

Cloud Observations and Processes in Sea Breeze Induced Convection over South-West Saudi Arabia

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Motivation

The Saudi Aerosol-Cloud-Precipitation Enhancement Campaign (SARPEC) overall objective is to obtain observations that assist in the determining effectiveness of cloud seeding techniques used for rainfall augmentation within the Kingdom of Saudi Arabia. Cloud observations are obtained at the -10 °C, -15 °C, and -20 °C levels as clouds develop and grow vertically.

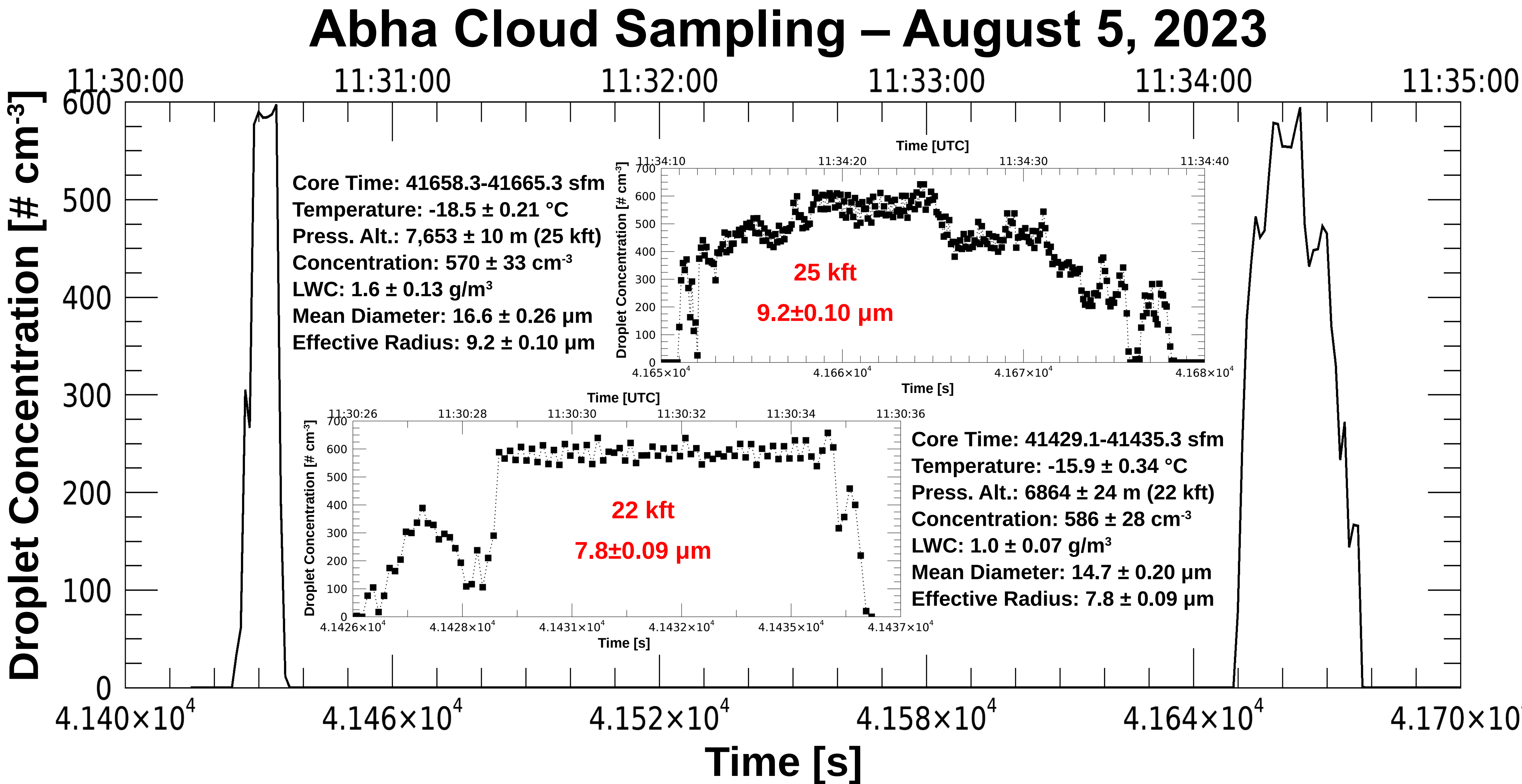
Data Set

The first SARPEC intensive operational period (IOP1) occurred in the 2023 summer, concurrent with the Asir mountain/escarpment seasonal monsoon in south-west, Saudi Arabia. Five cloud physics missions occurred from 5 August 2023 to 16 August 2023. In-situ measurements of cloud microphysics properties are obtained using the North Dakota Citation Research Aircraft.



Image showing the aircraft instruments deployed on the North Dakota Citation Research Aircraft, which included a Cloud Droplet Probe (CDP).

Observations

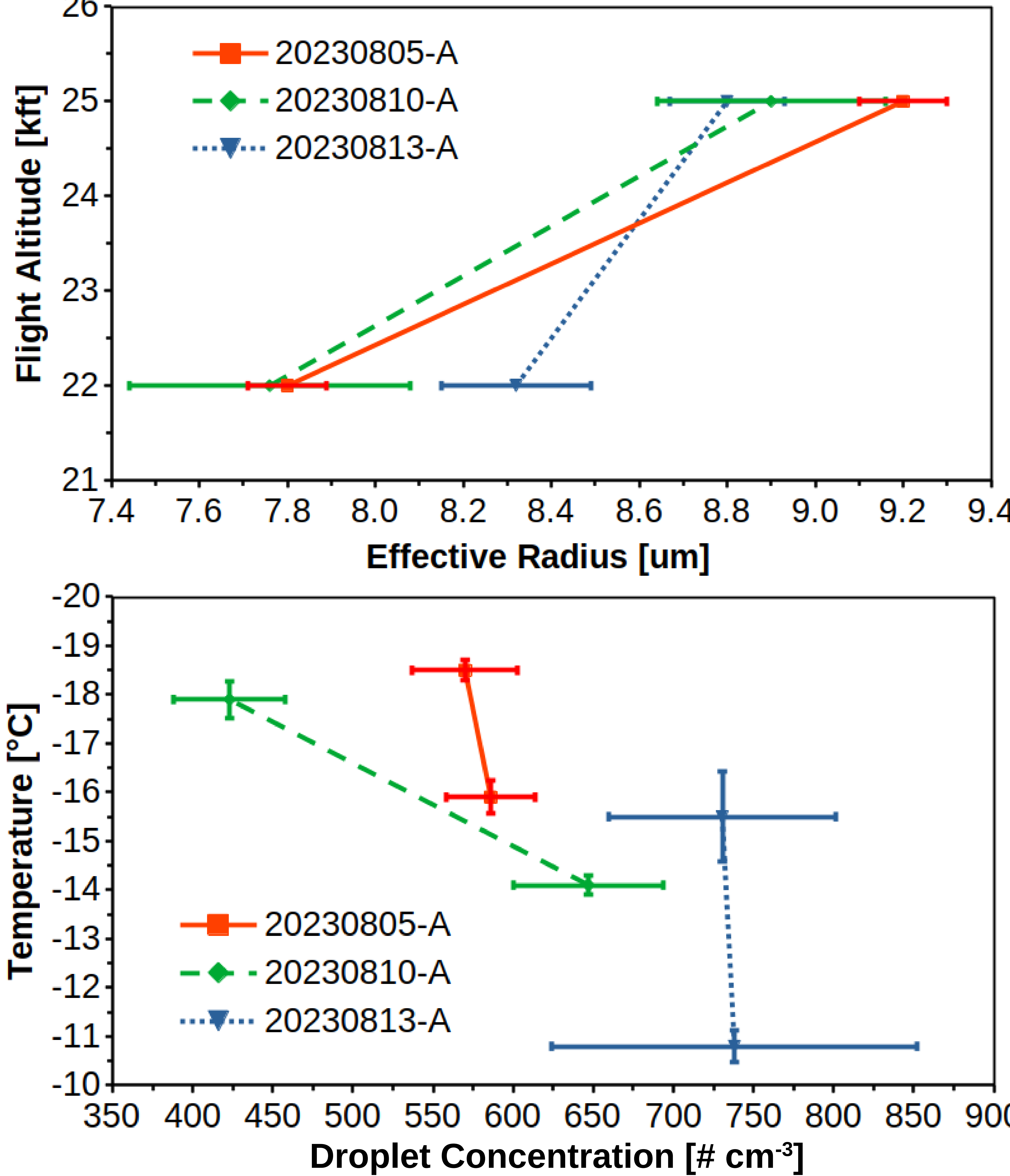


Plots showing the cloud droplet probe (CDP), 1 Hz measurements at two altitude of the same developing cumulus clouds, along with 10 Hz inserts for each flight level sampled.

Cloud	Cloud Core Time Altitude Concentration			Flight	Temperature		Concentration		Effective Radius	
ID	Start	End	Total	Height	Mean	STD	Mean	STD	Mean	STD
Date-Cloud	SFM	SFM	s	kft	°C	°C	# cm ⁻³	# cm ⁻³	μm	μm
20230805-A	41429.1	41435.3	6.2	22	-15.9	0.34	586	28	7.8	0.09
20230805-A	41658.3	41665.3	7.0	25	-18.5	0.21	570	33	9.2	0.10
20230810-A	41429.1	41435.3	6.2	22	-14.1	0.19	647	47	7.8	0.32
20230810-A	41658.3	41665.3	7.0	25	-17.9	0.37	423	35	8.9	0.26
20230810-A	46526.0	46526.7	0.7	28	-29.2	0.30	221	18	9.2	0.22
20230813-A	42072.2	42079.6	7.4	22	-10.8	0.32	738	114	8.3	0.17
20230813-A	42380.3	42385.6	5.3	25	-15.5	0.92	731	71	8.8	0.13
20230813-A	43250.6	43255.7	5.1	29	-24.0	0.60	392	41	9.0	0.33
20230814-A	44038.5	44048.5	10.0	25	-15.3	1.50	692	98	10.7	0.18
20230814-B	44408.9	44417.1	8.2	25	-21.3	0.33	438	52	8.3	0.17

Table showing convective core information for cloud sampled during the SARPEC summer IOP. All clouds were seedable targets; however, only the second pass on 20230814-B was a seeded cloud.

Results



Plots showing effective radius and concentration vertical change.

Conclusions and Future Work

- Two cloud cores have increased droplet effective with altitude and similar concentrations, which indicates a lack of droplet coalescence in parcel’s updraft.
- Similar analysis will be conducted for measurements obtained in the central region of Saudi Arabia during IOP2 and IOP3.