Aerosol and cloud microphysical measurements in Istanbul Turkey

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The PAPRICA project - Introduction

The Precipitation Augmentation Program and Research on Istanbul Clouds and Aerosols (PAPRICA) is aimed to study and analyze the potential benefits of weather modification in the area of Istanbul. The project is expected to provide a broad perspective on the feasibility and the effectiveness of weather modification as well as provide additional data for studying other atmospheric phenomena that are of high scientific research value such as regional global warming effects, heat island effects, aerosol loading and trace gas chemistry. This work is being conducted and coordinated by Seeding Operations and Atmospheric Research (SOAR) with the scientific support of the National Center for Atmospheric Research (NCAR) and Texas A&M University (TAMU). Istanbul Technical University (ITU) and the Disaster Coordination Center (AKOM) are also involved in the conduct of the PAPRICA project.

Instrumented Platform Description

The SOAR Cheyenne II is equipped with the Differential Mobility Analyzer (DMA, 0.01µm to 0.5µm), the Passive Cavity Aerosol Spectrometer Probe (PCASP, 0.1µm to 3µm), the Cloud Droplet Probe (CDP, 2µm to 50µm), the Cloud Imaging Probe (CIP, 25µm to 1500µm), the Liquid Water Content (LWC) probe, the Cloud Condensation Nucleus (CCN) counter, the AIMMS air data probe and trace gas analyzers. This range of instruments gives the scientists a spectrum of measurements in the temporarily suspended aerosol range and in the cloud hydrometeor range.


SOAR Piper Cheyenne II research aircraft


Left: AIMMS & PCASP

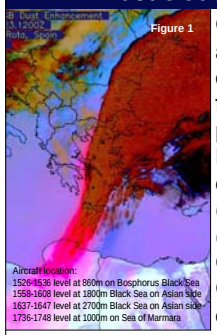

Right: CIP & CDP


CCN counter

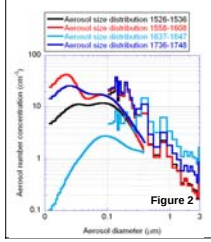

DMA instrument

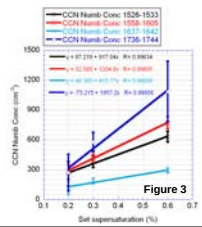
Figures on the left show the CCN counter and DMA as installed in the aircraft.

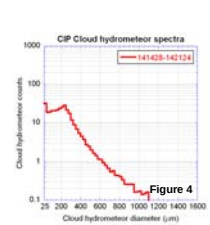
Dust cloud interactions over Istanbul



On the 23rd March 2008 the research aircraft measured dust aerosol and cloud over the Black Sea. The cloud extended from Libya to Turkey with Sahara dust plume from Libya (pink in Figure 1). Figure 2 shows the aerosol size distribution with the tail of the distribution (>1µm) indicative of dust above 2km (1637-1647, 1736-1748). Corresponding CCN distributions are shown in Figure 3. CIP spectra at cloud base at an altitude of 3650m is shown in Figure 4.







In situ aircraft validation of satellite retrieved cloud properties

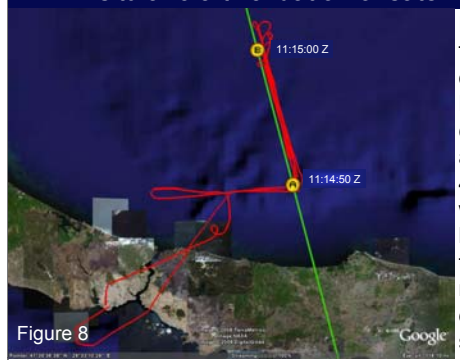
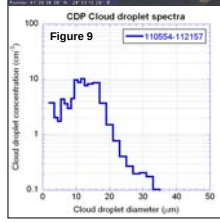
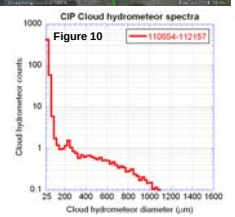


Figure 8 shows the research aircraft flight track (red) and the CloudSat overpass track (green) on the 21st March 2008. The aircraft conducted cloud penetrations 300m below the altostratus cloud top at an altitude of 4500m. The aircraft measurements were made on the satellite overpass heading between point A and point B at the satellite overpass time. In-cloud measurements of the cloud droplet size distribution and the cloud hydrometeor size distribution during the CloudSat overpass time are shown. The objective of these measurements is to better explain regional variations of precipitation, clouds and aerosols.

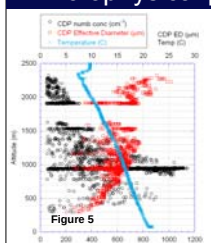
Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) is equipped with an active lidar instrument with passive infrared and visible imagers.

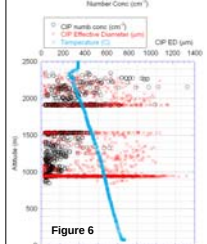
CLOUDSAT is equipped with a Cloud Profiling Radar (CPR)

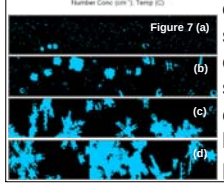




Microphysical properties of precipitating clouds

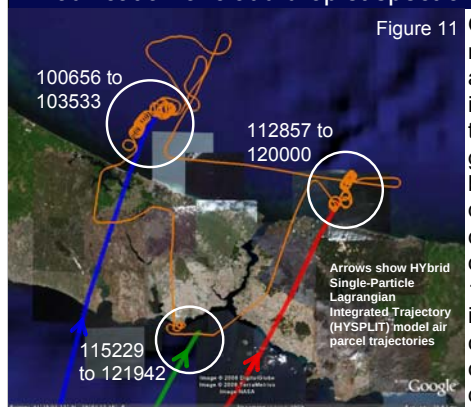






On 13th February 2008 the SOAR research aircraft flew in cloud north of Lake Terkos. Figure 5 shows the measured cloud droplets through the embedded convection with droplet concentrations reaching 900cm^{-3} at cloud base. Since the cloud base to cloud top temperatures ranged from 1.2ºC to -12.7ºC, most of the cloud droplets were supercooled. Cloud droplet concentrations decreased from a maximum of 1100cm^{-3} to less then 200cm^{-3} in a cloud depth of 1256m. The CIP plot (Figure 6) shows that large concentrations of large cloud hydrometeors are present at a temperature of -9.8ºC. Figure 7 identifies these hydrometeors as having a variety of habits ranging from supercooled droplets (a), graupel mixed with supercooled droplets (b), dendritic crystals (c), and snow (d). These data show that riming is present, where ice crystal and drop collisions produce larger ice crystals or snow that precipitate.

Modification of cloud droplet spectra in the Istanbul pollution plume



On the 20th March 2008 the SOAR research aircraft conducted cloud and aerosol measurements in areas identified in Figure 11. The orange track is the aircraft track and the blue, green and red arrows are HYSPILT back trajectories. The aerosol size distribution, the CCN number concentration and the cloud droplet distribution are shown. The 112857-113857 (red) aerosol size distribution is polluted by downtown Istanbul causing an increase in the CCN concentration and a narrowing of the drop size distribution (Figure 12, red).