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

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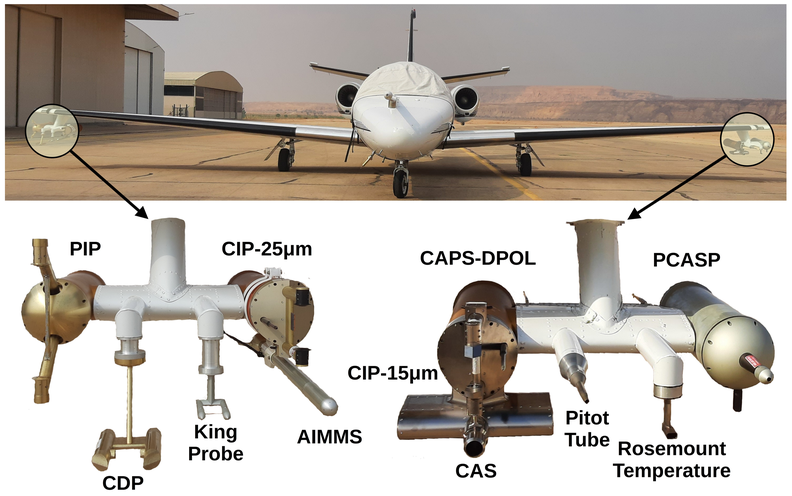
Motivation

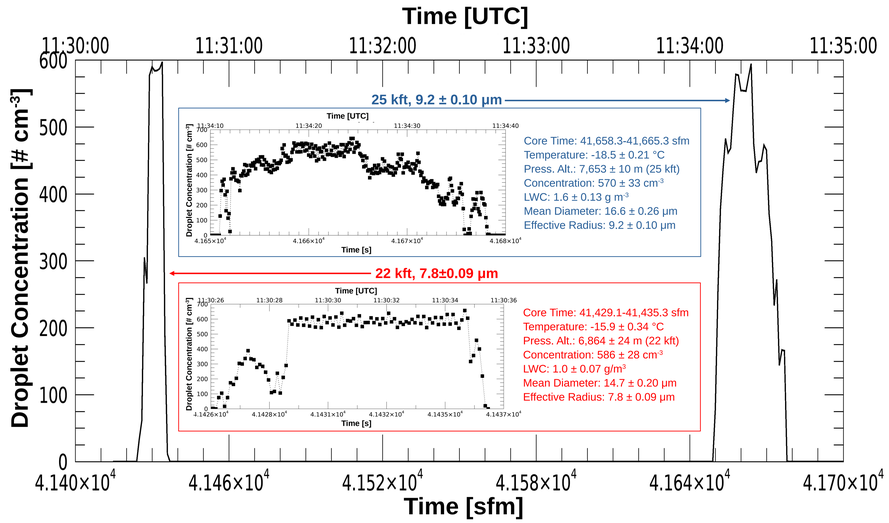
The Saudi Aerosol-Cloud-Precipitation Enhancement Campaign (SARPEC) overall objective is to obtain observation that assist in determining the effectiveness of cloud seeding techniques used for rainfall augmentation within the Kingdom of Saudi Arabia. Cloud observations are obtained at the -10 °C, -15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

Data Set

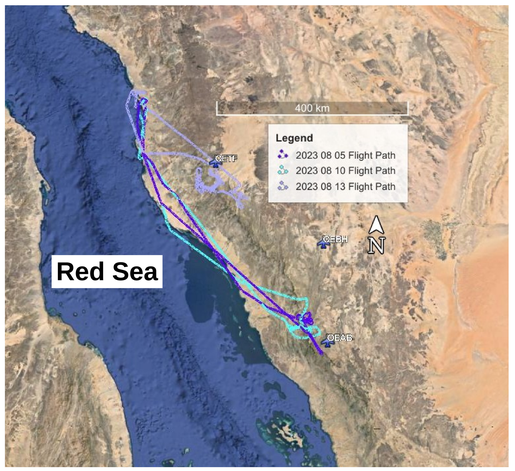


The first SARPEC intensive operational period (IOP1) occurred in the 2023 summer, concurrent with the Asir mountain/escarpment seasonal monsoon in south-west, Saudi Arabia. In-situ measurements of cloud microphysics properties are obtained using the North Dakota Citation Research Aircraft, which included a Precipitation Imaging Probe (PIP), Cloud Droplet Probe (CDP), King Hot-wire Liquid Water Content Probe (King Probe), a Cloud Imaging Probe with 25 µm diodes (CIP-25µm), an Aircraft Integrated Meteorological Measurement System (AIMMS), a Cloud, Aerosol, a Precipitation Spectrometer with Depolarization (CAPS-DPOL) that contains a Cloud and Aerosol Spectrometer (CAS) and a Cloud Imaging Probe with 15 µm diodes (CIP-15µm), a pitot tube for measuring air speed, an aircraft total temperature probe (Rosemount Temperature) and a Passive Cavity Aerosol Spectrometer Probe (PCASP).

Observations

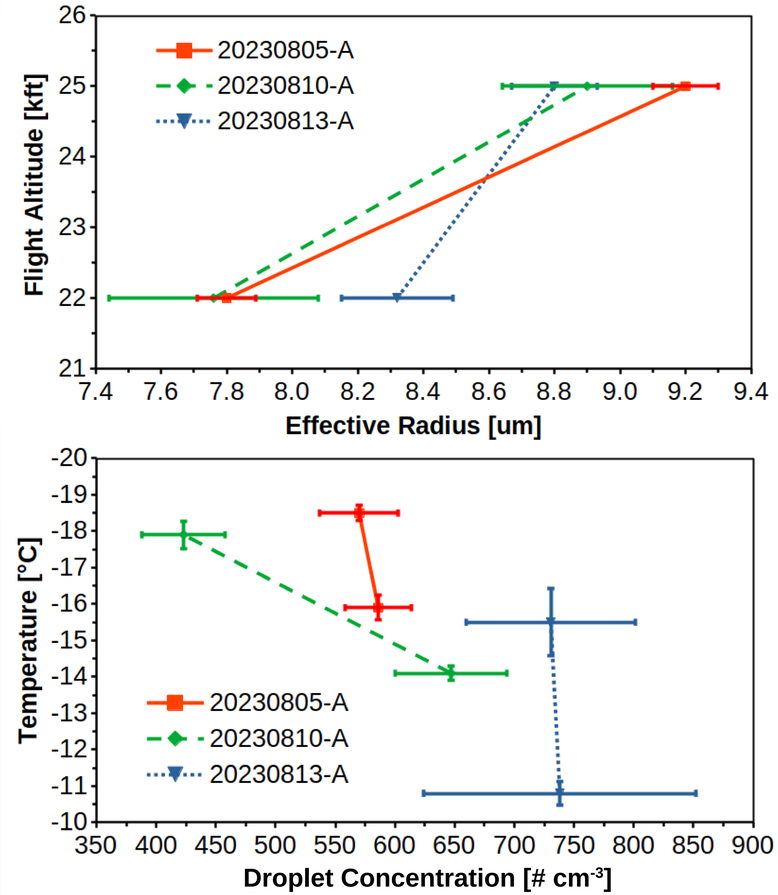


Time series plots showing sampling of the convective core at two altitudes on 5 August 2023. Measurements are from the cloud droplet probe (CDP) averaged to 1 Hz, along with 10 Hz inserts showing core sampling at 22 and 25 kft. Core sampling statistics are given for the time period where CDP droplet concentration is the highest and relatively constant.



Google Earth image showing three flight tracks where a cloud was sampled at different altitudes. The sampled convective clouds developed due to an afternoon sea-breeze bring high relative humidity air from the Red Sea up the escarpment. The convective clouds form just east of the escarpment peak. High level winds typically titled developed clouds back towards the Red Sea at higher altitudes.

Results



Plots showing effective radius and concentration vertical change.

Conclusions and Future Work

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