P1.14 LONG TERM CLIMATOLOGICAL CHANGES IN FOG INTENSITY AND COVERAGE

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1. INTRODUCTION

Several recent studies have revealed a widespread decrease in low visibilities caused by fog. Long term decreases in fog over several decades have been reported in Canada, Argentina, and Brazil. During the period 1961 through 1990, fog decreased significantly at two major airports in the Los Angeles Basin. In the United Kingdom, a 45% decrease is seen for 28 stations when the period 1974 to 1983 is compared to the period 1950 to 1959. This decrease is attributed to the passage of the Clean Air Act in the United Kingdom in 1956 (Musk 1991). In addition to a decrease in particulate pollution, growth of urban heat islands and long term ocean-atmosphere cycles are hypothesized to have a role in the frequency and intensity of fog. Long-term (50 year) records were examined for 12 cities in the United States to determine the extent to which low visibility frequencies have decreased.

2. BACKGROUIND

Fog is generally not a major topic in climate change studies. However, fog occurrence affects many aspects of our everyday life. Transportation is the main industry that we hear of as being affected by fog. Airport delays and highway accidents frequently accompany heavy fog events. However, fog affects other industries as well as plant life. Numerous plants worldwide are dependent upon fog as an important source of moisture. In viticulture, some varieties of grapes thrive where fog is an important part of the climate. Free space optics is another industry where fog is important. Climatological duration and intensity of fog are important factors in determining deployment strategy.

Recently, several studies have been completed that indicated worldwide changes in fog distribution are taking place. In South America, Araujo, Freitas and Goncalves (2001) have seen a continuous decrease in Sao Paulo's fog from the 1930s to the present. There was an interruption in the decrease from about 1950 to 1980. They see urban development and sea surface temperatures as important factors in their fog regime. Elsewhere in South America, Hoffman and Nunez (2001) noted a decrease in fog days in the urbanized area of Buenos Aires, but no change in the surrounding rural areas. In the country of Georgia, when the period 1936-1963 is compared to the 1964-1990 period, 38 of 70 stations reported a decrease in foggy days while 5 of 70 showed an increase in fog. The author attributed the decrease in fog to an increase in atmospheric aerosol content (Amiranashvili, 2001). In Canada, over the past 30 years, a 20% to 30% reduction in fog events has been reported. For example, from 1951 to 1980, some Atlantic coast stations reported an average of over 150 days of fog per year, while from 1971 through 1999, that number dropped to a maximum of 132 days per year (Muraca et. al., 2001). In Libya, a downward trend was observed from 1960 to 1990, but with some exceptions (Fenali, 2001).

Although the majority of researchers reported fog decreases, this was not always the case. In Northwest India, Singh (2001) observed five consecutive winter seasons with the number of foggy days ranging from 15 to 46 against a long term average of 10 days. This was attributed to global climate change. More clearly, in Yerevan, Armenia, an increase was seen during the 1990s, but this was attributed to an energy crisis which forced residents to use heating stoves that produced significant emissions (Hovsepaya, 2001).

In the United States, Witiw and Baars (2001) saw a decrease in fog at two Los Angeles area locations that appeared to be correlated with the phases of the Pacific Decadal Oscillation.

3. DATA AND METHODS

Fifty years of data (1948-1997) from 10 US airport locations were examined. One station, Denver, had 46 years of data (1947-1994) and another, Dallas-Fort Worth had 44 years of data (1954-1997). (Prior to 1973, data from Greater Southwest Airport, which was later incorporated into Dallas-Fort-Worth, were used.) Locations for which 50 years of data were available included Seattle-Tacoma, San Francisco, Los Angeles, Long Beach, Minneapolis-St. Paul, Boston, LaGuardia (New York); Baltimore-Washington International (BWI); Reagan National (Washington) and Atlanta Hartsfield. Data were examined for reports of dense fog, defined as visibility less than ¼ mile (400 meters). Very rarely does anything other than fog reduce visibilities below this threshold. For each location, a simple t-test for means was performed on the first half and on the second half of each data set. A two-tailed test was used with $\alpha = .05$.

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4. RESULTS

Of the 12 locations analyzed, a decrease in dense fog was observed at seven locations. These included Seattle-Tacoma, San Francisco, Los Angeles, Long Beach, La Guardia, BWI and Washington Reagan. Boston showed an increase, and a slight increase was seen in Denver. Results in Minneapolis-St. Paul, Atlanta and Dallas-Fort Worth were not significant. The biggest change was seen in Los Angeles, where the frequency of dense fog decreased from 1.43% to 0.51%. In Boston, an increase in dense fog occurrence from 0.35% to 0.55% was observed. Trend plots of Boston, Dallas, and Los Angeles are seen below. Percentage of time visibility is greater than or equal to ¼ mile is plotted against year.

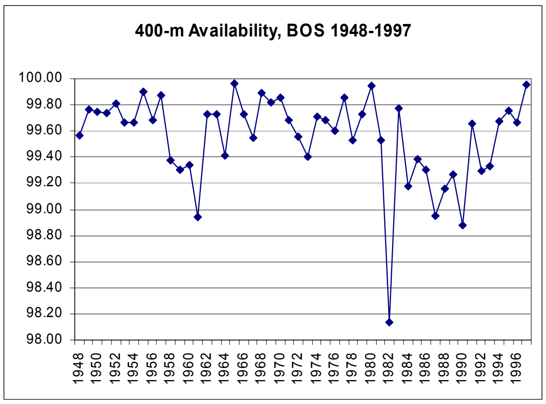

Figure 1. Trend plot for Boston, 1948-1997.

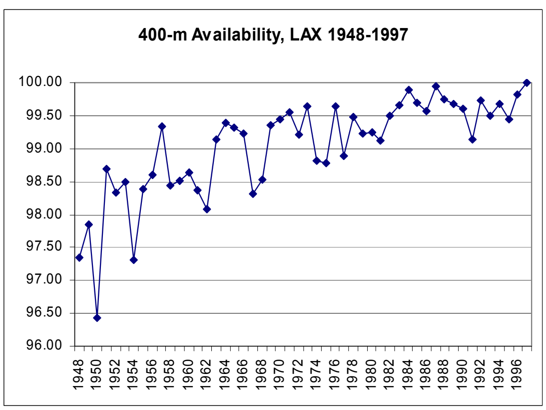

Figure 2. Trend plot for Los Angeles International, 1948-1997.

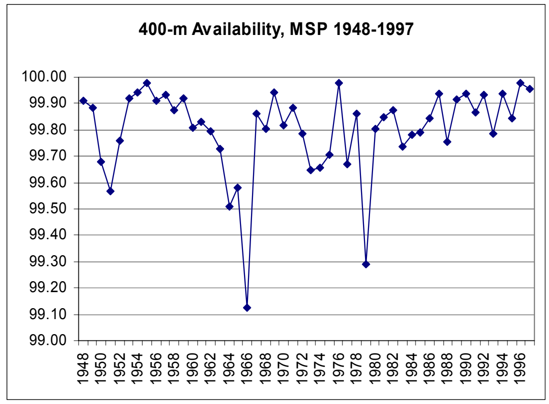

Figure 3. Trend plot for Minneapolis, 1948-1997.

5. CONCLUSIONS

Of the 12 locations we examined, seven showed a definite decrease in fog; only two showed an increase. Of the two locations that showed increases, only the increase in Boston (0.20%) could be considered large. The increase in dense fog seen at Denver was less than 0.05%. There does appear to be a trend toward fog decrease in the United States. The causes of such a trend are uncertain. Some phenomena that should be considered are long term atmosphere-ocean cycles, trends in particulate pollution, and increasing urbanization and the accompanying urban heat island effect. It is interesting to note that all four West Coast locations showed a fog decrease, and that all three California locations showed a continuous trend throughout the period.

6. REFERENCES

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