For discussion on
23 May 2016

LEGISLATIVE COUNCIL
PANEL ON ENVIRONMENTAL AFFAIRS

Updating of the "Pollutants in the Atmosphere and their Transport over Hong Kong" ("PATH") Modelling System

PURPOSE

This paper supplements the information paper "Updating the PATH Air Quality Modelling System" (CB(1)735/15-16(01)) dated 29 March 2016.

PATH MODEL

2.   PATH is a 3-dimensional model developed in 2001 to simulate air quality over the whole Pearl River Delta (PRD) region including Hong Kong.   It comprises three major components –

(a)   Meteorological Module – to generate meteorological data (such as wind speed, wind direction, temperature and pressure) for air pollutant dispersion calculation.

(b)   Emission Processing Module – to perform spatial and temporal allocation of the emissions of all emission sources according to their geospatial and operational characteristics.   Its emission database covers major emission sources in Hong Kong, the PRD region, other parts of the Mainland and down to North Thailand in the south.

(c)   Chemistry and Transport Module – to simulate the transportation, chemical transformation and dispersion of air pollutants.

3.   In its development, PATH adopted the latest relevant technology development and scientific understanding of air pollution at the time.   The model was validated against meteorological and air quality monitoring data and reviewed by two independent air quality modelling experts.   These efforts confirmed that the model is scientifically robust and suitable for conducting air quality assessments in Hong Kong.

4.   Since then, air quality science and computing technology have advanced

such that the three major components adopted in PATH have their updated versions. The updates could enable the simulation of the complex chemistry of particulate formation, better simulation of the air pollutant dispersion mechanism, refined grid resolutions and better computation efficiency.

THE UPDATE

5.   The PATH updating work started in 2008 and was undertaken by a consultant team comprising scientists in the fields of weather simulation and air quality modelling from the United States (US) and Hong Kong.   The updated PATH is named PATH-2016.   The updates to the key modules are as follows –

(a)   Meteorological Module – adopted the Weather Research and Forecasting (WRF) Model developed by the US National Center for Atmospheric Research (NCAR).   The module makes use of meteorological data from the Final Operational Global Analysis database of NCAR and those measured within the PRD region and Hong Kong to perform the weather simulation.

(b)   Emission Processing Module – adopted the Sparse Matrix Operator Kernel Emissions (SMOKE) modelling system developed by the United States Environmental Protection Agency (USEPA). SMOKE is an open-source software and free for all users.   Unlike its preceding version, it does not rely on proprietary software and can thus avoid the associated cost.

(c)   Chemistry and Transport Module – adopted the Community Multi-scale Air Quality (CMAQ) modelling system developed by the USEPA. CMAQ is widely adopted in the air quality modelling community for scientific research as well as regulatory applications.   Apart from having the latest simulation algorithms for air pollutant dispersion and pollutant formation chemistry, it also allows the scientific community to contribute to its further development.

6.   Besides, PATH-2016 has also the following key updates –

(a)   The calculation of PATH-2016 can cover the whole China and most of Asia such that long-range transportation of pollutants within the Asia region can be simulated.   This feature is useful for examining super-regional pollution scenarios.   In addition, the grid size covering the PRD region has been refined from 4.5km to 1 km to improve the resolution of the model results (see Annex I).

(b)   The maximum number of chemical species considered in PATH-2016 is expanded to 138 so that more advanced chemical reaction mechanisms developed for smog and particulate formation processes can be considered in the model.

(c)   The emission inventory for the Mainland has been updated using the Multi-resolution Emission Inventory (MEIC) developed by Tsinghua University.   The emission inventory for the PRD region and Hong Kong has been updated by local studies.

7.   A summary comparing the major changes between PATH and PATH-2016 is provided in Annex II.

8.   PATH-2016 has been validated against a full year of meteorological and air quality monitoring data obtained in 2010.

9.   A Working Group was set up to review the performance of PATH-2016. The Working Group comprises eight academics in the fields of air quality science and modelling from local universities and representatives of Environmental Protection Department (EPD) (membership are provided in Annex III).   The Working Group held four meetings from December 2014 to October 2015 to review the performance of PATH-2016 and agreed in its last meeting on 30 October 2015 that the validation results confirmed the adequacy of PATH-2016 for simulating the background air quality for the PRD region.   **The Working Group recommended its use in Environmental Impact Assessment (EIA) over the old version in consideration of its incorporation of the latest developments in the field of air quality science, refined calculation algorithm and validation with more recent air quality measurement results.**

10.   PATH-2016 was then rolled out in January 2016 with the relevant program, data, results and tools as well as modelling guidelines published on EPD's webpage.

FUTURE UPDATING WORK

11.   PATH-2016 will be updated every five years with the latest land use, meteorological and emission information. EPD will start the scoping exercise for the next update to PATH-2016 in 2016 with a view to starting the next update in 2017.

Environmental Protection Department
May 2016

Coverage of the Four Domains of PATH-2016
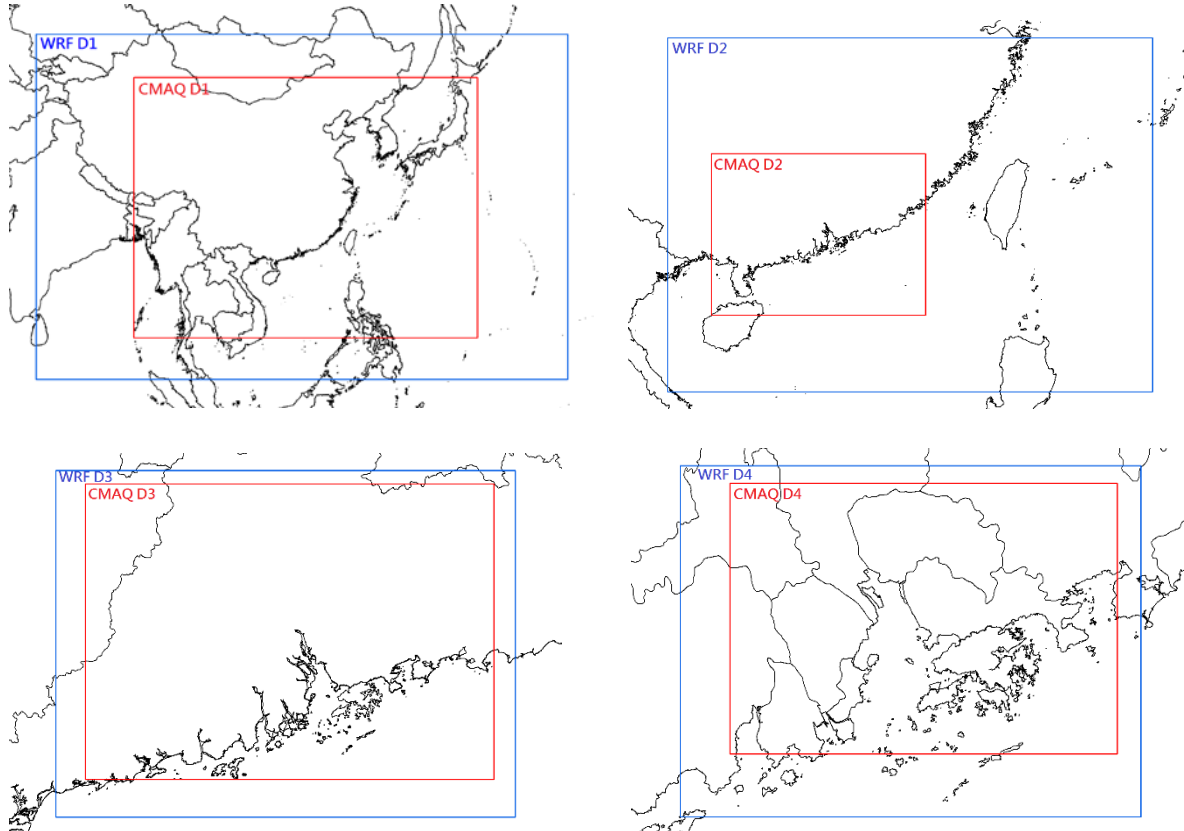
Remark: WRF and CMAQ D1 to D4 in the above figure indicate the coverage of the four domains of the Meteorological Module and Chemistry and Transport Module of PATH-2016, respectively.

Comparison of PATH and PATH-2016

Features	PATH	PATH-2016
Technology	Major components were developed in 90's	Based on the development of the past 10 years
Pollutants and chemical species considered in the model	Ozone, NO, NO_2, SO_2, VOC, TSP and PM10 (total 33 chemical species)	Ozone, NO, NO_2, SO_2, VOC, TSP, PM10 and PM2.5 (total 138 chemical species)
Coverage	Half of the Mainlandand down to North Thailand in the south	Whole of the Mainland and most of Asia
Domain grid sizes	40.5km, 13.5km, 4.5km and 1.5km	27km, 9km, 3km and 1km
Number of vertical layers	19	26
Computation efficiency	Designed for computation on single CPU	Designed for computation on multiple CPUs

**Working Group on Application of Numerical Models to
Environmental Impact Assessment in Hong Kong**

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