INTRODUCTION

The meteorology of coastal British Columbia, particularly the Greater Vancouver Regional District (GVRD) is complex: land–sea breezes from the Strait of Juan De Fuca, the urban heat island of the city of Vancouver, and the topography of the surrounding Coast Range mountains combine to create complex flow patterns. Additional complexity is added to the system through the emissions: particulate sea-salt may be carried inland from the ocean, urban anthropogenic emissions are released from the city, significant agricultural emissions of ammonia occur further inland on the valley floor, and biogenic emissions on the surrounding mountains have pronounced elevation dependence, in response to altitude-dependent changes in vegetation. All of these factors combine to make this region a good test-bed for meteorological and air-quality models. Here, we discuss work in progress towards comparing the results of two air-quality models in this region, the Community Multiscale Air-Quality modelling system (CMAQ) and A Unified Regional Air-Quality Modelling System (AURAMS). A feature of this study is a concerted effort to minimize differences in the model inputs, hence allowing a focus on differences between the chemical transport models themselves.

Model setup

Aim: Evaluate both models for this region, while harmonizing as many model inputs as possible.

Model versions: CMAQ 4.6, AURAMS 1.4.2

Horizontal projection system (same for both models): polar stereographic, 93 x 93 gridpoints, 12-km resolution.

Emissions data: both models use same emissions database (2006 Canadian, 2005 US, processed by the Sparse Matrix Operating Kernel Emissions system (SMOKE). The chemical speciation differs between the two models (AURAMS uses ADOM-II for the gas-phase chemistry, while CMAQ is configured here for SAPRC-99). The two models use different methodologies for primary particulate speciation and size disaggregation.

Driving meteorology: both models are driven by the same driving meteorology, provided by the Canadian Global Environmental Multiscale model (GEM, v3.2.2), in turn driven by Canadian Meteorological Centre 00Z operational analyses, 30 hour simulations with the first 6 hours discarded as spin-up.

Simulation periods: Jan. 28th to Feb. 28th, 2005
July 15th to Aug. 15th, 2005

The table below compares the overall statistics for the domain of Figure 1 for the summer 2005 period.

### Table 1: Statistical comparison between observations for the 12-km resolution domain measurement sites vs CMAQ or AURAMS for the summer 2005 period.

<table>
<thead>
<tr>
<th>Variable</th>
<th>CMAQ</th>
<th>AURAMS</th>
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<tbody>
<tr>
<td><strong>Number of pairs</strong></td>
<td>41846</td>
<td>41789</td>
</tr>
<tr>
<td><strong>Root Mean Square Error</strong></td>
<td>16.24</td>
<td>21.25</td>
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<tr>
<td><strong>Normalized Mean Bias (%)</strong></td>
<td>37.77</td>
<td>75.42</td>
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</table>

During the winter (see Table 2, next column), the differences between the two models is more pronounced, with the CMAQ bias being attributable once again to overpredictions at low O₃ concentrations (at night). With the longer and stronger surface inversions expected during the winter period, CMAQ difficulties with nighttime titration are amplified.

While the observed PM₂.₅ concentrations are higher in the winter (compare Tables 1 and 2), the positive bias for AURAMS has become worse in the winter simulation. CMAQ once again has a smaller magnitude, negative mean bias. CMAQ statistics for the winter simulations are better than AURAMS for all measures except slope and correlation coefficient, but the relative improvement for AURAMS for these two statistics is less than in the summer.

The above work suggests that the use of a lower cut-off in diffusivity of 1 mm/s may account for much of the differences between the two models — but that the use of this cut-off cut may mask other problems in the model setup. The identification of the above emission errors in this study has led to a review of the Canadian emissions temporal and spatial allocation factors (M. Moran, J. Zhang, Q. Zheng). New emissions are being generated which will hopefully improve the PM₂.₅ predictions. Other investigations have examined AURAMS operator splitting methodology. These improvements will be used in a second comparison of the models in the near future.