

3.5 Modeling Overview

3.5.1 Model Background

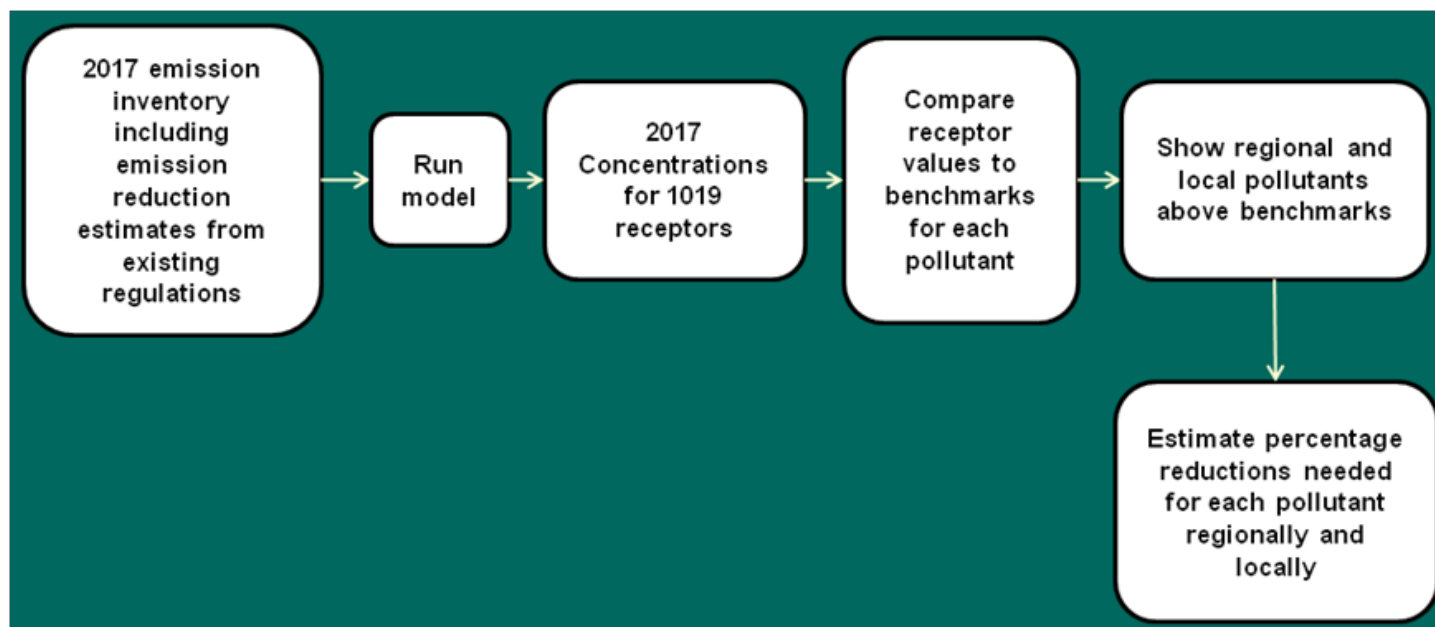
Air quality dispersion modeling is a mathematical approximation or representation of air quality using emissions data and information about how emissions are dispersed in the air, including the effects of terrain and mixing and transport by wind.

Modeling is an effective tool to estimate the impact of air toxics over a large region, such as the PATS study area. Modeling allows the estimation of pollutant concentrations in ambient air for which monitoring would be prohibitively costly to measure, or for which there are no effective methods. Once a model is established, DEQ can estimate the effect of future emissions changes and potential reductions.

In order to model air toxics in the PATS study area, DEQ determined the pollutants of concern, established study area boundaries, developed emissions information for all categories of sources, and then ran the dispersion model. The results of the model, expressed as annual average pollutant concentrations, were then compared to Oregon's ambient benchmark concentrations. DEQ started with 2005 emissions as a base year, which corresponded to available monitoring and air toxics emissions inventory data, and then projected these emissions to 2017 levels and re-ran the model.

The flow chart in Figure 20 shows the steps of assembling and interpreting the PATS model once 2017 emission projections were available.

Figure 20: 2017 Model Analysis



3.5.2 Model

Because of the diverse types of emissions sources in the PATS study area, including point sources (industrial facilities, gas stations), linear sources (roads, rail lines), delineated area sources (airports, shipping channels), and broad-spread area sources (diffuse population activities such as residential home heating), there was no model perfectly suited to estimate concentrations with great accuracy for all categories. DEQ selected CALPUFF to model concentrations because it performs generally well in estimating a broad range of emissions types. DEQ did not choose to use a Gaussian plume model (such as used in industrial source regulatory modeling) due to the size of the PATS modeling domain and its complex terrain of high hills, river channels, and broad valleys. The CALPUFF model as approved by EPA is the model of choice for long-range transport of

pollutants in areas of complex terrain, as in the PATS domain. Moreover, DEQ used CALPUFF for Portland's first local scale air toxics modeling effort (the Portland Air Toxics Assessment, or PATA) in 2006. As a result, this previous experience with CALPUFF provided a basis for model performance, and allowed re-use of the on-site meteorological data for developing the CALMET windfields used in PATS.

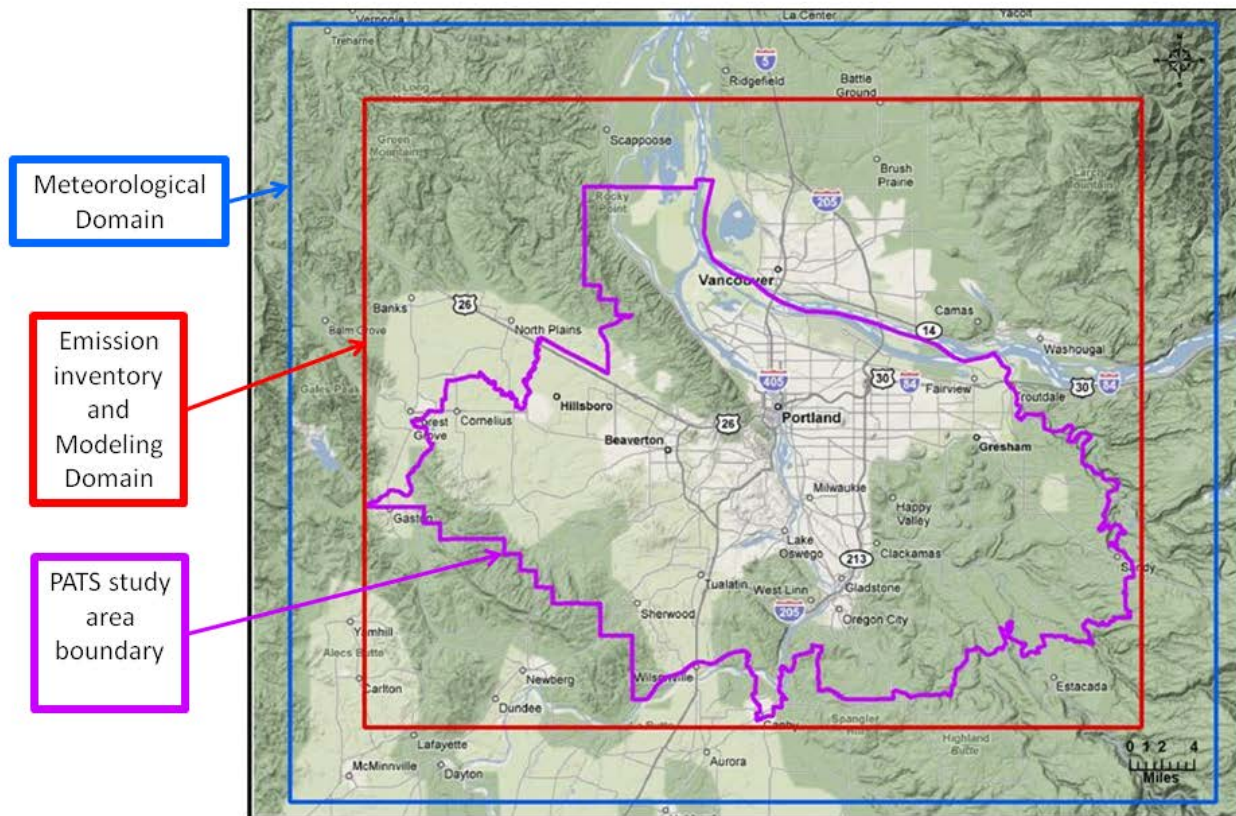
In general, CALPUFF can be described as a dispersion model that characterizes emissions and resulting modeled concentrations by creating a stream of pollutant puffs that wander across the domain in response to hourly changing windfields. The inputs to this model include dispersion parameters, meteorological data (windfields), and emissions data. There is no atmospheric chemistry in CALPUFF to model the formation in the atmosphere of secondary pollutants, such as formaldehyde, however a decay function was incorporated to allow for the short half lives of the more active toxics, such as 1,3 butadiene. Although there is no chemistry, CALPUFF does estimate modeled concentrations at a higher areal resolution than concentrations predicted by Eulerian grid chemical transport models, and this was an important consideration.

3.5.3 Modeling Domains

In order to prepare for the PATS project, DEQ analyzed the 1999 National Air Toxics Assessment (NATA) information showing air toxics risk at Portland area census tracts. Using this information along with community growth patterns, jurisdictional boundaries, and previous air quality boundaries for ozone and carbon monoxide, DEQ established a study area boundary intended to include potential air toxics concerns in the Portland area. DEQ made an effort to keep the boundary distinct from other jurisdictional entities that may want to initiate their own separate community based air toxics efforts, such as the Salem/Keizer area.

Figure 21 shows three different boundaries or domains in the PATS model. The purple line delineates the study area boundary and represents the area in which air toxics concentrations were to be modeled by CALPUFF, and where emission reduction targets would be estimated. The red boundary is the computational domain in which emissions data were entered. This domain is larger than the study area in order to include emission sources outside the study area that could potentially influence the study area. The blue line shows the meteorological domain. The larger meteorological domain allows for the recirculation of pollutant puffs back into the computational domain in response to changing wind patterns. The PATS project also included emission data for the Vancouver area as that area is part of the same airshed as Portland, and modeled concentrations from these emissions have the potential for impacting the PATS study area. In addition, DEQ is working in partnership with the Southwest Washington Clean Air Agency, and will share the PATS results with them. The models used in assessing air toxics are described in more detail in [Appendix 10.4](#).

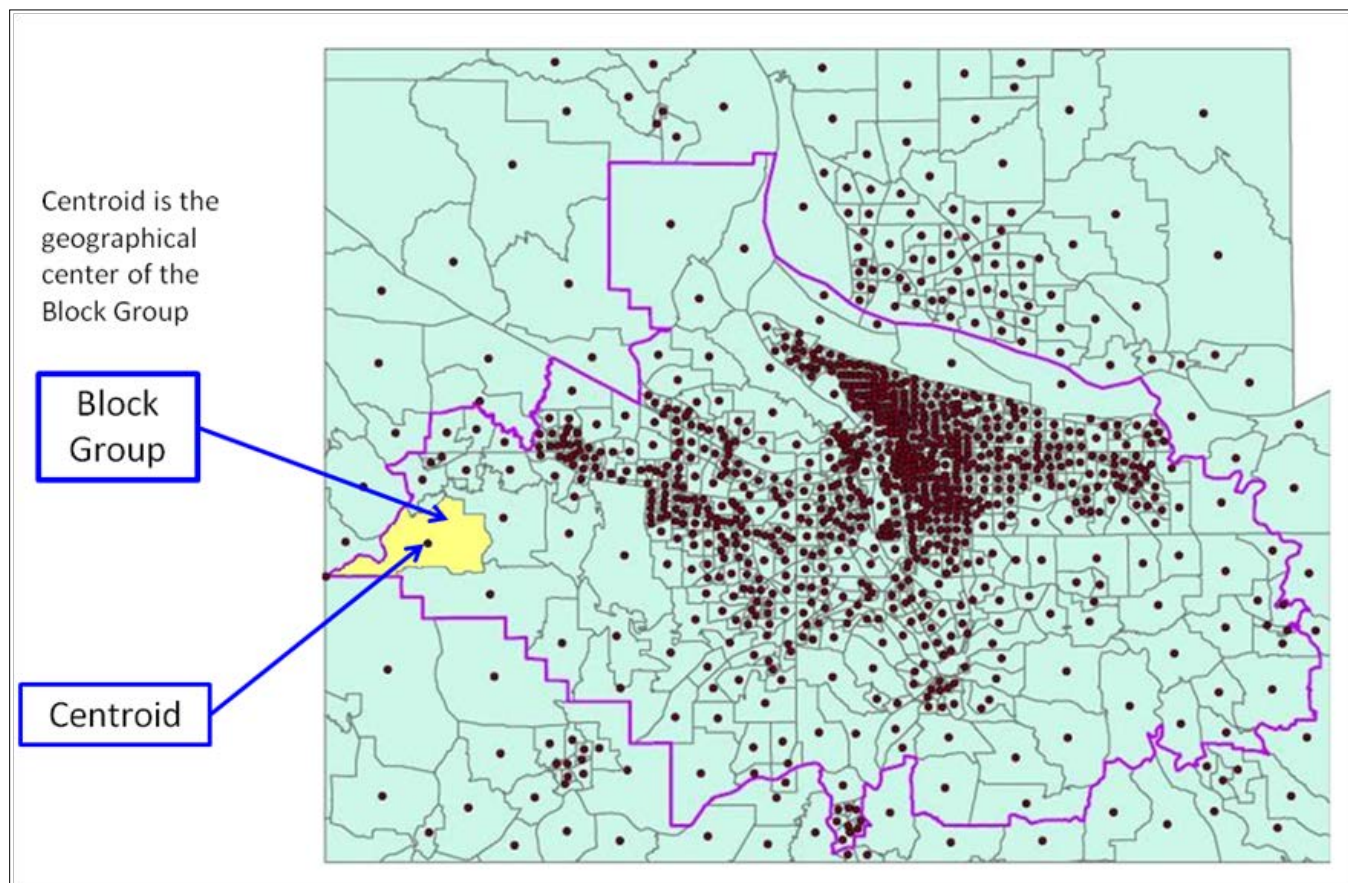
Figure 21: Modeling Domains



3.5.4 Receptors

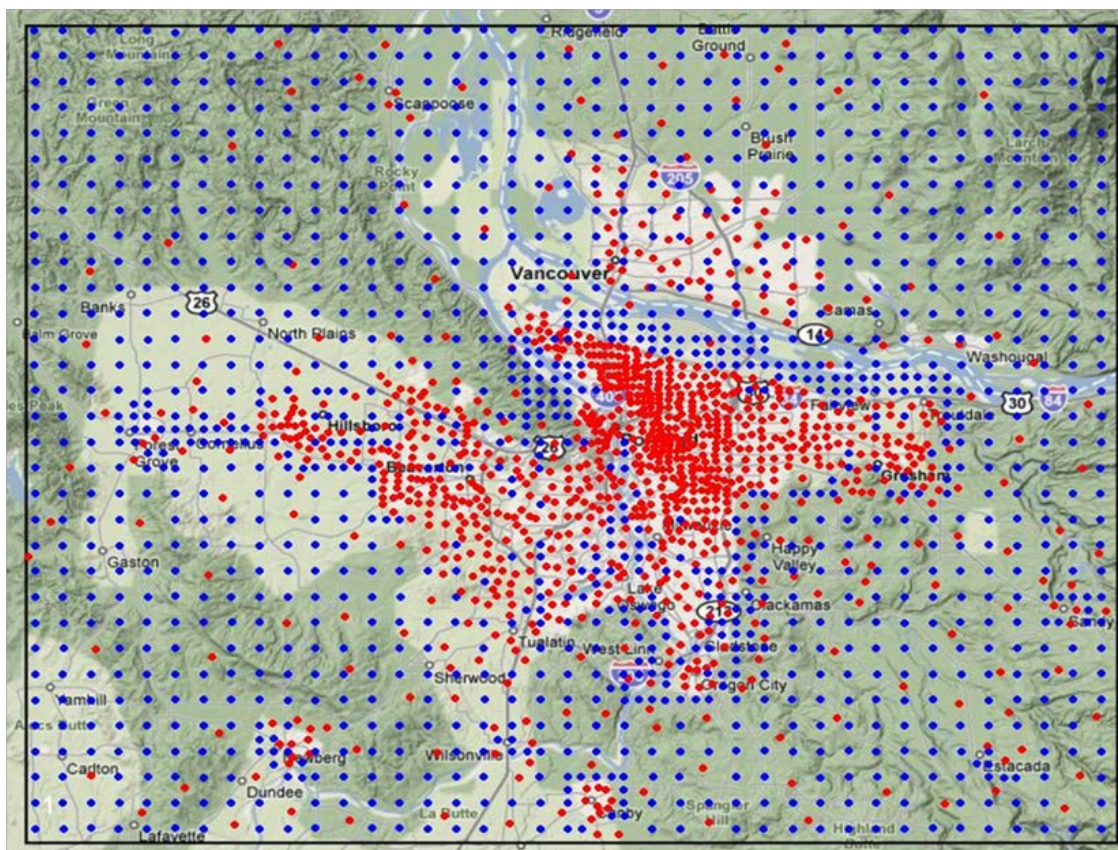
The primary locations used to estimate toxic concentrations in the PATS project are the geographic centers, or centroids, of the year 2000 census block groups in the study area. In the CALPUFF model, these 1019 locations are referred to as model receptors, and can be considered 1019 virtual monitors of the annual average concentrations for each of the 19 modeled PATS pollutant concentrations. Since census block group boundaries are drawn to contain roughly the same number of people, about 4,000, the largest number of modeling receptors occur in the areas of highest population. Figure 22 shows the locations of the block groups, and the CALPUFF receptors located at their centroids. As described in section 4 below, these modeling receptor concentrations can be analyzed to show regional and local concentration patterns, and the source categories that are significant contributors to these concentrations. The location of the highest toxic concentrations, and the source categories that are largely responsible for those concentrations, helps support the development of emission reduction strategies and where they will be effective. Placing receptors in census blocks also allows DEQ to analyze block group level population statistics collected by the U.S. Census Bureau, facilitating an initial analysis of potential environmental justice factors in the study area.

Figure 2: Census Block Groups and Block Group Model Receptors at Centroids



One disadvantage of using census block group locations is that in areas of low population density there are insufficient receptors to characterize pollutant concentrations over larger land areas. For example, the Forest Park area and the industrial land just south of the Columbia River are represented by fewer than a dozen receptors. Adding more modeling receptors to these areas will help the understanding of model performance. As a result, PATS added over 1,000 receptors to areas with less population density. The additional receptors were added in a gridded overlay to fill in areas in the domain with few census block groups. In addition, for some point source facilities, additional receptors were placed at the property line. The 2017 model run included estimated concentrations for both the original and additional receptors, although for consistency with census data, the final risk estimates analyzed to define levels above benchmarks used only the original 1019 census block group receptors. Figure 23 below illustrates original receptors in red and additional receptors in blue.

Figure 23: Updated Modeling Receptors



3.5.5 Model Runs

To understand impacts from the many source category emissions in the study area, DEQ developed the emissions inventory for PATS, formatted data for input to CALPUFF, and ran multiple model runs for each source category. Table 6 summarizes the modeled categories, the type of source (whether the source is modeled as point, area, or volume), if the type is “area”, whether the source is a polygon, or is area-wide and gridded, and the number of sources. For a description of polygon and area sources, please [see section 3.4](#).

Table 6: Source Category Modeling Types and Model Runs

Source Category	Type	Area Type	Number of Emission Sources
Stationary Sources			
Industrial Emissions	point		222
Industrial Emissions	volume		32
Dry Cleaners	volume		198
Gas Stations	volume		638
POTWs	area	polygons	27
Area Sources (general)	area	gridded	1446
Residential Wood Combustion (RWC)	area	gridded	1446
Residential Open Burning (ROB)	area	gridded	1446
Solvents	area	gridded	1446
Lawn & Garden	area	gridded	1446
On-Road Mobile (ORM)			
Hot Links	volume		2147
Warm Links	volume		5224
Cold Links	area	gridded	1446
TAZs	area	gridded	1446
Non-Road Mobile (NRM)			
Other	area	gridded	1446
Construction	area	gridded	1446
Airports	area	polygons	15
Airports	volume		1
Comm Marine: OGV in transit	area	polygons	
Comm Marine: hotelling/manuevering + harborcraft	area	polygons	
Comm Marine: Barge traffic	area	polygons	
Rec Marine: Large Water	area	polygons	
Rec Marine: Small Water	area	gridded	1446
Rail: Hot Links	volume		4360
Rail: Cold Links	area	gridded	1446
Rail: Yards	area	polygons	11