User's Manual of ABaCAS-OE

1 Introduction

Optimized Edition of Air Benefit and Control and Attainment Assessment System (ABaCAS-OE) is a system to develop optimized (least cost) control strategies for specified air quality goal. It integrates the five ABaCAS decision support tools (1) an international control cost estimate tool (ICET), (2) a real-time emissions control and air quality response tool (RSM-VAT), (3) a Least Cost Control Optimizer (LE-CO) tool, (4) an air quality attainment assessment tool (SMAT-CE), and (5) a health and economic benefit tool (BenMAP-CE), and provides a user-friendly framework for policy makers to conduct cost-efficient control strategy analysis.

1.1 Functional framework of ABaCAS-OE

ABaCAS-OE links the five ABaCAS tools together to help users to get optimized control strategies for specified air quality attainment by running them with a master script. Fig. 1 shows the functional framework of ABaCAS-OE. Firstly, users set up the attainment goals (e.g., 35 μg m^{-3} for annual mean of $PM_{2.5}$ and 100 ppb for daily 1-hour maxima of O_3). Secondly, the real-time responses of $PM_{2.5}$ and O_3 to emission reduction ratios will be calculated using SMAT-CE by combining with monitor data. Thirdly, the reduction ratios of different pollutants and regions will be input into control cost optimizer (iteration calculation among LECO, ICET and RSM-VAT) to find out optimized control cost strategies for meeting the environmental targets with minimal cost. Later, the optimized control cost strategies will be input into BenMAP-CE to estimate the health and economic benefits resulting from changes in air quality. Finally, it will output a cost/benefit ratio for these optimized emissions control strategies.

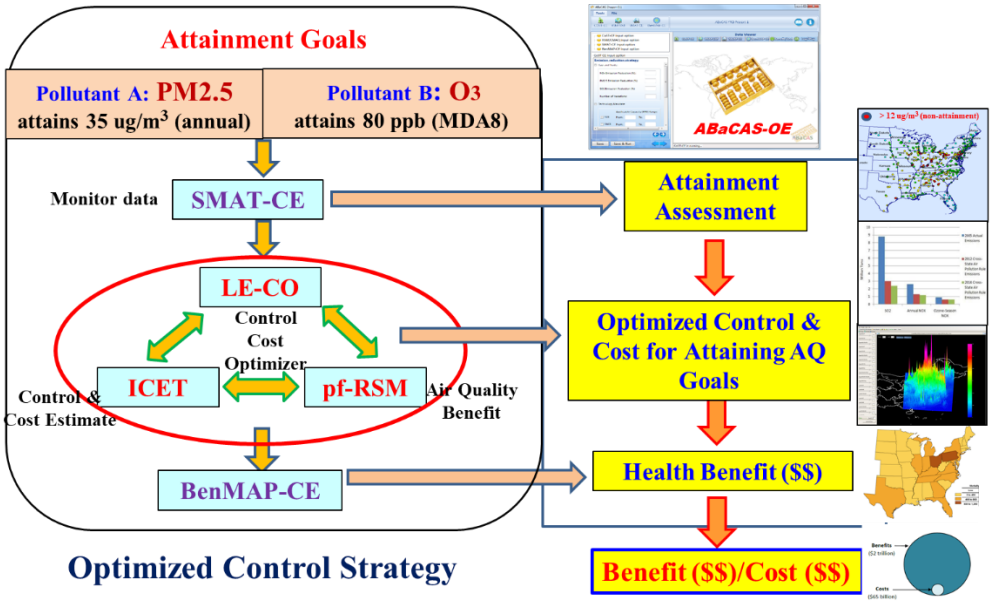

Fig. 1 Functional framework of ABaCAS-OE

1.2 Who Can Use ABaCAS-OE?

ABaCAS-OE can be used by a wide range of persons, including scientists, policy analysts, and decision makers. Most end users (policy makers) can directly use the ABaCAS-OE to select the optimal combination of controls that can not only meet air quality and health benefits standards but are also the most cost-efficient control strategy among all candidates.

In a word, ABaCAS-OE can be used in the following aspects:

➢ **Strategy design and assessment screening tool**

➢ **Optimization**

- Can be used to develop optimal combinations of controls to attain standards at minimum cost.

➢ **"What If?" Analyses**

- Provide real-time cost-benefit results for different attainment scenarios.

1.3 Computer Requirements

ABaCAS-OE requires a computer with:

➢ .Net Framework Version 4.0 or higher.

➢ 32-bit or 64-bit Windows 7/Windows 8/Windows 10.

➢ 2 GB RAM or greater.

➢ 10 GB free disk space or greater.

1.4 Installing/Uninstalling ABaCAS-OE

1.4.1 Installing ABaCAS-OE

➢ Download ABaCAS-OE Software Package on the ABaCAS website. This tool and corresponding example data are available for registered users at this website: http://www.abacas-dss.com/abacas/Software.aspx.

➢ Double click ABaCAS-OE_Setup.exe to install the program, it will appear the following figure.

Fig. 2 Setup Window

➢ Click "**Next**" button, users should choose install location in

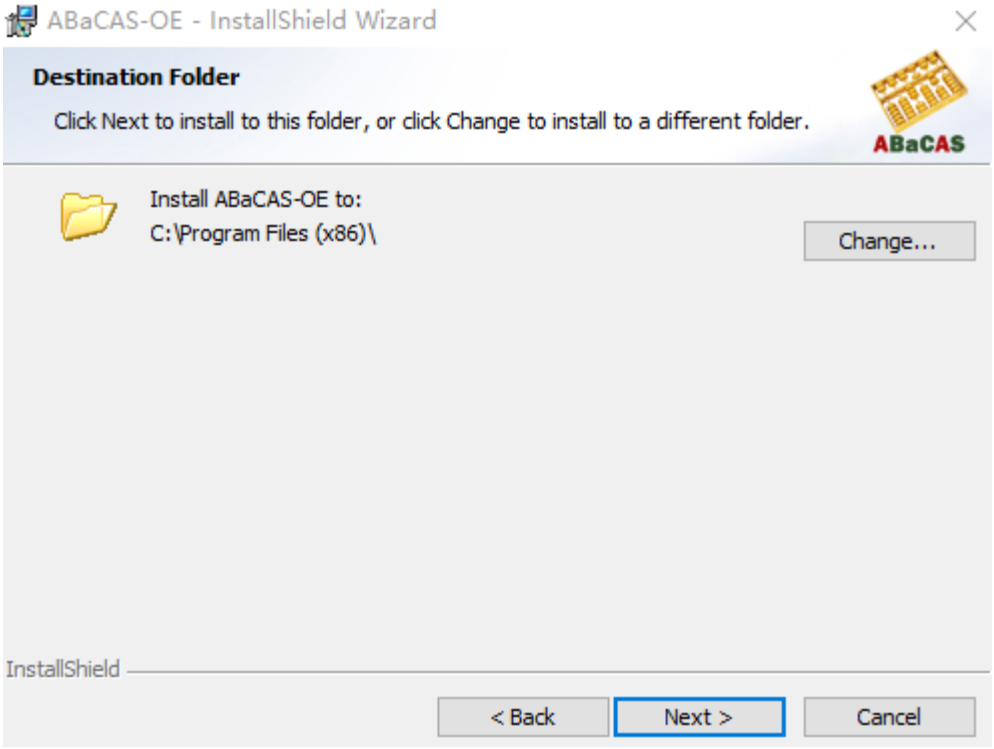

Fig.

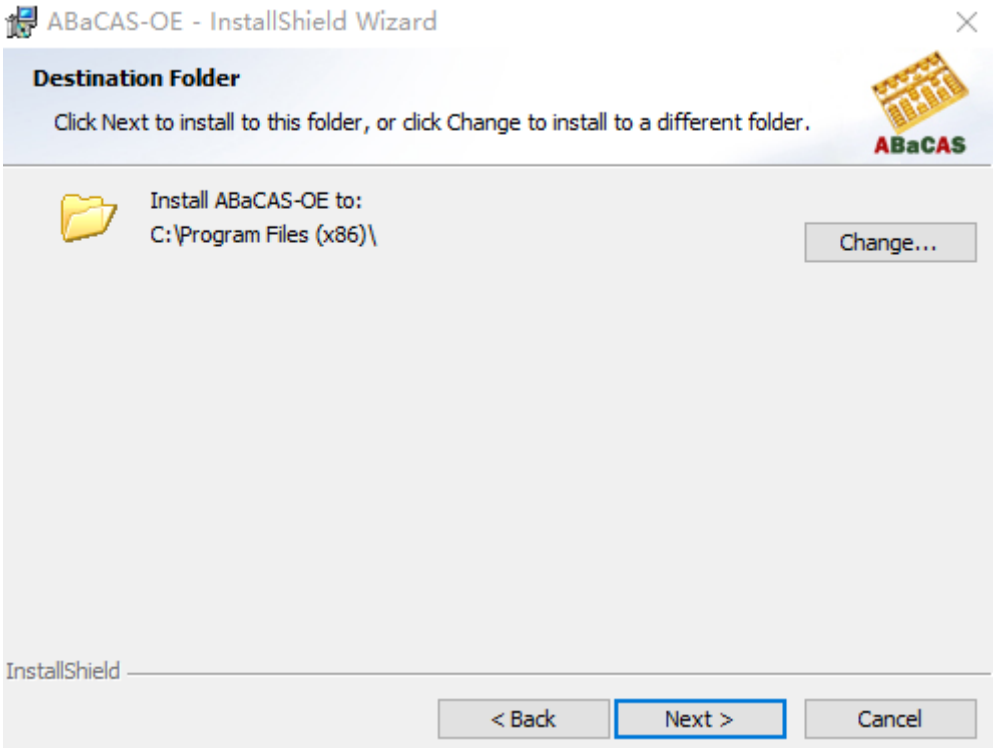

Fig. 3 Choose Install Location

➢ Click "**Next**" button, it will show the "Ready to Install" window as shown in

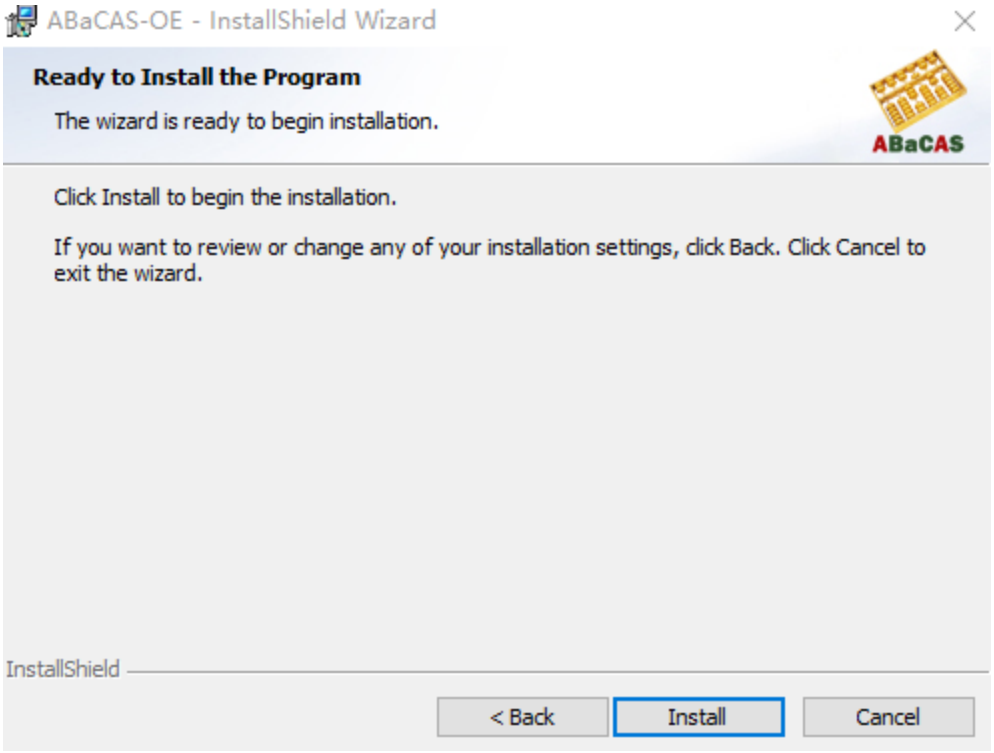

Fig. .

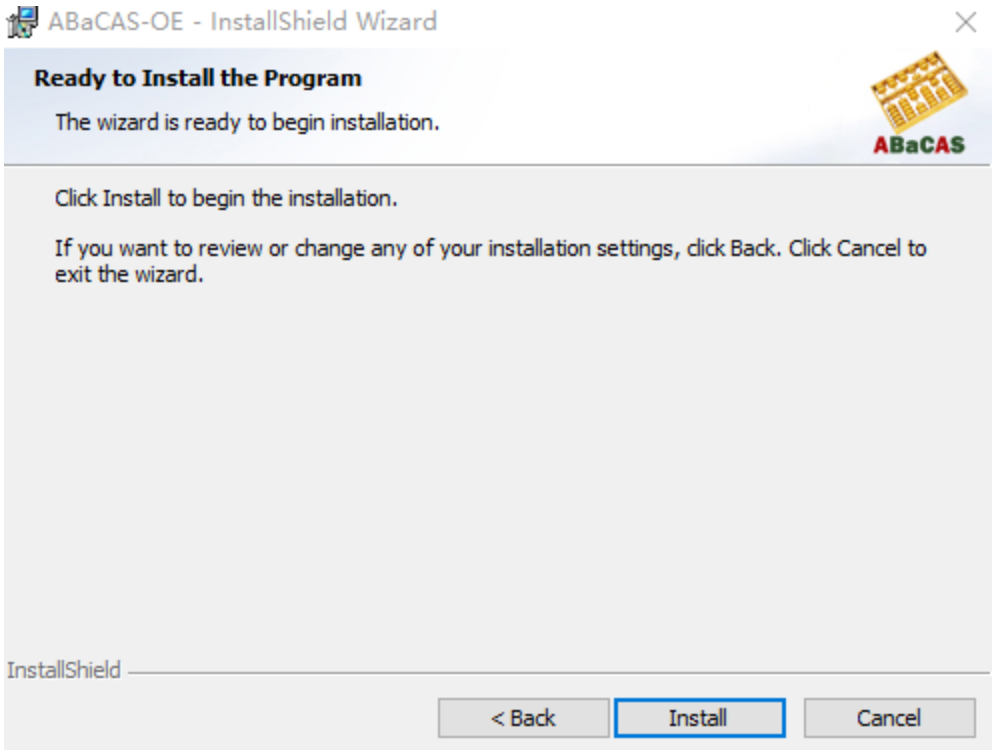

Fig. 4 Ready to Install

➢ Click "**Install**" button and ABaCAS-OE will be installed.

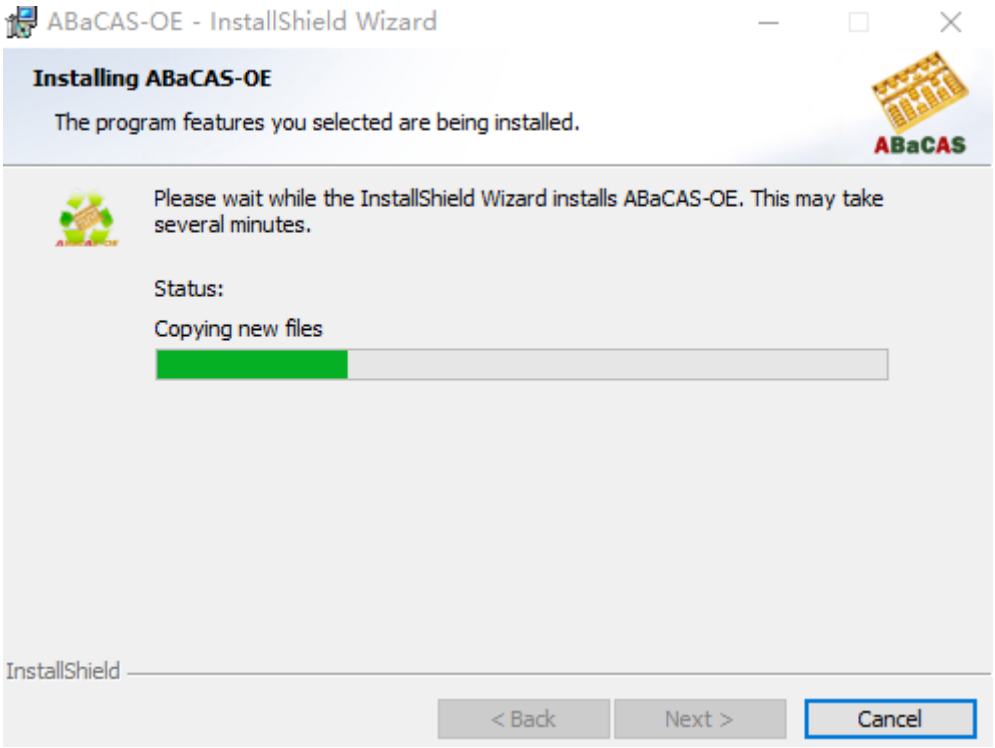

Fig. 3 Installation Processing

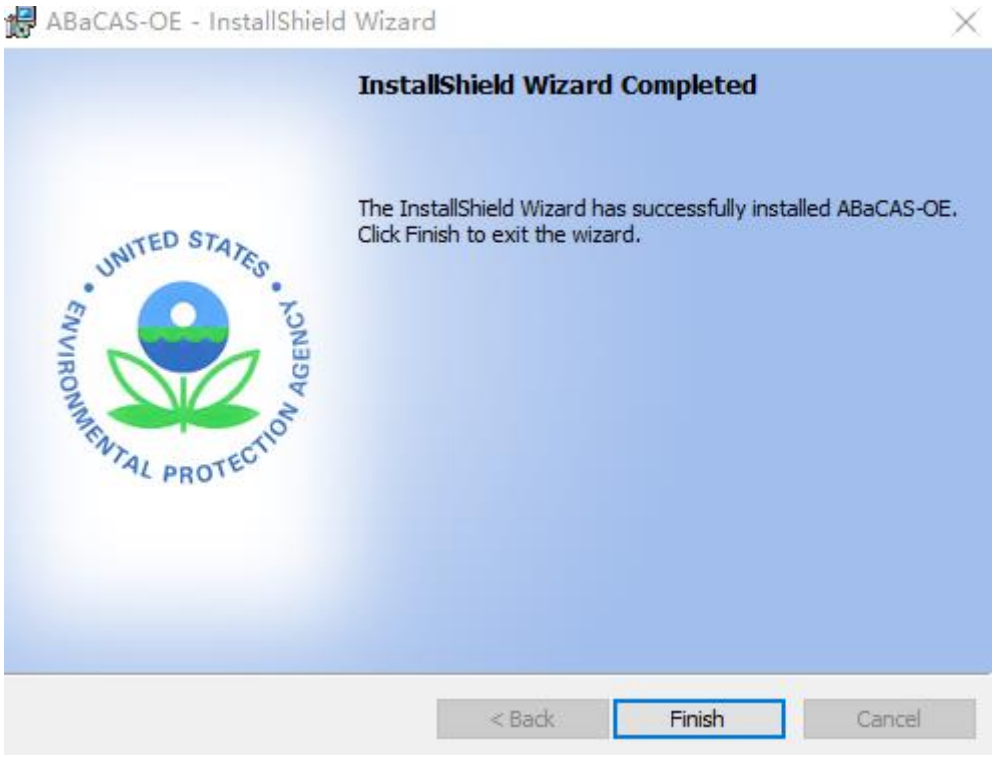

Fig. 4 Installation Complete

➢ Click "**Finish**" button and installation complete.

1.4.2 Uninstalling ABaCAS-OE

➢ Go to Control Panel.

➢ Select ABaCAS-OE and click Change/Remove, it will appear following figure.

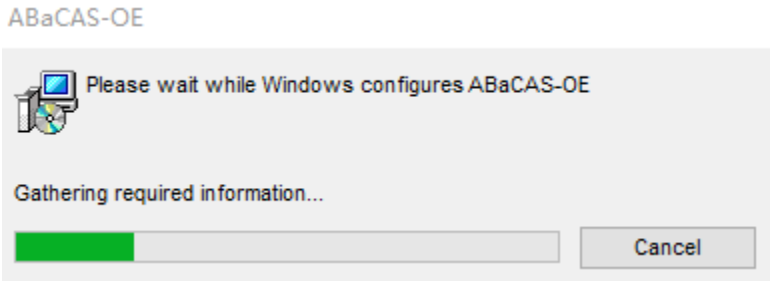

Fig. 5 Uninstallation Processing

➢ After a few seconds, uninstallation will finish.

1.5 Contacts for Comments and Questions

For comments and questions, please contact Prof. Yun (Dustin) Zhu at South China University of Technology, Environmental Simulation and Information Laboratory.

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Email: zhuyun@scut.edu.cn

Telephone: 020-39380017.

1.6 Sources for More Information

For files that you can use in ABaCAS-OE:

➢ Air Benefit and Cost and Attainment Assessment System (ABaCAS) website, available at: http://www.abacas-dss.com/abacas/Software.aspx.

2 Terminology and File Types

The first section of this chapter explains common terms used in this user's manual. Section 2.2 describes in detail the necessary format for externally-generated model and monitor data files that can be read into ABaCAS-OE.

2.1 Common Terms

➢ **ABaCAS-OE: Optimized Edition of Air Benefit and Cost and Attainment Assessment System.**

2.2 File Types

➢ **Base Year PM Monitor Data**: A *.csv file for PM concentration of each monitor site of base year. It contains each site's geographic location、station name and PM concentration.

➢ **Base Year O3 Monitor Data**: A *.csv file for O3 concentration of each monitor

site of base year. It contains each site's geographic location、station name and O3 concentration.

- **Factors File**: A *.csv file for emission factor information. It contains each factor's attributes、size and source.
- **RSM File**: A *.rsm file created by RSM-VAT.
- **Receptor Region File**: A separate *.txt file which defines the grids of the analyzed cities.
- **Mapping File**: it is a simple text file (*.csv), which is used to link the Region, Pollutant, Source in ICET with those in RSM. For example, "Shanghai" used in ICET will be instead of "SH" in RSM.
- **Control Input File**: it should be in the form of a simple text file (*.csv). This file contains:(1) Unit control costs in various control factors under different emission reductions;(2) The default control level;(3) Unit of Emission and Cost;

Data Sources mainly come from those control strategy models (e.g., EMF/CoST, GCAM, TECAS, GAINS-Asia, LEAP, etc.) or research reports/references or field investigation of local factories in the areas/cities.

- **Pooled Grid Definition**: it is used to aggregate the grid value into the value of a target region level (e.g., county or state level). It is noted that this file should have overlaps with the grid definition file in SMAT-CE input options.
- **CFG Configuration File**: it is a configuration file (*.cfgx), which is used for health impact assessment.
- **APV Configuration File**: it is a configuration file (*.apvx or *.apvrx), which is used for environmental benefit assessment.

Table 1 presents the above the different file types, their name and their file extension.

Table 1 File types generated by ABaCAS-OE

Filename	File Extension
Base Year PM Monitor Data	*.csv
Base Year O3 Monitor Data	*.csv
Factors file	*.csv
RSM file	*.rsm
Receptor Region file	*.txt
Mapping file	*.csv

Control Input file	*.csv
Pooled Grid Definition	*.shp
CFG Configuration File	*.cfgx
APV Configuration File	*.apvx or *.apvrx

3 Main Interface

The main interface of ABaCAS-OE can be shown in Fig. .

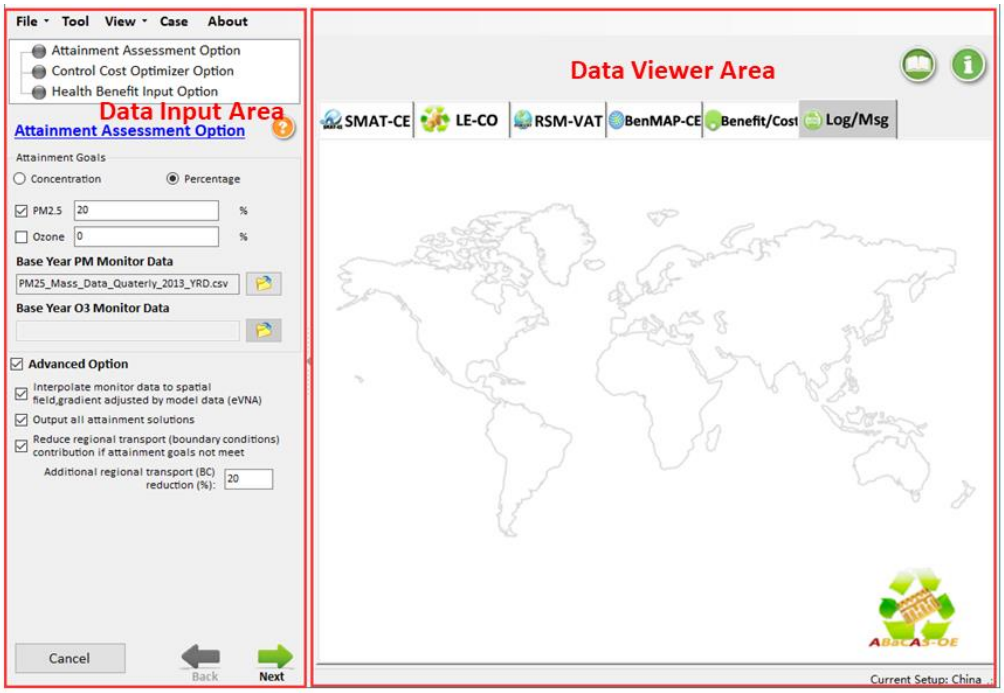


Fig. 8 Main interface of ABaCAS-OE

➢ Click **File** button on the toolbar of the main interface, there are six options that users can choose.

1) Go to file, click **Open Projec**t button, locate the *.proj file and open it.
2) Click **New Project** button to create a new project.
3) Click **Save Project** button to save a created project.
4) Click **Example Cases** button to use the configuration files of the relevant projects that have been configured without having to select and set each module one by one.
5) Click **Options** button to modify the executable path of each subsystem of ABaCAS-OE and data storage path.
6) Click **Exit** button to exit system.

➢ Click **Tool** button to set and run related tools individually according to the needs of users, including ICET, RSM-VAT, SMAT-CE and BenMAP-CE.

➢ Click **View** button on the toolbar of the main interface, there are two options that users can choose.

1) Click **Setting Viewer** button to view the setting interface.

2) Click **Data Viewer** button to view the visual analysis interface.

➢ Click **Case** button to view the existing case studies in China, the US or the other regions.

➢ Click **About** button to see the version and copyright information of ABaCAS-OE.

➢ In addition, there are three different input options for inputting different data or configurating the calculation parameters, including Attainment Assessment Option, Control Cost Optimizer Option and Health Benefit Input Option.

3.1 Attainment Assessment Option

➢ The Attainment Assessment Option includes **Attainment Goals**, **Base Year PM Monitor Data, Base Year O3 Monitor Data** and **Advanced Option**, as shown in 错误!未找到引用源。.

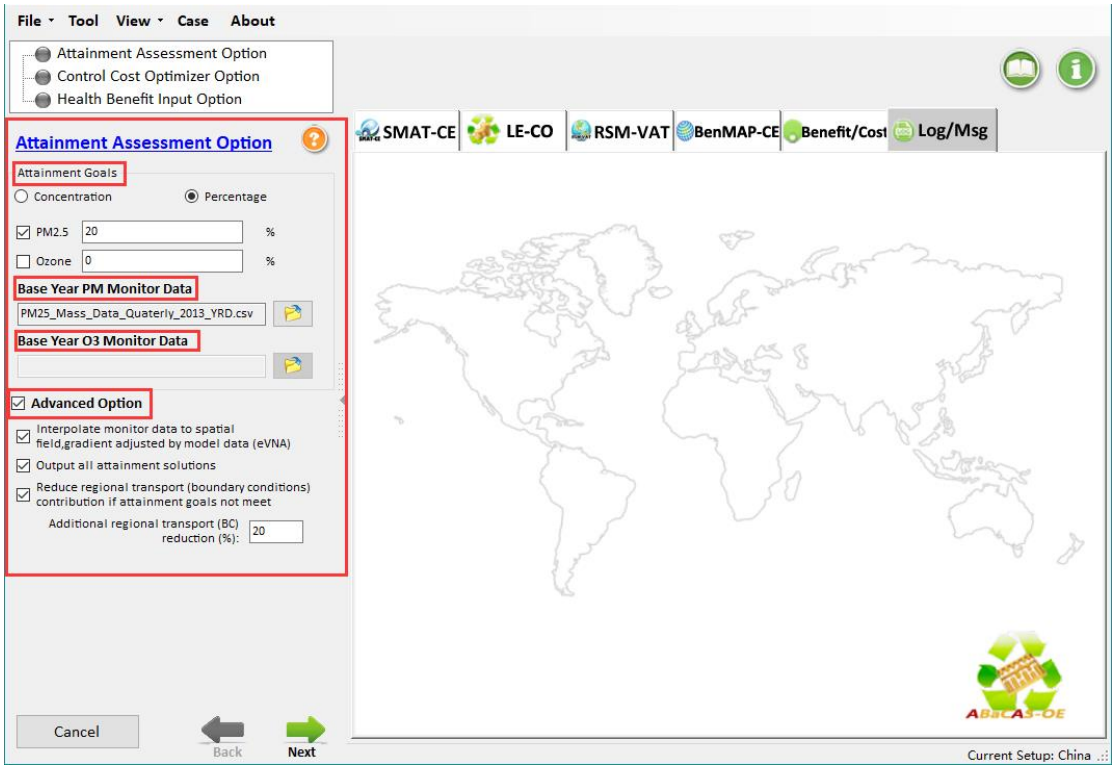


Fig. 9 Attainment Assessment Option

➢ **Attainment Goals:** allows users to set the target concentration/percentage while selecting target pollutant. For example, users can choose $PM_{2.5}$ or ozone, or both as target pollutant according to their needs. And then, users can set their target concentration/percentage.

➢ **Base Year PM Monitor Data:** If users choose PM as target pollutant, they need to set the corresponding baseline monitor data. With these data, the rationality of the model prediction value can be guaranteed.

➢ **Base Year O3 Monitor Data:** If users choose O_3 as target pollutant, they need to set the corresponding baseline monitor data. With these data, the rationality of the model prediction value can be guaranteed.

➢ **Advanced Option:** allows users to set more options. For example, users can check "eVNA" to interpolate monitor data to spatial field，gradient adjusted by model data, check "Output all attainment solutions" or not to output only one optimal attainment solution and check "Reduce regional transport (boundary conditions) contribution" to output attainment solutions if all the previous simulation solutions are not meet attainment goal.

3.2 Control Cost Optimizer Option

➢ The Control Cost Optimizer Option includes **LE-CO Calculation Input options**, **RSM Input Options** and **ICET Input Options**, as shown in **错误!未找到引用源。**.

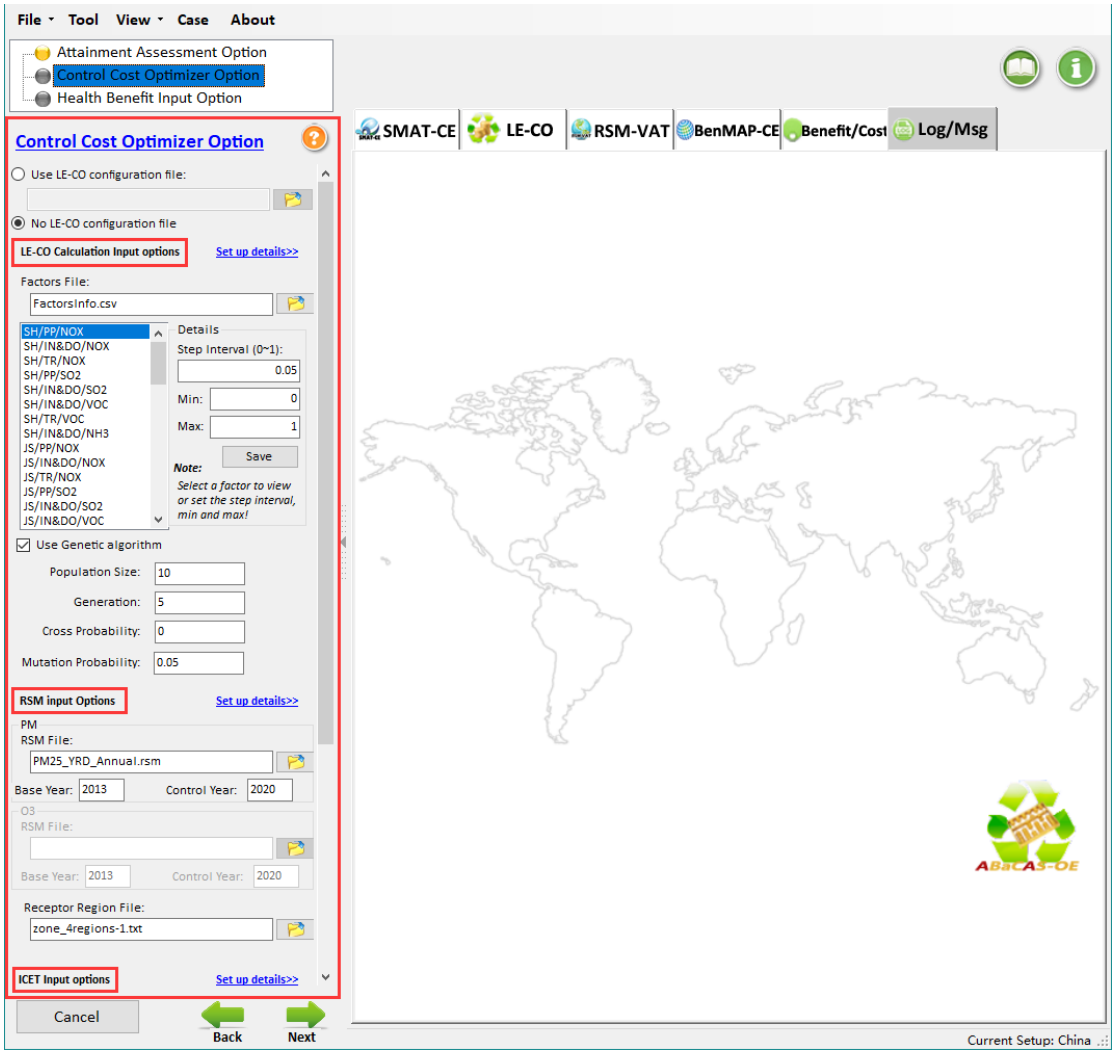


Fig. 10 Control Cost Optimizer Option

3.2.1 LE-CO Calculation Input options

➢ The LE-CO Calculation Input options include **Factors File**, **Details** and **Use Genetic algorithm**, as shown in 错误!未找到引用源。. In addition, user can choose whether or not to use LE-CO configuration file.

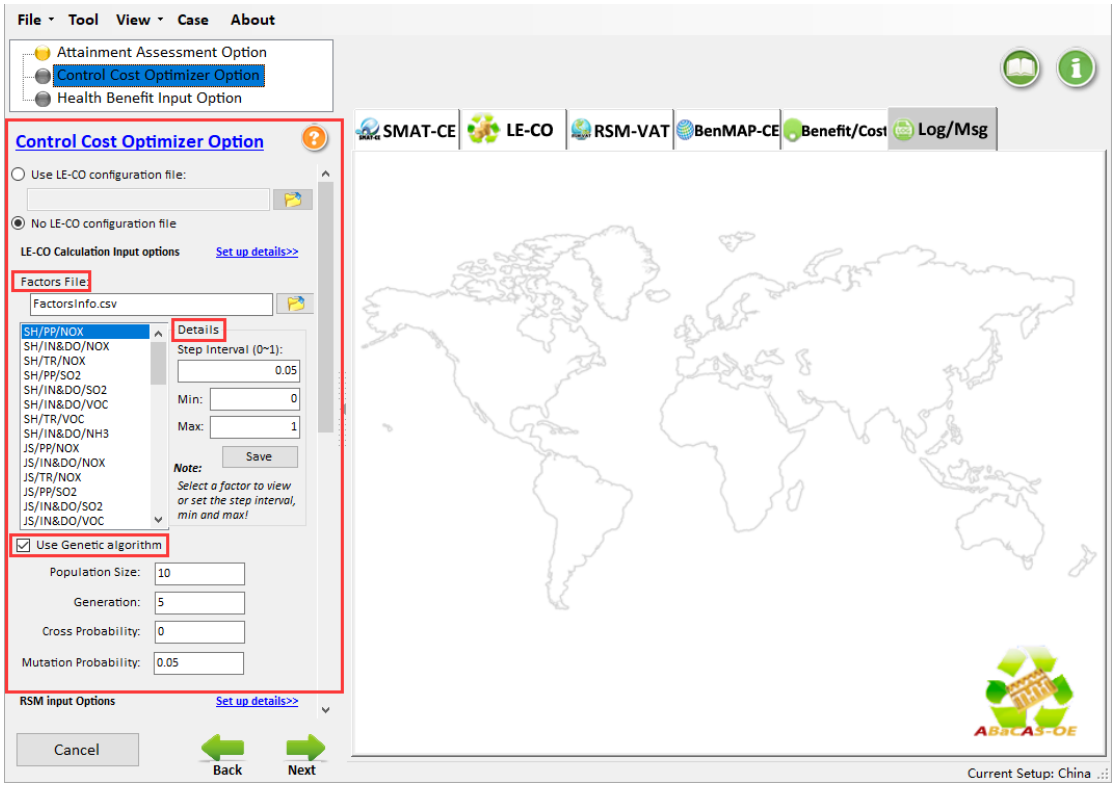


Fig. 11 LE-CO Calculation Input options

➢ **Factors File:** allows users to set the factors of specific region.

➢ **Details:** allows users to determine the number of control scenarios by setting the step interval, minimum and maximum values.

➢ **Use Genetic algorithm:** allows users to use "Population Size" to set the number of original scenarios, use "Generation" to set the number of iterations and use "Cross Probability" or "Mutation Probability" to set the range of changing randomly for factors. These choosing of parameters depend on the numbers of factors. With the growing of iterations, the calculation will be convergent to an optimal solution.

3.2.2 RSM Input options

➢ The RSM Input Options allow users to set **RSM File** based on different pollutants and select two pollutants simultaneously, as shown in **错误!未找到引用源。**.

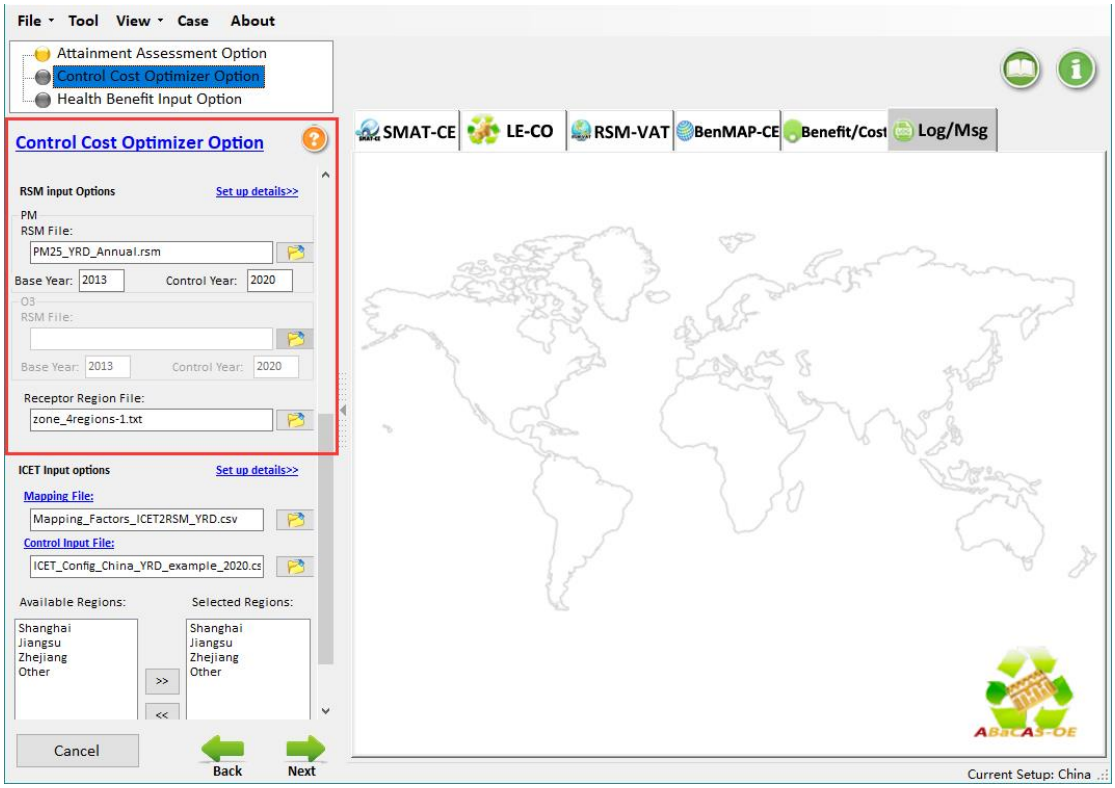


Fig. 12 RSM Input options

3.2.3 ICET Input options

➢ The ICET Input Options allow users to set **Mapping File** and **Control Input File**. And users can also select specific region for calculation and analysis, as shown in 错误!未找到引用源。.

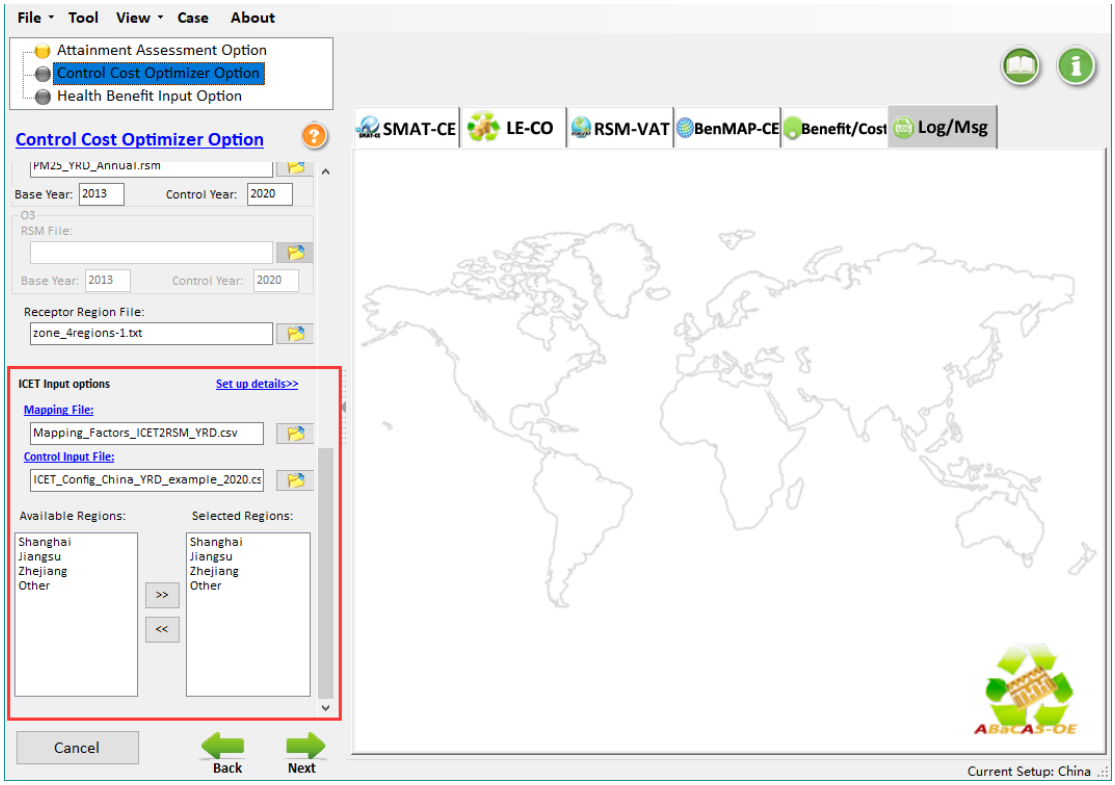


Fig. 13 ICET Input options

3.3 Health Benefit Input Option

➢ The Health Benefit Input Option includes **Pooled Grid Definition**, **CFG configuration file or result file**, **APV configuration file or result file** and **Audit Trail Report**, as shown in **错误!未找到引用源。**.

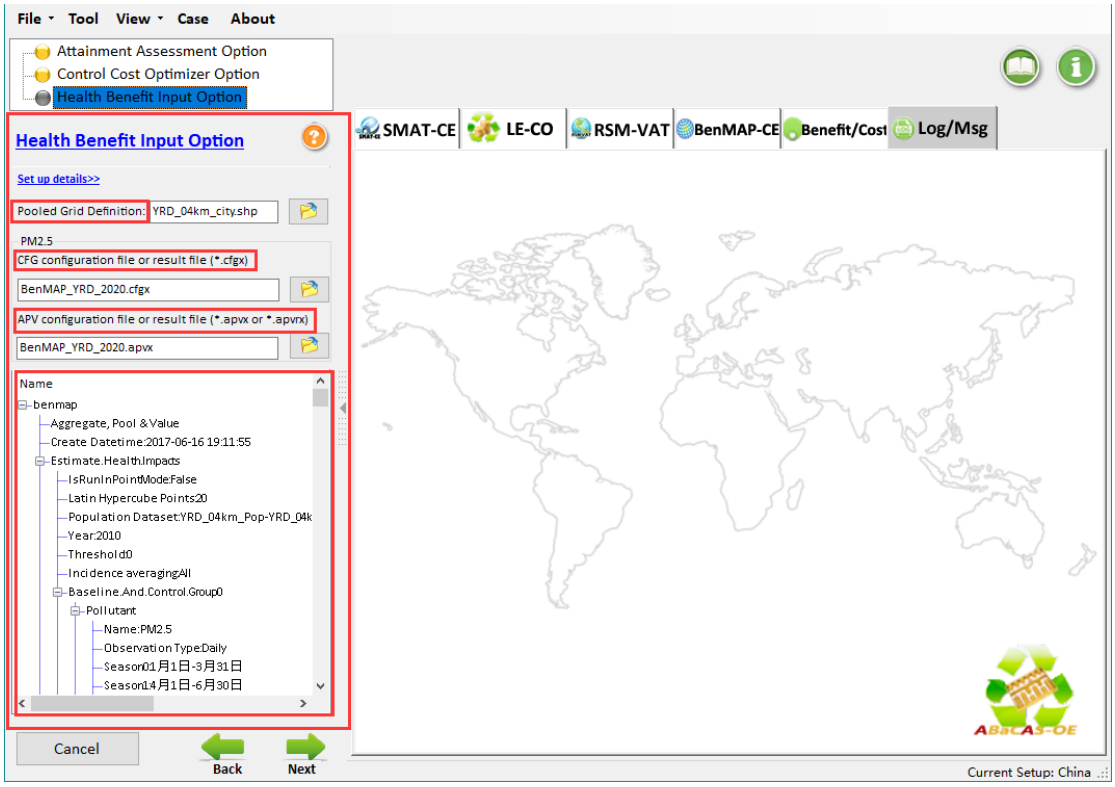


Fig. 14 Health Benefit Input Option

➢ **Pooled Grid Definition:** allows users to set the grid information of specific region.

➢ **CFG configuration file or result file:** includes a list of parameter information needed for a health impact assessment.

➢ **APV configuration file or result file:** includes a list of parameter information needed for an environmental benefit assessment.

➢ **Audit Trail Report:** allows users to view the detailed configuration information.

4 Run ABaCAS-OE

After the input settings are complete, users need to click "**Next**" to start running ABaCAS-OE. And users can view the running messages through "**Log/Msg**", as shown in 错误!未找到引用源。.

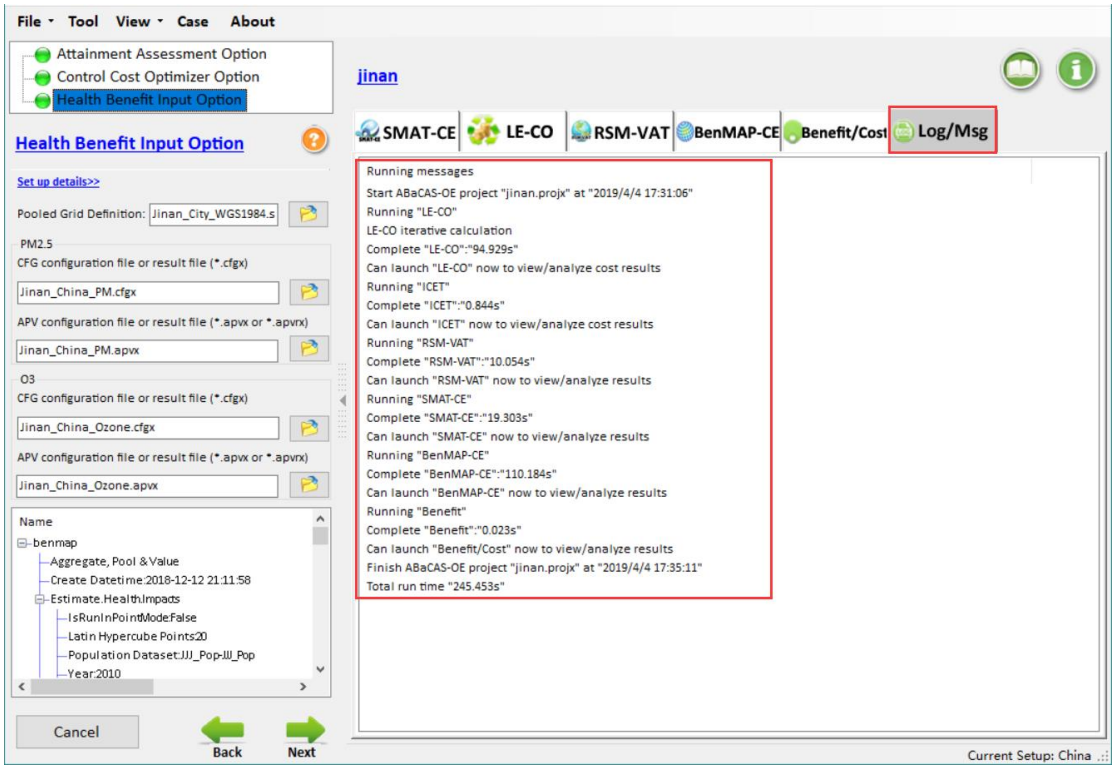


Fig. 15 Running Messages

5 Operation Results

When the ABaCAS-OE is finished, the system provides various display ways for its four subsystems (SMAT-CE, LE-CO, RSM-VAT and BenMAP-CE) of visualized analysis, including **MAP**, **GIS**, **Chart** or **Data**, as shown in **错误!未找到引用源。**.

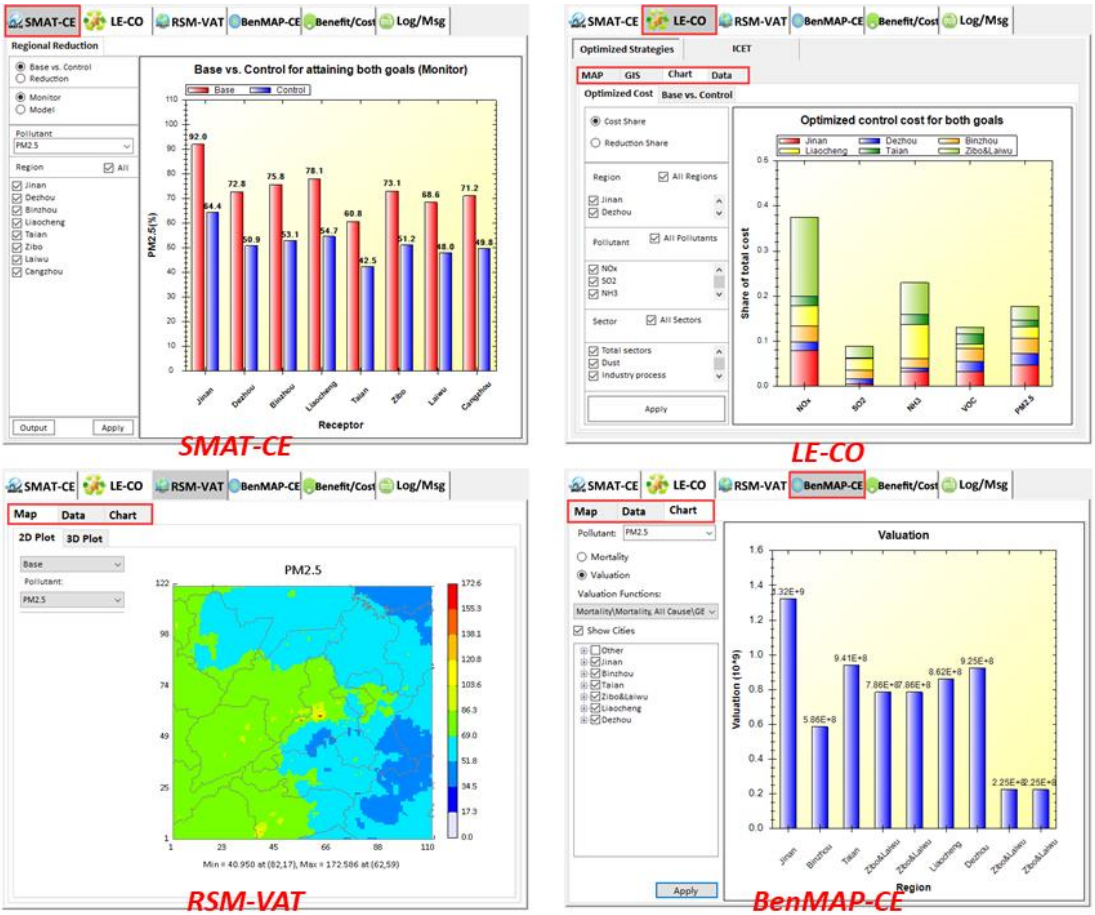


Fig. 16 Data Viewer of ABaCAS-OE results

5.1 The results of SMAT-CE

➢ In Chart module, users can view the comparison between the baseline and predicted values and their reductions of different regions/cities, including configurating plot according to their preferences, as shown in Fig. .

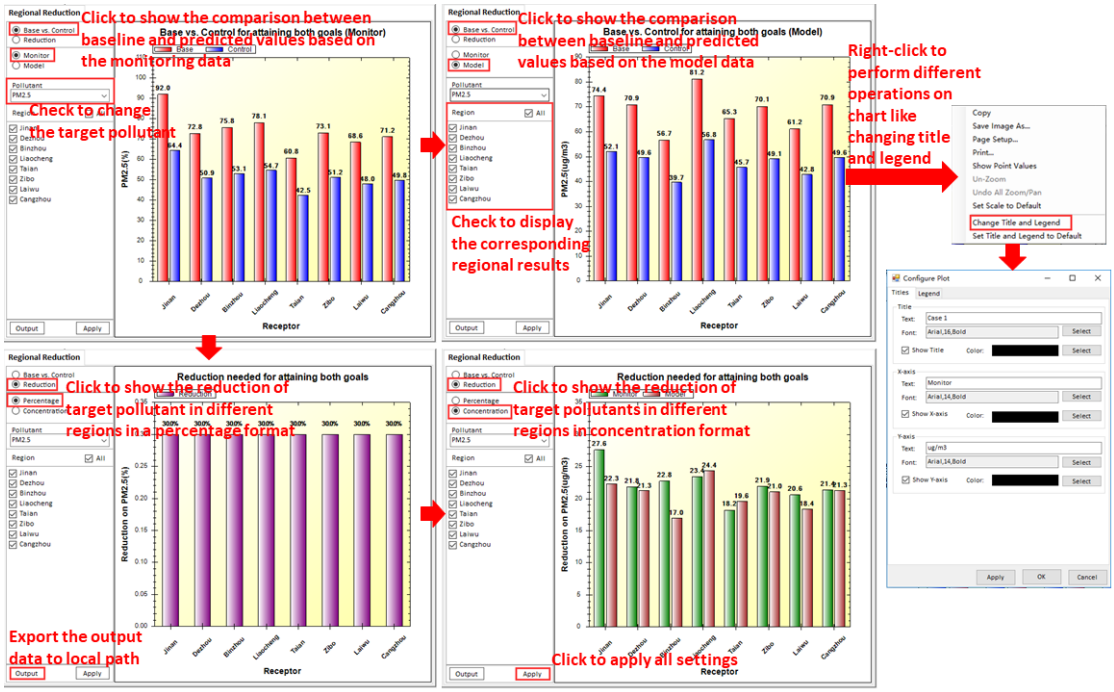


Fig. 17 Chart results and configuration options of SMAT-CE

5.2 The results of LE-CO

5.2.1 The results of Optimized Strategies

➢ In Map module, users are allowed to show the concentration distribution of different attainment scenarios. Users can also set specific plot type and perform different operations on map (e.g., zoom in or zoom out domain), as shown in Fig. 18.

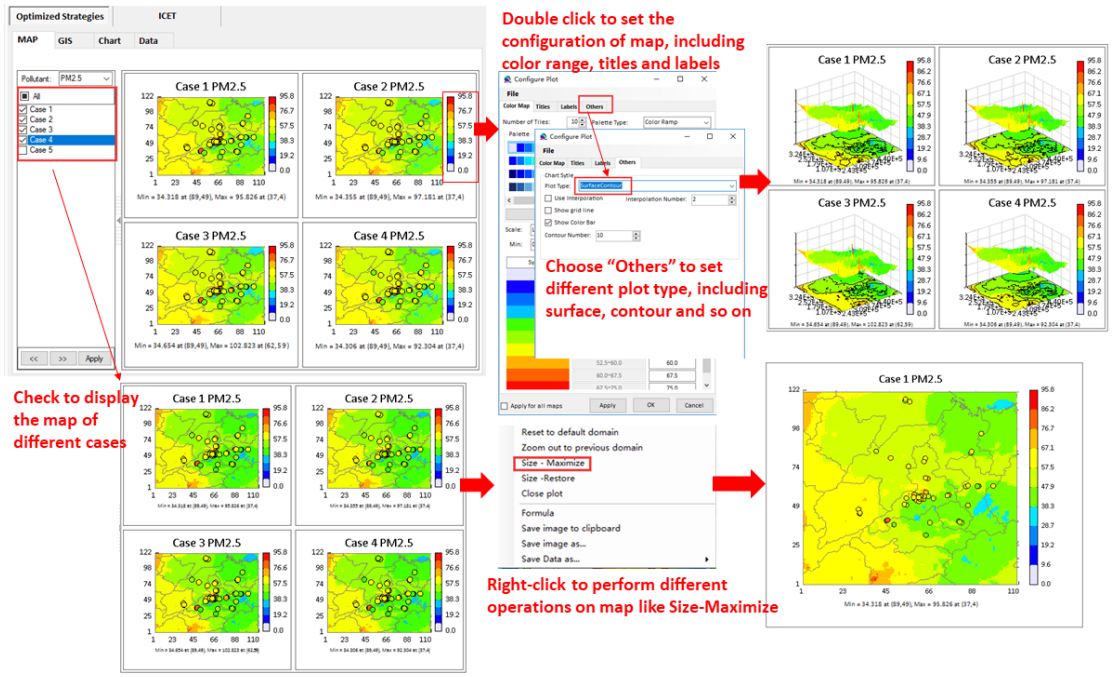


Fig. 18 Map results and configuration options of Optimized Strategies

➢ In GIS module, it allows users to view the attainment results of different scenarios in each monitor site. It also provides a function for user to configurate legend as needed, as shown in Fig. .

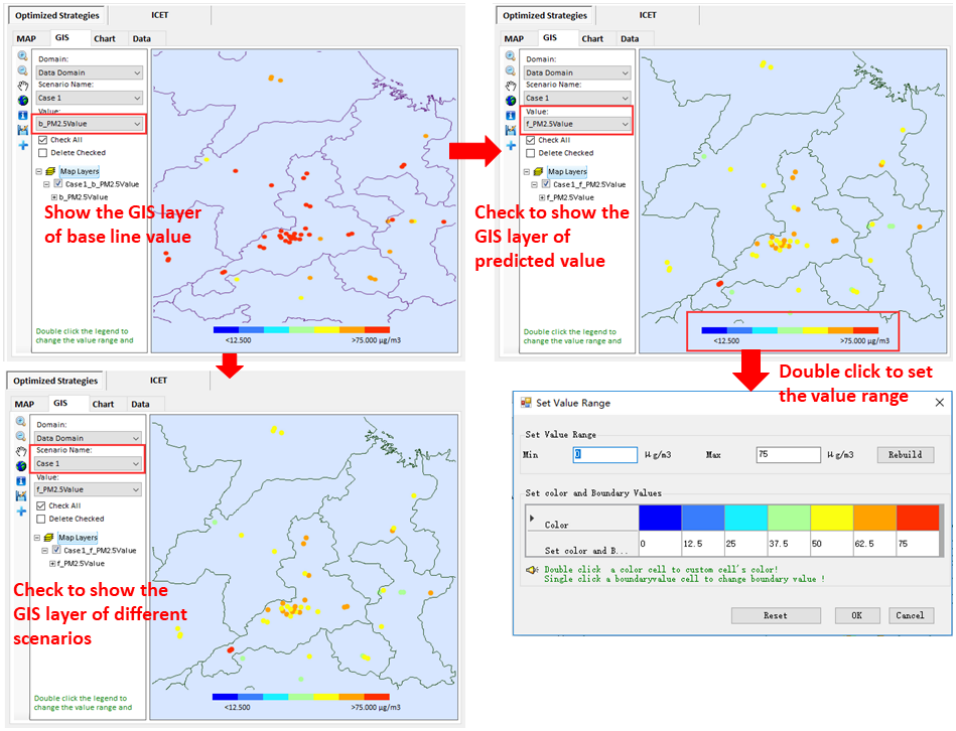


Fig. 19 GIS results and configuration options of Optimized Strategies

➢ In Chart module, users can also view the results of different scenarios and monitoring sites, including configurating plot according to their preferences, as shown in Fig. .

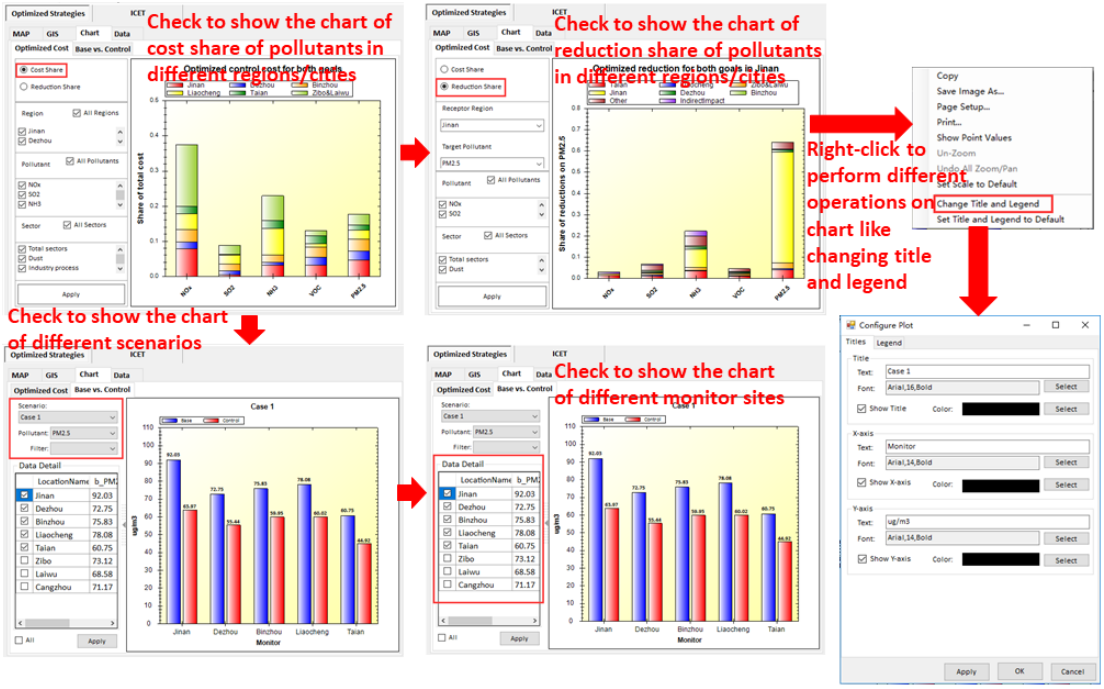


Fig. 20 Chart results and configuration options of Optimized Strategies

➢ In Data module, it provides more details information for each attainment scenario, e.g., control cost, attainment concentration for each monitor sites and emission reduction and so on. Users can check their interest fields to show or export data for further study, as shown in Fig. .

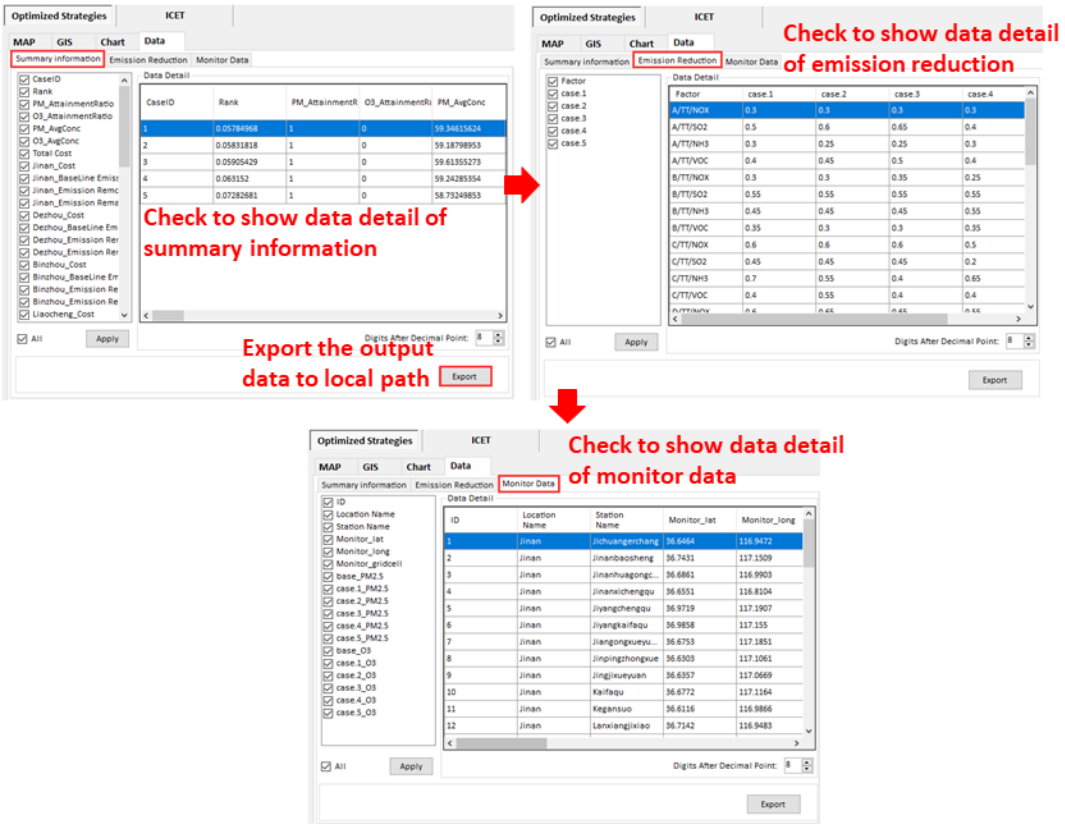


Fig. 21 Data detail results and configuration of Optimized Strategies

5.2.2 The results of ICET

➢ In Data module, it provides more details information about pollutant control strategies, e.g., total removal cost, removal cost of each pollutant, and baseline emission and so on. Users can check their interest fields to show or export data for further study, as shown in Fig. .

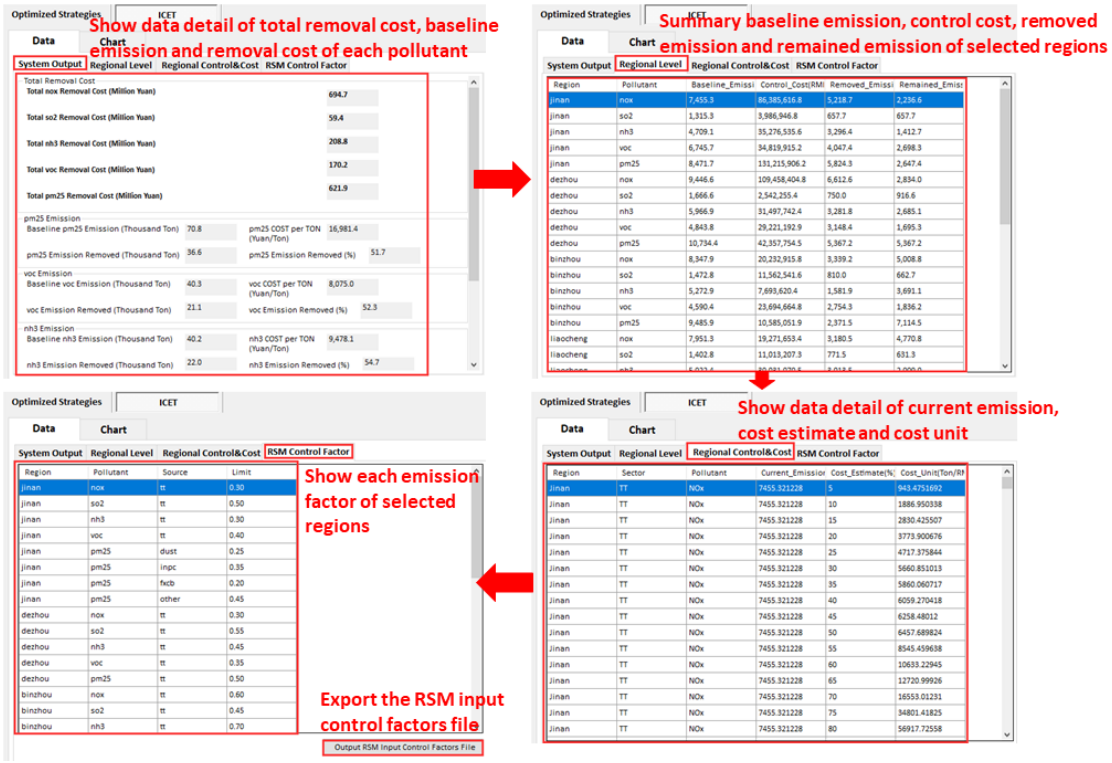


Fig. 22 Data detail results and configuration of ICET

➢ In Chart module, users can also view the results of different pollutant control strategies, including configurating plot according to their preferences, as shown in Fig. .

Fig. 23 Chart results and configuration options of ICET

5.3 The results of RSM-VAT

➢ In Map module, users are allowed to show the concentration that responds in real time to the emission reduction control. Users can also set specific plot type and perform different operations on map (e.g., zoom in or zoom out domain), as shown in Fig. 24.

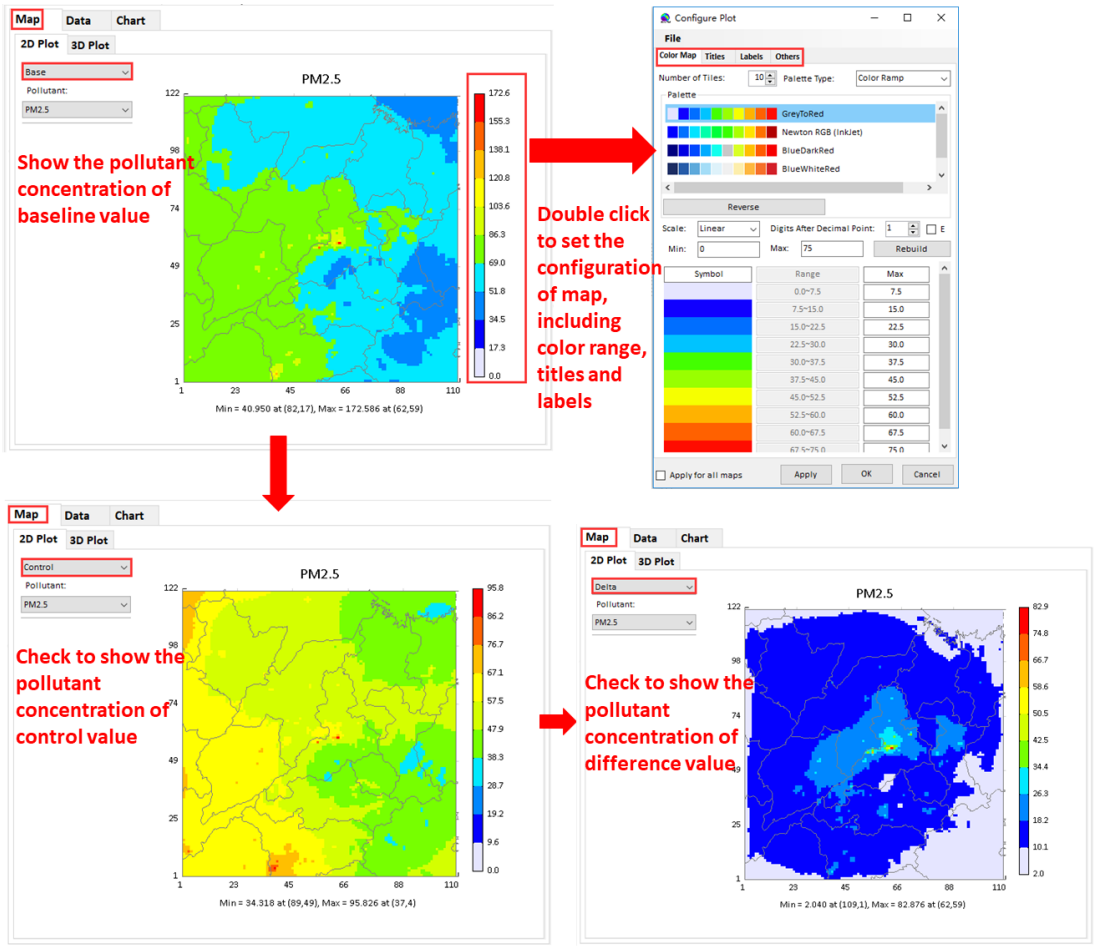
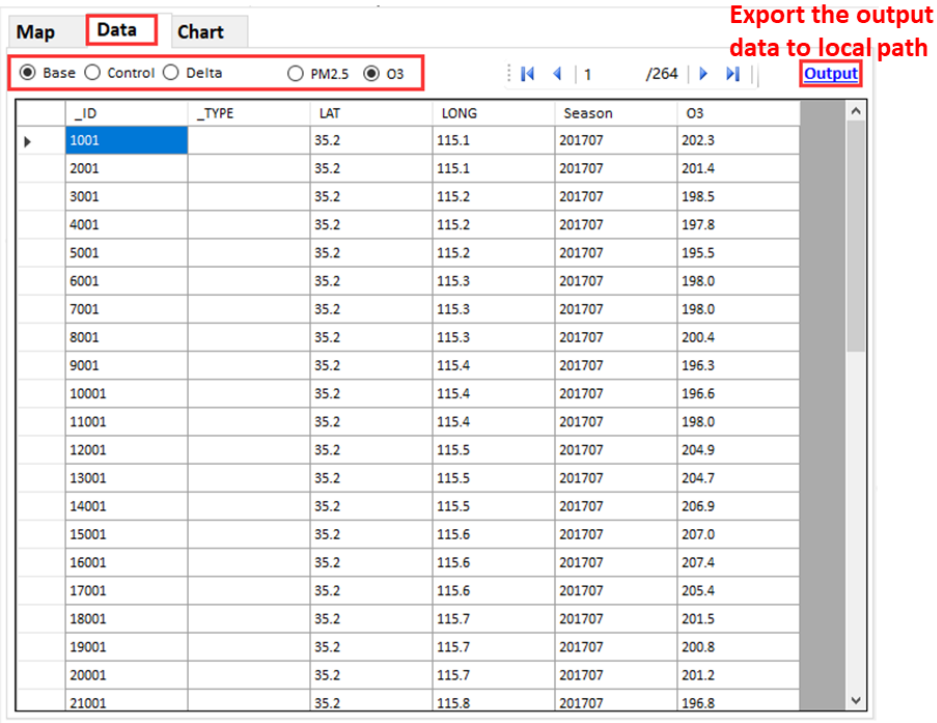


Fig. 24 Map results and configuration options of RSM-VAT

➢ In Data module, it provides more details information about concentration of selected pollutant e.g., baseline value, control value, and difference value and so on. Users can check their interest fields to show, as shown in Fig. .



_ID	_TYPE	LAT	LONG	Season	O3
1001		35.2	115.1	201707	202.3
2001		35.2	115.1	201707	201.4
3001		35.2	115.2	201707	198.5
4001		35.2	115.2	201707	197.8
5001		35.2	115.2	201707	195.5
6001		35.2	115.3	201707	198.0
7001		35.2	115.3	201707	198.0
8001		35.2	115.3	201707	200.4
9001		35.2	115.4	201707	196.3
10001		35.2	115.4	201707	196.6
11001		35.2	115.4	201707	198.0
12001		35.2	115.5	201707	204.9
13001		35.2	115.5	201707	204.7
14001		35.2	115.5	201707	206.9
15001		35.2	115.6	201707	207.0
16001		35.2	115.6	201707	207.4
17001		35.2	115.6	201707	205.4
18001		35.2	115.7	201707	201.5
19001		35.2	115.7	201707	200.8
20001		35.2	115.7	201707	201.2
21001		35.2	115.8	201707	196.8

Fig. 25 Data detail results and configuration of RSM-VAT

➢ In Chart module, users can also view the emission reduction effects of emission control, including configurating plot according to their preferences, as shown in Fig. .

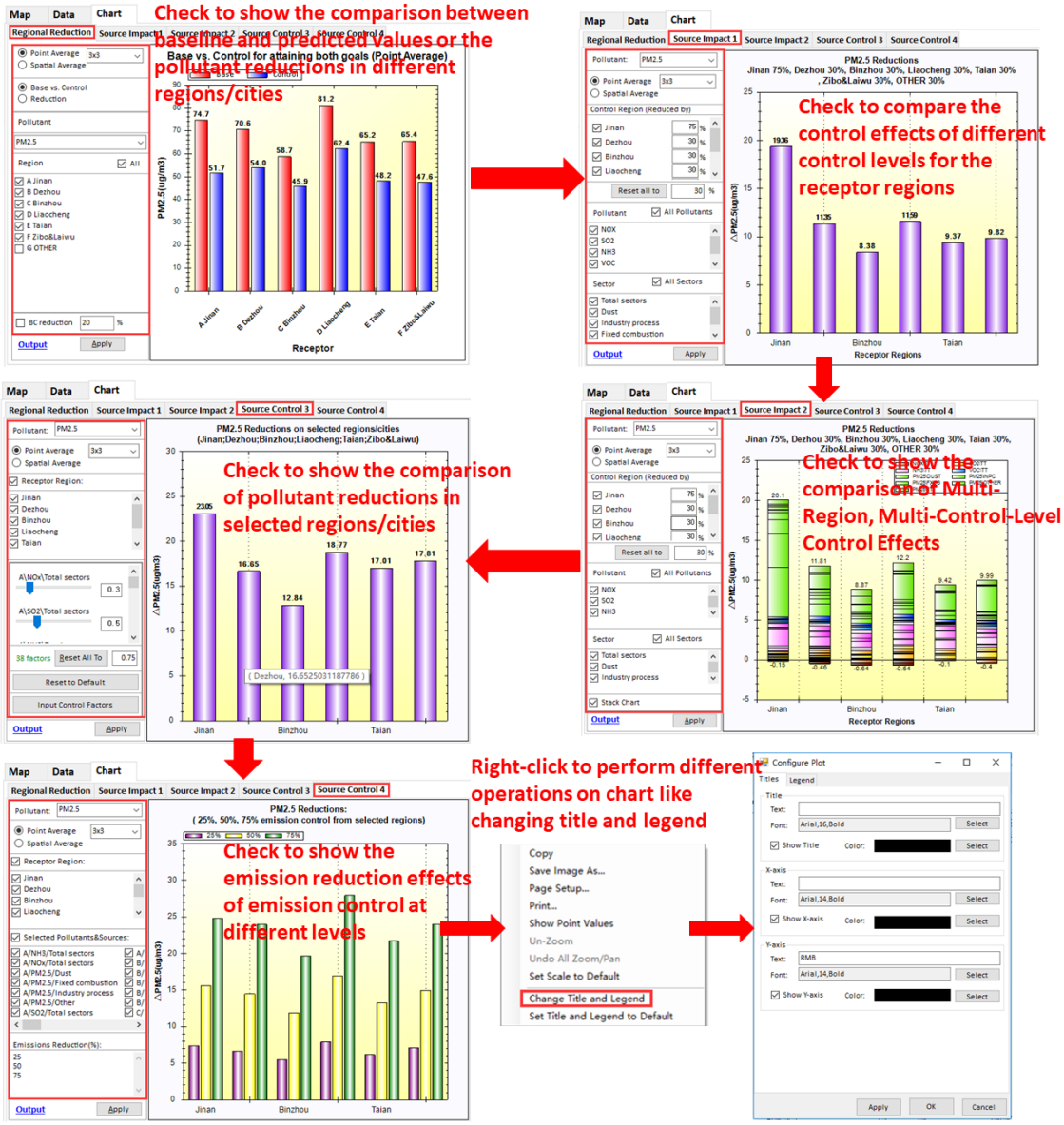


Fig. 26 Chart results and configuration options of RSM-VAT

5.4 The results of BenMAP-CE

➢ In Map module, users are allowed to show the mortality and valuation results. Users can also confugurate legend as needed, as shown in Fig. 27.

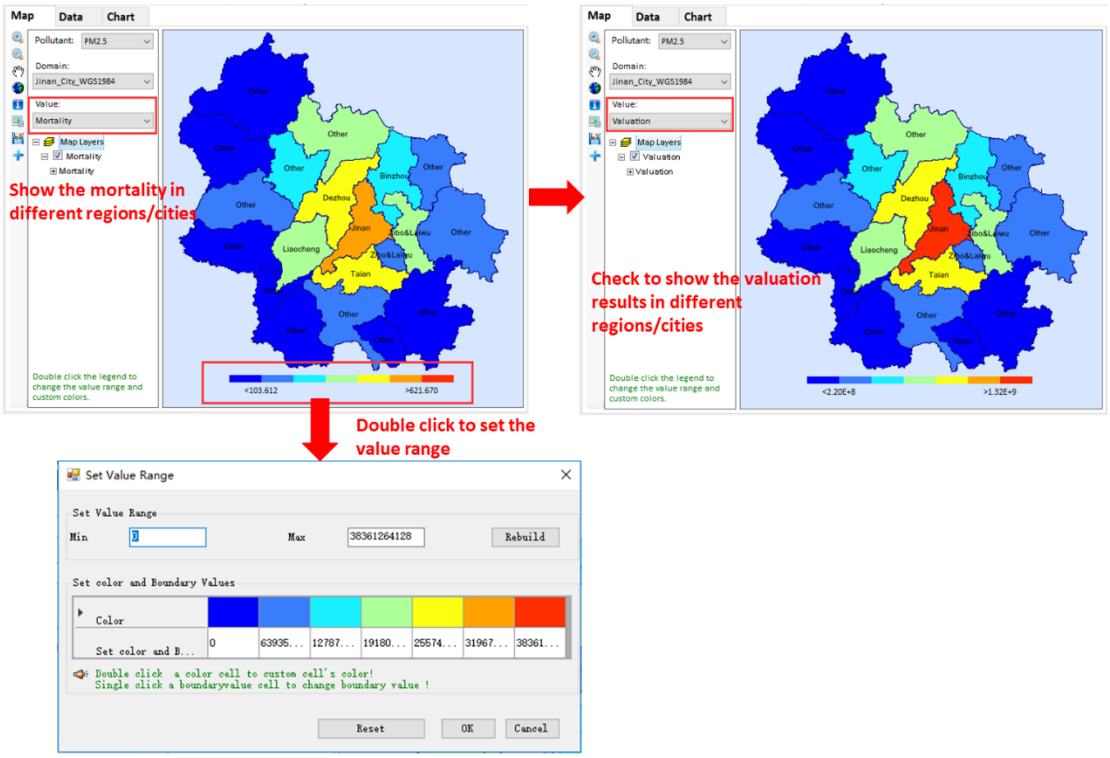
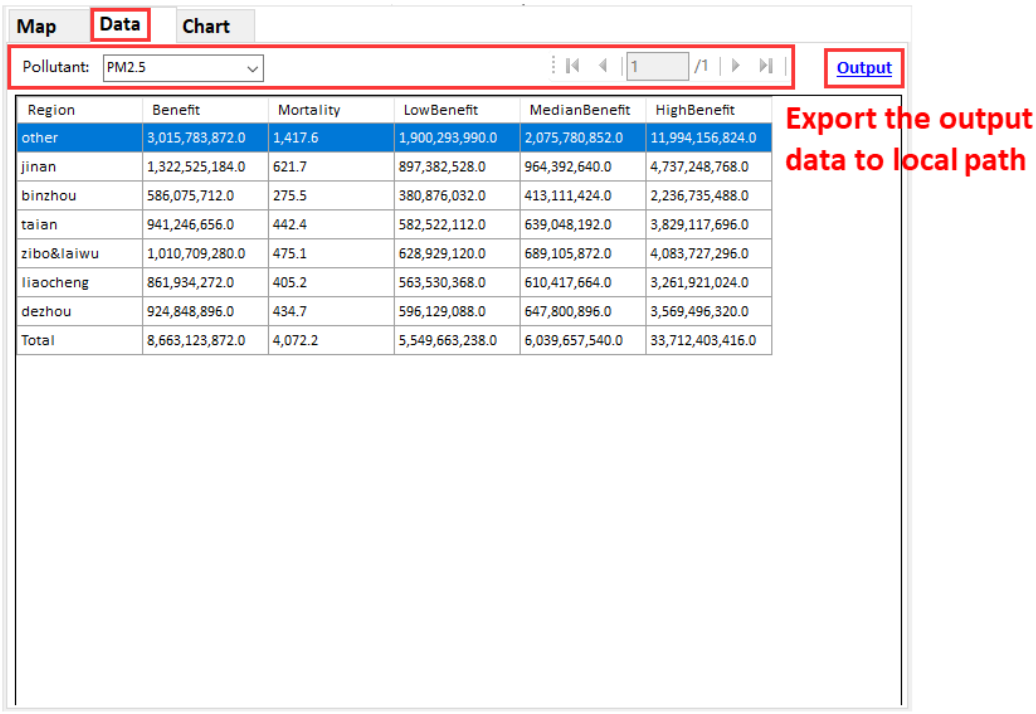


Fig. 27 Map results and configuration options of BenMAP-CE

➢ In Data module, it provides more details information about mortality and a range of benefits of each region e.g., low benefit, median benefit, high benefit and so on, as shown in Fig. .



Region	Benefit	Mortality	LowBenefit	MedianBenefit	HighBenefit
other	3,015,783,872.0	1,417.6	1,900,293,990.0	2,075,780,852.0	11,994,156,824.0
jinan	1,322,525,184.0	621.7	897,382,528.0	964,392,640.0	4,737,248,768.0
binzhou	586,075,712.0	275.5	380,876,032.0	413,111,424.0	2,236,735,488.0
taian	941,246,656.0	442.4	582,522,112.0	639,048,192.0	3,829,117,696.0
zibo&laiwu	1,010,709,280.0	475.1	628,929,120.0	689,105,872.0	4,083,727,296.0
liaocheng	861,934,272.0	405.2	563,530,368.0	610,417,664.0	3,261,921,024.0
dezhou	924,848,896.0	434.7	596,129,088.0	647,800,896.0	3,569,496,320.0
Total	8,663,123,872.0	4,072.2	5,549,663,238.0	6,039,657,540.0	33,712,403,416.0

Fig. 28 Data detail results of BenMAP-CE

➢ In Chart module, users can also visually view the mortality and valuation results in different regions/cities, including configurating plot according to their preferences, as shown in Fig. .

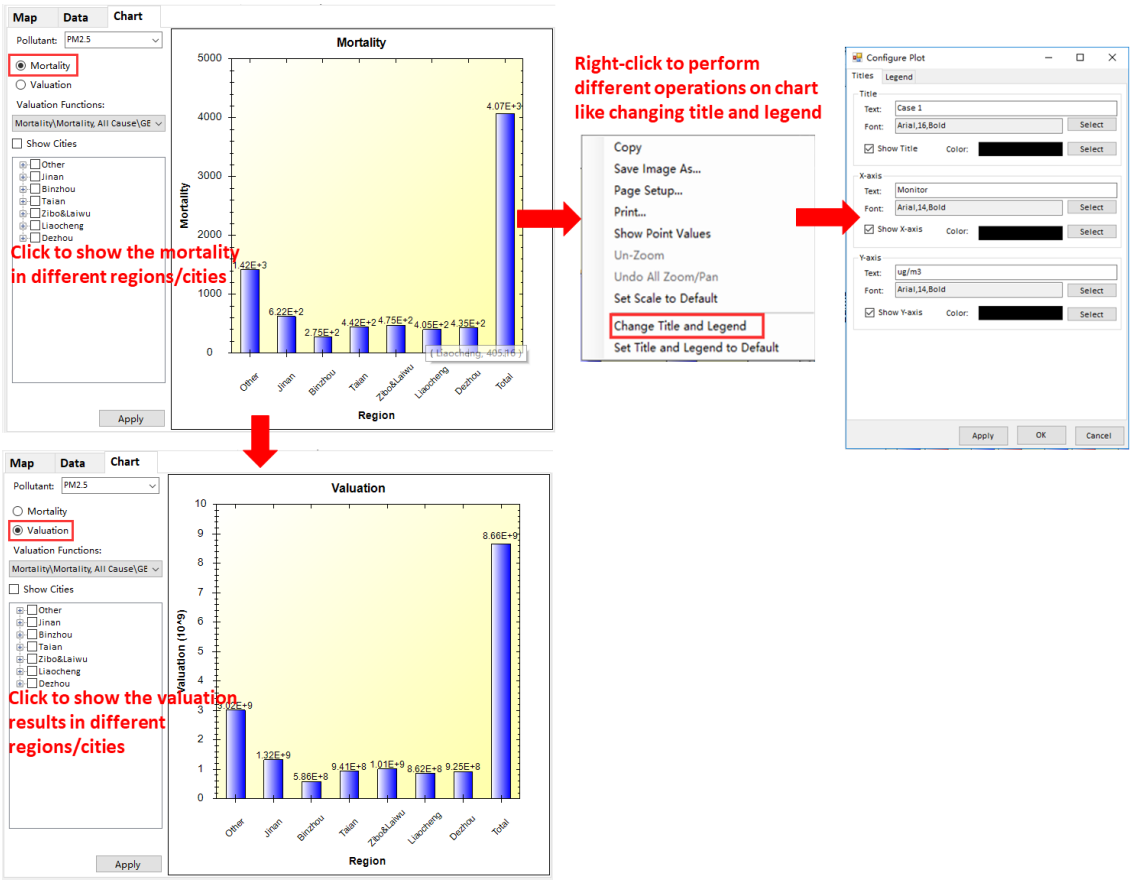


Fig. 29 Chart results and configuration options of BenMAP-CE

6 Case Study in China

In order to better introduce how to use ABaCAS-OE, we will take a case study in China for example.

6.1 Create a new project

➢ Click **File** button, and choose **New Project** option to create a new project.

6.2 Set input parameters

➢ Choose **$PM_{2.5}$** as target pollutant and set the target percentage to 30 %.

➢ Click the file button  which is the monitor data corresponding to $PM_{2.5}$ to select a **Base Year PM Monitor Data** and open it. The details of Base Year PM Monitor Data is shown Fig.30.

Quarter_ID	_TYPE	LAT	LONG	Quarter_I	PM25	LOCATION_	STATION_NAME
1		36.6464	116.9472	201701	103.8616	Jinan	Jichuangerchang
2		36.7431	117.1509	201701	120.8155	Jinan	Jinanbaosheng
3		36.6861	116.9903	201701	85.66558	Jinan	Jinanhuagongchang
4		36.6551	116.8104	201701	92.6089	Jinan	Jinanxichengqu
5		36.9719	117.1907	201701	99.87852	Jinan	Jiyangchengqu
6		36.9858	117.155	201701	93.13418	Jinan	Jiyangkaifaqu
7		36.6753	117.1851	201701	85.25469	Jinan	Jiangongxueyuan
8		36.6303	117.1061	201701	86.95302	Jinan	Jinpingzhongxue
9		36.6357	117.0669	201701	78.99095	Jinan	Jingjixueyuan
10		36.6772	117.1164	201701	81.9893	Jinan	Kaifaqu
11		36.6116	116.9866	201701	87.99015	Jinan	Kegansuo
12		36.7142	116.9483	201701	108.1632	Jinan	Lanxiangjixiao
13		36.6653	116.9378	201701	88.94962	Jinan	Nongkesuo
14		36.2833	116.4596	201701	107.5461	Jinan	Pingyinchengqu
15		36.2922	116.478	201701	104.3693	Jinan	Pingyinkaifaqu
16		36.5957	117.0204	201701	77.46541	Jinan	Shandongluneng
17		37.3167	117.164	201701	94.37934	Jinan	Shanghechengqu
18		37.2642	117.1385	201701	94.60902	Jinan	Shanghekaifaqu
19		36.6368	117.2727	201701	74.70196	Jinan	Shangzhixueyuan
20		36.6872	117.0619	201701	102.7154	Jinan	Shengzhongzicangku
21		36.6411	117.0276	201701	79.93753	Jinan	Gaoxinxuexiao
22		36.6627	117.0494	201701	90.9182	Jinan	Shijiancezhan
23		36.6871	117.5374	201701	99.95289	Jinan	Zhangqiuchengqu
24		36.6763	117.5128	201701	95.19905	Jinan	Zhangqiukaifaqu
25		36.5398	116.8059	201701	79.02929	Jinan	Changqingdaxuecheng
26		36.5522	116.772	201701	85.45882	Jinan	Changqingdangxiao
27		36.6372	117.0365	201701	92.75034	Jinan	Shibowuguan
28		36.6612	117.0203	201701	83.52923	Jinan	Quanchengguangchang
29		37.19109	116.8704	201701	81	Dezhou	Ertongleyuan
30		37.34006	116.5708	201701	75.5	Dezhou	Jianlizhan
31		37.46083	116.3282	201701	61.75	Dezhou	Jiuququanchunjingshuichang
32		37.38424	117.9542	201701	81	Binzhou	Shihuanbaoju
33		37.40531	117.9683	201701	75	Binzhou	Diershuichang
34		37.70317	118.1537	201701	71.5	Binzhou	Beizhongxinxiao
35		36.41281	116.0065	201701	79.25	Liaocheng	Quzhengfu
36		36.48508	115.9888	201701	75.75	Liaocheng	Dangxiao
37		36.42711	116.0111	201701	79.25	Liaocheng	Liaodadongxiao
38		36.01747	117.1139	201701	61	Taian	Jiancezhan
39		36.2106	116.5809	201701	54.25	Taian	Renkouxuexiao
40		36.22791	117.1917	201701	67	Taian	Dianlixuexiao
41		36.81633	118.0552	201701	61	Zibo	Renmingongyuan

Fig. 30 Base Year PM Monitor Data

- Check **eVNA**.
- Check the **Output all attainment solutions**.
- Check the **Reduce regional transport (boundary conditions) contribution**.
- Click **Next** button to enter the interface of **Control Cost Optimizer Option,** as shown in the Fig. .

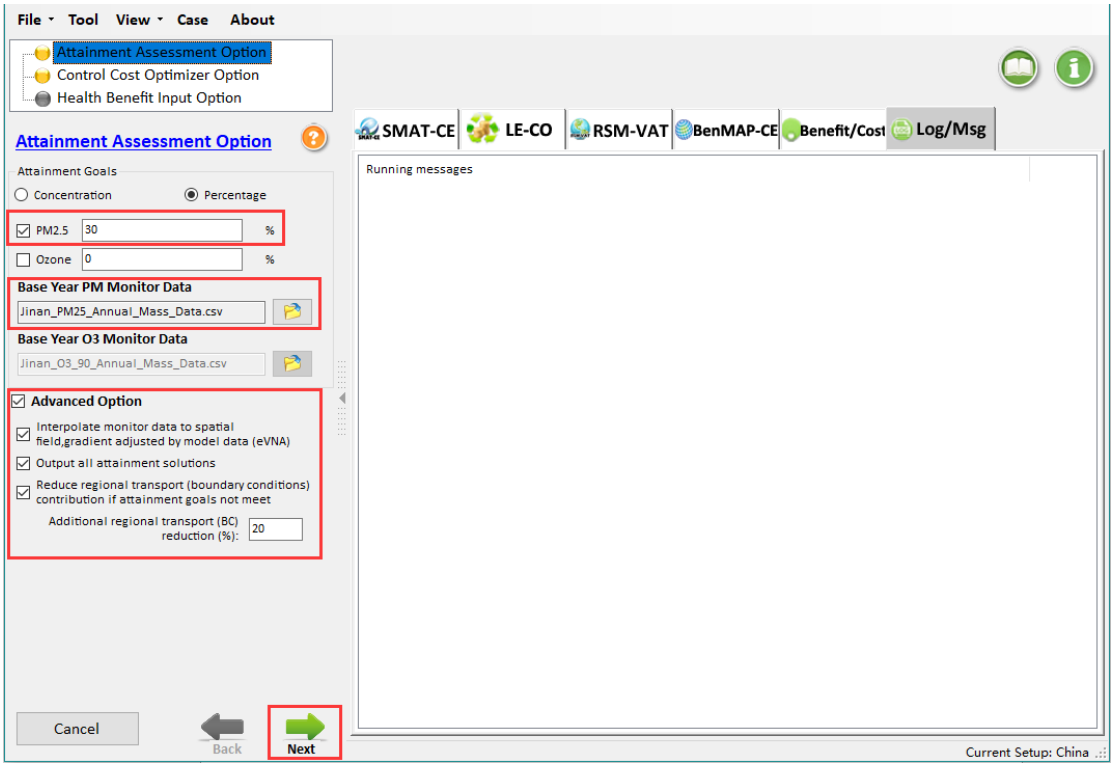


Fig. 31 Set attainment goals

➢ Choose **No LE-CO configuration file**.

➢ Click the file button  which is in the upper-right of the main interface to select a **Factors File** and open it. The details of Factors File is shown Fig.32.

Region	Pollutant	Source	Limit	Min	Max
A	NOX	TT	0.05	0	1
A	SO2	TT	0.05	0	1
A	NH3	TT	0.05	0	1
A	VOC	TT	0.05	0	1
B	NOX	TT	0.05	0	1
B	SO2	TT	0.05	0	1
B	NH3	TT	0.05	0	1
B	VOC	TT	0.05	0	1
C	NOX	TT	0.05	0	1
C	SO2	TT	0.05	0	1
C	NH3	TT	0.05	0	1
C	VOC	TT	0.05	0	1
D	NOX	TT	0.05	0	1
D	SO2	TT	0.05	0	1
D	NH3	TT	0.05	0	1
D	VOC	TT	0.05	0	1
E	NOX	TT	0.05	0	1
E	SO2	TT	0.05	0	1
E	NH3	TT	0.05	0	1
E	VOC	TT	0.05	0	1
F	NOX	TT	0.05	0	1
F	SO2	TT	0.05	0	1
F	NH3	TT	0.05	0	1
F	VOC	TT	0.05	0	1
G	NOX	TT	0.05	0	1
G	SO2	TT	0.05	0	1
G	NH3	TT	0.05	0	1
G	VOC	TT	0.05	0	1
A	PM25	DUST	0.05	0	1
A	PM25	INPC	0.05	0	1
A	PM25	FXCB	0.05	0	1
A	PM25	OTHER	0.05	0	1
B	PM25	TT	0.05	0	1
C	PM25	TT	0.05	0	1
D	PM25	TT	0.05	0	1
E	PM25	TT	0.05	0	1
F	PM25	TT	0.05	0	1
G	PM25	TT	0.05	0	1

Fig. 32 Factors File

- Set the **Step Interval** to 0.05, the minimum value to 0 and maximum value to 1.
- Check **Use Genetic algorithm** to set the **Population Size** to 10, the **Generation** to 10, but the **Cross Probability** and the **Mutation Probability** take default values, as shown in the Fig. .

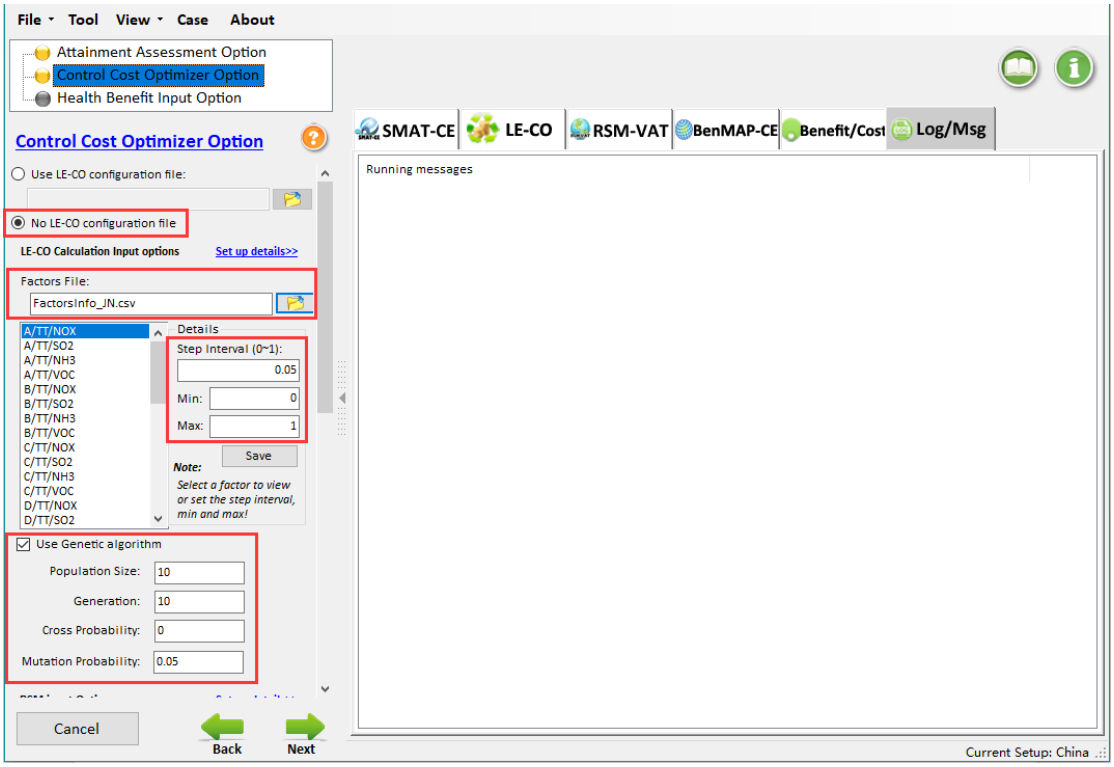


Fig. 33 Set factor information

➢ Click the file button  to select a **RSM File** and open it.

➢ Set the **Base Year** to 2017, the **Control Year** to 2020 in PM settings area, as shown in the Fig. .

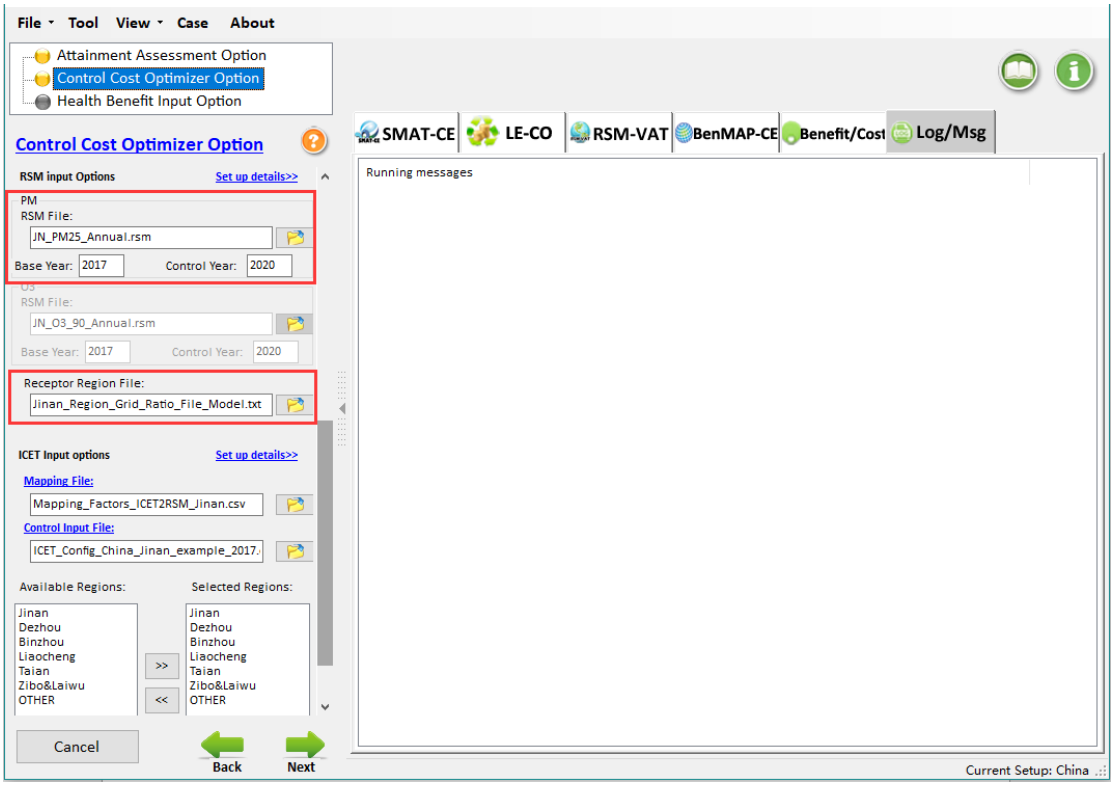


Fig. 34 Set RSM information

➢ Click the file button  to select a **Receptor Region File** and open it. The details of Receptor Region File is shown in Fig.35.

```
1 34 32 8.794603934 A Jinan
1 35 32 5.385847419 A Jinan
1 36 32 6.775355024 A Jinan
1 37 32 6.455231211 A Jinan
1 34 33 69.1956159 A Jinan
1 35 33 90.98942958 A Jinan
1 36 33 92.83000316 A Jinan
1 37 33 60.99224907 A Jinan
1 38 33 8.620133975 A Jinan
1 41 33 22.05390712 A Jinan
1 34 34 81.25546341 A Jinan
1 35 34 100 A Jinan
1 36 34 100 A Jinan
1 37 34 100 A Jinan
1 38 34 76.82431281 A Jinan
1 39 34 7.822602685 A Jinan
1 40 34 77.70259154 A Jinan
1 41 34 99.70629765 A Jinan
1 42 34 89.31932517 A Jinan
1 43 34 70.52337193 A Jinan
1 44 34 7.788943883 A Jinan
1 34 35 78.92412029 A Jinan
1 35 35 100 A Jinan
1 36 35 100 A Jinan
1 37 35 100 A Jinan
1 38 35 100 A Jinan
1 39 35 100 A Jinan
1 40 35 100 A Jinan
1 41 35 100 A Jinan
1 42 35 100 A Jinan
1 43 35 100 A Jinan
1 44 35 46.72702402 A Jinan
1 34 36 86.44026541 A Jinan
1 35 36 100 A Jinan
1 36 36 100 A Jinan
1 37 36 100 A Jinan
1 38 36 100 A Jinan
```

Fig. 35 Receptor Region File

➢ Click the file button  to select a **Mapping File** and open it. The details of Mapping File is shown in Fig.36.

Cost_Regi	RSM_Regic	Cost_Sect	RSM_Sectc	Cost_Poll	RSM_Pollutant
Jinan	A	TT	TT	NOx	NOx
Dezhou	B	DUST	DUST	PM25	PM25
Binzhou	C	INPC	INPC	SO2	SO2
Liaocheng	D	FXCB	FXCB	NH3	NH3
Taian	E	OTHER	OTHER	VOC	VOC
Zibo&Laiw	F				
OTHER	G				

Fig. 36 Mapping File

➢ Click the file button  to select a **Control Input File** and open it, as shown in the Fig. . And the details of Control Input File is shown in Fig.38.

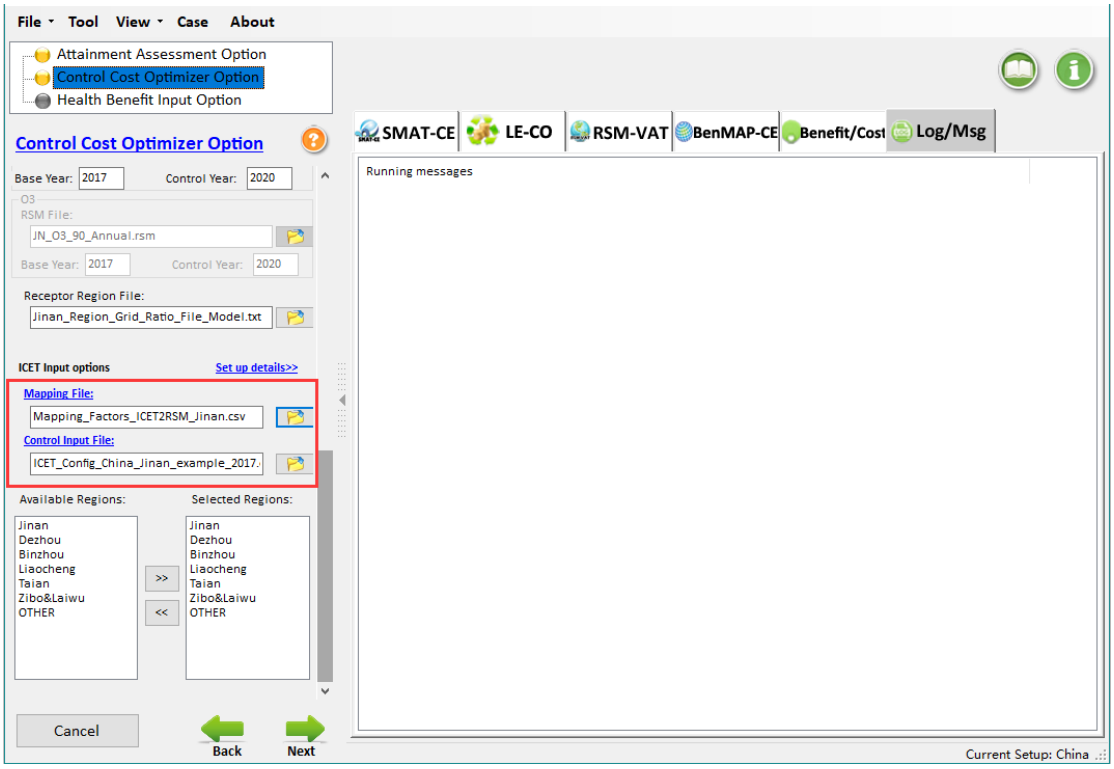


Fig. 37 Mapping File and Control Input File

Region/Sector/Pollutant Control Setup & Input: Control Cost Setup & Input:

Currency RMB EmissionsTon

Available	Control_R	Control_S	Control_P	Control(%)	Region	Sector	Pollutant	Current_E	Cost_Esti	Cost_Unit($/ton)
Jinan	Jinan	TT	NOx	58.42	Jinan	TT	NOx	7455.321	5	943.4752
Dezhou		TT	SO2	47.28		TT	NOx	7455.321	10	1886.95
Binzhou		DUST	PM25	55.39		TT	NOx	7455.321	15	2830.426
Liaocheng		INPC	PM25	55.39		TT	NOx	7455.321	20	3773.901
Taian		FXCB	PM25	55.39		TT	NOx	7455.321	25	4717.376
Zibo&Laiwu		OTHER	PM25	55.39		TT	NOx	7455.321	30	5660.851
OTHER		TT	NH3	0		TT	NOx	7455.321	35	5860.061
		TT	VOC	0		TT	NOx	7455.321	40	6059.27
	Dezhou	TT	NOx	58.42		TT	NOx	7455.321	45	6258.48
		TT	SO2	47.28		TT	NOx	7455.321	50	6457.69
		TT	PM25	55.39		TT	NOx	7455.321	55	8545.46
		TT	NH3	0		TT	NOx	7455.321	60	10633.23
		TT	VOC	0		TT	NOx	7455.321	65	12721
	Binzhou	TT	NOx	58.42		TT	NOx	7455.321	70	16553.01
		TT	SO2	47.28		TT	NOx	7455.321	75	34801.42
		TT	PM25	55.39		TT	NOx	7455.321	80	56917.73
		TT	NH3	0		TT	NOx	7455.321	85	80473.57
		TT	VOC	0		TT	NOx	7455.321	90	102350
	Liaocheng	TT	NOx	58.42		TT	NOx	7455.321	95	135262.8
		TT	SO2	47.28		TT	NOx	7455.321	100	181371.5
		TT	PM25	55.39		TT	SO2	1315.301	5	308.316
		TT	NH3	0		TT	SO2	1315.301	10	616.632
		TT	VOC	0		TT	SO2	1315.301	15	924.9479
	Taian	TT	NOx	58.42		TT	SO2	1315.301	20	1233.264
		TT	SO2	47.28		TT	SO2	1315.301	25	1541.58
		TT	PM25	55.39		TT	SO2	1315.301	30	1849.896
		TT	NH3	0		TT	SO2	1315.301	35	2363.197
		TT	VOC	0		TT	SO2	1315.301	40	2876.497
	Zibo&Laiw	TT	NOx	58.42		TT	SO2	1315.301	45	3389.798
		TT	SO2	47.28		TT	SO2	1315.301	50	6062.409
		TT	PM25	55.39		TT	SO2	1315.301	55	14274.26
		TT	NH3	0		TT	SO2	1315.301	60	23669.65
		TT	VOC	0		TT	SO2	1315.301	65	33065.04
	OTHER	TT	NOx	58.42		TT	SO2	1315.301	70	42460.43
		TT	SO2	47.28		TT	SO2	1315.301	75	60435.91
		TT	PM25	55.39		TT	SO2	1315.301	80	78411.4
		TT	NH3	0		TT	SO2	1315.301	85	98786.12
		TT	VOC	0		TT	SO2	1315.301	90	114362.4
						TT	SO2	1315.301	95	129938.6

Fig. 38 Control Input File

➢ Select one or more of the seven options in the **Available Regions** column as shown in the Fig. , and the click >> button, the selected options will appear in the **Selected Regions** column which as shown in the Fig. .

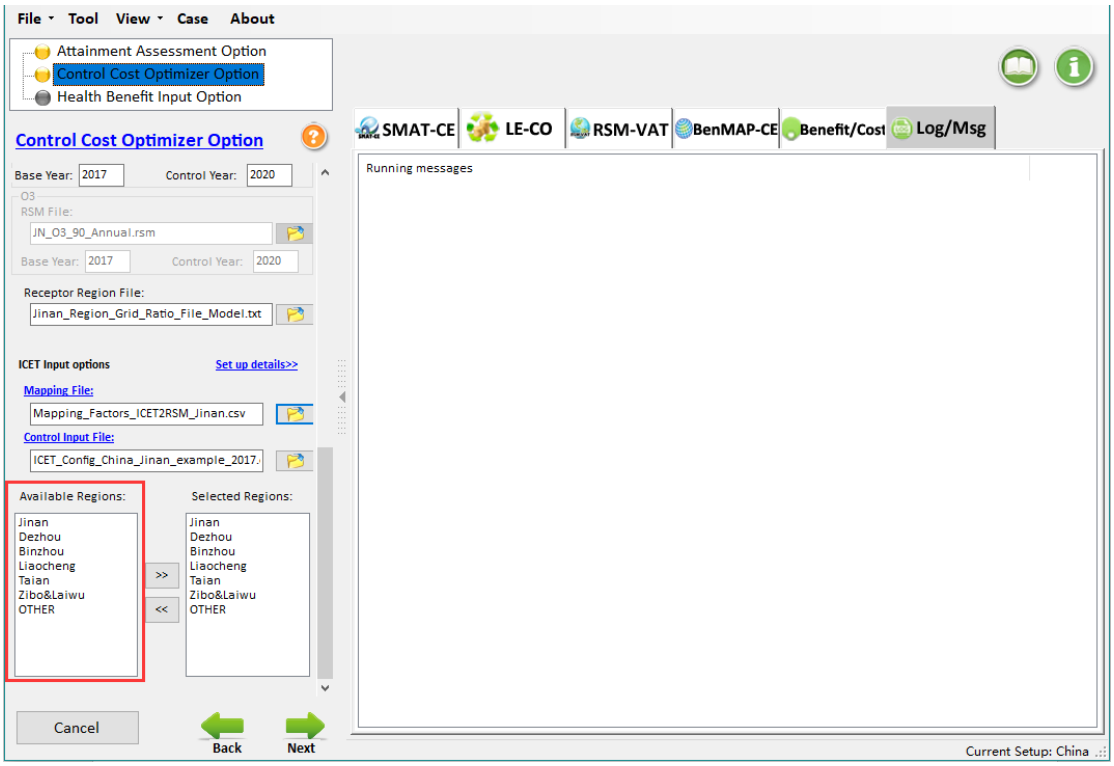


Fig. 39 Available Regions

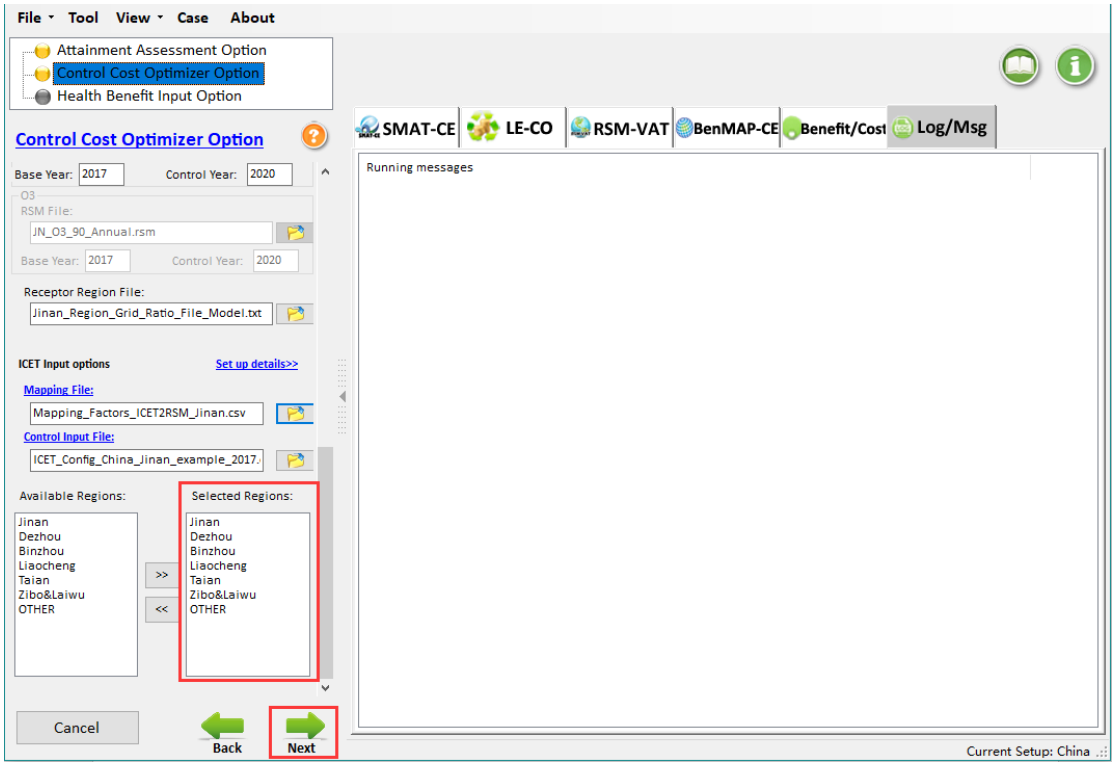


Fig. 40 Selected Regions

➢ Click **Next** button to enter the interface of **Health Benefit Input Option,** as shown in the Fig. .

➢ Click the file buttons  which correspond to **Pooled Grid Definition, CFG configuration file and APV configuration file** and then open them, as shown in the Fig. . And the details of Pooled Grid Definition is shown in Fig.42.

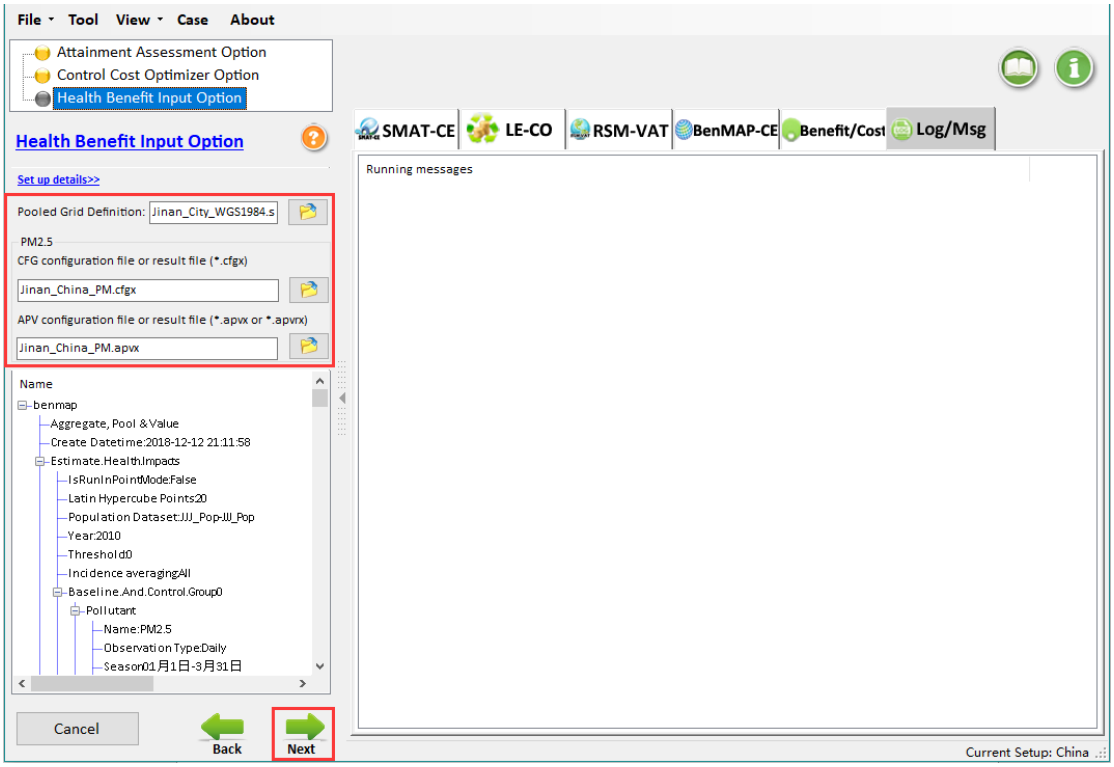


Fig. 41 Set health benefit information

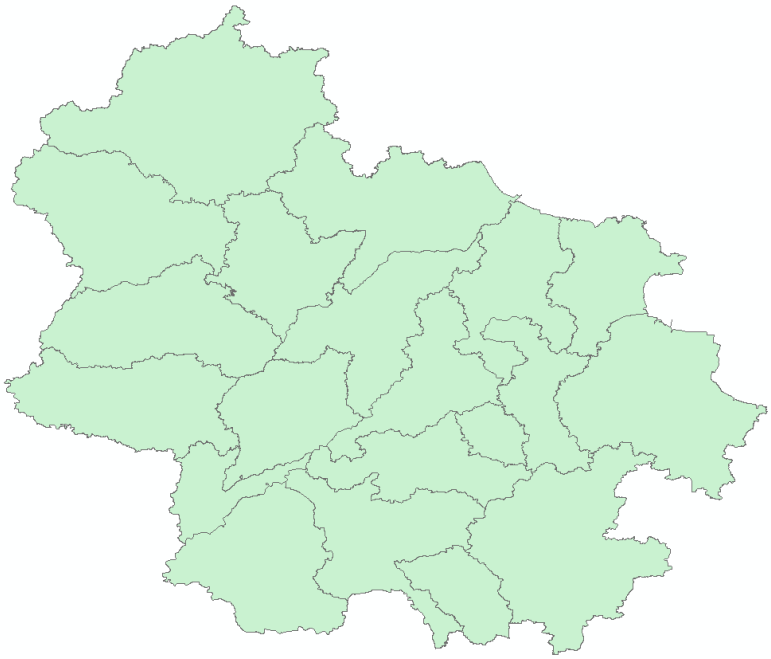


Fig. 42 Pooled Grid Definition

➢ Click **Next** button and Fig. will appear, choose **yes** to run the program.

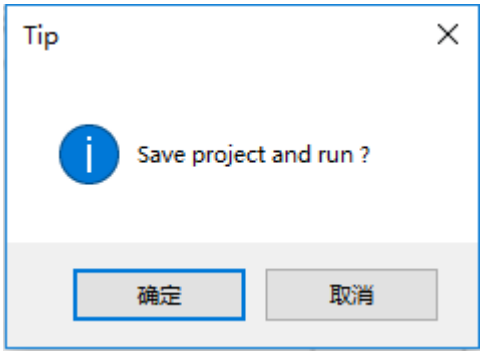


Fig. 43 Save project and run

6.3 View Result

6.3.1 SMAT-CE

6.3.1.1 Chart results

➢ From the Fig. , we can directly view the comparison between the baseline and predicted values of different regions, which bases on the monitoring data. For example, the baseline value in Jinan is about 92％ but its predicted value is about 64.4 ％.

Fig. 44 Chart results of SMAT- CE

6.3.2 LE-CO

6.3.2.1 Optimized Strategies

6.3.2.1.1 Map results

➢ From the Fig. , we can know that the maps show the concentration distribution of $PM_{2.5}$ for five attainment scenarios and their minimum and maximum concentrations.

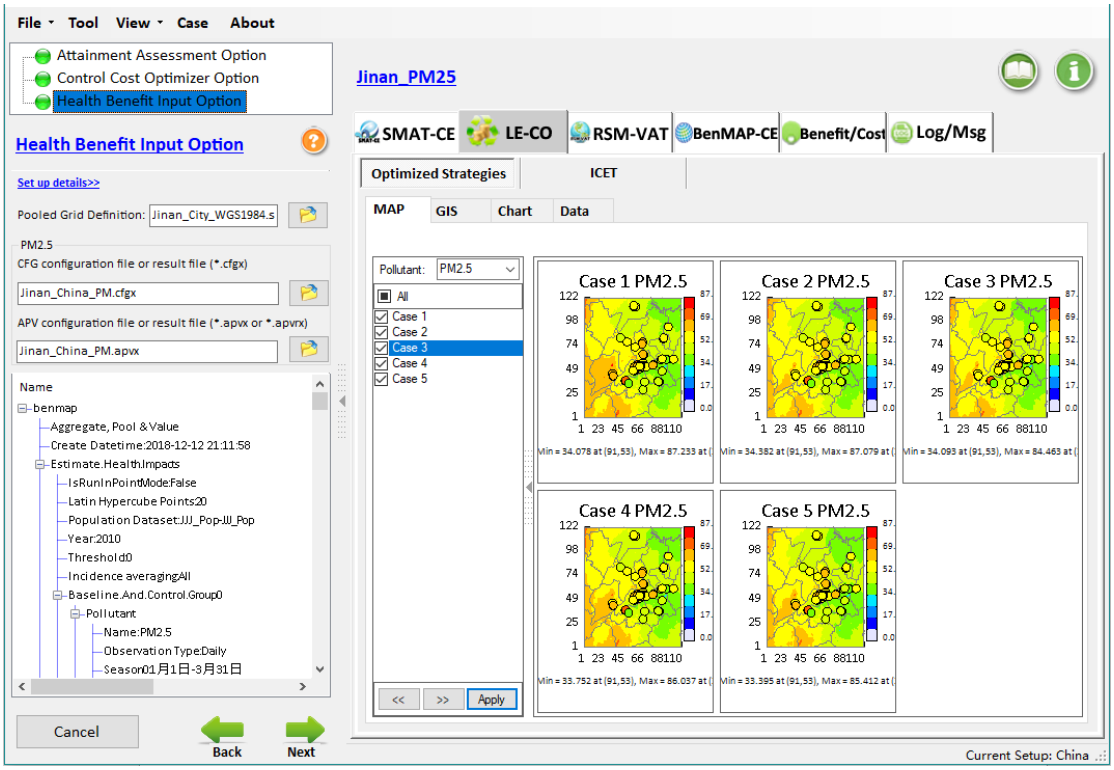


Fig. 45 Map results of Optimized Strategies

6.3.2.1.2 GIS results

➢ From the Fig. , we can know that the GIS shows the attainment results of five scenarios in each monitor site. And there are more than 10 red points which indicate no-attainment results in case 1.

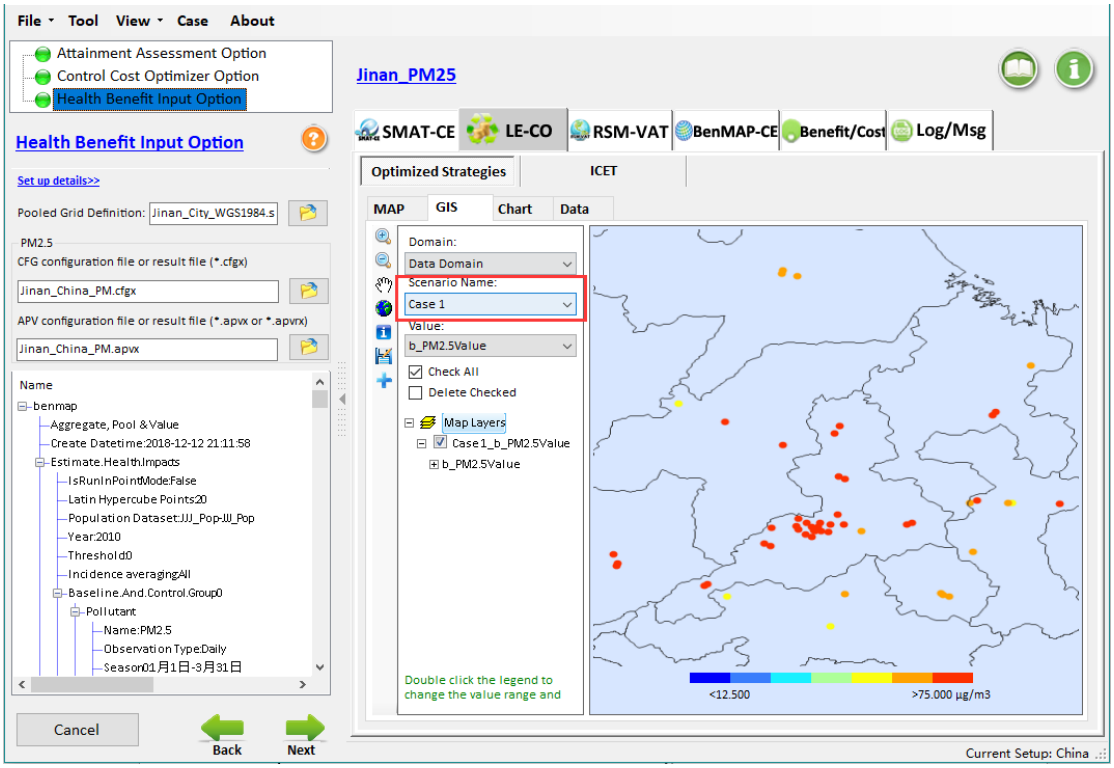


Fig. 46 GIS results of Optimized Strategies

6.3.2.1.3 Chart results

➢ From the Fig. , we can directly view the reduction between the baseline and predicted values of different scenarios and monitoring sites.

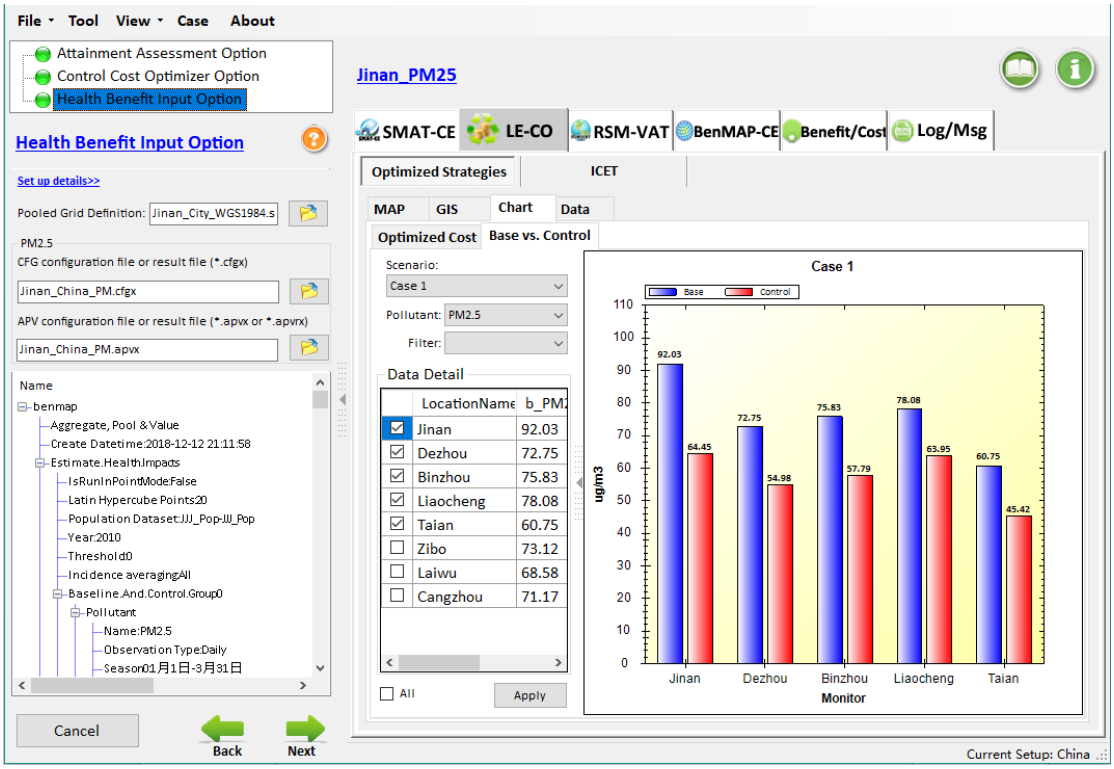


Fig. 47 Chart results of Optimized Strategies

6.3.2.1.4 Data results

➢ From the Fig. , we can view more details information for each attainment scenario. Just take the summary information as an example, in case 1, the attainment ratio of $PM_{2.5}$ is about 100％, the total cost is about 1.99 billion yuan and the average concentration of $PM_{2.5}$ is about 59.06 μg/m^3 and so on.

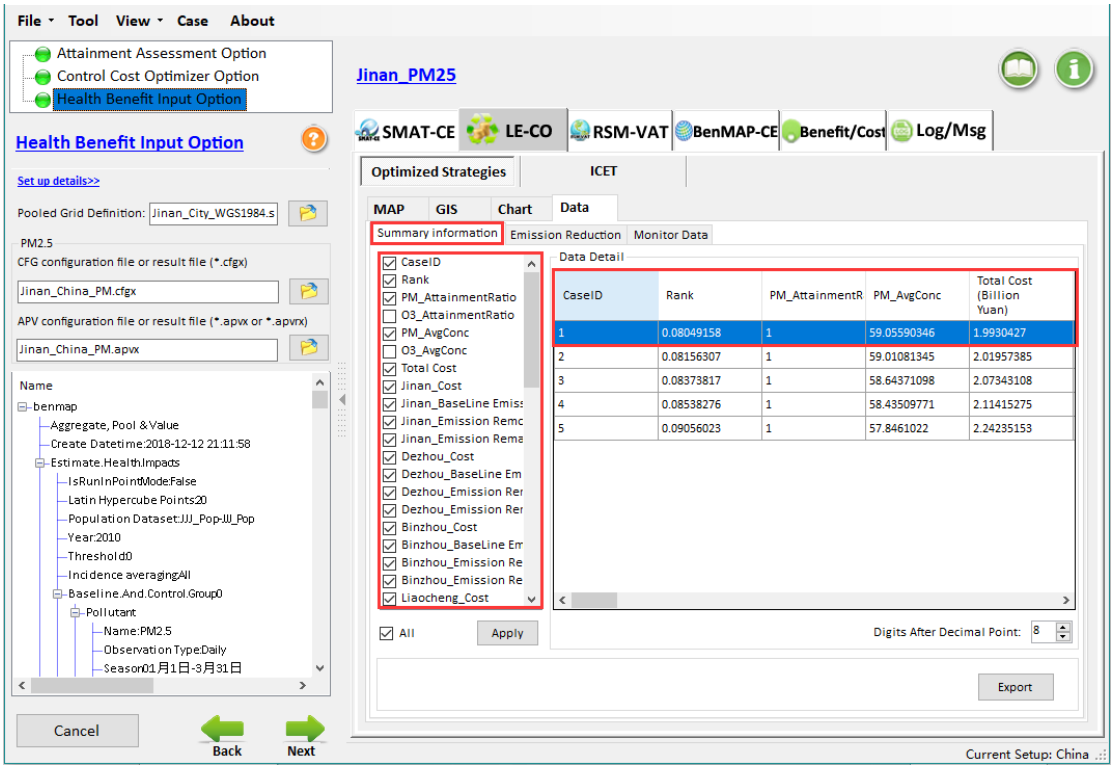


Fig. 48 Data results of Optimized Strategies

6.3.2.2 ICET

6.3.2.2.1 Data results

➢ From the Fig. , we can view more summary information which contains total removal cost, baseline emission and removal cost of each pollutant. For example, the total $PM_{2.5}$ removal cost in Jinan is about 970.8 million yuan, the baseline $PM_{2.5}$ emission is about 70.8 thousand ton and the removal cost of $PM_{2.5}$ is about 24201.4 yuan/ton and so on.

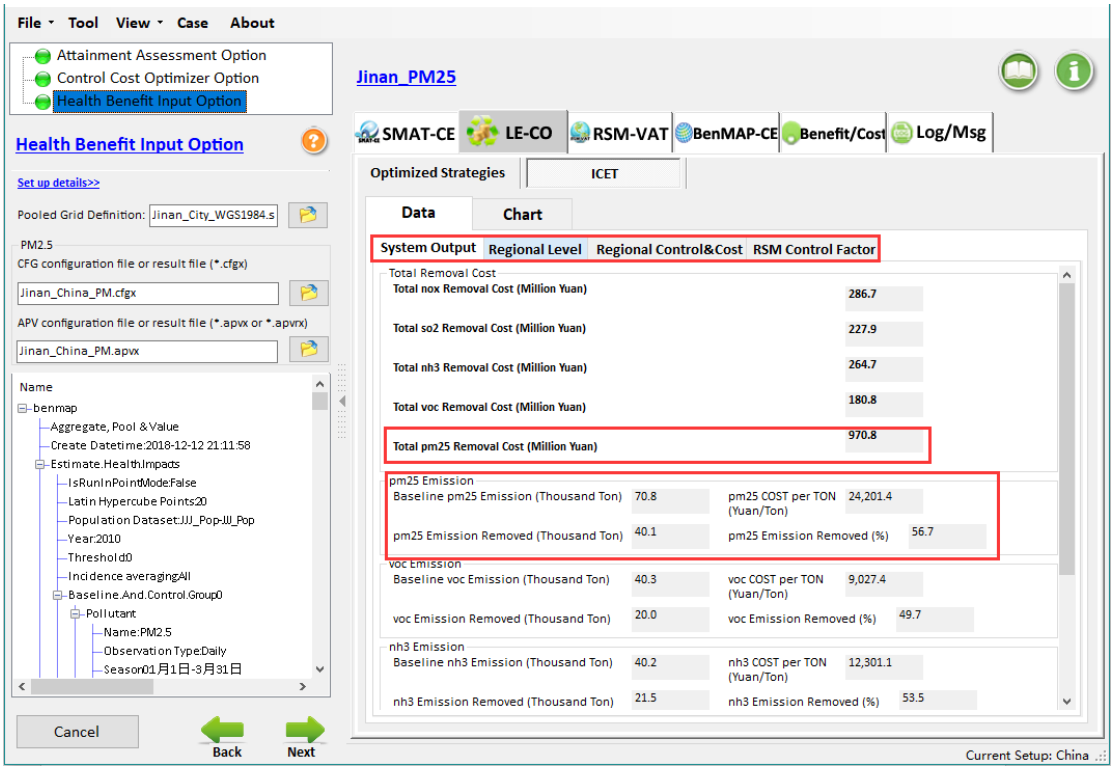


Fig. 49 Data results of ICET

6.3.2.2.2 Chart results

➢ From the Fig. , we can directly view the emissions or control cost comparison of different regions in different pollutants.

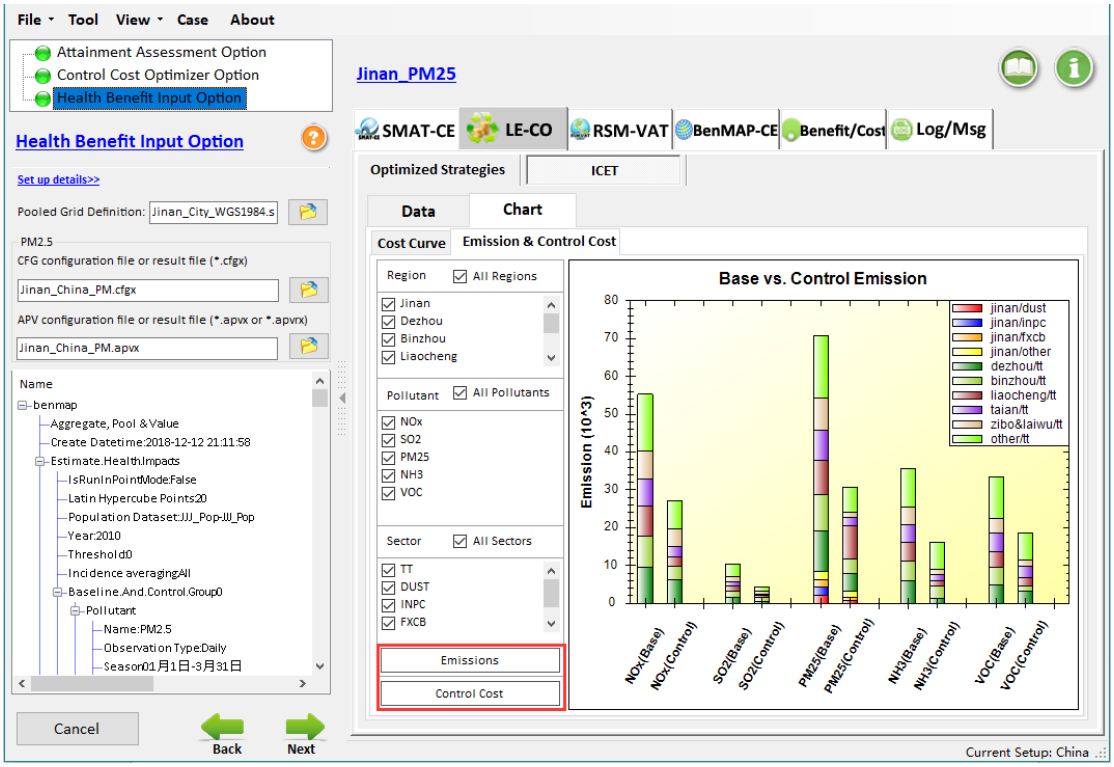


Fig. 50 Chart results of ICET

6.3.3 RSM-VAT

6.3.3.1 Map results

➢ From the Fig. , we can intuitively know that the maps show the $PM_{2.5}$ concentration that responds in real time to the emission reduction control.

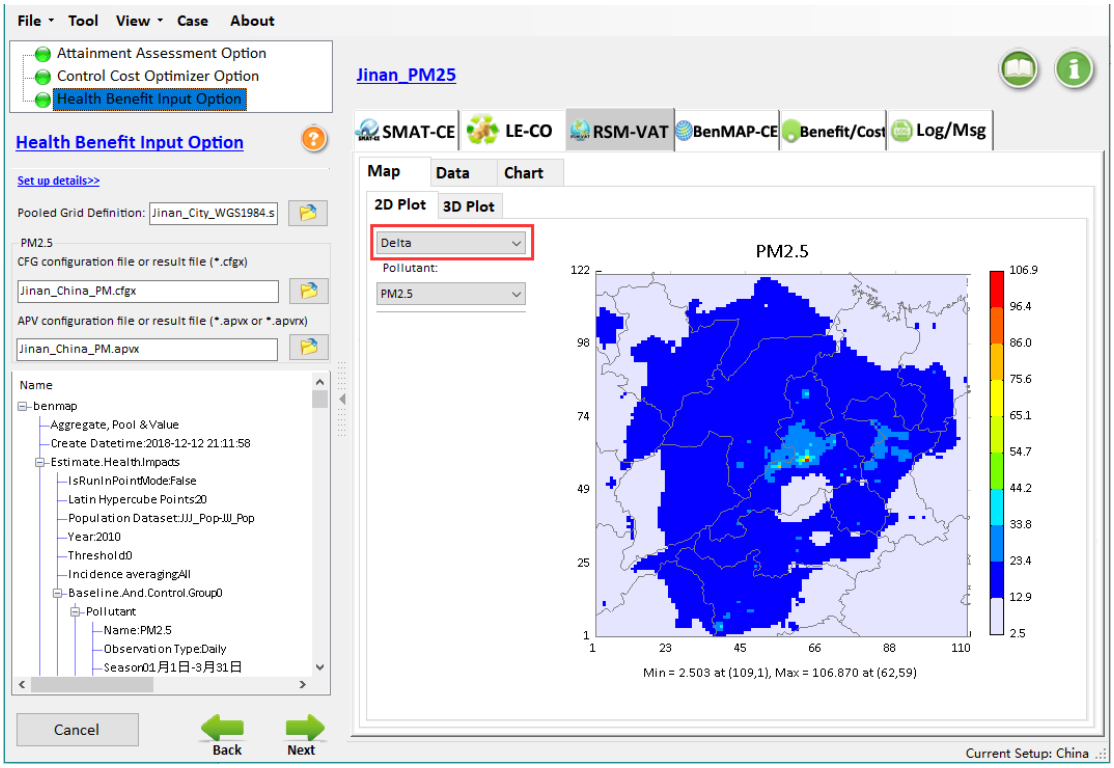


Fig. 51 Map results of RSM-VAT

6.3.3.2 Data results

➢ From the Fig. , we can view more details information about the emission reduction effects.

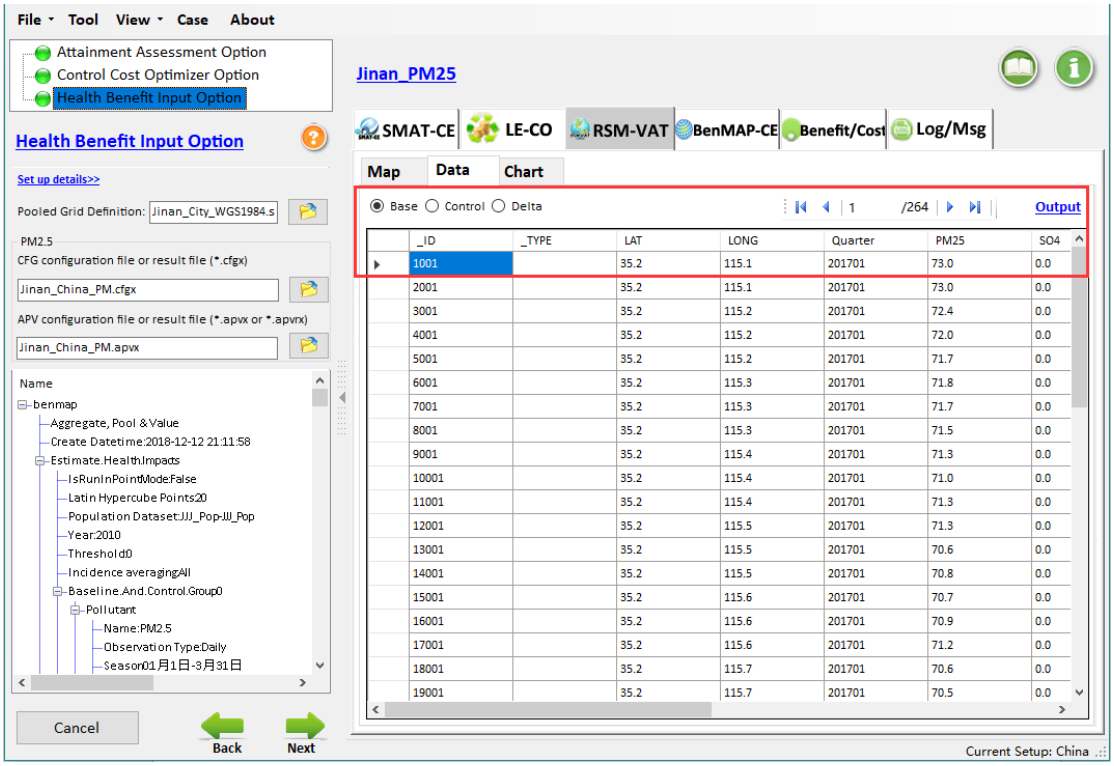


Fig. 52 Data results of RSM-VAT

6.3.3.3 Chart results

➢ From the Fig. , we can directly view the emission reduction effects of emission control. For example, the $PM_{2.5}$ reduction in Jinan is about 22.8 $\mu g/m^3$.

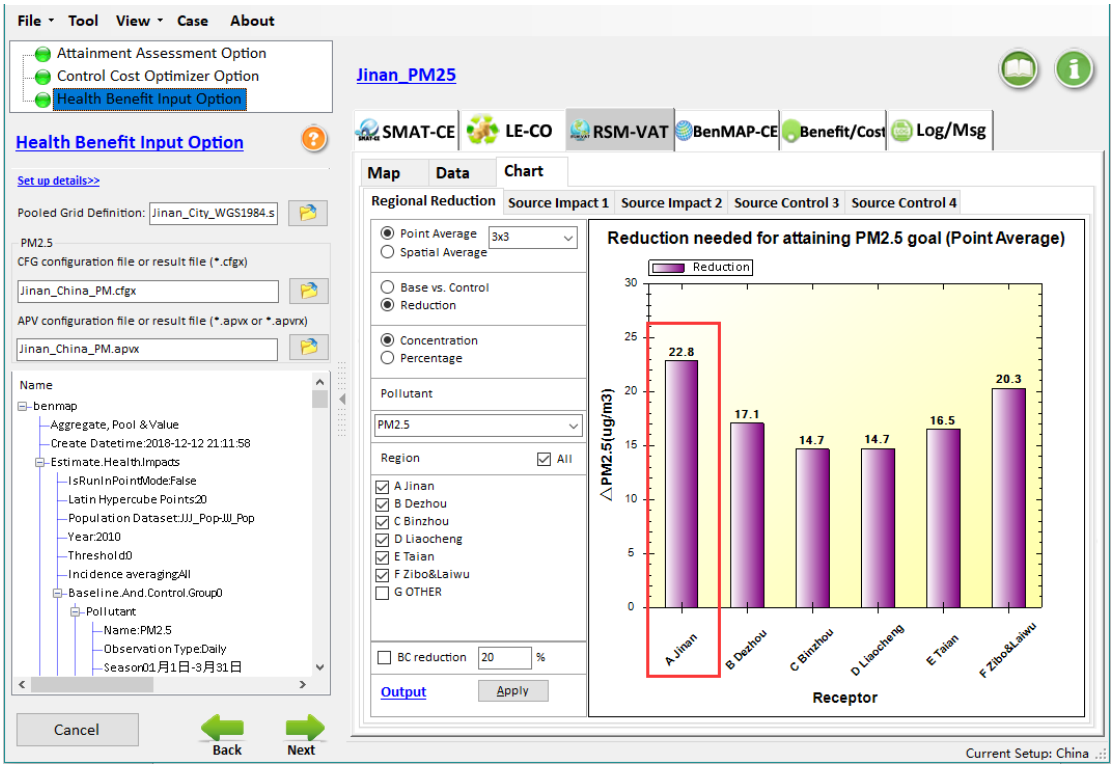


Fig. 53 Chart results of RSM-VAT

6.3.4 BenMAP-CE

6.3.4.1 Map results

➢ From the Fig. , we can know that the maps show the mortality and valuation results of different regions.

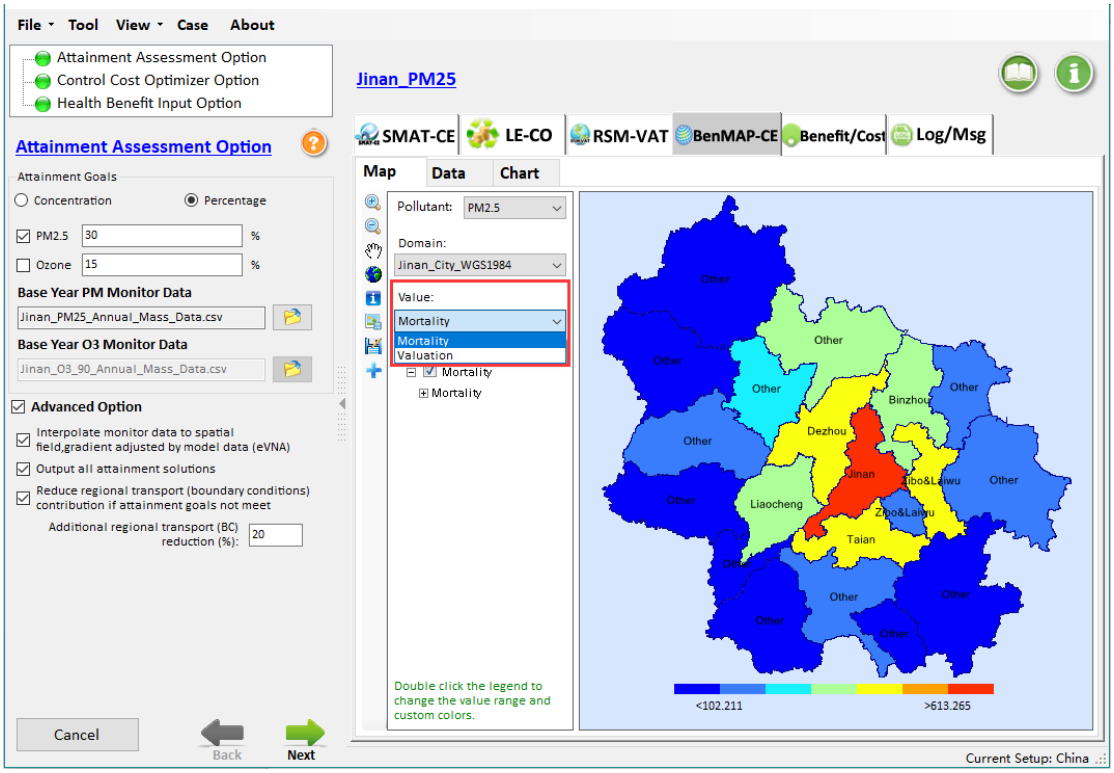


Fig. 54 Map results of BenMAP-CE

6.3.4.2 Data results

➢ From the Fig. , we can view more details information which contains benefit, mortality, medianbenefit and so on. For example, the benefit in other is about 3273985054 yuan.

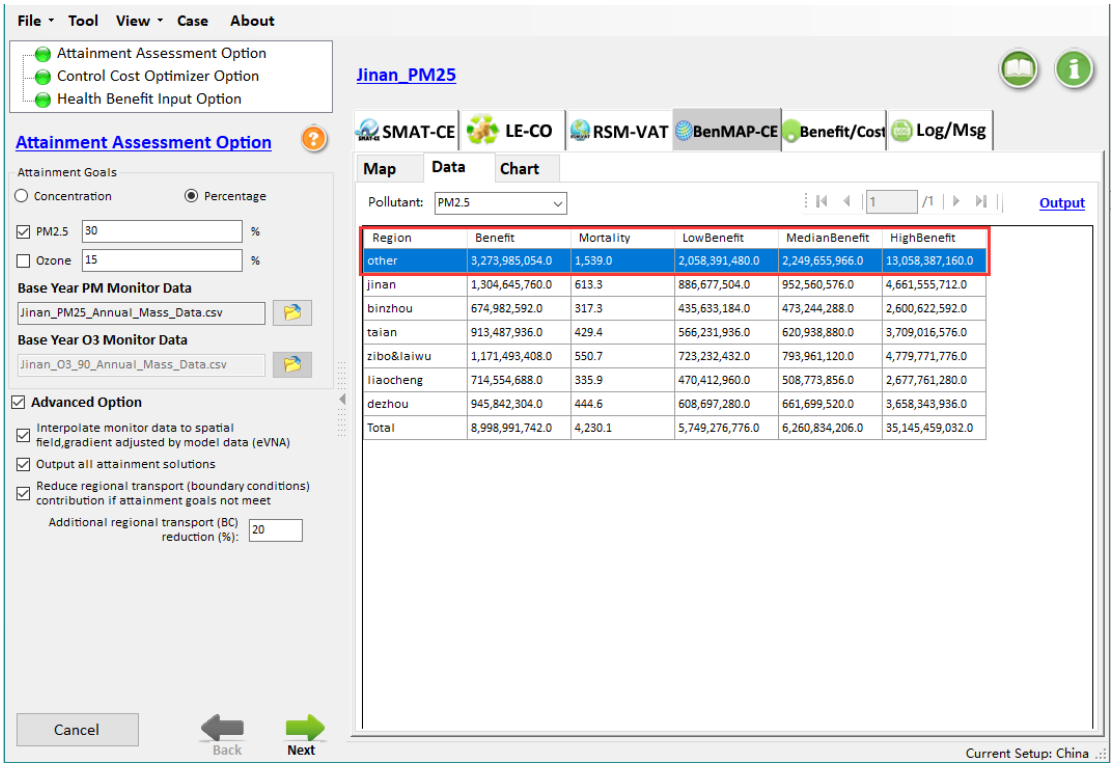


Fig. 55 Data results of BenMAP-CE

6.3.4.3 Chart results

➢ From the Fig. , we can directly view the mortality and valuation results in different regions/cities. For example, the mortality in Jinan is about 6.13E+2.

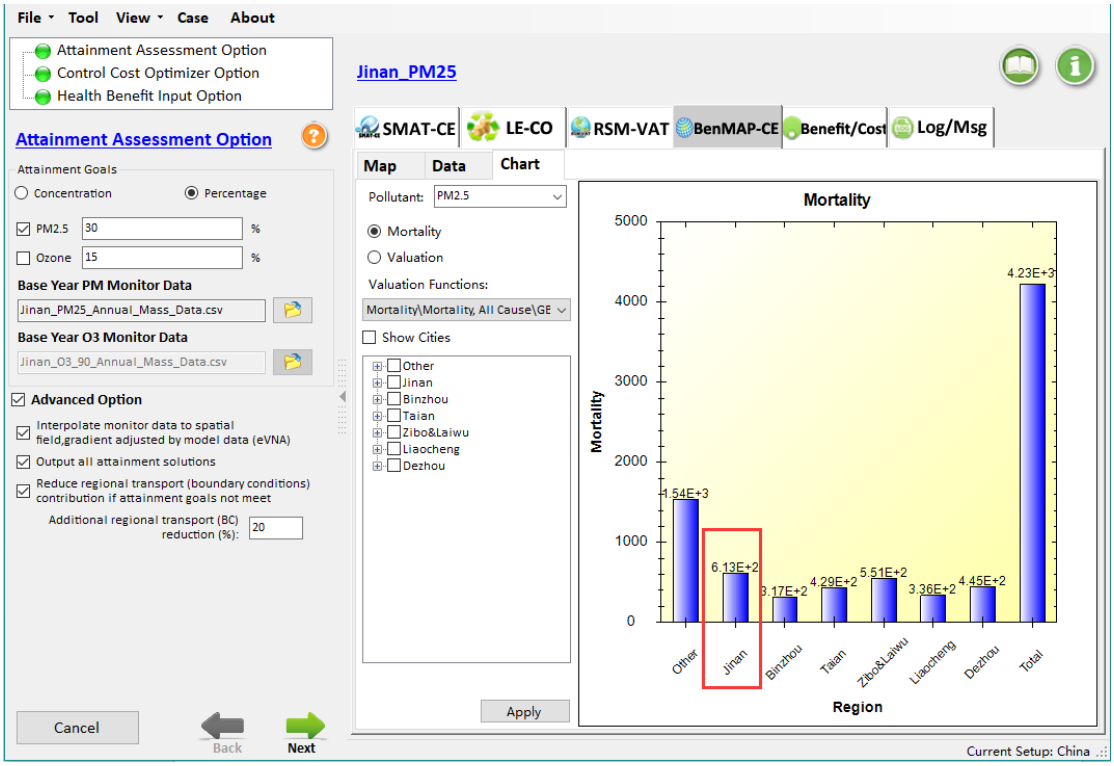


Fig. 56 Chart results of BenMAP-CE

6.3.5 Benefit/Cost

6.3.5.1 Chart results

➢ From the Fig. , we can directly view total benefit/cost ratio after taking effective measures is about 4.7.

Fig. 57 Chart results of Benefit/Cost

6.3.5.2 Data results

➢ From the Fig. , we can view more details information which contains cost, benefit, benefit/cost and so on. For example, the benefit/cost ratio in Jinan is about 3.6.

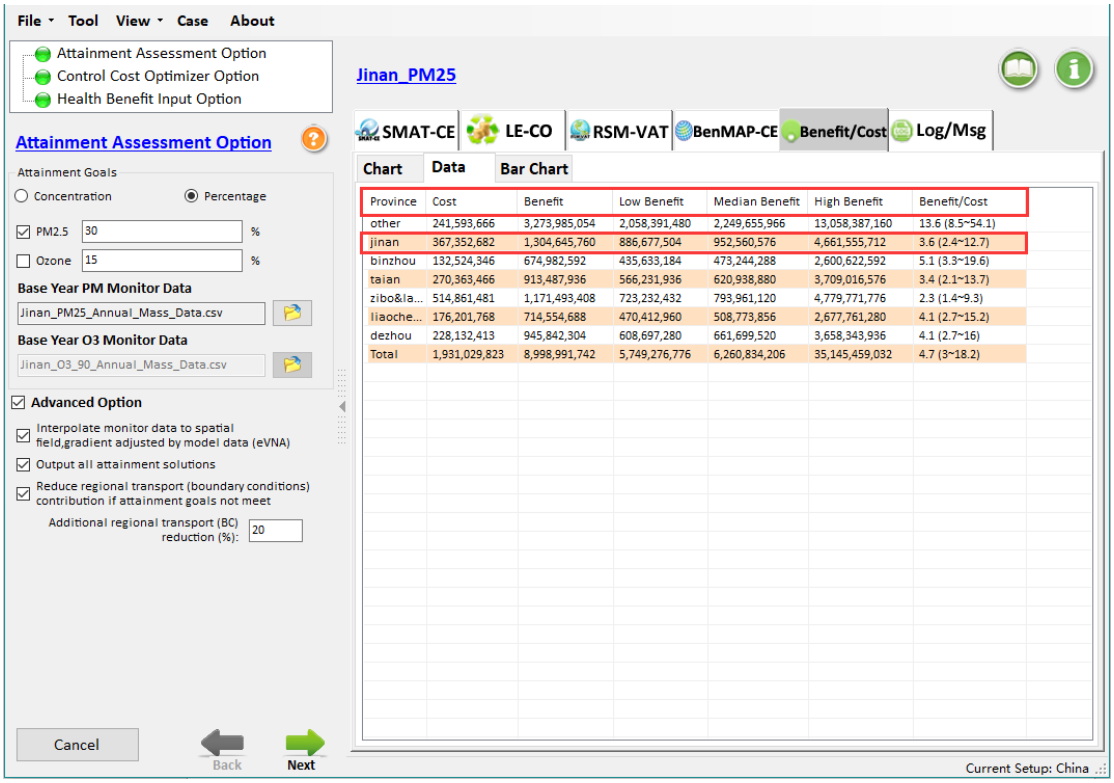


Fig. 58 Data results of Benefit/Cost

6.3.5.3 Bar Chart results

➢ From the Fig. , we can view the benefit/cost ratios in different regions/cities more intuitively.

Fig.59 Bar Chart results of Benefit/Cost