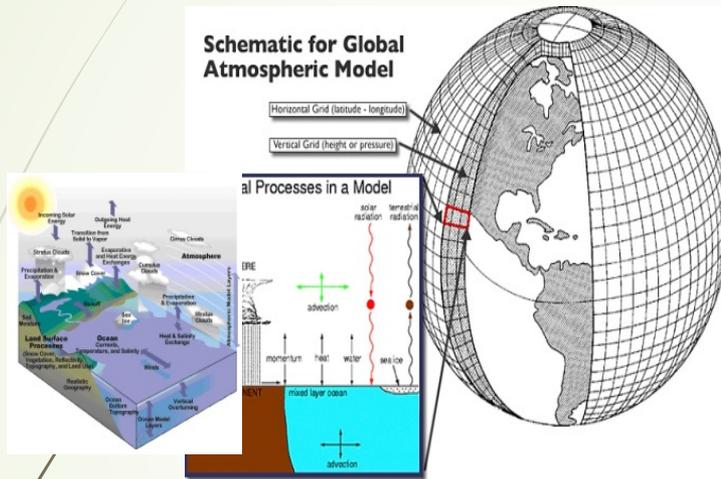


NO_x emissions estimates based on satellite observations

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Levelt

Introduction

Emission inventory



Input for air quality simulations and forecasts

Help policy makers with air quality regulations



Emission estimates

➤ Bottom-up approach

➤ Statistics combining local information:

- Emission activities
- Emission factors
- Source types

➤ Satellite-based approach

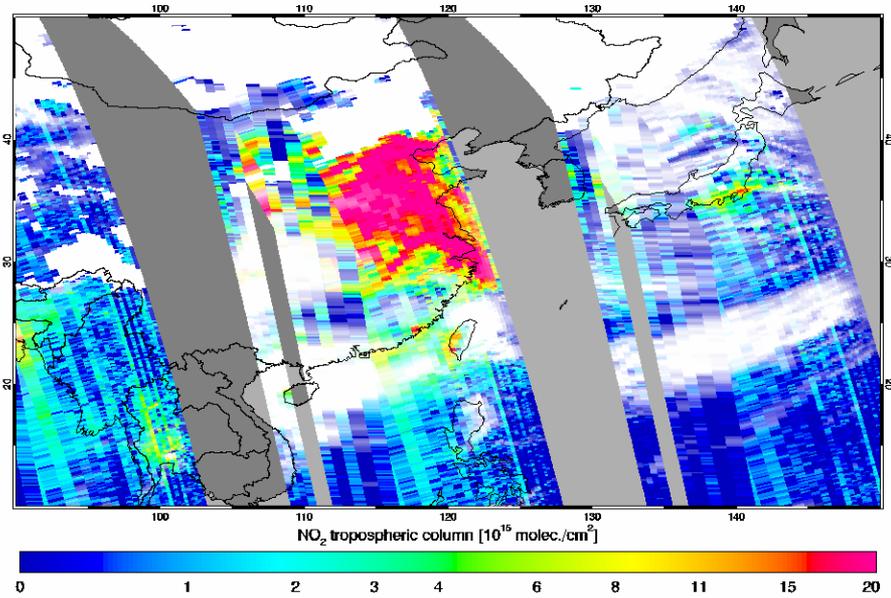
➤ Inversion methods combining satellite observations and chemical transport model:

- 4DVAR techniques (Stavrakou et al., 2008)
- Kalman filter (Mijling et al., 2012)
- Ensemble Kalman filter (Miyazaki et al., 2012)
-

What do we actually see from space?

OMI NRT tropospheric NO₂ 19 Jan 2016

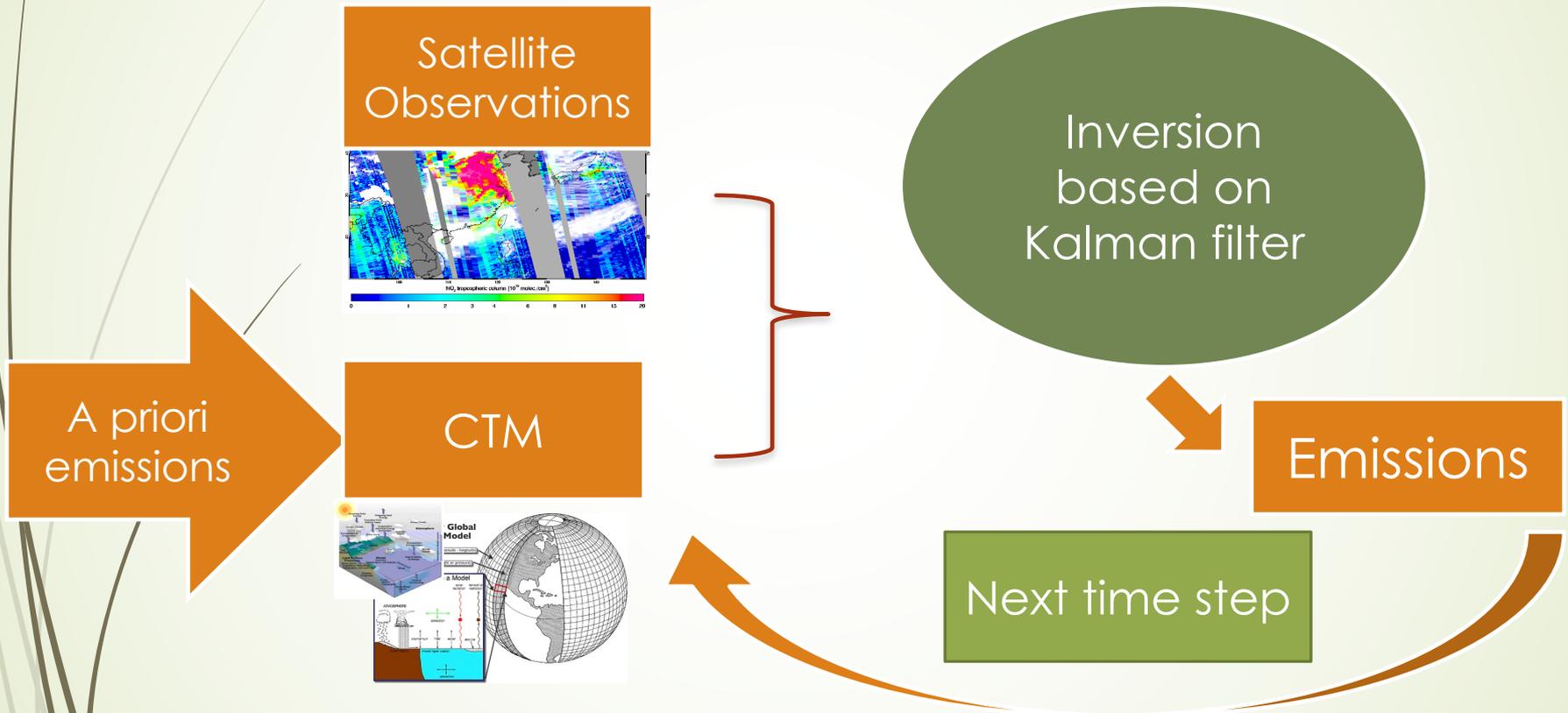
KNMI/NASA



NO_x
Emissions?

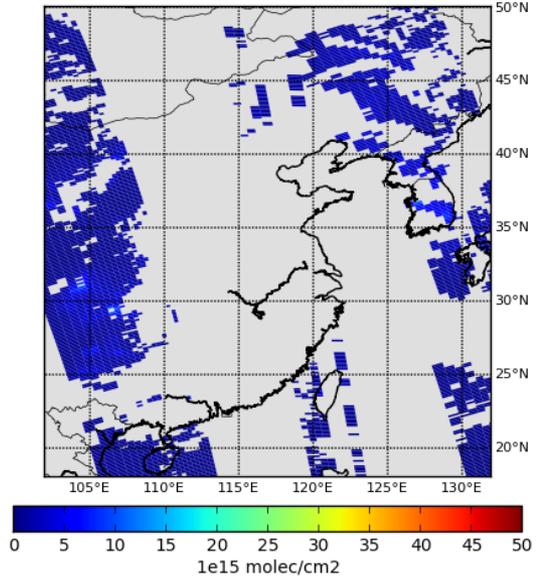


DECSO: Daily emission estimates constrained by satellite observations

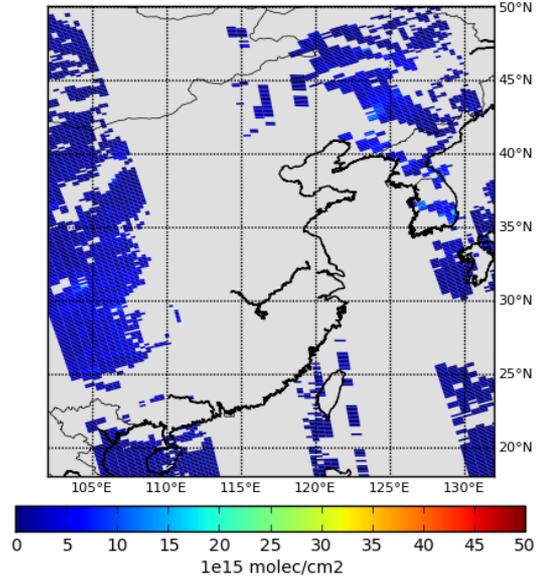


- Key part: the sensitivity of the observed NO₂ column concentration on the NO_x emissions in the CTM

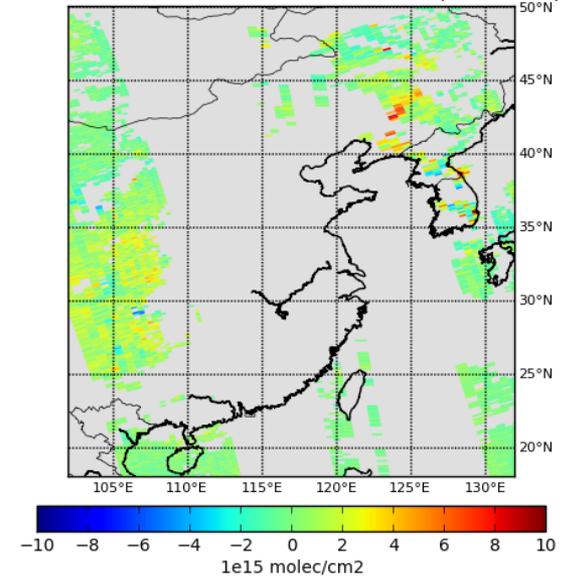
Model forecast



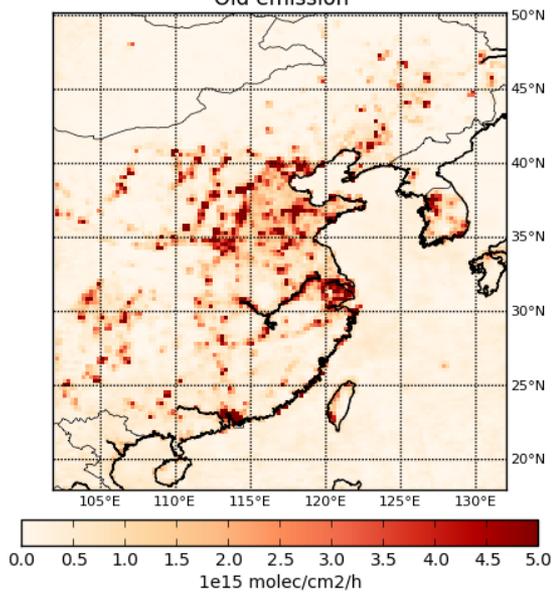
Satellite observation



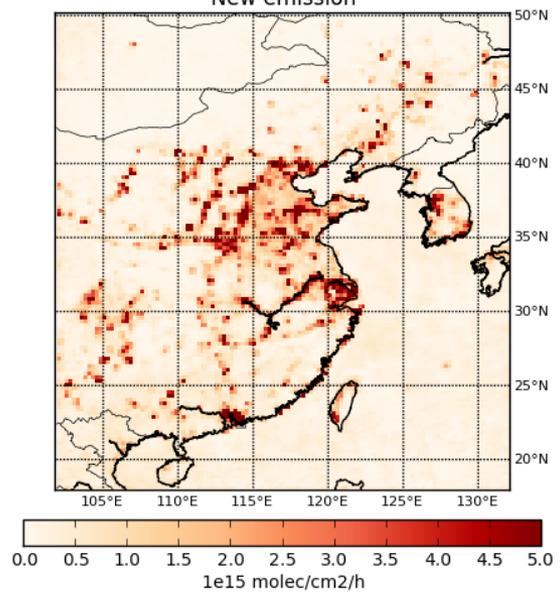
Difference between Model and Satellite (obs-model)



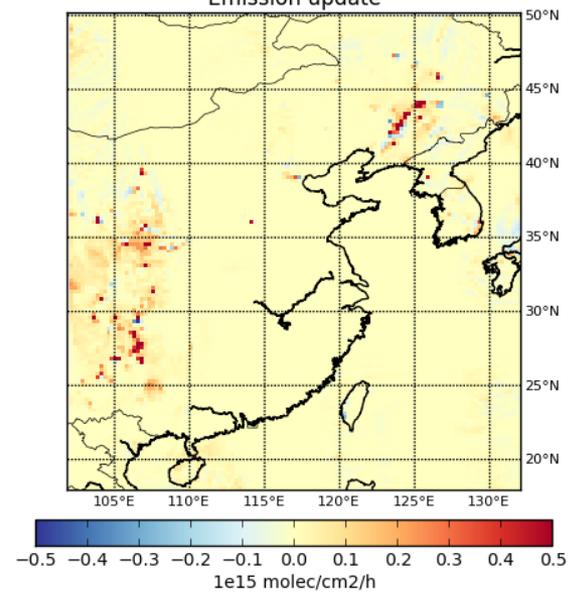
Old emission



New emission



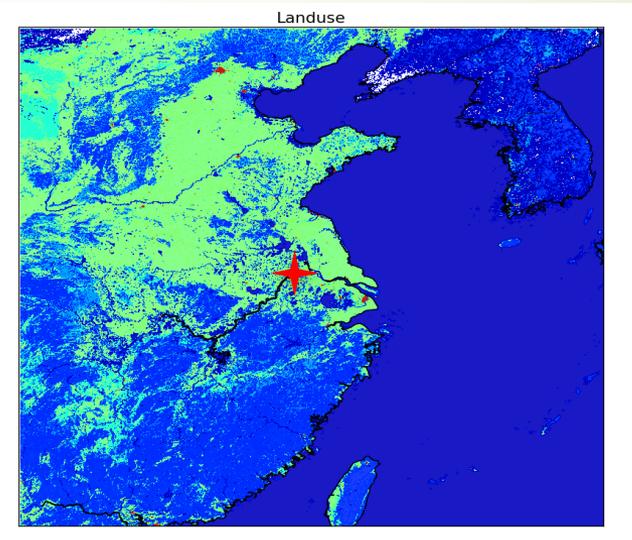
Emission update



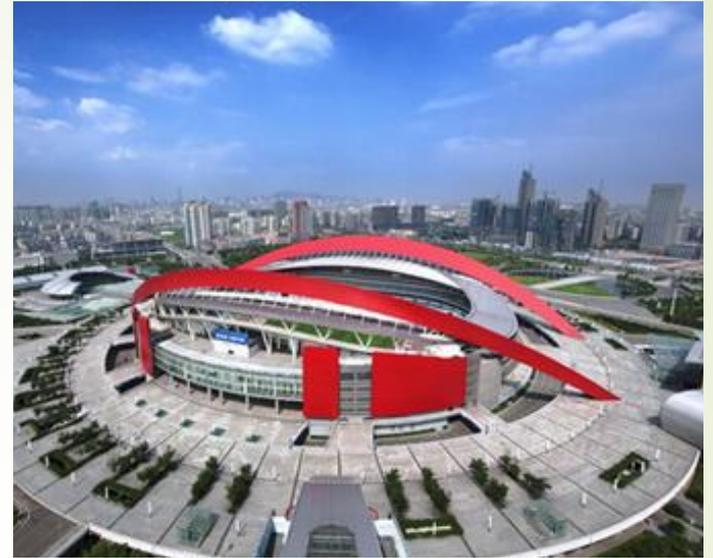
A Case study

► The Nanjing Youth Olympic Games

- Population: 8.2 million
- Date: 16 to 24 August, 2014
- Regulations taken by local government

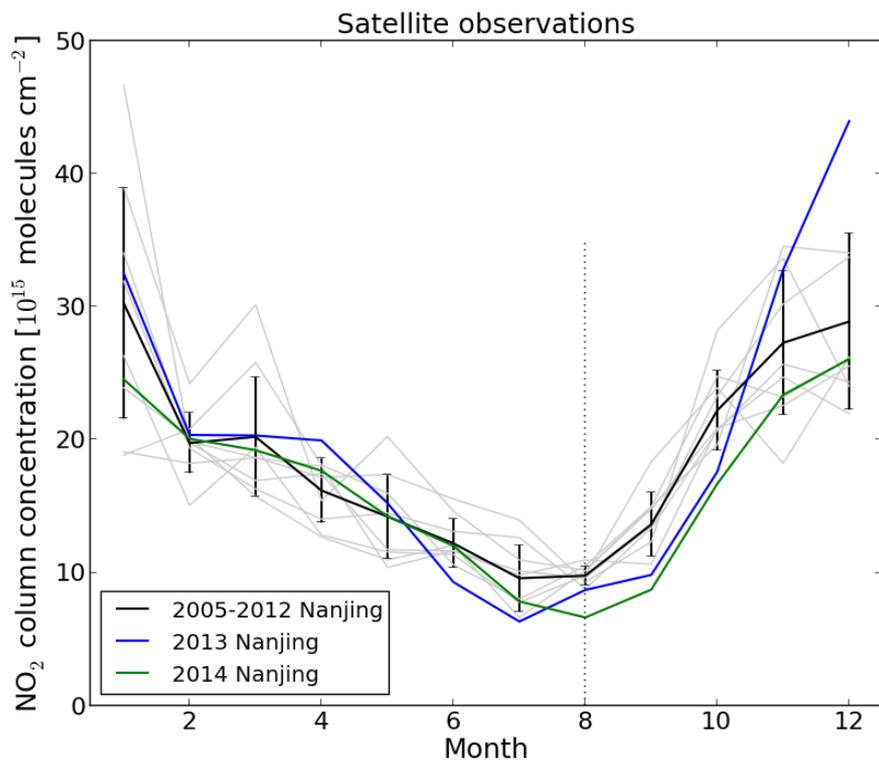




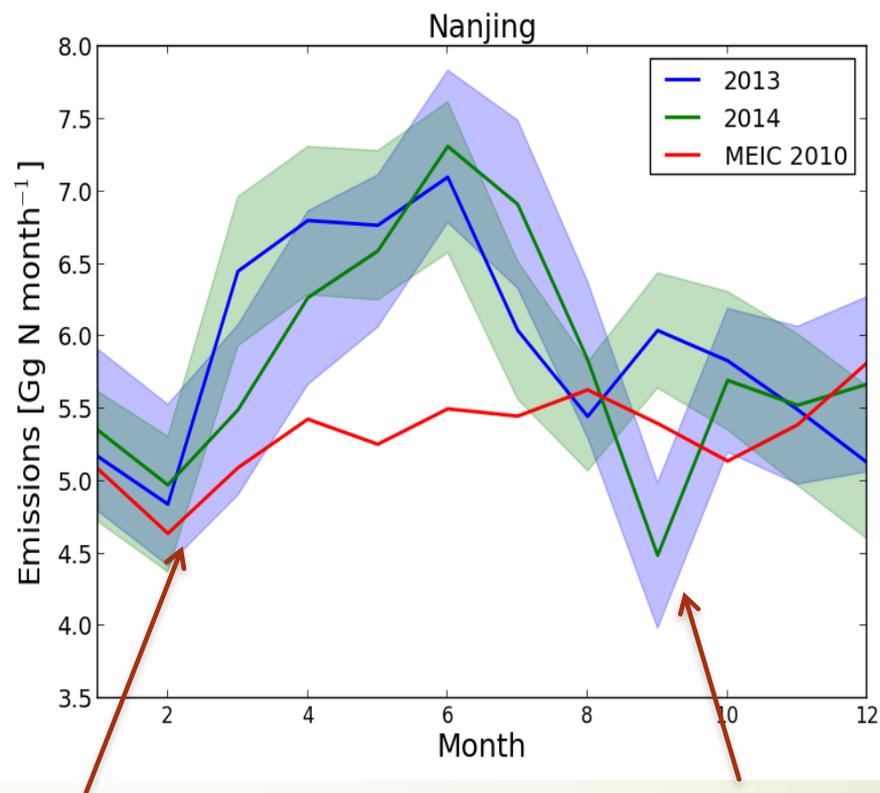


Can we see the effect on emissions via satellite observations?

Satellite observations vs. satellite-derived emissions



A decrease of 32% in August. But this could be caused by the rainy weather.

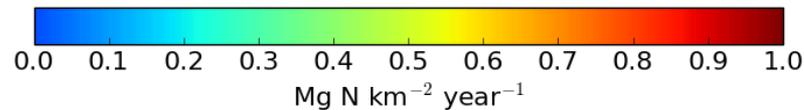
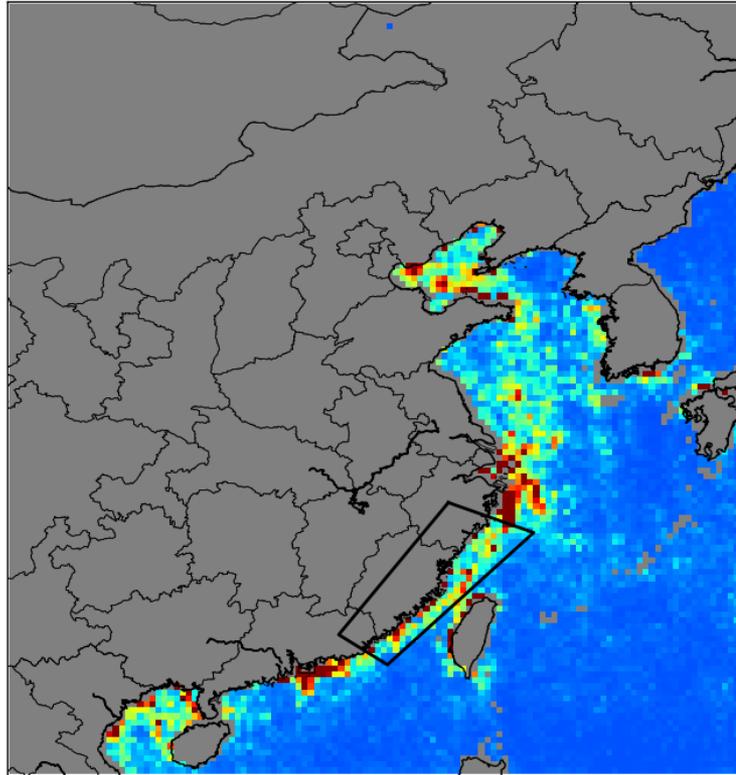


A reduction about 10%

A reduction about 25%

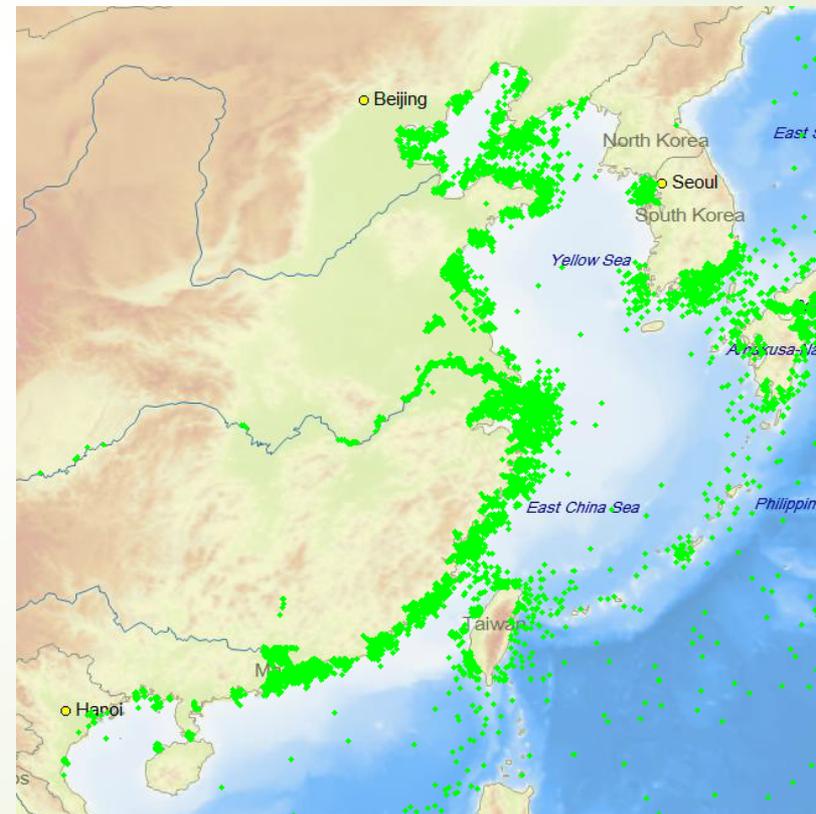
Shipping emissions derived from space

NO_x emissions (DECSO v5)

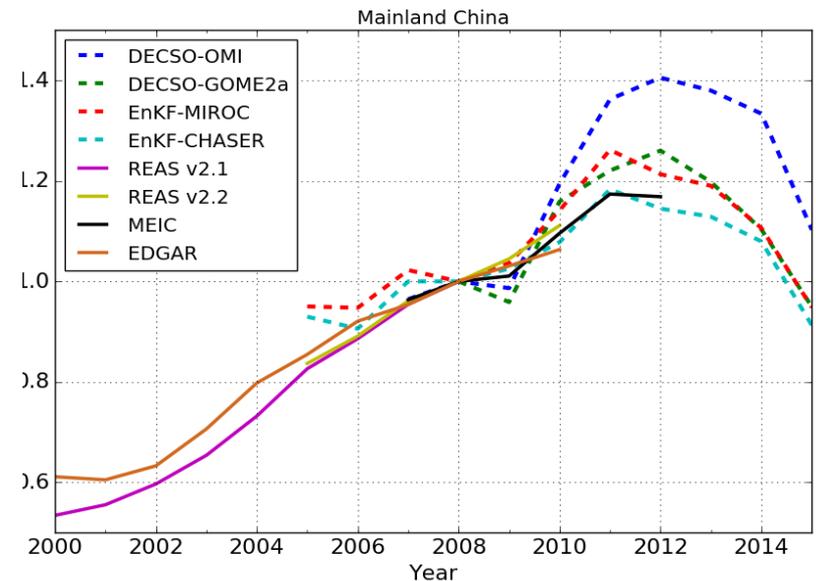
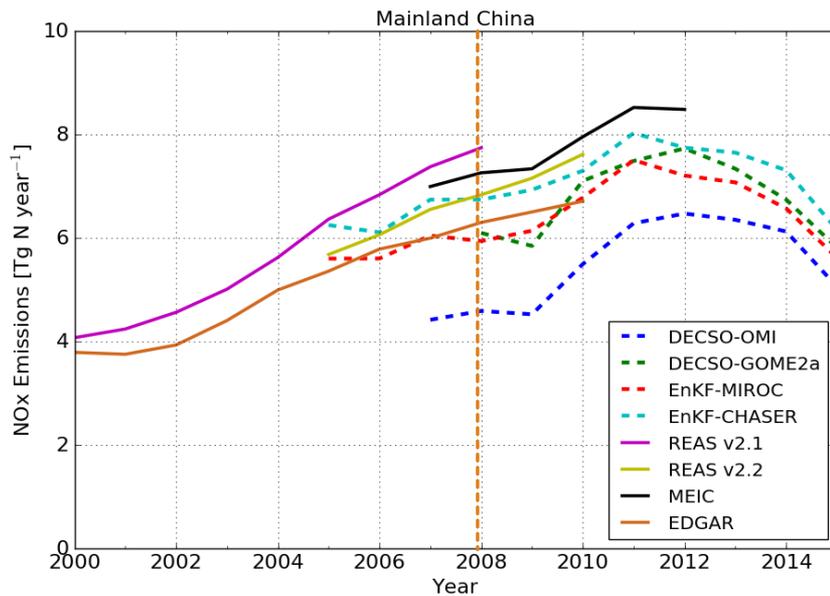


Ship emissions near the Chinese coast areas; 55 Gg N per year

Comparable to ship locations:

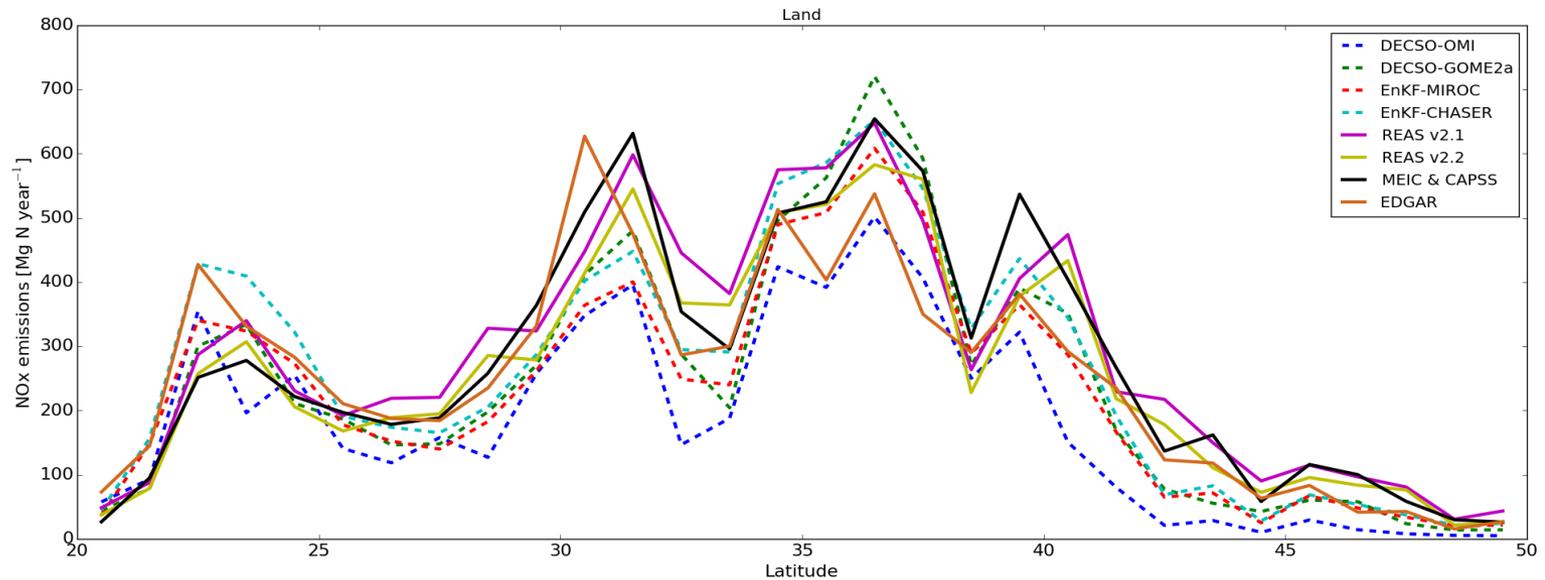


Intercomparison: temporal evaluation



Standard deviation: 1 Tg N yr⁻¹ in 2008,
about 20% of the average

Intercomparison: spatial distribution



- High correlation of emission distribution on a provincial level : $R > 0.8$
- Good agreement of emissions along latitude

Bottom-up approach

- Detailed information about emission source types
- Uncertainties from the statistics
- Infrequent update



Satellite-derived approach

- Fast update: daily and global
- Difficulty: distinguish emissions from different source categories





Conclusions

- Satellite-based approach is able to detect NO_x emission change in a short time period.
- Satellite-derived emissions are in good agreement with bottom-up emissions.

Recommendations

- The information from satellite-based approach and bottom-up approach can be combined.