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POLLUTANT RECIRCULATION IN THE LOWER FRASER VALLEY (BRITISH COLUMBIA, CANADA) – NUMERICAL STUDY WITH MC2.

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1. INTRODUCTION

In recent years, the region of Vancouver and Lower Fraser Valley (British Columbia) has experienced episodes of elevated primary and secondary pollutant levels. Those levels are unusually high, for the population of roughly two million inhabitants. Several experimental campaigns (Pacific93, Pacific200, Steyn et al. 1997) have been organized to investigate the physical mechanisms responsible for such elevated levels. It has been hypothesized that the particularly low boundary layer height in the valley, and recirculation processes, induced by mesoscale circulations, play an important role.

2. ATMOSPHERIC CIRCULATIONS

The atmospheric motions in the region are the result (in cases of low synoptic forcing), of the combination of mountain/valley winds (in the main valley as well as in the tributaries), slope flows induced by mountain ridges up to 2000 m height a. s. l., land/sea breezes, and channeled flows in the Georgia Straight between Vancouver Island and the Mainland. This complex situation has been studied with the mesoscale atmospheric model MC2 (version 4.9.1, Laprise et al. 1997) for four days (10-13 of August 2001) of the Pacific2001 field experiment. In those days the highest ozone concentrations of the whole campaign were recorded.

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3. MODELLING TECHNIQUE

The technique used to investigate the recirculation consists of modeling the dispersion of several passive tracers emitted from the city of Vancouver, close to the coast line (where the strongest emissions are located), for different periods of the day (e. g. one tracer from 600 to 1800 of the 10th of August, a second tracer from 1800 of the same day to 600 of the 11th, etc.). Evidence of recirculation of pollutants is that the modelled emissions return over the city, after emissions have stopped. Besides the inherent scientific interest in the phenomena of mesoscale atmospheric recirculation, the technique can be used to calculate air mass age and emission times. This information can be useful to define abatement strategies, in order to reduce (or prevent the increase) of future pollutant levels (population in the region is increasing at the rate of forty thousand new inhabitants per year).

4. NUMERICAL RESULTS

An analysis of the results shows the existence of three main recirculation processes: 1) a day-to-night recirculation, where tracers emitted during daytime and pushed inland by sea-breezes, valley winds and upslope flow, are transported back towards the coast by down-slope flows and mountain winds at night; 2) a night-to-day recirculation, where tracers emitted during night and pushed over the sea by land breezes, are brought back over land during daytime by sea breezes; 3) a day-to-day recirculation where tracers emitted during daytime are transported vertically by up-slope flows, and stored in a reservoir layer. Those tracers are then fumigated back to the ground the following day (see Figure).

References

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Steyn, D. G., J. W. Bottenheim, and R. B. Thompson, 1997: Overview of Tropospheric Ozone in the Lower Fraser Valley, and the Pacific '93 Field Study, *Atmospheric Environment*, **31**, 2025-2035.

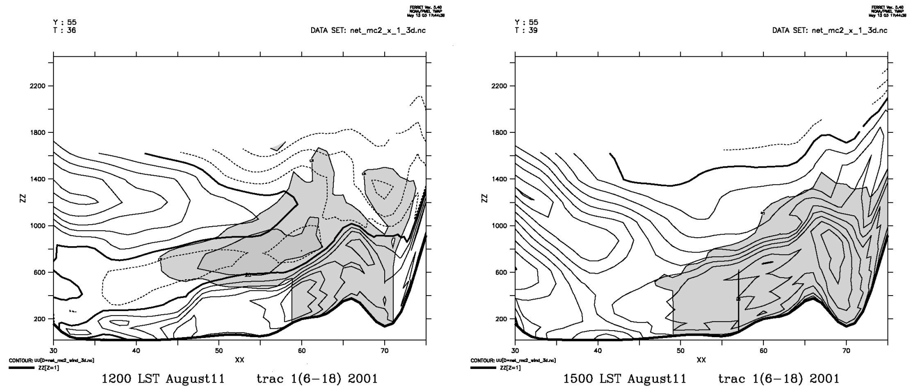

Figure: East-West vertical cross-section of tracer concentration (shaded) at 1200 PST and 1500 PST. The thick solid line at the bottom is the topography. From left it is possible to distinguish: Vancouver Island, the Georgia Straight, Vancouver and the bottom of the Lower Fraser Valle, the Cascade Mountains. The tracer has been emitted between 600 and 1800 of the day before, and it has been transported in an elevated reservoir layer by up-slope flows and sea-breeze return current (1200 PST, left panel). Later, when the convective boundary layer increases, it is fumigated down to the ground (right panel, 1500 PST).