



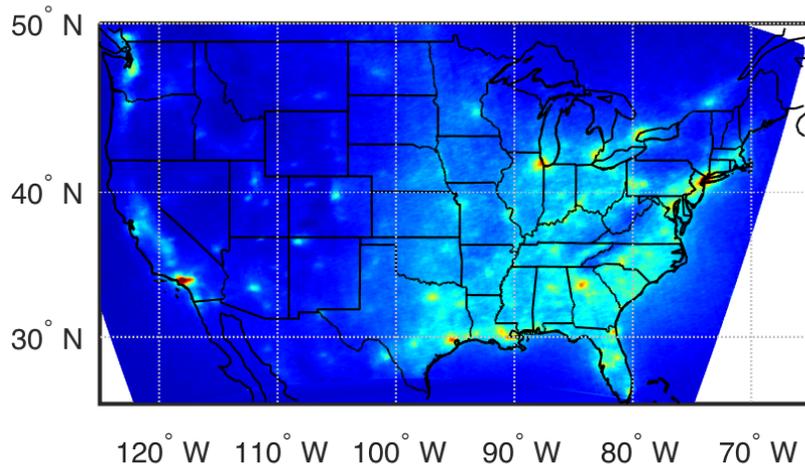
Effects of daily meteorology on satellite *a priori*

Implications for constraint of NO_x
chemistry from space

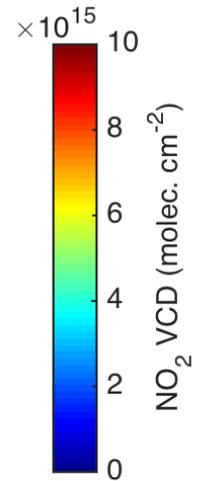
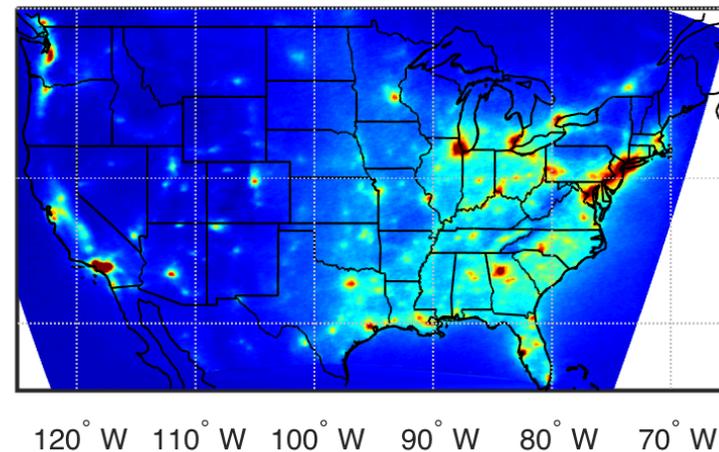
Joshua L. Laughner, Azimeh Zare, Ronald C. Cohen
Dept. of Chemistry, University of California, Berkeley

NO_x emissions and lifetime are each affected by the other

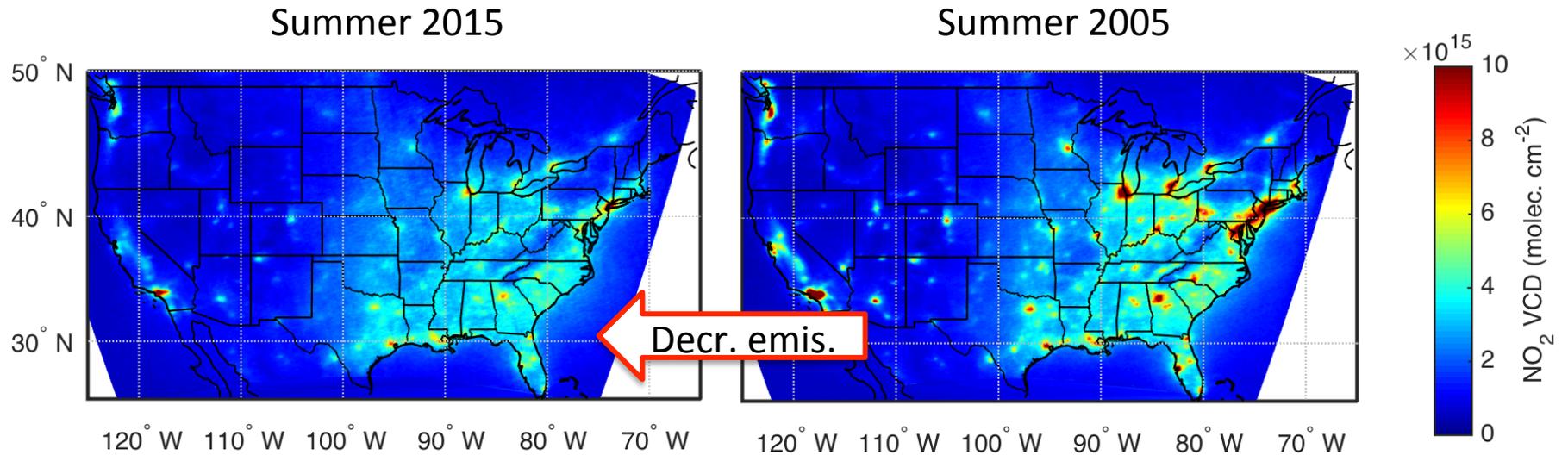
Summer 2015



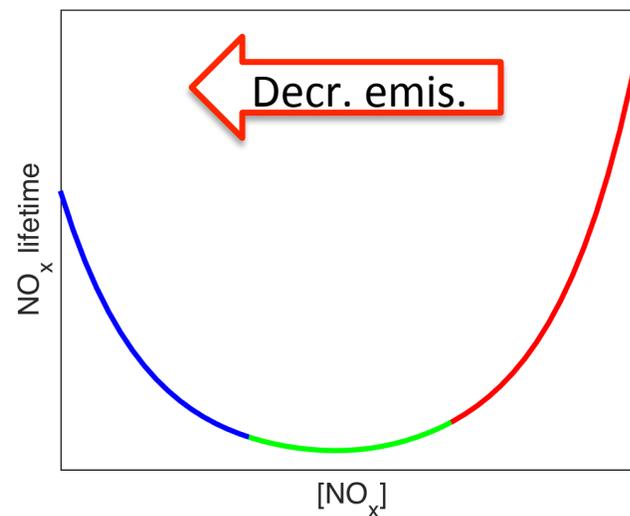
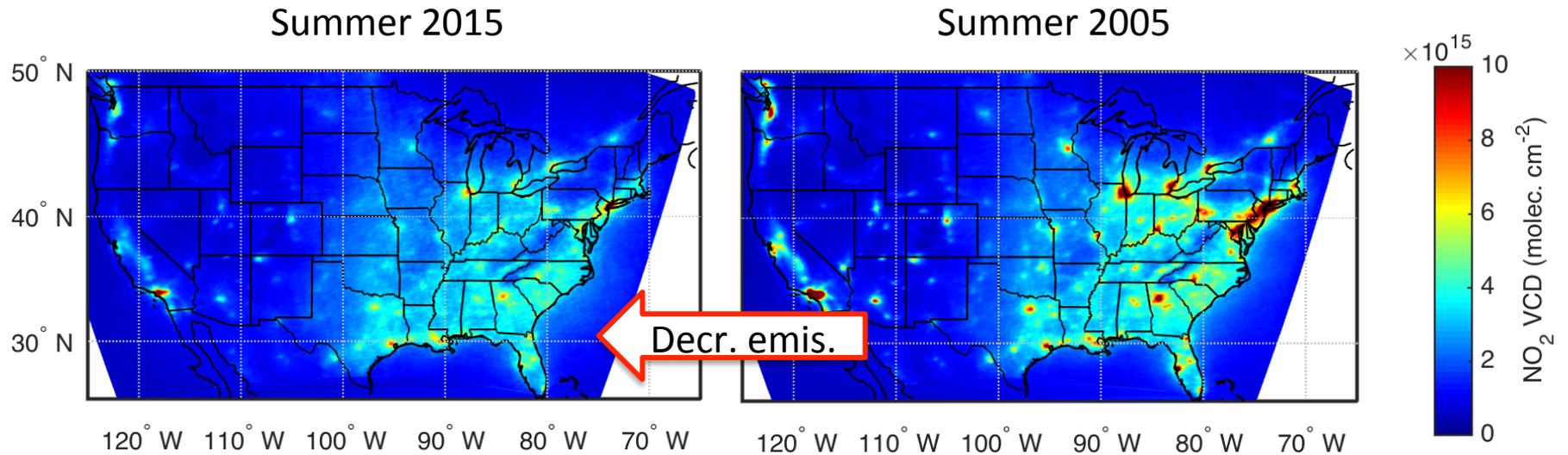
Summer 2005



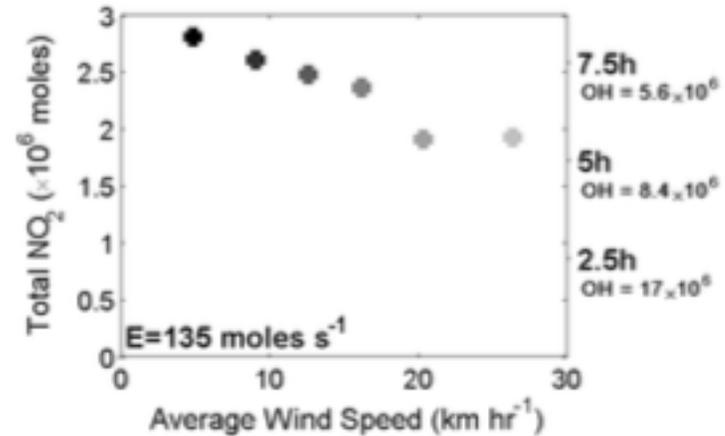
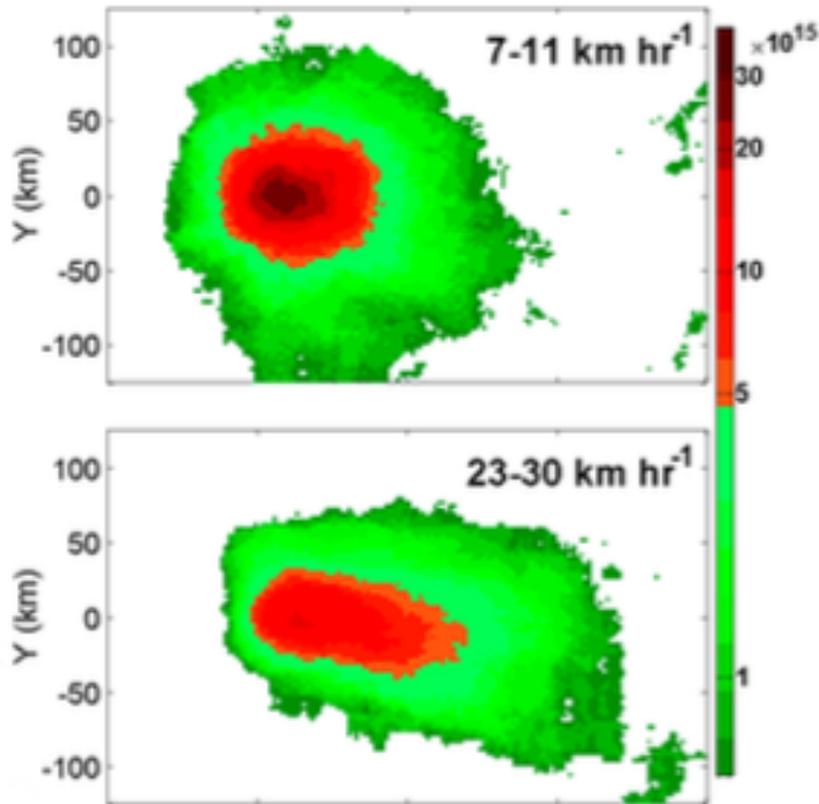
NO_x emissions and lifetime are each affected by the other



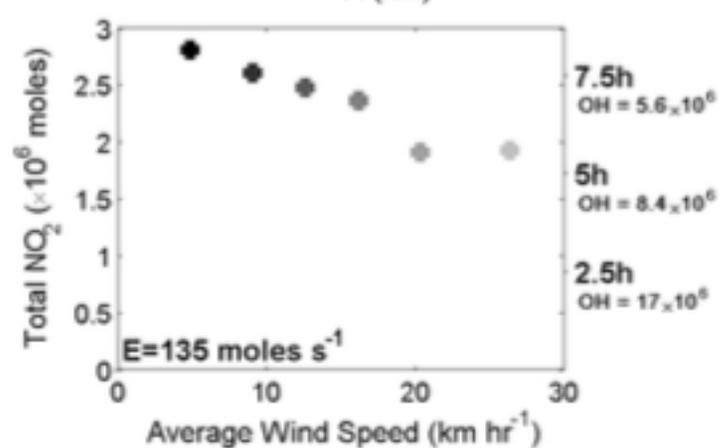
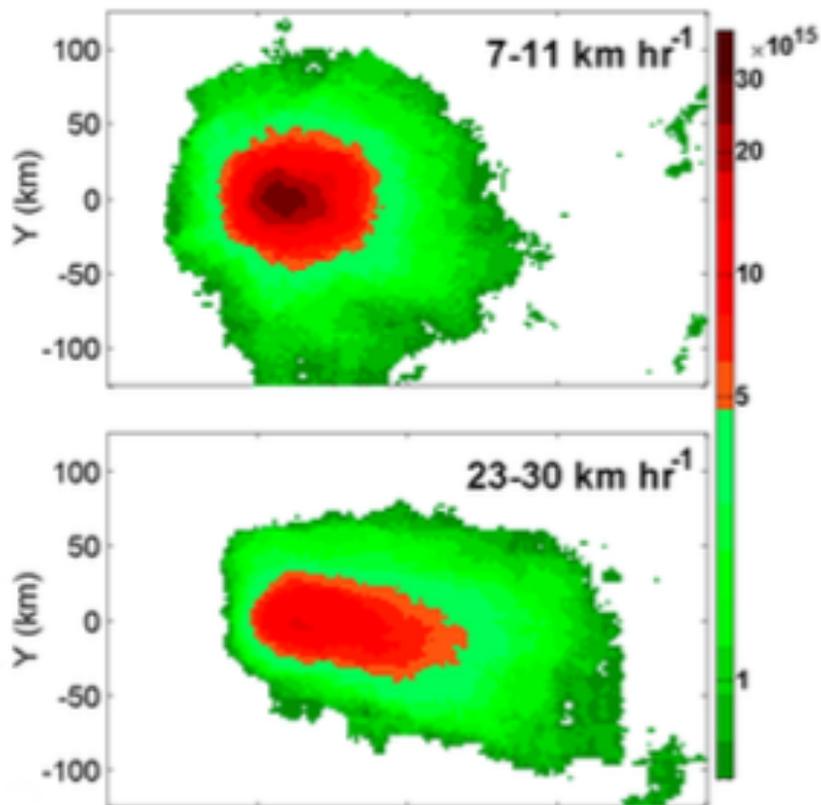
NO_x emissions and lifetime are each affected by the other



Meteorological variables also impact lifetime



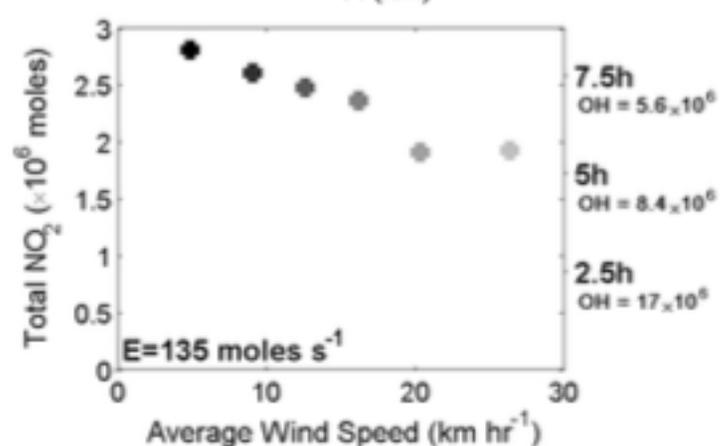
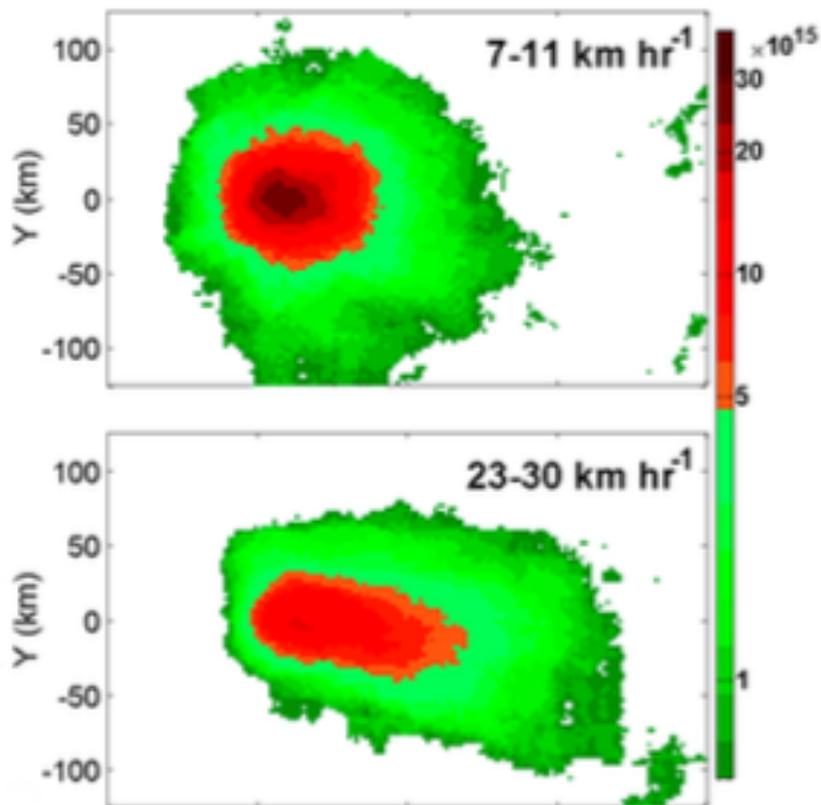
Meteorological variables also impact lifetime



Wind speed 

Lifetime 

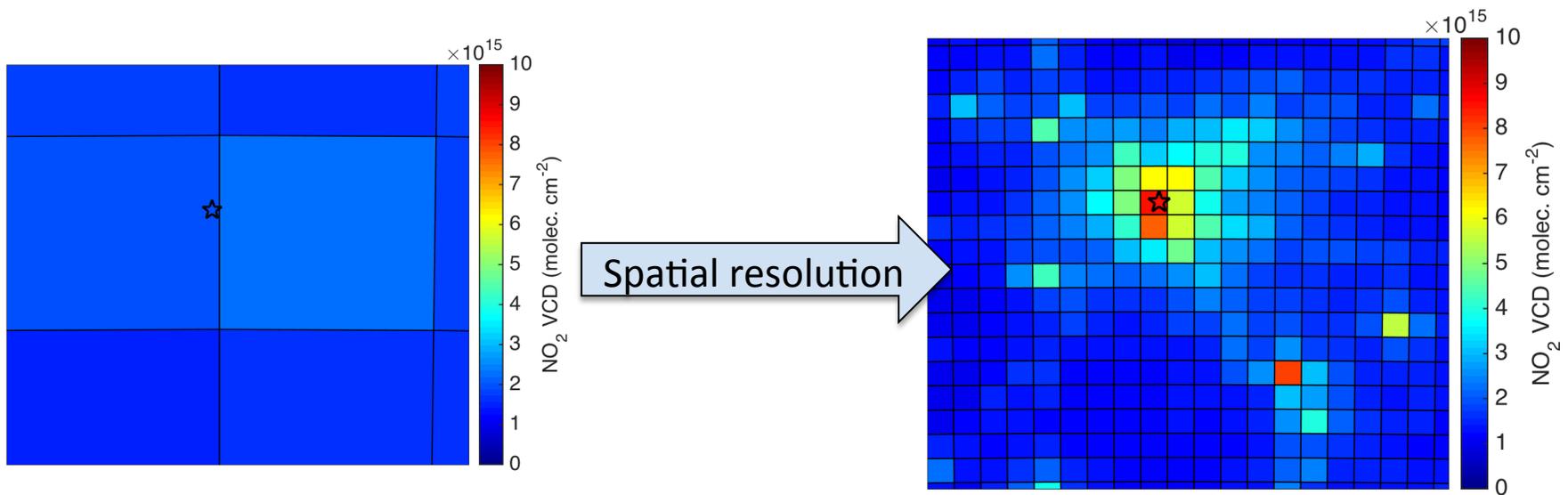
Meteorological variables also impact lifetime



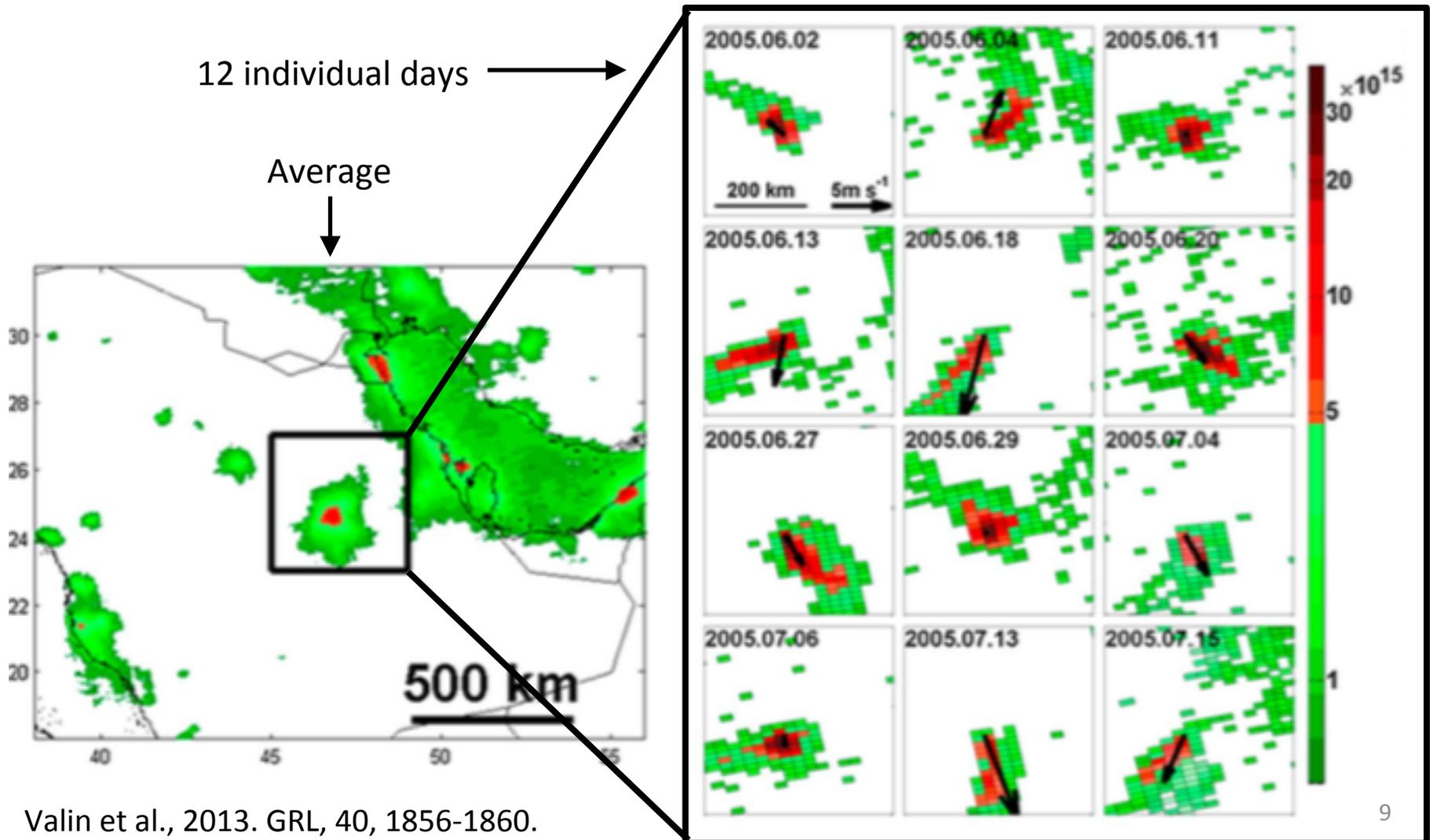
Wind speed 
Lifetime 

UV/Visible retrievals need to model NO_2 profiles to account for sensitivity.

To study urban NO_x emission and lifetime, we need to correctly model NO_2 plumes.



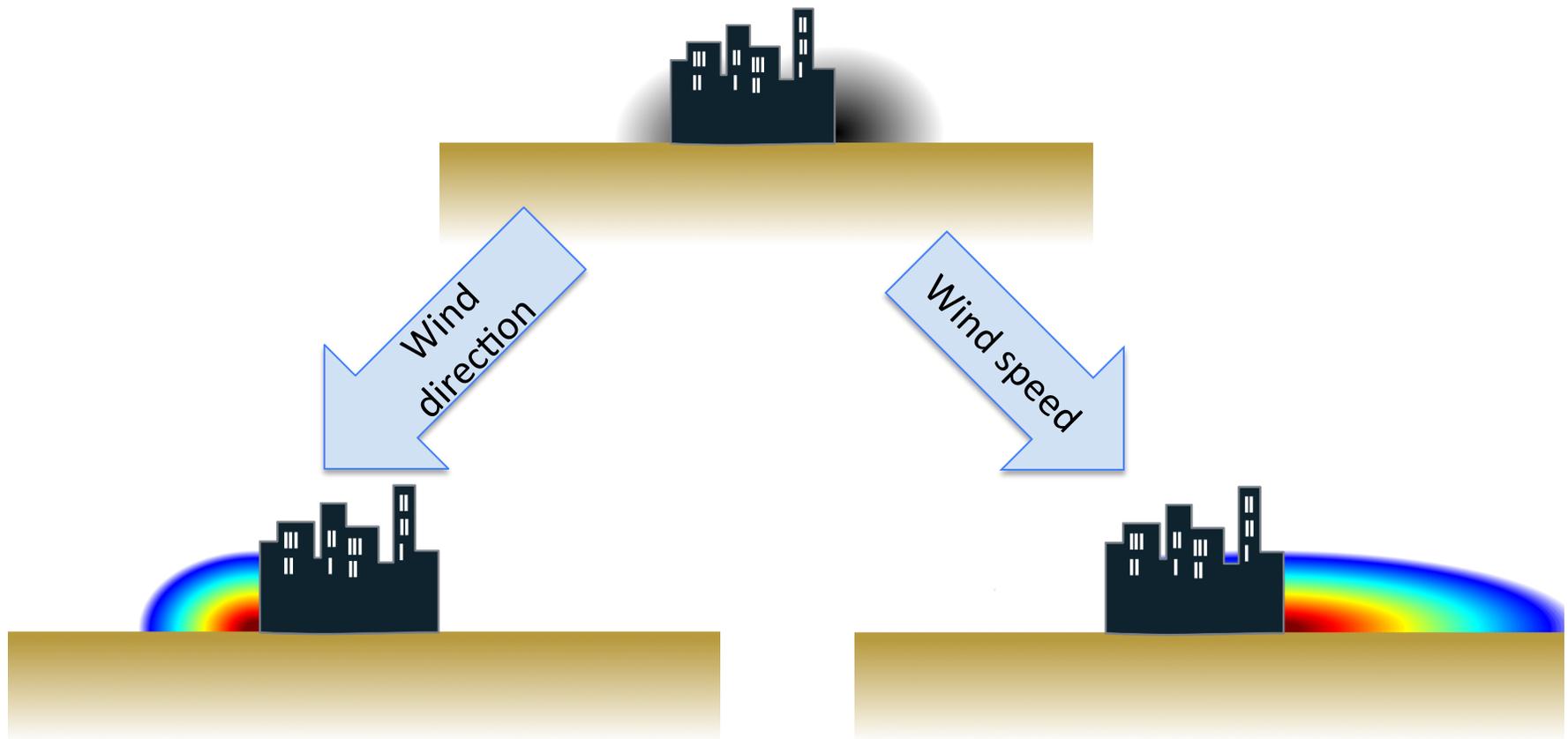
But a time averaged plume does not represent most days' plume well



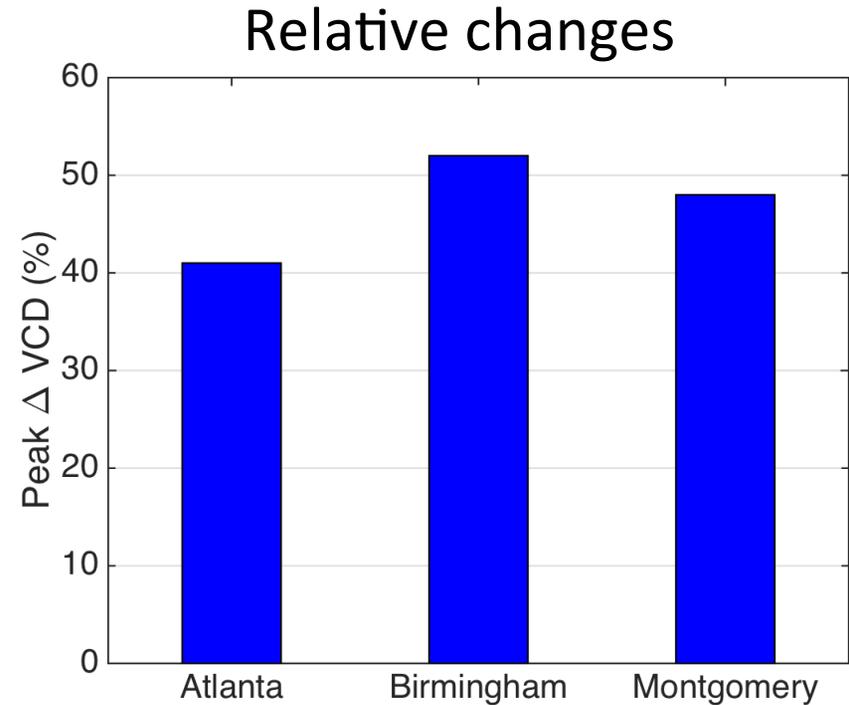
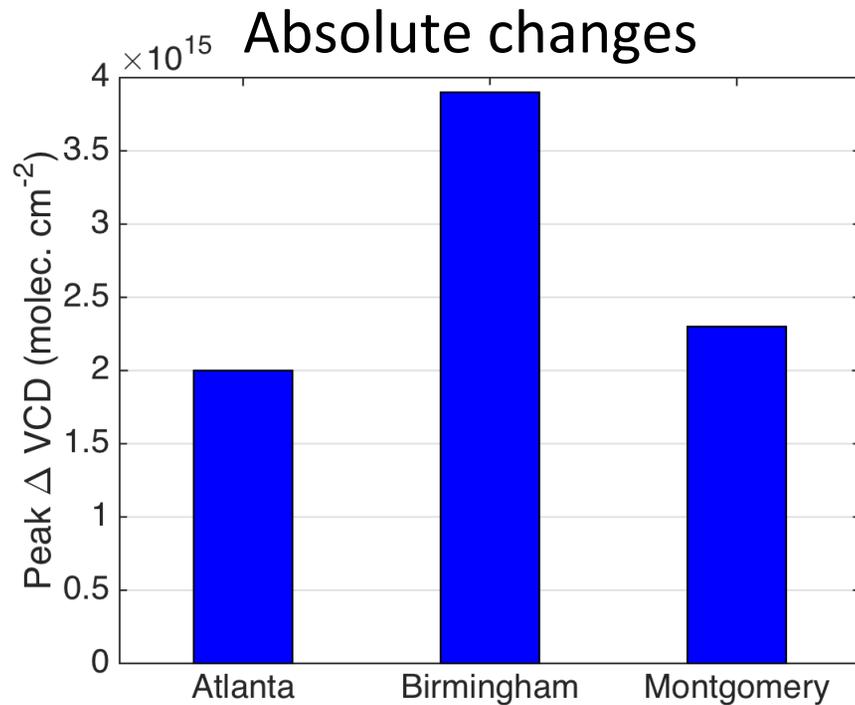
Valin et al., 2013. GRL, 40, 1856-1860.

Monthly profiles lead to bias in the AMF – every day is different

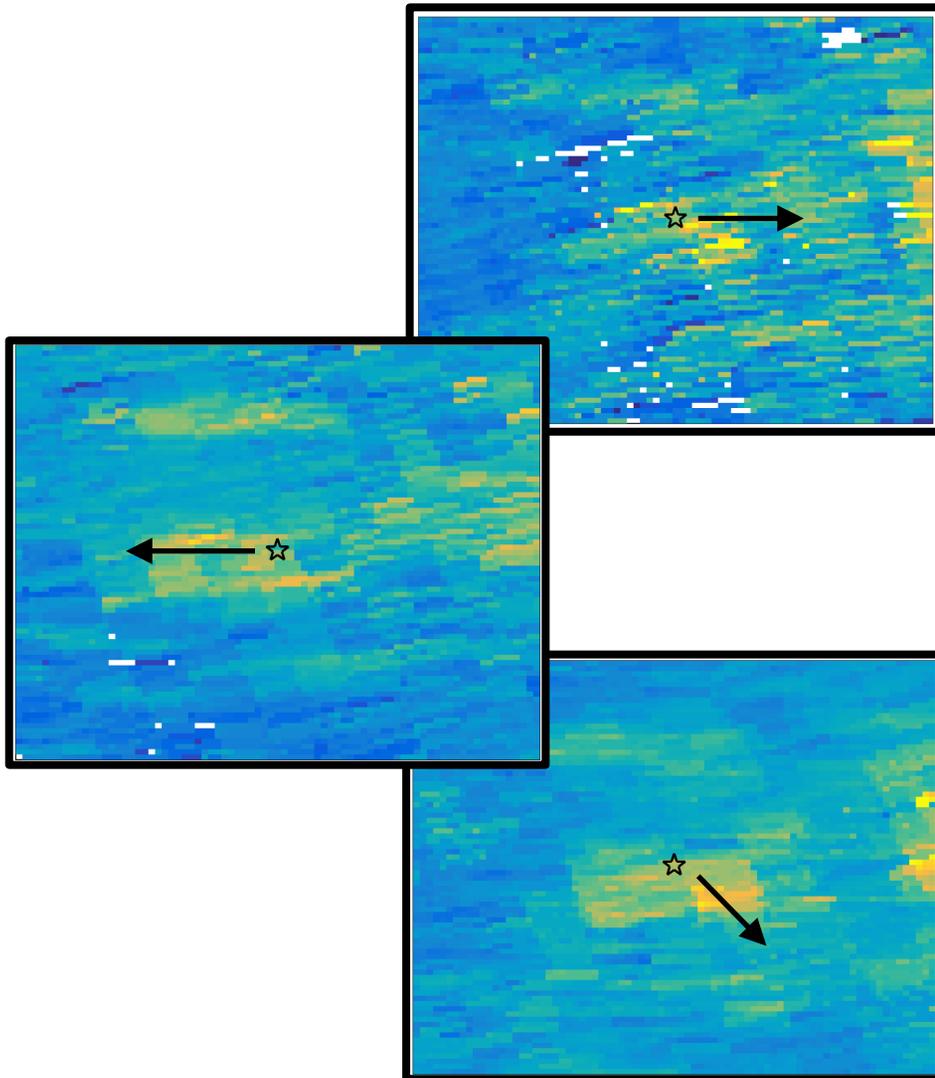
Monthly profiles



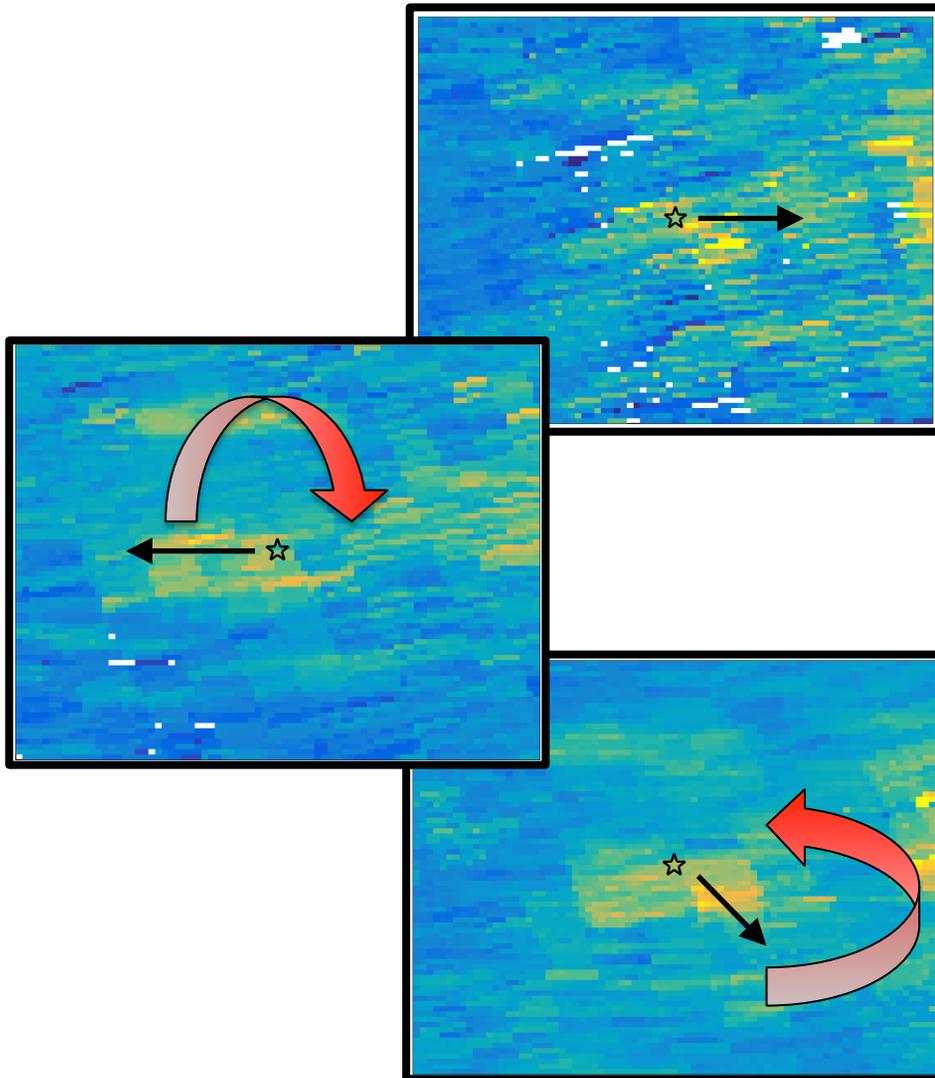
Exchanging monthly 12 km profiles for daily ones leads to significant changes in day-to-day VCDs



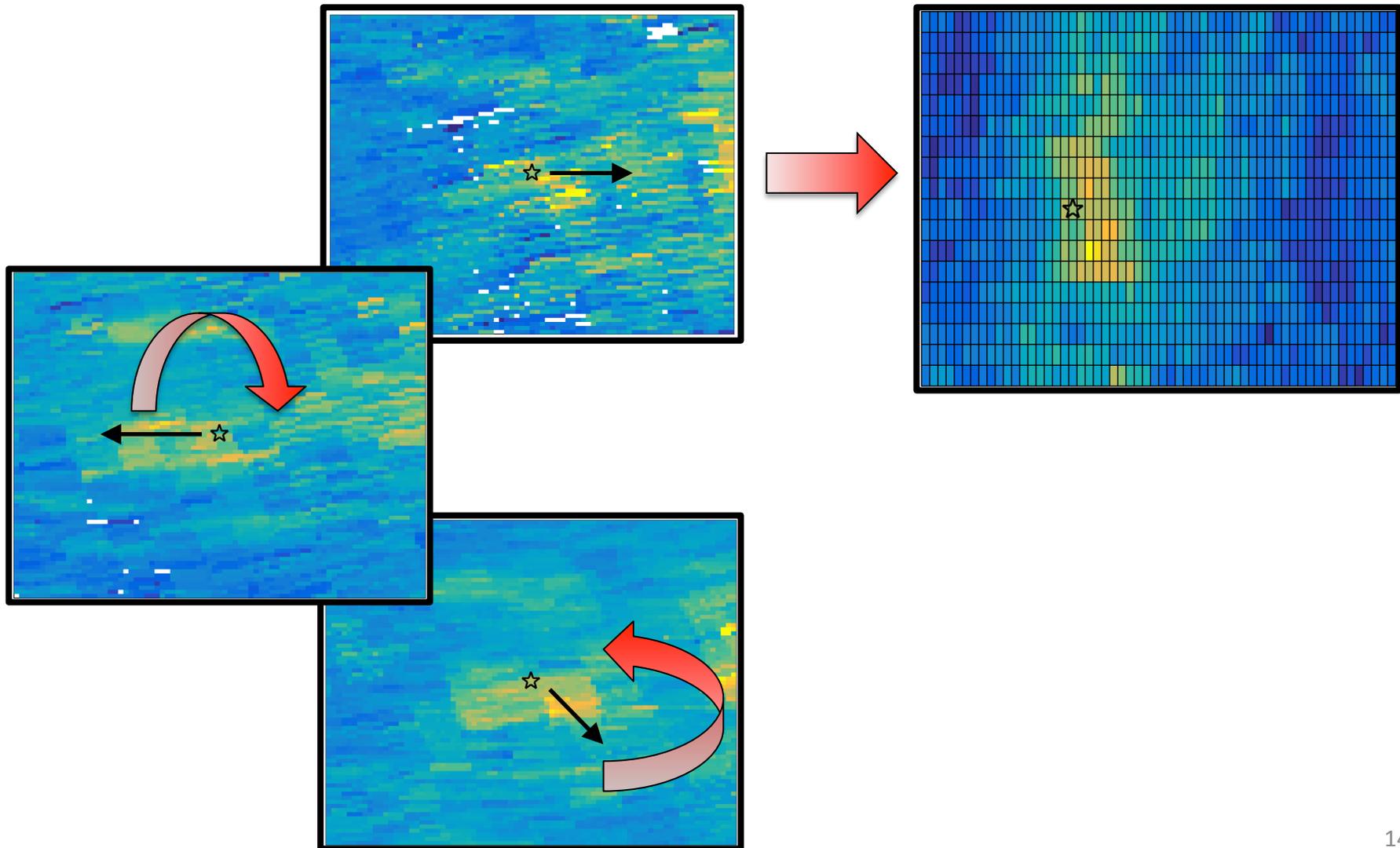
Using daily, 12 km *a priori* profiles improves our ability to constrain lifetime and emissions



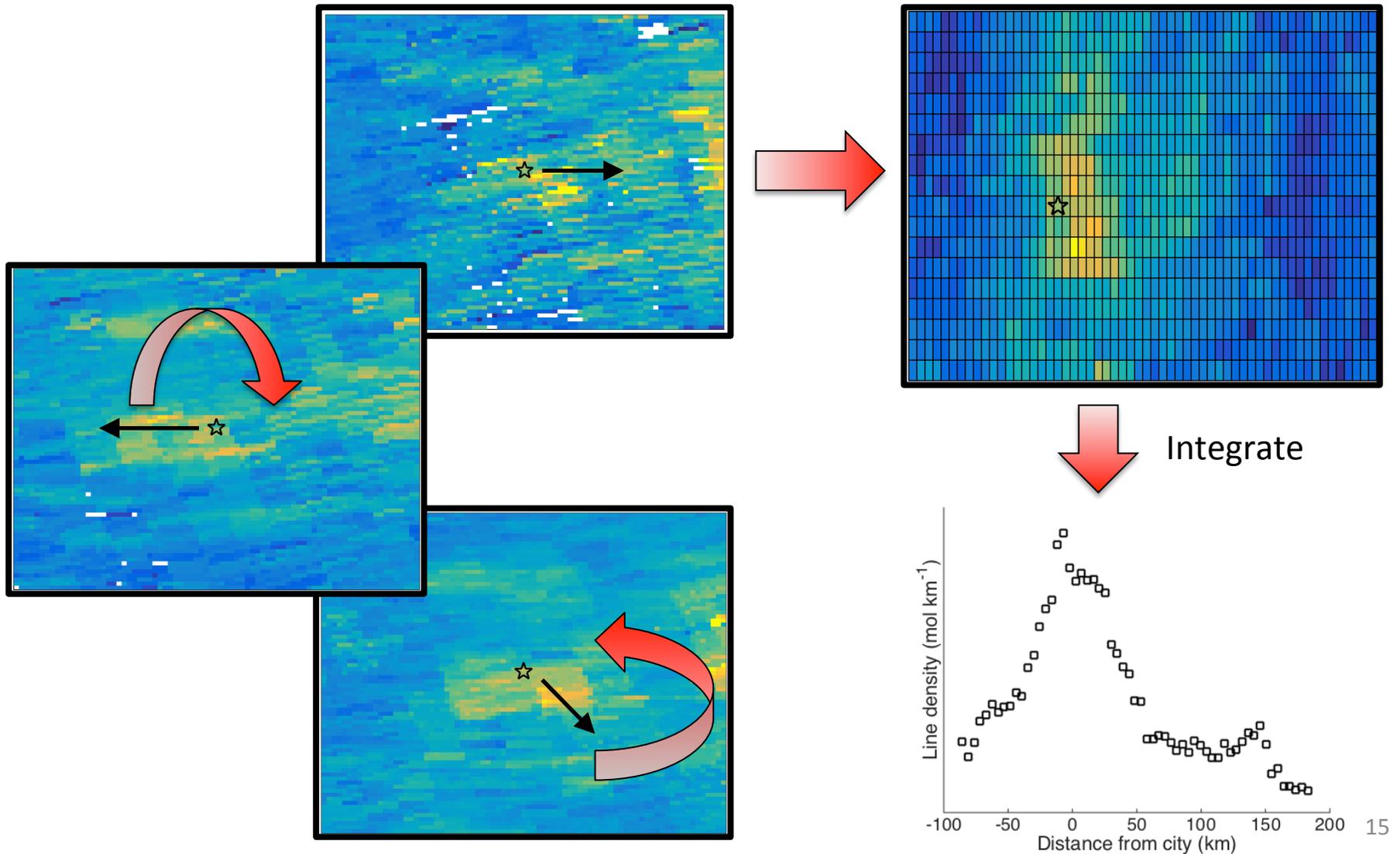
Using daily, 12 km *a priori* profiles improves our ability to constrain lifetime and emissions



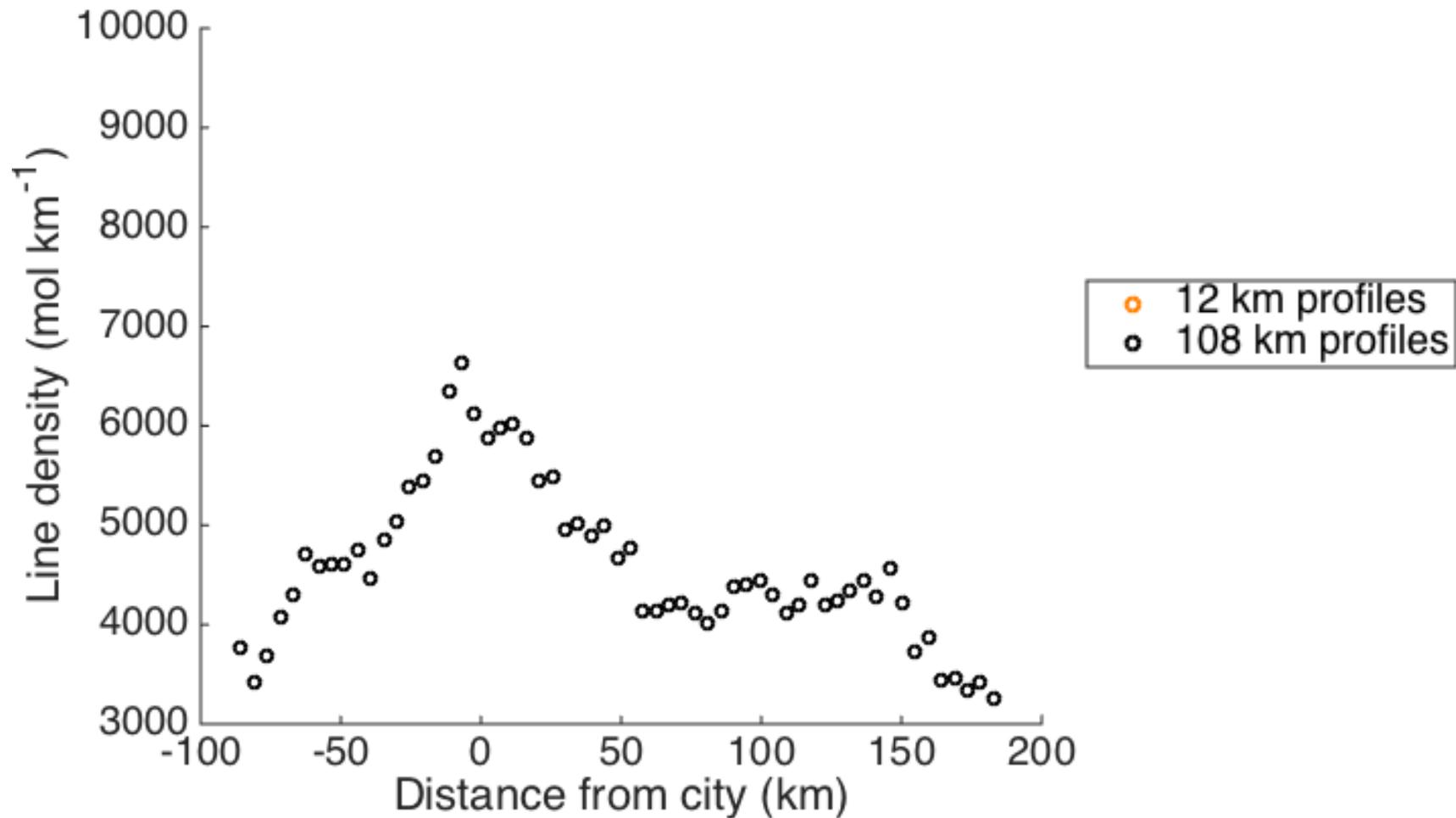
Using daily, 12 km *a priori* profiles improves our ability to constrain lifetime and emissions



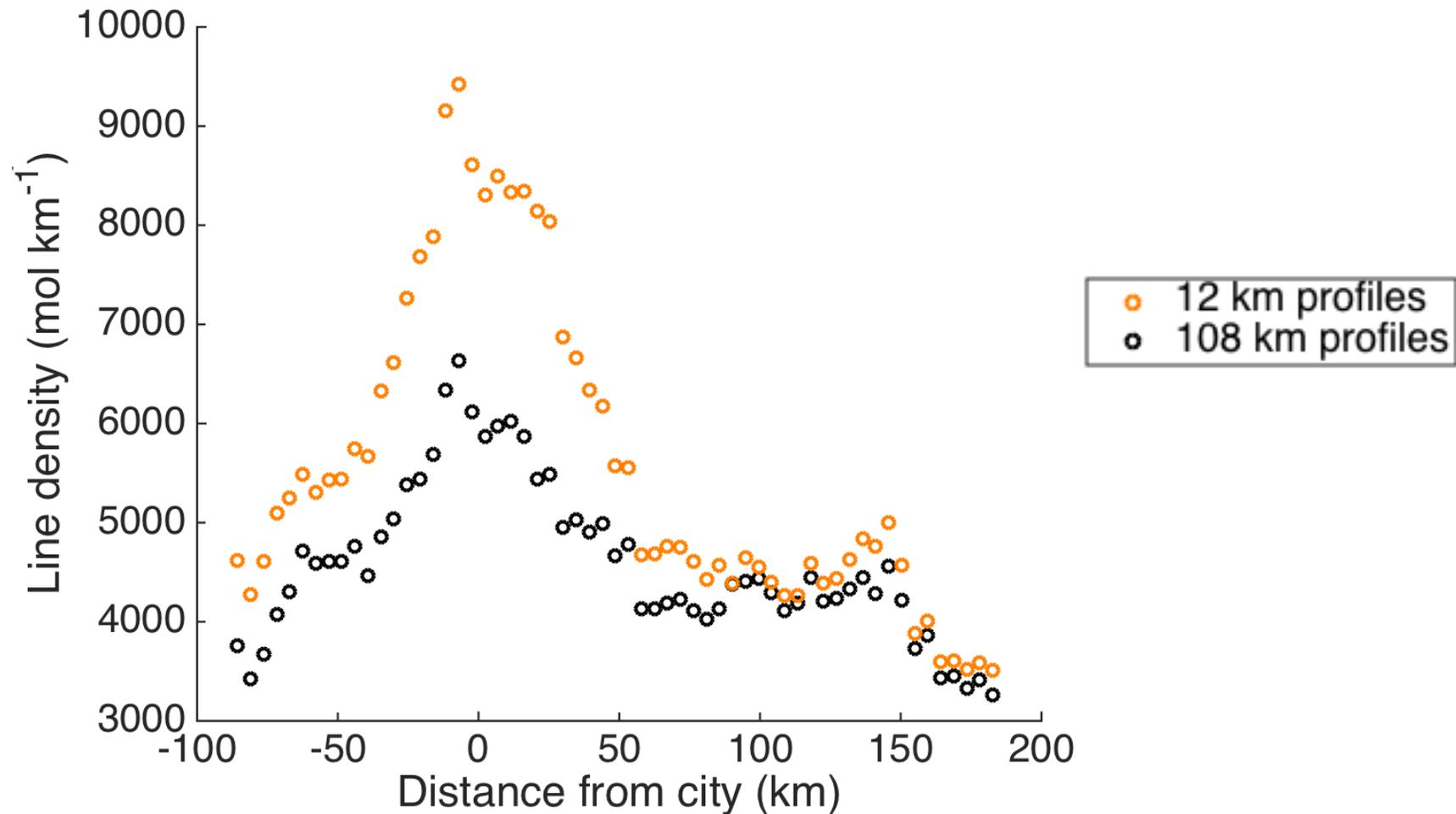
Using daily, 12 km *a priori* profiles improves our ability to constrain lifetime and emissions



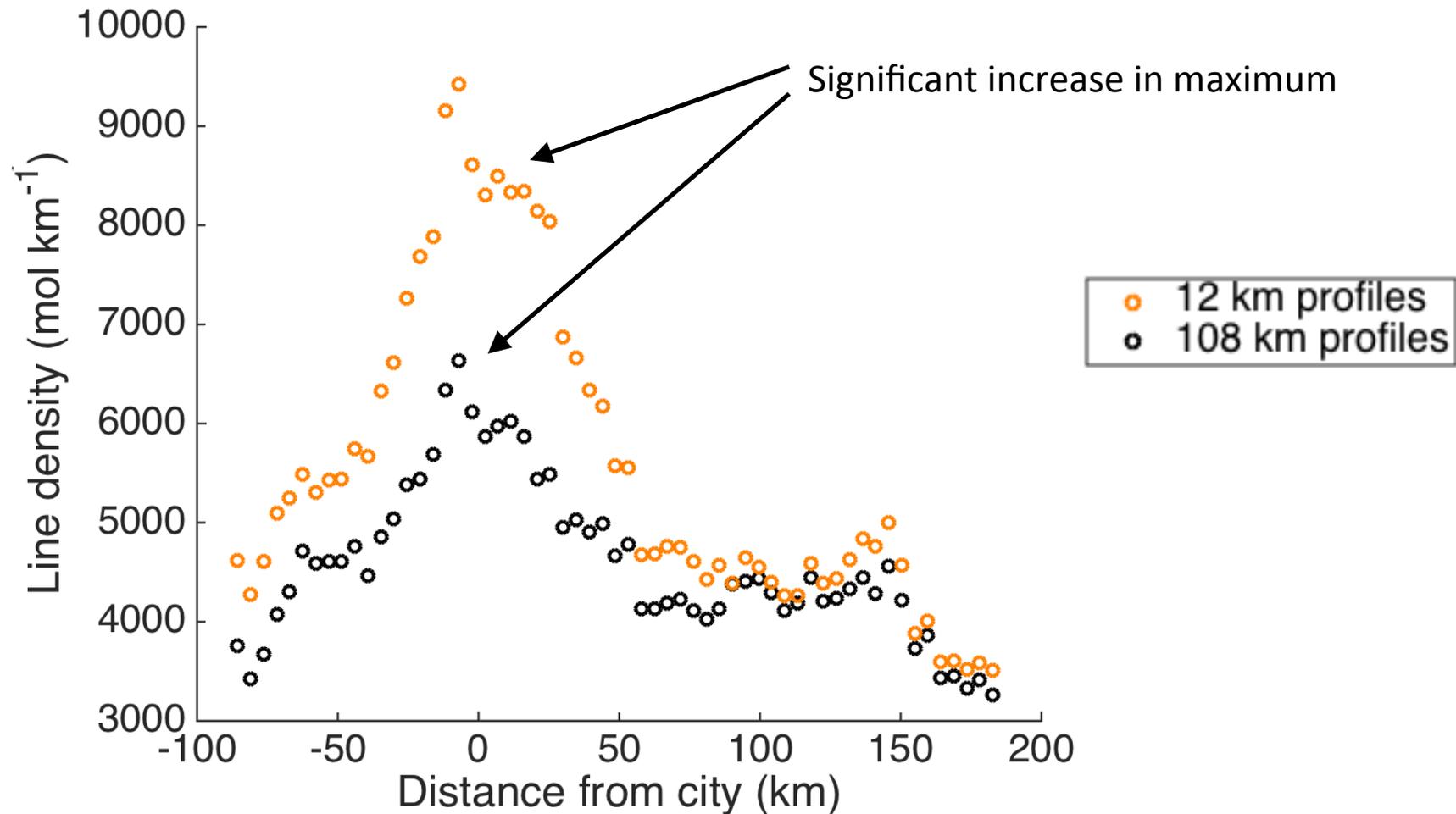
The spatial resolution of the *a priori* profiles significantly affects the line densities



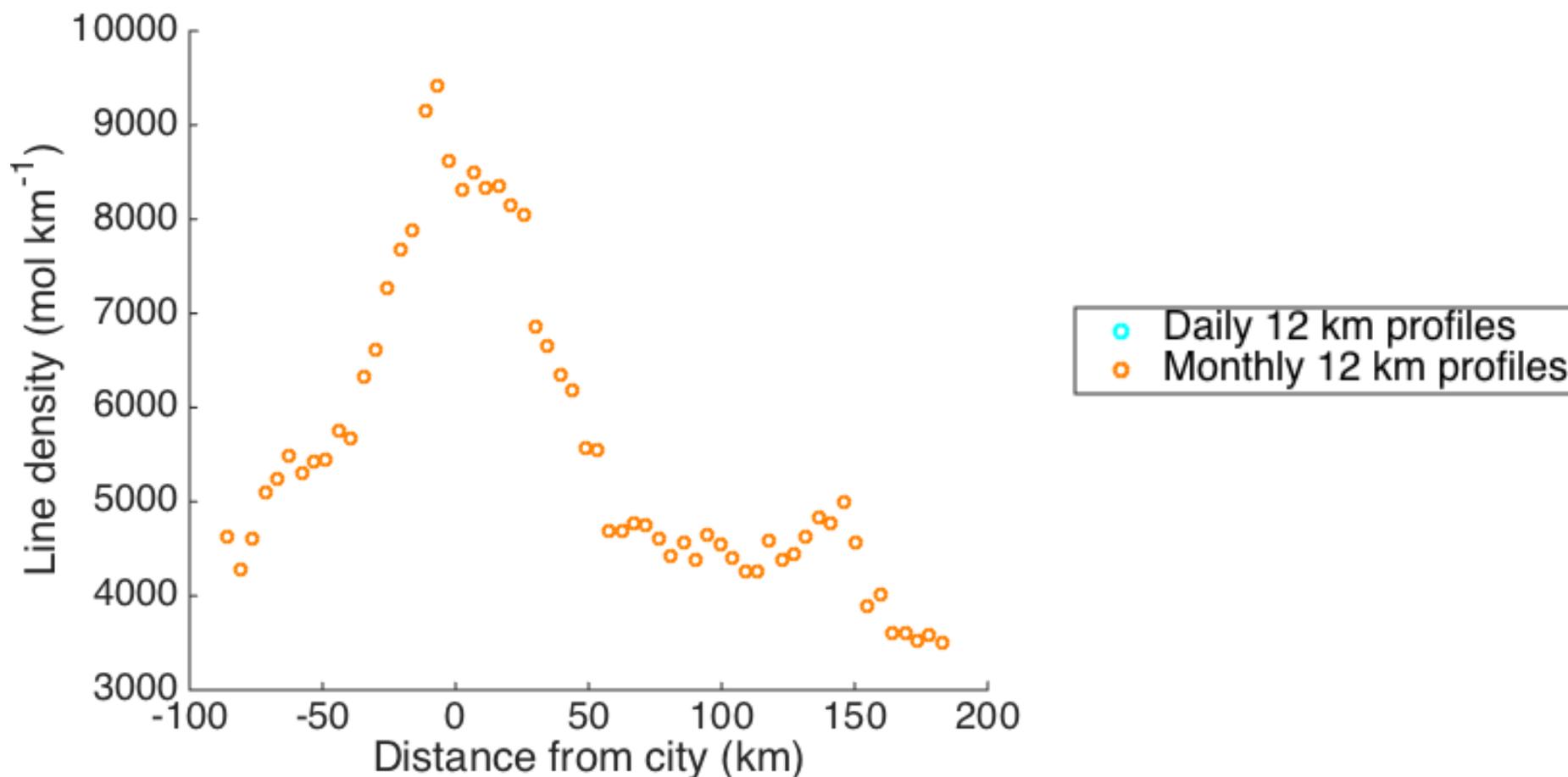
The spatial resolution of the *a priori* profiles significantly affects the line densities



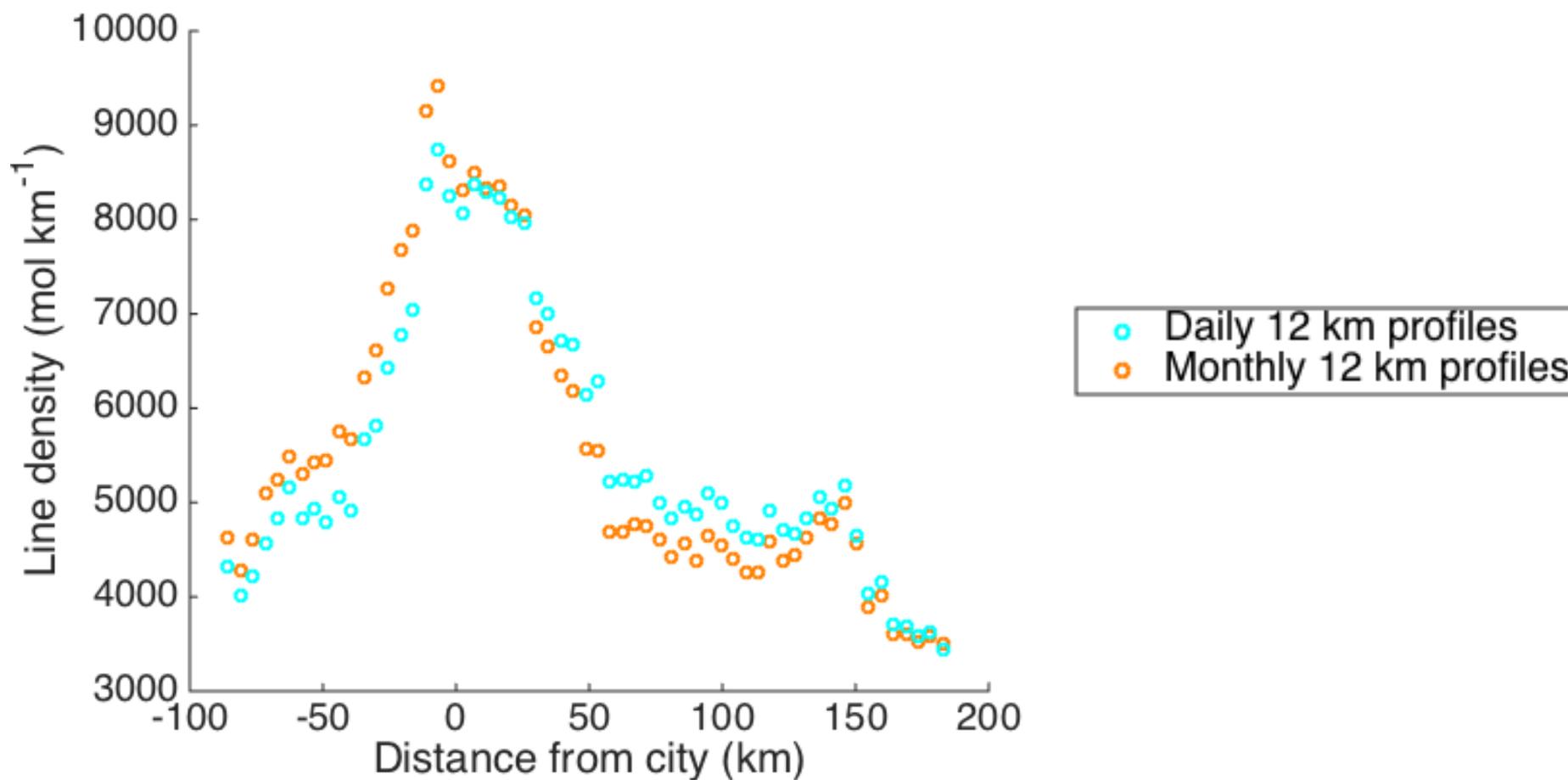
The spatial resolution of the *a priori* profiles significantly affects the line densities



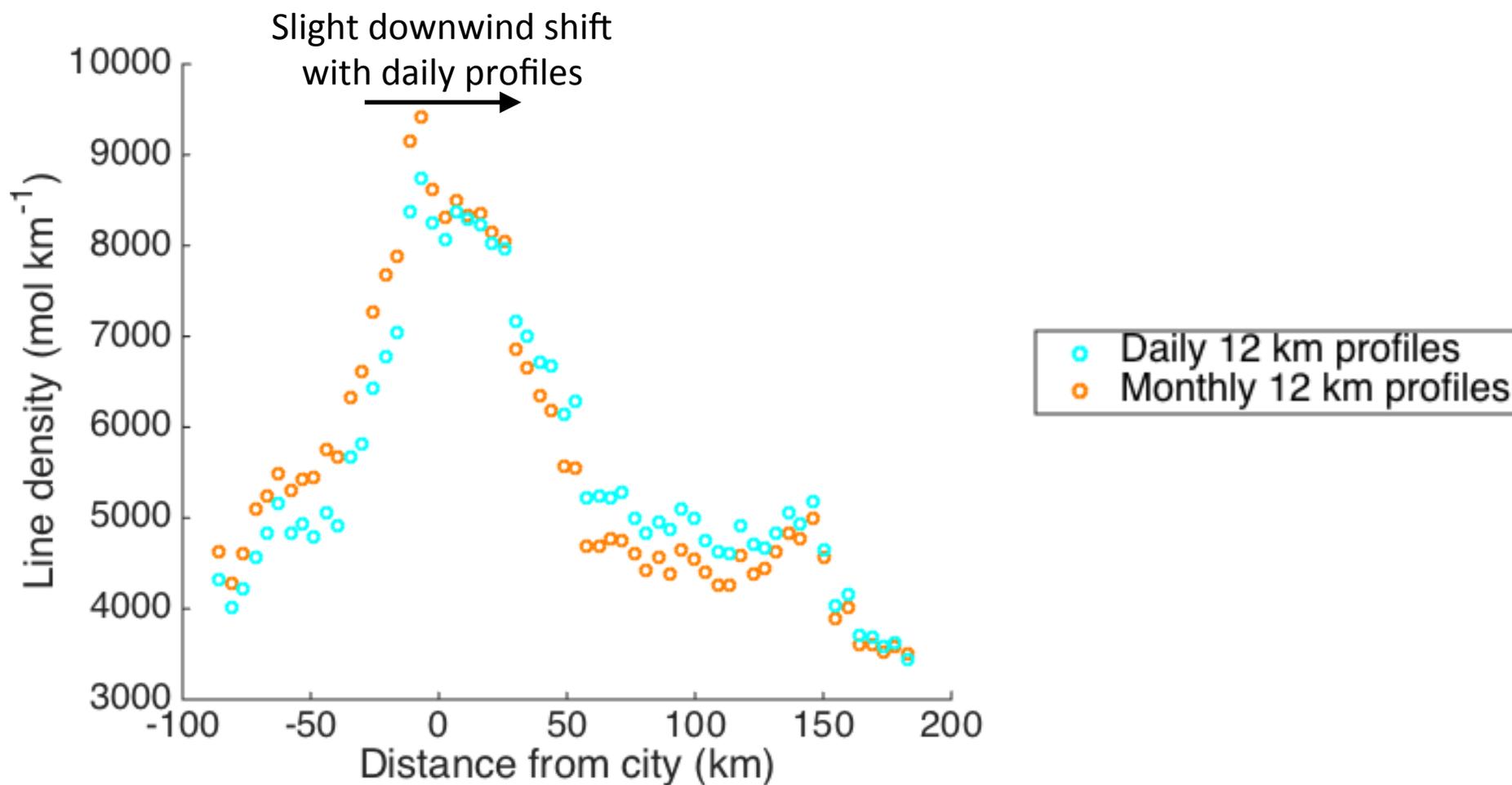
The effects of temporal resolution of the profiles is more subtle, but also systematic



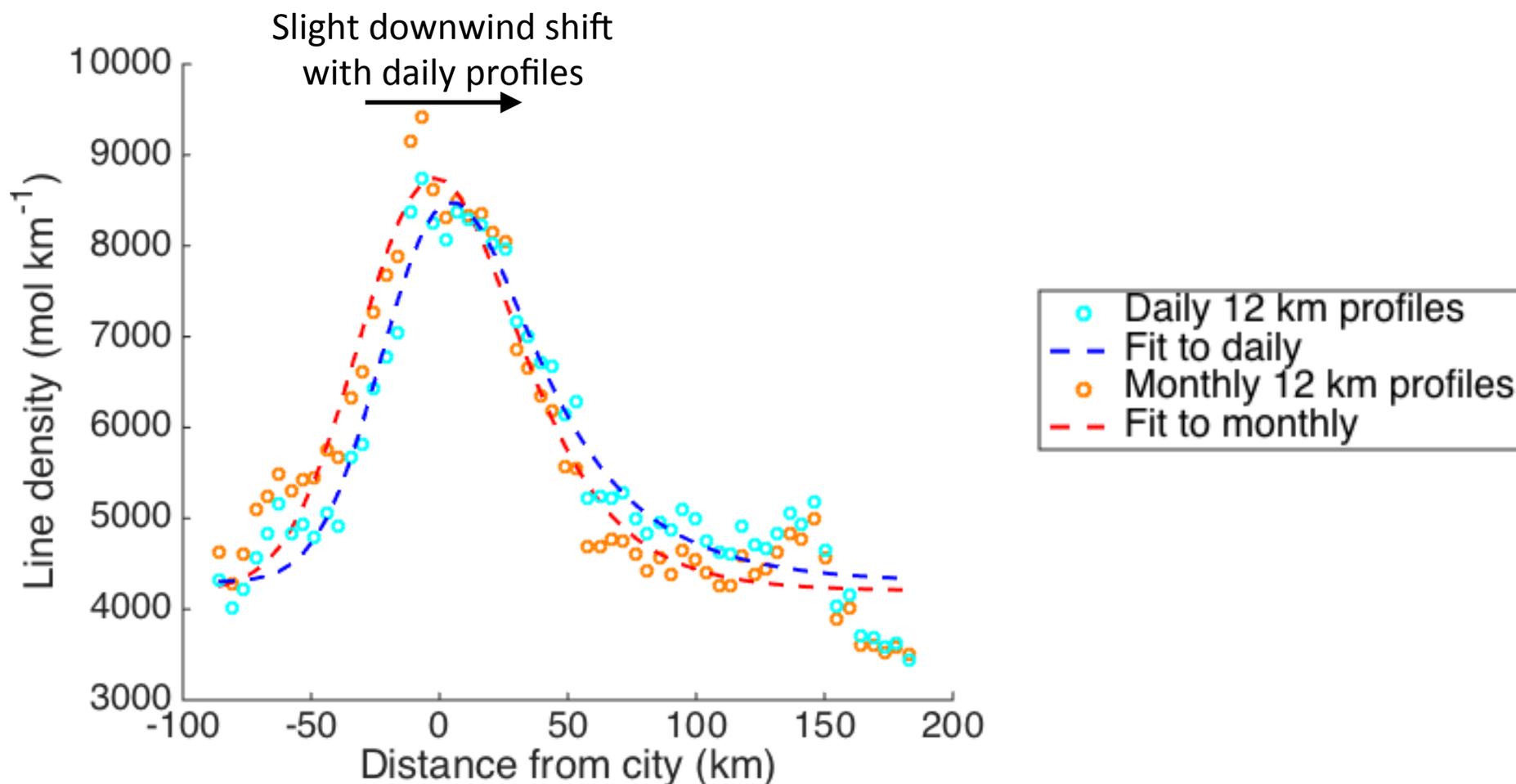
The effects of temporal resolution of the profiles is more subtle, but also systematic



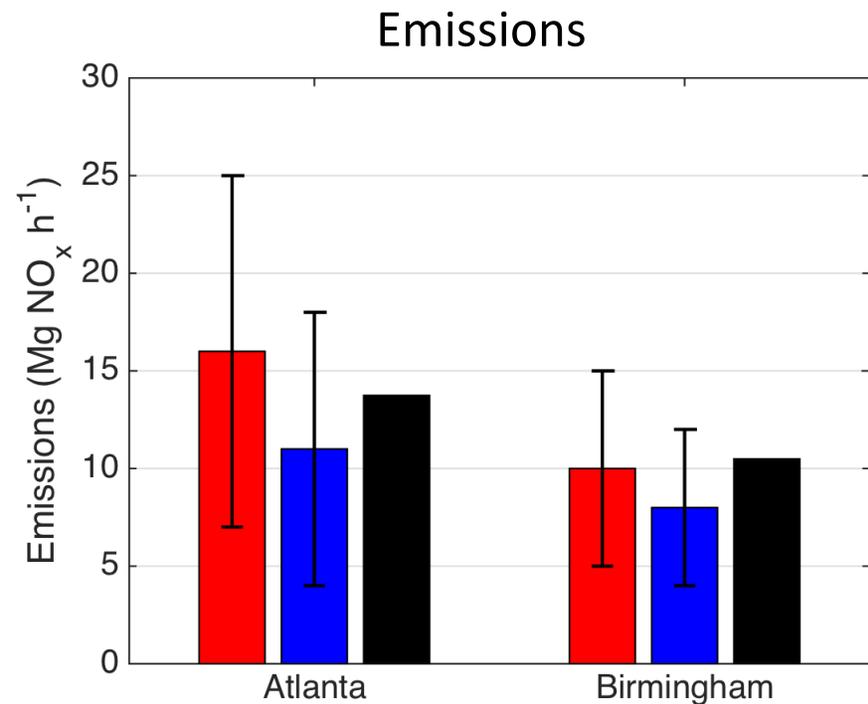
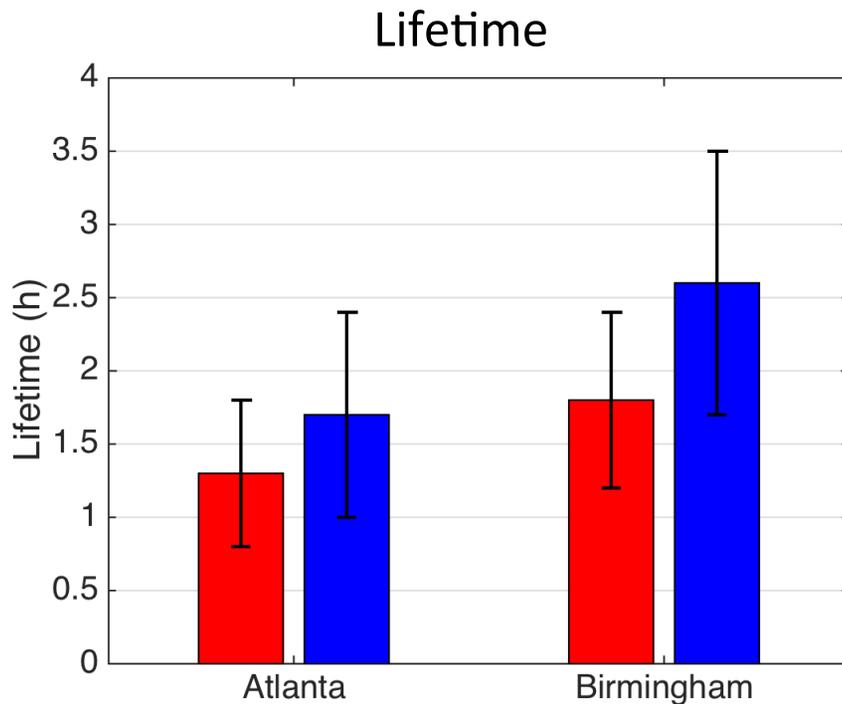
The effects of temporal resolution of the profiles is more subtle, but also systematic



The effects of temporal resolution of the profiles is more subtle, but also systematic



Values of emissions and lifetime derived from the EMG fits:

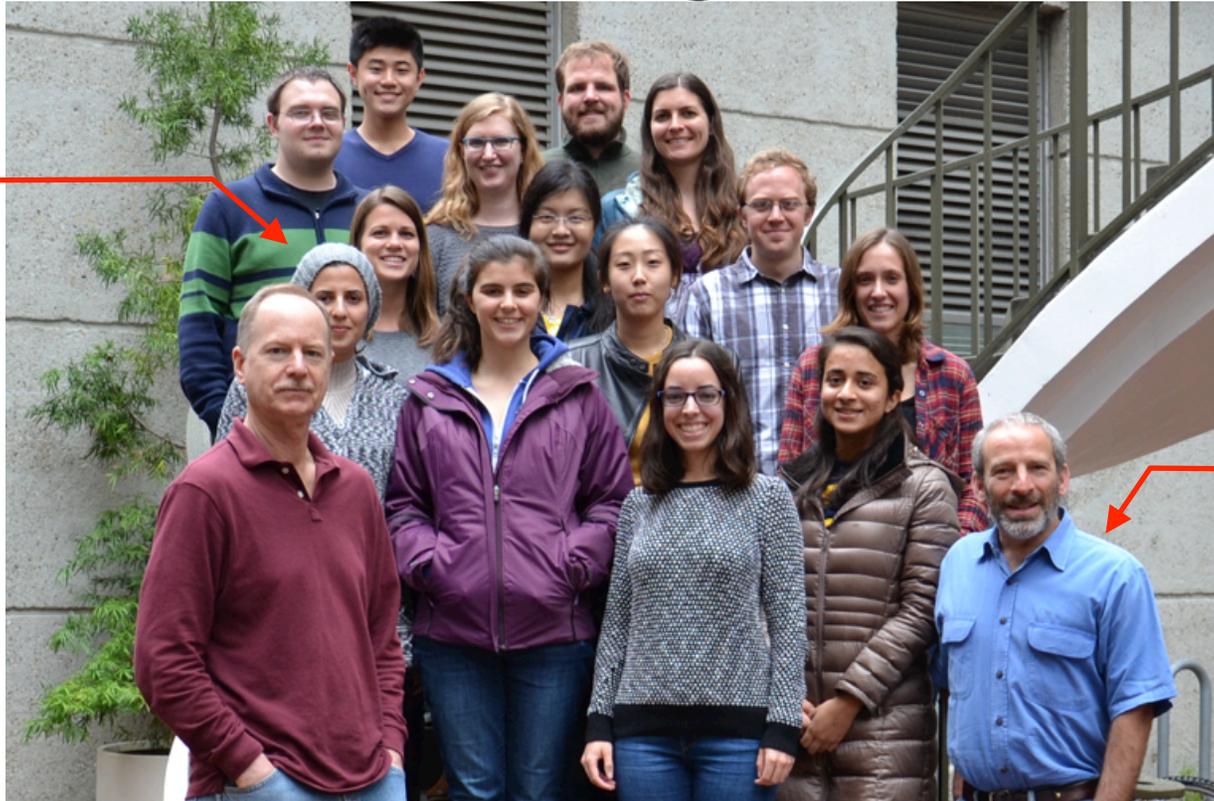


Summary

- We see that switching from monthly to daily *a priori* profiles at 12 km leads to significant changes in derived emissions and lifetime
- We plan to expand this retrieval to the continental US for 2012-2014 to study NO_x lifetime under varying conditions
- We also plan to study the agreement between top-down and bottom up emissions using this retrieval.

Acknowledgements

Azimeh



Ron

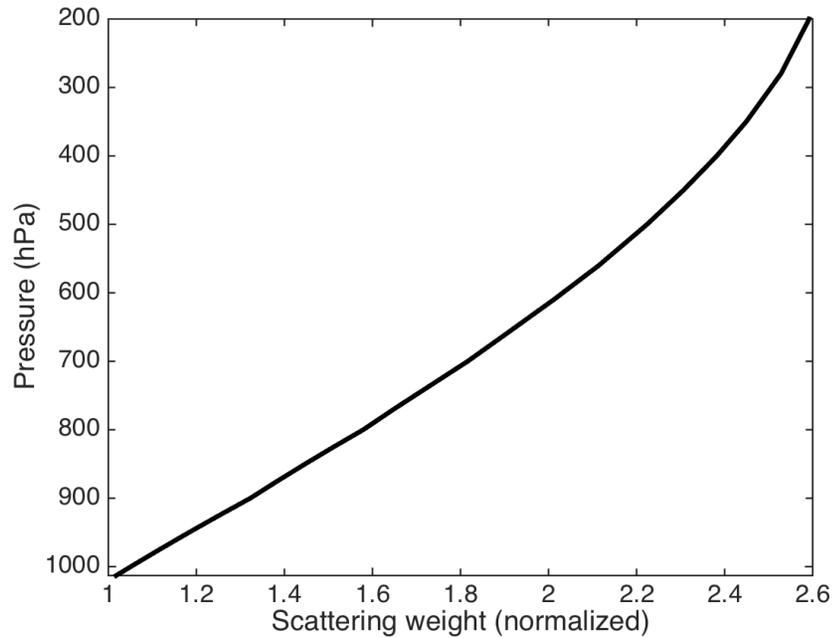
Funding grants:

- NASA ESS Fellowship: NNX14AK89H
- NASA Grants: NNX15AE37G and NNX14AH04G
- TEMPO Project Grant: SV3-89019

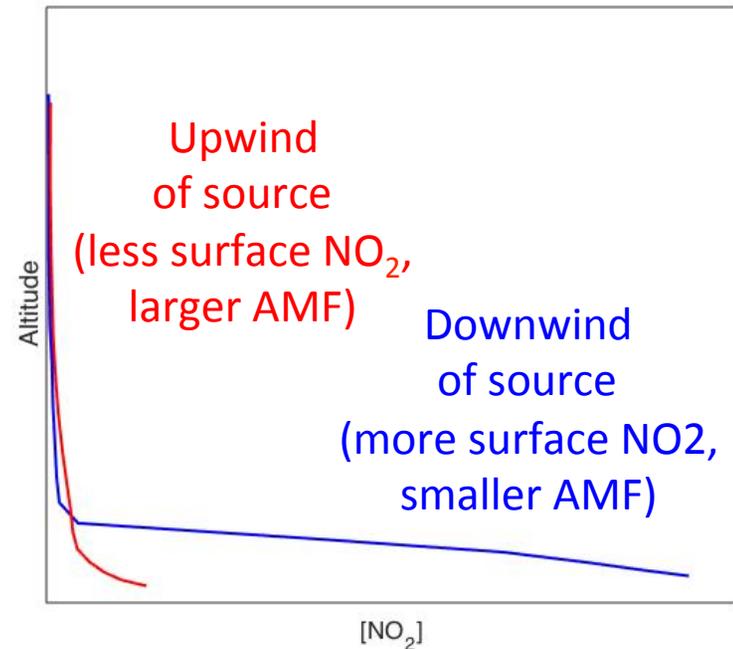
ADDITIONAL SLIDES

AMFs convert slant to vertical columns.
They depend on scattering weights and *a priori* NO₂ profiles.

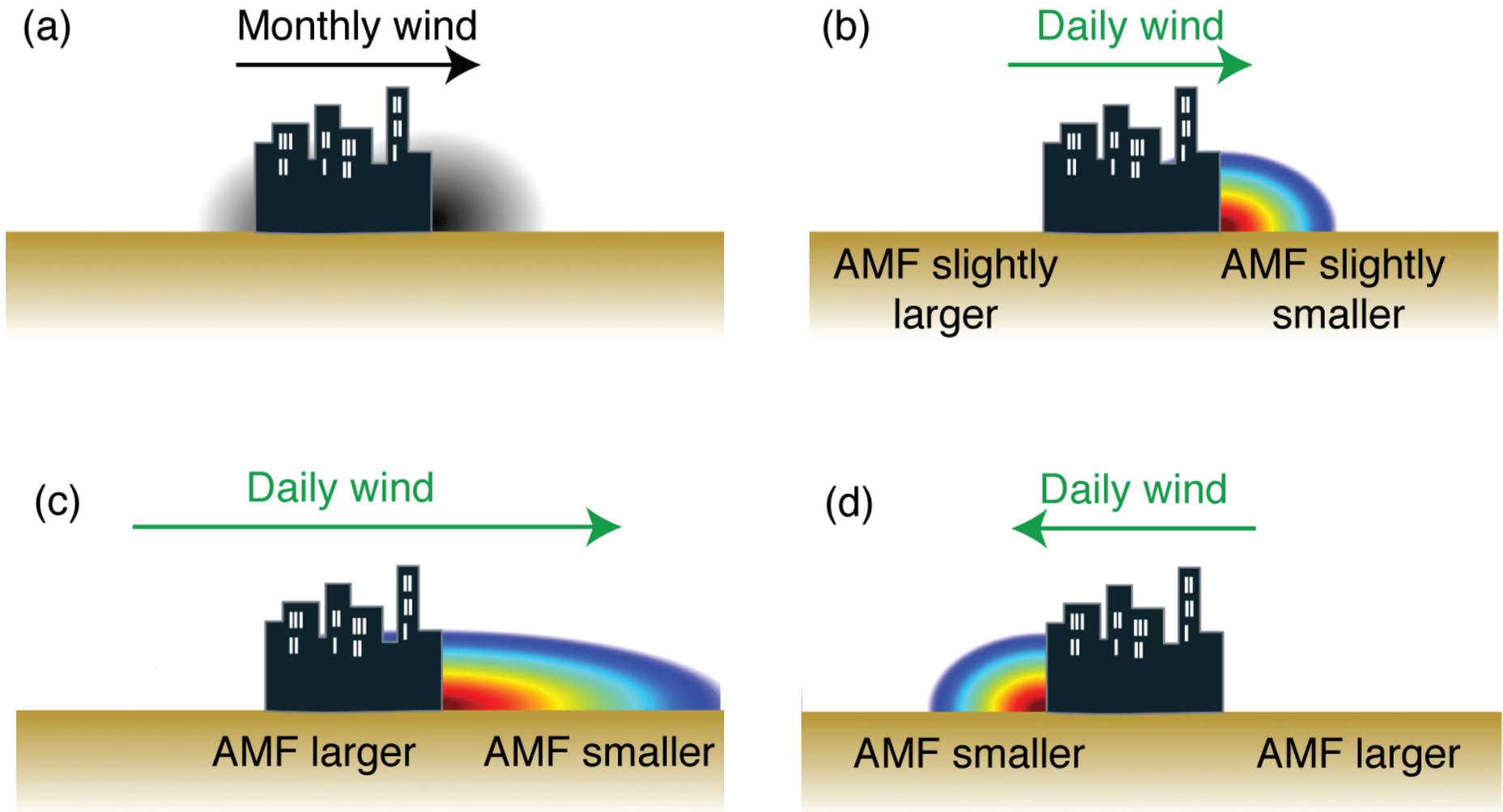
Scattering weights –
how sensitive is OMI to NO₂ at altitude z?



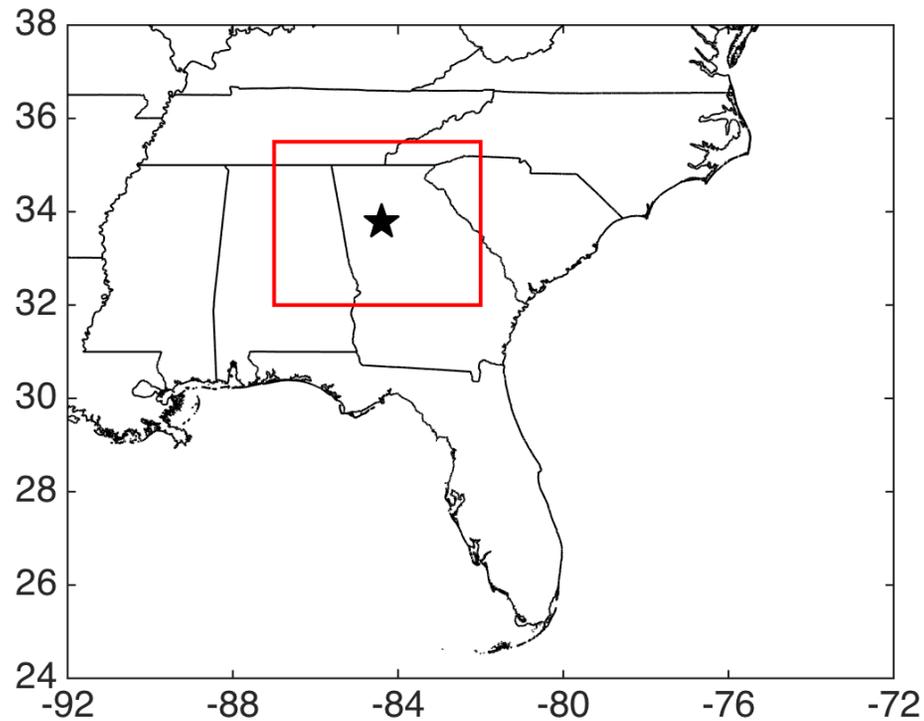
a priori NO₂ profiles –
best guess of vertical position of NO₂



The use of daily *a priori* profiles at fine spatial resolution is needed to capture changes in source plumes

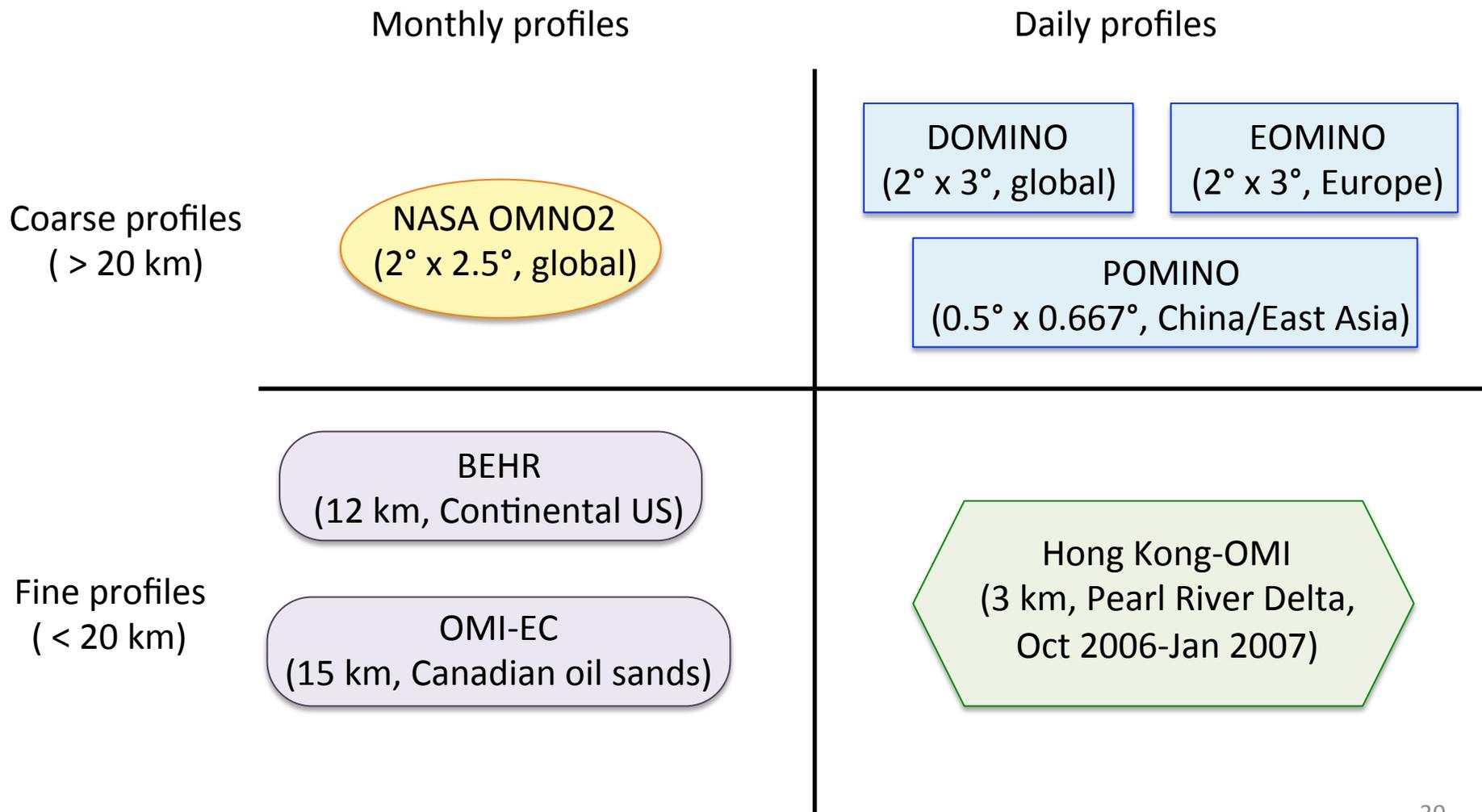


Our study focuses on Atlanta, GA, USA:



- Monthly and daily 12 km profiles simulated using WRF-Chem
- Both implemented in the Berkeley High Resolution (BEHR) NO₂ retrieval
- Limited test domain, June-Aug 2013

Most existing products use *a priori* profiles that are coarse in space or time



First we evaluate the effect of daily profile at fine spatial resolution using 2 retrievals:

Pseudo retrieval:

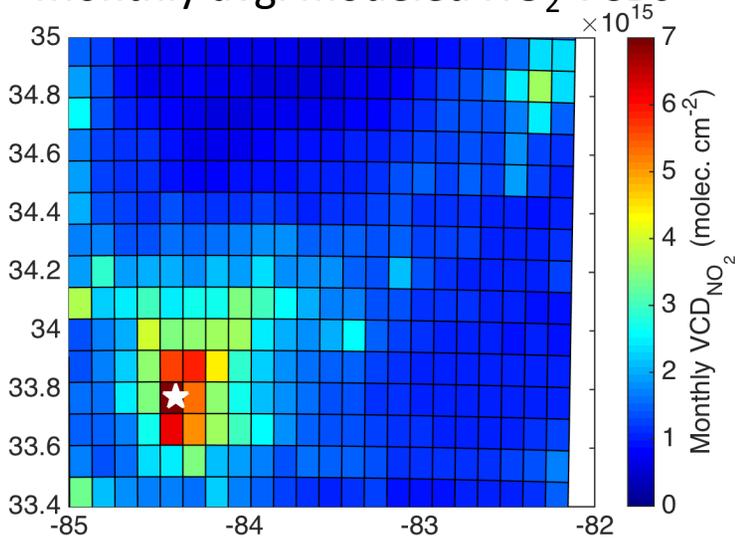
- One set of OMI pixels used over multiple days
- All ancillary parameters (SZA, VZA, RAA, albedo, surf. pressure) are constant for each pixel.
- Pixels close to nadir; gives best resolution
- Pixel footprints are in the same location day-to-day
- Cloud fractions set to 0

Full retrieval:

- Standard BEHR retrieval with daily profiles implemented
- Pixels with cloud fraction >20% or influenced by row anomaly are rejected

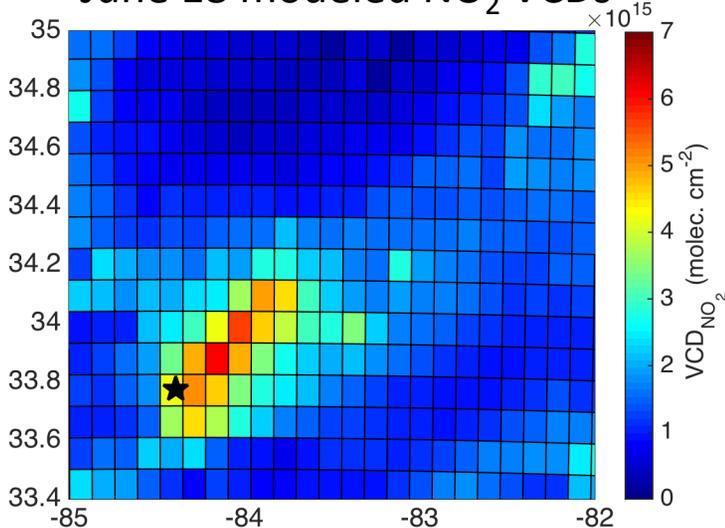
With all other parameters fixed, including daily *a priori* profile leads to significant changes in AMFs

Monthly avg. modeled NO₂ VCDs

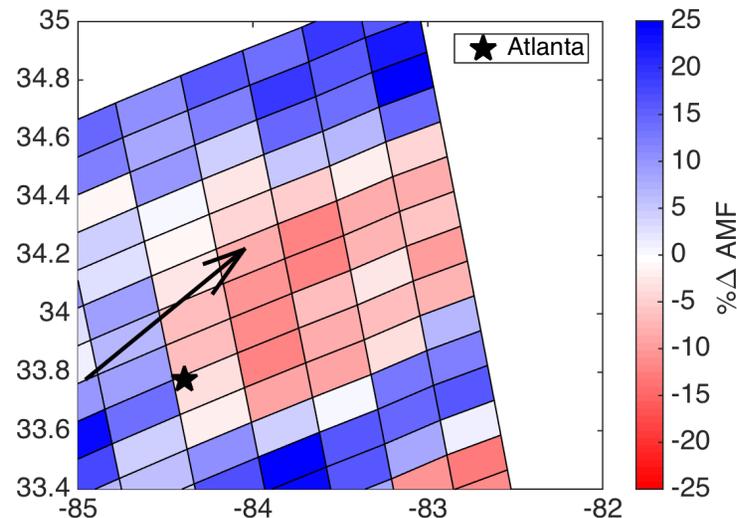


- June 18, 2013
- Wind in same direction as average, but faster (6.8 m s⁻¹ vs 3.9 m s⁻¹)

June 18 modeled NO₂ VCDs

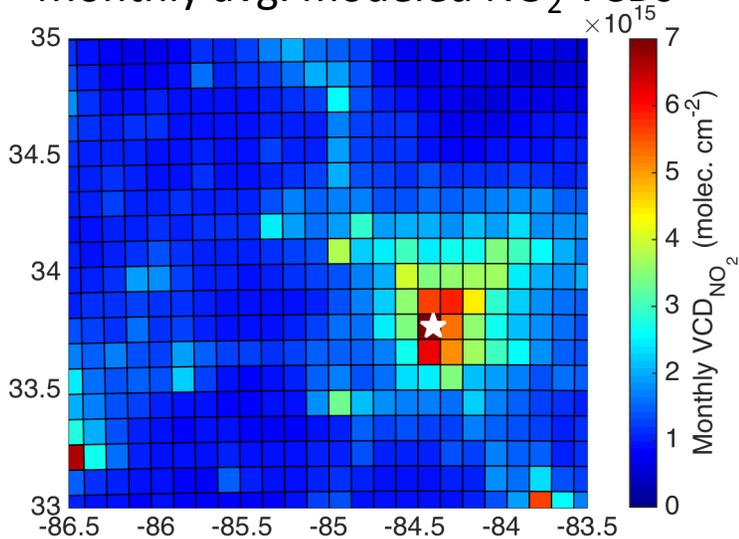


% change in AMFs (daily – monthly *a priori*)



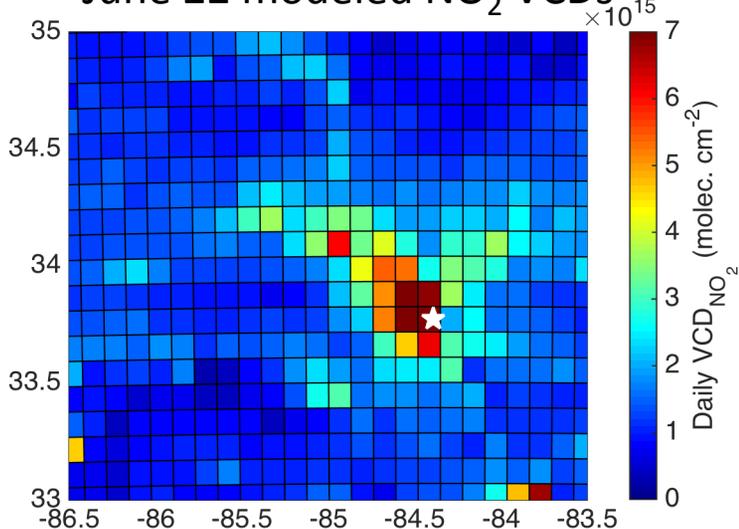
With all other parameters fixed, including daily *a priori* profile leads to significant changes in AMFs

Monthly avg. modeled NO₂ VCDs

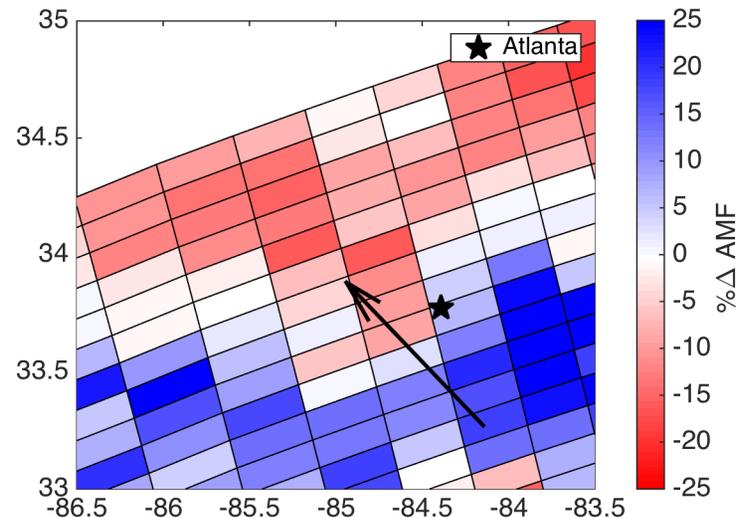


- June 22, 2013
- Wind has changed direction compared to average
- Changes in wind speed can have an impact as well

June 22 modeled NO₂ VCDs



% change in AMFs (daily – monthly *a priori*)



Average change in VCDs

