Aerosol Effects on Cloud Microphysics in VOCALS:

What pollutants participate in cloud formation in SEP, and how do they influence SCu albedo and precipitation?

Preliminary Results

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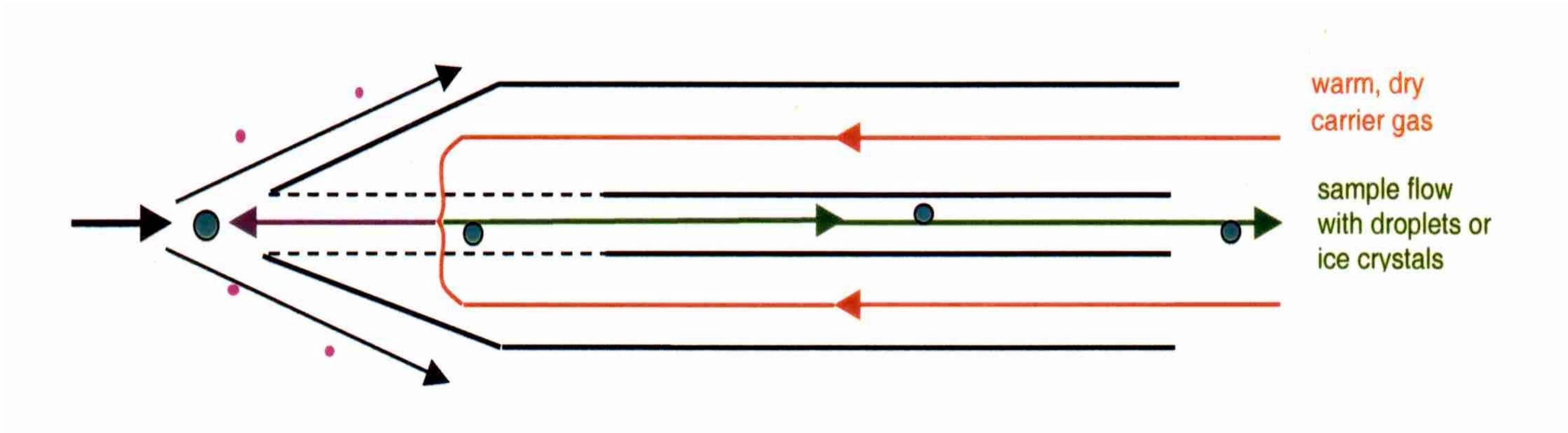
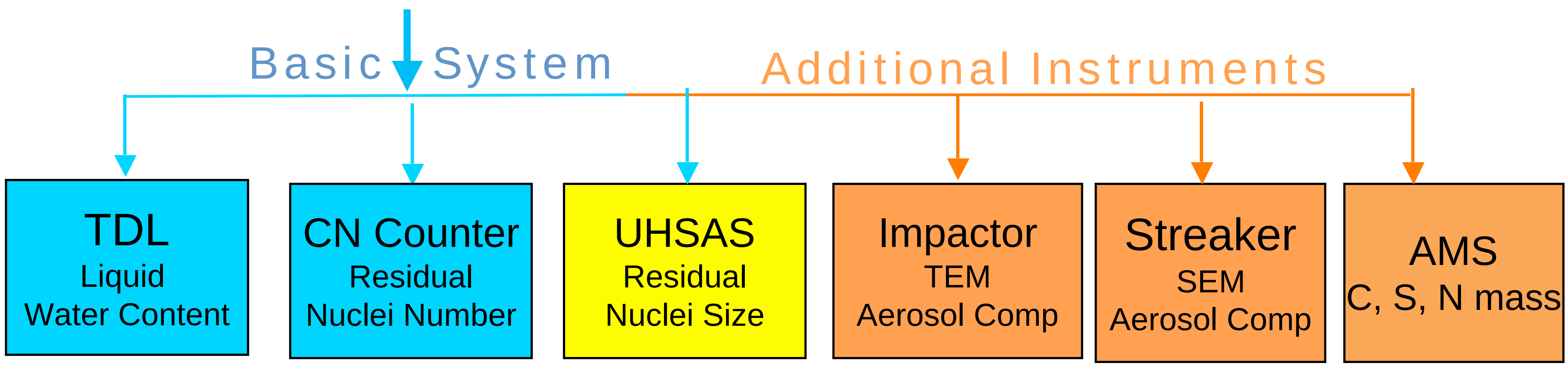
Counterflow Virtual Impactor (CVI)

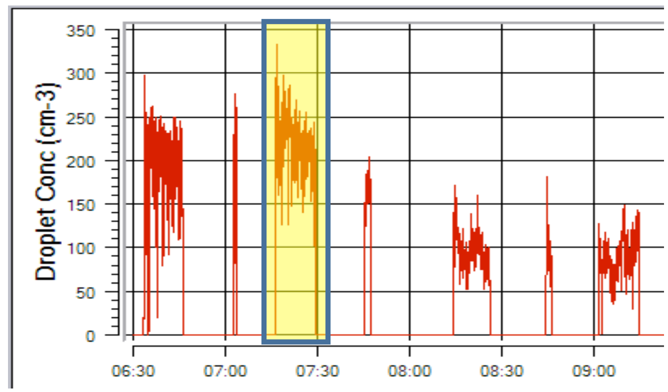


- Collects droplets while rejecting interstitial aerosols & vapor
- Evaporates water so sample stream has non-volatile residual particles
- Change minimum size (cut size) of drops by changing counterflow rate

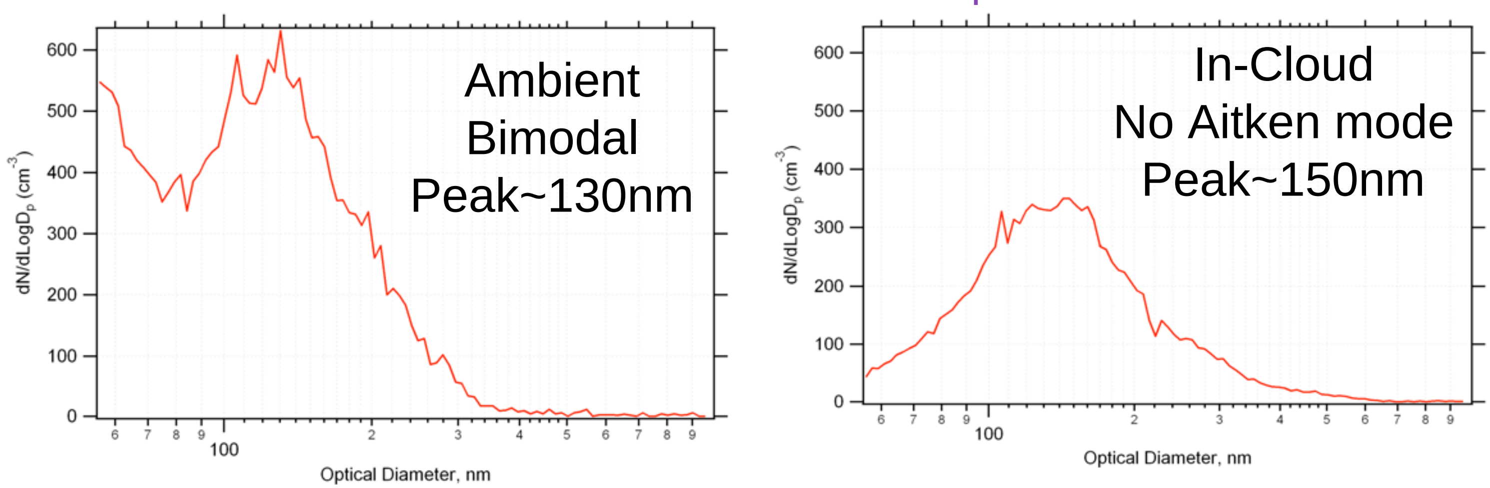


Which nuclei form droplets?
Are they different from population?
How do pollution aerosols participate?

Outbound case from R3, 75W



R3 Outbound: Below Cloud Ambient vs. Droplet Residuals

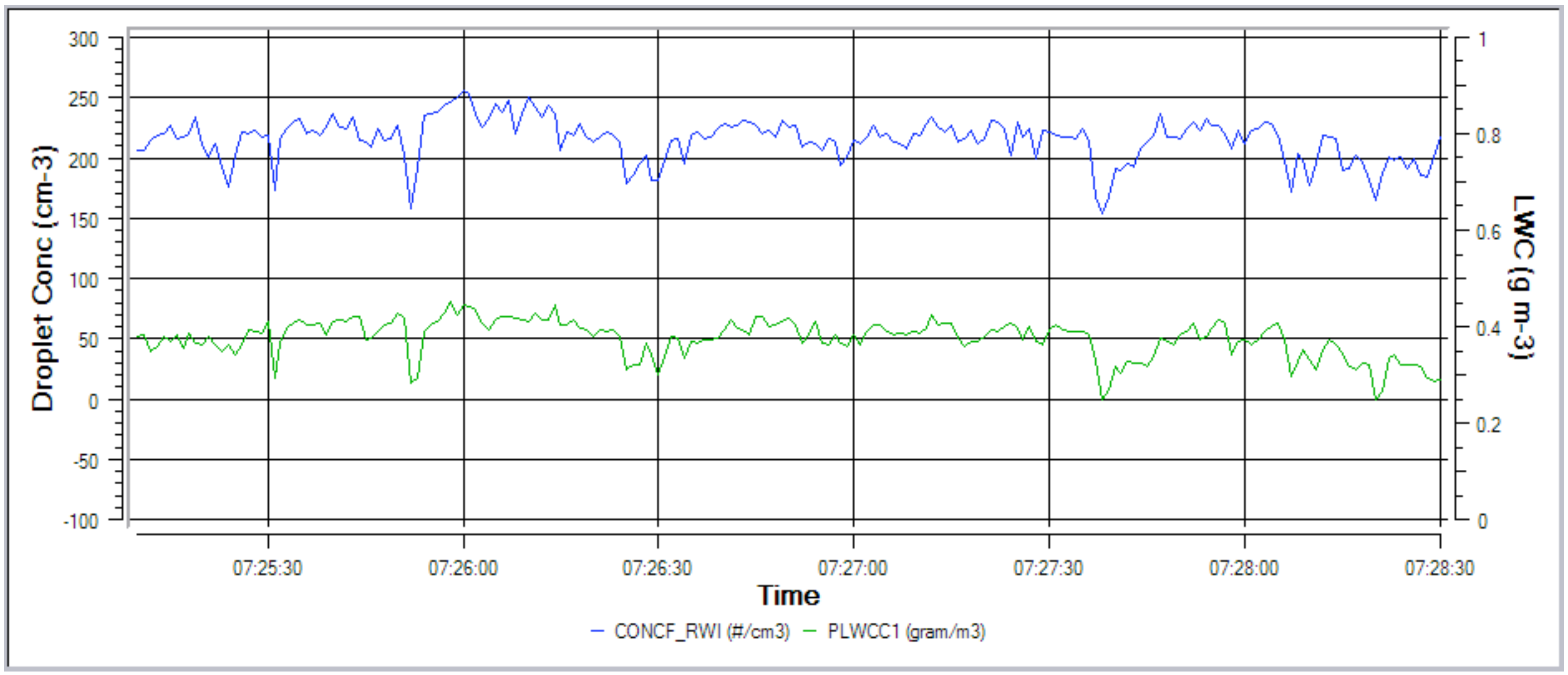


Which Nuclei form *Largest* Drops?

Important for understanding drizzle formation, mixing process, chemical reactions

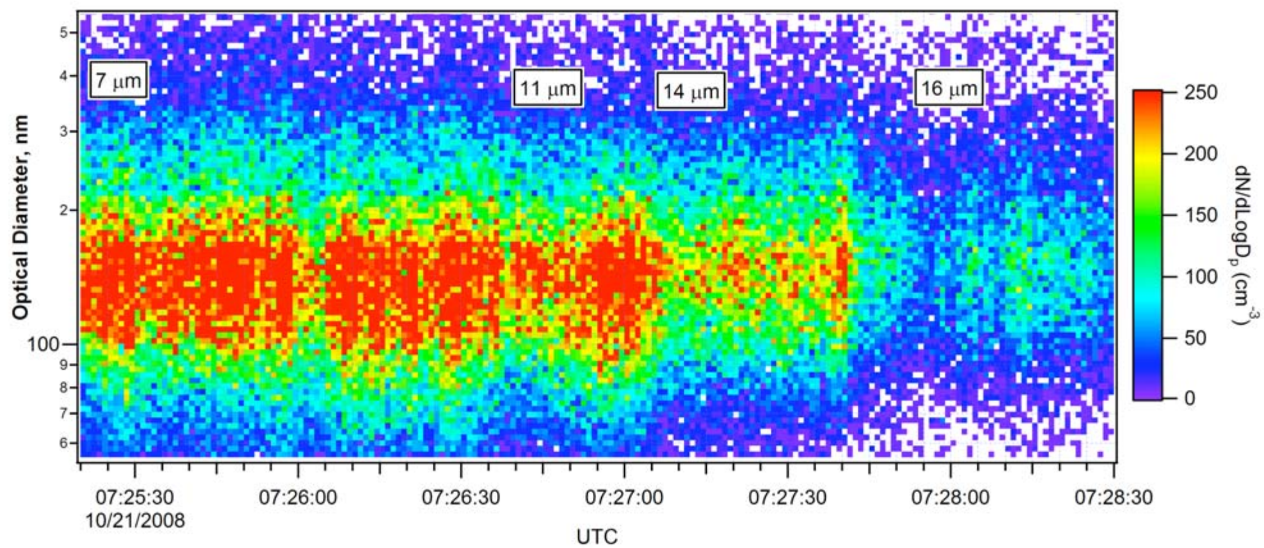
Condensational growth theory predicts that largest drops are formed from largest nuclei

R3 Outbound: Period with Low Microphysical Variability During Sampling



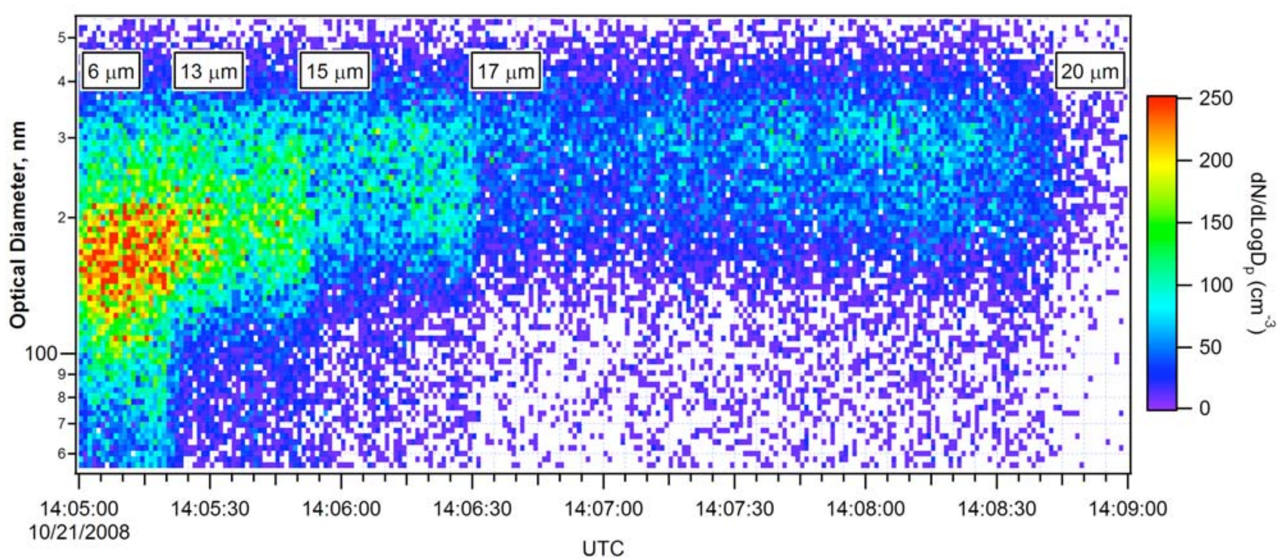
Changes in Residual Size Distribution with Drop Size

R3 outbound

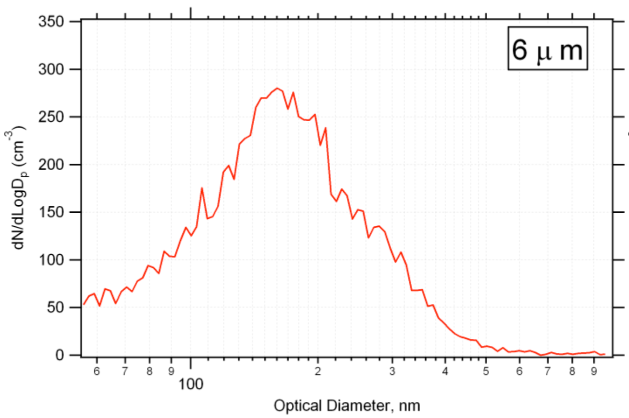


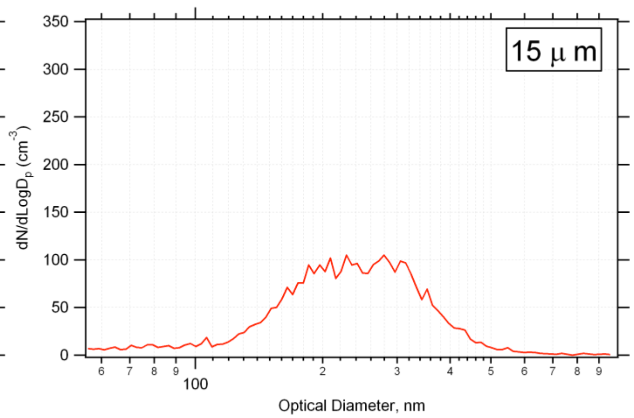
Smaller nuclei are progressively excluded as we exclude smaller droplets

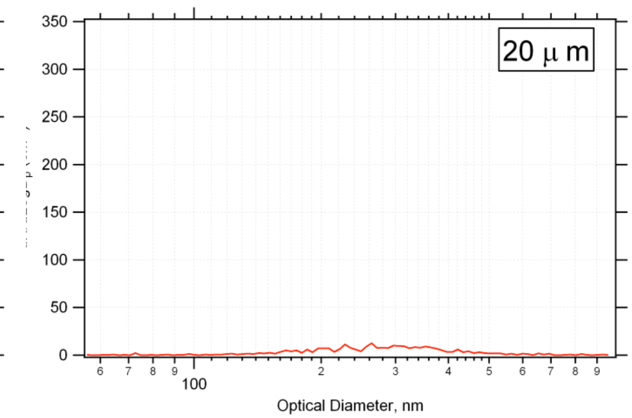
R3 inbound
t + 6.5 hours



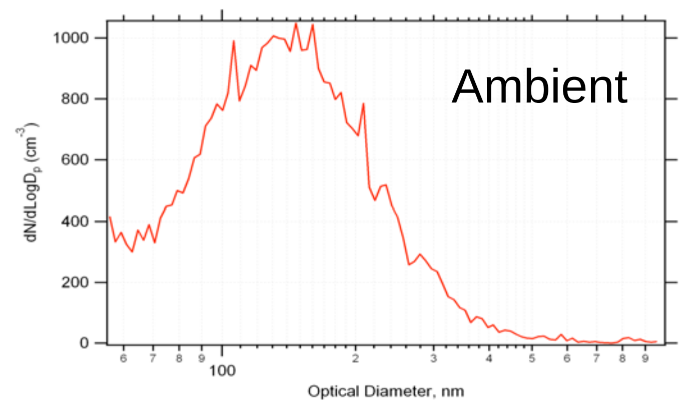
Changes with Drop Size: R3 Inbound





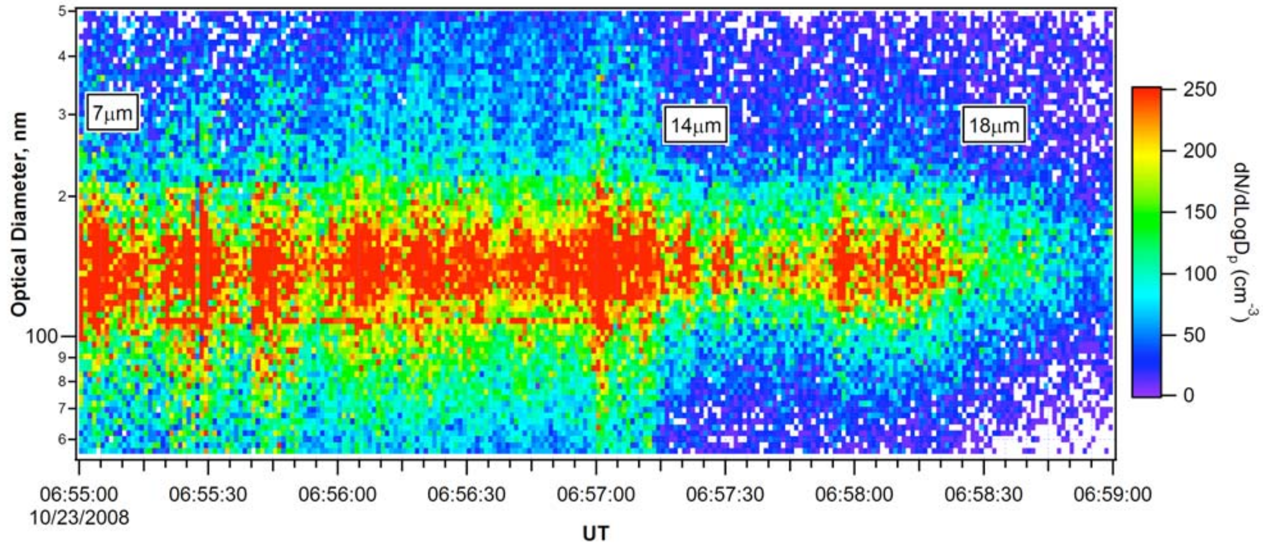


Largest drops form on a very special population of the largest nuclei

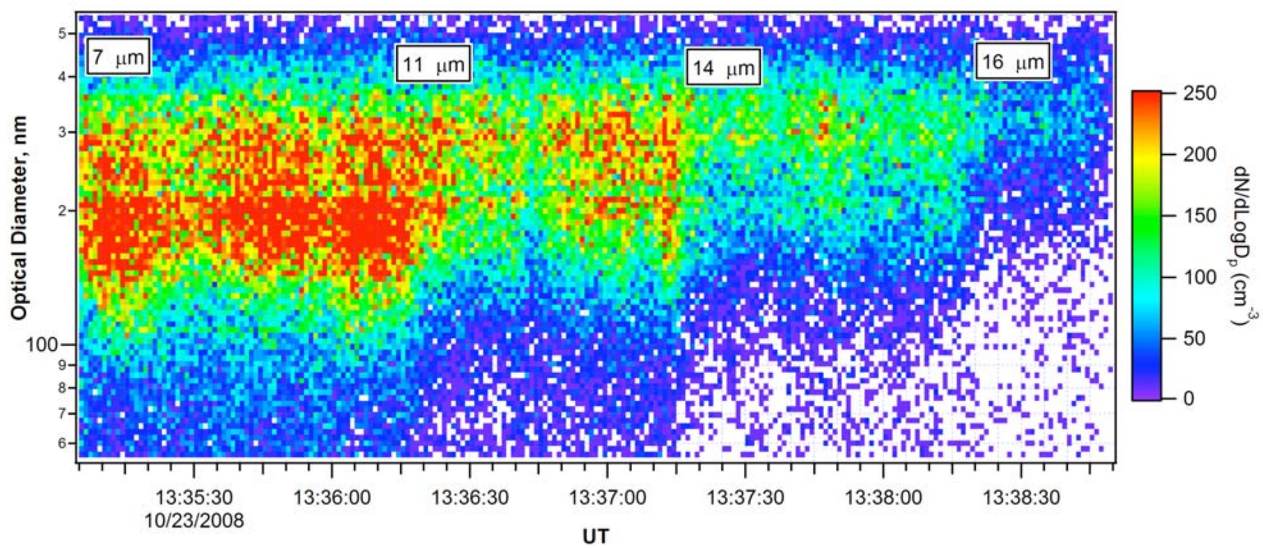


R4: Similar shift, but... inbound leg shows much larger mean sizes

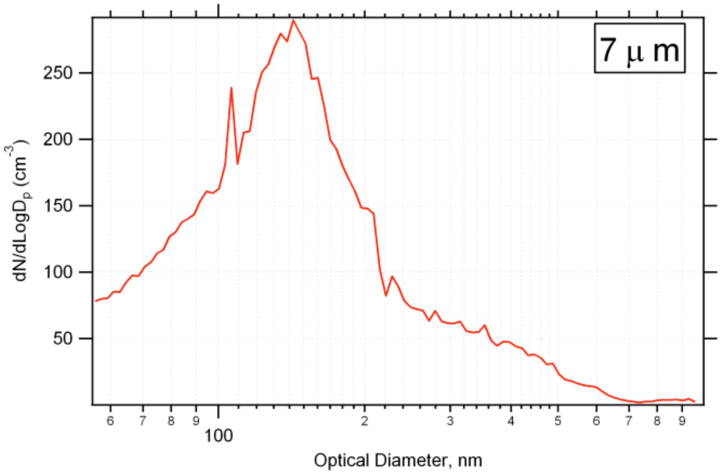
R4 outbound

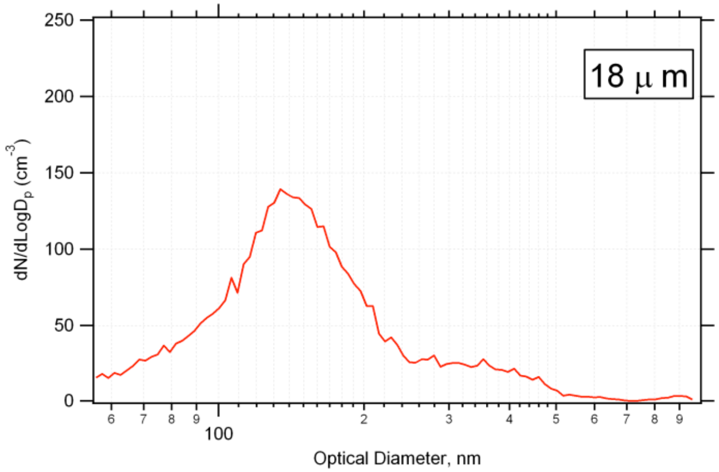


R4 inbound
t + 6.5 hrs

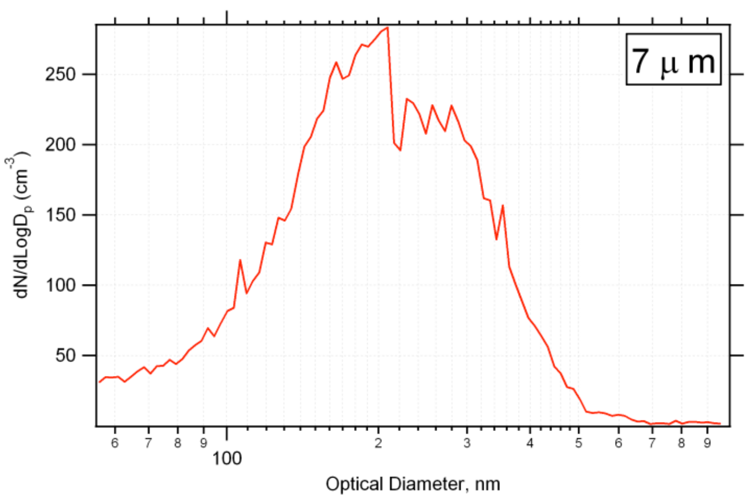


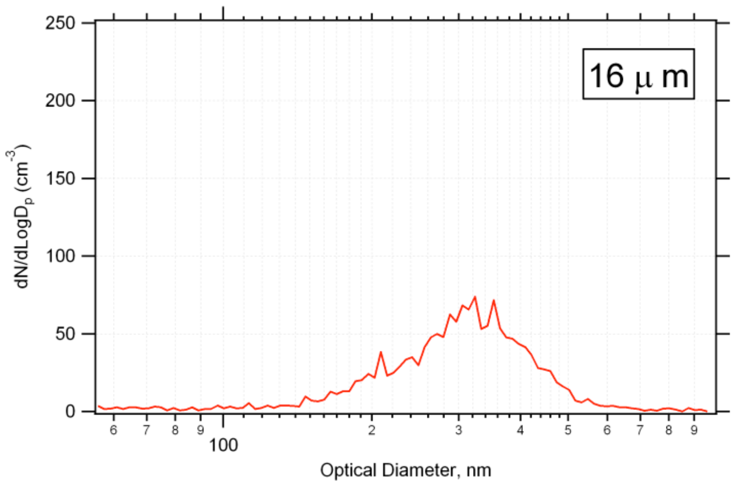
R4 Outbound





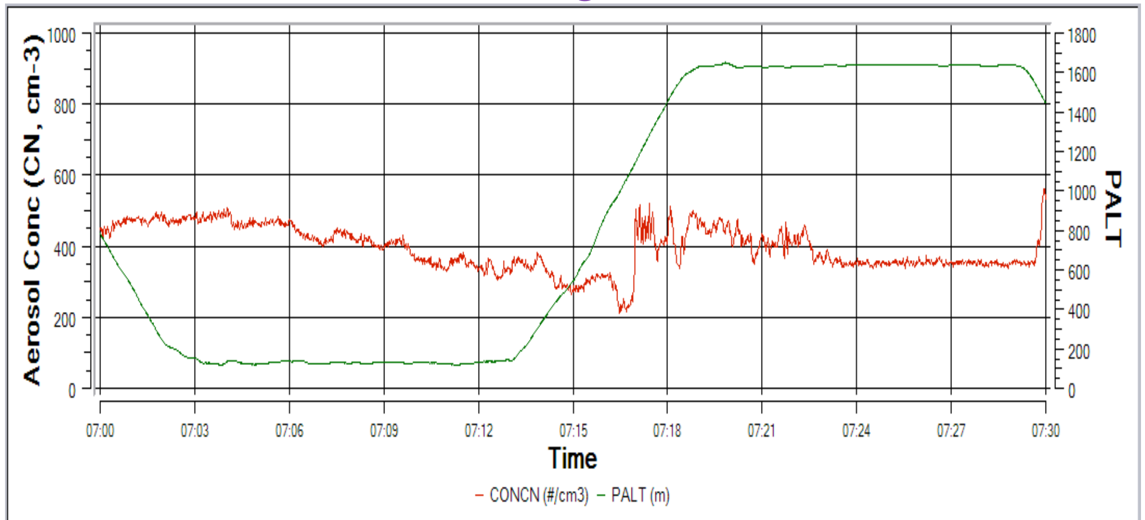
R4 Inbound: Much larger mean residual sizes than for outbound leg



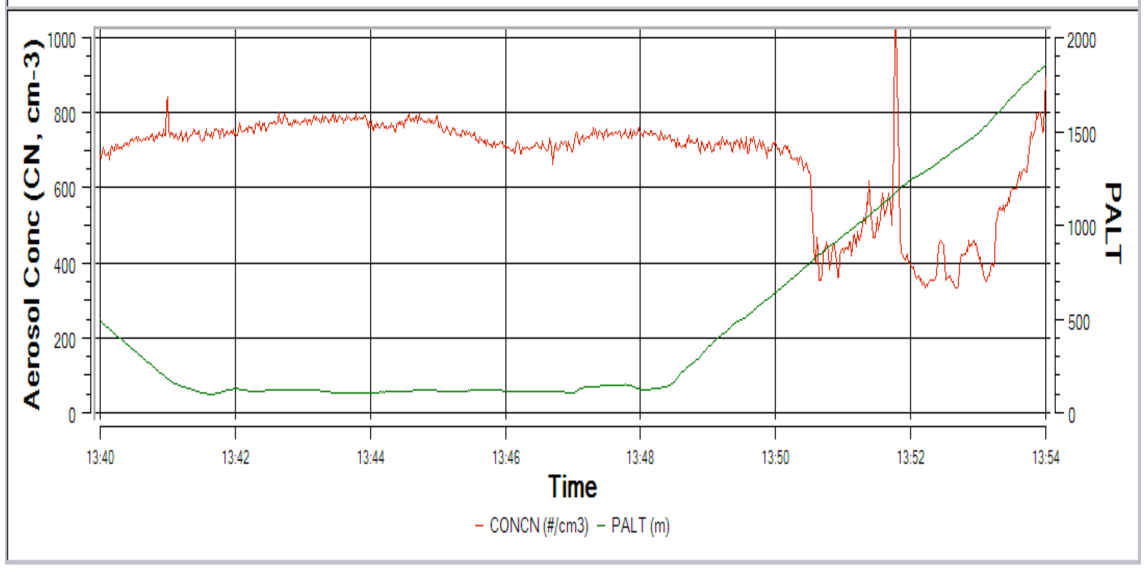


R4: Why are Outbound and Inbound Legs so Different?

R4 Outbound: (73W)
Total below cld CN ~400 cm^{-3}
~250 cm^{-3} are large, > 55 nm

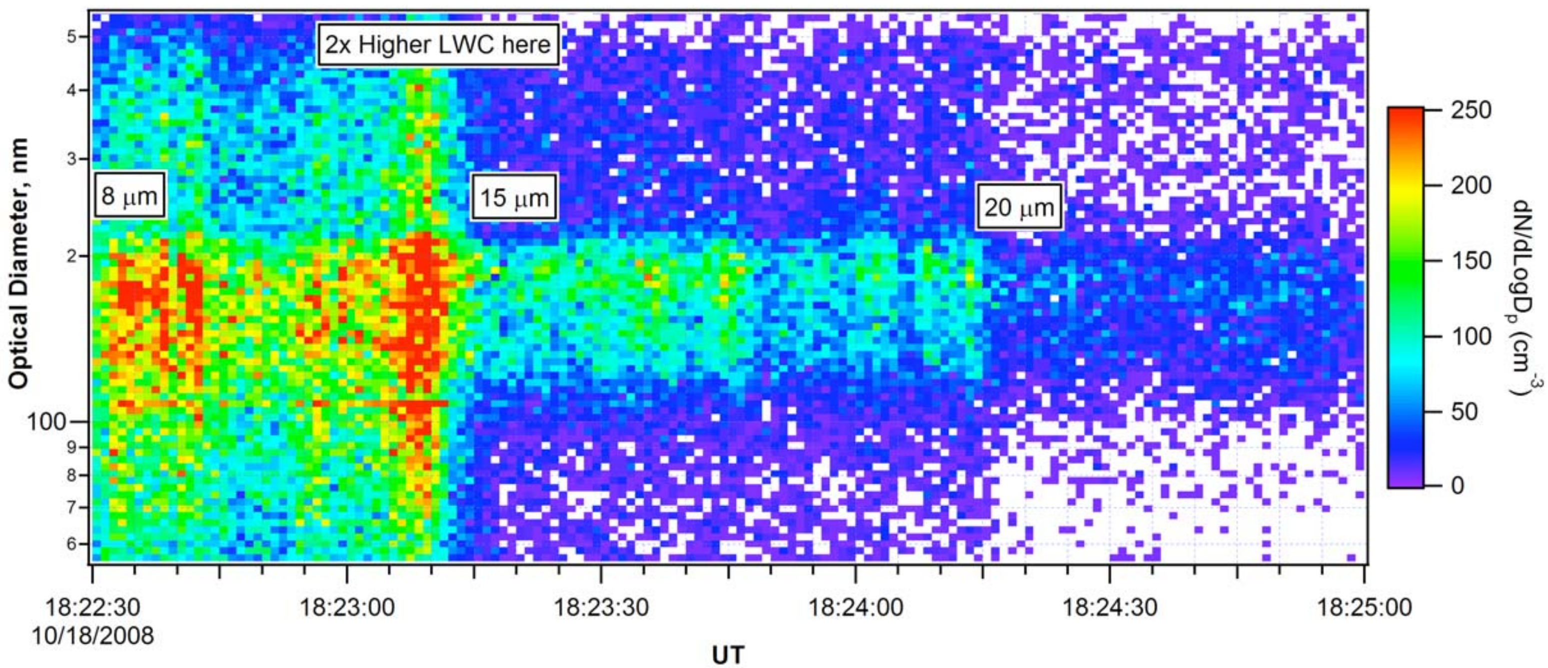


R4 Inbound (71 W near Arica)
Total below cld CN ~700 cm^{-3}
~650 cm^{-3} are > 55 nm



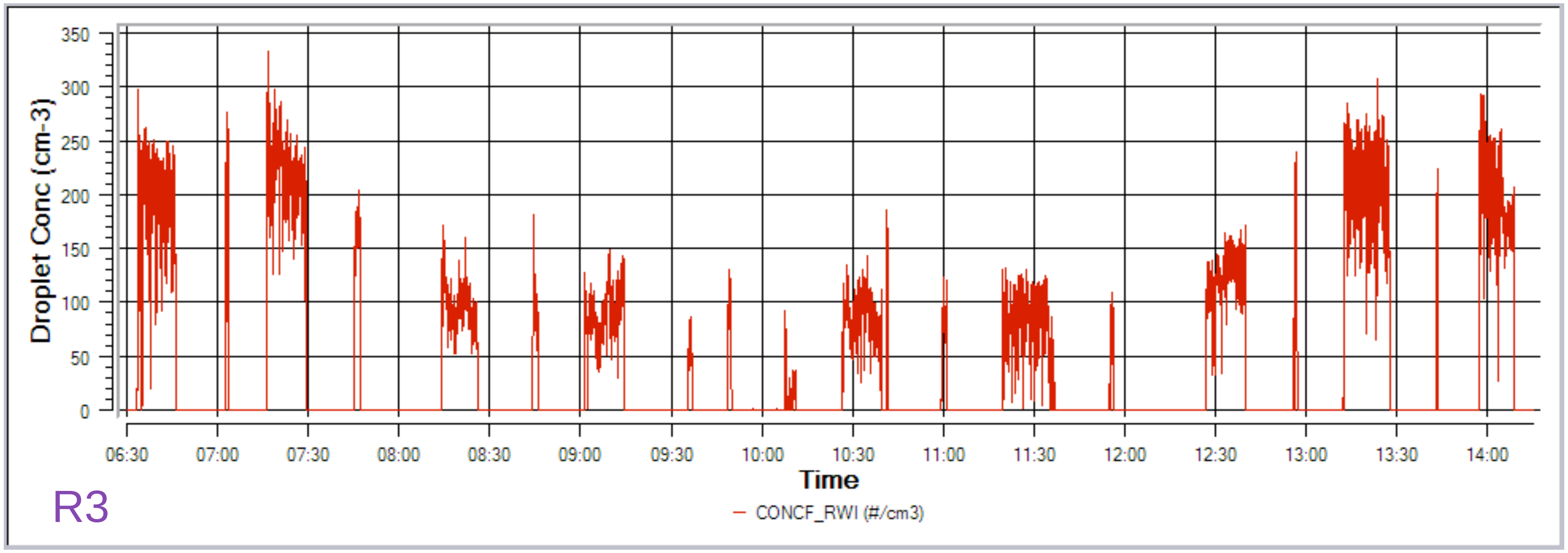
Additional pollution probably reason for larger residual sizes on inbound leg.
Despite >2x more particles > 55 nm, only 30% more droplets inbound—
Not all large pollution particles are activating in this case.

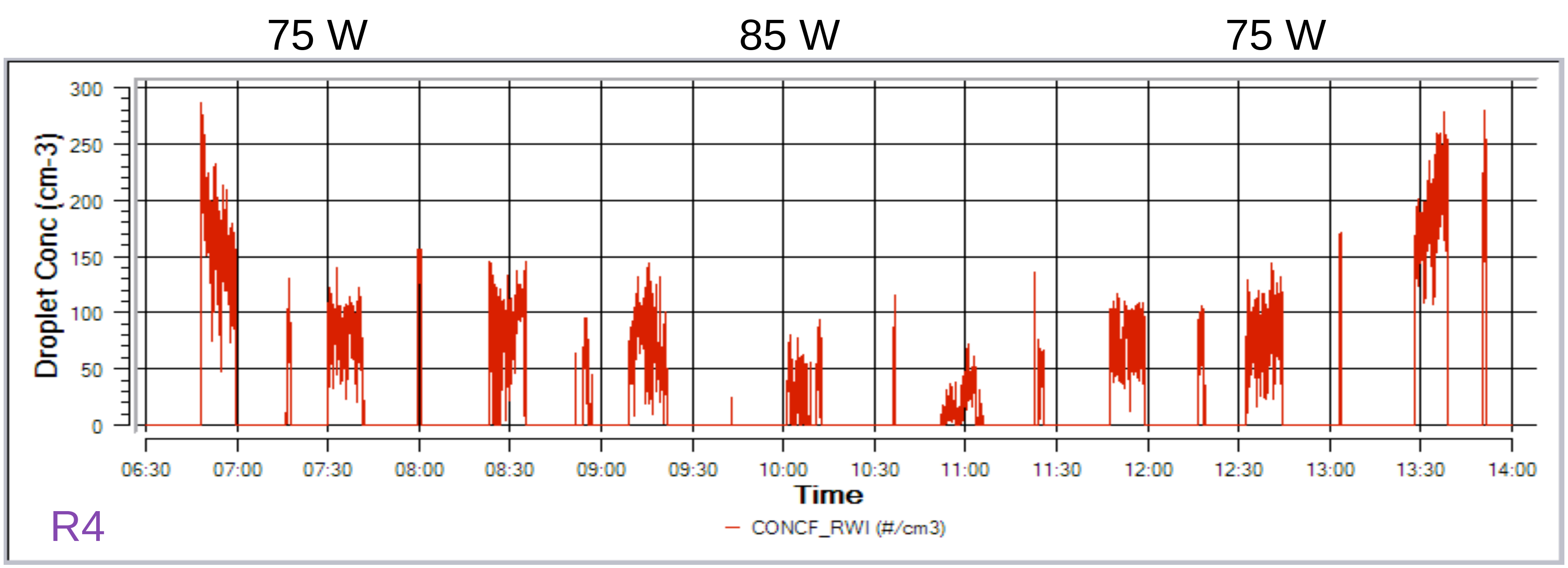
So, Size does matter.
But, R2 does not seem to follow the pattern



A little mystery: In this case, largest drops have ~ equal proportions of large and small nuclei. Less hygroscopic particles? Inhomogeneous mixing? Need to combine with chemical data

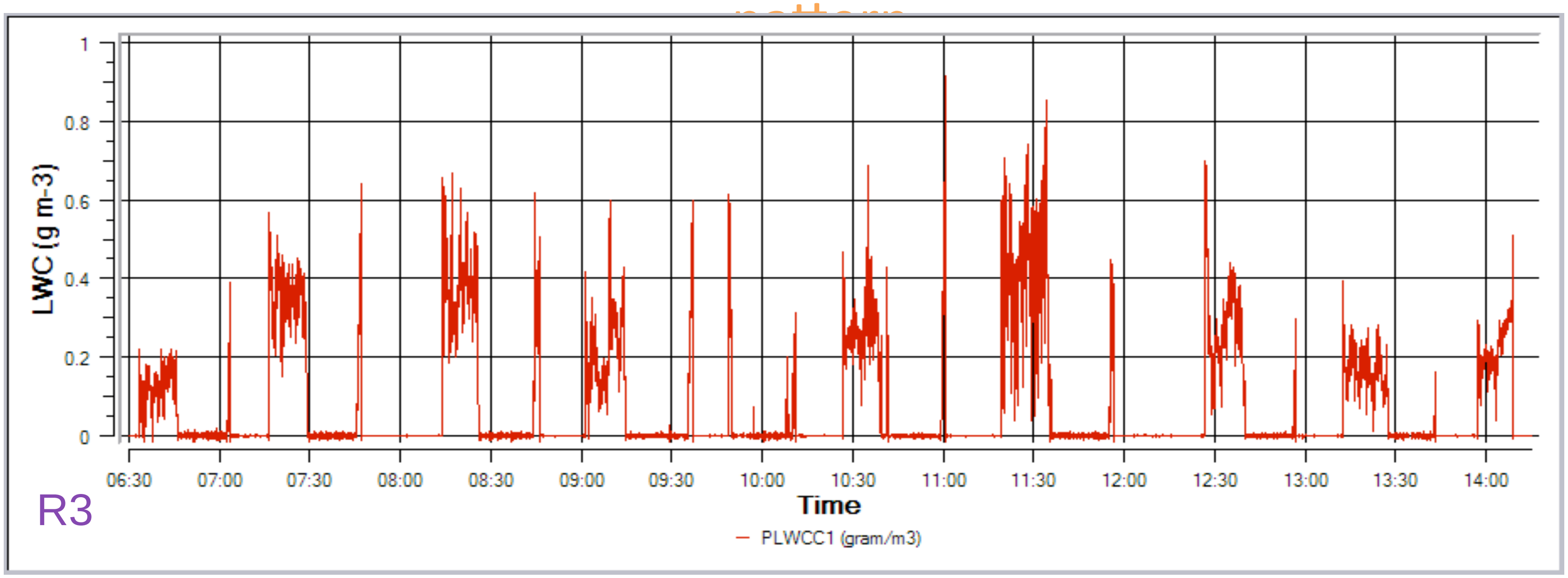
R3 & 4, 20°S Overview: Increased aerosol clearly affects N_d



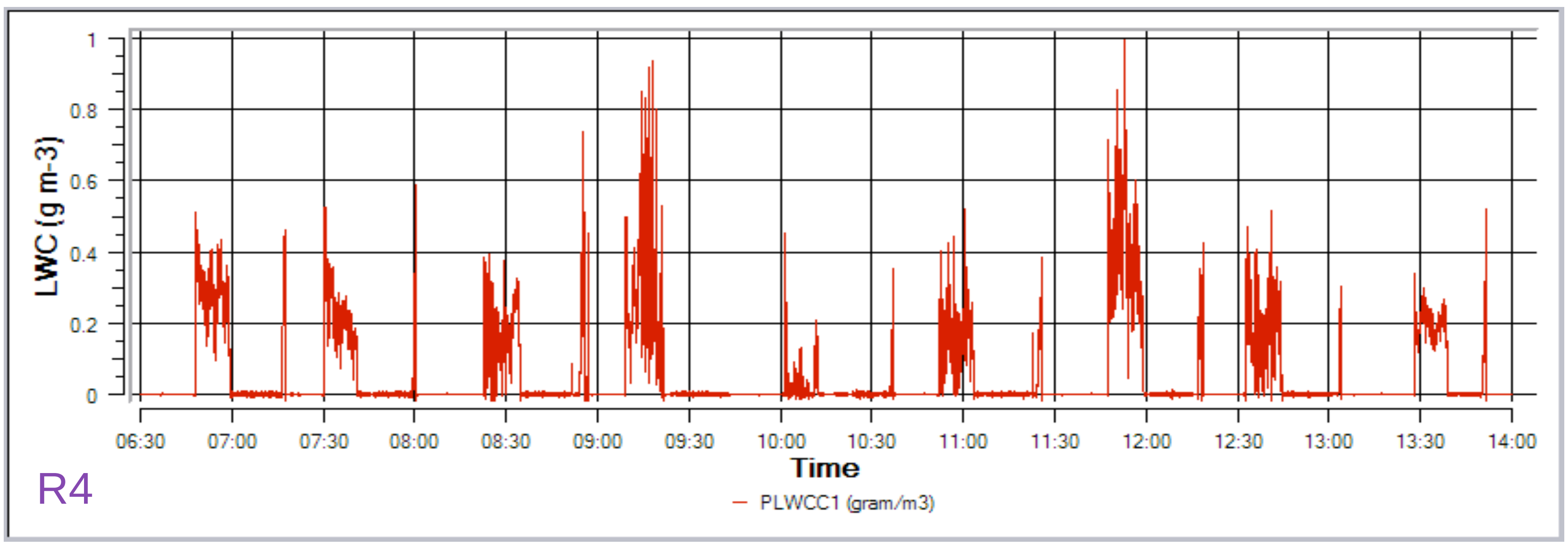


Droplet effective radius is typically ~30% smaller near shore

R3 & 4, 20°S Overview: LWC (LWP) not constant, does not follow pattern



75 W 85 W 75 W

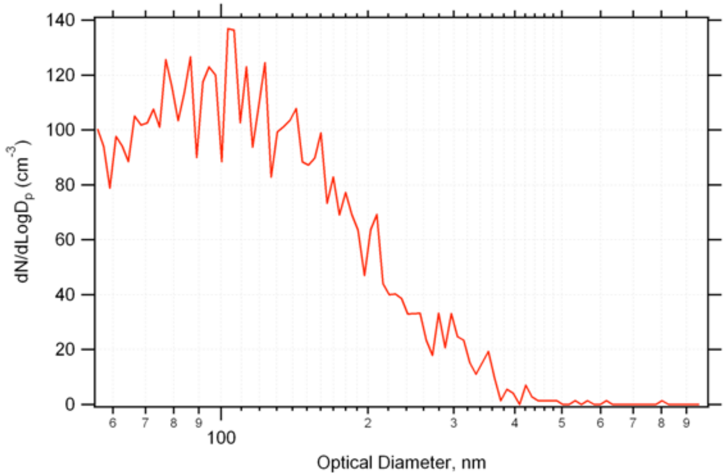


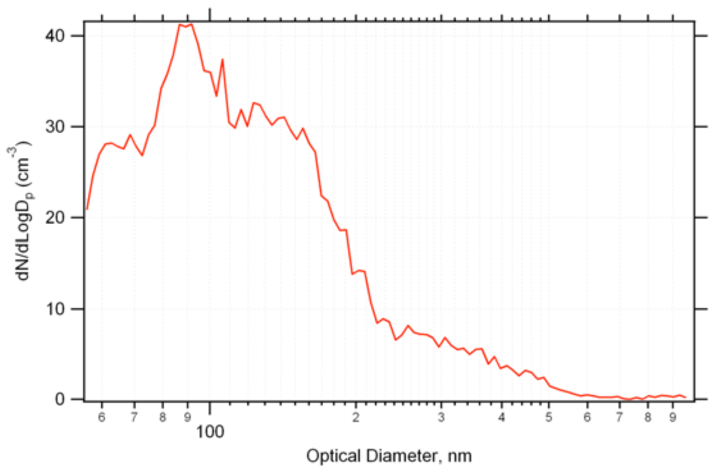
Optical thickness $\tau^* \approx (3LWP)/(2\rho_w r_e)$

LWP changes may swamp droplet radius changes, which are smaller

Clean (R4) Size Distributions

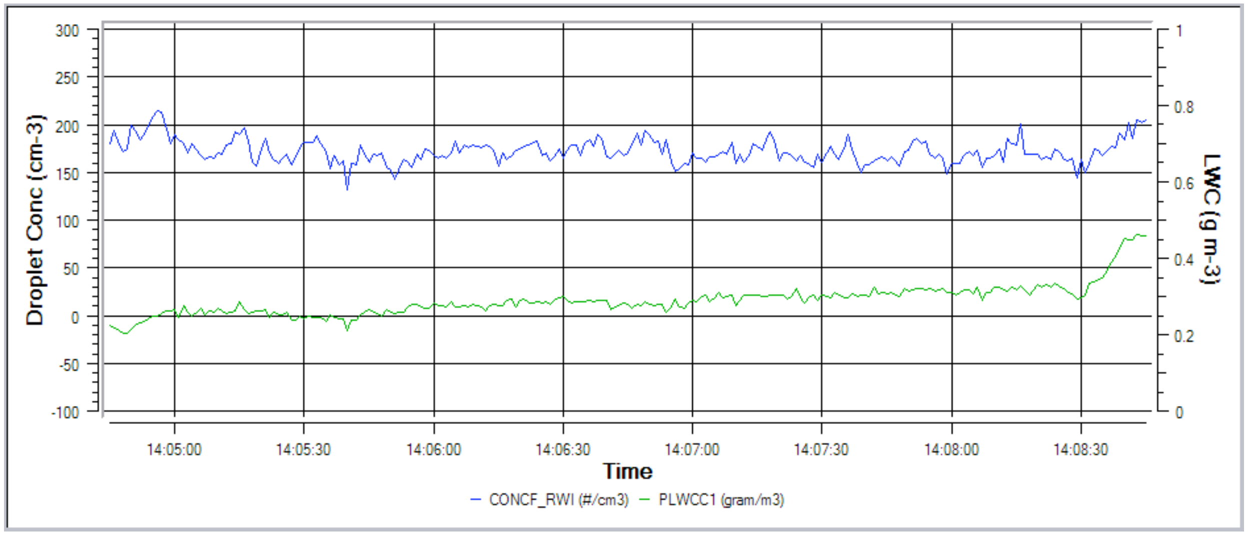
Clean Cloud Case: Below Cloud Ambient vs. Droplet Residuals (N_d~40 cm^{-3})





Clean CVI residuals do not seem to show as much shift in size as polluted distributions. May be indicative of increased and different (inhomogeneous) mixing processes

Extra Stuff



R3 Inbound (t+6.5 hr)

N_{drop}= 178 cm^{-3}

LWC~ 0.29 g m^{-3}

D_{drop} ~ 13.3 μm

CN ~500-600 cm^{-3}

R3 Inbound: Below Cloud Ambient vs. Droplet Residuals