P1.7 EFFECTS OF TOPOGRAPHY UPON MOUNTAIN PINE BEETLE (DENDROCTONUS PONDEROSAE) TRANSPORT AND DISPERSION AS INDICATED BY MESOSCALE METEOROLOGICAL MODELS

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1. INTRODUCTION

The Mountain Pine Beetle (MPB, *Dendroctonus ponderosae*) is a natural part of the forested ecosystem in western North America at endemic population levels. However, due to recent weather conditions and an abundance of mature LPP (lodgepole pine, *Pinus contorta*), population levels have reached epidemic proportions in several regions of British Columbia. The current outbreak stretches approximately 4.2 million hectares, the largest in the history of the province. Resource managers have recognized the importance of documenting the advance of the MPB through aerial surveys (to assess the spatial extent of the previous year's population) and ground data collection (to determine the spatial extent of newly infested stands). Production of a predictive model of MPB dispersion has the potential to direct ground surveys of MPB infestation and therefore reduce costs. Employing atmospheric models to determine the extent of MPB dispersal, especially over the longer ranges (i.e. between stands) should provide a regional visualization of spatial infestation extent that could become a useful tool for resource managers. As a preliminary step in the production of the full MPB dispersal model, this research seeks to validate the models used and explore fundamental relationships between MPB dispersal and local topography.

2. PROJECT OVERVIEW

The larger research project consists of two main parts: validation of the models used in the study with a SO2 case study and determination of fundamental relationships between topography and MPB dispersal. Preliminary simulations of wind and particle dispersal over idealized topography will be shown here.

The Regional Atmospheric Modeling System (RAMS) (Pielke et al., 1992) is run to produce the 3-dimensional meteorological fields necessary to run HYPACT that then models dispersal of the particles (MPB). The topography of the domain as well as model initialization are idealized in order to clarify the effect of topography on local wind circulations. Once RAMS begins running, the topography creates complexity in the wind field due to its thermal influences on the atmosphere. As a control, a completely flat landscape has first been simulated. Two other landscapes consist of a sinusoidal mountain-valley system running in either a north-south or an east-west direction. This tests the effect of each of 4 different aspects (north-, south-, east- and west-facing slopes) at potentially limiting MPB transport and dispersal over the landscape. HYPACT emits an assumed number of beetles at specified sites within the domain. Several sites are tested in each domain to determine the effect of release site on resultant concentration.

3. METHODS

3.1 Meteorological data for initializing the model

RAMS is run in horizontally homogeneous mode in which a single sounding is used to initialize each simulation. In order to select a representative sounding, 35 dates were selected based upon published MPB emergence dates (4) and heating cycle dates (31) from 1995-2002. The heating cycle dates were defined as day 3 of a period where temperature was greater than 20 °C and less than 30 °C during July and August. The reasoning behind these criteria is that ambient temperature is the major cue for MPB emergence which occurs in mid to late summer (Safranyik et al., 1992; Safranyik & Linton, 1993). The emergence rate has also been shown to increase with temperature up until the threshold of 30 degrees Celsius, the majority occurring when daily maximum temperatures have exceeded 20 degrees (Safranyik et al., 1989).

RAMS is initialized at 12 UTC (0400 LST) to allow the model to spin-up before adding beetles in the late morning. All 12 UTC sounding data were examined individually to observe temperature and wind profiles. 500 hPa maps for each date were also viewed to determine upper-level patterns. Boxplots and descriptive statistics were used to determine the spread of temperature (°C), dew-point temperature (°C), wind speed (m/s) and direction (degrees) at significant pressure levels. Upper-level wind patterns (regional winds) were used to separate the potential simulation dates into 2 main groups: upper-level ridge to the west of B.C. (regional winds blowing from the northwest – 16 dates), and upper-level ridge to the east of B.C. (regional winds blowing from the southwest – 16 dates). 3 potential simulation dates were omitted as they did not belong in either group. After separating the dates into groups, much less spread (as shown in boxplots) was detected for variables (Figs. 3.1.1 and 3.1.2).

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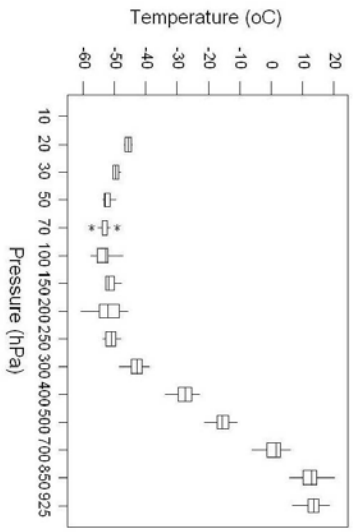

Figure 3.1.1: Boxplot of temperature at significant pressure levels for soundings with upper-level ridge to the east

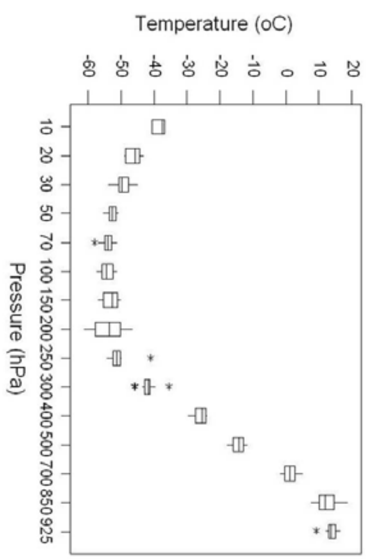

Figure 3.1.2: Boxplot of temperature at significant pressure levels for soundings with upper-level ridge to the west

Due to the prevalence of the two upper-level patterns, two representative soundings are used (one from each group) to initialize RAMS. To determine the most representative sounding, RMSE (Root-Mean Square Error) and RMSVE (Root Mean Square Vector Error) were calculated for each date which were then compared to all other dates in the east or west group to which it belongs. RMSE was calculated for T and Td at 925, 850, 700, 500 levels and summed together to give 2 measures: RMSE–T and RMSE–Td. RMSVE calculated based on u and v components of winds at 925, 850, 700, 500 levels and summed to give a single statistical measure of wind variables. Low values for RMSE or RMSVE indicated that the date is most similar to other dates in the group based upon that variable, but the lowest values for each of the variables did not occur on the same date. The solution was a ranking system to determine the best overall date to simulate. Dates in the top half (lowest values) of RMSE-T were ranked from 1 to 8. Dates in top half (lowest values) of RMSE-Td were also ranked from 1 to 8. Dates that were included in both lists were considered as potential dates for simulation. Of these potential dates, overall ranks for RMSE-T, RMSE-Td and RMSVE were summed and the three smallest sums in each group are deemed the most plausible modeling dates. Once the "top three" dates were selected, the 500 hPa maps were again studied to determine the best match to the composite map for each group (as determined from a synoptic climatology). In the group with the upper-level ridge to the west, the map with the lowest sum more closely resembled the composite. The east group was more complex, so in order to determine the most representative 500 hPa map, both 6 UTC and 18 UTC maps also had to be considered for the "top three" dates due to a short-lived low over the Pacific at the southern end of British Columbia. The dates chosen for simulation are: August 2, 1999 (upper-level ridge to the east) and July 23, 1996 (upper-level ridge to the west) (Figs. 3.1.3 and 3.1.4).

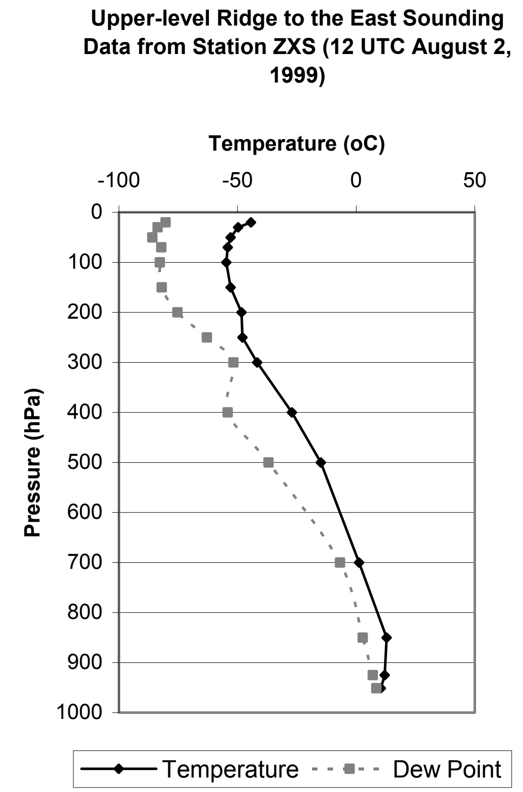

Figure 3.1.3: Input sounding data for upper-level ridge to the east

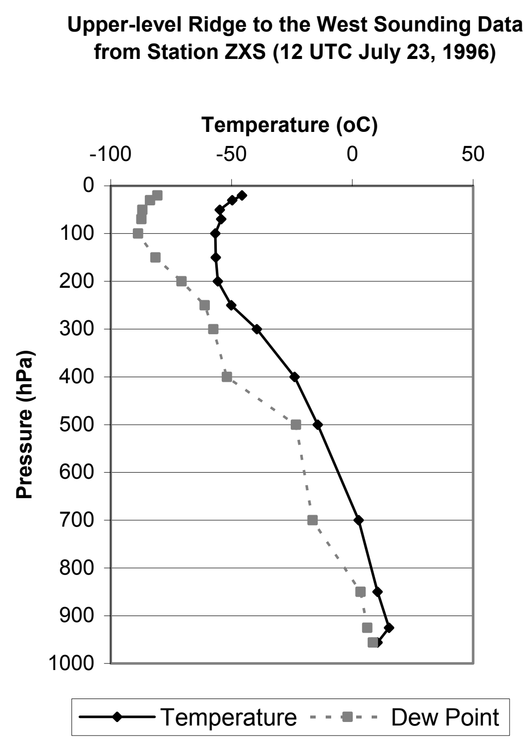

Figure 3.1.4: Input sounding data for upper-level ridge to the west

3.2 Topography and Grid Set-up

Sounding data were collected from the Prince George (ZXS) upper-air station located at a latitude of 53.9 and longitude of -122.0 and elevation of 601 masl. For this reason, the flat topography was set at 601 m. Other topography set-up included sinusoidal terrain running either N-S or E-W. In order to specify a sinusoidal wave, amplitude and wavelength are required. These data were obtained from mapsheet 93C (Anaheim Lake), a location near Tweedsmuir Park (a location with a large MPB infestation). An average of several peak and valley elevations gave a peak-to-ridge distance (double the amplitude) and an average of several peak-to-peak distances gave the wavelength. Due to the complex terrain, a nested grid design was employed. Grid 1 is 20 x 20 (16000 m resolution) with flat topography at 1251 masl (half-way point up slope). Grid 2 is 42 x 42 (4000 m resolution) with sinusoidal topography. Grid 3 is 100 x 100 (1000 m resolution) with sinusoidal topography interpolated from grid 2 with elevation ranging from 601 to 1901 masl. Each grid was centered at the latitude and longitude of the radiosonde release location.

4. FUTURE WORK

Realistic simulations of Prince George region SO2 concentrations will be used as an illustration of the capability of RAMS/HYPACT at simulating real-life situations and add strength to the findings. Currently, testing of different convective parameterization schemes to determine the most effective one in the complex artificial topography is being undertaken. Once complete, qualitative study of the RAMS output will involve comparison to published studies (of weather patterns associated with topography) to ensure the simulated wind and temperature patterns are accurate. Also underway is determination of effective release parameters for MPB and producing particle plots in HYPACT for simulations. Once completed, quantitative comparison of HYPACT output will be assessed between control (flat) and variable (sinusoidal) topographies to determine whether an effect is present and/or which landscapes offer the greatest forcing on MPB dispersal. After completing the MPB dispersal component of the study,

5. ACKNOWLEDGEMENTS

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