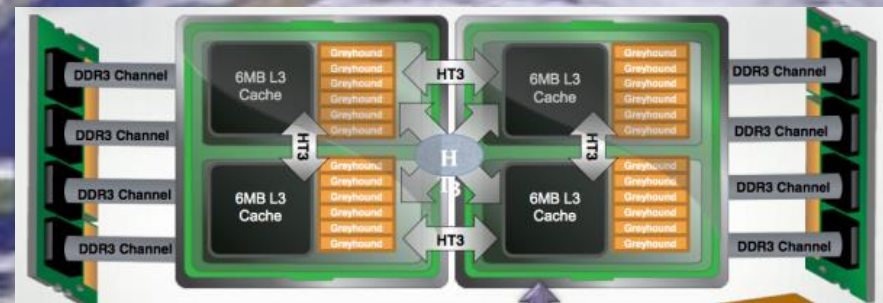
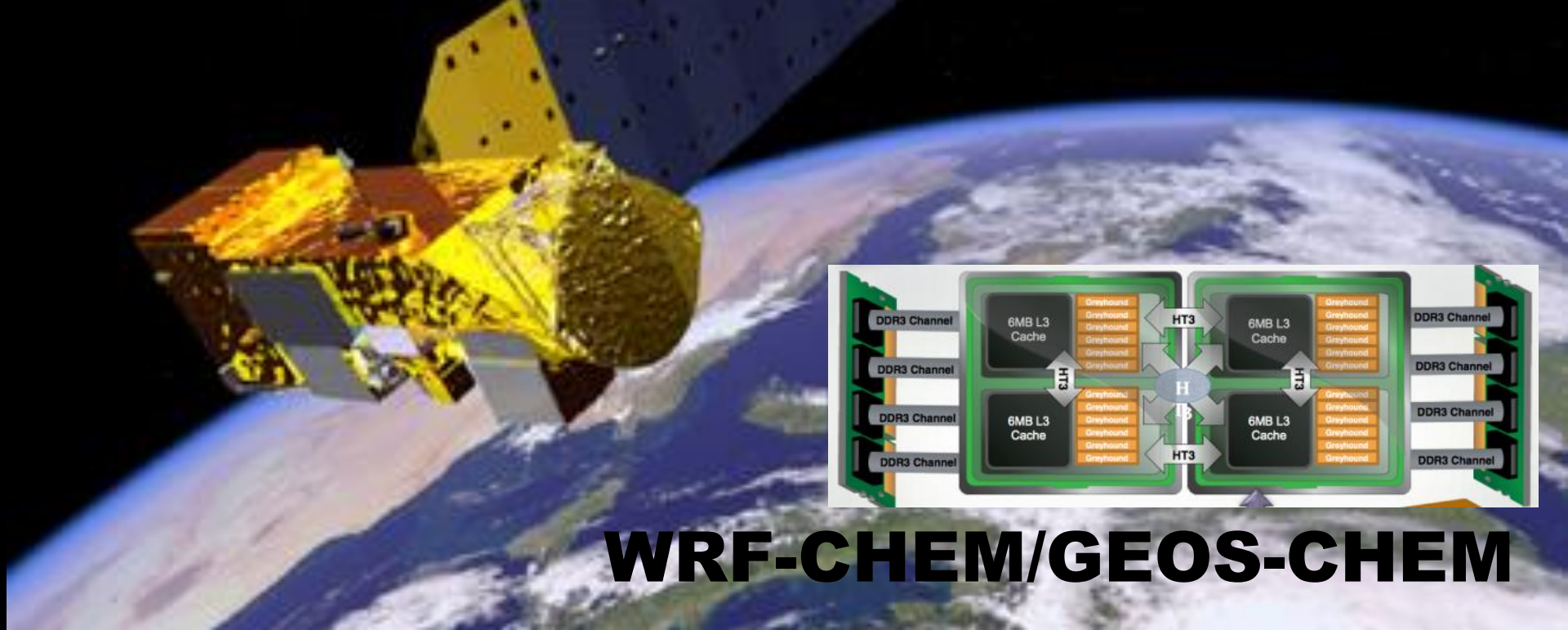




Using space-based observations to understand urban emissions and chemistry

**Ronald C. Cohen
UC Berkeley**

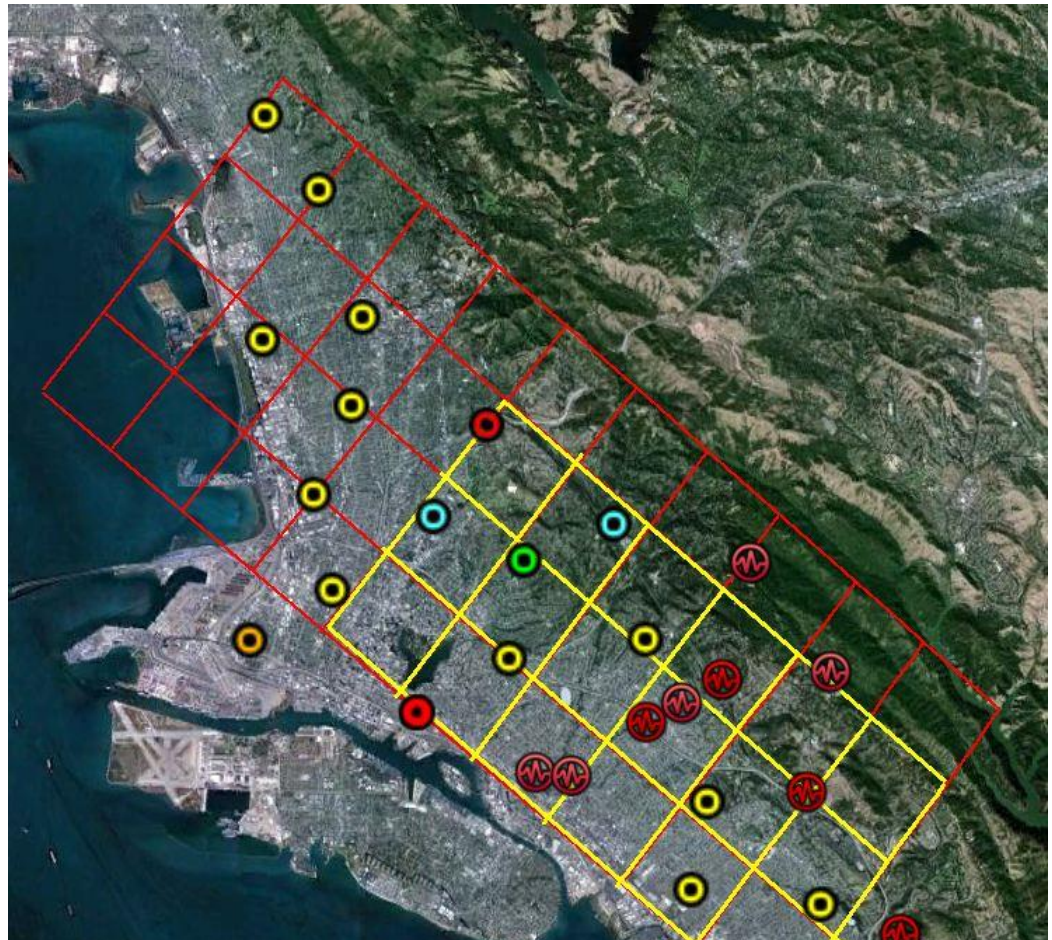
\$ NASA



WRF-CHEM/GEOS-CHEM

BEACO₂N

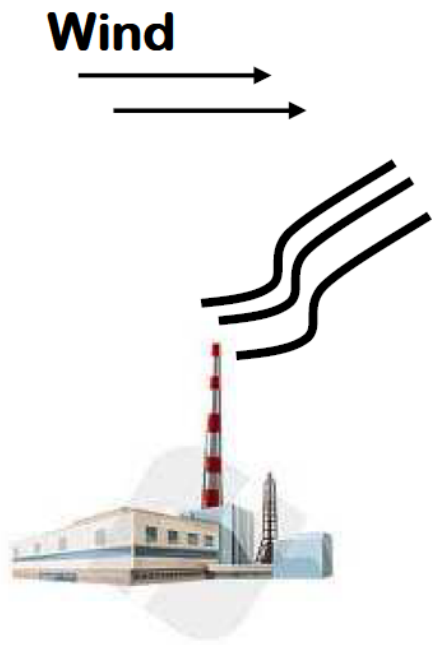
The BERkeley Atmospheric CO₂ Observation Network



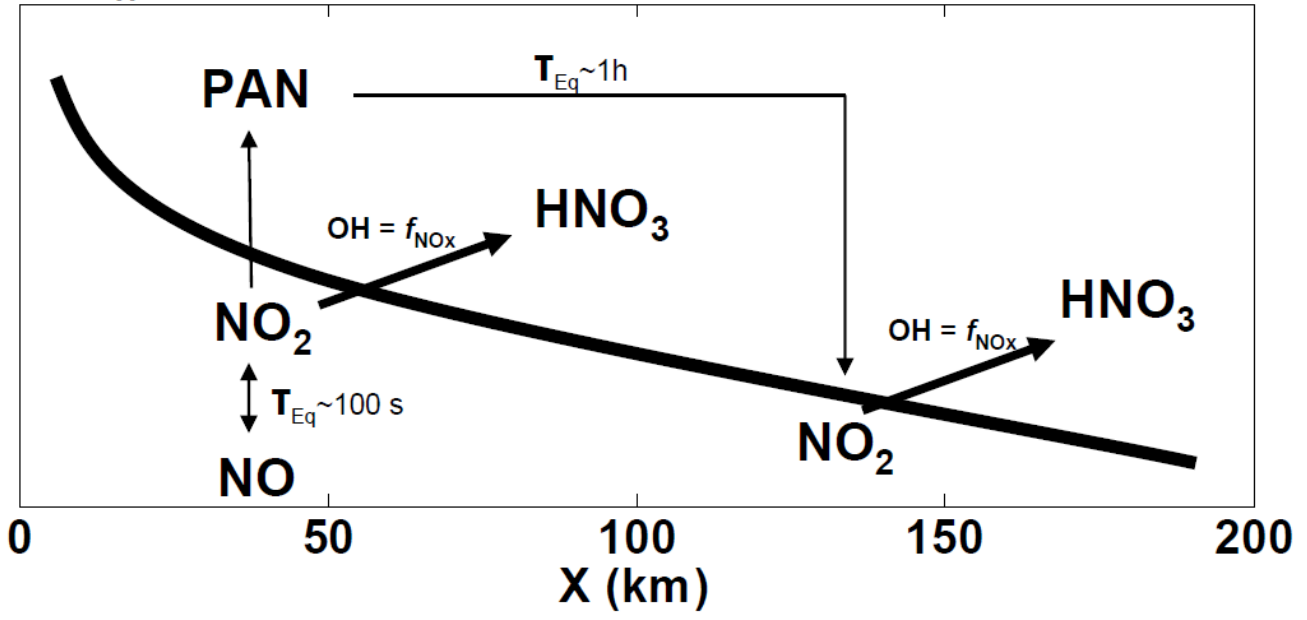
Sensor array for CO₂, NO₂, O₃, ...

Nodes deployed on school rooftops

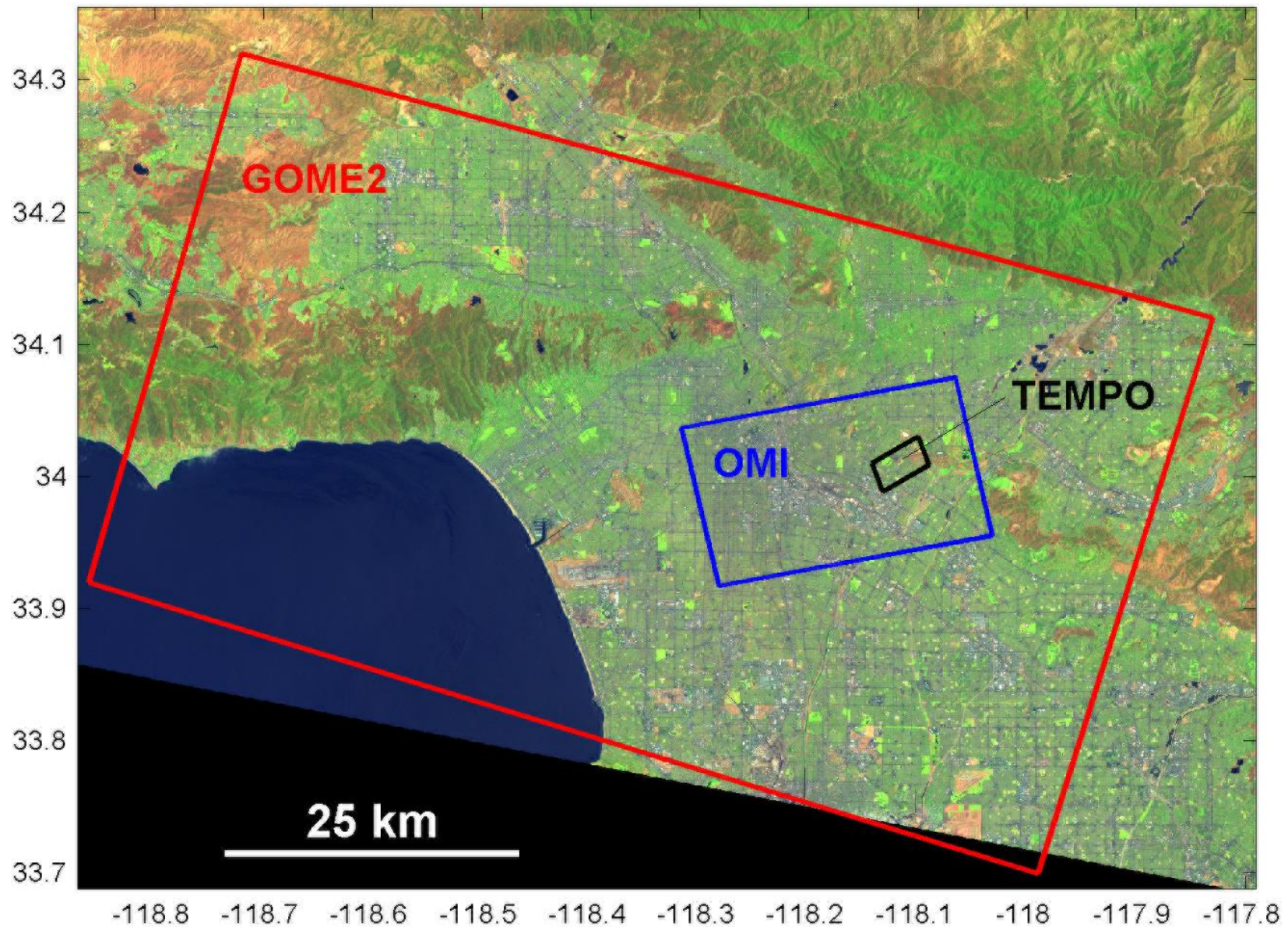
<http://beacon.berkeley.edu/>



NO_x concentration



Instrument Footprint over Northwest Los Angeles

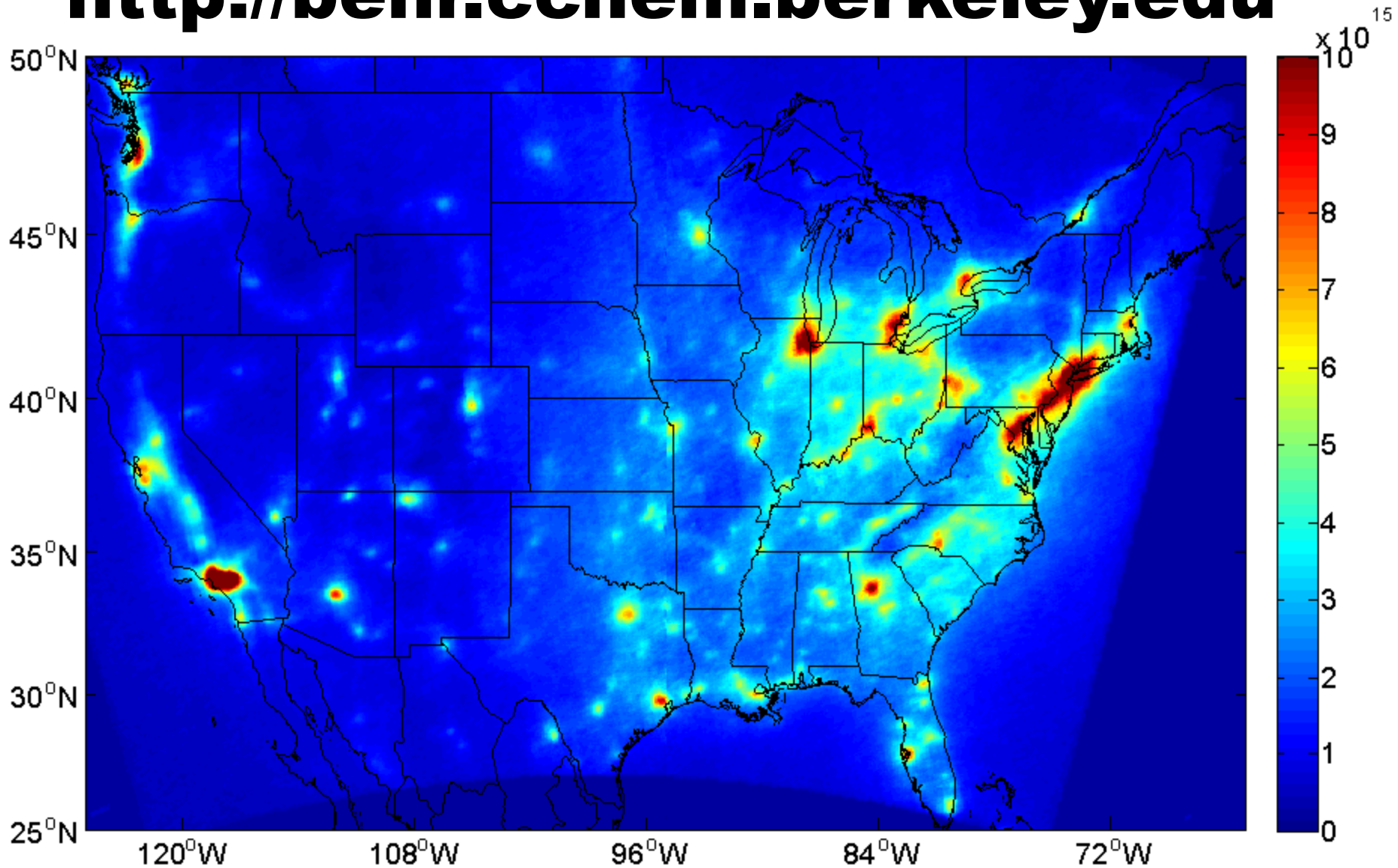


**1. We need a retrieval
that is accurate at
spatial scales of ~10 km**

Berkeley High Resolution Retrieval (BEHR)

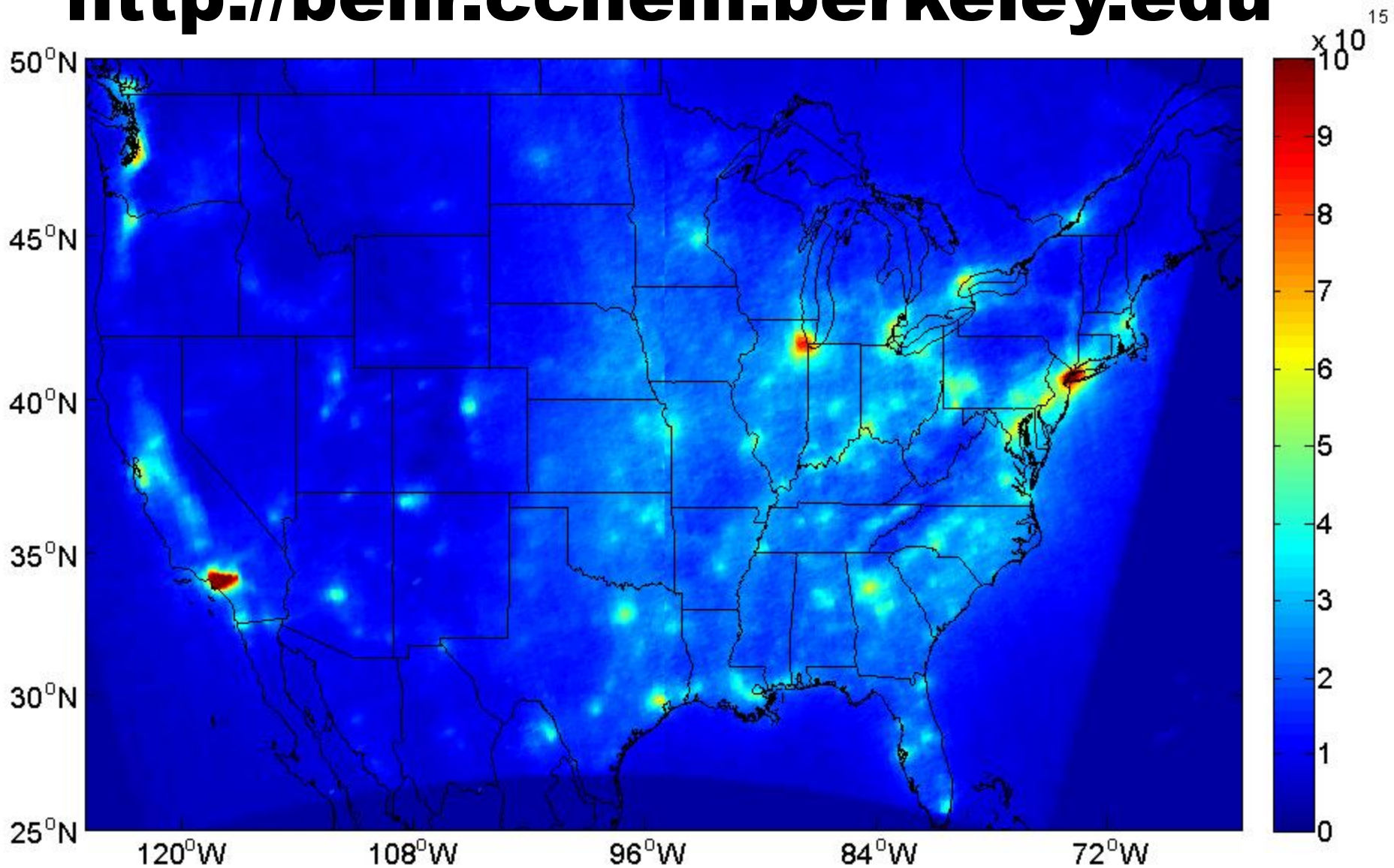
	NASA standard	BEHR
Terrain pressure	High-res terrain database, center of OMI footprint	High-res terrain database, average over OMI footprint
Terrain reflectivity	Monthly $1^{\circ} \times 1^{\circ}$	MODIS, 8 day $0.05^{\circ} \times 0.05^{\circ}$
NO₂ profile shape	Annually $2^{\circ} \times 2.5^{\circ}$	WRF-Chem, Monthly $4 \times 4 \text{ km}^2$ (CA&NV) $12 \times 12 \text{ km}^2$ U.S.
Clouds	OMI cloud product	MODIS cloud product

<http://behr.cchem.berkeley.edu>



Summer 2005

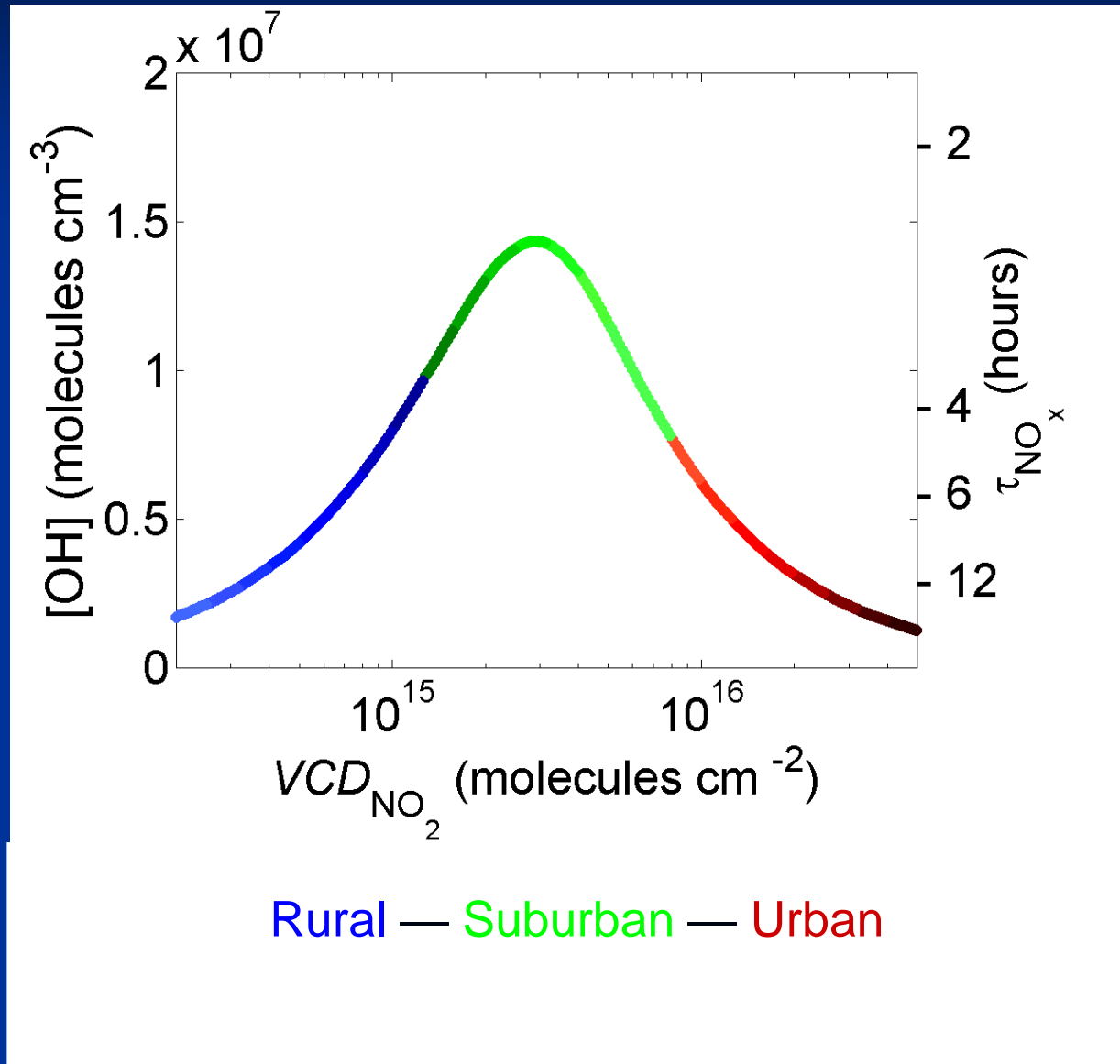
<http://behr.cchem.berkeley.edu>

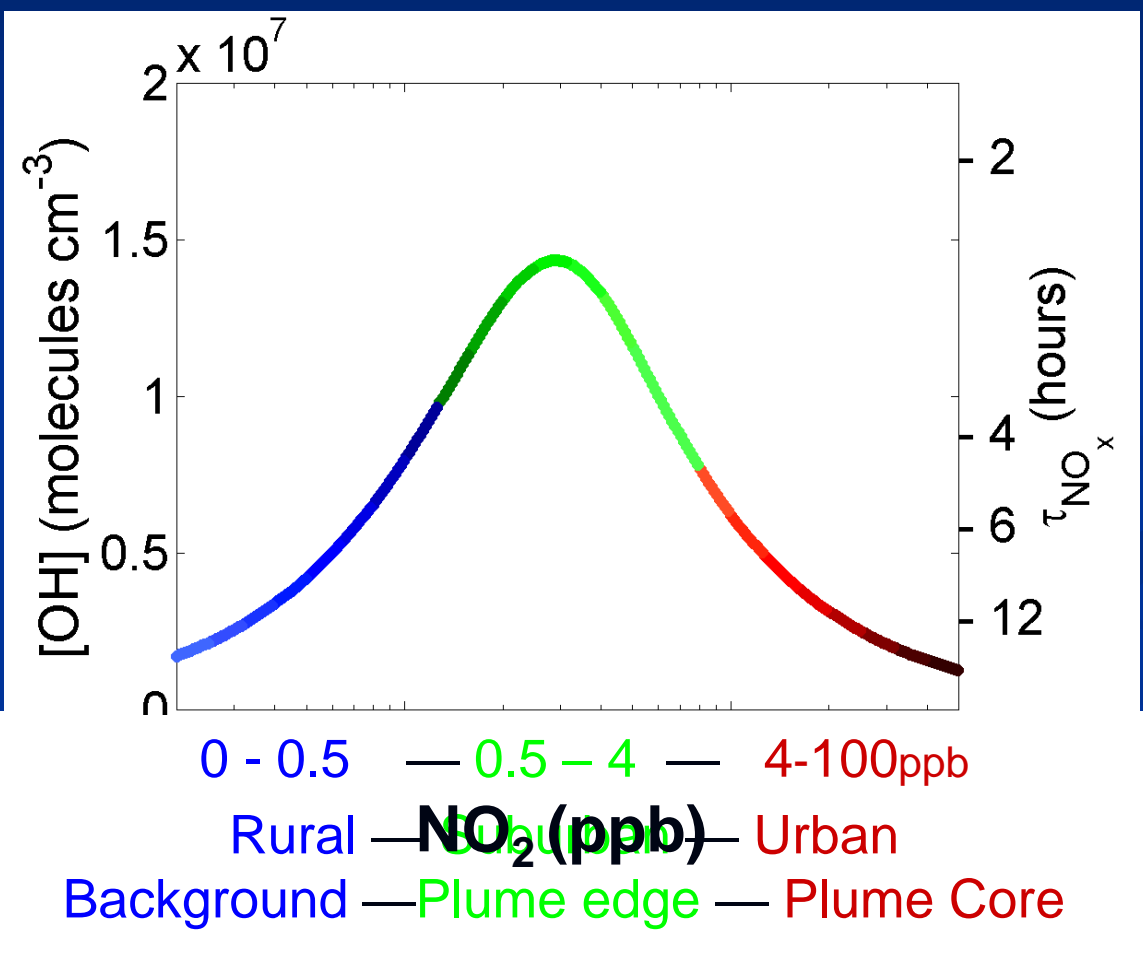


Summer 2011

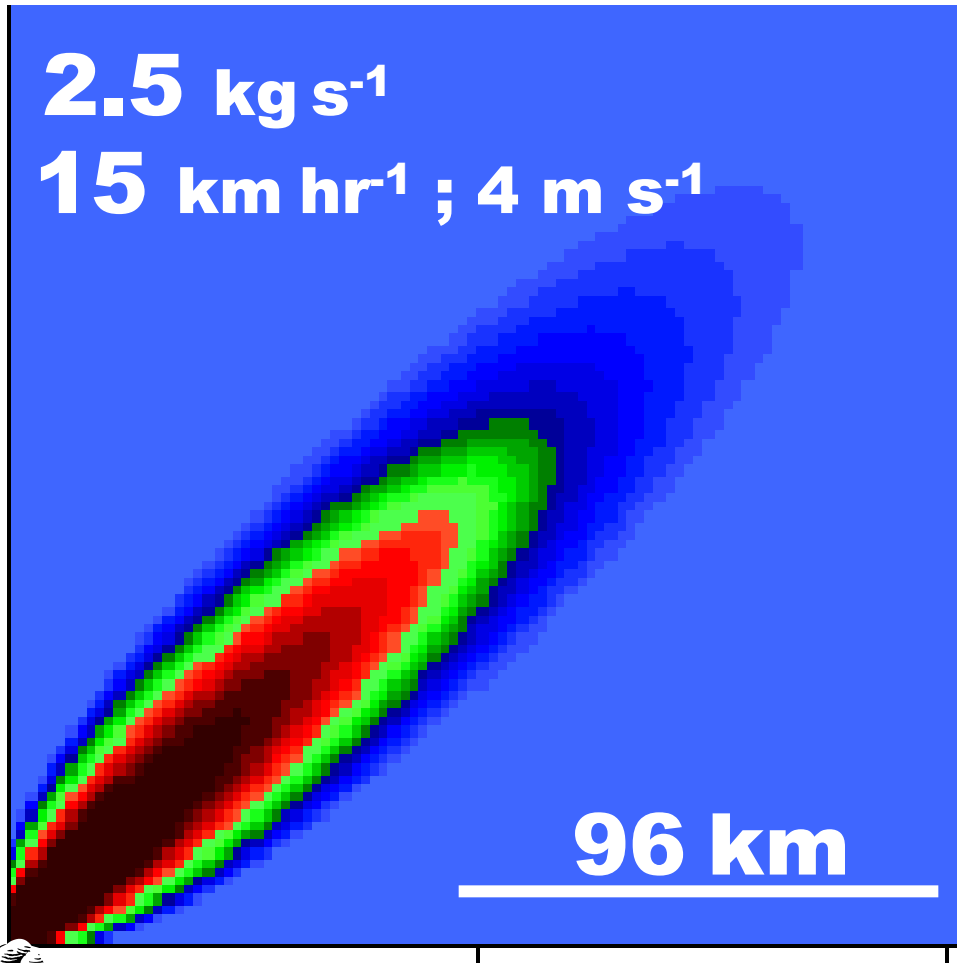
2. Resolving chemistry and emissions from space

OH is nonlinear with NO_2





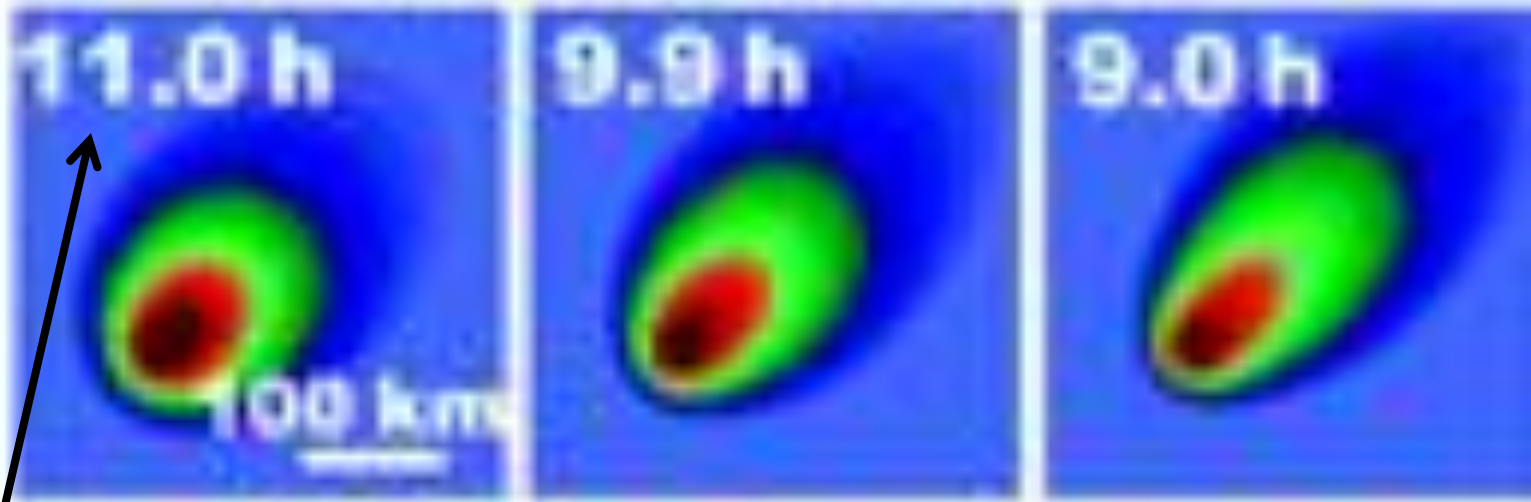
2-d (or 3-d WRF)



- **constant emissions**
- **advection**
- **dilution**
- **chemical feedback.**

Prediction: lifetime of NO_x depends on wind speed

Slow winds →

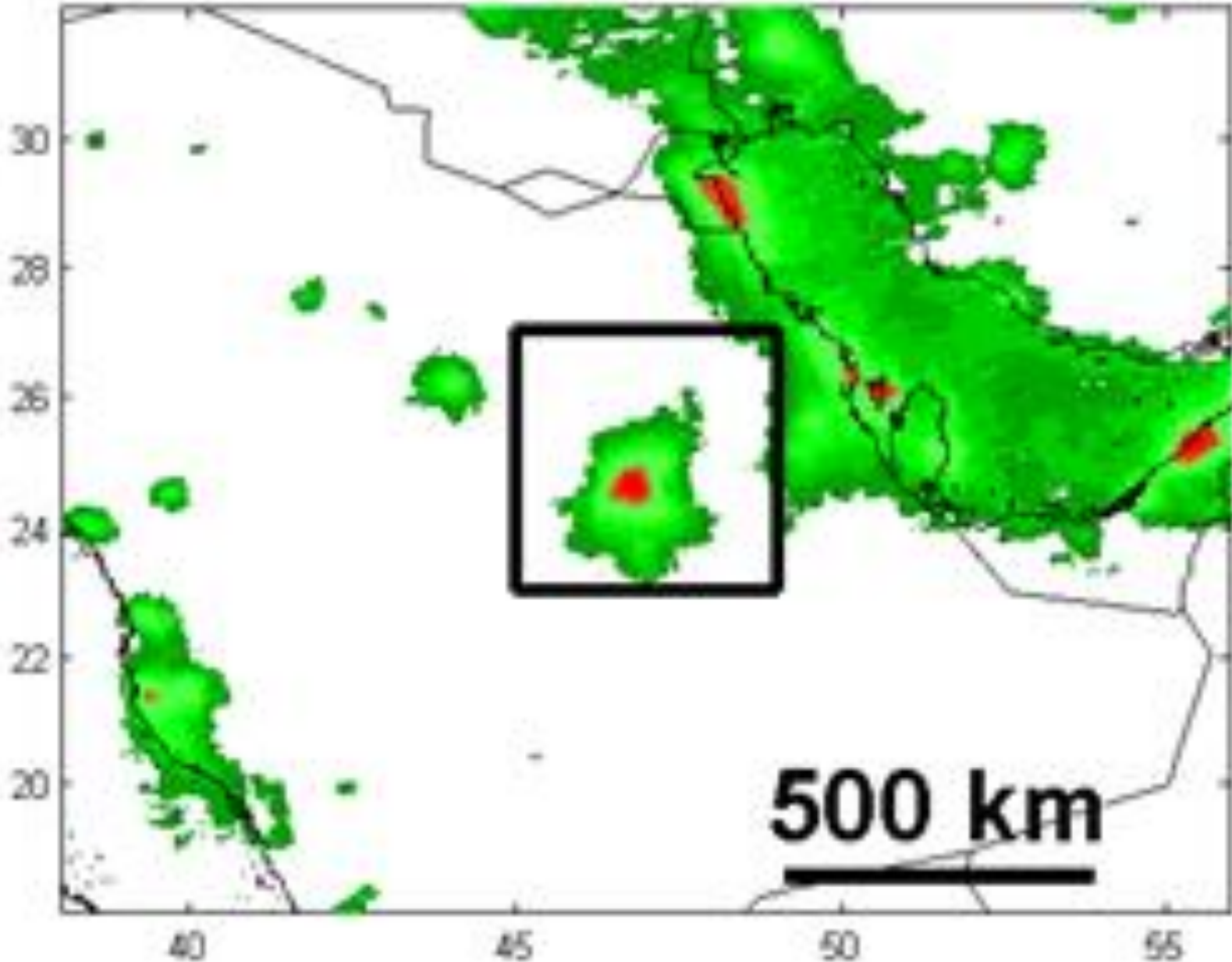


Lifetime

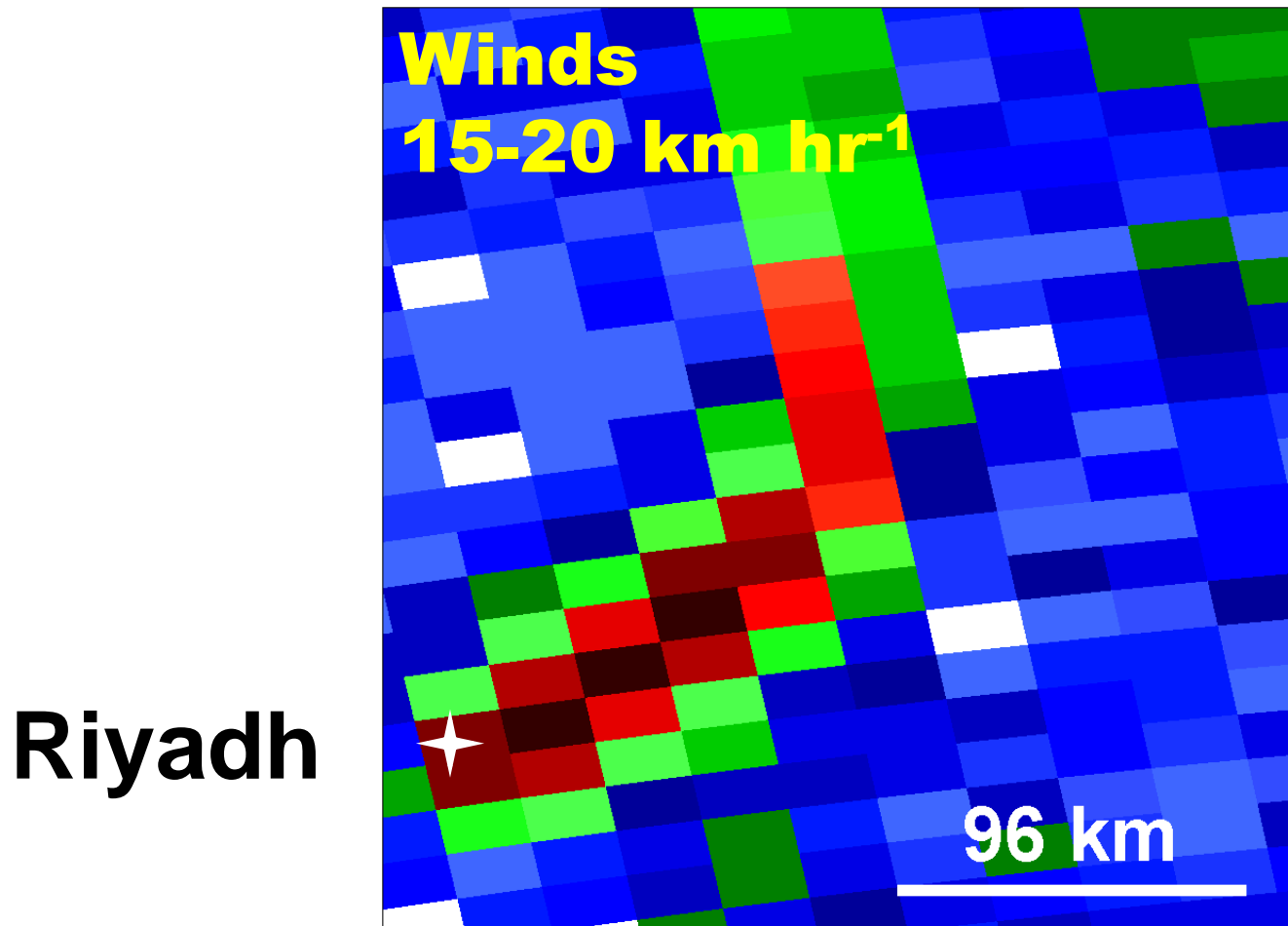
Prediction: lifetime of NO_x depends on wind speed.



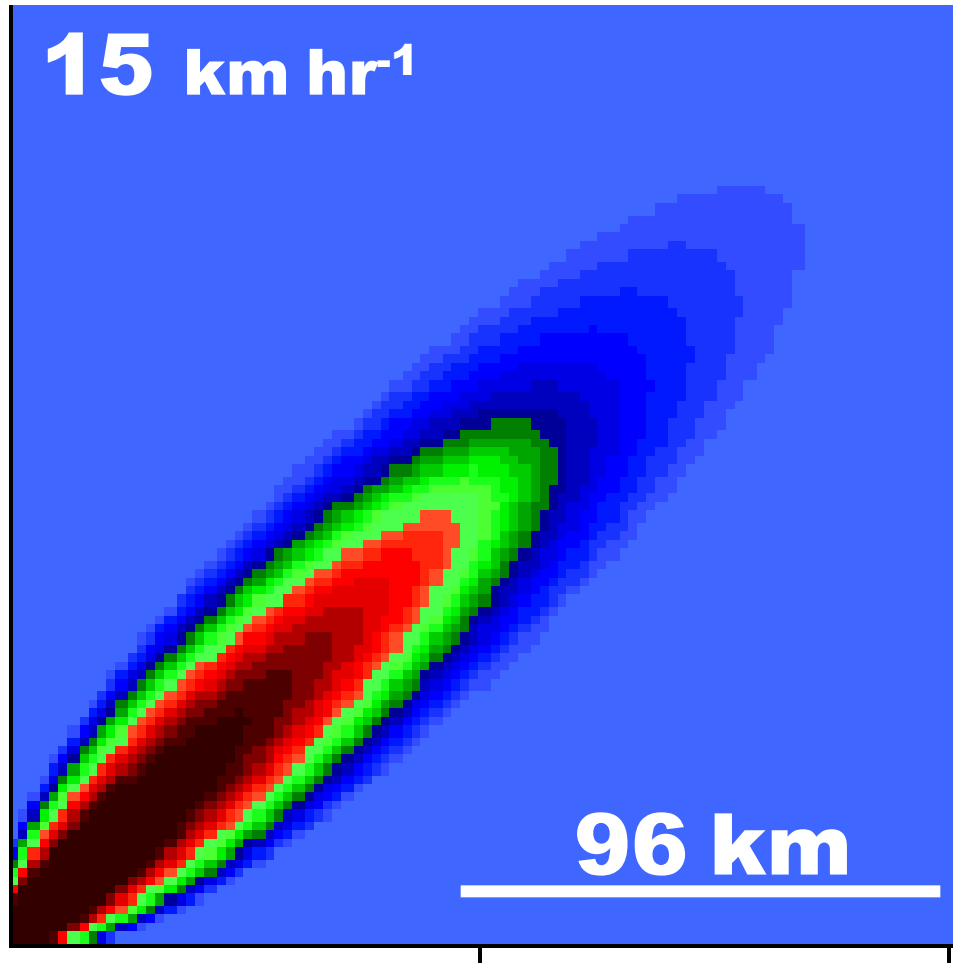
Riyadh

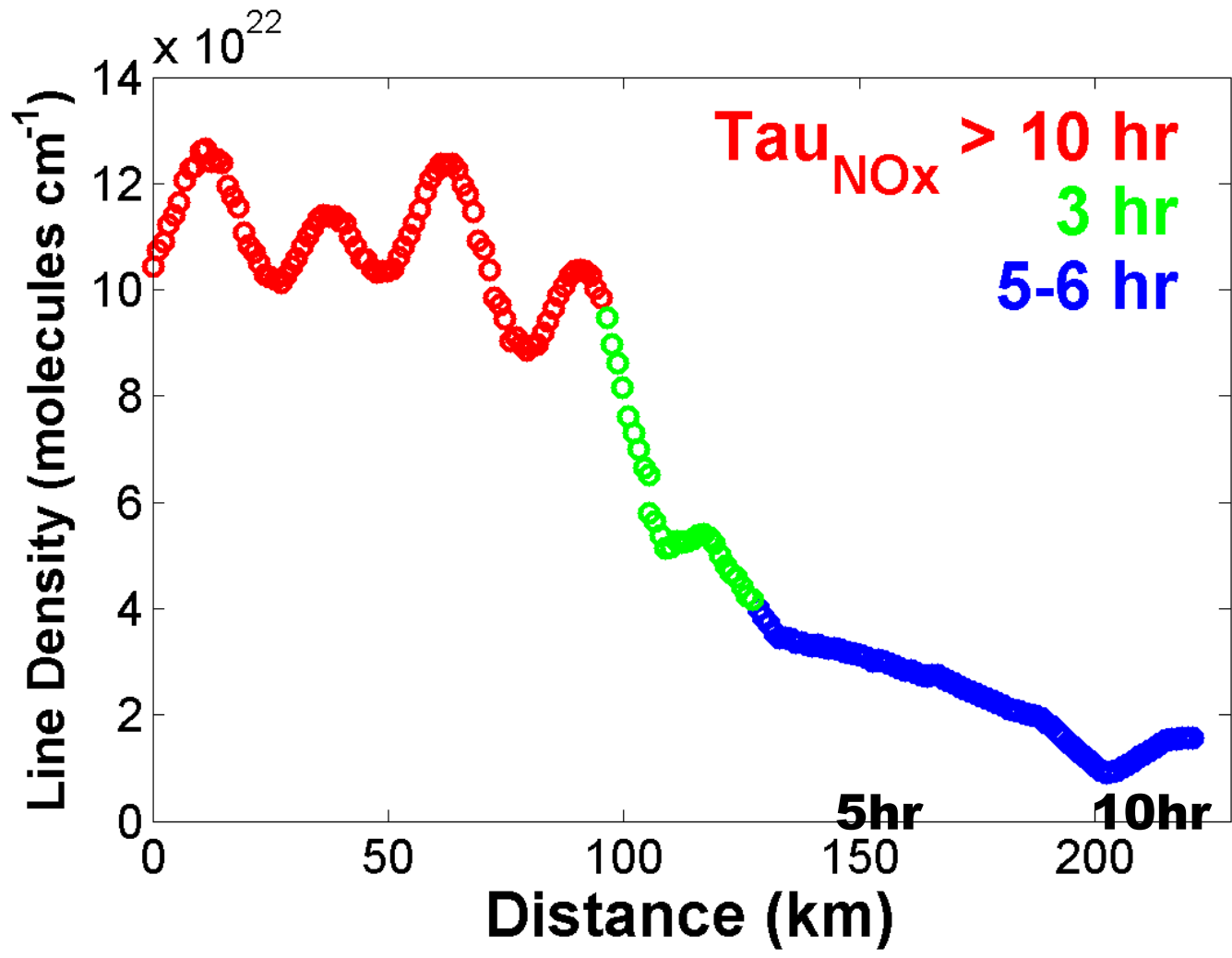


Riyadh urban plume (OMI)



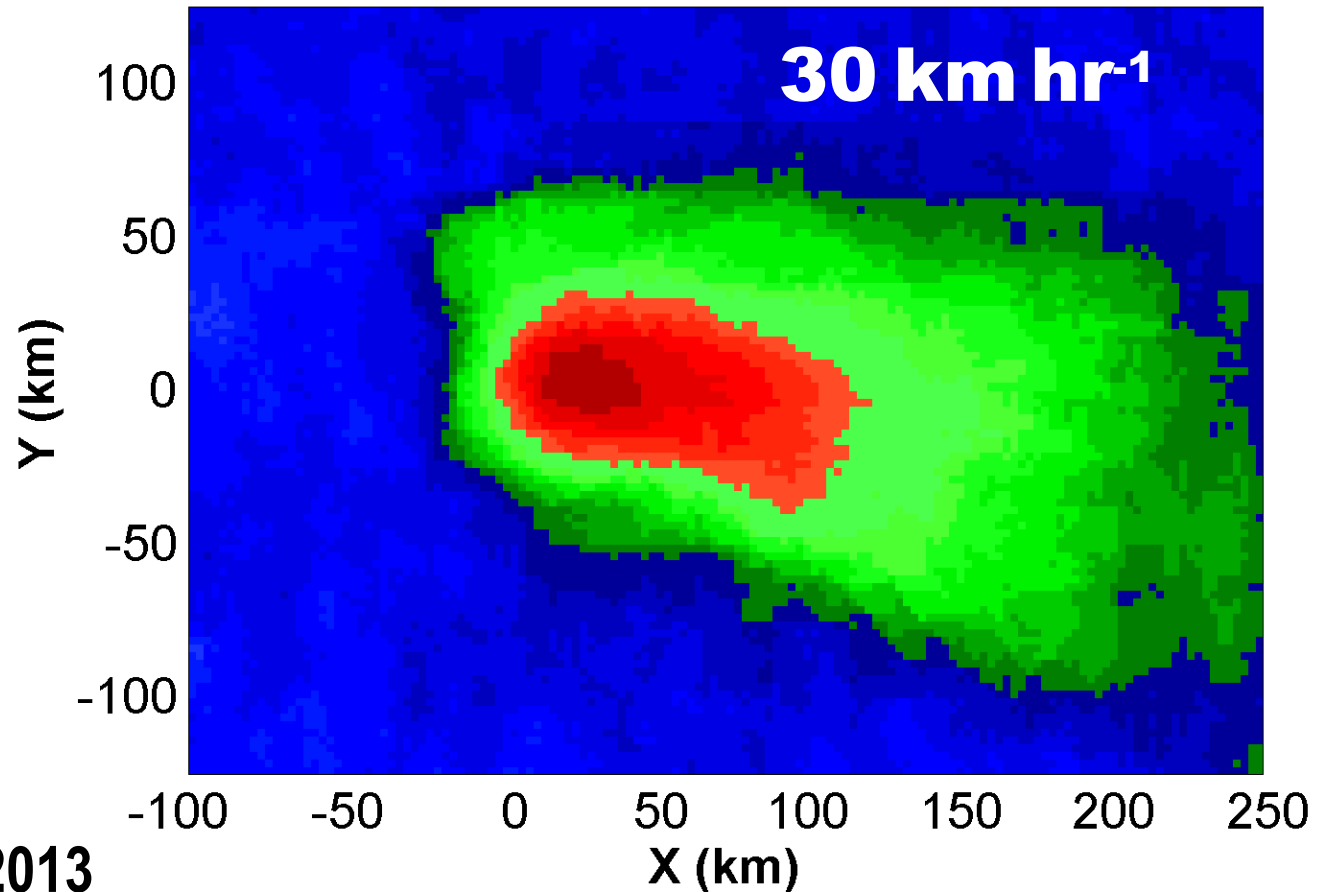
A model plume

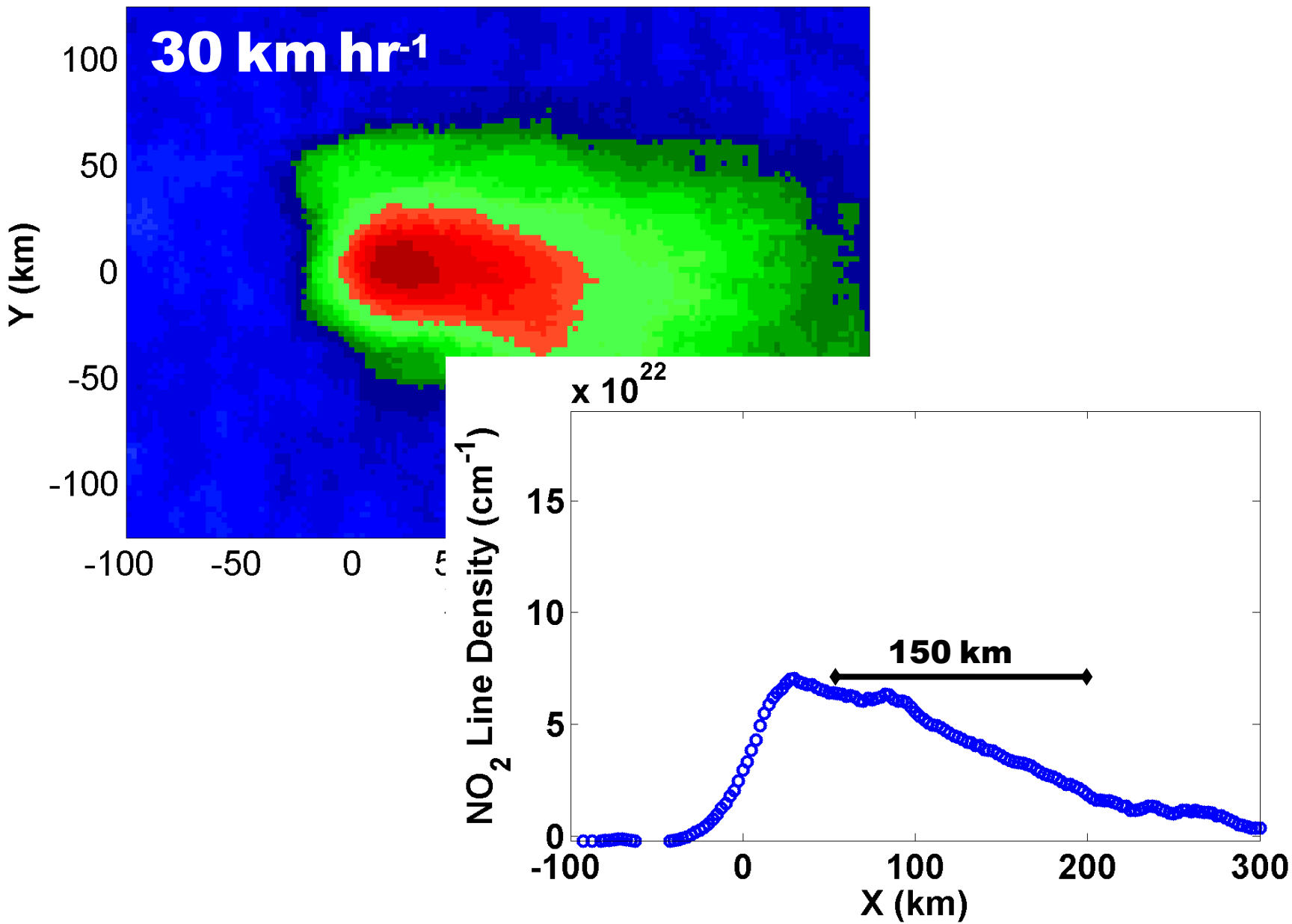




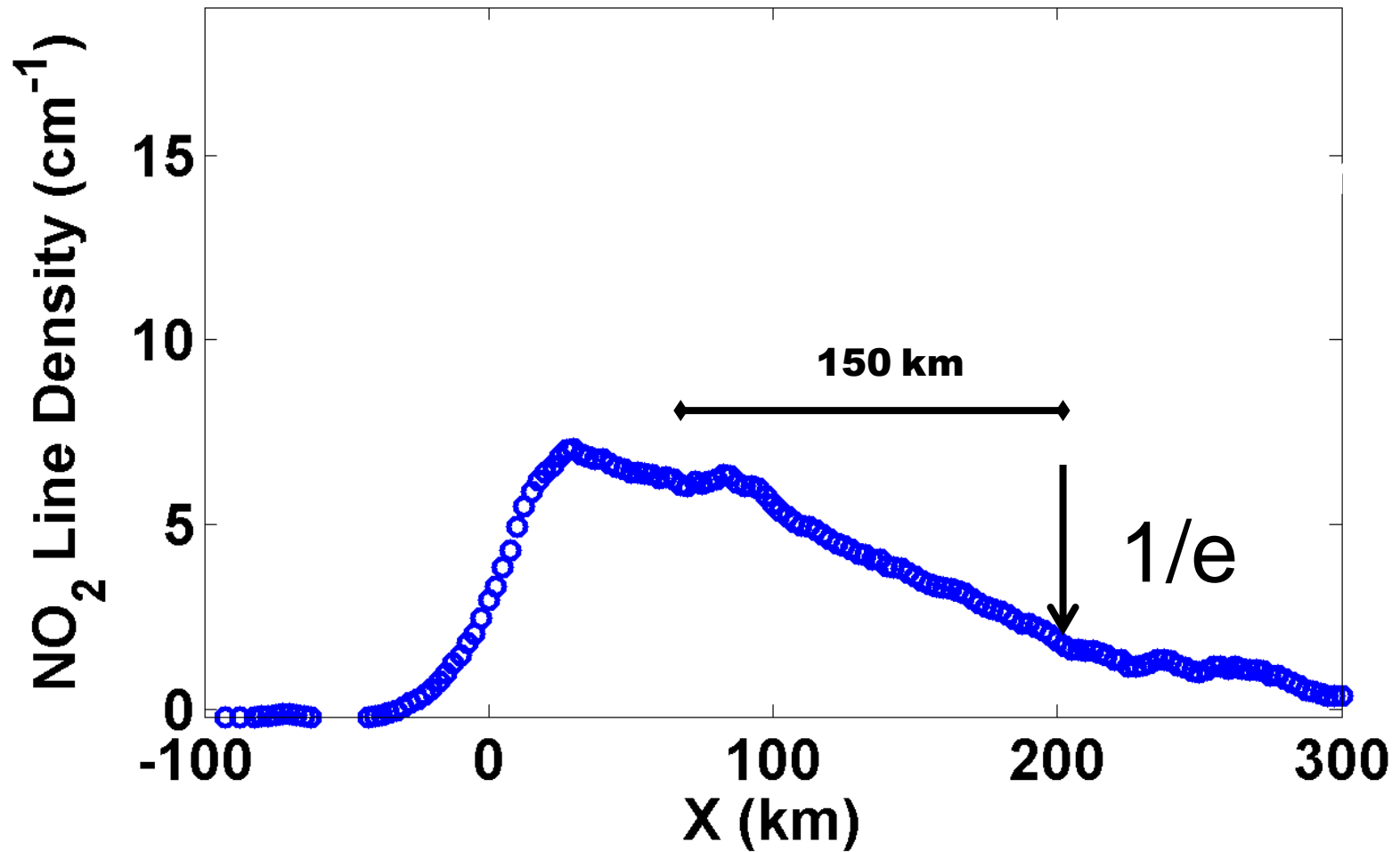
Rotate winds to x direction (see also Beirle et al. Science, 2011)

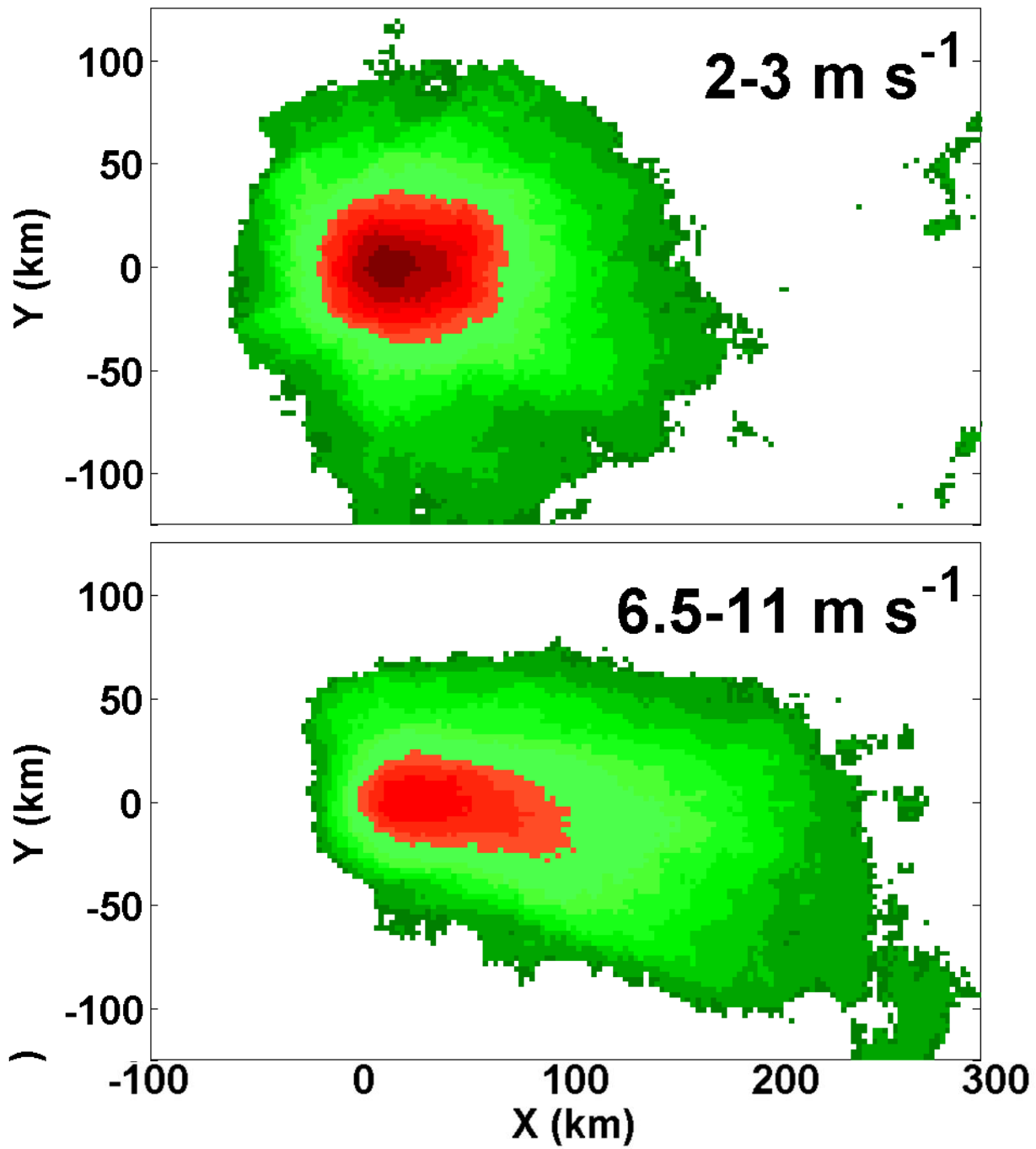
Sort by wind speed





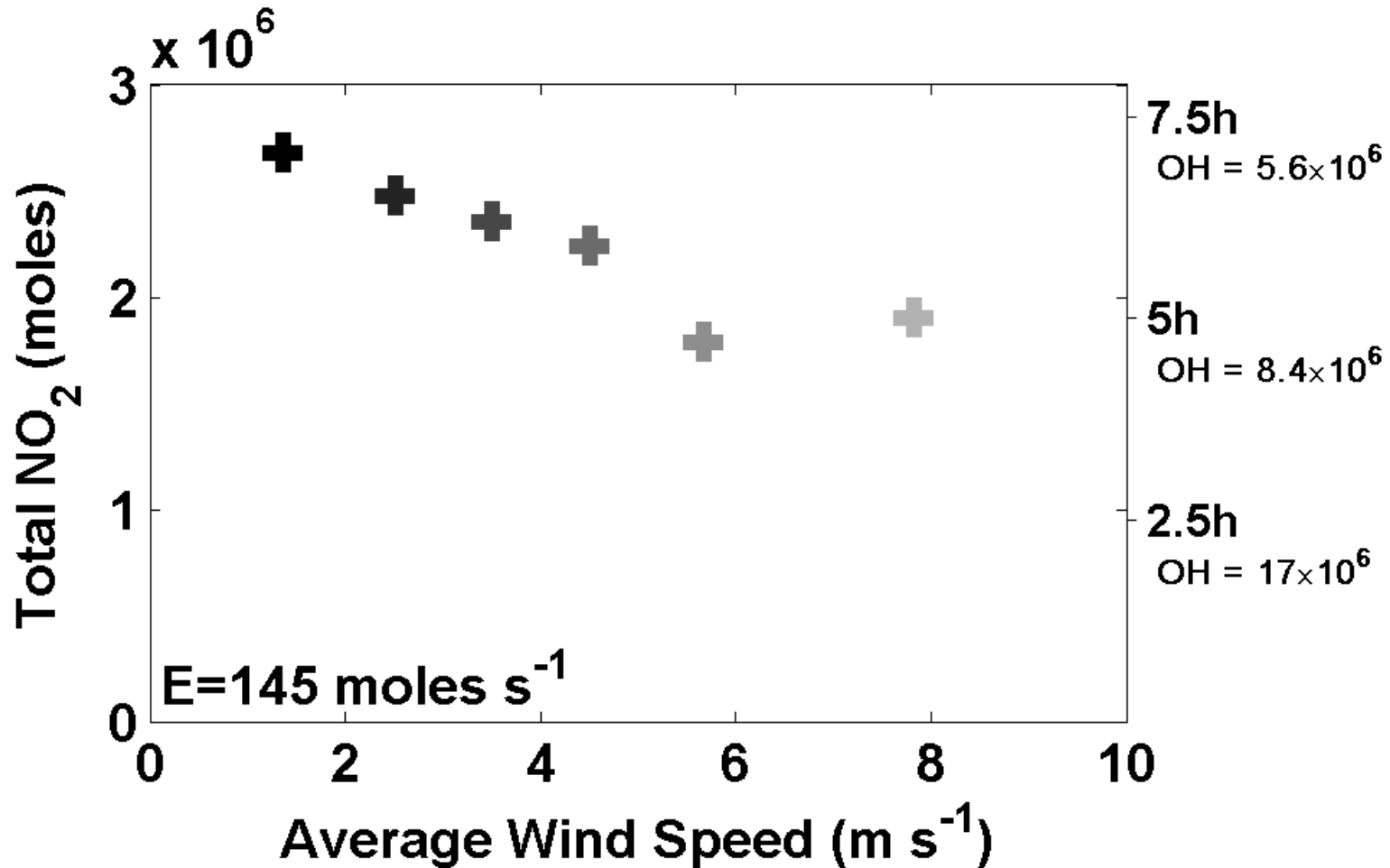
The NO₂ lifetime

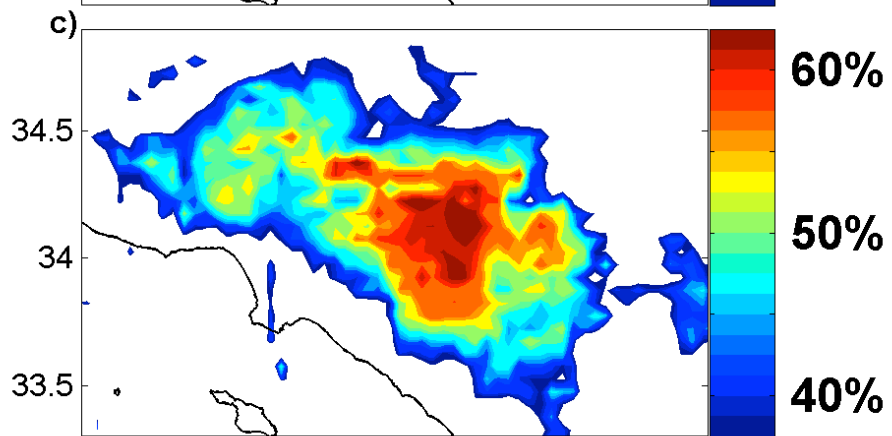
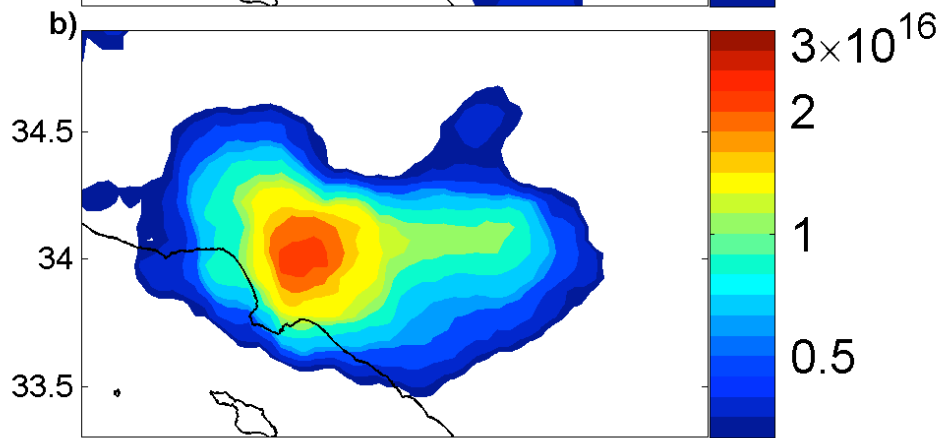
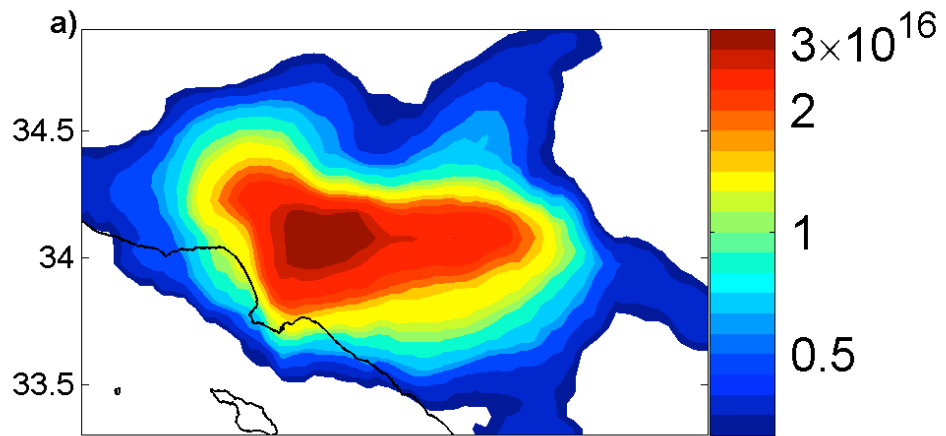




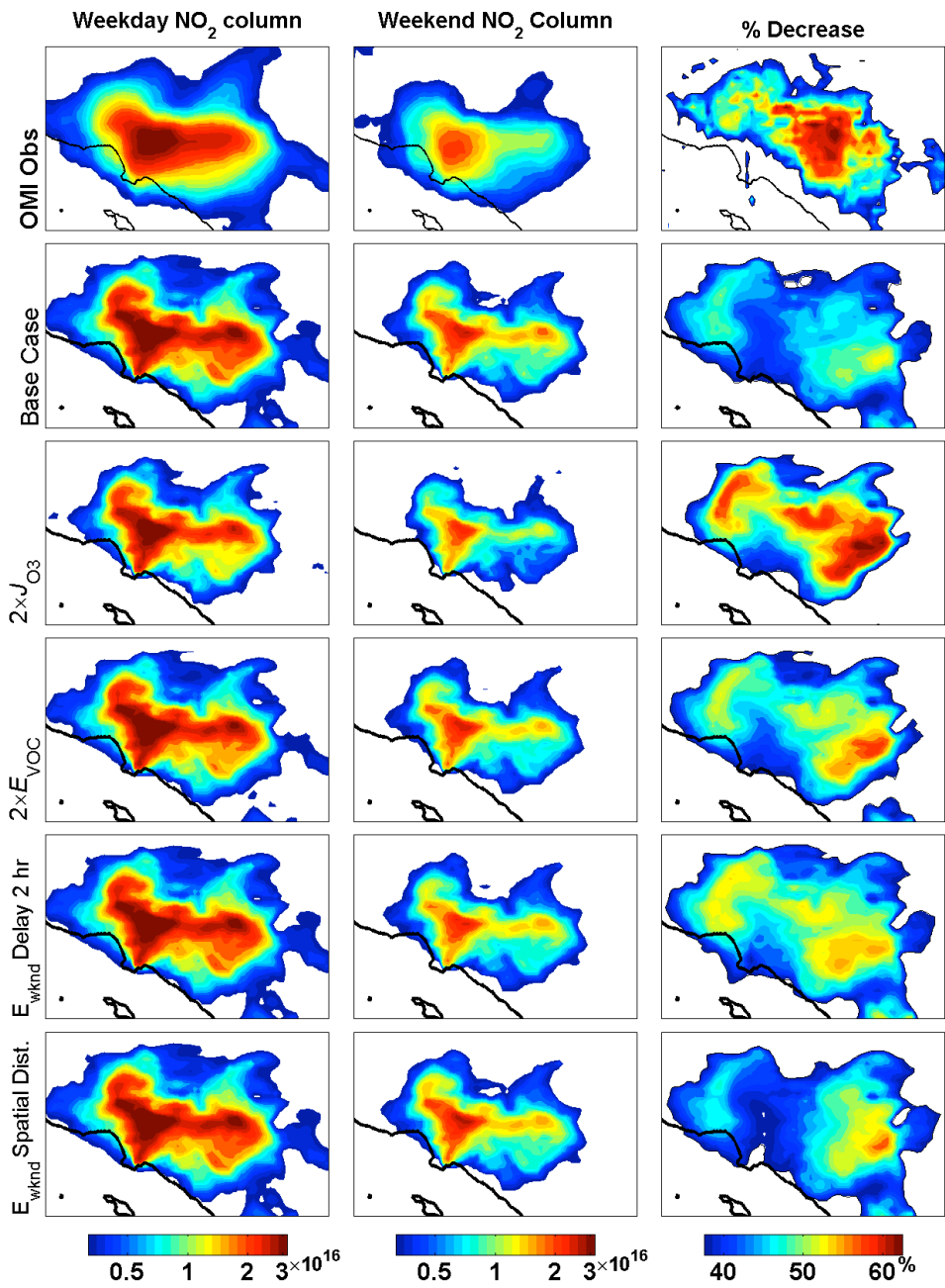
Integral of the entire plume

NO_x lifetime and OH_{effective}



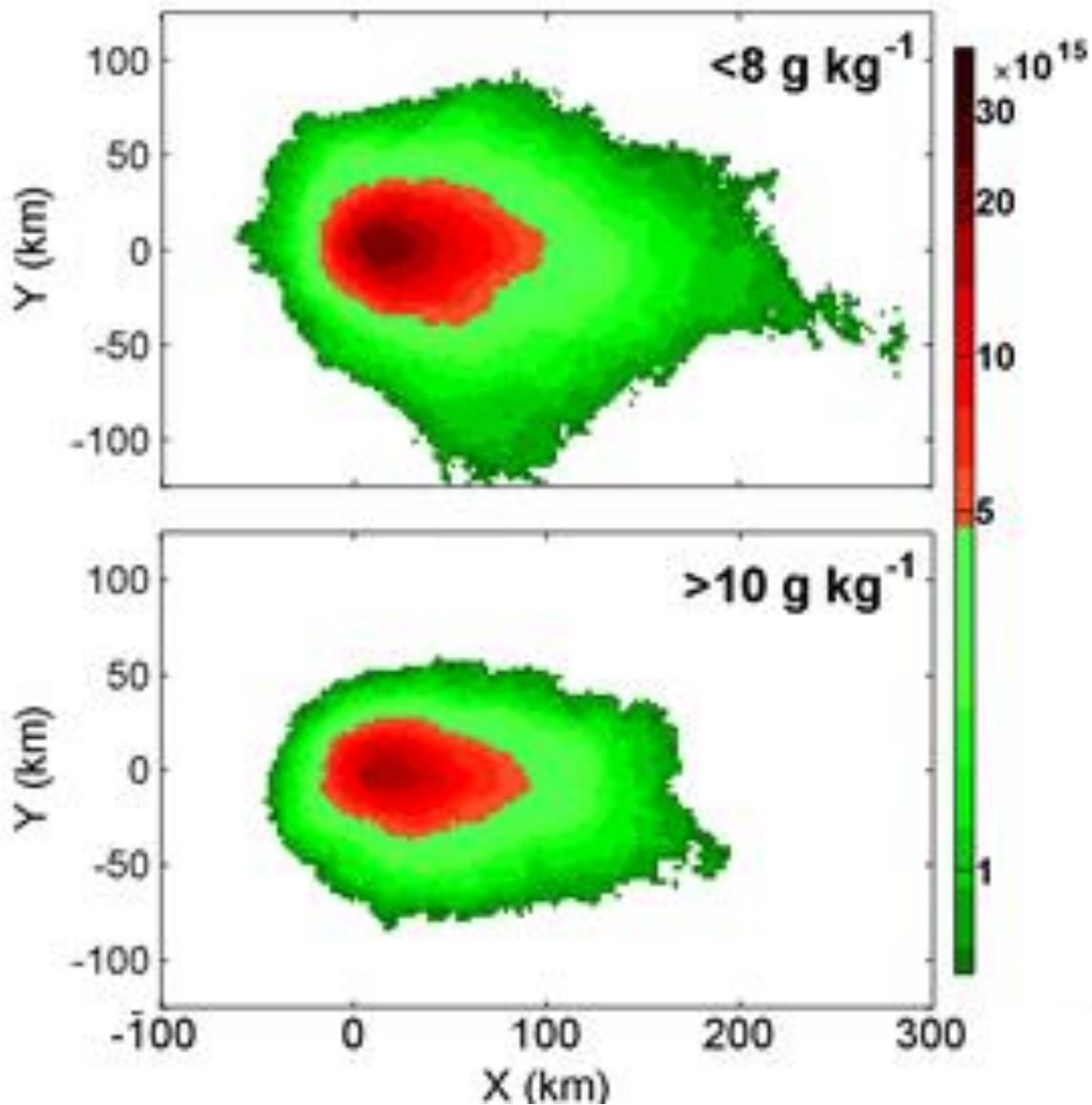


d)



**The same ideas hold true
for variations in H_2O —the
source of the OH**

Riyadh



**Low water,
less OH,
more NO₂**

**High water,
more OH,
less NO₂**

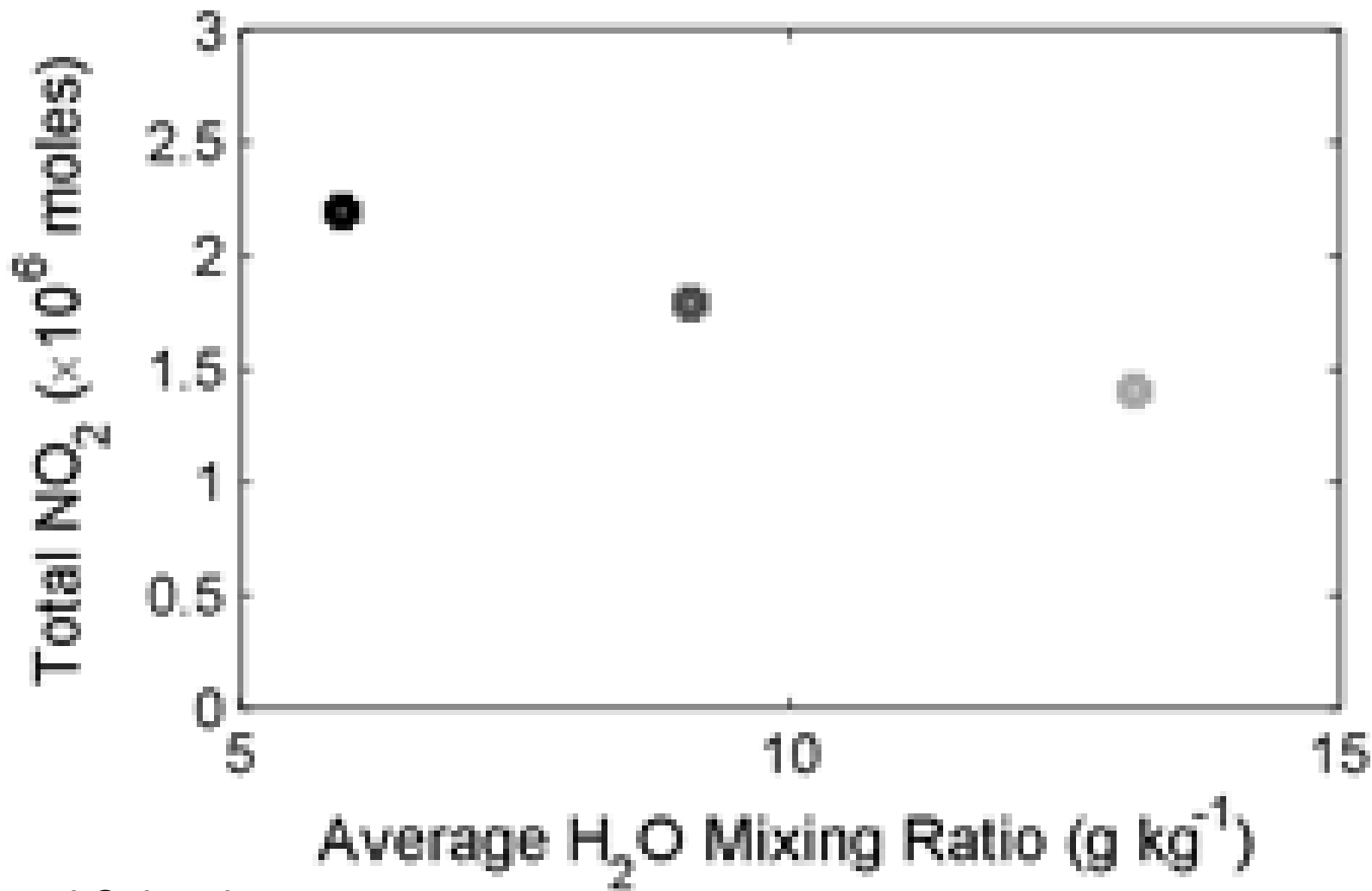
H₂O

longer

lifetime

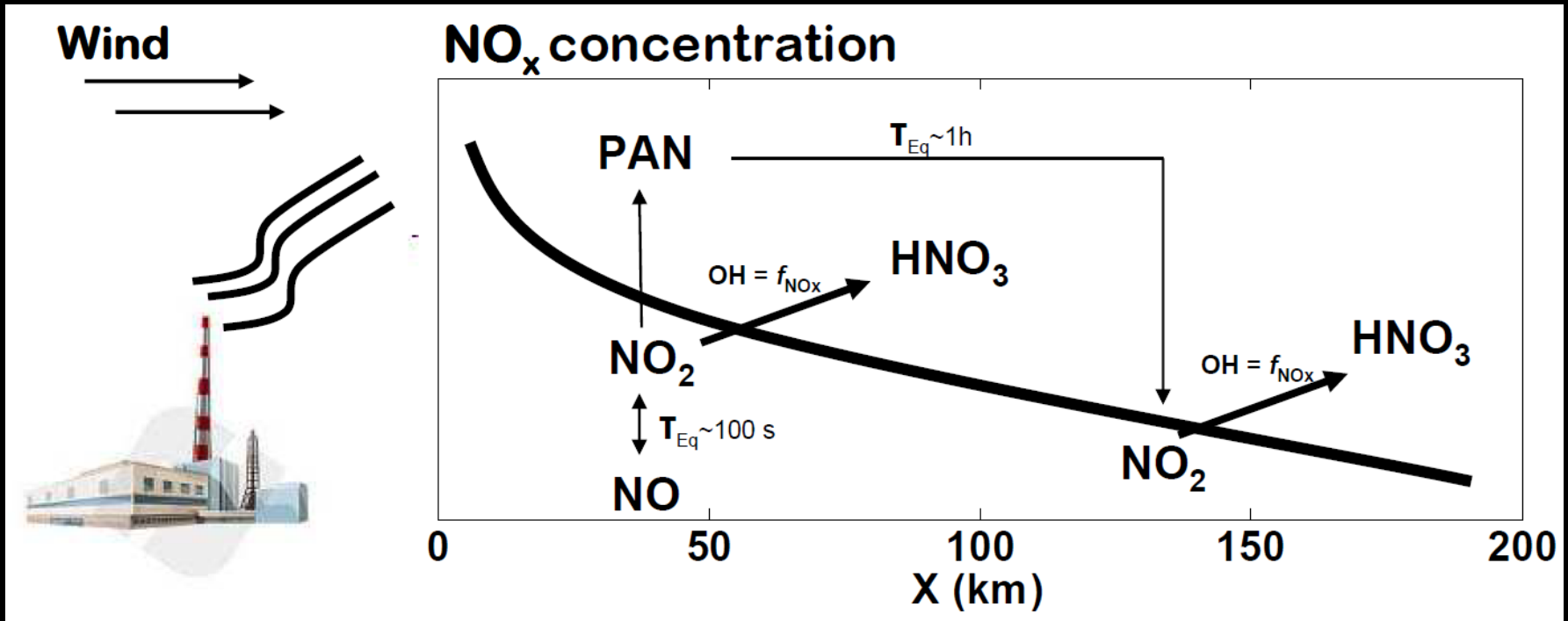


shorter



Conclusions:

**TEMPO, GEOCAPE,
TROPOMI, ...**





Thank you

Luke Valin
PhD November 2012

\$\$ NASA