Royal Netherlands Meteorological Institute
Ministry of Infrastructure and the Environment

Fast emission estimates for rapidly changing economies constrained by satellite observations

Bas Mijling, Jieying Ding, Ronald van der A

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GLOBEMISSION

- Overview of the DECSO algorithm

- Middle East
- South Africa
- North and South Korea
- China (emission trends and a case study)

From concentrations to emissions: Basic tools

NO_2 retrievals from OMI and GOME2

CHIMERE
0.25 °×0.25°

Properties of DECSO*

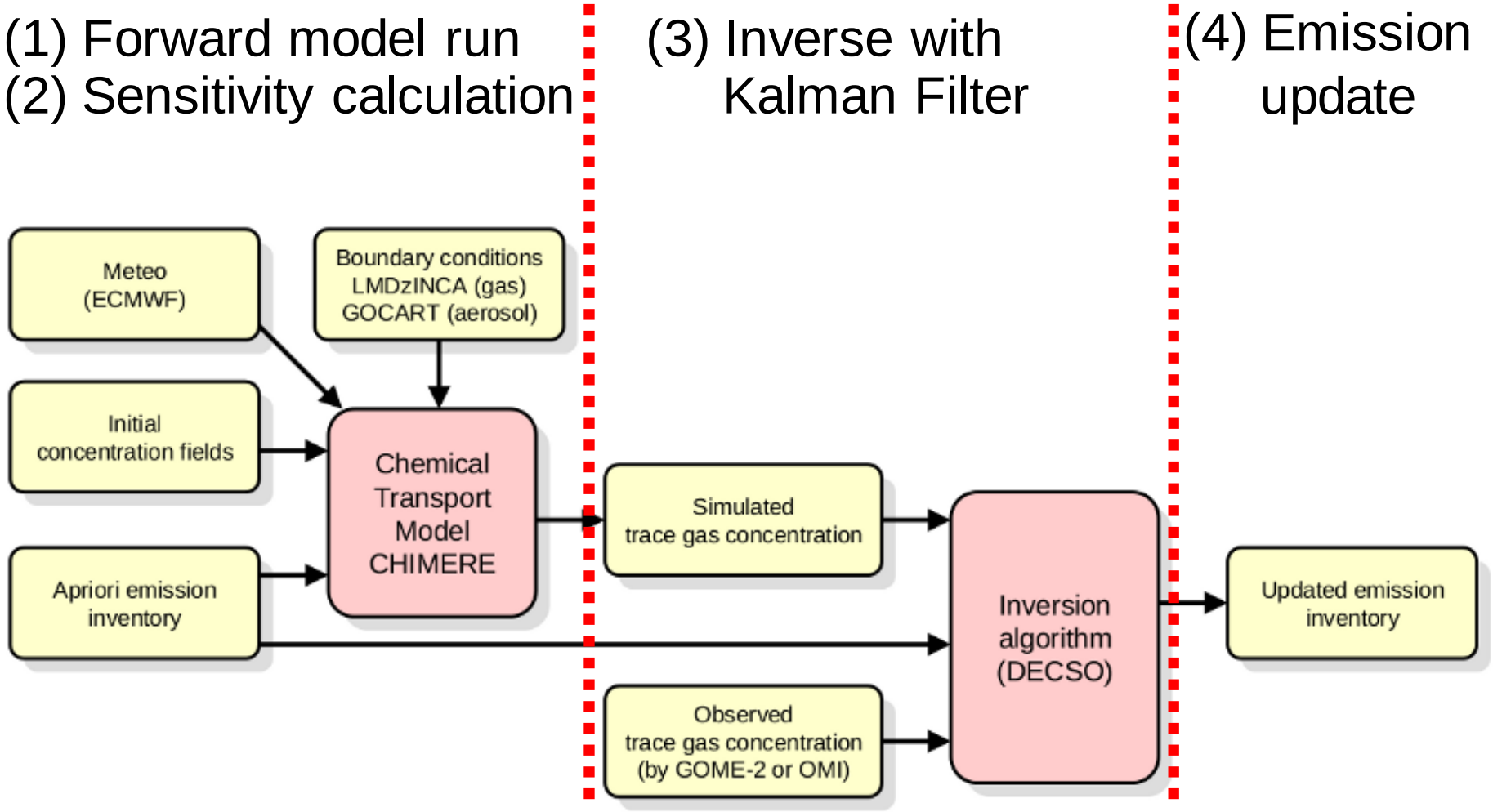
Takes transport into account
enables high resolution (~25×25 km^2)

Relatively fast
enables operational emission estimation

Emission updates by addition
enables detection new hotspots / relocation existing hotspots

* **D**aily **E**mission estimates **C**onstrained by **S**atellite **O**bservations

Overview DECSO



Mijling and Van der A (2012), *Daily emission estimates from space*, J. Geophys. Res.

DECSO algorithm improvements

Version v1 → v3a

- **Improved concentration simulation**

  Emission injection height according to sector.

- **Improved source-receptor (sensitivity) calculation**

  Switching to backward trajectory calculations.

- **Improved inversion algorithm**

  Full inversion in Kalman gain matrix calculation.

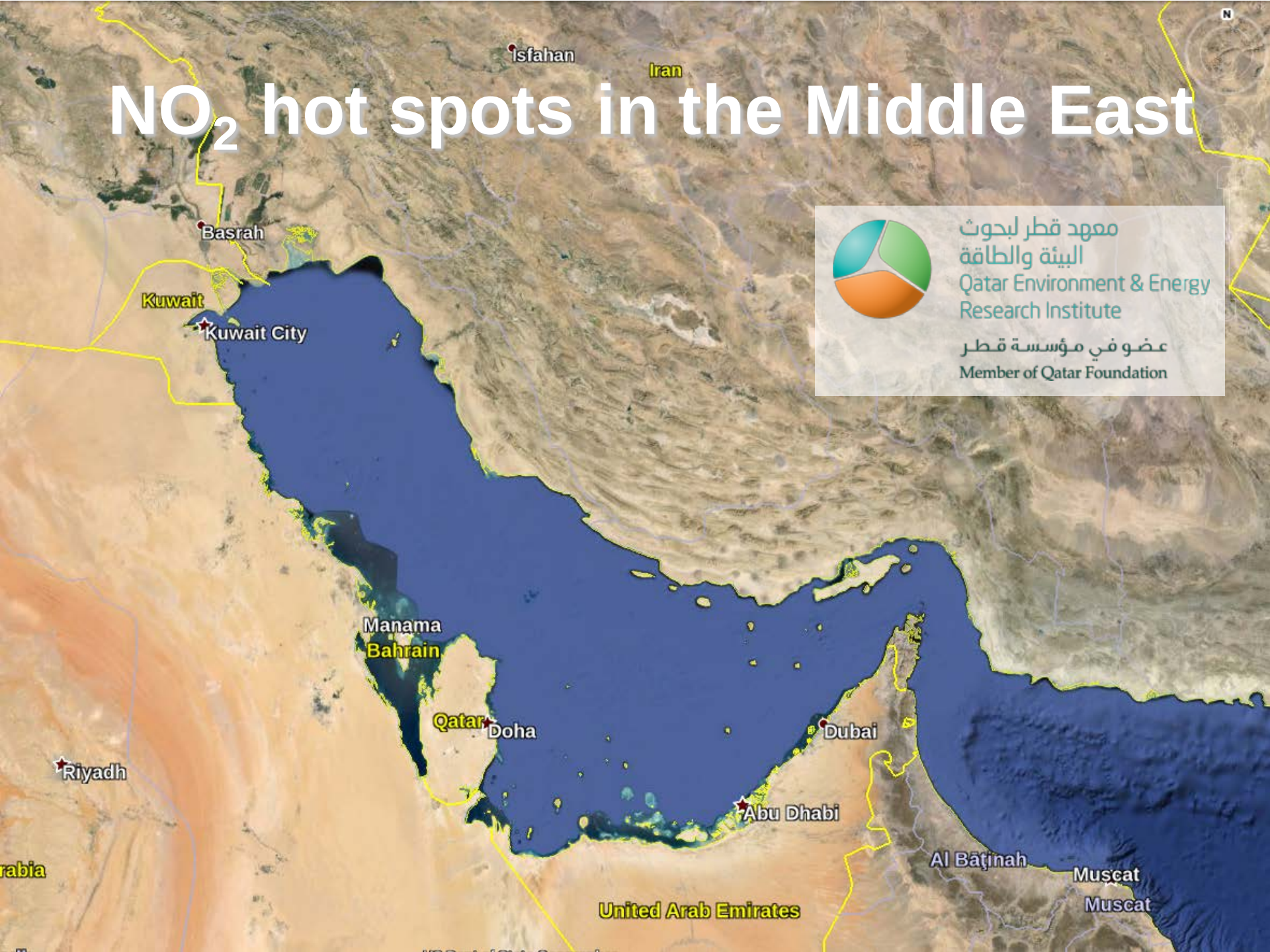
- **Improved emission update scheme**

  (1) Reduces noise and bias over remote areas;

  (2) Update of NO_x-correlated pollutants (CO, PM, SO_2);

  (3) Grid cell dominated by power-plant dominated: inject emissions into model layer corresponding to stack height.

- **Building a Kalman smoother**



NO_2 hot spots in the Middle East

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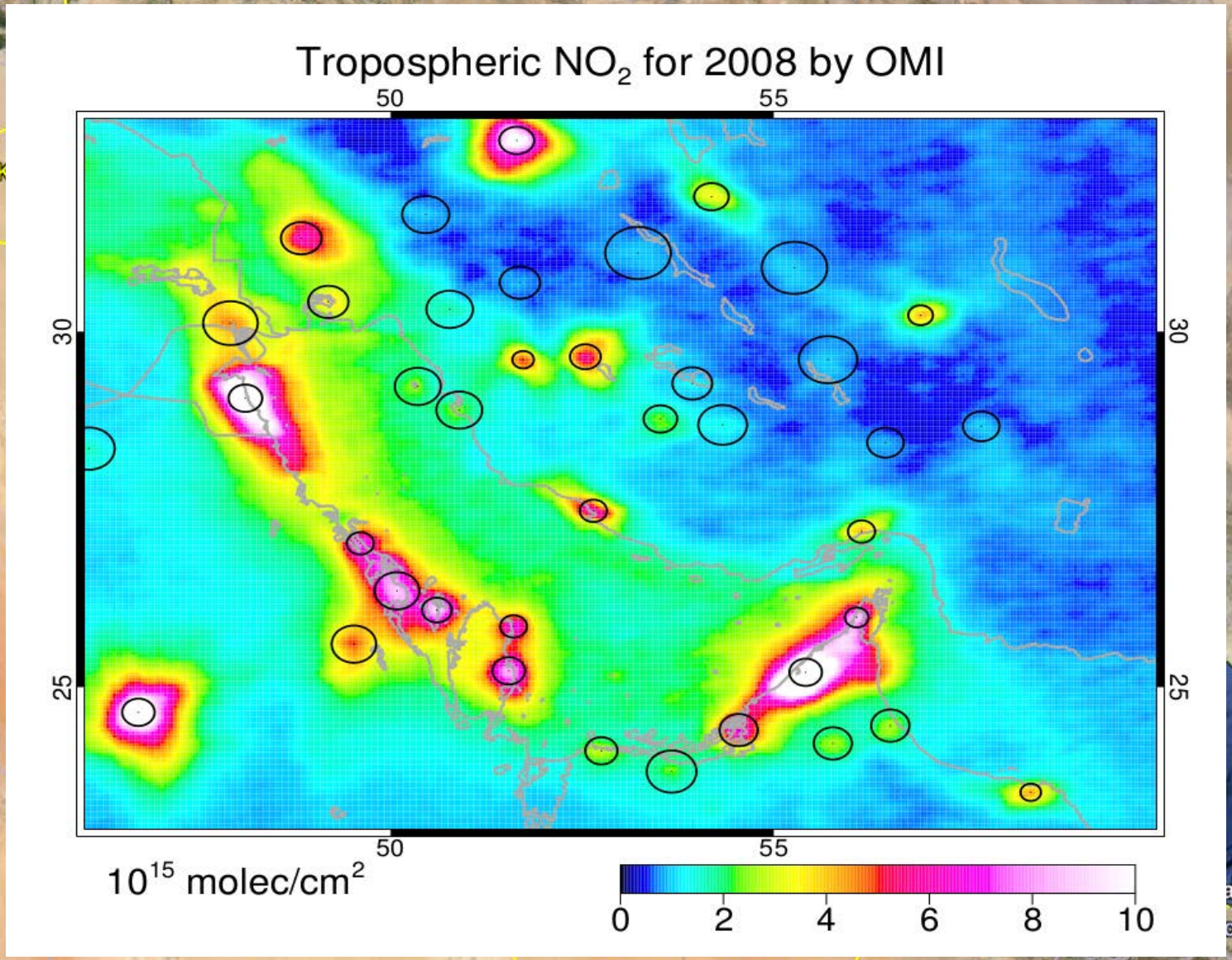
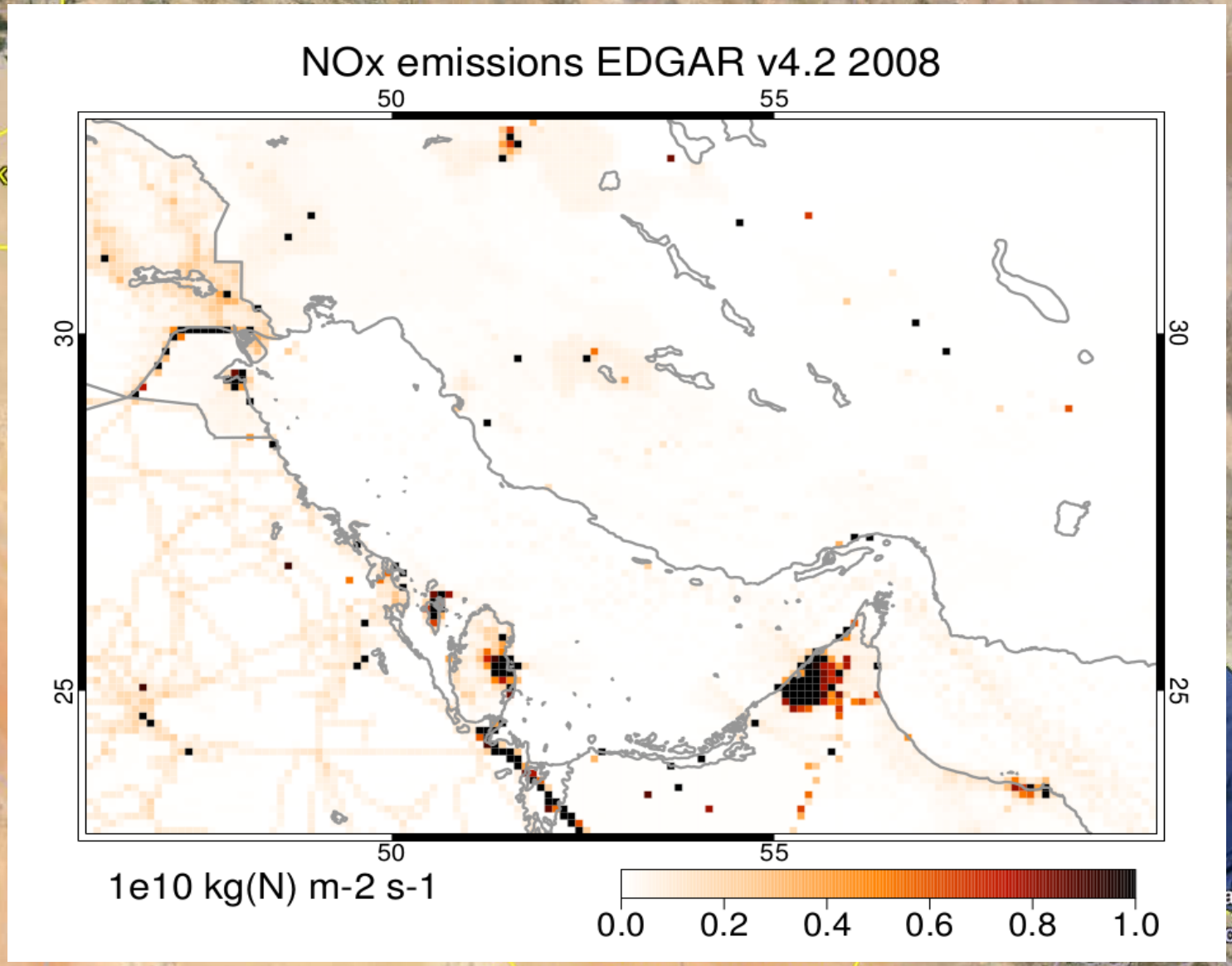
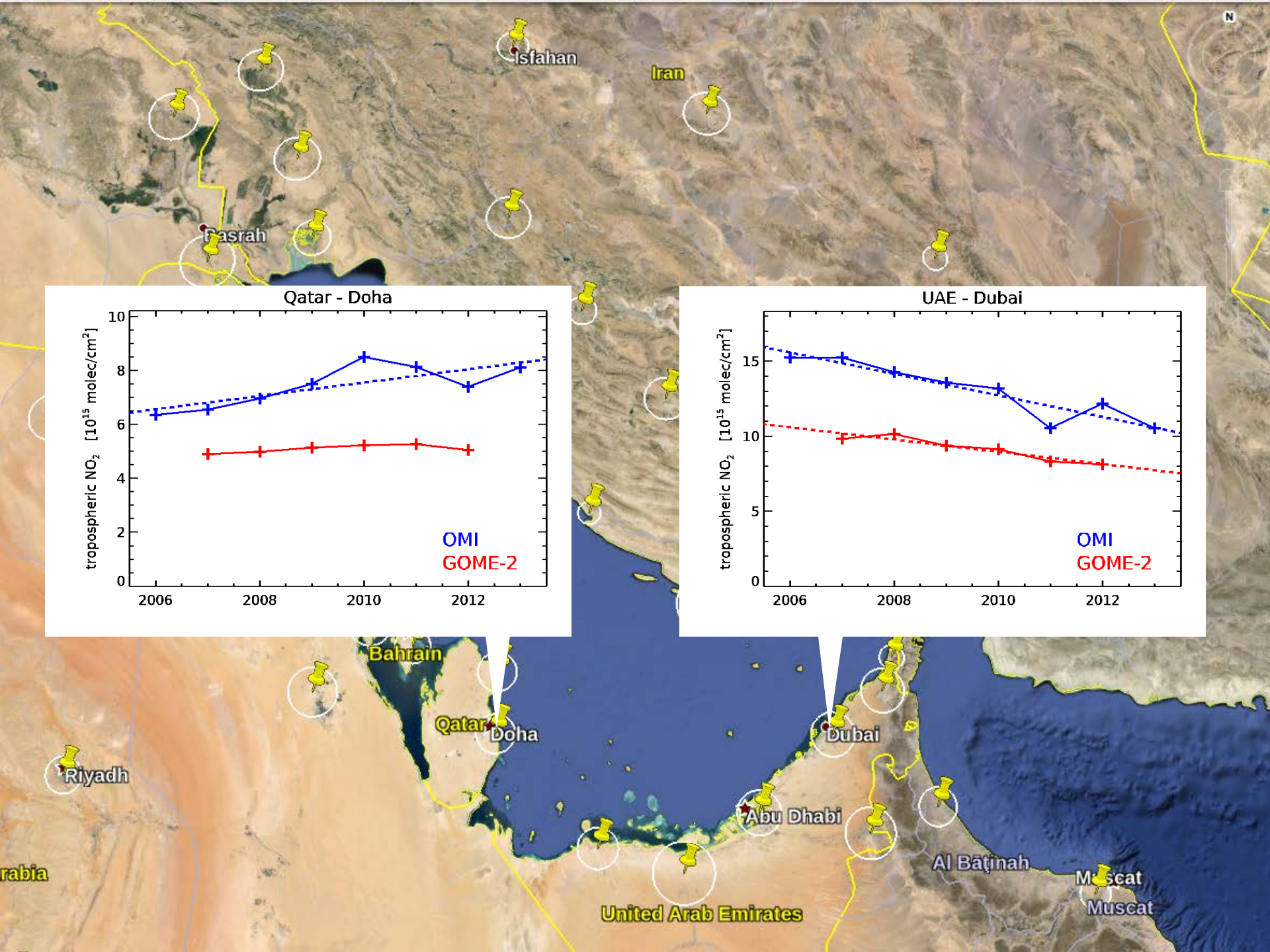
عضو في مؤسسة قطر
Member of Qatar Foundation

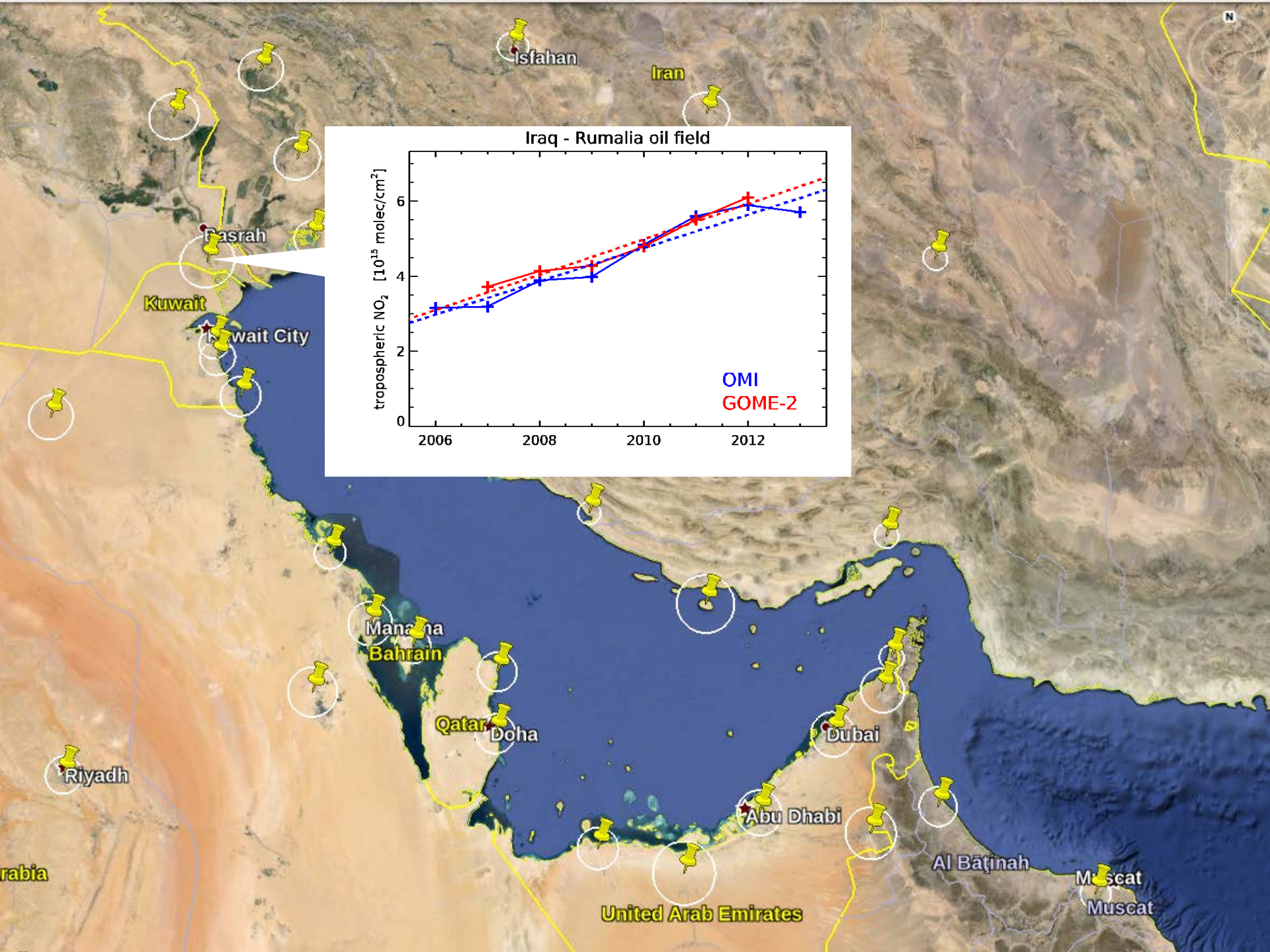
NO_2 hot spots in the Middle East

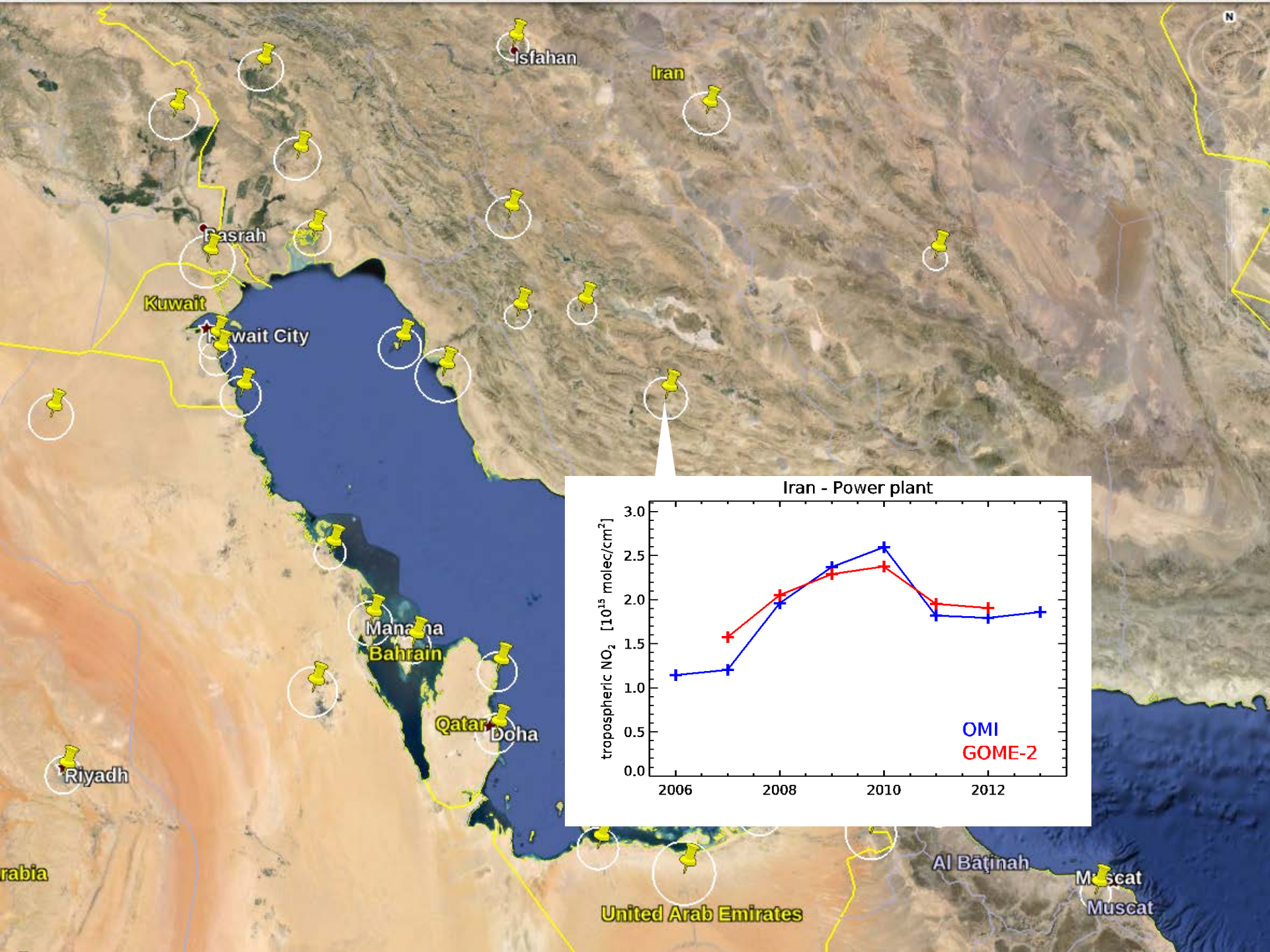


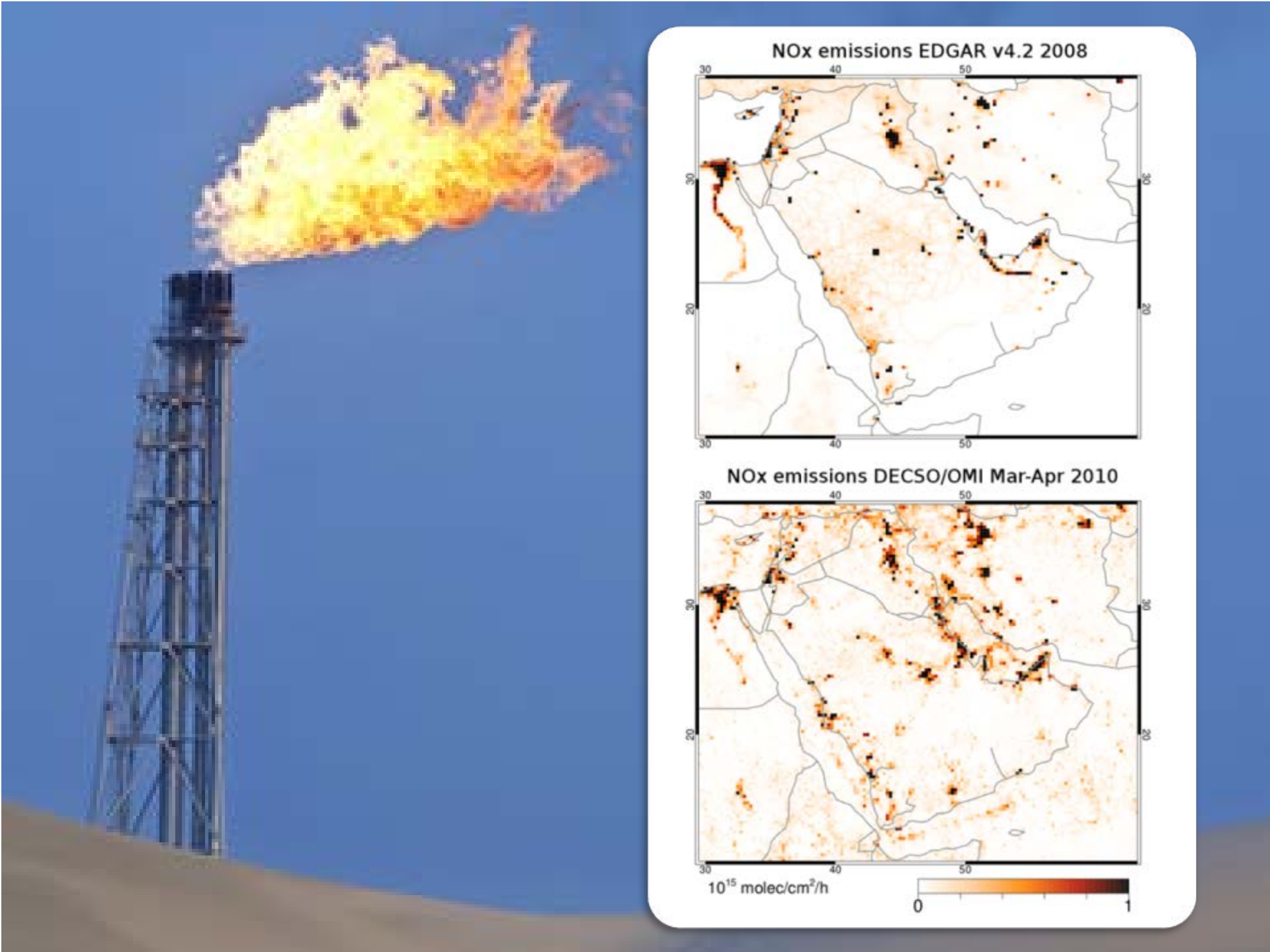
NO_2 hot spots in the Middle East



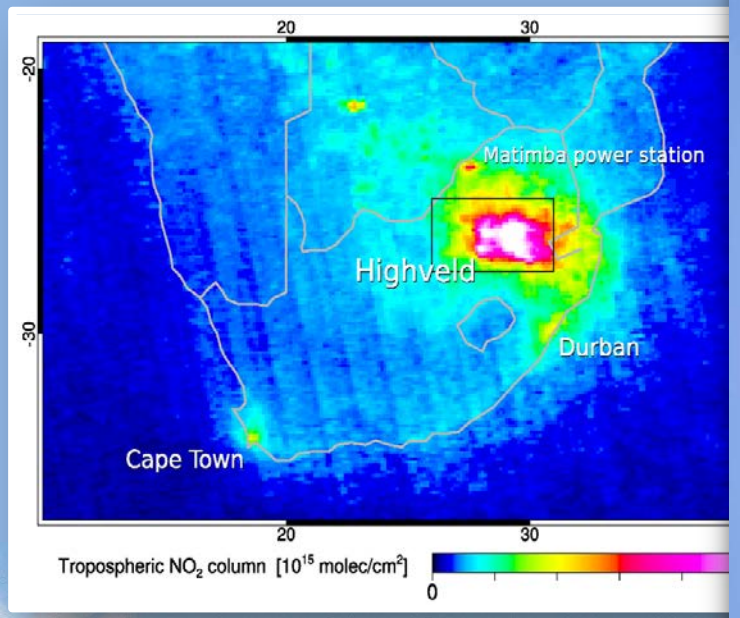

Isfahan
Iran
Basrah
Bahrain
Qatar
Doha
Dubai
Riyadh
Abu Dhabi
Al Baţinah
Muscat
United Arab Emirates
Qatar - Doha
tropospheric NO2 [10^15 molec/cm^2]
0
2
4
6
8
10
2006
2008
2010
2012
OMI
GOME-2
UAE - Dubai
tropospheric NO2 [10^15 molec/cm^2]
0
5
10
15
2006
2008
2010
2012
OMI
GOME-2


Iraq - Rumalia oil field
tropospheric NO_2 [10^{15} molec/cm^2]
0
2
4
6
2006
2008
2010
2012
OMI
GOME-2
Isfahan
Iran
Basrah
Kuwait
Kuwait City
Manama
Bahrain
Qatar
Doha
Dubai
Riyadh
Abu Dhabi
Al Bāţinah
Muscat
United Arab Emirates

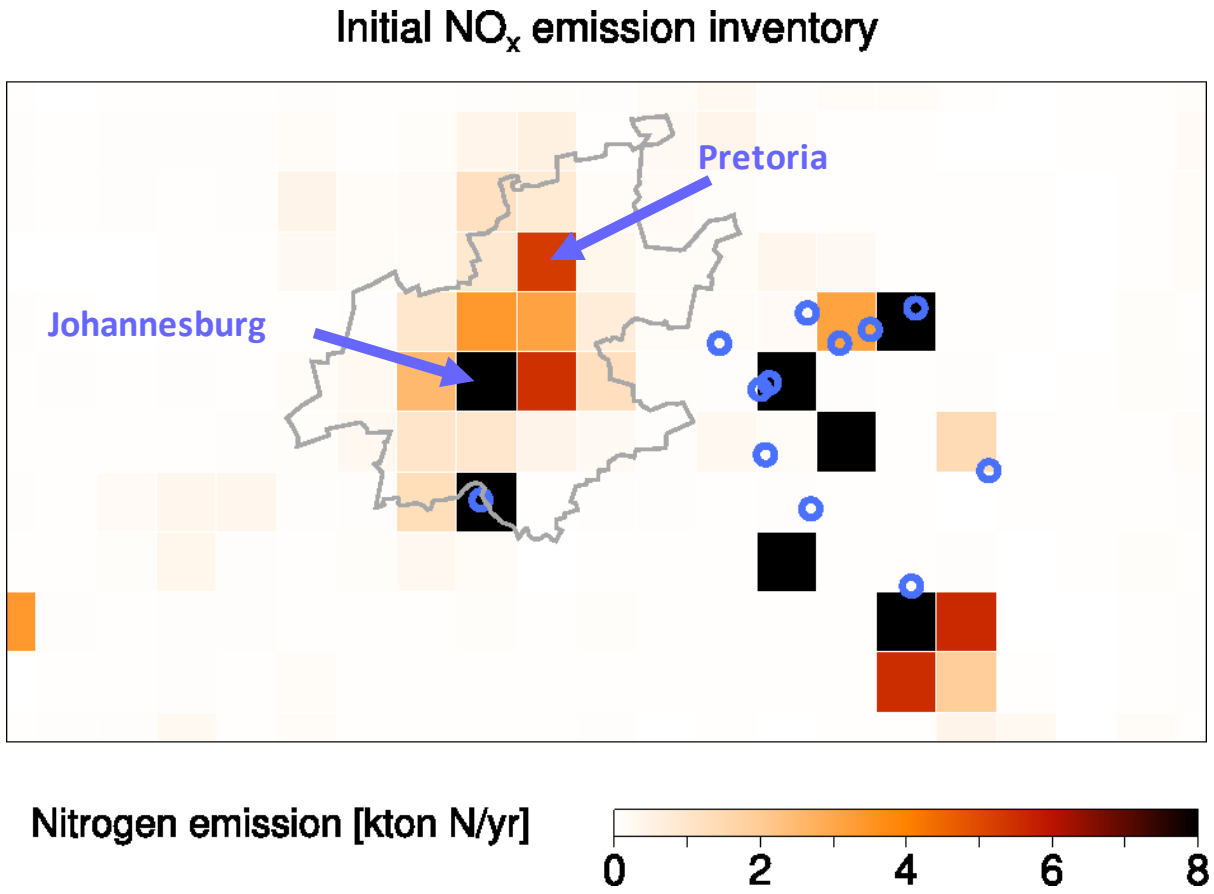

Isfahan
Iran
Basrah
Kuwait
Kuwait City
Manama
Bahrain
Qatar
Doha
Riyadh
United Arab Emirates
Al Bāţinah
Muscat
Iran - Power plant
tropospheric NO2 [10^15 molec/cm^2]
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2006
2008
2010
2012
OMI
GOME-2


NOx emissions EDGAR v4.2 2008
30
40
50
30
20
NOx emissions DECSO/OMI Mar-Apr 2010
10^{15} molec/cm^2/h
0
1

Emission hot spots in South Africa



Highveld NO_x emissions

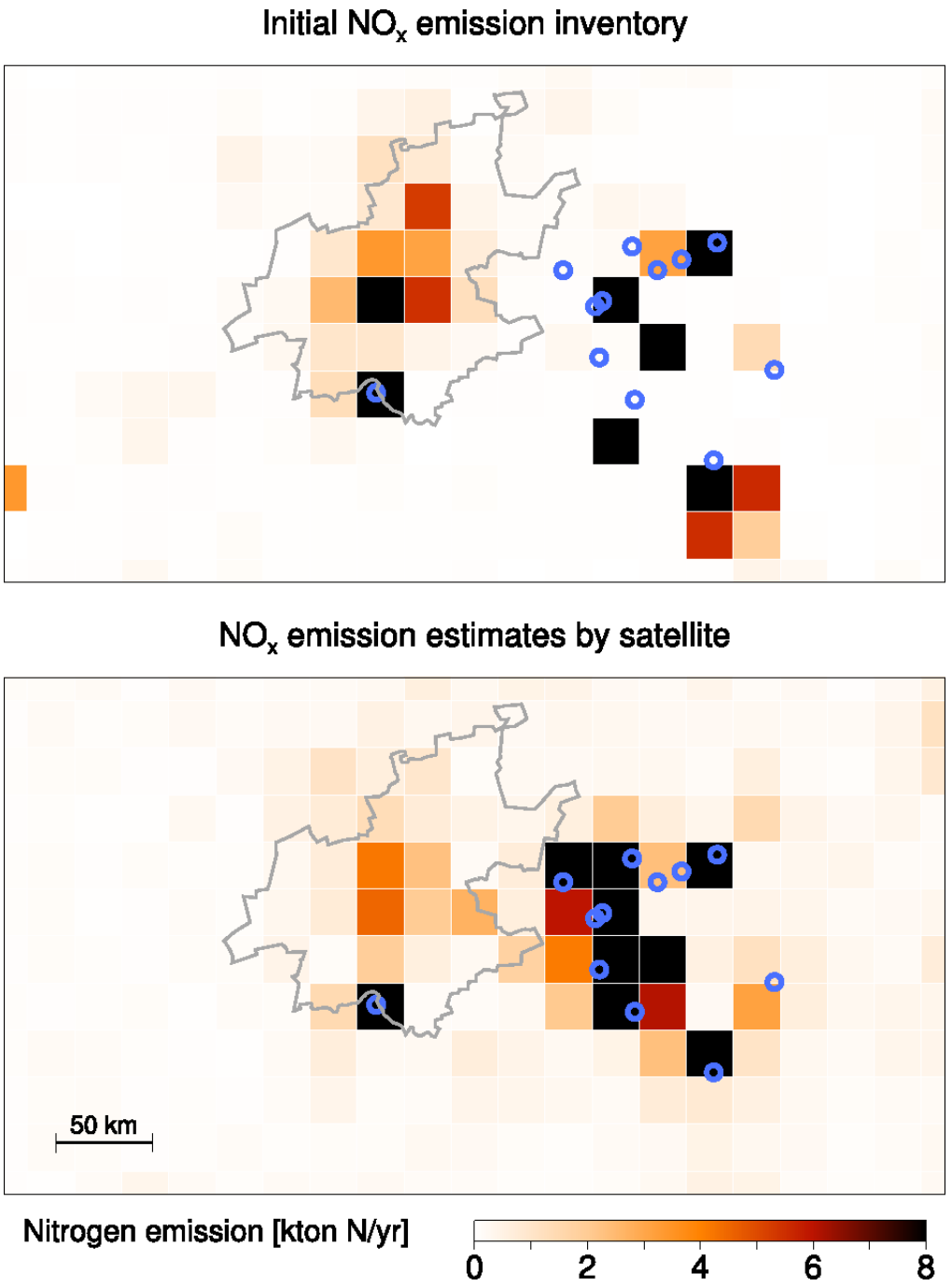


EDGAR v4.2 2008

Highveld NO_x emissions

EDGAR v4.2 2008

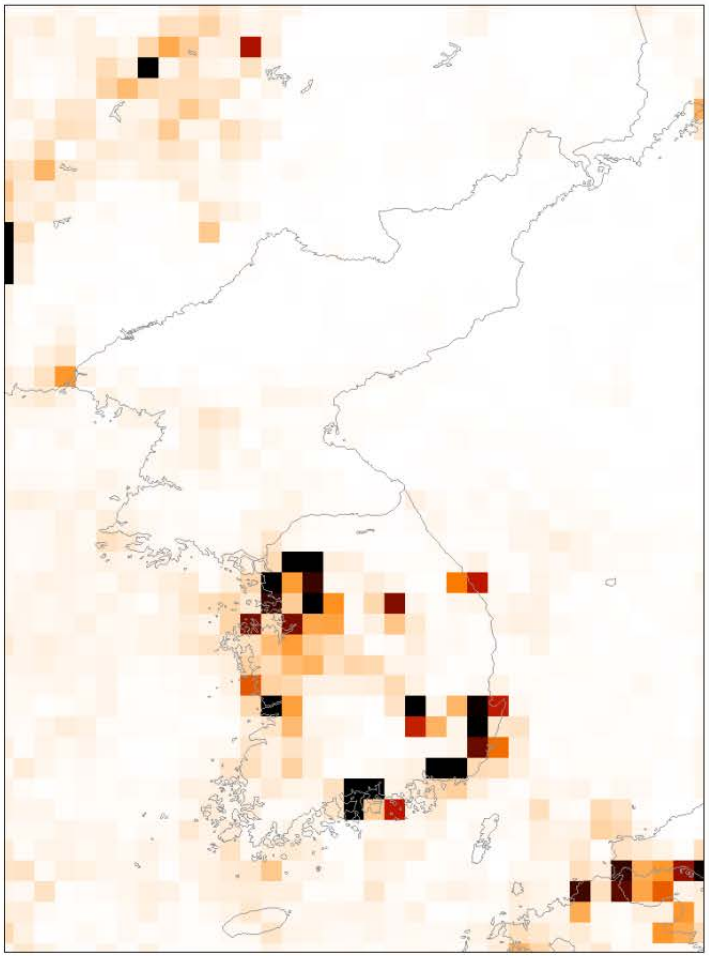
DECSO + OMI 2009-2010



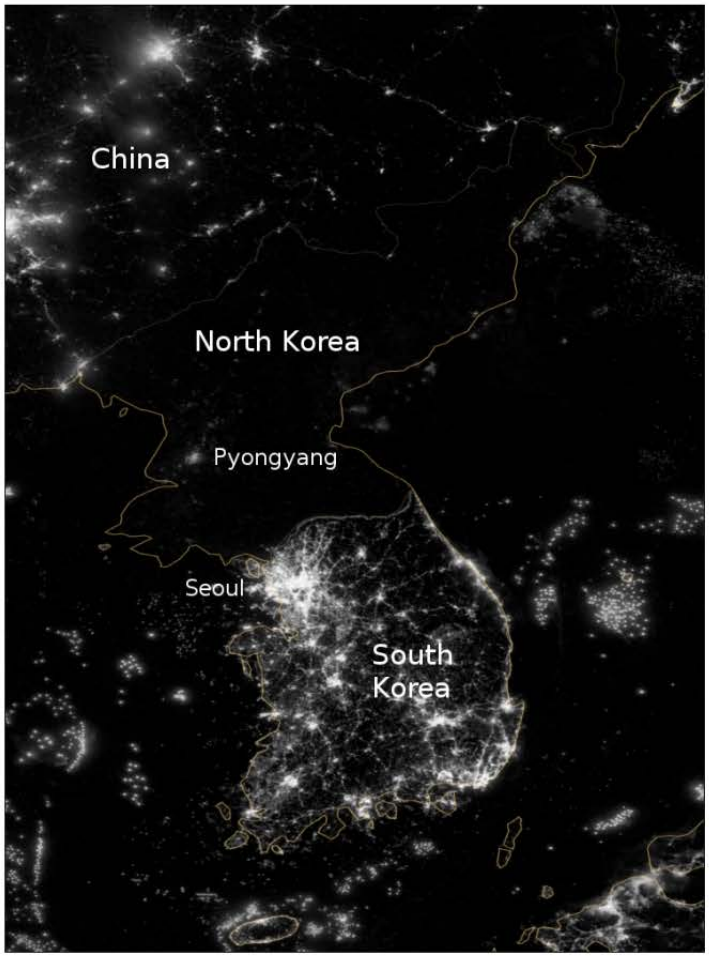
Korea at night

North vs South Korea

NO_x emissions by OMI (2011)

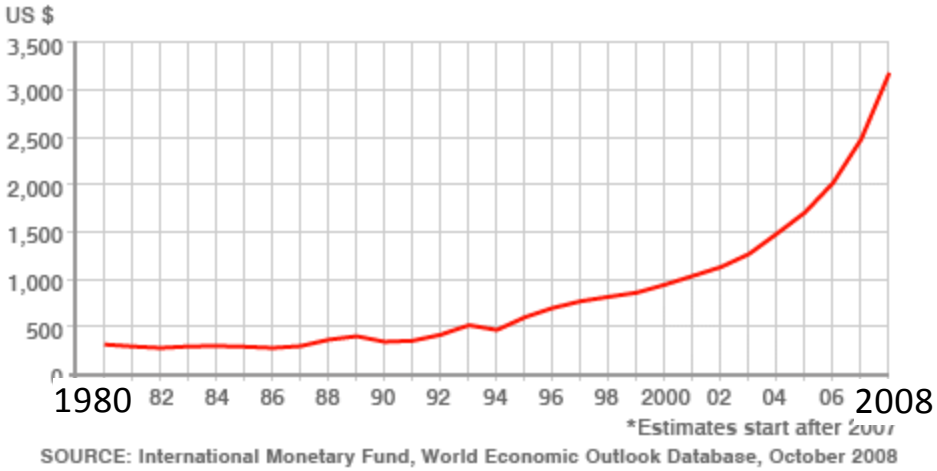


Nighttime lights by VIRRS

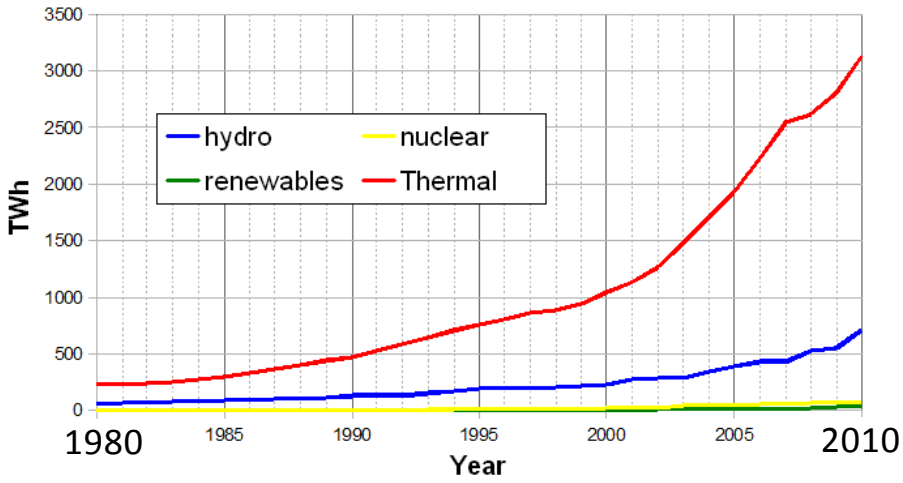


China: Economic indicators

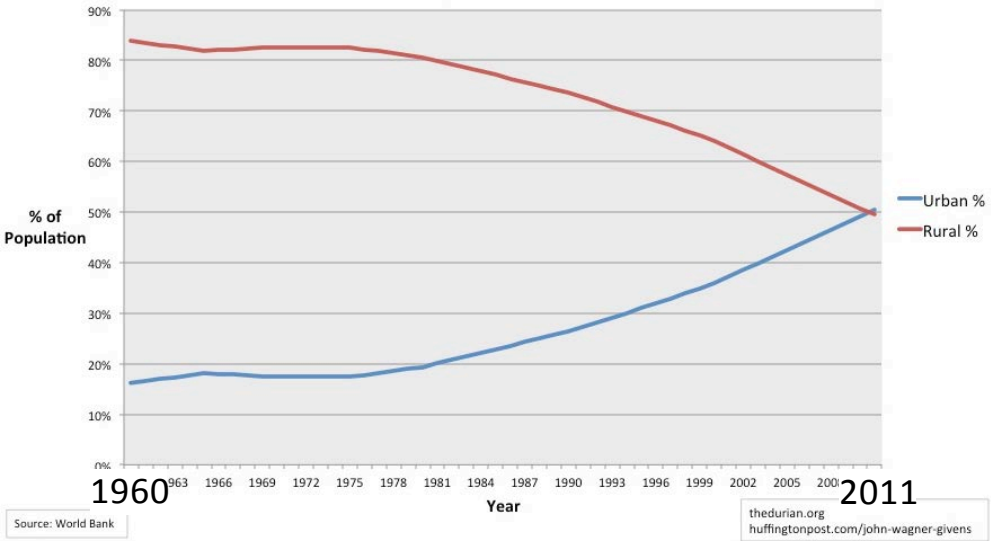
Average annual income per capita, 1980-2008



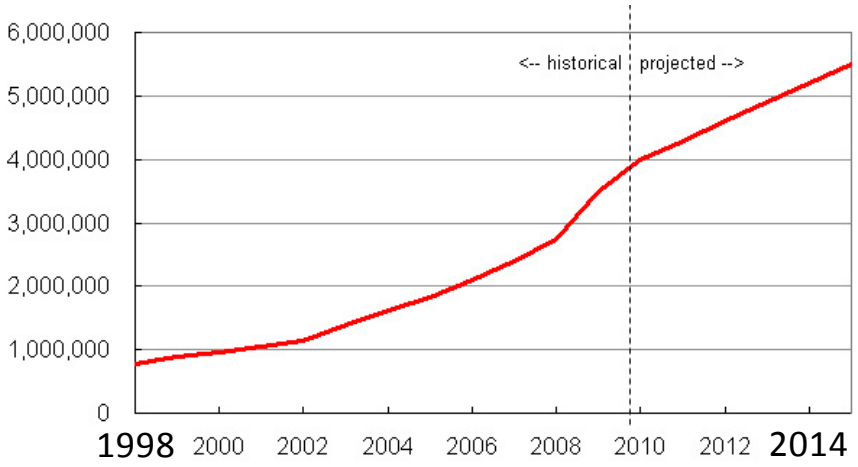
China's electricity production, 1980-2010



China's urbanization, 1980-2011



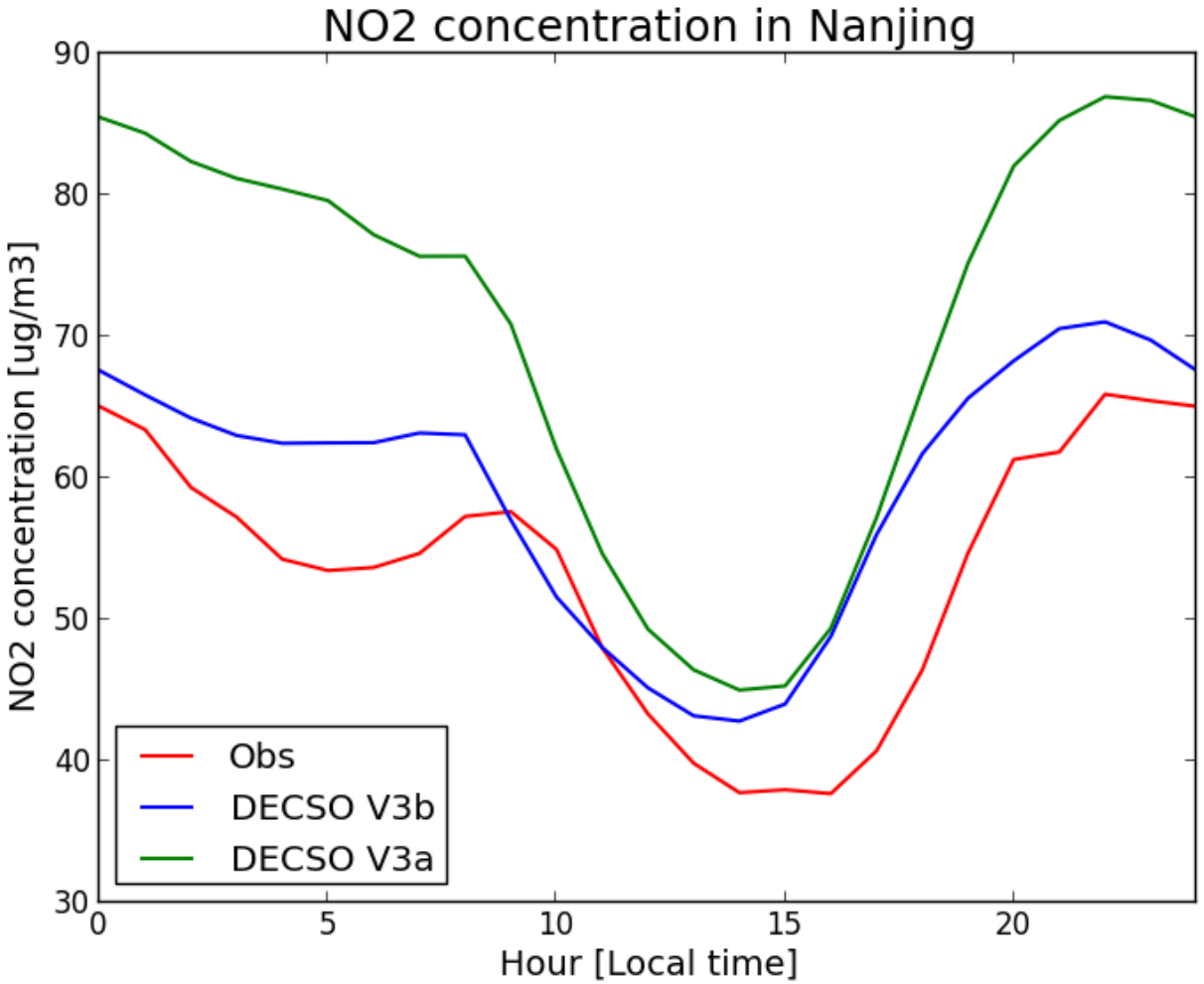
Number of vehicles in Beijing, 1998-2015



Source: China Statistical Yearbook, China Daily (17/2/09)

New CHIMERE version

DECSO v3a → v3b

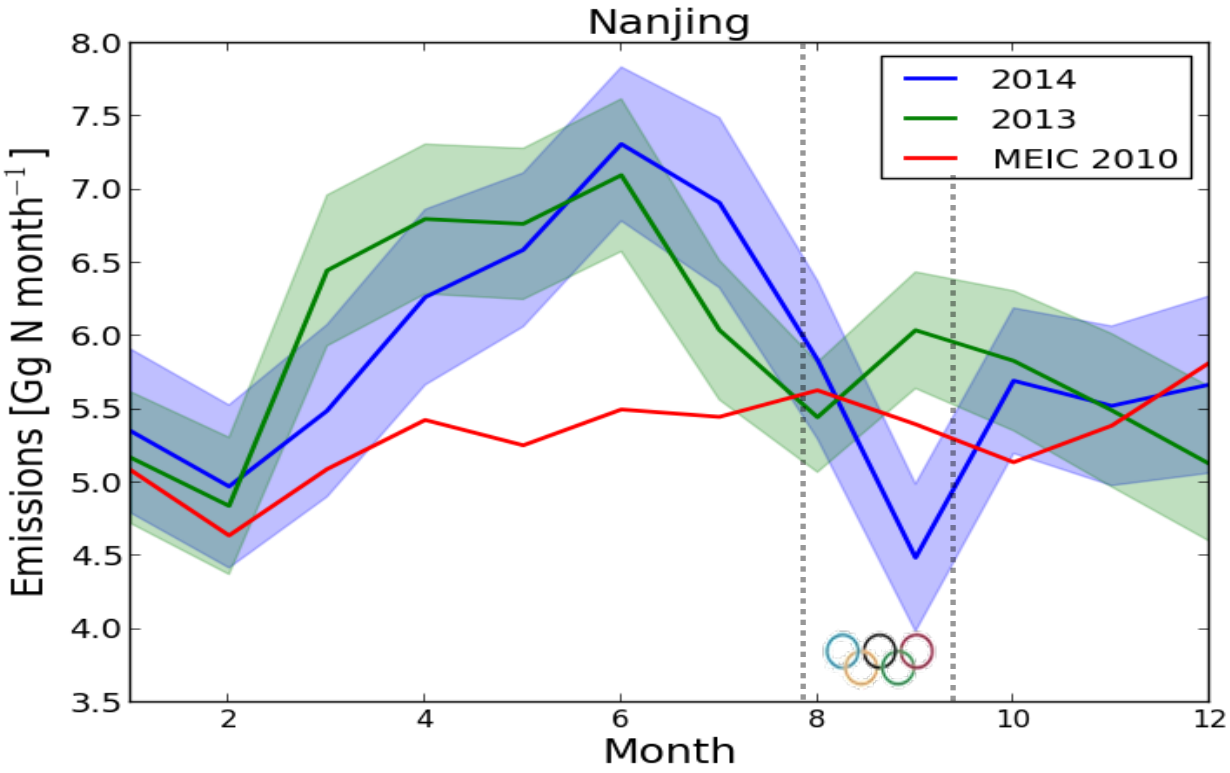


- Update from version 2006 to 2013
- Updated landuse database

Better agreement in diurnal cycle, especial nighttime values

(work by Jieying Ding)

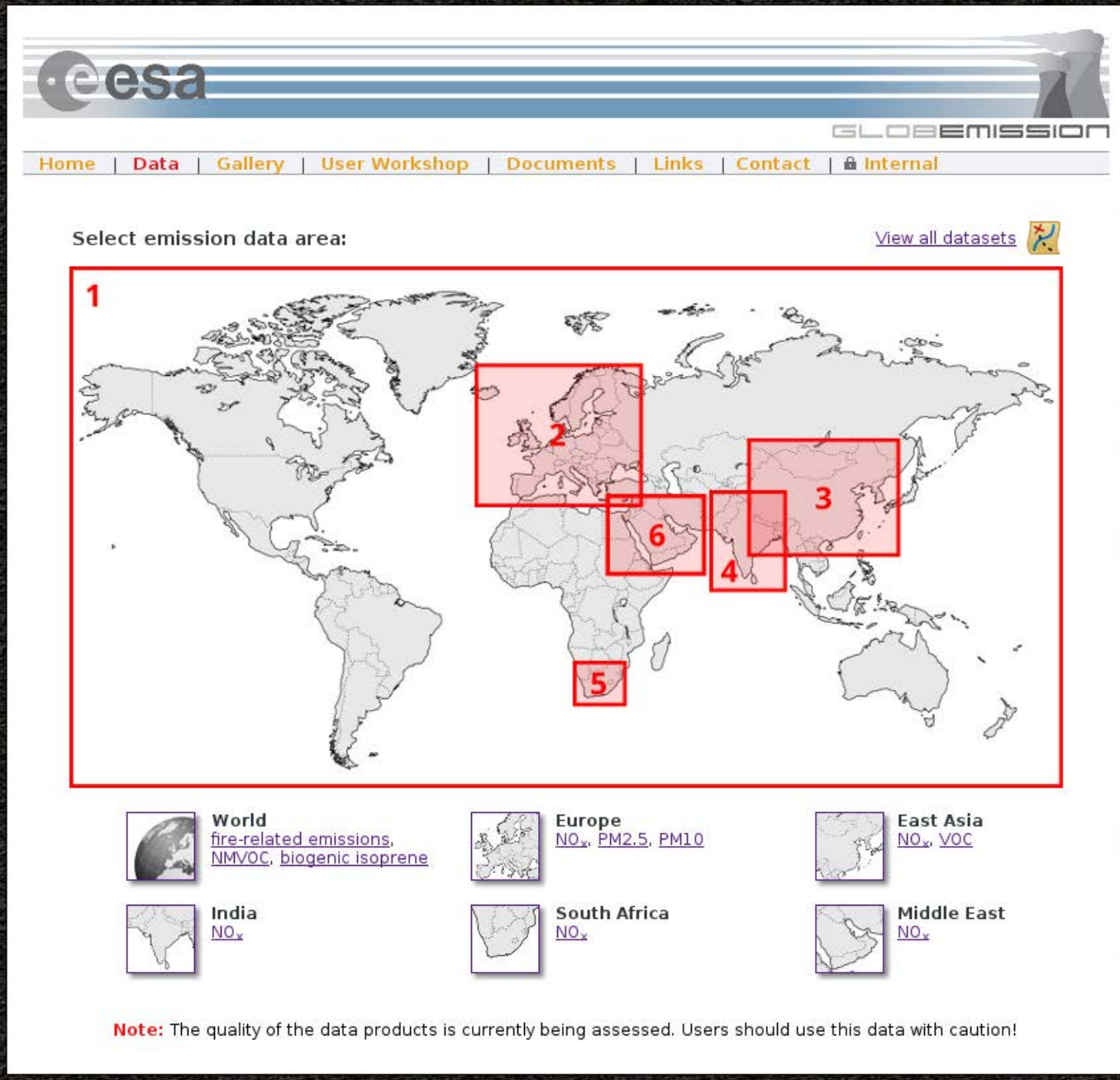
Case study:



The monthly NO_x emission estimates by DECSO in Nanjing for **2013** and **2014**, and the monthly NO_x emission of the MEIC inventory of **2010**. The shaded areas show the error of the mean NO_x emission estimates from DECSO.

Ding et al., Atmos. Chem. Phys. Discuss., 15, 2015

www.globemission.eu/data



Outlook

- DECSO algorithm improvement
  - Better lifetime estimation
  - Kalman smoother
  - Reduction of bias by negative emissions
- Validation
- Application to European emissions
- Extension of time series

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