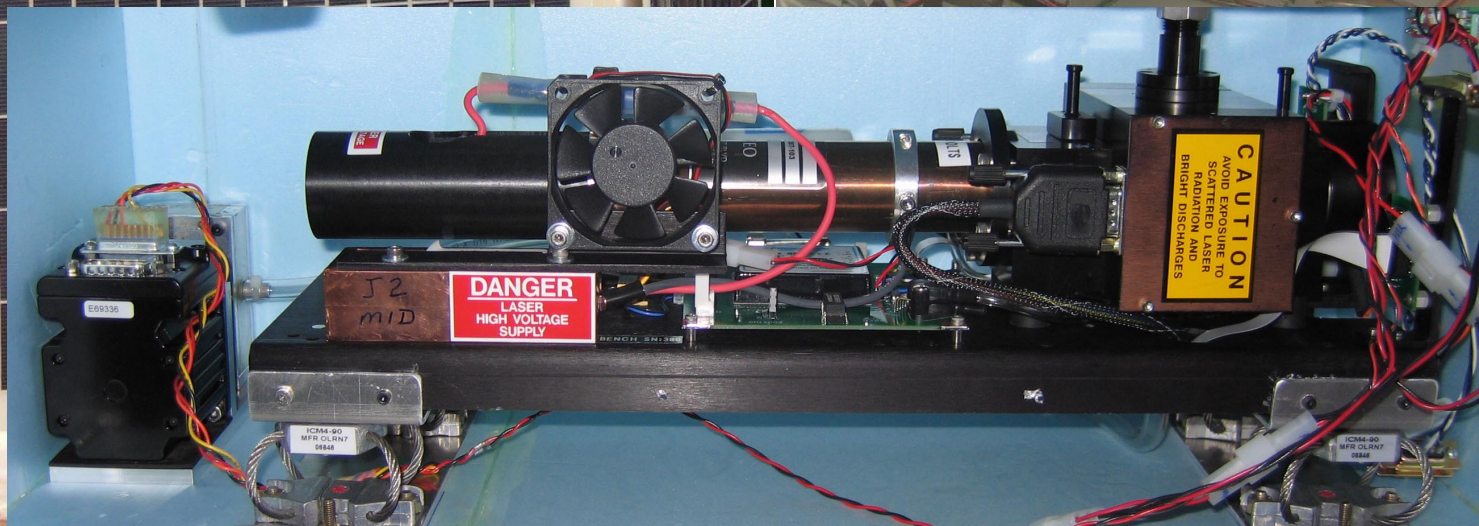
Particle measurements from a Lagrangian platform near the tropical tropopause: Results form the February 2010 pre-Concordiasi campaign

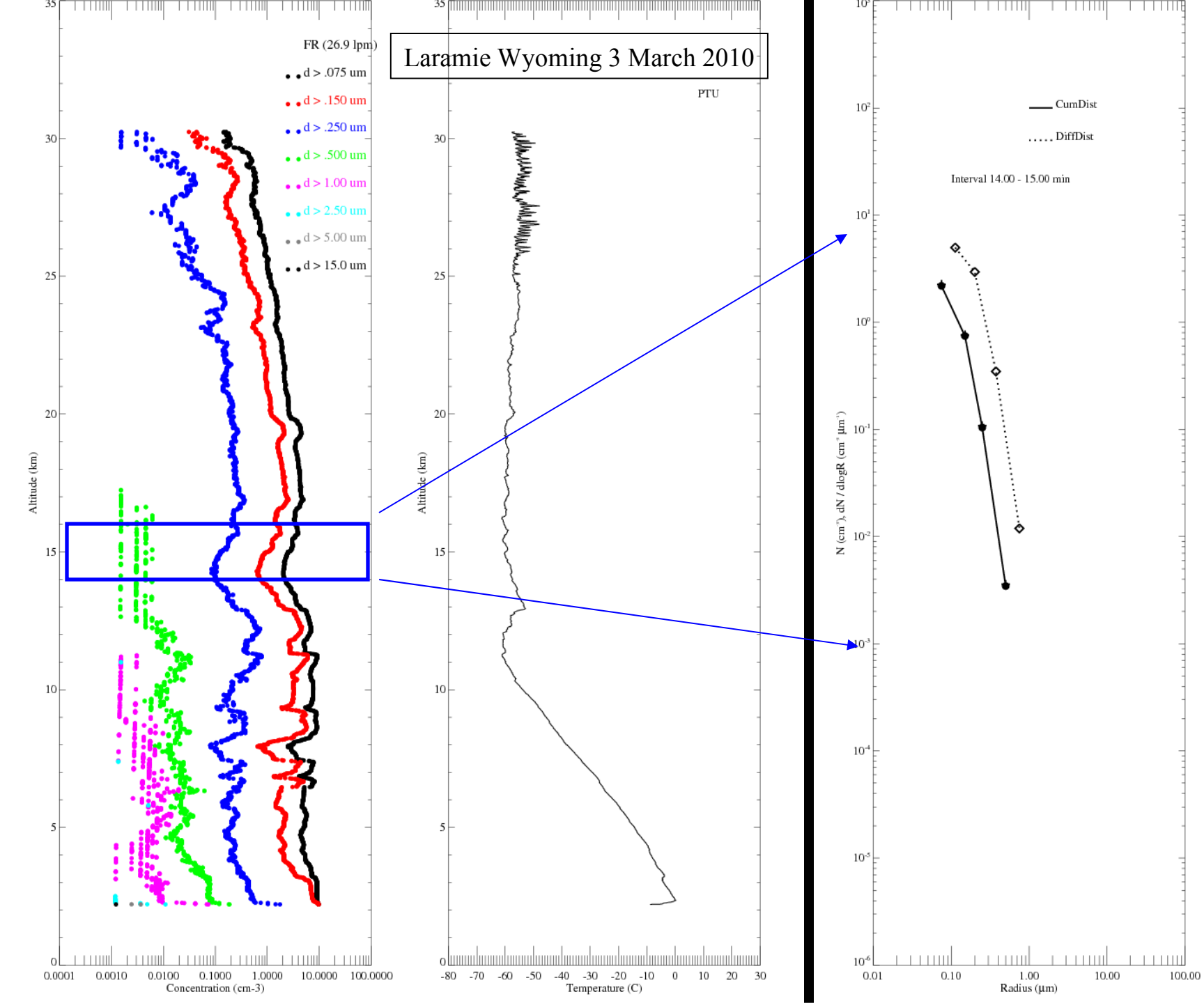
Terry Deshler, Stan Smith, Louis King
Department of Atmospheric Science
University of Wyoming

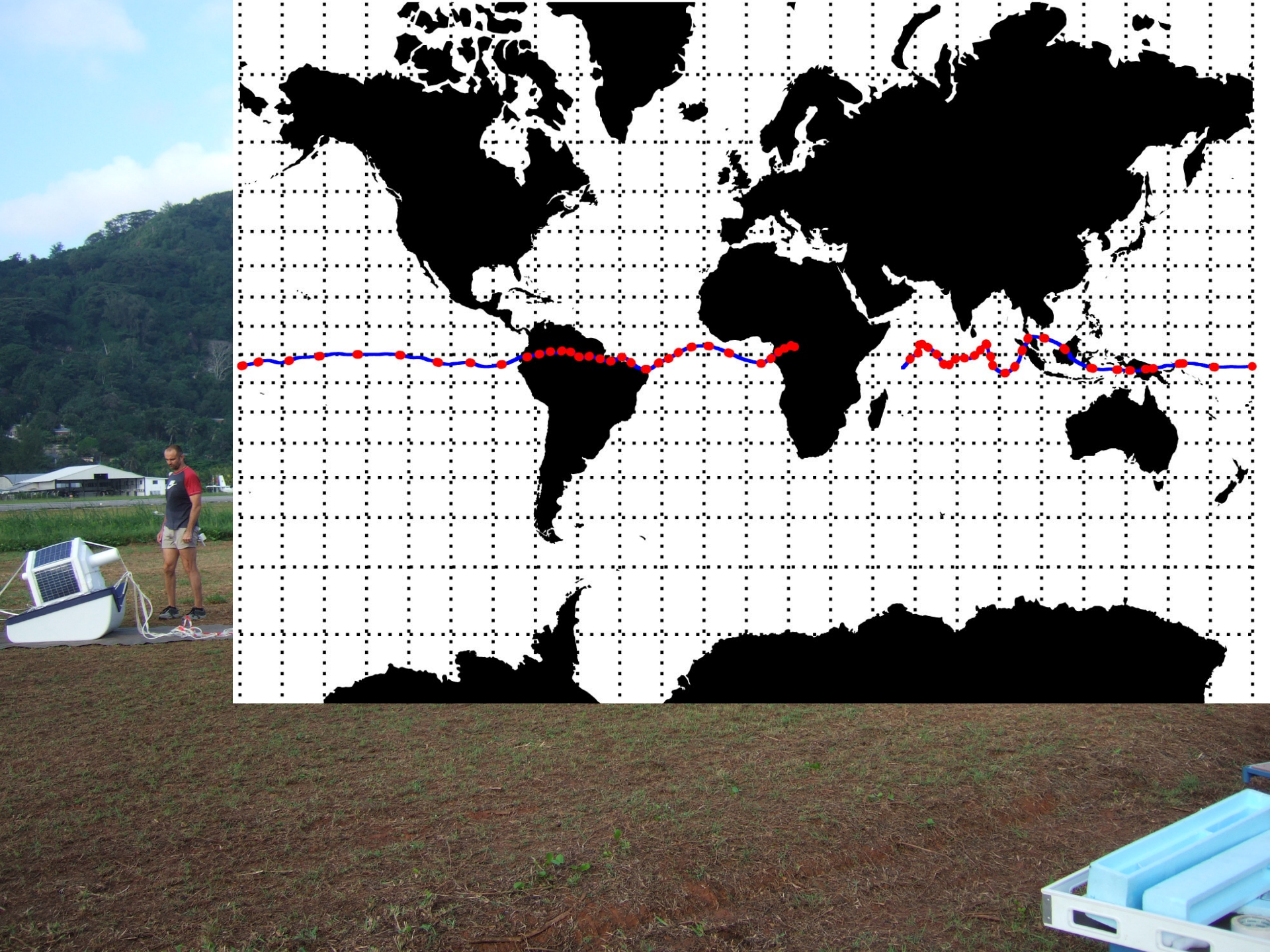
- Wyoming Paticle Counter (WPC)
- pre – Concordiasi campaign – Seychelles February 2001
- Concordiasi campaign – McMurdo August September 2010
  - Operational requirements
- Conclusions

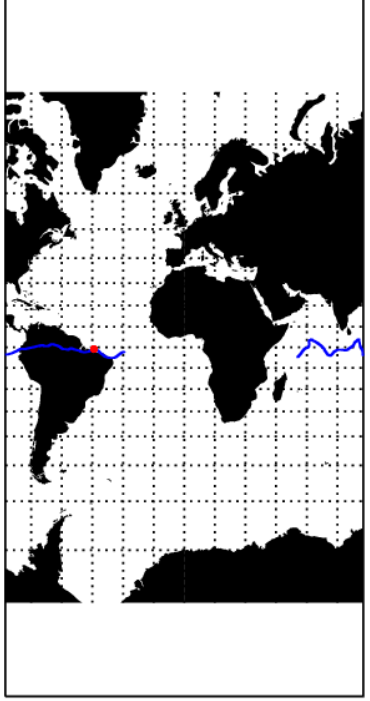


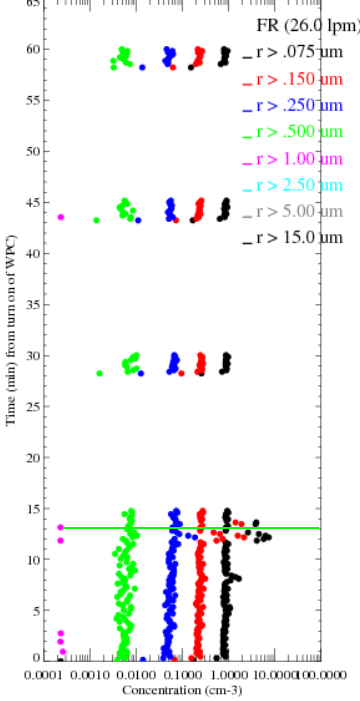

UW

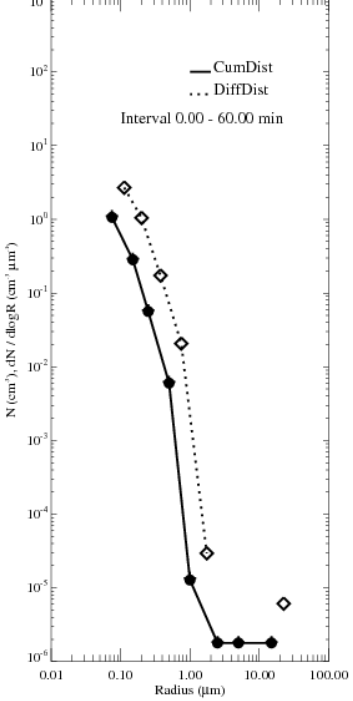

J2
MID
DANGER
LASER
HIGH VOLTAGE
SUPPLY
CAUTION
AVOID EXPOSURE TO
SCATTERED LASER
RADIATION AND
BRIGHT DISCHARGES

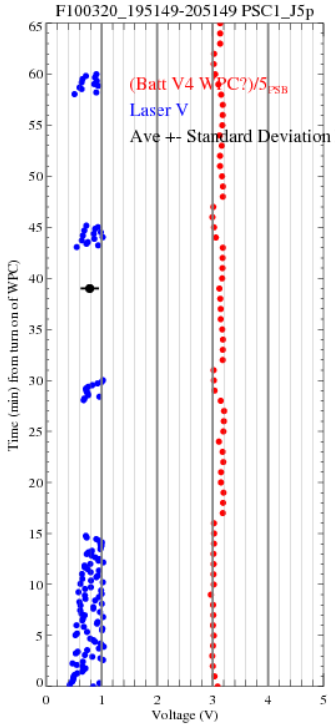

Laramie Wyoming 3 March 2010
FR (26.9 lpm)
d > .075 um
d > .150 um
d > .250 um
d > .500 um
d > 1.00 um
d > 2.50 um
d > 5.00 um
d > 15.0 um
Altitude (km)
Concentration (cm-3)
PTU
Temperature (C)
CumDist
DiffDist
Interval 14.00 - 15.00 min
N (cm⁻³), dN / dlogR (cm⁻³ µm⁻¹)
Radius (µm)

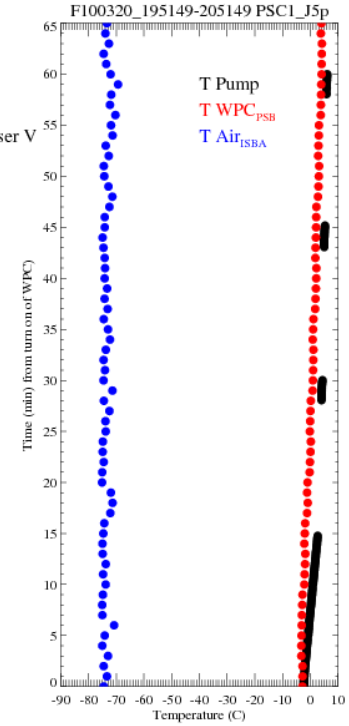


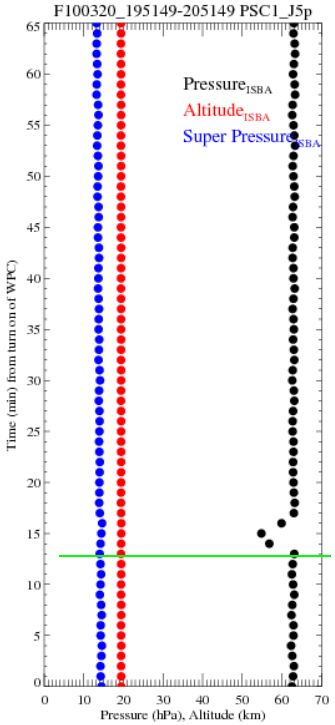


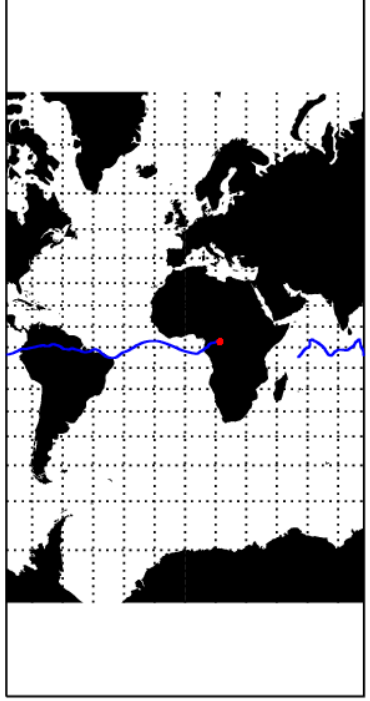

FR (26.0 lpm)
r > .075 um
r > .150 um
r > .250 um
r > .500 um
r > 1.00 um
r > 2.50 um
r > 5.00 um
r > 15.0 um
Time (min) from turn on of WPC
Concentration (cm-3)

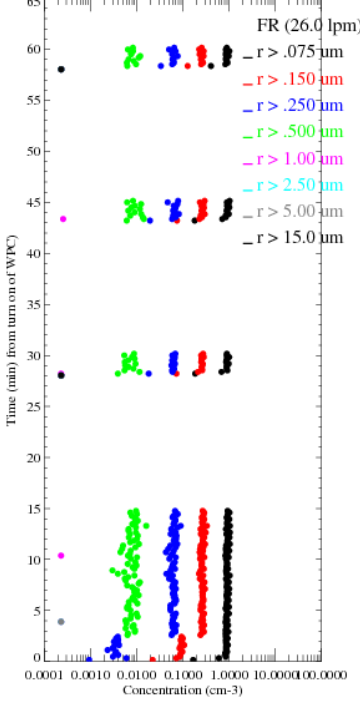

CumDist
DiffDist
Interval 0.00 - 60.00 min
N (cm⁻³), dN / dlogR (cm⁻³ µm⁻¹)
Radius (µm)

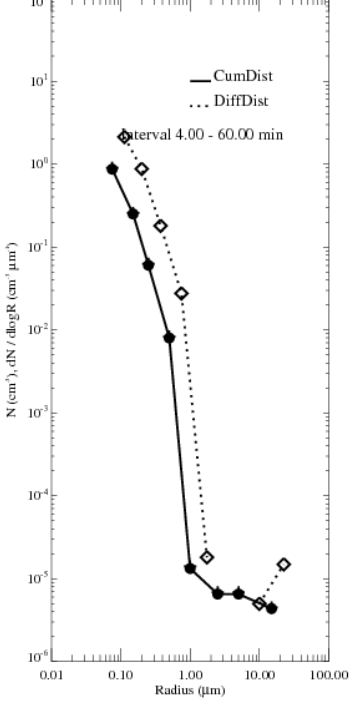

F100320_195149-205149 PSC1_J5p
(Batt V4 WPC?)/5PSB
Laser V
Ave +- Standard Deviation Laser V
Time (min) from turn on of WPC
Voltage (V)

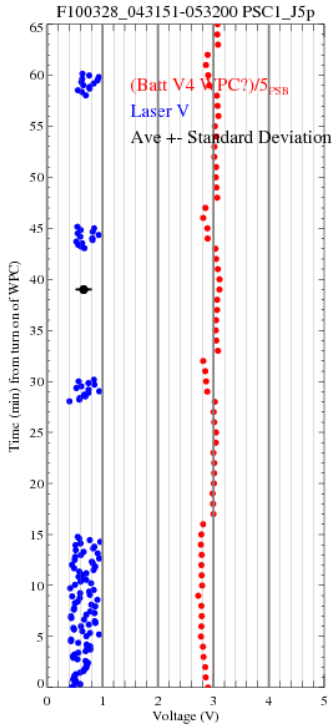

F100320_195149-205149 PSC1_J5p
T Pump
T WPCPSB
T AirISBA
Time (min) from turn on of WPC
Temperature (C)

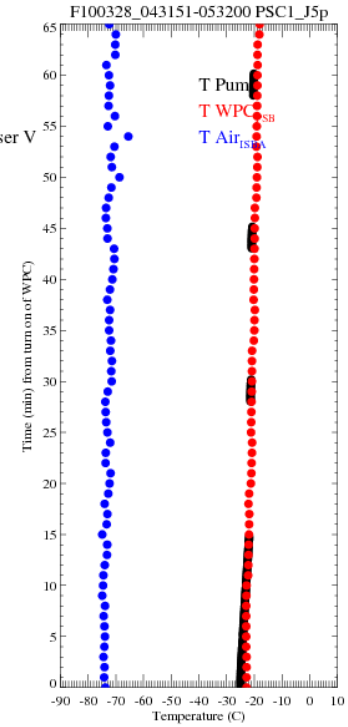

F100320_195149-205149 PSC1_J5p
PressureISBA
AltitudeISBA
Super PressureISBA
Time (min) from turn on of WPC
Pressure (hPa), Altitude (km)

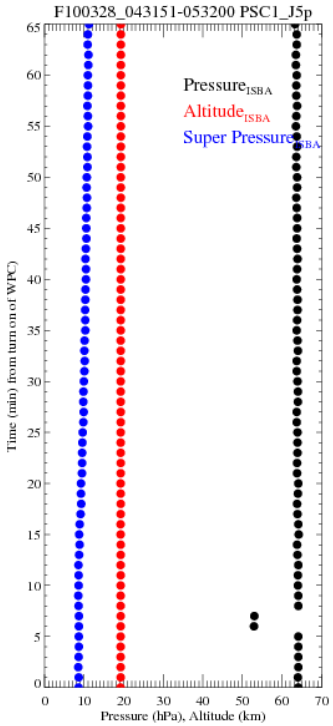


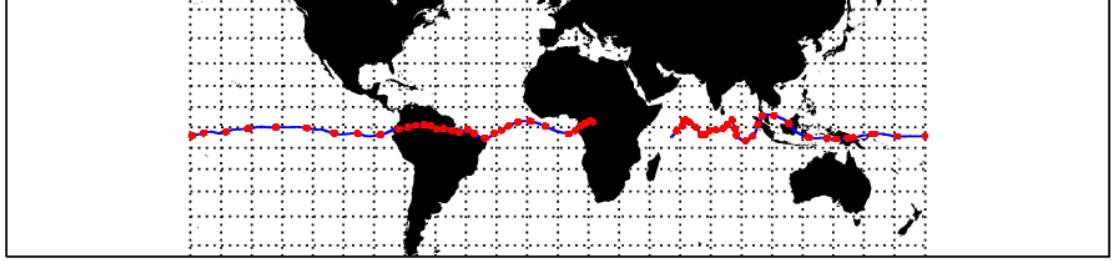

FR (26.0 lpm)
r > .075 um
r > .150 um
r > .250 um
r > .500 um
r > 1.00 um
r > 2.50 um
r > 5.00 um
r > 15.0 um
Time (min) from turn on of WPC)
Concentration (cm-3)

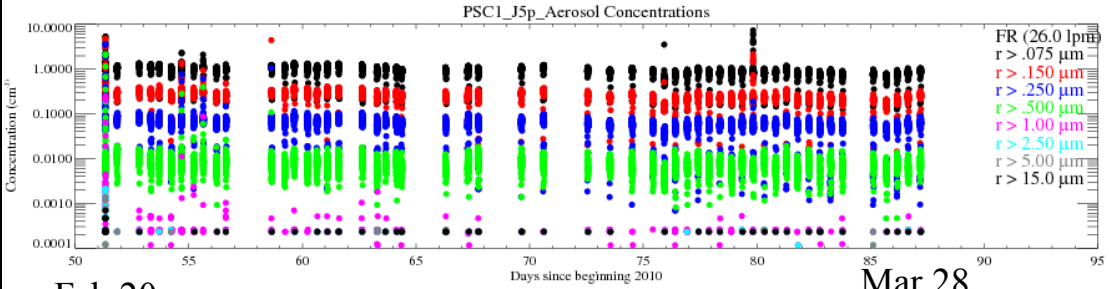

CumDist
DiffDist
Interval 4.00 - 60.00 min
N (cm⁻³), dN / dlogR (cm⁻³ µm⁻¹)
Radius (µm)


F100328_043151-053200 PSC1_J5p
(Batt V4 WPC?)/5PSB
Laser V
Ave +- Standard Deviation Laser V
Time (min) from turn on of WPC)
Voltage (V)


F100328_043151-053200 PSC1_J5p
T Pump
T WPCPSB
T AirISBA
Time (min) from turn on of WPC)
Temperature (C)

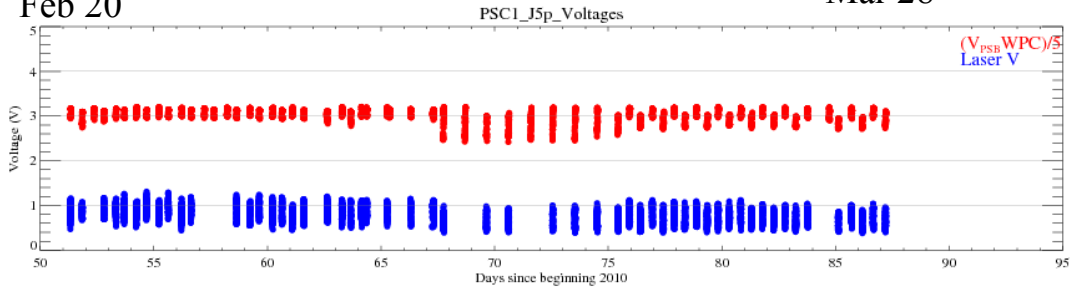

F100328_043151-053200 PSC1_J5p
PressureISBA
AltitudeISBA
Super PressureISBA
Time (min) from turn on of WPC)
Pressure (hPa), Altitude (km)

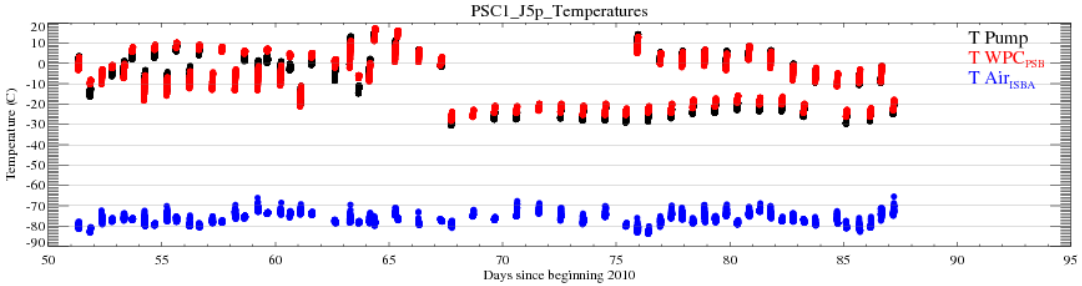


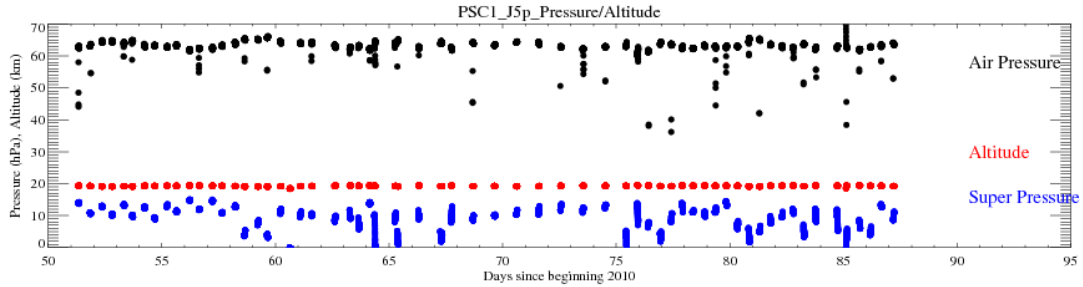

PSC1_J5p_Aerosol Concentrations
Concentration (cm⁻³)
Days since beginning 2010
FR (26.0 lpm)
r > .075 µm
r > .150 µm
r > .250 µm
r > .500 µm
r > 1.00 µm
r > 2.50 µm
r > 5.00 µm
r > 15.0 µm

Feb 20

Mar 28


PSC1_J5p_Voltages
Voltage (V)
Days since beginning 2010
(V_PSB WPC)/5
Laser V


PSC1_J5p_Temperatures
Temperature (C)
Days since beginning 2010
T Pump
T WPC_PSB
T Air_ISBA


PSC1_J5p_Pressure/Altitude
Pressure (hPa), Altitude (km)
Days since beginning 2010
Air Pressure
Altitude
Super Pressure

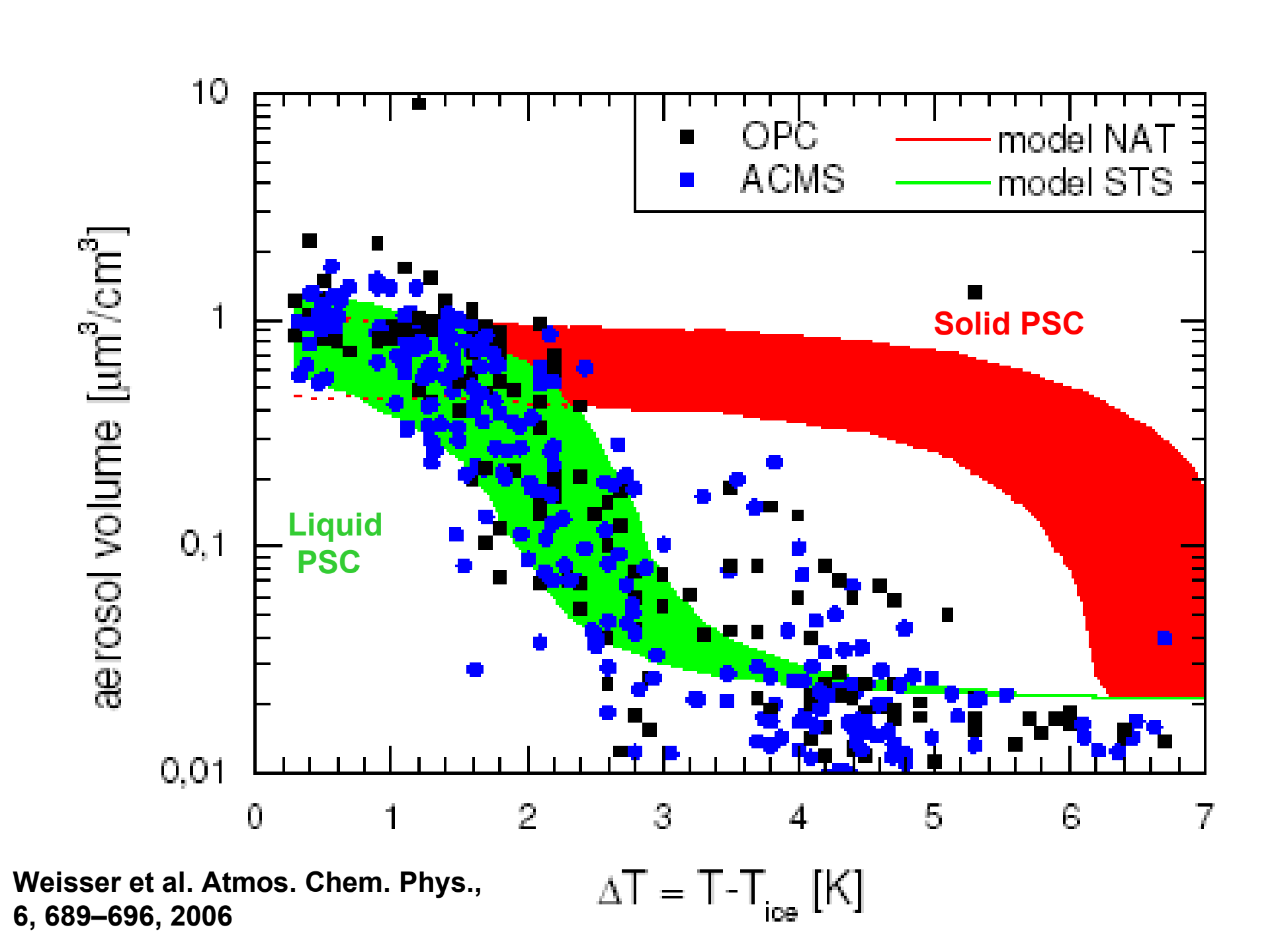
Quasi-Lagrangian measurements of polar stratospheric cloud particle development from long-duration balloon platforms – NSF-OPP proposal

- **Goal**
  - Capture the processes of particle growth during formation and dissolution of polar stratospheric clouds (PSCs) as instruments pass into and out of temperature regimes favorable for PSC development.
  - Particle and Temperature measurements provide observations of threshold temperatures for PSC particle condensation forming:
    - Liquid cloud particles, including some estimates of their growth rate
    - Solid nitric acid trihydrate (NAT) particles, including estimates of their nucleation threshold.
  - The question of solid PSC (NAT) nucleation is one of the major unanswered questions concerning PSC particle development.

Importance

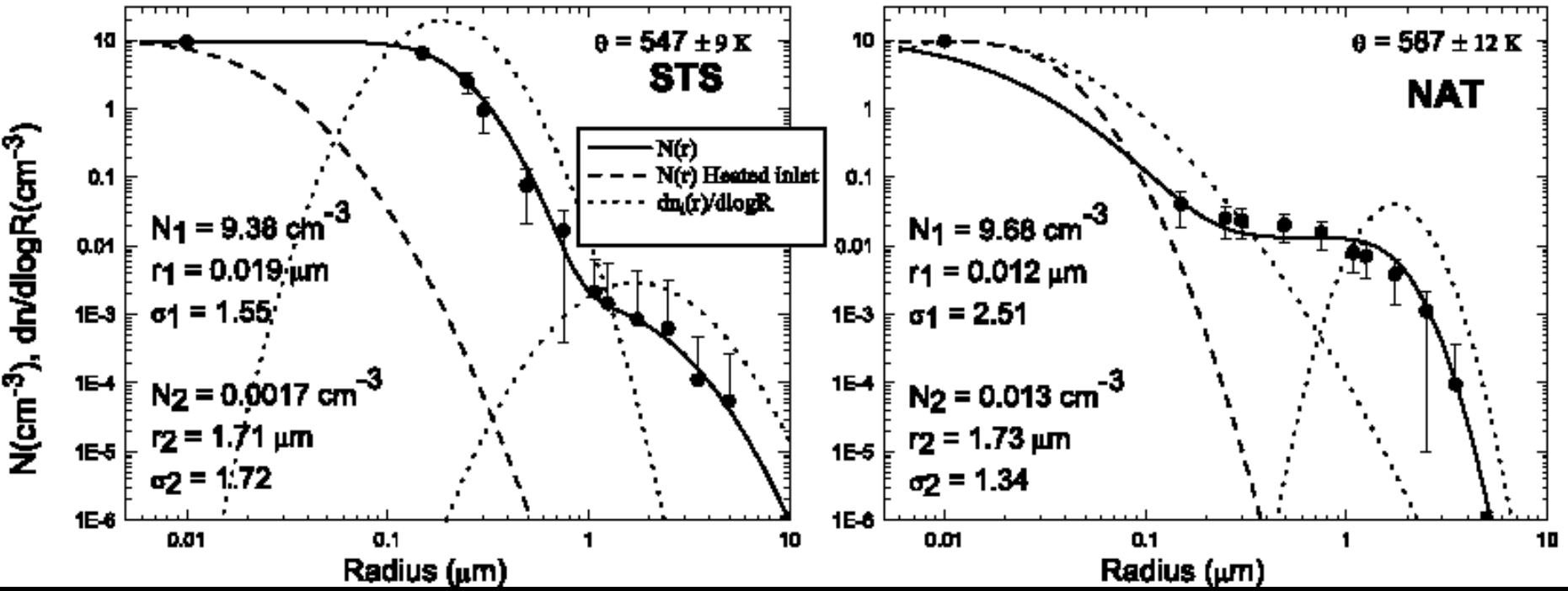
- **Nucleation thresholds for solid PSC hydrates are necessary for incorporation of more realistic PSC models into current ozone loss models. At what temperature should models form PSCs?**
  - **$T(PSC_{solid}) \sim T(PSC_{liquid}) + 3\ K \sim T(PSC_{ice}) + 7\ K$**

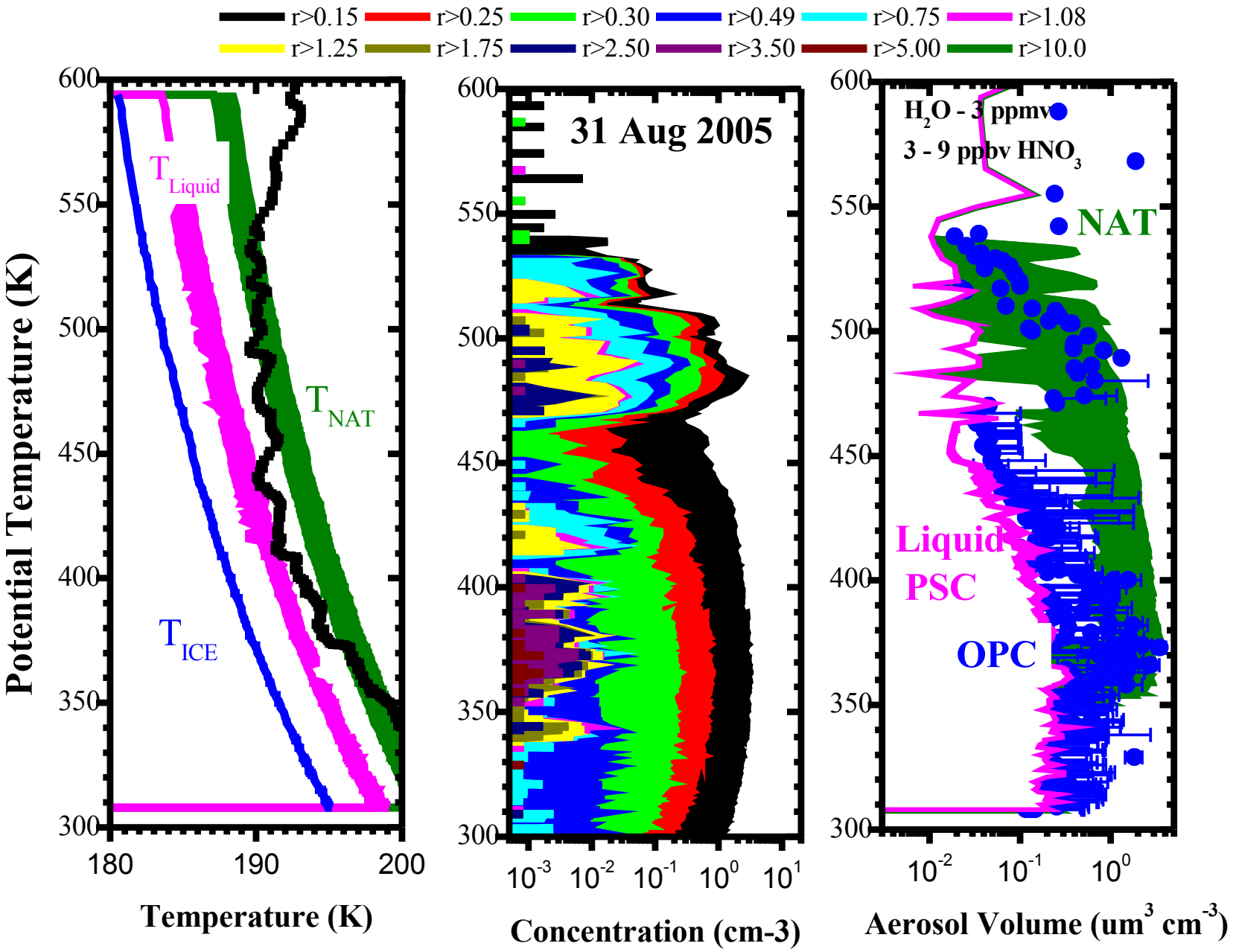
- **Laboratory nucleation thresholds ($\sim T_{ice}$-2K) appear too cold based on limited field observations.**

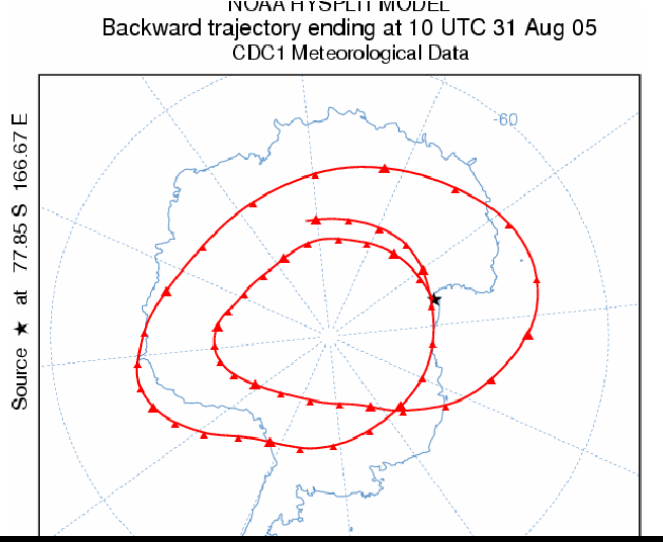


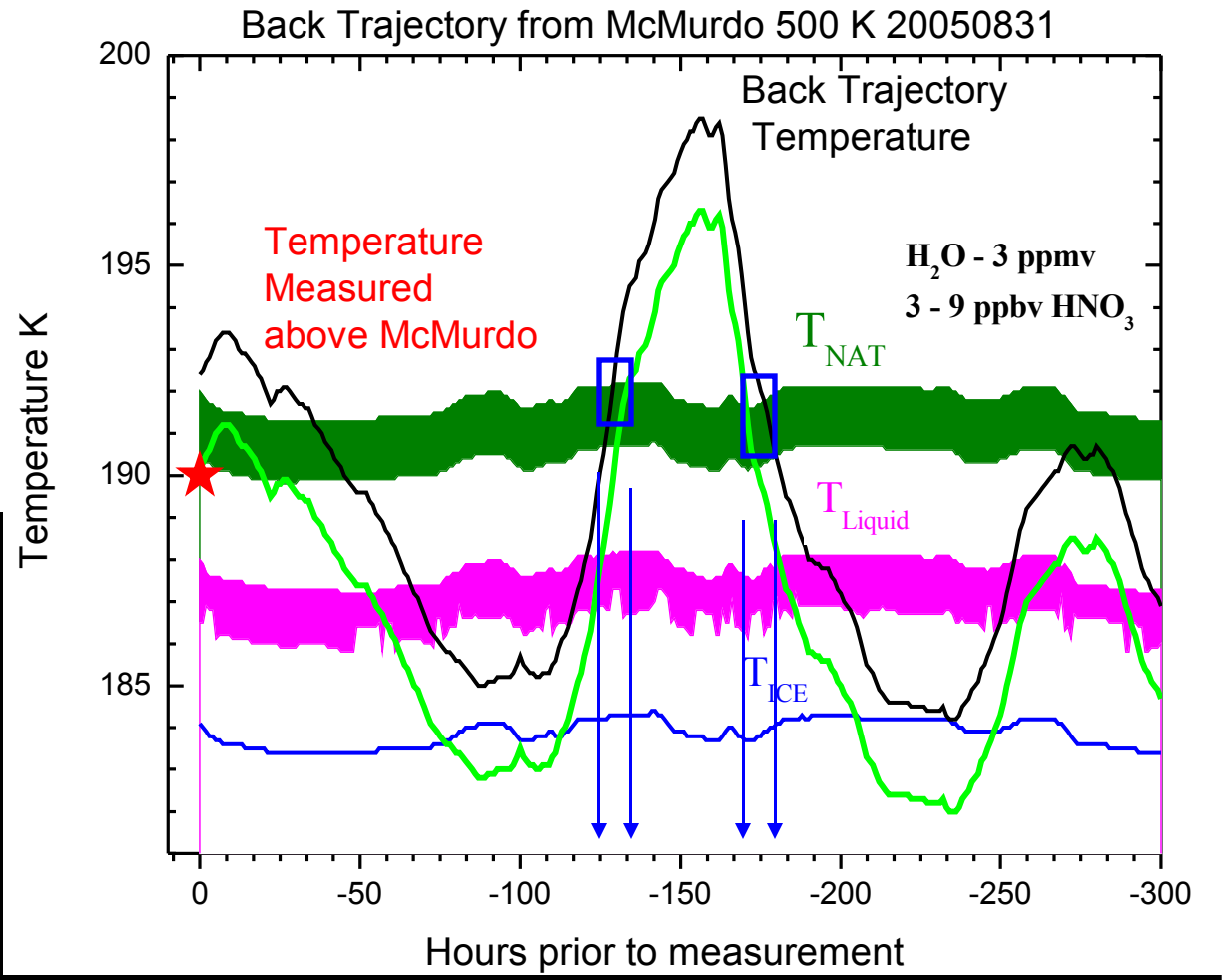
Weisser et al. Atmos. Chem. Phys., 6, 689–696, 2006

J. Geophys. Res., 2003



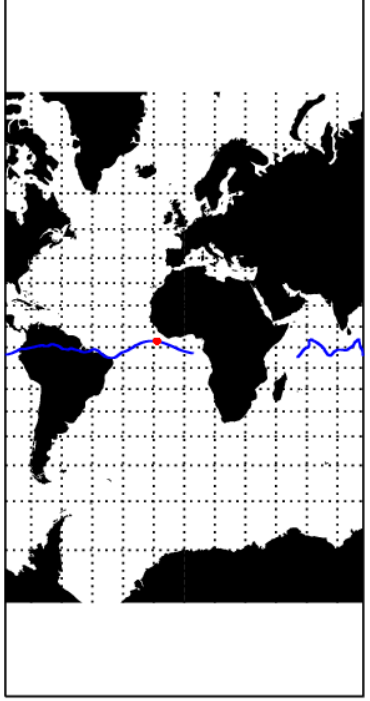

r>0.15
r>0.25
r>0.30
r>0.49
r>0.75
r>1.08
r>1.25
r>1.75
r>2.50
r>3.50
r>5.00
r>10.0
Potential Temperature (K)
600
550
500
450
400
350
300
T Liquid
T NAT
T ICE
180
190
200
Temperature (K)
31 Aug 2005
10-3
10-2
10-1
100
101
Concentration (cm-3)
H2O - 3 ppmv
3 - 9 ppbv HNO3
NAT
Liquid
PSC
OPC
10-2
10-1
100
Aerosol Volume (um3 cm-3)

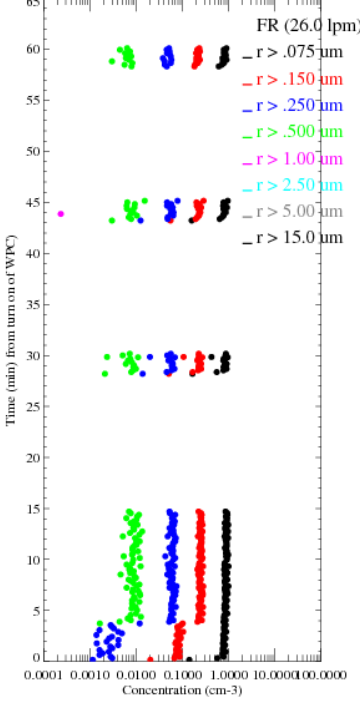

NOAA HYSPLIT MODEL
Backward trajectory ending at 10 UTC 31 Aug 05
CDC1 Meteorological Data
Source ★ at 77.85 S 166.67 E
-60

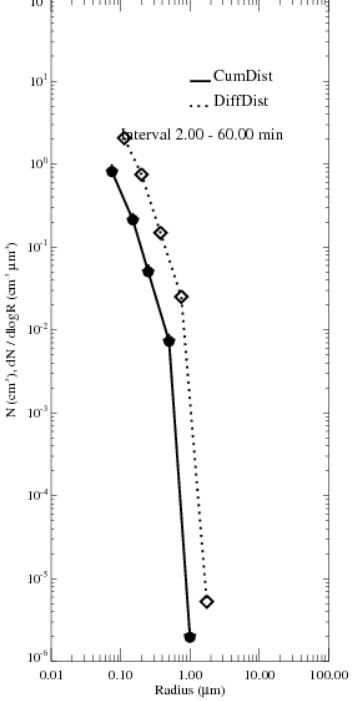

Back Trajectory from McMurdo 500 K 20050831
Back Trajectory
Temperature
Temperature
Measured
above McMurdo
H2O - 3 ppmv
3 - 9 ppbv HNO3
TNAT
TLiquid
TICE
Temperature K
Hours prior to measurement
200
195
190
185
0
-50
-100
-150
-200
-250
-300

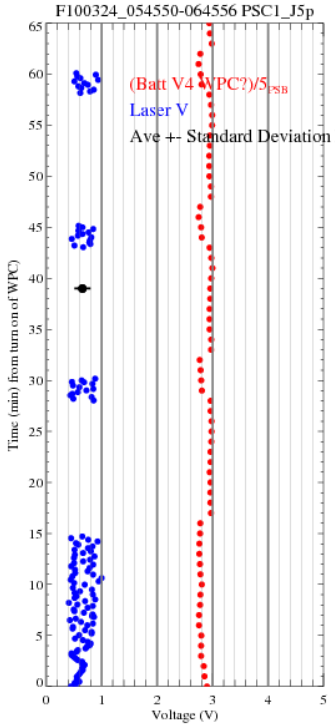
Conclusions

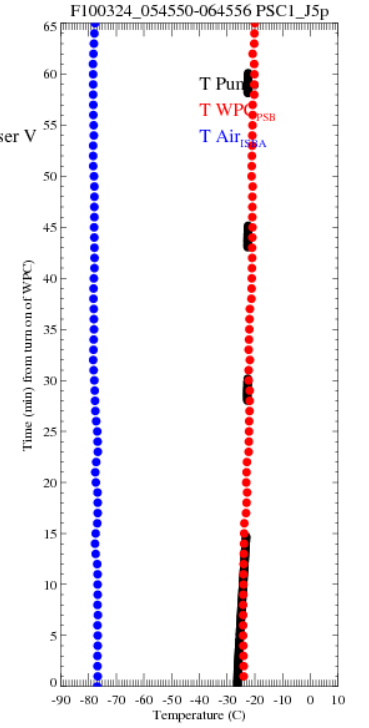
- **Field measurements coupled with back trajectories suggest NAT nucleation temperatures are warmer than laboratory estimates.**
- **Field estimates are uncertain because of:**
  - **Uncertainties in back trajectory histories**
  - **Uncertainties in the model analyzed temperatures**
  - **No estimates of particle growth rate along air parcel tracks.**
- **Lagrangian in situ microphysical measurements would reduce uncertainties in:**
  - **air parcel history**
  - **temperature accuracy**
  - **particle type and growth**
- **The successes of the pre-Concordiasi campaign are very promising indications for completing the planned measurements from McMurdo in 2010!!!**

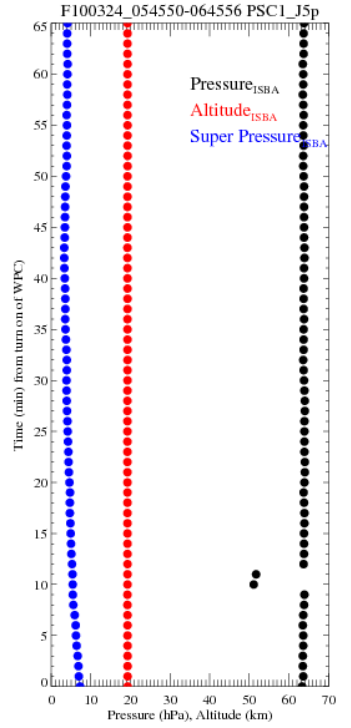



FR (26.0 lpm)
r > .075 um
r > .150 um
r > .250 um
r > .500 um
r > 1.00 um
r > 2.50 um
r > 5.00 um
r > 15.0 um
Time (min) from turn on of WPC
Concentration (cm-3)


CumDist
DiffDist
Interval 2.00 - 60.00 min
N (cm-3), dN / dlogR (cm-3 µm-3)
Radius (µm)


F100324_054550-064556 PSC1_J5p
(Batt V4 - WPC?)/5 PSB
Laser V
Ave +- Standard Deviation Laser V
Time (min) from turn on of WPC
Voltage (V)


F100324_054550-064556 PSC1_J5p
T Pump
T WPC PSB
T Air ISBA
Time (min) from turn on of WPC
Temperature (C)


F100324_054550-064556 PSC1_J5p
Pressure ISBA
Altitude ISBA
Super Pressure ISBA
Time (min) from turn on of WPC
Pressure (hPa), Altitude (km)