1.6 MODELING POLLUTANT DISPERSION FROM ELEVATED AND GROUND LEVEL SOURCES AFFECTED BY SEA-BREEZE CIRCULATIONS PRODUCED BY CAPE COD AND ITS SURROUNDINGS

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1. INTRODUCTION

A model development investigation has been performed to better quantify the dispersion of pollutants from various source types in the region of Cape Cod Massachusetts. The technology developed will be used by epidemiologists to better understand the role of sea and land breeze circulations in the dispersal of pollutants from important sources in the region. A companion paper at this conference (Seaman, et al, 2002) discusses the adaptation of the MM5 mesoscale model for the prediction of the fine grid (1.33km) meteorological fields used in this work. The MM5 meteorological model was used to drive another flow field model, CALMET, and two different atmospheric dispersion models (SCIPUFF and, CALPUFF) for purposes of predicting air quality concentrations. These dispersion models have varying capabilities to incorporate the complexities of the predicted flows. SCIPUFF and CALPUFF are capable of simulation the dispersal of pollutants under time and spatially varying conditions. A third model ISCST3 which assumes straight-line trajectories for each hour simulated was driven with conventional airport meteorological input data. The full report compares the results of the three dispersion models for the same case study events. The case study events consist of summertime periods of strong sea breeze circulations as well as occasions when land breeze effects are evident. Because of the specific topography of Cape Cod, converging sea breezes are apparent and important.

The circulations cause very different air quality impacts from low-level pollutant releases than from high level releases. Also the locations of the sources relative to the three nearby large water bodies are shown to be a very important factor for the models that better simulate the complex three dimensional aspects of the flows involved. Four sources are simulated: two are large power plants. One is a ground level area source and the fourth is a highway.

This paper shows a typical depiction of the flow fields and ground level concentration patterns and provides a comparison of maximum predicted values resulting from the power plant emissions.

2. RESULTS

Figure 1 (top) is a snap shot in time depiction of the flow fields from MM5/CALMET and the predicted concentrations resulting from the Brayton Point Power Plant from CALPUFF at 7 am on July 1,2000. This case hour (1100 UTC) is an hour earlier than the start of the trajectory simulation in the case study set of hours discussed in Seaman, et al, 2002. The plume is traveling toward the southeast. At 11 am, Figure 1 (bottom) shows that MM5 predicts onshore flows normal to several shores simultaneously. An associated converging flow field is north of the power plant. The contaminated air shown south of the plant in this figure will move northward.

Figure 2 shows model-to-model comparisons of the predicted maximum concentrations (coupled in time but not location) for several of the case study hours. The number of samples is too small to draw statistically significant conclusions. Most of the highest concentrations predicted by the models are associated with mid to late afternoon sea breeze flows.

3. SUMMARY

The coupling of a fine grid version of MM5 to drive dispersion models capable of accommodating spatially and time varying meteorological fields is a suitable way to simulate the air quality implications of sources affected by sea breeze flows.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

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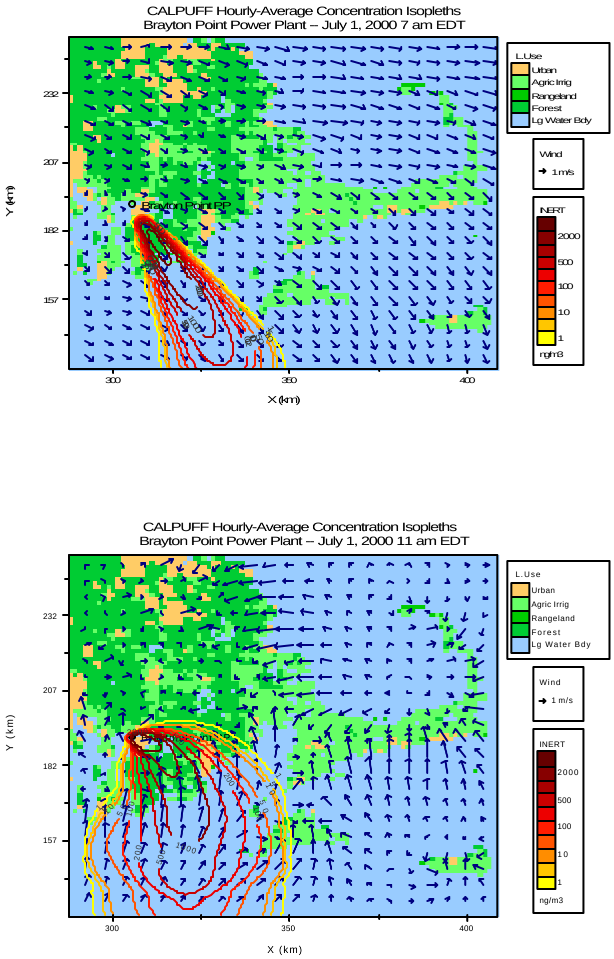

Figure 1. Top: CALMET surface layer wind vectors and air quality isopleths arising from the Brayton Point PP at July 1 at 7am EDT. Bottom: Same but at 11 am.

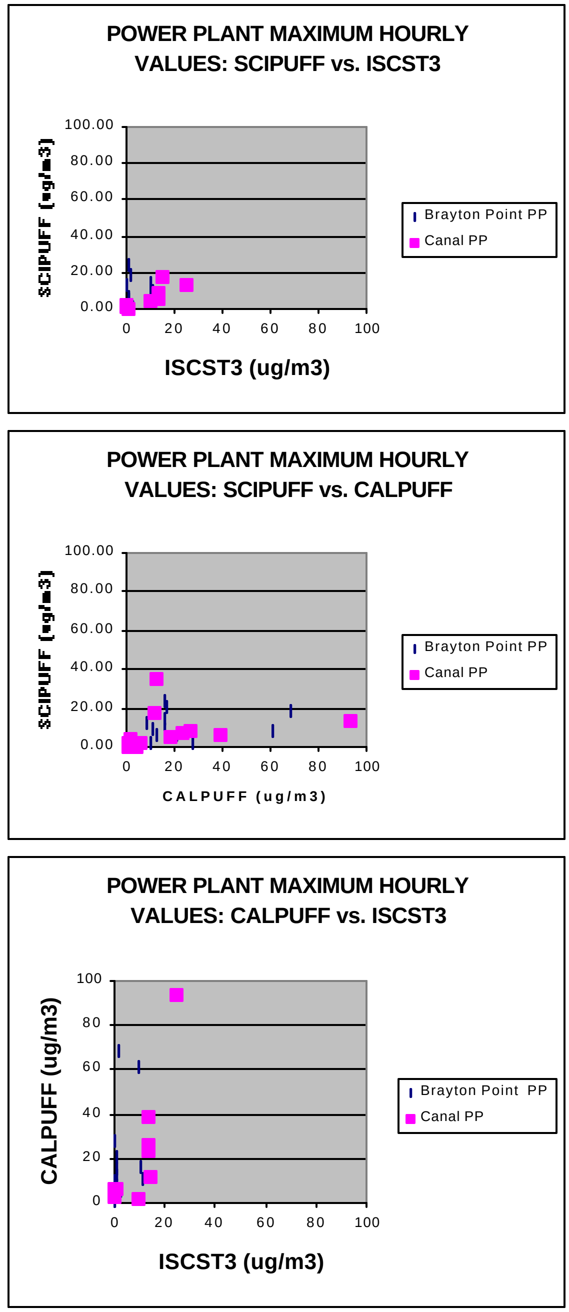

Figure 2. Comparisons of maximum hourly ambient air concentrations for SCIPUFF, CALPUFF and ISCST.