National Aeronautics and Space Administration

A STUDY OF OZONE AT RAILROAD VALLEY, NV and TRINIDAD HEAD, CA

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Abstract

Ozone is an air pollutant and toxic in the lowest part of the atmosphere, and inhaling it could cause permanent damage to animals' respiratory system. Long term exposure to high concentrations of O_3 has been linked with the development of asthma in children. Because of its complicated role in our atmosphere, scientists are studying its depletion and recovery in the stratosphere, and the minimization of ozone formation in the boundary layer (the lowest part of the atmosphere). Here at NASA Ames Research Center (ARC), the Atmospheric Branch of Earth Science Division is conducting a study to examine and compare ozone concentrations in the atmosphere boundary layer (0 to ~ 2 km above the surface of the Earth) to those of the free troposphere (~2 km to ~10 km, where the regional transport occurs), and to validate the accuracy of the ozone instrument used in the experiment. Using a 2BTechnology, Inc., Dual Beam Ozone Monitor installed inside the wing pod of an Alpha jet aircraft based at Moffett Field, California, vertical profiles of O_3 concentrations have been collected at Trinidad Head (THD), California, and Railroad Valley (RRV), Nevada. The airborne data at THD are also compared to standard measurements collected by the National Atmospheric and Oceanic Administration (NOAA) using a balloonborne DMT Electrochemical Concentration Cell Ozonesonde. My area of research is to support the calibration of the O_3 instrument, to aggregate the ozone measurements, and to analyze the data collected.

The Atmospheric Boundary Layer

The atmospheric boundary layer (ABL) is the mixed layer of the atmosphere closest to the ground, where people live, work, and play. As such, it has significant influence on a number of important atmospheric and environmental issues. Fig. 1.

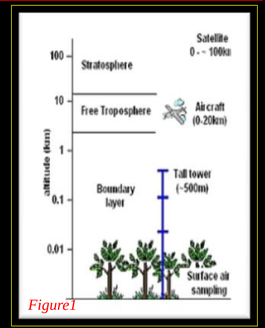

Figure1

Why Railroad Valley?

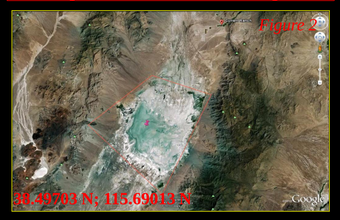

Figure 2

RRV is a dry lake bed (playa), flat desert site with virtually no vegetation. It is a target site for calibration of various satellite radiometers. Figure 2.

Why Trinidad Head?

Figure 3

THD is an important site to observe both regional and global influences. There is insignificant anthropogenic influence. Figure 3.

Instrumentation

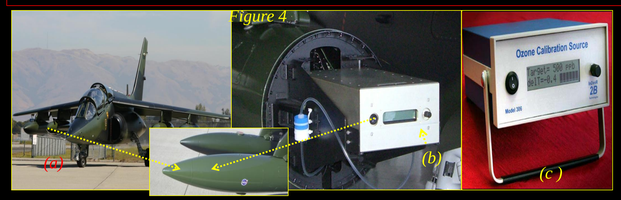

Figure 4

The Alpha Jet (fig. 4a) made a downward spiral from 25,000 ft (msl) to 500 ft above ground level with a radius of approximately 3 miles. The spiral took approximately 20 minutes. The O_3 sensor (fig. 4b) was aboard the aircraft. O_3 calibration source (fig. 4c).

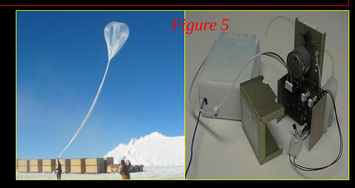

Figure 5

Ozonesonde is launched on a lightweight balloon that is mated to a conventional meteorological radiosonde. It transmits information on O_3 to a ground receiving station. It ascends to altitudes of about 115,000 ft (35 km) before it bursts. Figure 5.

Data Comparison

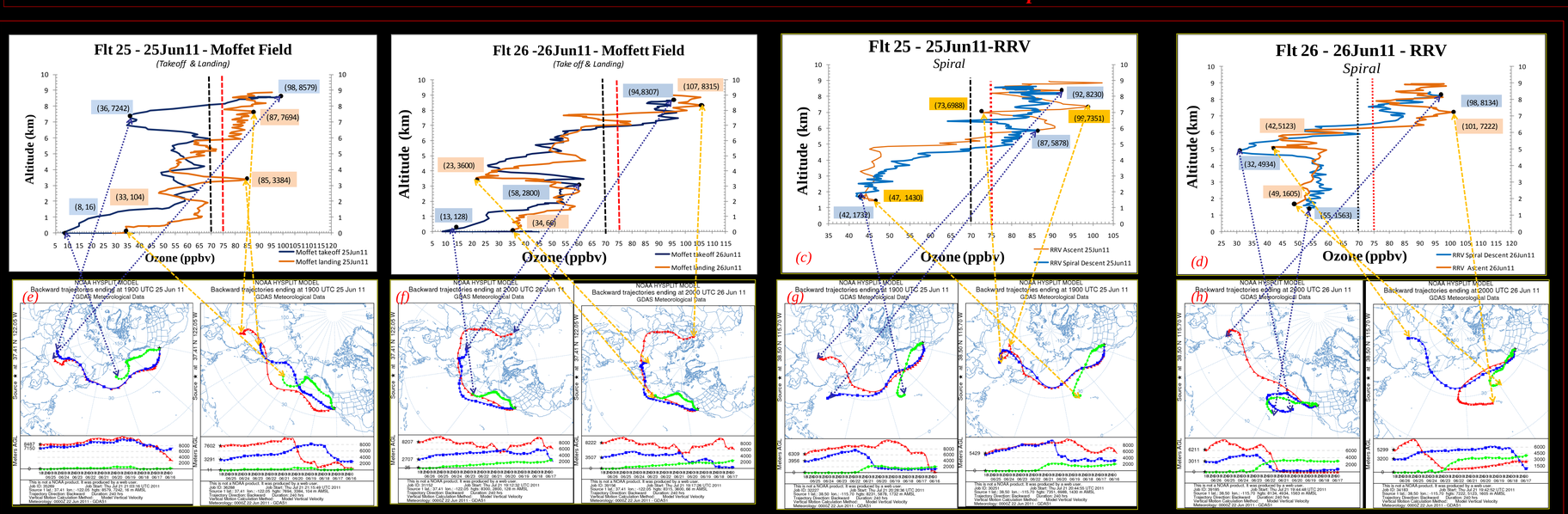

Figure 6. (a), (b), (c), & (d) show the O_3 values measured during the spiral descent (blue) of the Alpha jet. The vertical lines (CA – black , and NV & Federal – red) on the graph represent pollutant standards which define the levels of exposure to O_3 that is considered relatively safe for an average person in good health. Using Hybrid Single Particle Lagrangian Integrated Trajectory Model (HYSPLIT), (e), (f), (g), & (h) show a ten-day backward trajectory of global air source coming from Asia to North America. The coordinates on each graph are correlated to the trajectory map by arrows drawn on each figure.

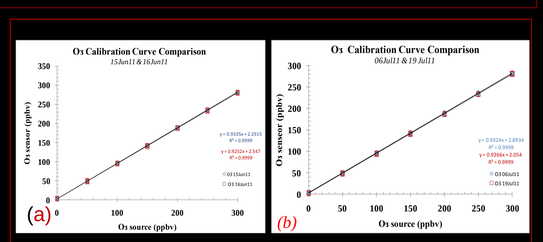

Figure 7. (a) & (b) show the linear relationship between the O_3 sensor (y-axis) and O_3 calibrations source (x-axis). The slope indicates a linear response of the sensor.

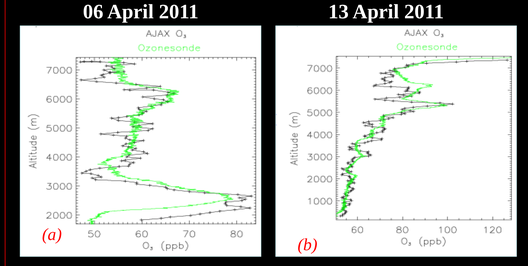

Figure 7. (a) & (b) show a robust measuring capability between the Ozonesonde and O_3 sensor. The variability can be impacted by the wind direction. Figure 7a shows that ABL (~2 - ~3km), O_3 reaches 80 ppbv at some points. Figure 7b shows O_3 mixing ratio is at its highest at the free troposphere (~5 – 7 km).

Results

O_3 minimum and maximum mixing ratio (taken from 25Jun11 & 26Jun11 flight):
>ABL : 8 ppbv & 68 ppbv.
➢Free Troposphere: 21 ppbv & 115 ppbv.

> That the higher the altitude, the higher the O_3 mixing ratio.
>Figure 6 suggests that higher O_3 mixing ratio is associated with higher altitude originates mainly from China. Further study is suggested.

HYSPLIT Trajectories show air in the:
>ABL originates from the Pacific Ocean.
>Free Troposphere originates mainly from China.
>ABL often had been in the free troposphere during the previous 10 days.

Future work

>RRV 2012 field deployment and observations are to be made on an annual basis.
>More test flights for Alpha jet at RRV, THD , & Bay Area coast.
>Regular O_3 sensor calibration.

Acknowledgement

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