

AIRBORNE OBSERVATIONS OF TRACE CHEMICAL SPECIES DURING T-REX.

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Abstract: Secondary initiatives for T-REX concerned the chemical and dynamical structure of the boundary layer in the valley under unperturbed conditions. The FAAM BAe 146 aircraft made several dedicated flights over the Sierra Nevada range and the Owens Valley under rotor, gravity wave and quiescent conditions in order to observe profiles and vertical exchange of trace chemical species. Extended Observation Period 02 (EOP02) a strong inversion was observed in association with an intense cold pool which formed overnight in the Owens Valley. At the top of the inversion a significantly elevated layer of ozone was seen coupled to low carbon monoxide. This paper focuses on characterising the vertical profiles of chemical species and physical parameters and will attempt to interpret these profiles in terms of advection on the valley, gravity wave and larger scale flows.

Keywords: T-REX, trace chemicals, cold pools, dynamics.

1. INTRODUCTION

The Terrain Induced Rotor Experiment (T-REX) based in the Owens Valley in California intended to observe the structure and evolution of atmospheric rotors, secondary initiatives for T-REX concerned the chemical and dynamical structure of the boundary layer in the valley under unperturbed (calm) conditions. The FAAM BAe 146 aircraft (from here on referred to as 'the Aircraft') made dedicated flights over the Sierra Nevada range and the Owens Valley under rotor and gravity wave conditions in order to observe profiles and vertical exchange of trace chemical species. Extended Observation Period 02 (EOP02) a strong inversion was observed in association with an intense cold pool which formed overnight in the Owens Valley. At the inversion a significantly elevated layer of ozone was seen coupled to low carbon monoxide, both indicative of air which has descended from aloft. The effect of the inversion is examined by inter comparison with a similar cold pool flight, EOP01, which did not have an inversion. A similar sortie was flown and increased levels of ozone were not seen within the Owens Valley. The ozone maximum during EOP02 raises the question of how this high ozone concentration air is maintained below the inversion

We look at this case in detail from a dynamical and chemical point of view. Back trajectory and proposed chemical modelling should give some insight into the dynamical and chemical mechanisms at work during this period.

2. RESULTS

Figure 1 shows the inversion which is approximately 7K in magnitude, at 3300m a.s.l. Coupled to this and shown in Figure 2 is the increased ozone concentration also seen around 3300m a.s.l, an increase of nearly 25 ppbv over a small altitude is observed in the Owens Valley. The Central Valley, situated to the west of Owens Valley, profiles (not shown) show similar characteristics but to a lesser extent, the inversion is only seen to be 4K at the start and end of the EOP 02 sortie. It is thought that the inversion has formed overnight, and is sustained and even strengthens over the day within the Owens Valley.

Figure 1 and 2 show the vertical variability of the chemical structure of the Owens Valley on this day, horizontal features were also observed during the two cold pool sorties as the aircraft flew north-south transects in the Owens valley. These flight legs show variations in the chemical and dynamical structure of the atmosphere. Dynamical properties indicate that the top of the boundary layer in the Owens Valley changes over the north-south legs made by the Aircraft. At both the northern and southern ends of the flight legs the inversion is higher, than compared with the middle of the leg. It is not understood why the height of the inversion varies over this scale. Inversions are regions of reduced vertical mixing, which leads to the question as to how the concentration of photochemically produced Ozone is sustained in this region throughout the day.

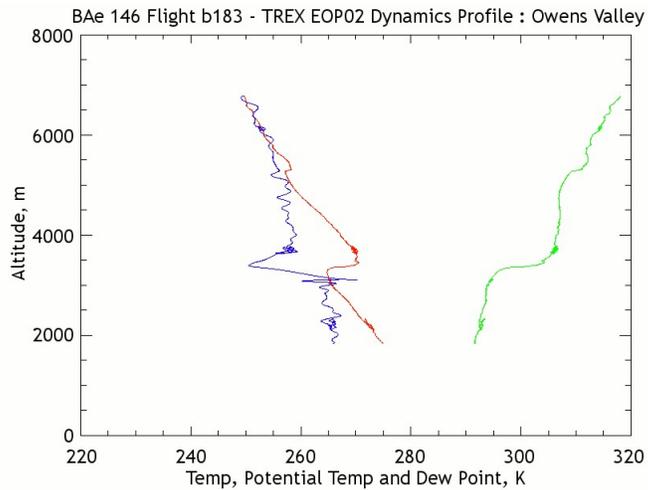


Figure 1: Dynamical profiles from the Aircraft, temperature (red line) shows the inversion at approximately 3300m a.s.l., dew point (blue line) in the region of the inversion is reduced. Potential temperature shows (plotted in green) that the inversion region is a stratified layer.

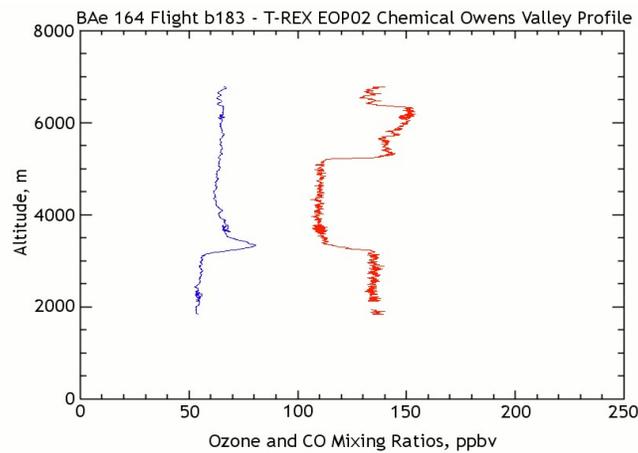


Figure 2: Ozone concentration in ppbv from the Aircraft data, plotted as a profile with altitude within the Owens Valley. The Ozone increase can be seen at approximately 3300m a.s.l. This peak in ozone is coupled to a decrease in CO concentration and the temperature inversion in Figure 1

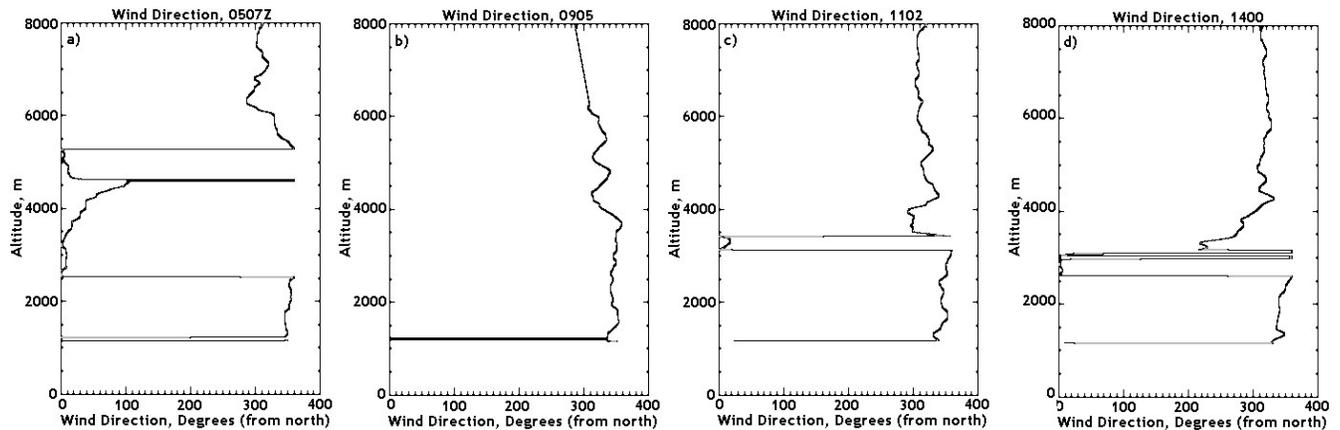


Figure 3: Wind Direction profiles. A series of four radiosonde ascents from Independence Airport, CA during IOP03. Plotted against altitude is wind direction. Development of southerly wind direction : can be seen at 3000m throughout the four profiles.

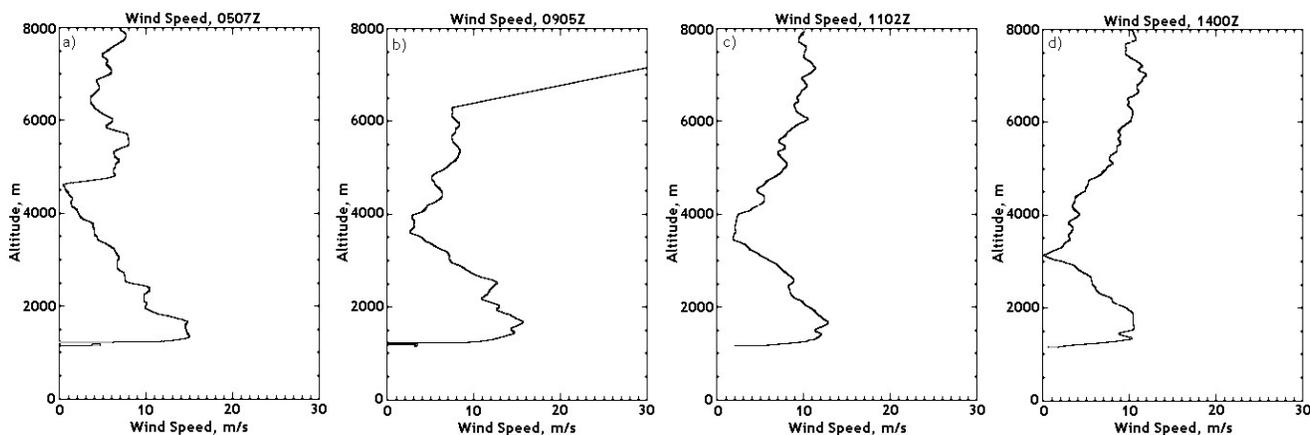


Figure 4: Wind Speed Profiles. A series of four radiosonde ascents from Independence Airport, CA during IOP03. Plotted against altitude is wind speed.. Wind speed drops from 7m/s to 1m/s in the inversion.

Temporal evolution of the dynamics in the Owens Valley during this period can be seen in Figure 3 and 4, which show radiosonde ascents from the town of Independence, CA. Southerly flow develops aloft in Figures 3c and 3d, although this is coupled with a very low wind speed (Figure 3c and 3d) and so may not be a significant direction change just a slackening of the winds at this altitude.

3. CONCLUSIONS

This case is a good example of a well developed cold pool event in the Owens Valley. In this case (EOP02) a strong inversion is observed with an increased concentration of ozone in the same region as the inversion. The concentrations of ozone and carbon monoxide are indicative of large scale descent of an airmass. This ozone peak is only observed in the thin inversion layer and inversions are regions of reduced vertical mixing as the atmosphere becomes stably stratified, which raises the question of where the high concentration of ozone has come from.

4. FUTURE WORK

Examination of this case has raised the question of how the inversion sustains the observed concentration of ozone. 1D chemical modeling could lead to insight of the possible mechanisms involved.

Surface data from a network of automatic weather stations is to be used to look at the dynamics of the lower boundary layer, before and during this event. It is possible to detect coherent structures in weather stations (Hauf et al., 1996)

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5. REFERENCES

Hauf, T., U., Fink, J., Neisser, G., Bull, and J.-G Stangenberg, 1996. A Ground-Based Network for Atmospheric Pressure Fluctuations. *Journal of Atmospheric and Oceanic Technology*. 13, 1001-1023.