SENSITIVITY ANALYSIS OF NO_X EMISSION ESTIMATES

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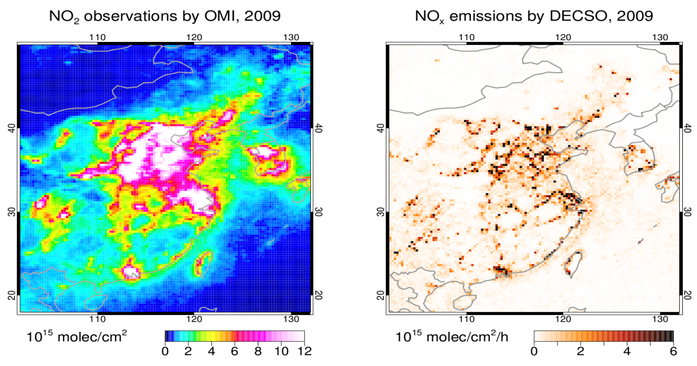
Abstract To study the sensitivity of the DECSO algorithm to the type of model, we implemented two versions of CHIMERE, V2013 and V2006, using two emission inventories, MEIC and INTEX-B, to simulate the air quality over east China in 2010. The comparisons of model results with measurements indicate that MEIC and CHIMERE V2013 are better than INTEX-B and CHIMERE V2006. From the results of the two chemical transport models, the Root-Mean Square Error (RMSE) is analysed to give an indication of the model error in DECSO.

Introduction

KNMI has developed the Daily Emission estimates Constrained by Satellite Observations (DECSO) algorithm (Mijling and van der A, 2012) for NOx emissions, which has been implemented over China by using the chemical transport model CHIMERE. In this research, we study the performance of the model and the error of the model used in the DECSO algorithm. We compare two versions of CHIMERE, V2013 (Menut et al., 2013) and V2006, to simulate the air quality over east China in 2010 using two emission inventories, INTEX-B (Zhang et al., 2009) and MEIC. To validate the model, we compare the results with ground measurements and OMI satellite measurements. By inter-comparison of the results from the two chemical transport models, the model error will be estimated and the effect of model differences on the DECSO results will be analysed. A good estimate of the model error is important for the performance of DECSO.



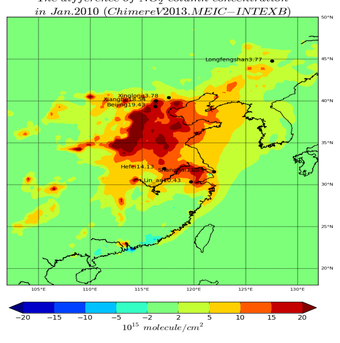
Methods

We use two CHIMERE model versions: V2013 and V2006. The two CHIMERE models have been implemented over east China (18-50^{0}N, 102-132^{0}E) with a 0.25x0.25^0 horizontal resolution and 8 vertical layers up to 500hPa.

To study the influence of different models and emission inventories, we have set up different runs over China for January and July 2010:

- CHIMERE V2006 using MEIC
- CHIMERE V2013 using MEIC
- CHIMERE V2013 using INTEX-B
- CHIMERE V2013 using MEIC with Deep Convection (DC) option

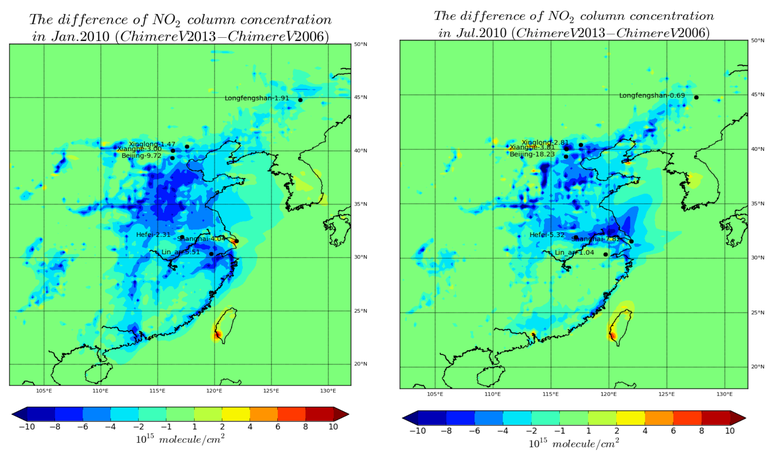
The MEIC emission inventory is higher than INTEX-B. In MEIC, the agriculture emission sector has been added and also the other sectors are updated compared to INTEX-B.



For comparison with observations we used OMI satellite observations with a spatial resolution of 24x13 km^2 in nadir till 68x14 km^2 at the swath edges. The overpass time is around 13:30 local time. The hourly ground measurement data at Xinglong station are provided by IAP.

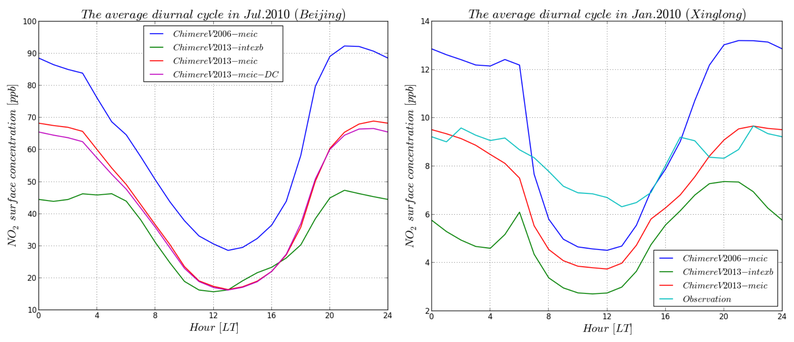
Results

1. Model intercomparison

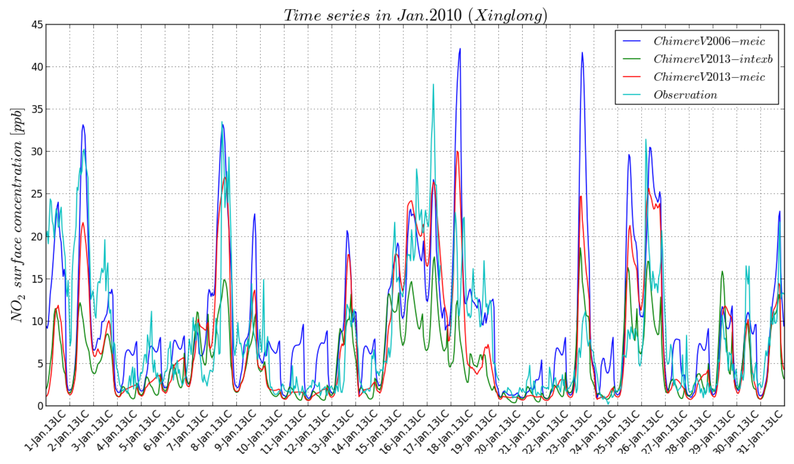


The NO_2 column concentration of CHIMERE V2013 is lower than that of CHIMERE V2006, especially over the highly polluted regions. This is because CHIMERE V2013 has a new transport scheme and secondary organic aerosol chemistry. In addition, its chemical reaction rates are updated.

2. Comparison with observations



The diurnal cycle comparisons over Beijing and Xinglong show that the pattern of the different simulations is very similar. The deep convection option in the model has little effect. At Xinglong station, all the simulations underestimate the NO_2 surface concentration during day time as compared with the ground measurements. The NO_2 diurnal cycle of CHIMERE V2013 with MEIC is closest to the ground measurements.

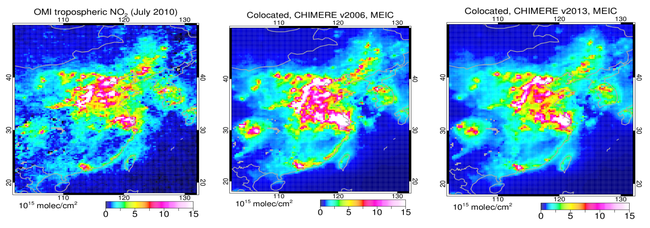


The time series figure above shows that both models have the capacity to simulate the diurnal cycle. Especially during night time, CHIMERE V2013 gives better results. CHIMERE V2006 overestimates the nocturnal NO_2 concentration at surface.

Xinglong Location

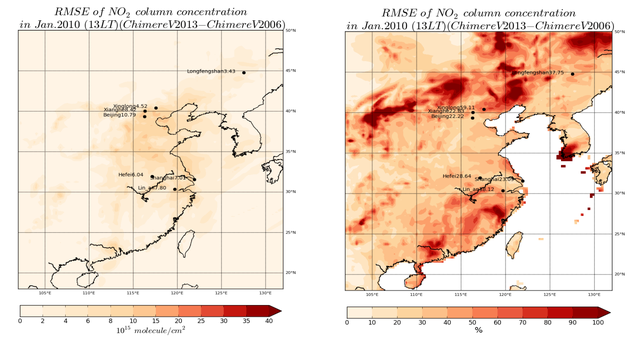
Model results compared with ground measurements	RMSE (ppb)	Correlation coefficient
CHIMEREV2006-MEIC	6.78	0.677
CHIMEREV2013-INTEX-B	8.38	0.647
CHIMEREV2013-MEIC	5.83	0.717

The RMSE of CHIMERE V2013 is the lowest, and the correlation coefficient of CHIMERE V2013 with the ground measurements is the highest. These show that CHIMERE V2013 performs better than the old version for this location.



The comparison with the OMI satellite measurements shows that CHIMERE V2006 overestimate the NO_2 column concentration, while CHIMERE V2013 is closer to the observation.

3. Model error estimates



The RMSE of NO_2 column concentration between the old and new CHIMERE model helps us to check the model error estimates in DECSO. We can see that the high RMSE at the middle east part of China is related to high NO_2 concentrations. The high relative RMSE may be due to the added biogenic emissions in the new CHIMERE.

Discussion and Conclusions

The MEIC inventory is better than the INTEX-B inventory. Using MEIC can decrease the time to converge to new NOx emissions in DECSO.

CHIMERE V2013 performs better than CHIMERE V2006. Therefore, the new CHIMERE model will be implemented in DECSO. We will also run CHIMERE V2013 for the whole year of 2010 to start a comprehensive validation of the new model.

The relative RMSE errors vary with geographical location. In DECSO, we assume that the model error is the same at different locations. We will further study the model error using RMSE and OmF statistics.

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