Developing a Vision for the Next-Generation Air Quality Modeling Tools: A Few Thoughts

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Vision and Scope

Looking backward:

- What are the shortcomings and limitations of current AQ modelling systems?
- What lessons can be learned from past model development efforts?

Looking forward:

- What are the issues to be addressed and the questions to be answered? (e.g., population exposures, impact of climate change, …)
- What capabilities does the model need to have? (forecasts? hindcasts? source attribution? grid nesting? adjoint? → a do-it-all model)

Considerations: Inputs

- Emissions → more dynamic, more explicit species
- Meteorology: 2-way → in-line "chemistry"
- Biogeophysics: more consistent and integrated across model processes, more detailed (e.g., satellite remote sensing)
- Chemical boundary conditions: time-dependent, consistent species, consistent with meteorology

Considerations: Science

- All-season, all-latitude (including polar regions), all-surface (including urban), neighbourhood-to-global scale
- Ability to accommodate new science
- Multiple compartments (atmosphere, canopy, soil, water, ice/snow)
- Support for chemical data assimilation
- “Instrumented” model (to diagnose and understand model behaviour and responses)

Considerations: Numerics

- Future computing environments are likely to be massively parallel (→ both fine- and coarse-grain parallelization)
- Support for multiple spatial scales, multiple grid descriptions, and grid nesting
- Careful consideration of conservation properties and order of error in fundamental choices regarding horizontal and vertical coordinates, grid discretization, time solver, operator sequence, advection scheme, …

Considerations: Flexibility

- Ability to add new species (e.g., selected toxics)
- Ability to choose different parameterizations of same process
- Ability to choose different numerical techniques
- Ability to choose different PM size distribution representations (modal vs. sectional) and mixing state representation
- Ability to include/exclude model processes (e.g., coagulation, horizontal diffusion, …)