1. Introduction

In an analysis of synoptic structures associated with high one hour and eight hour ozone in the Dallas Ft.Worth (DFW) area it was also found that stationary fronts were associated with the three highest ozone events in the summer of 1999 (HARC Report Project H012.2004.8HRA - McNider et al. 2005). These frontal zones by their very nature are complex in both their winds and thermal settings.

In examining why fronts have been associated with high concentrations in the DFW area and many areas in the South, six hypotheses have been proposed:

(1) Light winds in and near the actual front leads to a zone of poor dilution leading to a build up of precursors and ultimately ozone.
(2) Higher surface temperatures due to light winds enhance thermal decomposition of NO_2 leading to longer chain lengths in ozone production. Additionally, higher temperatures enhance surface biogenic and evaporative hydrocarbon emissions.
(3) Subsidence on the north side of the front inhibits boundary growth and reduces dilution of boundary layer air from mixing from above.
(4) The very nature of a stationary front means that movement of the front back and fourth can lead to short and even circular trajectories leading to a build up of ozone.
(5) Due to the complex trajectories in a frontal zone and ultimate connection of the frontal surface to a tropopause fold the air above the front may be enriched with ozone of stratospheric origin.
(6) Some stationary fronts have deformed flows rather than convergent flows and thus have little lifting and associated cloudiness leading to a productive photochemical environment.

As a result of these hypotheses and the previous findings under SOS a pilot program was developed and proposed to use aircraft during the TEXAQSII to sample in the vicinity of a stationary front if one presented itself. The Baylor Aztec aircraft with ozone, NOy, backscatter along with winds, temperature and pressure was selected to fly the stationary front experiment. On August 21 a stationary front was forecasted to sag near to the DFW area. A flight was planned and carried out to sample across the front and the vertical structure. A similar flight was carried out the following day (August 22) when the front sagged south of DFW. During the flights ozone and NOy distributions were collected along with other chemical and meteorological data.

Three interim reports were filed under this project. The first report (April 1, 2009) provided the basic aircraft data and dealt primarily with the physical atmosphere. It included initial MM5 model results for the flight periods. The second report (May 1, 2009) made comparison to modeled ozone and aircraft observations including cross-section analysis The third interim report (November 20, 2009) addressed two components of the environment during the stationary front flights – (1) an analysis of trajectories near the frontal zone on August 21 and 22, 20006 and (2) an analysis of clouds and photolysis

rates near the frontal zone. These interim reports are included as appendices to this final report.

The purpose of this final report is two-fold first to highlight key results from these detailed interim reports and summarize characteristics of the observed and modeled fronts. It will also address the model and aircraft data in light of the hypotheses above. Second, the report will address the policy implications of stationary fronts in the SIP development process.

2. Description of Aircraft Flights

2.1 Flight Plan and Synoptic Analysis

A flight plan was developed that had the intent to transect a stationary front in the vicinity of DFW. The flight was nominally to depart south of the stationary front from the aircraft staging airport in Waco make an initial sounding ascent and then fly north until the front was encountered. North of the front a second sounding ascent would be made then the flight would return south back to the staging airport. The desire was to have a frontal position near the DFW area, preferably catching the front as it sagged south over the DFW area. A secondary criterion was that temperatures would be in the 90's and that the front was slow moving enough that precursors could accumulate.

2.1.1 August 21, 2006 Flight

During the flight window (August 1- August 31) several frontal events presented themselves. However, early in the period the fronts became stationary over central Oklahoma and never sagged for enough to meet the flight requirements. One of these fronts did reach the Red River but temperatures were not very warm. Based on meteorological briefings on August 18-19th it was felt that a weak cold front would become stationary near the Oklahoma border the sag into the DFW region. The front seemed to meet all the criteria of past frontal zones which had caused high 1 hour and 8 hour events in the DFW area. Temperatures were expected to be in the mid 90's and UH model forecast gave a hint that high ozone would occur. Thus, a flight was called for Monday, August 21 with a possible follow-up flight on Tuesday, August 22. Figures 1 -4 give a sequence of synoptic maps showing the frontal position. The August 21-22 event appeared to have all the attributes desired. The front was a well developed stationary front and temperatures were high enough for significant photochemical production. The forecast held and the flight was made. Figure 5 shows the plan view of the flight with ozone levels colored coded on the flight track. The approximate location of the front is indicated although additional analysis may change this location. The initial low level ozone at the start of the flight was relatively low (45-50 ppb) perhaps due to surface scavenging in the nocturnal boundary layer. Aloft in the ascent portion of the track (see figure 6) ozone levels were higher in the 60 ppb range and reaching near 70 ppb at the top of the sounding.

As the aircraft moved north at flight level (2500 ft) ozone in the boundary layer gradually increased (see figure 7). There was a relatively sharp increase in ozone near where the