Impact of Emission Inventory Update on Ozone Forecast Over Northeast Asia

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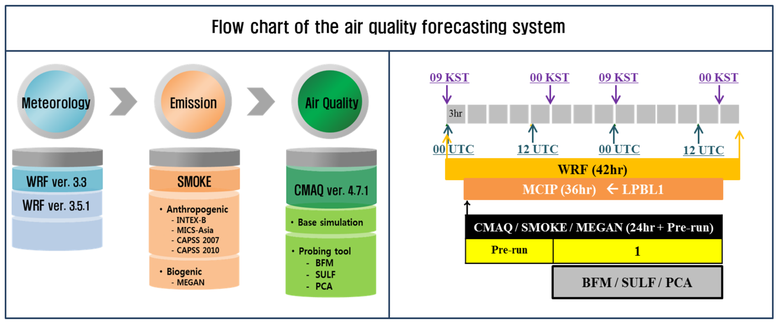
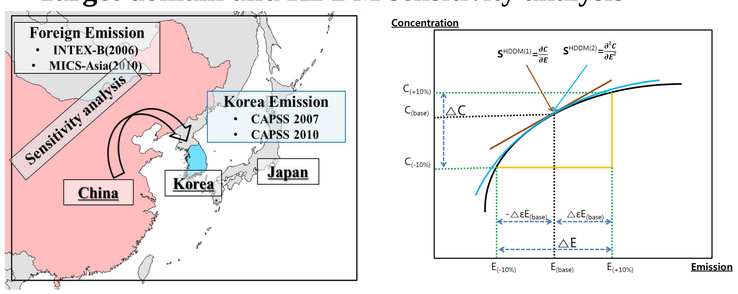
• Introduction

- The Integrated Multi-dimensional Air Quality System for Korea (IMAQS/K) has been operating since May 2012, to provide regional air quality forecast over Northeast Asia (27-km), South Korea (9-km), and over the Seoul Metropolitan Area (SMA, 3-km.)
- Due to rapid economical changes in this region, timely update of emission inventory (EI) is crucial in regional air quality forecast.
- **We have investigated the impact of recent emission inventory updates on ozone forecast over Northeast Asia.**



• Methodology

• Target domain and HDDM sensitivity analysis



• Emission scenarios for this study

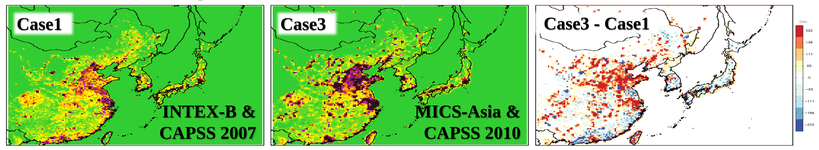
Case	Foreign Emission	Korean Emission	HDDM
1	INTEX-B[1)] 2006	CAPSS[3)] 2007	X
2	INTEX-B 2006	CAPSS 2010	O
3	MICS-Asia[2)] 2010	CAPSS 2010	O

Note : 1) Intercontinental Chemical Transport Experiment – Phase B
2) Model Inter-Comparison Study
3) Clean Air Policy Support System(NIER)

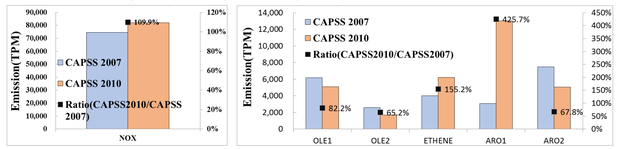
- Three combinations of emission inventories are used in regional CMAQ simulation.
- CMAQ runs with High-order Decoupled Direct Method (HDDM) for 2014 summer are also conducted and analyzed.

• Emission comparisons

• NOx emission spatial distribution

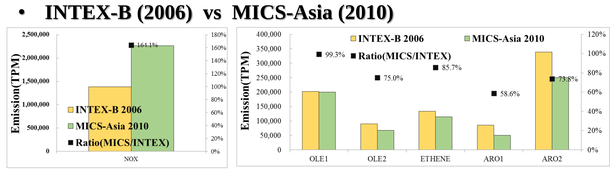


• CAPSS (2007) vs CAPSS (2010)



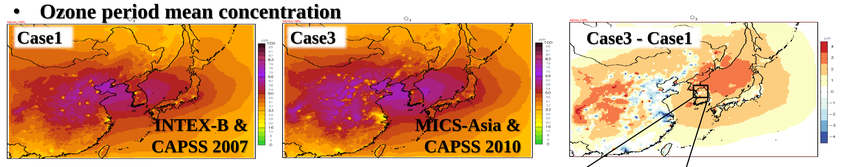
- NO_x emissions were increased about 10~50% over big cities, e.g. Central East China (CEC) and Seoul.
- VOC emissions were decreased over China.

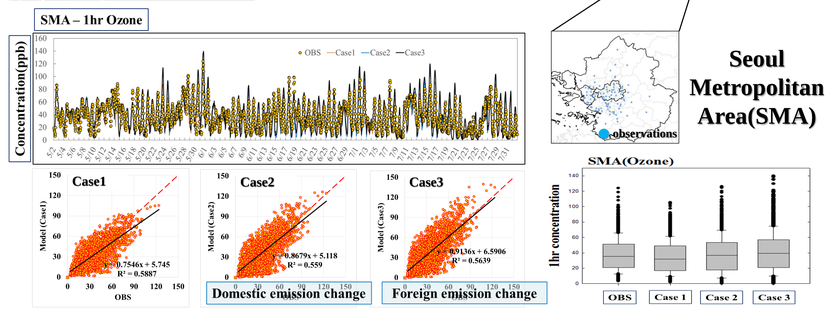
• INTEX-B (2006) vs MICS-Asia (2010)



• Results 1 : Ozone simulation

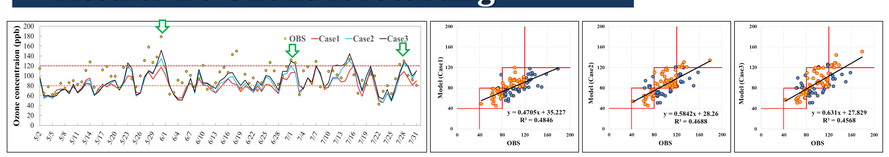
• Ozone period mean concentration





- Simulated ozone concentrations mostly have increased except the CEC area.
- The use of latest EI (Case3) has improved accuracy in predicting high ozone concentration (~6 ppb increase) over the SMA

• Results 2 : Ozone forecasting



Hit Rate (%)

Grade	Range(ppb)	Case1	Case2	Case3
Moderate	40~80	92(23/25)	76(19/25)	68(17/25)
USG	80~120	52(25/50)	62(31/50)	60(30/50)
Unhealthy	120~300	0(0/17)	35(6/17)	47(8/17)

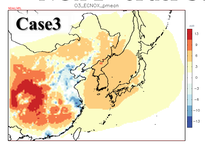
False Alarm Ratio (%)

Grade	Case1	Case2	Case3
Unhealthy	0 (0/0)	14 (1/7)	33 (4/12)

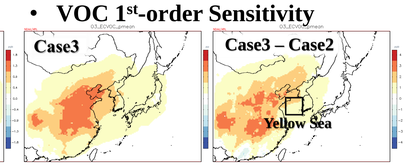
- Both hit rate and false alarm have been increased by emission update in Case3.

• Results 3 : Sensitivity analysis

• NOx 1st-order Sensitivity



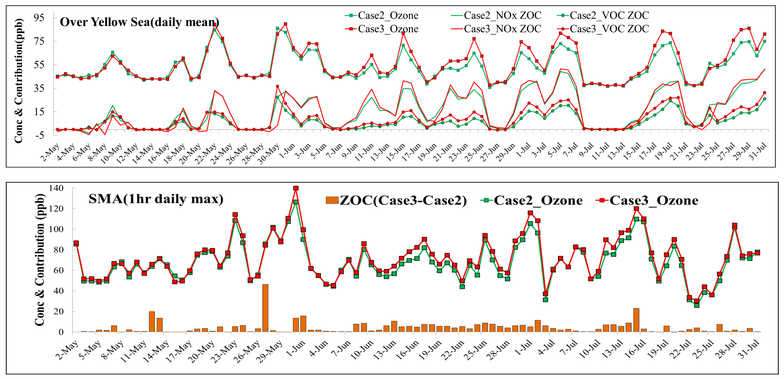
• VOC 1st-order Sensitivity



- HDDM analysis shows higher ozone sensitivities in the downwind area to Chinese NO_x and VOC emissions.

• ZOC (Zero out contribution)

$$ZOC = C_o - C_{\Delta\varepsilon i} = S_i^{(1)} - \frac{1}{2} S_i^{(2)}$$



	Ozone Conc. (period mean)	ZOC of NOx (ppb)		ZOC of VOC (ppb)	
		High ozone (>80ppb)	Low ozone	High ozone	Low ozone
Case2	38	**23.4**	12.2	18.0	5.7
Case3	41	**30.0**	13.2	19.4	6.8

- NOx emissions contribute negative ozone production in the CEC while enhancing ozone production in the downwind areas, e.g. Yellow Sea and South Korea. This indicates that Chinese NOx emissions update may have impacts on peak ozone concentrations in the downwind areas depending on transport and photochemistry.

• Conclusions

- We investigated the impact of latest emission inventory updates on air quality forecast for South Korea. Using MICS-Asia 2010 and CAPSS 2010, NO_x emissions are increased about 10~50% over big cities, e.g. Central East China and Seoul, while VOC emissions are decreased over China.
- The emission inventory updates resulted in the increase of predicted ozone concentration and the hit rate improvement in daily forecasts.
- Chinese NO_x emission update tends to increase the amounts of ozone formation on the downwind area. This implies potentially significant impacts on prediction accuracies for high ozone concentration days.