Development of ECCC's Regional Transport Model for Simulation of Atmospheric Greenhouse Gases at High Spatial and Temporal Resolution

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With the advent of space-based observations of greenhouse gases (GHG) such as carbon dioxide (CO_2) and methane (CH_4) at high spatial resolution, as well as the expanding surface networks of GHG measurements, it may now be possible to constrain surface GHG fluxes at regional scale by atmospheric inverse modeling. However, this requires the high-resolution transport model to be able to accurately simulate GHG variability on synoptic and mesoscales captured in the measurements. Also, high-resolution anthropogenic and biospheric prior fluxes are required to provide detailed information associated with high-resolution topography and surface geophysical characteristics.

Here we present the development of a regional transport model for GHG, aiming at understanding the high spatio-temporal resolution interaction of the atmosphere and surface GHG fluxes, mainly focusing on Canada and the United States as shown in Fig. 1. This is an extension of the development of Environment and Climate Change Canada's (ECCC) Carbon Assimilation System (EC-CAS) that is based on a global version of operational ECCC weather forecast and environmental prediction model. Our regional model is run at a 10 km horizontal grid spacing with 80 vertical levels spanning the ground to 0.1 hPa. The added benefit of the regional model over our low resolution global model (0.9° horizontal grid spacing) is assessed in terms of modeled tracer concentration and meteorological forecast quality. We find that our regional model has the capability to simulate high spatial and temporal scales of atmospheric GHG concentrations both horizontally- and vertically-based on comparisons to observations from various GHG observing systems including surface network, aircraft, and OCO-2 satellite. In addition, several sensitivity tests are conducted to investigate the impact of different lateral boundary conditions on modeled concentrations.

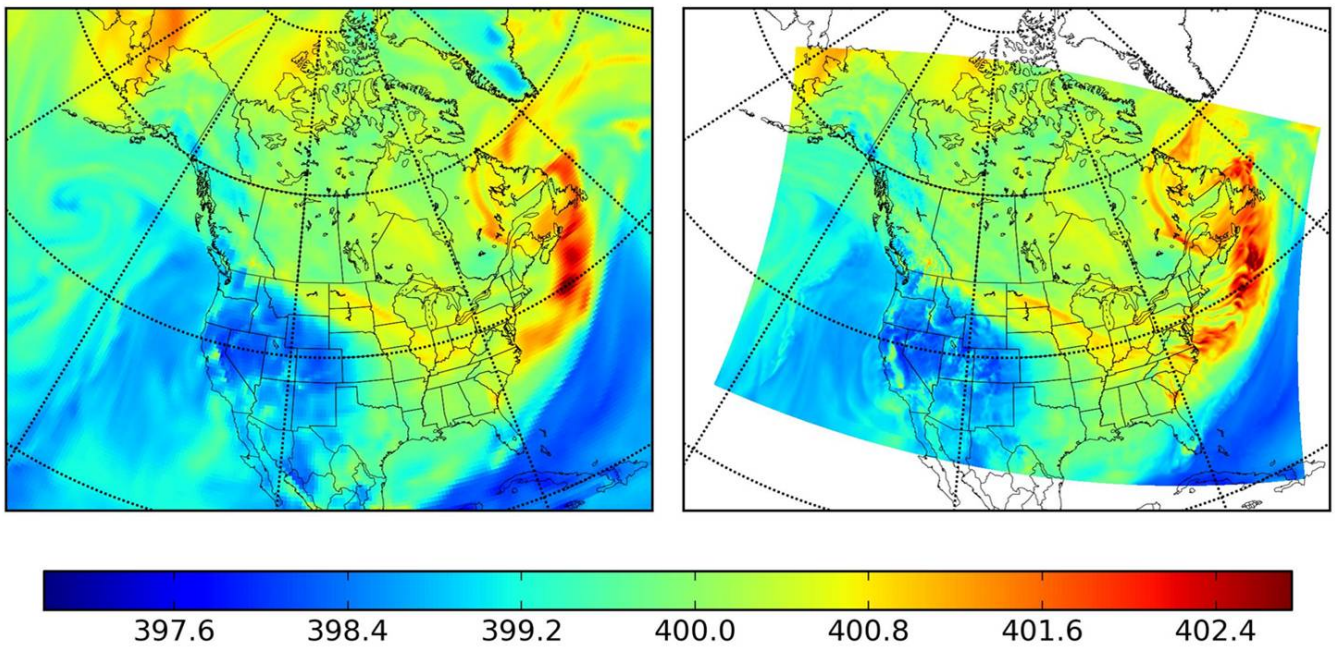

Figure 1. An example of modeled column mean CO_2 (ppm) weighted by air mass from global **(left panel)** and regional model **(right panel)** on 5 January 2015 22:00 UTC.